

CANADA'S OWN ELECTRONICS MAGAZINE

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electronics today

OCTOBER 1978



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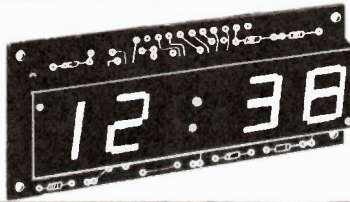
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MA1002 CLOCK MODULE

MA1002A: 12 Hour Display assembled and tested module only \$14.95
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 LED display digital electronic clock module
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MA1003 12V CAR CLOCK



Here is an assembled and tested clock ready to run on 12 volts DC. Designed for the new car manufacturers to replace those troublesome mechanical clocks, this module will be useful wherever a crystal controlled clock is desired. Its own crystal time base assures accuracy of 2 seconds per day at 25 degrees C., and 5 seconds per day over the range of minus 25 degrees to plus 65 degrees C. Draws less than 5 MA, with display off yet maintains accurate time.

\$24.95 WITH 3 P.B. SWITCHES Case available

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BOARD ONLY

THIS COUNTER HAS BEEN DESIGNED WITH THE HOME BUILDER IN MIND. ALL PARTS ARE AVAILABLE IN MANY PLACES. THE CIRCUIT IS TRIED AND TRUE, THE SINGLE SIDED BOARD IS EASY TO WORK ON AND ANY MISTAKES ARE EASY TO CORRECT. THE COUNTER IS USEABLE TO 500 MHZ. SENSITIVITY AT THAT FREQUENCY IS TYPICALLY 100 MV. WE ESTIMATE THAT IF CARE IS TAKEN THE COUNTER CAN BE BUILT FOR ABOUT \$75.00, LESS IF NO CASE IS USED AND A LARGE JUNKBOX IS AVAILABLE. BOARD ONLY \$14.95

LOGIC PROBE KIT

THIS LOGIC PROBE FEATURES A 7 SEGMENT READOUT THAT SHOWS 4 LOGIC LEVELS AS FOLLOWS. An 'H' FOR HIGH IS SHOWN FOR VOLTAGES ABOVE 2.5VDC. An 'L' FOR LOW IS SHOWN FOR VOLTAGES BELOW 0.6VDC. An '0' FOR OPEN IS SHOWN FOR VOLTAGES BETWEEN 0.6 AND 2.4 AND A 'P' SHOWN FOR A PULSE FOLLOWING THE FALLING EDGE OF A PULSE OR WAVEFORM. THE PROBE IS QUITE COMPACT AND SHOULD BE VERY USEFUL AS A TROUBLESHOOTING TOOL. COMPLETE KIT \$14.95

8K STATIC RAM BOARD FULLY BUFFERED, 5100 BUS SOCKETS, 4 5V REGS ON BOARD, USES 21L02 RAM'S 450 ns, \$149.50 KIT. ADD \$30.00 FOR 250 ns. DATA ON REQUEST.

8080 BASED 5100 BUS CPU BOARD SOON TO BE AVAILABLE THIS UNIT WILL HAVE AN ONBOARD FLOPPY DISC CONTROLLER AS WELL AS 48 K OF RAM POTENTIAL. IT WILL SELL IN THE \$300.00 AREA WRITE IF INTERESTED.

RE 6416 TERMINAL A 64x16 VIDEO TERMINAL KIT, RS232, 20 MA CURRENT LOOP ON BOARD, 4- STROBE SELECT, 5VDC 700 MA, \$159.95 KIT

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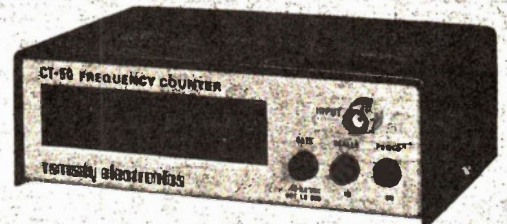
91

CHIPS

741DIP.4	\$1.00
FET741.3	\$1.00
555	2/\$1.00
556	1/\$1.50
7447	1/\$.90
7490	1/\$.60
21L02(450)	\$1.60
7400	1/\$.20
7404	1/\$.20
7805	1/\$1.00
7905	1/\$1.50
+++OTHERS ASK	

CT-50 FREQUENCY COUNTER

Outstanding Performance at an Incredible Price



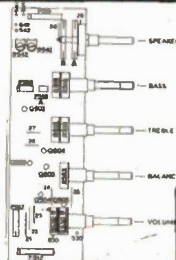
DESCRIPTION: The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 MHz and up to 600 MHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on. Use the order blank below or call us directly and prefer yours today!

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- CT-50, WIRED AND TESTED\$149.95
- ACCESSORIES
- CT-600, 600 MHZ PRESCALER OPTION\$ 33.95
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- LOW PASS FILTER, FOR AUDIO USE\$ 19.95
- VHF RUBBER DUCK ANTENNA WITH BNC CONNECTOR. \$ 14.95
- COLOUR BURST ADAPTOR, USES NETWORK RUBIDIUM STANDARD FOR UP TO .001 PPM ACCURACY,\$ 18.95

DEALS

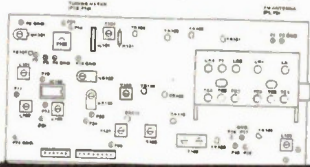
ARKON STEREO CONTROL AMPLIFIER

A stereo control amplifier with bass, treble, balance and volume controls on board. Features low noise operation, detent controls, additional switch for switching front-rear speakers. This is a surplus bargain from a famous Canadian manufacturer and could not be offered for twice the price if it had to be made from scratch. \$24.95



ARKON AM-FM STEREO TUNER KIT

A stereo AM/FM tuner kit featuring a prebuilt chassis with IC stereo decoder, muting, FFT front end, de-emphasis, stereo beacon, tuning meter, and 4 stages of tuning selectivity for the best rejection of strong adjacent stations as well as excellent fringing reception. This receiver will easily outperform units costing hundreds of dollars more. A surplus bargain from a famous Canadian builder. \$39.95



VIDEO MODULATOR KIT

The most economical video modulator kit around, yet is one of the best at any price. \$9.95

ARKON MAG PREAMP KIT

A great kit, stereo mag preamp, puts out 1 volt from 50 mv, low noise, 12 volt \$6.95 Built...\$8.95

DECISION MAKER KIT

A novel kit much used in Ottawa. 2 CMOS IC's flash 2 leds, stops at random. Great fun for all. \$6.95

ATARI VIDEO MODULATOR

The famous ATARI tv game video modulator. Not a kit, all set to go, runs on 5vdc. \$12.95

MINI-KITS

- VIDEO DECODER KIT \$5.95
- SUPER-SNOOP AMPLIFIER \$5.95
- FM WIRELESS MIKE KIT \$4.95
- DECISION MAKER KIT \$6.95
- ATARI VIDEO MODULATOR \$12.95
- LED BLINKER KIT \$2.95
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Economy plus

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OCTOBER 1978

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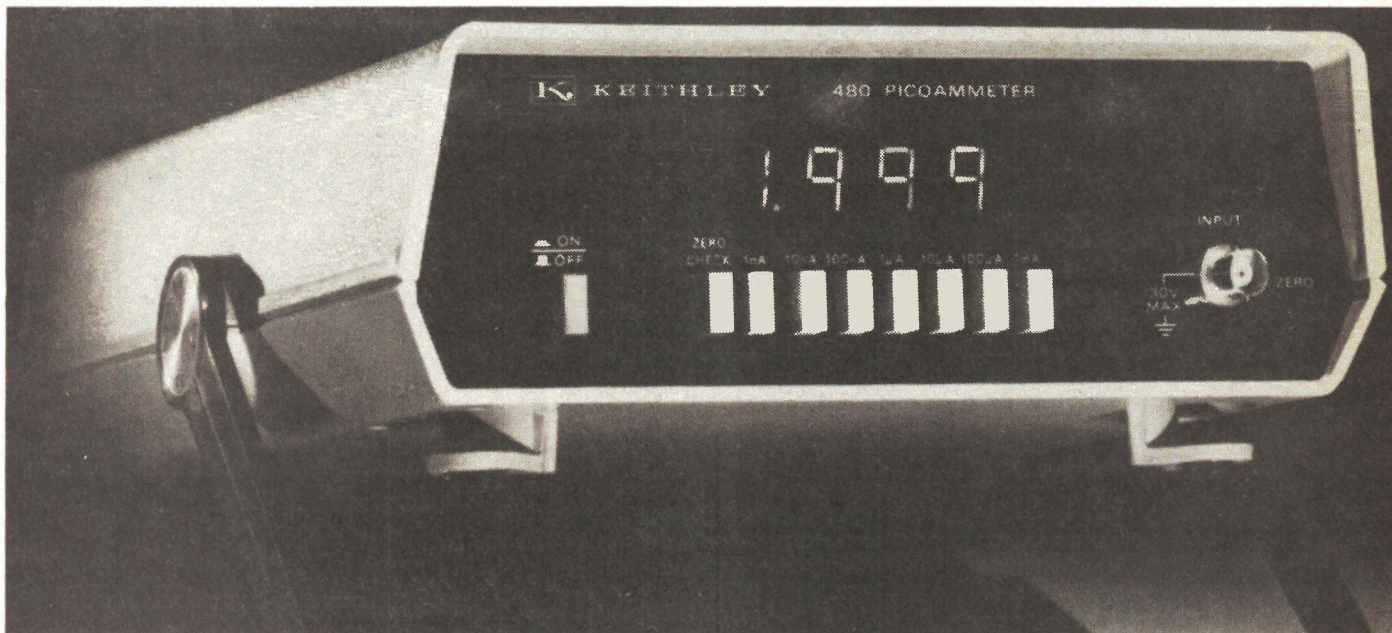
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NEWS DIGEST



Picoammeter

Keithley Instruments, Cleveland, Ohio, now offers a simple, economical means to measure minute currents. The model 480 picoammeter utilizes seven ranges to measure currents from 1pA to 2mA.

The stable resolution of 1 picoampere provides 4 decades greater sensitivity than most DMMs. Less than 0.2mV input voltage drop (burden) keeps the Model 480 from disturbing

the circuit under test. This significant improvement over DMMs maintains accuracy throughout semiconductor voltage levels.

The Model 480 has several features extending its use. The built-in analog output is useful in making plots or as part of a control loop. A battery option permits total isolation from line for portability or critical in-circuit

measurements. Overload protection, up to 1000V transients, eliminates need for concern in handling and connecting the input leads.

The US price is \$329. For more information please contact Radionics Limited, 195 Graveline St., Montreal, Que. H4T 1R6.

Length and Associated Quantities

The National Research Council, Ottawa, is holding a two day seminar on the Measurement of Length and Associated Quantities, October 17 and 18, 1978. Guest speakers will be from the National Bureau of Standards, USA; the National Measurements Laboratory, Australia; the National Engineering Laboratory, Scotland; the Department of National Defence, Ottawa; Bausch & Lomb, USA; Hewlett-Packard Ltd., California; and Diffracto Ltd., Windsor. There will be an exhibition of precision metrology equipment and visits to the NRC laboratories during the period of the seminar.

For more data contact: Mrs. M-C Léonard, Physics Division, National Research Council, Montreal Road, Ottawa, Ontario. K1A 0R6.

Electrotechnical Standards

Professor N. Takagi, President of the International Electrotechnical Commission (IEC), the organization responsible for the preparation of world-wide standards in the electrical and electronic fields, announced his programme for the future progress of the IEC in Florence this summer.

The programme comprises two main points: All new IEC standards should be completed within four years of beginning work. And new fields of interest should be standardized as early as possible (and not when technology has become accepted).

For more information about the work of the IEC, please contact the Standards Council of Canada, International Standardization Branch, 2000 Argenta Road, Suite 2-401, Mississauga, Ontario. L5N 1V8.

Softspot: Crisis

Unfortunately we are unable to publish a Softspot this month, but here is some important information we omitted from the program we published in August ETI. Thanks to Wes Potter:

Execution:

1) Step 2: input seed, then press A; game starts

2) Step 4: input move, then press R/S

3) Step 17: press B for a new round beginning

4) Russian's scores and passes by are output as negative values

Other:

5) Delete steps: 167, 166, 162, 161, 067 to 054, 023, 022, and replace step 075 (RCL A) with RCL B for a slightly faster, but slightly cheating program.

6) Step 106 is STO-5

7) Step 212 ABS comes after the second PAUSE



DVOM Accessories

Triplet has added a new RF probe & AC clamp-on ammeter adapter to its model 3300 hand-size, 3½ digit DVOM.

The RF probe (79-411) may be used as a signal tracer and gain analyzer as well as an RF voltage measuring device. It has a frequency range of 50kHz to 200MHz. Set selector switch voltage is from 2 to 200 volts and 35 VAC is maximum for the probe. It will also work with Triplet's model 3000 DVOM.

The second accessory to be introduced is the model 10-D, AC clamp-on ammeter adapter. This adapter will measure AC current when the jaws are clamped around a single conductor of the circuit in which the current is to be measured. It reads out directly as AC amperes. Accuracy is +5% of reading 5 to 200 amperes. Below 5 amperes, accuracy can be maintained by looping two or more turns of the conductor through the clamp and dividing the reading obtained by the number of loops through the clamp.

For further information contact Len Finkler Limited, 25 Toro Road Downsview, Ontario, M3J 2A5.

Fliers

This month we have received fliers from J&J and Tenco.

The J&J bargains are mainly semiconductors, with some specials on switches (five microswitches for \$1) and pots (15 trimpots \$1, 5 minipots \$1). The computer experimenter can get a 4004 CPU, a 4308 housekeeping ROM, a 4002 RAM-with-4-bit-port (320 bits in

ETCO's US Catalog

A Canadian company expands to the States; ETCO of Montreal are now giving away their Canadian-printed US catalog. Their merchandise comes from surplus inventories, overstocks,

bankruptcies, etc, and includes all sorts of bizarre items, plus the more usual parts and equipment. For a free copy write ETCO Electronics, Dept ET29, North Country Shopping Center, Rte 9N, Plattsburg, NY 12901.

Update for DMM Survey & Scope Survey

First Hameg: in last month's issue there was a full page of information on the Hameg HM812 (dual-trace, 40MHz, storage scope). But it didn't get into the survey in that issue. So make a note on page 26 to refer to the rear cover gatefold BCS catalogue for the details on this model.

Then there are two companies who didn't get any mention at all. First there's Conway. They sent us the details of their scopes on the 12th of July and they didn't arrive til August (too late). And they are only a few miles away. They carry four models:

The Conway COS316 MkIII is a single-trace 15MHz model with 8 by 10 cm display. Sensitivity from .5mV/cm to 50V/cm in switched 1-2-5 sequence. Sweep from .2us/cm to 50ms/cm in 11 steps (and x5 magnifier gives to 40ns/cm). Triggering is automatic and adjustable, with TV setting.

The Conway COS326 MkIII is a dual-trace 16 MHz model with 8 by 10 cm display. Sensitivity from 10mV/cm to 50V/cm in 12 steps. Timebases from .5us/cm to .5s/cm in 1-2-5 sequence (extended to 2.5s/cm or magnified x5 to 100ns/cm). X-Y mode. Automatic adjustable trigger with TV positions.

The Conway 279 and 383 are specialist scopes: four traces each on big screens. The 279 has a 17" screen, response to 100 kHz, and timebases from 30s to 1ms per sweep. The 383 has a 23 by 33 cm display and 50 kHz bandwidth; timebases are also from 30s to 1ms per sweep.

Contact Conway Electronic

registers of twenty 4-bit characters) and a 3101A RAM (16x4) . . . \$14.95.

The Tenco specials are in equipment — speakers, mikes, tools, meters, etc. Write Tenco Electronics Ltd., Box 24804, Stn C, Vancouver, BC, V5T 4E9. Or Tenco Electronics Ltd., 75 Denison St., Markham, Ont., L3R 1B5.

J&J are at PO Box 1437, Winnipeg, Man., R3C 2Z4.

Enterprises at 88 Arrow Road, Weston, Ont., M9M 2L8.

Finally we have DMM and scope info from Miller Marketing, of 55 East 5th Ave., Vancouver, BC, V5T 1G7. Their four DMMs are the ME521 and ME522 (under the Miller Marketing label) and the 3202 and 3203 (with a 'Hinki' label). The Miller 521 is a look-alike of the EICO 272 with identical specifications. The 522 is a 3½-digit LCD type which measures (full-scale) 200mV to 1000V DC, 200mV to 600V AC, 200uA to 1A, DC and AC, and 200 ohms to 20 megohms. Auto-polarity.

The 3202 is a 3-digit LCD meter measuring with autorange from 1V to 999V AC, or from .1V on low range, and from 1 to 999A AC, or from .1A on low range. On high range there is a peak-hold function. Resistances can be measured between 1 and 999 ohms, or .1 and 99.9 ohms. Measuring DC requires mentally multiplying by 1.4.

The 3203 is a 3½-digit LCD type with semi-autorange and auto-polarity. In the high range full-scale is 199.9V AC or DC, 199.9 mA DC, or 199.9 kilohms. In the low range you get 1.999 V AC or DC, 19.99 ma DC, and 1.999 kilohms. Using the high-voltage input gives readings up to 1000 V or 19.99 V. On the resistance range this input gives you 1999 kilohms or 19.99 kilohms.

Then there are Miller scopes, two of them. The 5516 is a dual-trace 20 MHz model with unspecified display size (looks like 10 by 8 cm, or slightly larger). Sensitivity ranges from 5mV to 10V per division. Timebases come in twenty steps from .2us to .5s per division, with a x5 magnifier. Triggering is automatic or adjustable. The 5516DL comes with built-in vertical signal delay line (approx. 120ns).

The other scope is the 5512A, dual-trace, 15 MHz, 8 by 10 cm display, type. Vertical sensitivity steps from 5mV/cm to 10V/cm and horizontal sweeps range from .5us/cm to .5s/cm in 1-2-5 sequence, with x5 magnifier. Triggering is auto or adjustable or TV. Also Z-axis facility.

The last time you saw a really new bench/portable DMM was 1972.

In 1972, the Fluke 8000A set new standards in the DMM market with reliable LSI design and innovative benefits.

Now look at the Fluke 8010A and 8012A bench/portables destined to be problem-solvers for the eighties!

- Large, razor-sharp LCD readout
- Touch and hold probe option.
- Fluke hybrid true rms converter with flat response to 50 kHz (within 3dB at 200 kHz).

- Real measurement power with six functions and 31 ranges.
- Conductance ranges for measuring leakage to 10,000 M Ω , also convenient for transistor beta and light intensity.
- Overload protection like no other DMM.
- Simple, extremely reliable single-chip CMOS design.

Choose the 8010A (10A high current) for \$299 or the 8012A (0.001 Ω resolution) for \$389. Canadian prices including duty and federal sales tax.

Contact the ACA office nearest you:



Allan Crawford Associates Ltd.

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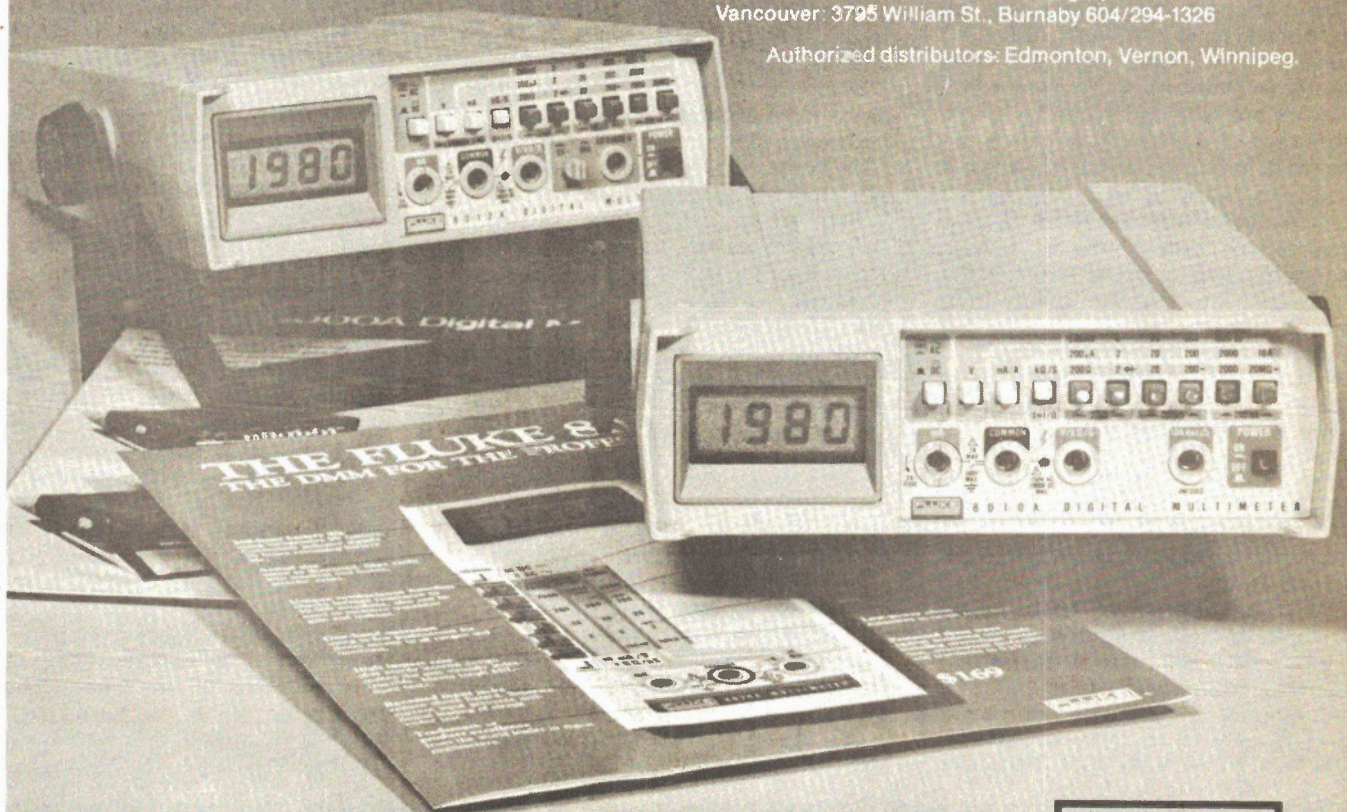
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Authorized distributors: Edmonton, Vernon, Winnipeg.



FLUKE[®]

New DMM

A new bench-portable 3½ digit digital multimeter will be introduced to the Canadian market by Allan Crawford Associates Ltd at the Canadian Communications and Power Conference (IEEE Show) in Montreal's Queen Elizabeth Hotel, Oct. 18-20.

The Fluke models 8010A and 8012A DMMs have 22 ranges of AC and DC volts and current, six ranges of resistance, and three ranges of conductance. The model 8010A has a 10 A current range, and the 8012A has ranges that allow measurements from 0.001 ohms to 10,000 megohms (it is claimed to be the widest range ohmmeter available). The two models are otherwise identical and are both available with rechargeable batteries.

A new "touch and hold" probe option makes it easy to capture the needed reading in a jungle of components.

Exceptional overload protection has been provided, including rejection of 6000 V transients and fusing to 600 V on the 2A current input. The conductance and resistance inputs have voltage withstand capabilities of 300 V RMS.

Other features are true RMS readings, 50 kHz bandwidth, and basic accuracy of +/- 0.1% on DC for one year. The specially commissioned liquid crystal display provides no-strain readout in any light, with improved temperature and humidity features.

Digital Telex Exchange

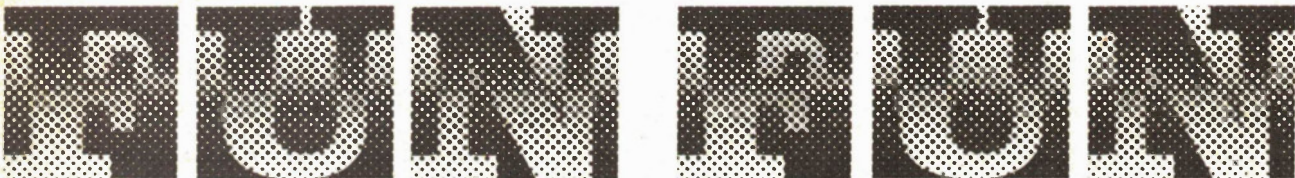
Canadian Marconi has recently installed its first all-digital International Telex Transit Exchange (CMA-745) for Teleglobe Canada, the corporation responsible for Canada's international telecommunications traffic.

The system will be used at Teleglobe as a Canadian gateway to the International Telex Network. The system is now undergoing on-site testing prior to its scheduled phasing into regular service in late 1978. The heart of the system is the loadsharing capability of a multi-processor configuration, composed of commercially available microprogrammed minicomputers, connected by a Time-Division Multiple Access (TDMA) switch.

Voltage Reference

A precision voltage reference which features outputs of +10.000V, +7.500V, +5.000V and +2.500V (which are selectable by simple pin-strapping) and requires no external components, has been introduced by Analog Devices. Designated the AD584 and priced from US \$3.50 in 100s, the device will output three simultaneous voltages which will typically track each other to 3 ppm.

A single external resistor will produce three negative voltage outputs; -10.000V, -7.500V and -5.000V. Additional voltages above, below or between the standard outputs are available by adding additional external resistors. The laser-trimmed AD584 features total temperature coefficients as low as 5ppm/°C, and low quiescent current of 1.0mA, maximum. A zero output strobe terminal is provided (which permits the device to be turned off) reducing the current drain to 100uA, typically. The device will operate with input voltages which vary between 12 and 40 volts. More info from Tracran Electronics.



A new extreme in electronic fun was recorded recently at the home of an ETI staff member. More fun than you would believe possible with today's products.

In next month's ETI our famous review team (Graham Wideman & Mark Czerwinski) tell you about a product shortly to be on sale in Canada, a product that enables you to play — in full colour — TV sports like baseball, tennis, hockey, handball, football, demolition derby, Grand Prix racing, drag racing, and more. Then there's the skill/action games like Dodgem, Zzzap, Sea Wolf, Missile, Panzer Attack, Red Baron, Space Race, Escape, and Clowns. For gamblers there's Blackjack, Poker, Acey-Deucey, Backgammon and Checkers. Then there's Checkmate, Gunfight and Scribbling.

The educational compendium includes Bingo Math, Speed Math, Letter Match, Spell 'n' Score, Crosswords, and Astrology. The Astrology feature lets you see a computer simulation of the stars and planets in the past, present or future, from any point in North America.

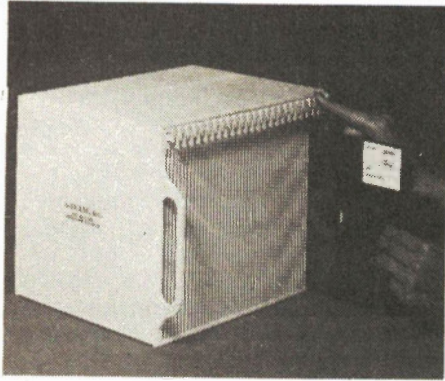
For the games there are four hand-controls with trigger and twist action.

But that's only half the story. The product has a built-in 5-function, 10-memory electronic calculator which records all operations for scrolling up and down on the TV screen. PLUS... **THIS IS A HOME COMPUTER!** In addition to the colour synthesizer (256 colours) and the music synthesizer (3-octave range) this computer offers a simplified and extended BASIC. The programming course teaches you to invent your own video games, to create video art and music. So, if you're a non-subscriber go to your newsstand and reserve a copy now.

Other top features of the November ETI (according to current plans) are:

- A hi-fi amp project which uses CMOS-switches on the pcb to control functions; the wires to front-panel (or remote-control) switches don't carry audio.
- A capacitance meter with linear scale.
- Feature articles on PCM (pulse-code modulation), on the dangers of lightning, plus much more.

microfile



Disk Storage

The A-Team Inc. of Colorado, have announced a floppy disk storage system offering fully indexed, instantaneous, retrieval of frequently used diskettes by push button control.

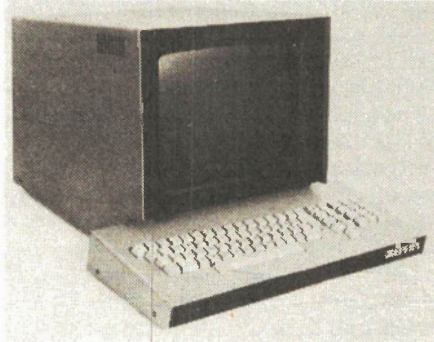
The systems are available in configurations which accommodate either 15, 30, or 50 diskettes.

Here's the U.S. prices: 15 slots \$69.95; 30 slots \$119.95; 50 slots \$179.95.

The A-Team, Inc, P.O. Box 719, Broomfield, Colorado 80020.

Canadian Terminal

Cybernex Limited of Ottawa have a new microprocessor-based video terminal. The standard MDL-100 features an 80x24 upper and lower case display of 7x12 dot matrix characters, a strobe/acknowledge parallel printer port and an RS232 interface with full current loop facilities.



Direct cursor addressing, read cursor address programmable tabs, line insert and delete, character insert and delete, block mode line and page transmit are all standard features.

The terminal operates at 10 baud rates from 75 baud to 19,200 baud. The transparency mode feature displays control codes on the screen to aid program debugging. The parallel printer port is remotely on/off controlled. In addition the operator can activate a page print from the keyboard.

The MDL-100's detached 81 key keyboard features Cherry mechanical crossbar key switches, TTY mode lock key, back space key, nine dual function keys, plus a 12 key numeric pad.

The interleaved CPU and refresh memory architecture allow operation of the terminal at maximum speed with no spurious flashing of the displayed information.

For detailed information on the MDL-100 contact Cybernex Limited, Marketing Division, 2183 Dunwin Drive, Mississauga, Ontario L5L 1X2. Phone (416) 828-2810.

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programming. Parts and service are available locally and delivery of units is immediate. Contact Telog Systems Limited, 68 Shorting Road, Scarborough, Ontario, M1S 3S3 (416) 291-6880.

Intel's Birthday

Intel Corp celebrated their tenth birthday in August this year. The photo shows Intel's top management with a mask drawing of the 8080 microprocessor. From left to right: Andrew S. Grove, Executive Vice President and Chief Operating Officer, Robert N. Noyce, Chairman, and Gordon E. Moore, President.

Initially, the company produced small, fast memory devices with a new bipolar technology, Schottky TTL. This was Intel's first technology innovation.

In 1969, it produced its first silicon-gate MOS/LSI RAM, a 256-bit device for small memory systems. In 1970, Intel made the first successful 1,024-bit RAM with its silicon-gate MOS/LSI technology. This device, the 1103, contains over 3,000 transistors in a single chip and is generally considered the device which initiated what is today



the \$750 million MOS semiconductor memory market.

In the next year, Intel introduced the industry's first microprocessor and the first erasable program memory (EPROM).

The EPROM was a significant technological innovation because it made the development of the programs for microcomputers practical. The microcomputer market today is the fastest growing portion of the

electronics industry today and is expected to reach over \$500 million in 1978.

Intel has introduced a notable "industry first" every year — 4-kilobit and 16-kilobit memory components, 8-bit and 16-bit high performance microprocessors, a complete microcomputer system on a single chip, a computer system on a single board, and many others. Its most widely used microprocessor is the industry-standard 8080 — of which there are more than 2 million in use today.

So far in 1978, Intel has announced the first single-chip codec (coder-decoder) for telephone systems and a 16-bit microprocessor, the 8086, that can address a million bytes of memory.

And the original silicon-gate MOS/LSI technology has advanced to the point where it is being used to produce devices with over 65,000 transistors in a single chip.



Audio Today

Developments in audio reviewed by Wally Parsons

SEVERAL MONTHS AGO, in the letters section of these pages, I printed a letter from a reader in California on the subject of bi-amping a set of automotive speakers. This reader turns out to be an old friend with whom I had lost contact, but who has been active over the years in professional audio. It is not a subject on which he really needed my advice, and was written with tongue firmly planted in cheek. So, why did I play it straight and run it, complete with answer (aside, of course, from filling space and proving that ETI really does get down into Canada's 11th province)?

The truth is, RWS touched directly on the fact that the whole subject of bi-amping, the techniques and appropriate applications, is not too well understood by many audiophiles, even many technically sophisticated ones, so this month seems to be as good a time as any to discuss it.

Bi-amplification, or, for that matter, tri- or multi-amplification involves powering each driver in a multi-way speaker system with its own amplifier, and splitting the audio spectrum up before the amplifiers, using either passive filters, similar in design to those used in passive cross-overs and single amplifiers, or active filters, using either discrete or integrated filters. There are several advantages to this, in addition to swelling the coffers of the amplifier manufacturers and the finance companies.

AMPLIFIER STABILITY

Although it is possible to design a passive cross-over network which will present a constant resistance load, in practice it is not so easy to build such a network. The large value capacitors required and the physically large

inductors involved are not easily held to close tolerances, so that calculated performance and real performance may be quite different. The calculated response of such networks can only be obtained when each leg is terminated in a resistive load, a condition which does not hold with real drivers. At the low resonance a driver presents a reactive load whose value may be considerably different from its rated value, and at the upper part of its range it will show a rising impedance characteristic due to voice coil inductance. Clearly, the actual power delivered to an individual driver may not correspond to the calculated cross-over characteristic, and the impedance appearing at the cross-over input terminals is not only not constant at all frequencies but contains considerable reactance over several portions of the audio spectrum. Some amplifiers get very unhappy with this state of affairs and show their displeasure in their performance, a phenomenon apparently little understood, judging by the mystery which seems to surround the subject of speaker-amplifier matching, and which is undoubtedly a major factor contributing to the large differences frequently observed in the sonic character of many amplifiers of similar specifications.

DAMPING

In a well-designed speaker system, each driver's main resonance will be kept well below its operating pass band. If an odd order network is used the driver will be fed from a source impedance which increases as frequency becomes remote from the pass band, so it doesn't benefit from amplifier damping, even if fed from an attenuator pad.

OPTIMUM CONDITIONS

Undoubtedly, the ideal mode of operation would be one in which each driver operates substantially in the pass band in which its impedance is relatively constant and essentially resistive, with the low resonance, although outside the major pass band, well damped by an amplifier's low output resistance, that same amplifier presenting a constant resistive load to its section of the cross-over, which can now be designed to tailor such characteristics as phase response and frequency slope, in order to optimize total system performance. While we're at it, we can sometimes get an output greater than the sum of the amplifiers' powers, in other words, something for nothing.

Whoa! Back up, there. What happened to the "no free lunch" principle? Actually, it still holds, but we are now optimizing our available power. Press on, and we'll see how.

POWER, VOLTAGE, CURRENT, AND ALL THAT JAZZ

We are accustomed to thinking of power amplifiers in terms of power output, but often forget that they are really constant voltage devices, and that signal levels within the amplifier are voltages, so we are now going to look at the output **voltage** of an amplifier when handling signals of different frequency and amplitude.

Fig. 1 shows the composite waveform which results from combining two pure tones remote in frequency and in which the higher frequency is of lower amplitude than the lower. The frequencies involved are 100 Hz and

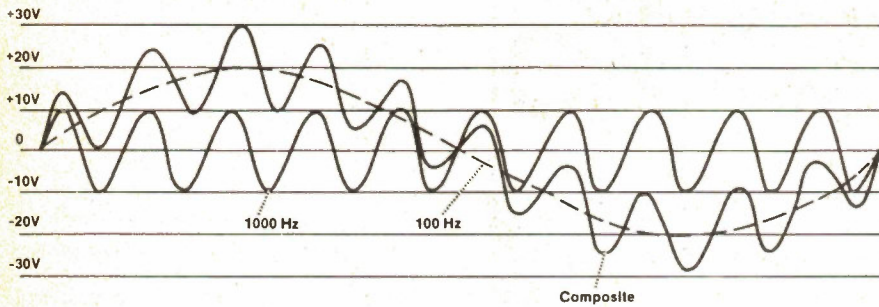


Fig. 1. Two signals of differing frequencies demand a surprising amount of power.

1000 Hz, respectively, and the voltages are 20 V and 10 V, peak voltages. These voltages will result in power levels of 50 W and 12.5 W respectively, across an 8 ohm load, provided that the load is resistive. It can be seen that the sum of the two voltages will result in a condition in which the total voltage is 30 V, for a total maximum instantaneous power of 112.5 W. In other words, if an amplifier is required to deliver high power at some low frequency, and is called upon to simultaneously handle another frequency at only half the level of the lower frequency, it still must deliver **over twice as much power** as it would if it only had to handle the lower frequency. Conversely, if it is called upon to deliver power at some middle or high frequency, and then we add a lower frequency at only twice the level, the amplifier must be capable of supplying almost **ten times as much power** as it would otherwise have to deliver.

Wow! No wonder so many of the super amps sound so clean. It doesn't take much to drive even a 300 W behemoth to clipping. If our aforementioned 100 Hz signal were driving the amplifier to full output at 50 peak watts, a state of affairs easily encountered on transient peaks (and remember, bass drums, tympani, and the like, have their fundamentals in this region) there is *no headroom to handle anything else*. And since real music contains more than single frequencies, this headroom really is needed.

Then too, this assumes a resistive load. If the load is reactive at any of the frequencies in question, then we may have to derate our amplifier, reducing the headroom even further. In fact, numerous tests have shown that even the biggest super amps are operating under clipping conditions a very high percentage of the time, especially on uncompressed signal sources.

The Fletcher-Munsen effect is characterized by a rise in the ear's response threshold as frequency is lowered. Consequently, at relatively low listening levels, including low performance volume, a higher proportion of the energy in a complex signal representing real music condition is concentrated in the lower frequency range, so a fairly large drop in level is required to produce a significant improvement in headroom.

ENERGY DISTRIBUTION

Just how serious is this problem in dealing with real programme, as distinguished from laboratory test tones? We all know that energy is not equally distributed throughout the spectrum in most music. Fig. 2 shows a generalized energy distribution curve for symphonic music, generally the most demanding type to reproduce (and if the Rock fans don't believe it, try one of the Brahms symphonies some time at concert hall level — if you can). Both Rock and Electronic music will contain higher amplitudes below 100 Hz and above about 3000 Hz, but the general distribution remains about the same. (See also ETI, March 1978 "About Equalization").

The very high levels encountered below 500 Hz, particularly between 500 Hz and about 150 Hz are obviously likely to produce the conditions described in Fig. 1. A very large part of the musical fundamental information appears in this region, which explains why it dominates the distribution curve, and, in conjunction with the bass region, is easily capable of driving even fairly powerful amplifiers into overload. In this area we also find large reactive components in the load, due either to driver or cross-over characteristics. Small wonder, then, that higher frequency fundamentals, as well as harmonics suffer so much mutilation. Obviously, we can solve this problem

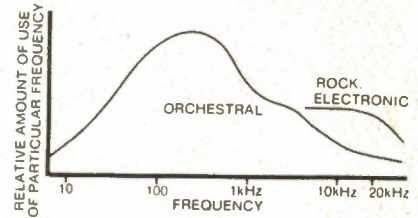


Fig. 2. Energy distribution of (classical) music.

by simply acquiring sufficient electrical horsepower, even if it means bringing in a separate 100 Amp service from the power company to handle it.

But, cost and efficiency aside, will that really do the job?

SLEWED-UP TRANSIENTS

Some time in the future I shall probably do a piece on amplifier slewing and transient performance, including so-call Transient Intermodulation Distortion (T.I.D.), but for now a brief description of this characteristic will have to suffice. Basically, slewing refers to the rate at which an amplifier's output voltage will change in response to an input voltage step. Since a transient signal generally is very similar to the leading edge of a voltage step (including a square wave) slewing performance provides a good indication of transient response. (Fig. 3).

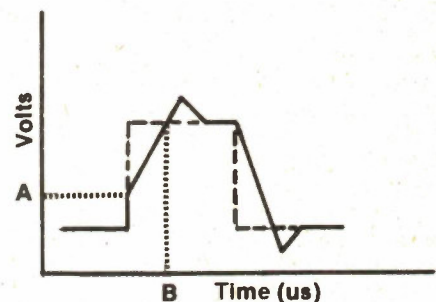


Fig. 3. Amplifier response to square pulse.

When a transient signal is applied to the input of the amplifier, output response is fairly fast up to some point determined by the amplifier's characteristics, beyond which a time delay occurs. Any attempt to pass a step at a faster rate will result in a slewing induced distortion, and it sounds pretty terrible. In other words, as long as either the transient signal's **amplitude** does not exceed "A" on the vertical, or amplitude co-ordinate of Fig. 3, or the **rise time** does not exceed "B" or the

horizontal, or time co-ordinate, it will remain within the slewing capability of the amplifier. Now, you might think that 50 V/us is more than sufficient to handle the 0.8 V/us discovered as maximum slew requirements, by Peter Baxandall, but look what happens when the amplifier is already delivering signal at close to maximum output. It may already be delivering a voltage above that represented by point "A" of Fig. 3, and the introduction of a transient signal will then place demands on the amplifier which exceed its slewing capabilities. The kind of distortion which results sounds very much like hard clipping, and, in a sense, that's exactly what happens, even though the peak signal may not ordinarily result in a clipping condition.

The major disadvantage of using higher power amplifiers to overcome the problem is that in such equipment the output devices' characteristics make a major contribution to slew limiting, and the cure tends to be horrendously expensive when you get into the kilowatt class. Much of the amplifier equipment used with musical instruments in concert is in this power class and I don't think you have far to look to discover why they usually sound so horrible (aside from any musical judgements which might be made) in comparison with recordings.

SOMETHING FOR NOTHING

Let's go back to Fig. 1 and our two signals. If the 100 Hz signal is handled by one amplifier, the power output which would result from its 20 V level into 8 ohms would be 50 W, and if the

1000 Hz signal is handled by another amplifier, its 10V level would result in a power output into 8 ohms of 12.5 W, for a total of 62.5 W. Compare that with a power output of 112.5 W when the two are combined and we see some obvious benefits. By splitting the signal up this way there are no intermodulation products because the two signals do not appear in the same amplifier and so cannot produce IM. Even with today's devices, it is still easier and less expensive to design a really first rate low power amplifier than an equal quality high power unit. This is especially true with respect to slewing characteristics, which become more critically at higher frequencies, precisely the range to be handled by our lower powered unit.

Experiments have shown that fairly high levels of distortion at low frequencies can be tolerated in a complex signal if higher frequency components are reproduced cleanly; the higher frequency tends to mask the distortion components of the lower.

We are postulating amplifiers of different power ratings. Why? Well, if we examine Fig. 2 again we see that the output requirements in different pass bands are quite different, due to energy distribution. And there is an additional bonus. Drivers used for mid and high frequencies are usually more efficient than woofers, especially if the latter are designed as air suspension systems. So, if, in our hypothetical system the 1000 Hz signal is handled by a driver 10 times as efficient as the one handling 100 Hz, then our power requirement

now drops to 1.25 W., all other conditions being equal!

IN PRACTICE

In actual practice, we are more likely to select each amplifier power on the basis of band-pass, driver efficiency, and driver power handling capacity, and it becomes a little more complicated than this brief run-down might suggest. But, with proper design, which really means designing the speaker, amplifiers, and cross-over as an integrated system, it is possible to achieve performance levels which would require power capabilities far exceeding the sum of the multi-amped system's amplifiers' outputs, and at considerably less cost.

Incidentally, one of the most common causes of tweeter burn-out is the very high level spikey wave-form with its high harmonic content which characterises the output of a single high power amplifier which is clipping. By eliminating this clipping, we are also protecting the tweeters.

Even the harmonics generated in the bass amplifier if driven to overload are generally not reproduced by the woofer, so even bass distortion is effectively reduced. Sub-woofering becomes a snap. The power levels required below, say, 50 Hz are more readily manageable when the sub-woofer has its own amplifier.

In fact, the same logic which dictates the use of multi-way speaker systems applies equally to the power amplifier portion of the chain.

But, more of this for a later column, with maybe some design examples.

Audio Today Products

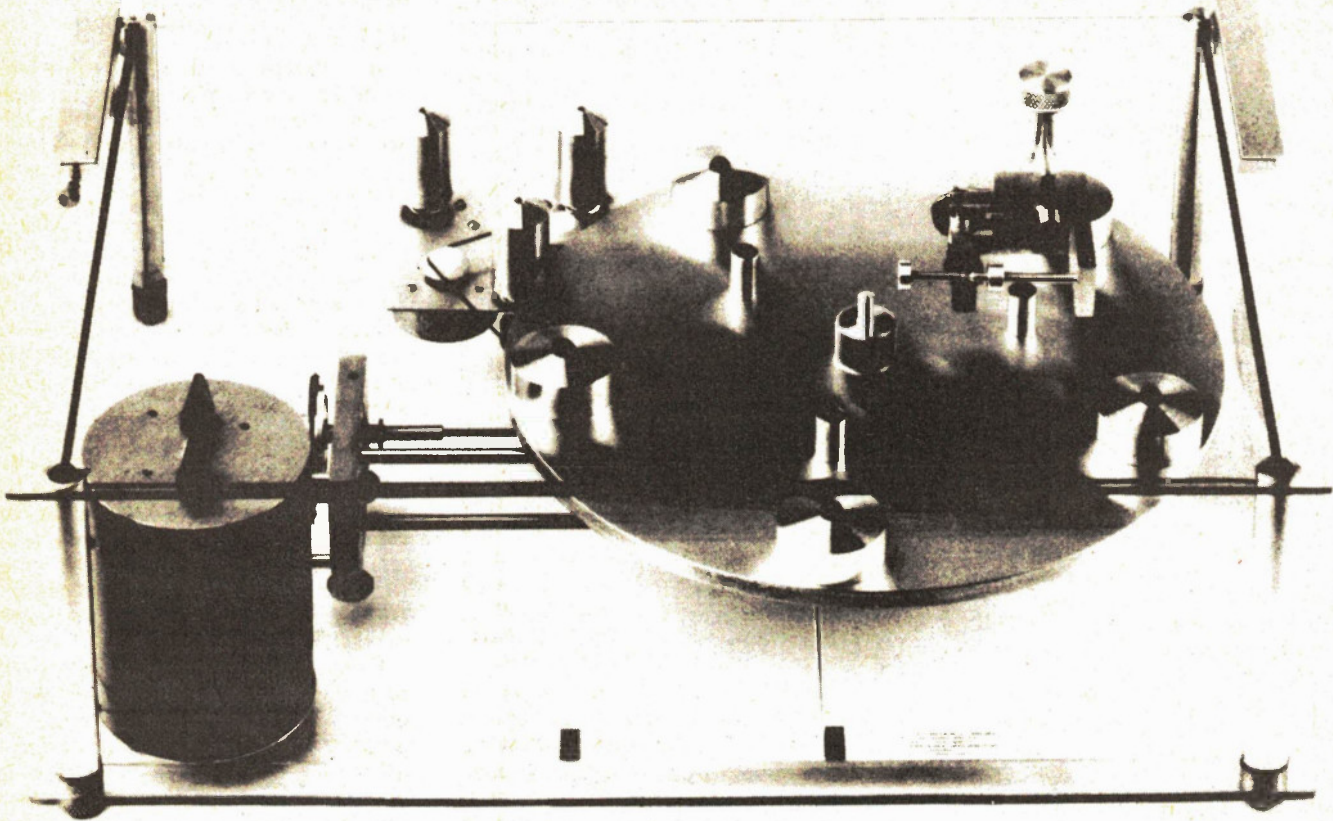
Audio developments reviewed by ETI's Contributing Audio Editor Wally Parsons

The Transcriber by Transcriptors

No matter how many turntables you've seen, I'm sure that you've never seen anything quite like a Transcriptors. They've all been characterized by the funny looking platter with the five point suspension, and the earlier models had an arm which they called "vestigial" and looked too fragile to hold up under the

mass of a pickup. Anyway, this new one is weird, at least in appearance, but it seems to work, and the mechanisms are indeed fascinating to handle and watch. The novelty with this model lies in the fact that the pickup is mounted on the lid, and laterally fixed. So how does it track the record? Simple. The turntable moves from left to right, via a servo-controlled motor. This strikes me as doing it the hard way, and when I

tried to find out why, when I first encountered it at the summer Audio Trade Show, I couldn't find anyone who knew the answer. Transcriptors are made in the Republic of Ireland, which may say something, but I'm not sure what. They seem to be distributed in Canada by Artech Electronics Ltd., 7370 Cote St. Luc Rd., Montreal, P.Q., H4W 1P8.

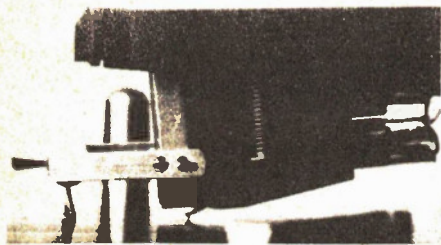


Q: How many Irishmen does it take to change a light-bulb? A: Three. One to hold the bulb and two to turn the ladder!

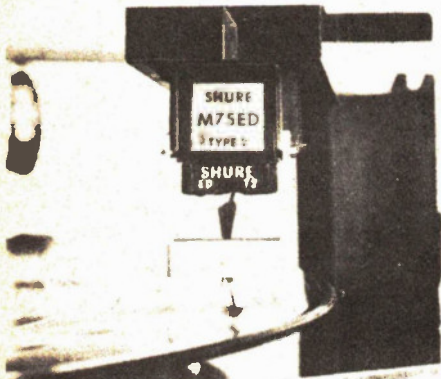
The Decca Microbe

The Decca Microbe is Decca's contribution to the world-of-add on gadgets, in this case the pickup mounted brush. Strange thing, not too long ago I used to hear people speak derisively about Stanton's brush, now maybe there's a stampede afoot to join the club. Anyway, Decca's unit consists of three brushes, one which protects the record if the pickup is dropped,

another cleans the record as it plays, and a third cleans the stylus. It's adjustable to fit a variety of pickups, and attached over the front of the pickup body. Decca's brochure shows it installed on a Shure pickup, rather than a Decca, but with a Decca arm. As Mr. Spock would say, "fascinating". Decca is distributed in Canada by Rocelco Inc., 1669 Flint Rd., Toronto, Ont. M3J 2J7.



Decca's Microbe



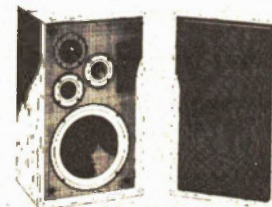
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Audio Today Letters

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

Recording Amplifier

I would like you to design a tape record-playback amplifier (June ETI-Audio Today) and also a stereo preamp as I am interested in building a complete stereo system, and these are the last two components I need. Your other audio projects seem to be of a very good quality and I hope you keep up the good work.

J. L., Waterloo, Ont.

I should have known that that comment about a universal recording amplifier would be picked up in Waterloo, that hot-bed of audiophilia. The offer is still open, but I repeat, that to make it universal I must have some idea of the range of decks and heads with which it should be compatible. For that I should like to know the make and model of deck you have in mind, assuming that you have one already.

And now that J. L. has brought up the subject of preamps, it would be informative to learn what features ETI readers consider important in a stereo preamp. How about it guys, what would you like to see in a preamp? Also, what would you like to do without?

Disco Lights

Hi! Have been looking all over for plans for a disco light system. It's called a "TENWAYS CHASER". I've been looking for these plans for over a year now, and I still haven't found them.

I'm sure that other people would be very interested in these units because they are very expensive in the stores, but not so expensive to make if you don't have too many functions on them. Would it be possible for you to print these plans or to tell me where I can get them.

Denis de Bellefeuille, 1939 36th St. S.W., Calgary, Alberta, T3E 2Y8.

Sad to say, I've never heard of the device, so I'm publishing your full name and address in the hope that some other reader might be able to help. Good luck.

Real Time Analysis

I really enjoy your magazine, particularly the Audio Systems sections. It was interesting that yesterday we were discussing building a real time Audio Analyser for use at Simon Fraser University to eliminate some of our sound problems in large lecture theatres.

I would like to see some articles on multi-media systems.

S. H., N. Vancouver, B.C.

Compliments are always welcome and are accepted most graciously. By now you will have seen both ETI real time analyzer projects. I think you will find the July version especially useful for your purpose. Of course, the analyzer is a tool, and after using it to find out what is wrong with the theatre response you will need a means of correcting it, such as the Graphic Equalizer published in the Oct '77 issue. This is now out of print, but back issues are available, and if you don't have it, it's worth your while getting it. Included are the necessary formulae for converting it to a 1/3 octave equalizer, if that's what you need. Also, the Acoustic Feedback Eliminator, (May '78) is a dandy little device that really works. With this kind of setup you ought to be able to achieve not only first class music reproduction, but really high voice levels for the public speaker who doesn't know how to publicly speak, or use a microphone properly.

Ambience Retrieval

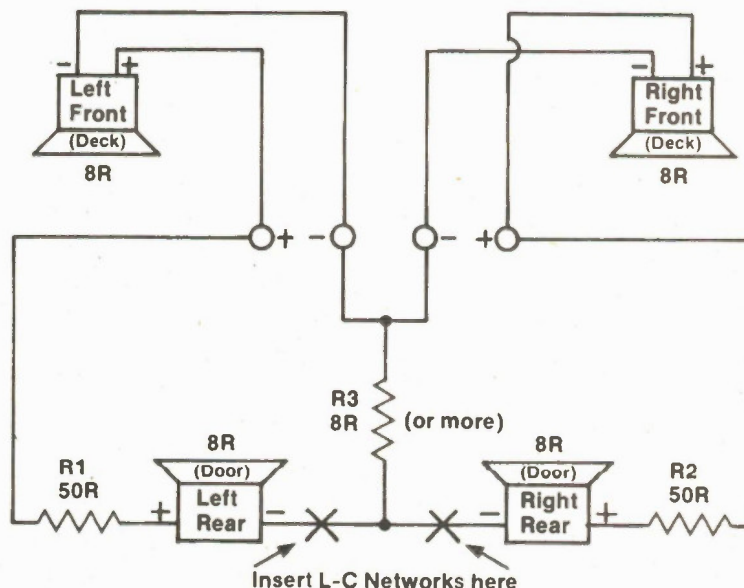
In the July 1978 issue a reader was considering bi-amping a van sound system, however you recommended an ambience quadrasonic system. I would be most thankful for any information on this topic.

G. V., Toronto

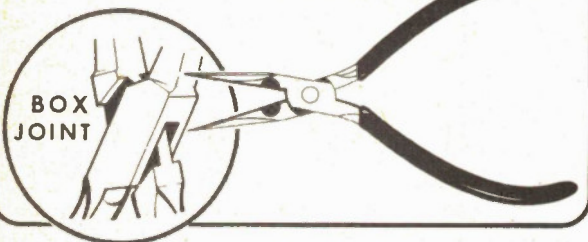
I could have gone into more detail at the time, but I thought it might be nice to see whether or not readers read letters other than their own. Happy days.

An appropriate circuit is shown in Fig. 4, and is basically the circuit developed in the early sixties by David Haller of Dynaco. It was originally dubbed "Dynaquad", and is sometimes called "Composer" and similar names by other manufacturers. Radio Shack has a ready made unit which, I believe, they call "Quartette" or something like that (sorry, my catalogue isn't handy at the moment). It was the first quadrasonic system to be marketed, and even had a four channel coding system and some recordings using the system I still have Dyna's demonstration record). It is also one of the very few systems which, in my opinion, produces a convincing ambience feel from stereo recordings. It functions by reproducing the difference signals between the stereo channels via the rear speakers. Each speaker is in phase with its front counterpart, but they are out of phase with each other. Especially interesting is the increased front-to-back imaging and the increased stability of centre front information. By ganging resistors R1 and R2 (which may be the higher resistance leg of an L-pad) rear channel level can be adjusted. Also, by inserting a fixed resistance in series with each speaker, it is possible to match sensitivity to low efficiency front speakers. R3 provides some blend and can be used to control the depth of ambience enhancement. Especially useful with mono recordings. My own version also used a 500 uf capacitor in series with each speaker and a 1 mH inductor in parallel to provide phase shift. The values were determined by experiment until it sounded right, so you might want to play with it. If R3 is replaced by a speaker, it will produce a centre channel. Watch your polarities, and have fun.

Fig. 4. Ambience circuit which Wally prefers over certain other quad sound systems.



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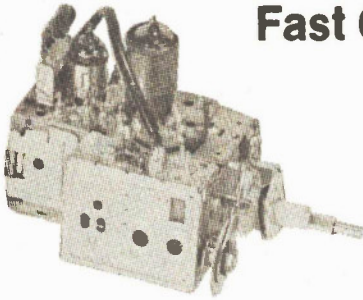
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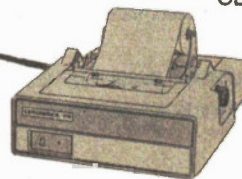
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One extremely important capability shared with HP's minicomputer, and full size computers, is its IEEE-488 Bus. This standard data/control channel means your PET can be directly connected to a variety of peripherals

and laboratory measuring equipment. Over 120 pieces of compatible equipment such as counters, timers, spectrum analyzers, digital voltmeters and printer plotters from manufacturers such as HP, Philips, Fluke, and Tektronix are currently available.

ROM Magazine, January 1978, writes, "THE PET comes out of the box, plugs into the wall, and is ready to use." It is equipped with a CRT video display with reverse and blink features, an alphanumeric keyboard with complete graphics and a built-in standard cassette tape deck.

PET PERIPHERALS

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Pet Printer (available soon)	995.00
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Personal Computing: Commentary

Peter Vogel comments on today's computer enthusiasts.

It all started back in 1974 when Intel introduced the 4004, the first true microprocessor. It developed almost by accident, as a result of Intel's efforts to produce a calculator of unprecedented flexibility. The shock waves of the hand-held calculator revolution were still being felt by every section of society and the back-room boys' eyes lit up with that "You ain't seen nothing yet" look as they drew up the chip-masks for their next product, the 8-bit 8008.

Assisted by the lessons learned from the cut-throat calculator business the microprocessor developed with frightening speed and predictability. Frightening not only because of the vast amount of high-technology and high finance poured into the field, but also because of the dramatic effect extrapolations of such technology can have on a broad spectrum of society. Predictable because everyone knew what was going to develop. The shrinking of calculators from giant cabinets to flip-top packs in the space of just a few years created an extraordinary blase attitude towards electronics. It was a spectacular demonstration of the omnipotence of the new technology of micro-electronics. It was proof that now nothing is impossible — just draw up the specifications, expend x thousand man-hours and y million dollars, and there you have it. So the microprocessor has been born at a time when nothing comes as a surprise any more. But maybe the real surprise is yet to come.

THE NEW "HAMS"

Of all the sub-sets of electronics hobbyists the most clearly defined to date has been the radio amateur. Members of this particular sect follow a technological

faith which started with the first wireless communication and has since flourished, gaining millions of followers in a relatively short time.

For many hams their hobby almost becomes a life-style within itself, always striving for that rare DX the eternal pursuit of that elusive one-to-one SWR. Is it possible that we are now witnessing the founding of a new faith, one whose god speaks in 1s and 0s rather than 5s and 9s?

By making a few comparisons between amateur radio and amateur computing certain patterns can be seen emerging which may be an indication of what course the future of personal computing might take.

POWER TO THE PEOPLE

Like amateur radio, amateur computing is high-technology which makes the latest developments in the science of electronics available to anyone at all who has the time and money to pursue them. The money factor is all important

the lower the cost of the hardware, the more people can afford to pursue the hobby. A reasonably useful micro-computer system might cost in the order of \$1000. Hams might spend this sort of money on radio gear, for that matter a radio-controlled aircraft enthusiast, amateur photographer or stamp-collector could easily spend that much on his hobby. So thanks to the microprocessor the cost of your own



personal computer is no longer a barrier to most people.

This new accessibility and the free interchange of ideas and information between hobbyists has the effect of distributing "computer power" over a broad spectrum of people. This leads to a breaking down of much of the mystique which has traditionally surrounded the world of computers; they are being de-mystified as the magic is systematically exposed as little more than sleight of hand. As large numbers of amateurs invade a hitherto sacred field which was once the sole province of a privileged few the elite will inevitably grow in number until it finally becomes plebian.

"HOMEBREW" VS "APPLIANCE"

As with amateur radio there are two factions within the computer cult, the "homebrewer" who builds his own equipment for the sake of the experience gained, and the "appliance operator" who buys a ready-built, going unit and gets what he wants from operating his instrument, writing programs and experimenting with the performance of the hardware as bought. His investment in the computer itself is more financial and less emotional than in the case of the homebrewer.

There is always some overlap between the two factions, but they can usually be classified by comparing the time spent building, testing and modifying the hardware to the time spent actually using it once it's working.

THE SKY'S THE LIMIT

Radio equipment has rather unique and interesting characteristics. It can never really be declared "finished". There is always more to add to the station, improvements to be made, better antennas, higher power, lower noise. Computers share this trait which makes them too the ideal subject for a hobby. Today's mass storage is tomorrow's scratch-pad. There is unlimited scope for improvement and expansion of the hardware.

If ever the computer itself should look like having its full complement of RAM, ROM and I/O parts, the hobbyist can turn his attention to the vast range of peripherals that are available to him. A radio transmitter can be hooked up to an antenna and a microphone and that's about it, but nothing can be so insular as to resist interfacing to a computer if the intrepid hobbyist uses a little imagination.

More importantly, once the computer is operative a literally infinite amount of software development waits to be done. Like radio operating, this phase of the hobby is particularly attractive because the operating cost is nothing more than the electricity bill.

THE JUNK BOX

Ever since the tradition of stripping a discarded radio chassis was established by the pioneers of amateur radio, the humble junk box has been the hallmark of the truly worthy hobbyist. In much the same way as one may judge someone's social standing by the way he dresses, how neatly his garden is kept, radio amateurs assess each other's status by the quality and quantity of the bits and pieces which lurk for years in the dark recesses of their junk box until their true worth is finally recognized and they are discarded. Because the microcomputer hobby is so new, junk box computer parts of good vintage are rarer, but there is always the stimulating challenge of pushing a seemingly irredeemable piece of obsolete equipment into service. Radio ham and computer hobbyist alike share the unique pride and joy of operating equipment which the professionals have officially declared worthless.

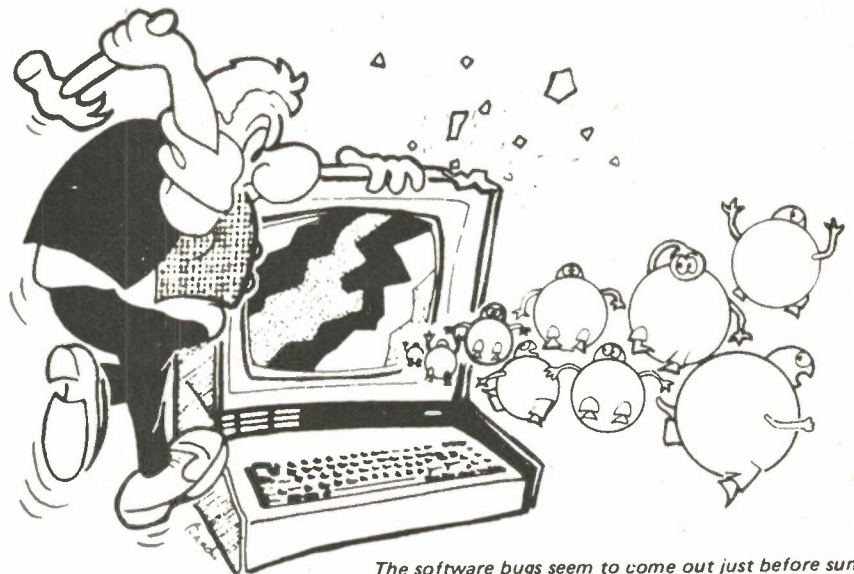
forging forth into extremes of technology (or bad practice, depending on how you look at it), generally revolving around a successful communication in spite of a red-hot "final", vast distances or an antenna made of wet string.

To the computer ham comparable feats entail successful execution of programs which are either exceptionally short or unbelievably long or so cunningly convoluted that not even the person who wrote it knows how it works. Thanks to the new technology involved there is also a whole new set of miracles which rely on getting a phenomenal number of logic functions into an incredibly small space.

Amateurs are in a rather unique position in that they are permitted to exceed manufacturers ratings to see to what limits they can push a particular component or piece of equipment. This practice gave rise to many novel techniques in the field of radio and a similar thing is bound to happen in computing.

TIME IS NOT MONEY

Amateurs make many other contributions to the science to which they are devoted as a result of the enormous amount of time they spend on their



DOING THE IMPOSSIBLE

Besides the resurrection of dead equipment, hams are keen on performing another type of miracle. This involves proving by practical demonstration that something which should by rights not be possible does, in fact, work. With amateur radio this usually entails

hobby. Because of the non-commercial nature of their pursuits, computer hobbyists can afford to undertake time-consuming projects which would not be economical as a professional enterprise.

Like the radio amateur who stays awake all night tuning across the bands looking for a rare contact, the computer

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John F. Thompson, NRI President

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ham often burns the midnight oil chasing an elusive bug in his software. Radio propagation never seems to be optimum at a civilized hour; similarly the software bugs only seem to come out just before sunrise.

With both amateur radio and amateur computing the real fun of the hobby lies in setting a goal and then achieving it no matter how long it takes or how inefficient the techniques used may be. The computer ham may devote hundreds of hours to developing a program that does nothing more than play a seemingly useless game. But, as with any technical hobby, a lot of valuable techniques are learned in the process.

SPREADING THE WORD

A natural development from any widely followed hobby is the formation of clubs where people with similar interests can meet and exchange ideas. Major amateur radio clubs like the Radio Society of Great Britain, the Amateur Radio Relay League and the Canadian Amateur Radio Federation have been established for many years and cater for hundreds of thousands of enthusiasts.

Even though the do-it-yourself computer hobby is so young there are already hundreds of computer hobby clubs. The biggest of these are found on the west coast of America which is where most of the world's microprocessor products originate. The Southern California Computing Society has many thousand members. At the moment there are over 200 smaller computer clubs in the USA and an estimated 20,000 people have their own personal computer.

The radio amateurs' "field day" has always provided a means of information exchange between individuals. As communication is the basis of ham radio, publicising such events poses no problems, but computer hams have only their specialist magazines for such promotion. A few conventions have been held by computer hobbyists where the main purpose has been to establish standards so that hobbyists can easily share the software they have developed. Manufacturers of personal computing hardware also take an interest in these gatherings because it is an excellent opportunity to find out what the hobbyist is interested in and therefore which products will sell.

SPEAKING OF COMPUTERS

Due to the unusually verbal nature of the hobby itself, radio amateurs have developed a unique vocabulary. The language which results has such a high jargon content and is spoken so fluently that it is quite unintelligible to the outsider. This serves to give the group its own identity and bind its members together.

Although amateur computing is still in its infancy its followers found that the computer industry had already provided them with a highly developed jargon, complete with an impressive range of off-the-shelf buzzwords which have been nurtured to perfection by 20 years of professional verbal dazzling. This they have eagerly seized and followers now have a language of their own.

The most telling sign of both radio and computer hams is their often amusing ability to construct seemingly meaningful sentences using all the rules of English grammar except that the keywords are replaced with strings of numbers or initials. The radio amateur might say, "QRX, I've got to check my SWR", while the computer amateur could hit you with, "I've put a PIA on my 6800 for I/O."

To the uninitiated talking in code like this seems like an awfully anti-social way of passing secret messages between club members. It serves to keep the in-group "in" by providing a feeling of comradeship for members and it keeps out all but the most determined newcomers.

FUTURE SHOCK (ELECTRIC)

Although personal computing is already well established as a hobby, the real impact of its advent is yet to come.

It is a characteristic of any hobby that those who pursue it develop great expertise in the field. A keen 10 year old stamp collector may know as much about stamps as a professional stamp dealer. Having spent his youth building radio transmitters a ham of 20 might know as much about radio as a University qualified electronic engineer.

We are now finding a new breed of hobbyist/expert, a hobbyist who has spent thousands of hours of leisure time building computers and programming them. He could well know more about computers than many professionals in

the field. As the hobby grows there will be more and more people to whom computers are second nature, people who are fully conversant with a broad range of computer concepts and totally up-to-date with the state of the art.

Traditional training and qualifications are already being seriously challenged by these hobbyists who might enroll in a University computer science course already knowing more than they will be taught.

As this flood of expertise hits the workforce we are bound to see dramatic changes in the status of the computer professional. Will there be a sudden surplus of computer engineers and programmers, or will the wave of new technology bring with it expansion of the industry to absorb it?

The remarkable advances in solid state technology which led to the development of microprocessors have made their mark on the electronics industry, but it's the "expertise explosion" which will follow that will have the real impact on society.

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Where?

Glenn Klassen of Winnipeg asks, "Where do we go?"

SOME TIME BACK Sir Wilfrid Laurier stated that the 20th century belongs to Canada. Obviously it doesn't, but it represents a type of progressive thinking that is lacking in Canada today. It seems apparent that we all look intent on keeping our own little corner of the world cosy, and let things be as they may. And in our apathy we all complain about weak, noncommittal leaders and dread the almost inevitable 1984 society.

What is the cost of this lack of self determination: rampant inflation, a plunging dollar, an unprecedented number of bankruptcies, a strangling bureaucracy, a massive national debt, the erosion of personal freedoms, and

more. And what do we hear about this dark cloud hanging on the horizon, voices echoing sentiments that we resign ourselves to being hewers of logs and drawers of water. One wonders how a nation as blessed as our own with talented people and resources could be in such a mess.

The problem is that we have left ourselves wandering around aimlessly for too long, leaving ourselves wide open for exploitation. The time is long overdue for setting goals for Canada. It is time we looked inwards at ourselves and determined what it is we want to do, what we want to be, and where we want to go. Not to look monolithically on a problem as small as the unity crisis.

Only when we have defined what our problems really are, can we determine their solution. Foreexample, we can only achieve a high quality of life only when we know what makes a high quality of life.

National goals, be they a conserver society or development of an electronics industry, should be set realistically with hard facts and the consensus of the majority. National purpose is an expression (*of faith*) in ourselves and the future. It is time we stopped looking to the American way of life as our model, and set our destiny. The decline and fall of the Canadian electronics industry demonstrates all too well what happens when we don't take control of our own destiny.

The only way to initiate this type of action is make yourself be heard. Politicians must take very seriously what their electorate has to say. And how can local representatives serve the people unless you let them know what you want. It's time we decided our future rather than the government bureaucracy.

CANADIAN PROJECTS BOOK NO. 1



5W Stereo Overled Bass Enhancer Disco Modules Metal Locator GSR Monitor

Fuzz Box Mastermind Reaction Tester Burglar Alarm Injector-Tracer Digital Voltmeter

HEART-RATE MONITOR

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

DOUBLE DICE

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

TOUCH ORGAN

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

PHASER

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

AUDIO LIMITER

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

SOUND-LIGHT FLASH

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

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CMOS Quickies

John Cox leads you into the world of CMOS: Complementary Symmetry Metal Oxide Semiconductor.

COSMOS TECHNOLOGY had hardly appeared before human ingenuity began to come up with the usual 'thousands of applications.' The 'quickie' projects here illustrates some of the things you can do with the humble CD4001 NOR gate. More importantly, they point you in the direction of using this simple and inexpensive chip to realise dozens of useful circuit functions for your own projects.

JUST FOR STARTERS

The basic COSMOS chips — gates and inverters — are ideal building blocks for many purposes besides their nominal ones. In fact, as we shall find out, they can even be used as linear amplifiers! Fig. 1 shows the internal schematics of a COSMOS inverter and NOR gate respectively, plus other basic principles. Although all the projects in this story use the 4001 NOR gate, operation is best understood by looking first at the simple inverter of Fig. 1A. Consider that the two FETs act as variable resistors. The upper (P-MOS) has a normal channel resistance of about 10kMeg, which drops to around 400 ohms when a negative voltage is applied to the gate; the lower (N-MOS) has similar characteristics, except that it is driven 'on' by a positive gate voltage. The two therefore act as a voltage divider, the voltage at point X of Fig. 1C being determined by the voltage applied to the two gates, which are tied together. Theoretically, a voltage of $V+/2$ applied to the gates will produce

the same voltage at point X, though in practice this is rather approximate due to production tolerances. A negative voltage on the gates will make the upper FET low in resistance, the lower FET high, thus producing an output 'high' (the voltage through the FETs dividing approximately 400:10⁹); a positive gate voltage will have the opposite effect and make the output near 0V.

The NOR gate of Fig. 1B uses four FETs in series-parallel. For a positive output both upper transistors must be 'on' and both lower ones must be 'off,'

i.e., a negative voltage must be applied to both gates, but a positive gate signal to either input will turn one or other upper transistor 'off,' which, since they

Fig. 1 (a)

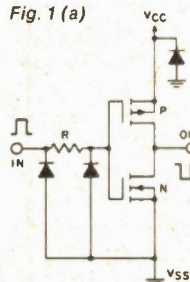


Fig. 1 (b)

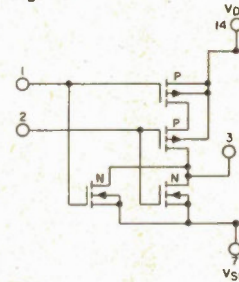
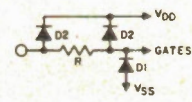
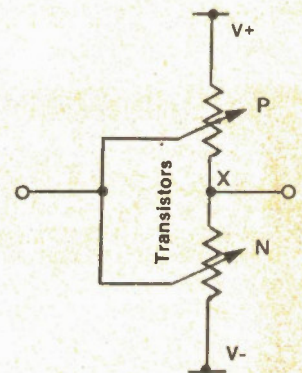


Fig. 1 Internal schematics of COSMOS NOT gate (inverter) and NOR gate. In (c) the FETs are pictured as variable resistors; the resistance of the upper (P-MOS) drops from infinitely high (around 10kMeg) to about 400 ohms when a negative voltage is applied to the gate, while the lower (N-MOS) works in vice-versa fashion. Together the FETs form a voltage divider, with the voltage at junction X determined by the input signal.

The input protection network is shown in d. Usually it does not affect operation, though in some cases (as in the Astable MV used in our 'tone generator') the diodes do perform a necessary role besides protecting the FETs — see text. e shows the 4001 pinout.

Fig. 1 (c)



D1 = 25 V
D2 = 50 V
R = 200 TO 2000 Ω

Fig. 1 (d)

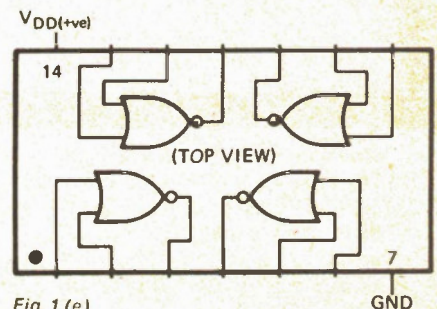


Fig. 1 (e)

are in series, will prevent the output from going high. This accomplishes the NOR function, and also gives us a useful gating facility, for connecting either input to 0V will turn the associated upper FET 'on' and leave the other pair free to act as an inverting amplifier, whereas connecting either input to V+ will turn its associated upper transistor 'off' and prevent the output from going high regardless of what signal is fed to the other pair. If the two inputs are tied together the two pairs of FETs track together; and the gate performs as a straight inverter without gating. The NOR gate is therefore more versatile than a plain inverter, which is why we have chosen the 4001 for our projects.

Fig. 1D illustrates the built-in gate protection, which you can forget about in most applications, though we will find the diodes serve 'external circuit' functions in some cases (e.g., the Astable MV Tone Generator described later). Finally, Fig. 1E shows the pinout of the 4001

SERIES

The reader should note that there are two series of CMOS chips available, loosely referred to as A and B series. This article generally refers to A series devices regarding specs. The B chips are identical in digital function, but able to supply higher output currents. They cannot be used in the linear mode, since if they are biased to the midpoint both output transistors are fairly on, thereby drawing much current and dissipating destructive amounts of heat.

The extra letter is generally tacked on somewhere at the end, such as in RCA's devices: CD4001AE and CD4001BE.

VIBRATORS

COSMOS inverters and NOR gates are especially handy for building multivibrators (which we shall refer to as MVs) — monostable, bistable and astable — with a minimum of external components, but you can use them as linear amplifiers, too, as is depicted in Fig. 2a and 2b. In Fig. 2A the input(s) is biased by feedback resistor Rf. Because of the high input impedance of FETs, there is virtually no voltage drop across Rf, and the circuit automatically

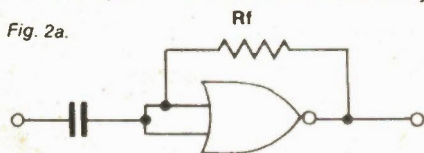
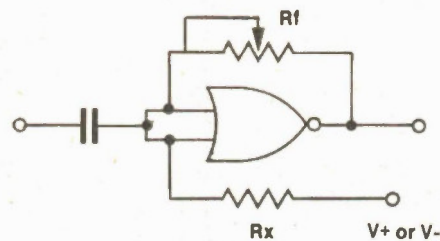


Fig. 2a.

Fig. 2. Biasing a 4001A for linear operation. V_{in} V_{out} $V+/2$ (no signal)

Fig. 2b.



biases itself at $V+/2$. However, this simple arrangement is not always adequate, due to chip variations; Fig. 2b shows how the midpoint can be precisely set by making Rf variable and adding Rx, which is connected to either V+ or V-, whichever is necessary to centre the bias point at $V+/2$. Note that an input capacitor must be used with this type of circuit, and if it is desired to use a feedback divider network to control gain, this must be strictly AC (that is, capacitor-isolated). Used in linear mode, COSMOS chips have very high gain at low levels of supply voltage (3V - 5V), but gain reduces as supply volts are increased. The net effect of these facts of life is to limit your expectations, but there are still many ways in which COSMOS can be used in linear mode to advantage. (One very ingenious example was given in J. P. Macauley's 'Cosmos Radio,' which was featured in Tech Tips, ETI, April 1978). In the 'Electronic Bell,' below, we have combined two linear phase shift oscillators, both in a single 4001 chip.

COSMIC CONSCIOUSNESS AND COMMON SENSE

At first sight, COSMOS sometimes seems too good to be true to some people (practically zero current consumption?) and too true to be good to others (don't go near it, you'll blow the gate!). The best approach is, forget about the rumours, but do bear the following in mind:

1. COSMOS current consumption is, indeed, negligible during quiescent conditions (with output low), and that makes COSMOS especially suitable for battery-operated circuits. But power requirements rise sharply during actual switching, the mean current draw depending on frequency. At 5Mhz COSMOS uses about the same amount of power as its TTL equivalent, and at higher frequencies than this, appreciably more.

2. The output capability of COSMOS is low, being typically 2.5 mA for a CD4001AE when used as a source and 1mA when used as a sink, at $V+ = 10V$. This is only a fraction of what we get

from, say, OpAmps used at similar values of V_{supply} , but is ample to drive other COSMOS devices because of their high input impedance. It is usually enough, also, to drive small signal transistors; a series resistor may be needed to limit the current if necessary.

3. The input protection devices make it next to impossible to blow a COSMOS gate with static discharge, but if you're bent on destruction there are plenty of ways left to go. One obvious one is to connect the supply the wrong way round; not so obvious is to connect a capacitor directly to the input (always insert a 1k series resistor therefore), feed in an input signal while the supply is disconnected, or feed in a signal of an amplitude higher than V_{supply} . It is also good practice to connect any unused input terminals to either the (+) or (-) rail.

The above pointers show that all you need is common sense, and that given that quality you'll find COSMOS as rugged as any other solid state technology. More rugged, in fact, in some ways — you can put a direct short across the output and still not blow the chip! (Which, if you are like this writer, is very comforting to know).

AUTO TURN-OFF TIME SWITCH.

This is the electronic version of those mechanical switches sometimes installed in industrial bathrooms, whose purpose is to turn off the light before you get through, thus saving the world from another energy crisis. No doubt you can think of many other amusing and even useful applications.

Basically, this circuit is a triggered monostable multivibrator (MV), or one which delivers a pulse (= output high) when triggered, the duration of the pulse being determined by the circuit's RC component values. It has one stable state to which it returns and in which it normally 'sits,' hence the name 'monostable.' You can build any kind of MV using two amplifiers, and since gates are amplifiers, the 4001's four gates allow you to build two MVs with a single chip and a minimum of external components — in fact, only the RC timing network and trigger arrangement need be added for a monostable.

If you look at Fig. 3, you will see that the circuit normally locks itself in to a state where B's output is low and A's is high. There is no voltage across C1, making B's inputs high and (since it is acting as an inverting amplifier) its output low. This also makes A's #1 input

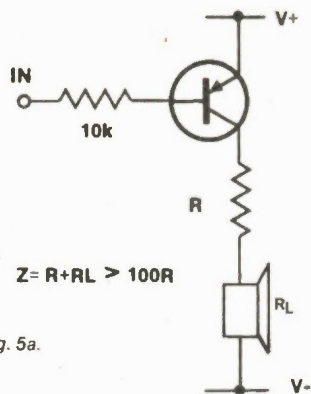


Fig. 5a.

Fig. 5. A shows a low power audio stage you can add to the Astable MV; the combined impedance of R and RL should be greater than 100 ohms.

disconnecting the #1 and #2 inputs of gate A and using the #1 input as a control terminal. Gate A will refuse to switch when #1 input is clamped to a positive voltage.

The actual frequency you will get with this circuit is little hard to predict because it depends to some extent on the transfer characteristics of the 4001 gates, which have rather a large production spread. Therefore it is usually necessary to trim R1, which can be done by making it a potentiometer.

Our present tone generator uses the circuit of Fig. 4, and with the component values shown gives a frequency range of (roughly) 600Hz — 6000Hz, according to the setting of R1. The gating facility is used to switch the tone on and off, and our PCB is arranged so that the switch terminals are on one side and the output terminals on the other. This, along with its compactness (two tone generators per chip/PCB), makes it very useful for use with keyboard-switch instruments, as well as economical — in fact, you could provide tone generators for three octaves with only 18 4001s. In such a case, you would no doubt repeat the PCB pattern several times per board rather than make separate 'little' PCBs.

The tone generator is, of course, a building block rather than a complete project. You will no doubt want to amplify the tones to drive a loudspeaker, and for this one the circuits of Fig. 5 can be used. Fig. 5b will give you 10W at $V^+ = 15v$, which is very loud indeed, if your power supply is up to it. Or you may prefer to use a regular linear amplifier, which might incorporate volume and tone controls — even wave shaping, if you want to go that far. Indeed, you might end up with a synthesiser, to which all we can say is 'Good Luck!'.

PULSED ALARMUS

The tone generator above could

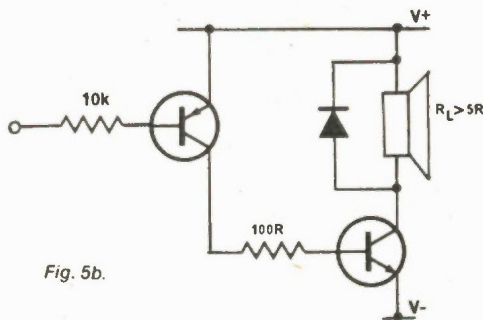


Fig. 5b.

B is a higher power stage which will give you about 10W at a supply voltage of 15V. You'll need a 1A supply to get this much power, however.

make a good alarm, but pulsing it raises it to the 'alarum' status! This is very simply achieved by using its gating facility to make a second astable MV turn it on and off at a more or less rapid rate. In Fig. 6, the tone generator formed by gates C and D (working at about 800Hz) is pulsed by the A and B astable MV, which operates at about 6Hz. You could, of course, alter R and/or C in either section to change the tone or slow the pulsing down for a thoroughly 'naval' sounding alarm. You could get some pretty lighting effects also, if you substituted a relay or SCR for the audio stage.

The schematic shown for this project is dual purpose, i.e., it can also be used for the Warbler which comes next. The difference is that the Warbler has three additional components (R3, R4 and D2 in Fig. 6). To build the Pulsed Alarum version, connect a jumper wire in place of R3 of Fig. 6 and omit R4 and D2.

WARBLER

As you can see from Fig. 6 this is very similar to the Pulsed Alarum above. Instead of switching the C-D tone

generator on and off (pulse mode), the A-B astable MV modulates it by varying the time period. Again, 6Hz and 800Hz are the frequencies used, but you can vary either or both to produce a variety of different effects.

The principle of modulating an astable MV in this way suggests, and has been used for some sophisticated forms of colour organ. These are somewhat beyond the scope of this story, but since we know how ingenious (not to say sophisticated!) our readers are, we will leave you with the thought in your head!

FRIAR GLICK'S NOSTRUM

Yet another astable, but put here to a very different and noble cause. (At least it may help you unruffle from the effects of blasting your eardrums with the previous projects — or perhaps from two many 'highs' and 'lows' multivibrating in your head). Here we have an MV running at frequencies ranging from approximately one or two hertz to above 30Hz, according to the setting of VR1. The four gates of the 4001 are used here, sections C and D being paralleled to provide additional amplification, and the output is fed to Q1 and Q2. Q1 amplifies and differentiates the signal via D1-3, producing a 'spike' across coil L1, while Q2 drives an LED which gives a visual indication of frequency.

The purpose of all this is to create a low frequency pulsed magnetic field, which is said by certain eminent doctors and researchers to help relieve symptoms of rheumatism, stress, allergy and all manner of ailments. Does it work? According to tests in the field, it helps sufferers, but being

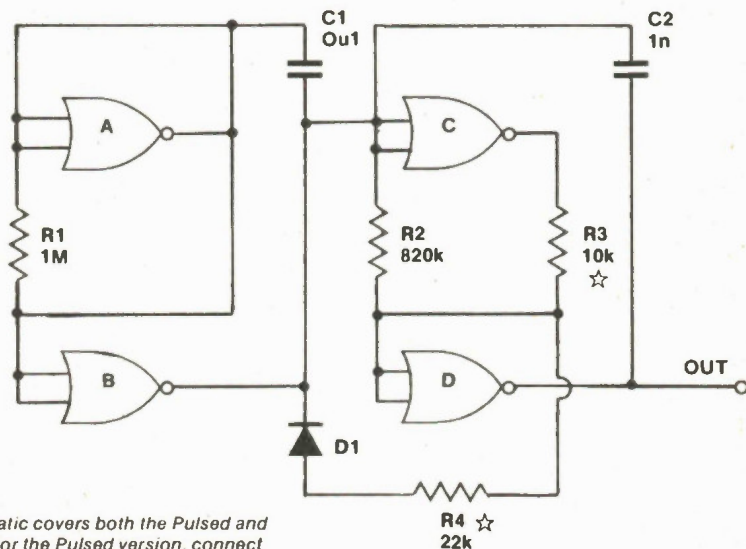
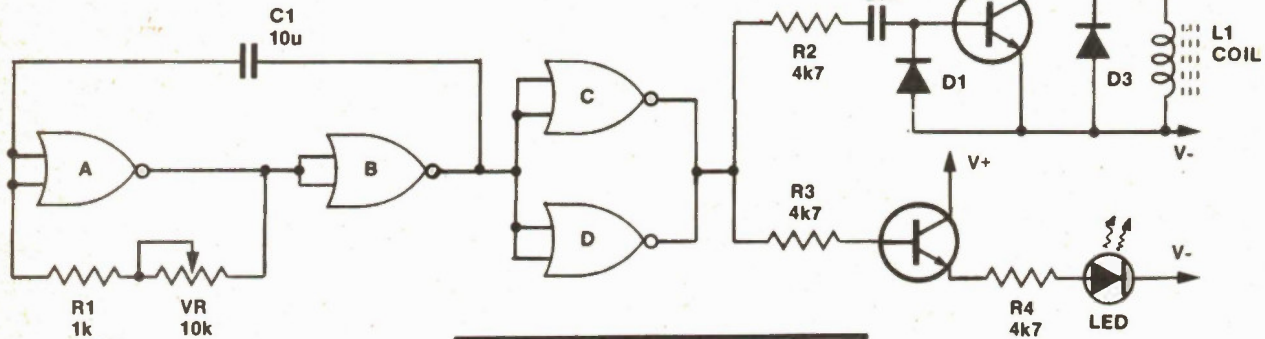


Fig. 6. This schematic covers both the Pulsed and Warble Alarums. For the Pulsed version, connect a jumper across R3* and omit R4* and D1*.

Fig. 7. Friar Glick's Nostrum, a device to take the devil out of people. Note that a transistor radio volume control fits nicely; if you also cut the PCB along the line X-X the device will fit a king-size cigarette pack with the

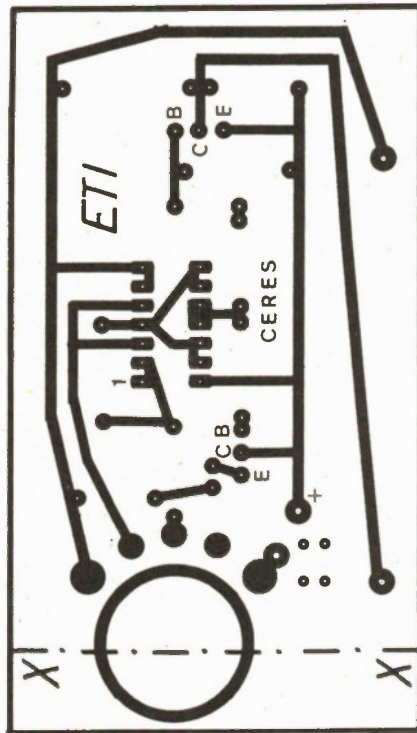
pack can be reinforced on the inside with epoxy glue). If you don't need a nostrum, you can adapt this circuit to other uses, since it will go up to RF with the right RC values. It's also the 1384th light flasher to appear in a magazine.



sceptical of modern research claims I asked my doctor what he thought. He replied that magnetism helped relax muscles, the ancient Egyptians had used magnets for that purpose, and his wife 'wouldn't be without one.' As for pulsed magnetic fields — the Egyptians, it seem, were onto that too; they used a spinning magnet to achieve an alternating effect mechanically. Later, in the middle ages, a certain Friar Glick travelled about Europe and made quite a good living out of his 'holy lodestone, which possesseth thuch an attraction for devils that when it be held at a short distance from the body of one afflicted by evil spirits, the demons "straightway fly into the lodestone to be entrapp'd therein for all eternity."

To all which one might add that the device (1978 version) covers the well known neuron switching frequency bands (alpha, beta etc.), and the tendency of the human nervous system to track with external frequencies (the 'natural' frequency of the earth coinciding with the alpha range, as it happens) may explain partly why the device may help the individual. No doubt it would be the ideal gift for arthritic relatives.

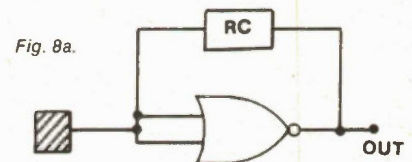
Besides the PCB, we have a photo for this project showing how the components are laid out. L1 consists of 600 turns of #38 wire around a core made up of two steel bolts which were previously laid end-to-end and taped together with Scotch 'Magic' tape. The result is compact and pocketable as you can see — and can be used for general application (in a pocket) or local field therapy, e.g. to treat a painful joint. (Not *that* kind!).



DINGS & DONGS

Everyone knows what a 'ding' is, and 'dongs' are very similar. The circuit of Fig. 8a is a simple way to achieve them. Here, the 4001A is set up as a phase shift oscillator (yes, this is linear model!) using the configuration of Fig. 8c. Adjustment of VR allows the circuit to be set just short of the oscillation point, but any disturbance will start it up. Oscillation is not sustained, so in practice the disturbance produces a 'ding' which dies away gradually, sounding very much like a bell. The pitch can be altered by varying the RC values of the feedback network, and effects from triangles to gongs are possible.

This circuit is very sensitive due to the high input impedance of the 4001A, and while Fig. 8a shows a conventional touch pad (a small square of PCB will do) connected to the inputs, the necessary 'disturbance' can be obtained by touching virtually any exposed point of the wiring. In fact, it is so sensitive that just touching a screwdriver to a piece of metal nearby (not connected to the circuit in any way) is often enough to ring the bell.



When the touch pad of Fig. 8a is used there is a tendency for 60Hz hum to be picked up from the operator's finger and be amplified. More practicable is the pushbutton arrangement of Fig. 8b. Due to R4 and R5 both inputs are effectively at 0V until a positive trigger is applied to #1. As explained earlier, grounding either input turns its associated upper FET 'on,' therefore, with #2 permanently at 0V, the #1 pair are free to behave as an inverter. (If you're not sure, check this out with the diagram of Fig. 1b).

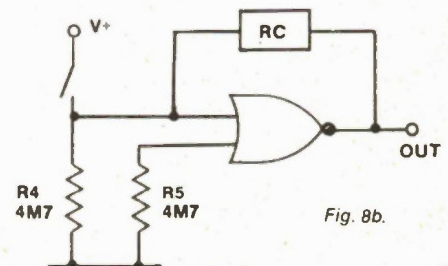


Fig. 8. Dings & Dongs. a shows a touch-triggered 'ding' generator. b: pushbutton version of a. c: RC phase shift network for 'dingdong' circuit. For 'bell' effect, use $R1 = R2 = 150k$, $C2 = C3 = 0.001\mu$, and $C1 = 0.005\mu$; for repeater in Fig. 8e (low frequency version) use $R1 = R2 = 1M$, $C2 = C3 = 0.015\mu$, and $C1 = 0.22\mu$. $R3$ should be $2M\Omega$ and $VR = 100k$ in both cases. d: For a two-tone 'dingdong,' use circuit of B, but use pushbutton to connect X or Y junction to $V+$ via series resistor. Try different resistor values, also try capacitor (see text). e: Circuit of Electronic Bell. f: Phase shift oscillator should see high impedance ahead. Try this network to feed into linear audio amplifier.

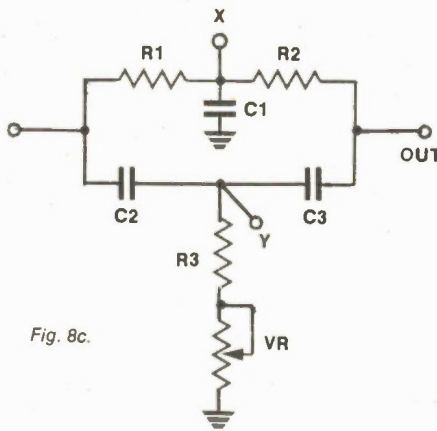


Fig. 8c.



Fig. 8d.

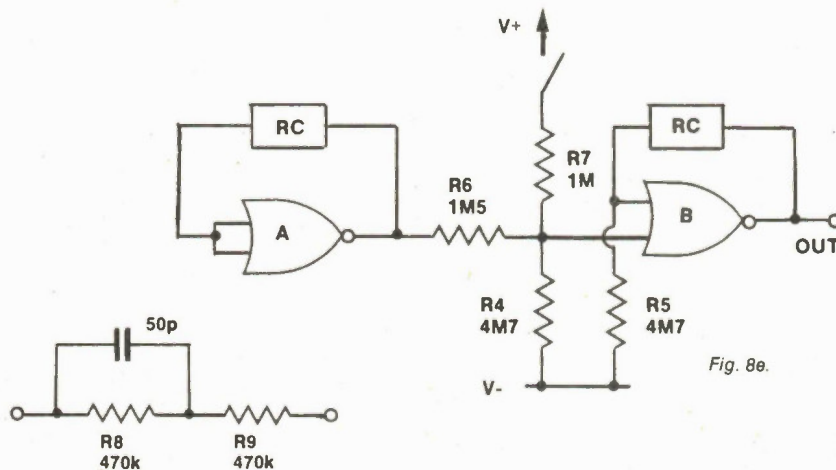


Fig. 8e.

Without making any other changes to Fig. 8b, you could remove the pushbutton switch from the input and use it to join either RC network junction point (X or Y) to $V+$ via a series resistor. Now when you press the button you will get a 'dingdong' or a 'dongding' (depending on which junction you use), the 'dong' occurring because you are triggering the circuit and cutting it off at almost the same time. If you try a capacitor in place of R in Fig. 8d you will get sustained oscillation when you press the switch (due to changing the RC network characteristic) which will die away gradually when the switch is released. Different values of capacitor will give different effects and the resulting sound is hard to classify.

In Fig. 8e we have an Automatic Ding Repeater, otherwise known as an Electronic Bell. In this, A is used as a low frequency oscillator to trigger B repeatedly (which is set up as before). There is a snag to this, namely that the switching tends to cause a 'click' as well as a 'ding,' however, use of a phase shift oscillator rather than an MV, plus the highest value possible for R6, minimises the effect and results in a

realistic 'telephone bell' type sound. It is also desirable to use a regular linear audio amplifier after the 4001 rather than the switching amplifiers shown earlier in Fig. 5, as is the case with previous 'dingdong' configurations. Probably anyone who goes this route for an electric bell rather than just go to the store and buy one is nuts, but from the viewpoint of experimental fun and amusing your friends it's a good one. When you've exhausted the fun and your friends have drifted off to seek more exotic entertainments, you will at least find yourself left with a very practical sinewave oscillator.

COSMOS FLIPFLOP

You can make a Flipflop with any pair of amplifiers, since it is really just another form of MV (called 'Bistable' because it will sit in either of two states indefinitely, changing state when a trigger is applied). Fig. 9 shows how this is accomplished with the 4001. However, this time we are not going to illustrate with an application, even though there are dozens one could

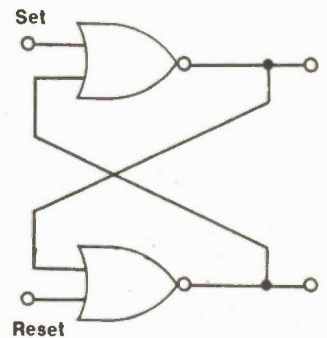


Fig. 9. 4001 Flipflop. A positive pulse to Set or Reset input will cause the outputs to change state and latch. Outputs are complementary (if A is high, B is low and vice versa). This is an RS flipflop, and you are on your own with it — but you might win a prize if you are smart!

think of. Instead, we are going to challenge you to see what **you** can come up with! We feel that anyone who has read this far deserves encouragement, so we are offering some modest prizes to those who can show their mastery of 4001 chips, plus a spot of imagination.

CONTEST

The senders of the four best and most cosmic circuits will each receive a free set of the new PC layout product, CERESIST, consisting of 14 sheets of dry transfers for pads, lines, IC sockets etc. These can be used directly on PCBs which are then ready-to-etch, so this prize should be very welcome to all you creative geniuses. Anyone can enter, but in order to win the following rules must be observed:

1. Your circuit must be based essentially on the 4001, i.e., you can add a transistor audio or booster stage, for instance, but the main circuit function must be accomplished by a CD4001.
2. Your circuit can be anything you like — logic, MV or linear application — and you can use up to 6 complete ICs (that's 24 NOR gates).
3. Circuits should be accompanied by a clear explanation of how they work. No special points will be awarded for the 'literary effort' but it will certainly count in overall evaluation.
4. Neatness and clarity will influence the judging — in fact, entries that look like a can of worms will not be judged at all!
5. In order not to weight the contest too heavily in favour of those who have been around in electronics a long time, two of the four prizes will be reserved for those over 21, one for those 17-21, and one for those under 17. You must state

which class you are in. (And there's no point claiming you're under 17, they're the smartest!)

6. Circuits of merit which do not win prizes will be submitted to the editor of ETI for consideration for 'Tech Tips.' There will also be additional sheets of CERESIST for those who show merit but whose ideas cannot be used.

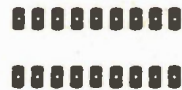
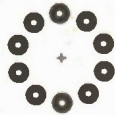
7. Entries must be received at ETI not later than October 15th, 1978. Writers, employees etc. of ETI (sorry, Wally Parsons, that's what you get for being a contributing editor!) are not eligible.

8. Winners will be notified by mail, results published in December News Digest.

9. Mail to: "COSMIC CONTEST", ETI Magazine, 25 Overlea Blvd., Unit 6, Toronto, Ontario M4H 1B1.

The four main prizes are each worth \$27.86 in the stores, so lay in a stock of chips and get working on it now!

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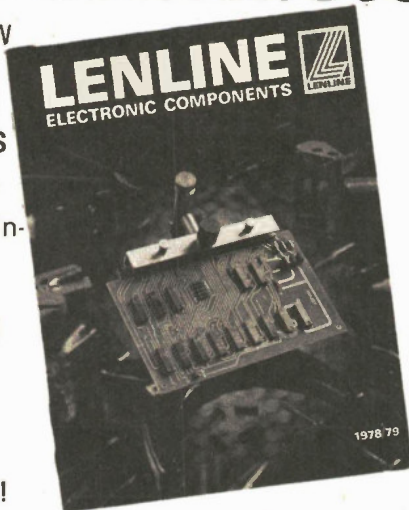
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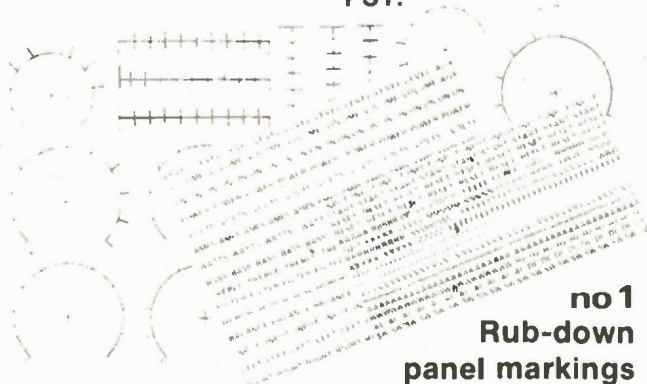
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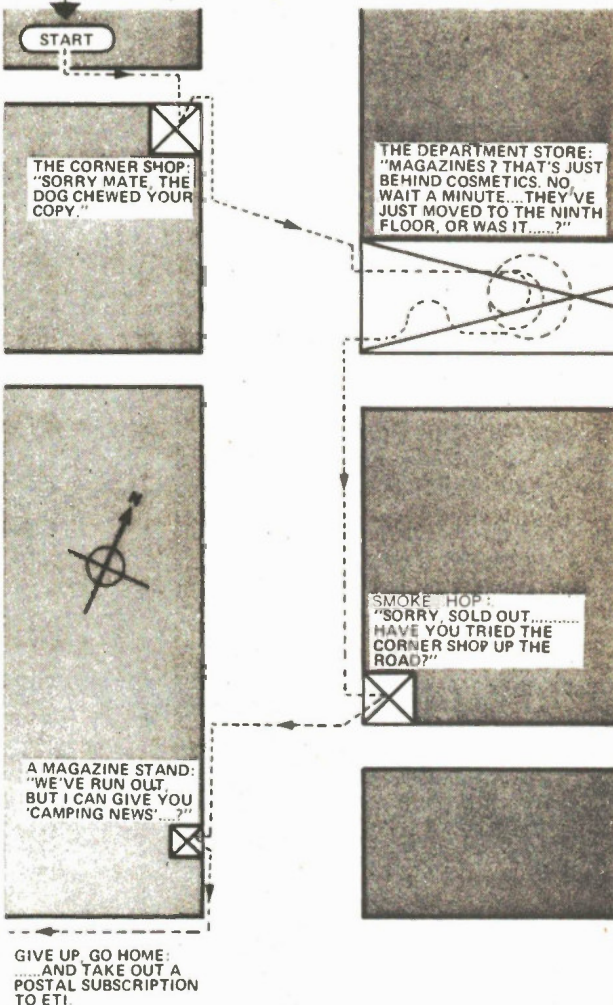
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Techniques for SSB by Phasing

Most people view phasing SSB as a technique belonging to the past. However, in this article Roger Harrison hopes to phase reverse your thinking by presenting some circuit ideas that are rare or non-existent in the amateur literature.

THE SINGLE SIDEBAND mode of transmitting voice signals has long been recognised as making very efficient use of transmitter power and available bandwidth.

In standard AM (amplitude modulation) systems the transmitted signal consists of the carrier and two sidebands. Disposing of the carrier saves at least 67% of the transmitter power, leaving only that power which is contained in the sidebands and is thus being usefully used in information transmission. By then using the power all in one sideband rather than two, less RF bandwidth is used with no loss of intelligibility, but allowing more users in the available space. The big problem with this marvellous system is how to generate the one sideband. Two major methods have been tried.

One of these methods, most commonly employed today, first generates at low power levels an AM signal, then uses sharp filters to knock out the carrier and one of the

sidebands. This signal is then amplified and transmitted. This system is limited by the sharpness of the filters available, and their cost.

The second system attempts to cancel out the carrier and undesired sideband by clever phasing and subtraction of the carrier and audio signals. This system's chief problem is the difficulty of generating a 90 degree out of phase audio signal.

The classic phasing method of SSB

generation is shown in Fig. 1. Traditionally, the audio phase-shift network used passive techniques usually employing R-C components (see references 3 and 4), although active 90° audio phase difference circuits were sometimes used (references 5 and 6).

Audio phase shift networks using L-C or R-L-C components are rare in literature, but a good circuit is described in reference 7.

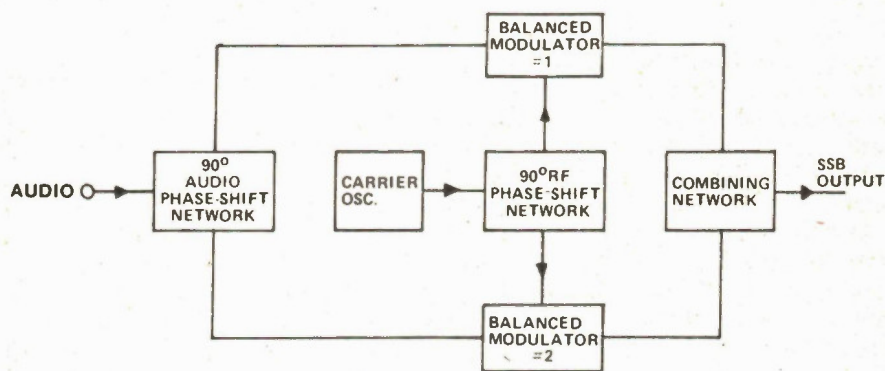


Fig. 1. Phasing method of SSB generation.

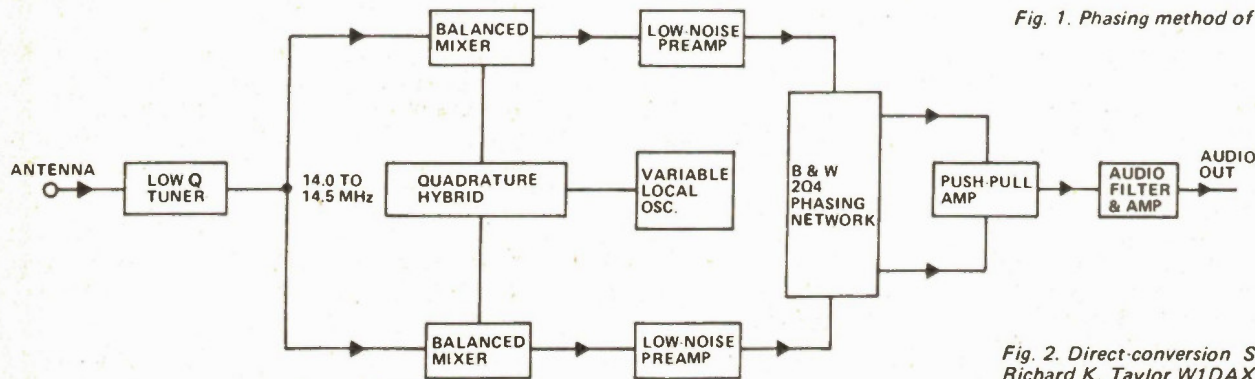


Fig. 2. Direct-conversion SSB receiver by Richard K. Taylor W1DAX (reference 9).

A modern active quadrature phase difference network was recently described by Dickey that used op-amps and R-C networks — see reference 8. We shall return to that one too.

These networks are all designed to provide a phase difference, between two output terminals, of 90° within $\pm 1^\circ$ or so across the speech band from 300 Hz to 3 kHz or thereabouts. The text books will tell you that this sort of performance results in an opposite sideband suppression of -40 dB, which is generally regarded as a respectable figure. At the same time the amplitudes of the outputs must remain within 2% of each other to maintain the same performance. It is probably not worth striving for much better than this as the intermodulation distortion of any amplifiers succeeding the SSB generator will be greater than the level quoted.

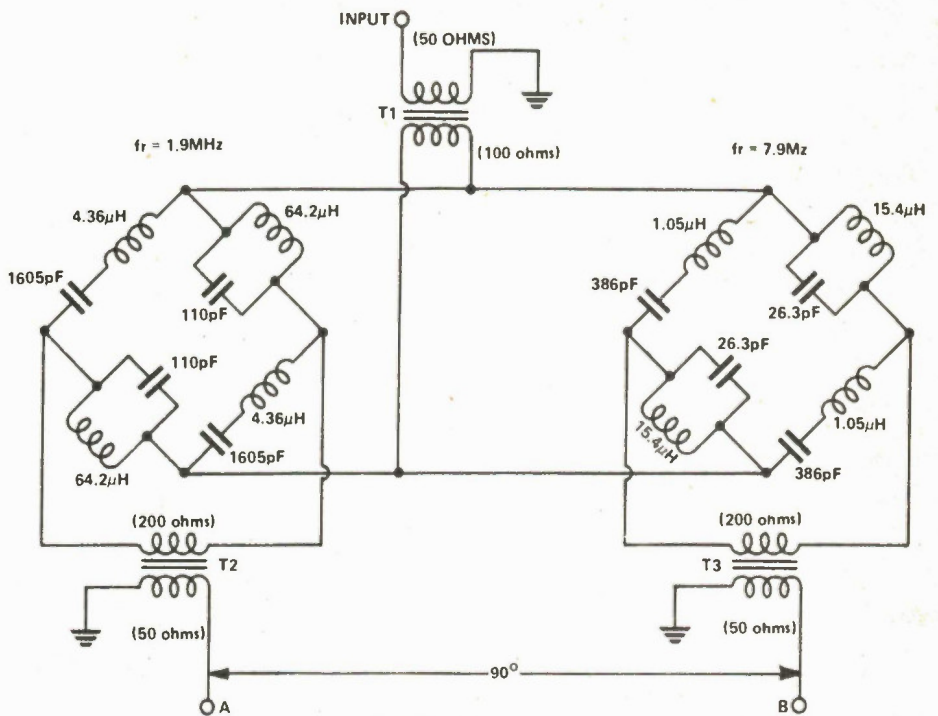
The RF quadrature phase difference networks were traditionally designed for single-frequency operation or operation over a very narrow band. A wide variety of techniques have been employed over the years, ranging from simple R-C circuits to coupled coils. Thus, the SSB was generated on one frequency and then heterodyned to the desired output frequency. Specifications for the RF PSN are similar to that for the audio PSN.

One of the drawbacks of phasing SSB, that accounted for much of the subsequent popularity of the filter method, was the alignment and the long-term stability problems of the phasing technique. I now think that a phase-reversal on that view is possible also.

To digress a little, let us consider for a moment direct-conversion techniques for SSB reception and perhaps generation. In 'Single Sideband for the Radio Amateur' (reference 9), Richard Taylor W1DAX describes a direct-conversion SSB receiver. A block diagram is shown in Fig. 2. The RF PSN covered the 20 m amateur band allowing the use of a variable local oscillator. If this technique is applied to Fig. 1 then we have direct-generation of SSB by the phasing method. Aha!

In one stroke we get rid of all those mixers and their nasty multiple-outputs-on-all-sorts-of-frequencies-including-the-one-we-want that is necessary when SSB is generated on one frequency and then heterodyned to the output frequency — usually including a VFO and band-switching arrangement along the way.

But . . . I can hear you all saying, that's (Fig. 2) only in a single band.



T1, T2, T3 — see text.

Fig. 3. Wideband RF quadrature phase difference network covering the range 1 MHz to 15 MHz designed by Jim Koehler, VE5FP. This network maintains a 90° phase difference between A and B within less than 1° across the range, and output amplitudes within 0.5 dB.

Each arm in each bridge network is adjusted to resonate at the frequency shown.

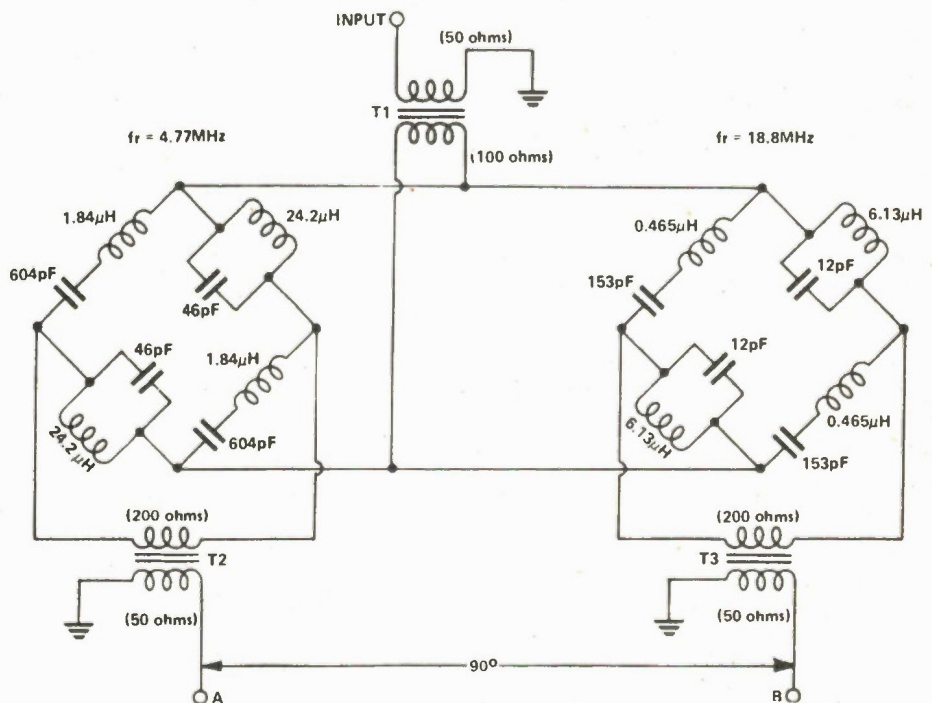


Fig. 4. Wideband RF quadrature phase network similar to Fig. 3. but covering 3-30 MHz.

What we need is a passive, wideband RF quadrature phase difference network. Right on!

PASSIVE, WIDEBAND RF QUADRATURE PHASE DIFFERENCE NETWORKS

Now this is where the story really starts. Peruse Fig. 3. This network is courtesy of Jim Koehler VE5FP/VK2B0V who designed it for a circularly polarised ionospheric antenna system during his sabbatical leave in Australia during 1974-75. Two bridge networks provide a 90° phase difference over the range 1 MHz to 15 MHz with a phase error of less than 1° and amplitude differences between the outputs less than 0.5 dB across the range. A similar network covering the decade from 3 MHz to 30 MHz is shown in Fig. 4. It has similar characteristics.

The input and output port impedances are 200 ohms for each bridge in the networks. The transformers T2 and T3 are wideband 4:1 RF transformers. These are available from commercial sources or you can make one yourself.

If desired, the output windings of T2 and T3 may drive the input ports of diode-ring double balanced mixers directly.

Although the inputs of each bridge in the network are in parallel, resulting in an input impedance to the network of 100 ohms, T1 may be the same as T2 and T3 as the mismatch has no serious effect on the performance of the network.

The Q of each inductor in the network must be above 50 or 60, preferably higher, and the coupling between each arm of a bridge, other than the direct connection, must be kept to a minimum. Toroids are therefore recommended and have proved quite successful. As an alternative, standard coil formers and screened-can assemblies have been used but the Q must be adequate. Ferrite cup-cores used in conjunction with these assemblies are pretty well a must for this job. The data for the inductors specifies the use of some small toroids which result in quite high Q inductors of very small size.

Each arm (one L and one C) is constructed individually and the inductor is adjusted to resonate at the frequency indicated by squeezing or spreading the turns around the core of the toroid until resonance is achieved. A GDO was used to indicate resonance. A

monitoring receiver is used to indicate how close to the frequency the GDO is.

An accuracy of 10-20 kHz is sufficient. This operation should be carried out with the components in situ before they are finally connected as per the circuit.

The required capacitors may be selected by measuring a batch and using those of appropriate value. Where several are used in parallel or series to make up a value, they may be temporarily tacked together and measured, one of them being changed as necessary to arrive at or very near the required value. Values within ±5% of the specified value are near enough.

Keep the layout symmetrical and uncluttered. Avoid long leads to the transformers.

Active wideband RF quadrature phase difference circuits have been described (reference 2 and 10). These use digital techniques which I won't go into here. The non-sinusoidal output waveforms of these circuits causes problems with spurious, and, although harmonics may be removed with low-pass filters following the generator, circuit simplicity is lost and the extra spurious are a factor that has to be taken into consideration. See reference 2.

AN UNUSUAL PASSIVE AUDIO PSN

The circuit in Fig. 5 is from reference 7. The network was designed by

Westinghouse in 1944 and subsequently described by Cheek (W3LOE) in 1948 as part of a phasing-type SSB exciter. In contrast to most R-C PSN's, which call for component values within 1%, the components in this network are relatively non-critical. The resistors and capacitors may be standard 5% or 10% tolerance types. Composition resistors and paper capacitors were used in the circuit described by Cheek. The main requirement is that each 40 mH inductor must resonate with the 1 μF capacitor at 800 Hz. The exact values appear to be uncritical so long as components of the nominal value specified are used. The 6 H inductor and the 6.2 nF capacitor must resonate at 800 Hz also. In the original description, Cheek used re-wound audio transformers for L1 and T1 and two 3 H low current power supply chokes in series for L2.

The 40 mH inductors may be made from 88 mH toroids, which are popular with RTTY enthusiasts. These consist of two 44 mH coils wound on a toroid and connected in series. Turns may be removed from the 44 mH winding until resonance is achieved, using a 1 μF capacitor to tune the winding. For this operation, an oscilloscope or VTVM and an audio oscillator are necessary. The oscillator could be coupled to the toroid by means of an added temporary link. Resonance should occur close to 800 Hz. The exact frequency has no magic about it, 800 Hz is simply the geometric mean between 160 Hz and

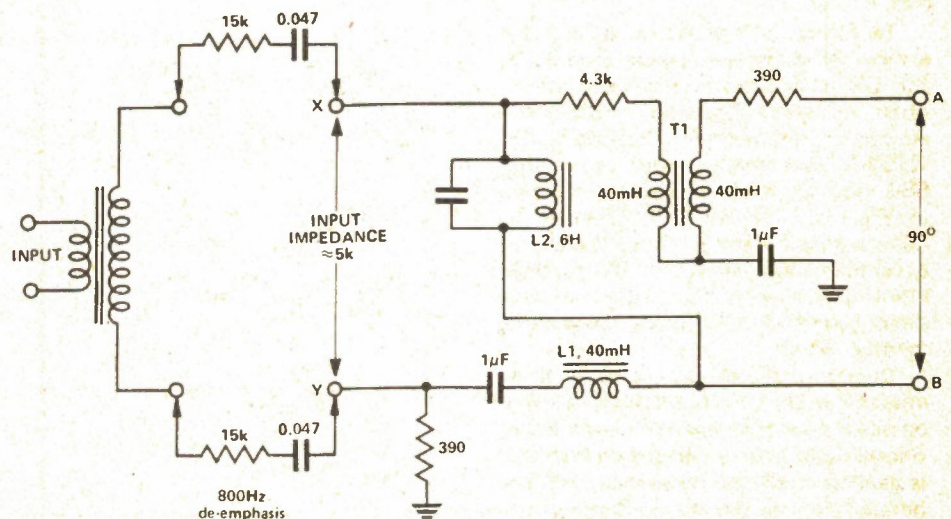


Fig. 5. Audio quadrature PSN using RLC components. This circuit was developed by Westinghouse in 1944 and described subsequently by Robert Cheek (W3LOE) in Nov. 1948 CQ.

4000 Hz which adequately covers the speech band. What is important is that each LC pair of the network resonates to the same frequency. This could just as easily be 750 Hz (geometric mean between 200 Hz and 2800 Hz) or 900 Hz (geometric mean between 270 Hz and 3000 Hz).

The transformer, T1, consists of two windings having equal numbers of turns wound on the same core resonated at 800 Hz (or whatever) with the 1 μ F capacitor. The two windings are connected in series, the dots on the circuit in Fig. 5 indicating the start of each winding.

Alternatively, each inductor may be wound on a standard pot-core assembly or a suitable low frequency toroid. Ordinary polyfilm capacitors are suitable.

The two quadrature outputs can drive into a low impedance, the characteristics of the PSN being largely unaffected by the actual load impedance, which may be as low as 400 ohms. Input impedance is about 5 k and should be floating with respect to ground — which necessitates a transformer or differential amplifier.

The speech amplifier preceding the PSN must include de-emphasis below 800 Hz. If the network is transformer driven a de-emphasis network consisting of two 15 k resistors and two 47 nF capacitors, connected in series with each input terminal, serves this purpose. The input impedance is then about 40 k and the input transformer should be suitable to drive this impedance. This is suggested by Cheek in reference 7.

This network maintains the 90° phase shift within $\pm 1^\circ$ or better between 300 Hz and 3.5 kHz. The amplitude balance between the quadrature outputs is within 2% or better between 200 Hz and 4 kHz. Thus, an opposite sideband suppression of -40 dB is readily maintained across the speech band and beyond. This together with the low input and output impedances and the relatively non-critical nature of the components gives this circuit some advantages over the more common RC audio quadrature phase-shift networks. The overall loss is about 12-14 dB (excluding the de-emphasis circuit). Naturally, the audio stages preceding the network must have a sharp cutoff above 3 kHz apart from the required de-emphasis.

A SUGGESTED PHASING SSB GENERATOR/ DETECTOR

Figure 6 shows a suggested circuit of a phasing SSB generator/detector using the RF and audio quadrature phase-shift networks discussed.

Providing the loss in the audio PSN does not prove to be a handicap, the circuit could be bilateral — that is it may be used directly either as a generator or as a demodulator. What's more, it is all-passive. However, the circuit may be adapted to use active mixers such as the Plessey SL640 or SL641 or the MC1596 made by National and Motorola etc or perhaps the Fairchild 796. Preamplifiers may need to be inserted in each quadrature channel input in the demodulator mode, if necessary, as was done by Taylor in his receiver (reference 9). The 7 dB pad in the local RF input may be omitted and a wideband transformer inserted as in Figs. 3 and 4. However, some isolation for the local RF source is desirable. The pad provides 50 ohms impedance to the source and presents 100 ohms to the RF PSN input.

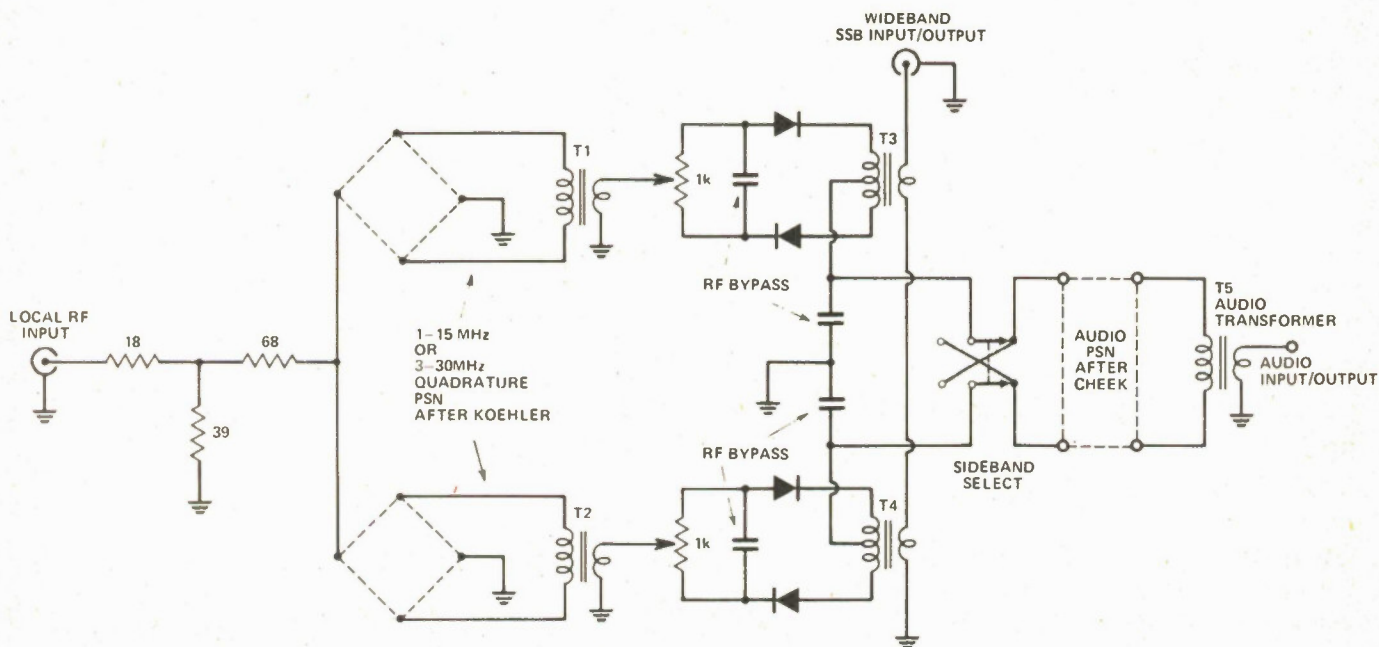


Fig. 6. Suggest passive bilateral wideband, phasing type SSB generator/demodulator.

The two 1k trimpots are for balancing the diode mixers. T1,2,3,4 are 4:1 wideband transformers as per Figs. 3 and 4.

For those interested in construction of such equipment, suitable cores and formers are available along with information from Philips or Neosid. Their addresses are: Philips Electron Devices, 601 Milner Ave., Scarborough, Ontario M1B 1M8. Neosid (Canada) Ltd., 10 Vansco Rd., Toronto, Ontario M8Z 5J4.

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Shortwave/

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

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

'28 Tested Transistor Projects' by R. Torrens, \$2.85.

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UFO Detector

Making no claims as to the efficacy of the device, we present a circuit that will provide an indication of the magnetic disturbances which much UFO literature associates with UFO activity.

EVERY YEAR MANY thousands of people see objects in the sky which they cannot explain in terms of their previous experience. In this sense the existence of unidentified flying objects (UFO s) is not a matter for debate — people see

flying things they cannot identify, thus, by definition, these things are unidentified flying objects.

The vast majority of sightings are caused by various objects or phenomena perceived in an unusual manner: cloud

formations, meteors, satellites, planets, an unusually bright star, temperature inversions, etc. There is also a substantial number of hoax devices.

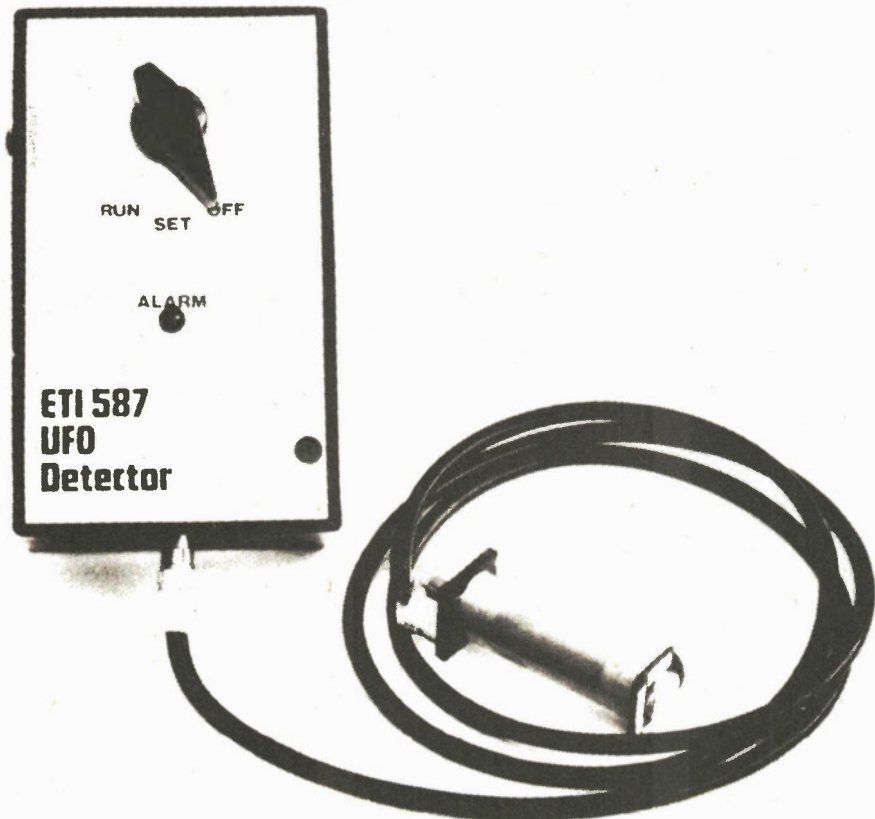
Most people are satisfied if presented with a rational explanation for what they have seen.

But a minority are not — they are 'conspiracy theorists' who deny totally the principle of Ockham's Razor. Faced with 99 probable explanations for an unusual happening — and just one explanation which complies with a previously accepted set of concepts — they will inevitably choose the odd one out.

No explanation or proof will convince the dedicated conspiracy theorist to think otherwise — a classic example of this is the oft-repeated story that the results of the USA Department of Air Force UFO Investigation 'Project Blue Book' have been suppressed. This is not really true. The Blue Book Project Files were declassified in 1970, and the USA Department of Air Force Office of Information state that the files are available to *all bona-fide researchers and media representatives*.

The conspiracy theory was well summed up by Salvador Freixedo at the UFO Conference in Acapulco (April 1977). 'The basic appeal of ufology (for the masses) is that it is a belief system rather than a field of scientific investigation'.

A further large number of classic cases quoted by ufologists has been well and truly debunked by Philip Klass (a technical journalist working with Aviation



Week and Space Technology magazine).

Klass's book ('UFOs explained') thoroughly demolishes the most classic cases and provides evidence which casts major doubt on those few remaining. Consider for example the often quoted 'UFO landing' in Socorro, New Mexico in 1964. It now turns out that the 'landing' was set up as a publicity stunt by the local mayor, who just happened to own that bit of land where the UFO 'landed'.

It is perhaps significant that no serious challenger has ever taken up the USA's National Enquirer's offer to pay one million US dollars for proof that UFOs are unnatural phenomena emanating from outer space.

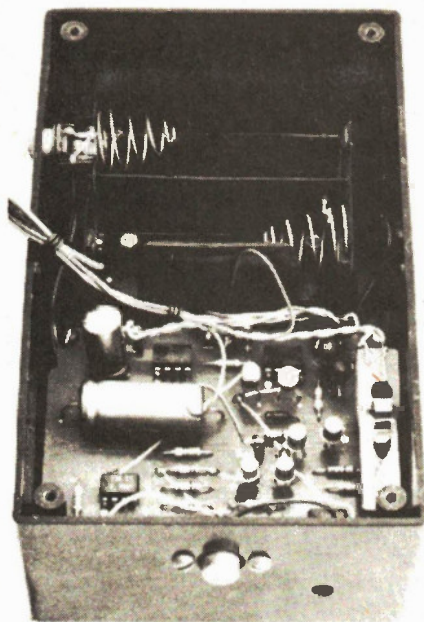
A small minority of ufologists should however be taken more seriously. These are dedicated people who investigate reported sightings as thoroughly as they are able.

Unfortunately most of their investigations tend to be 'unscientific' in the sense that they lack the rigorous discipline which truly scientific investigation demands. Nevertheless, it is to the movement's great credit that they realise their investigational limitations and are currently doing their best to check out as thoroughly as they can a number of previously accepted classic sightings. In fact magazines such as the authoritative US official publication 'UFO' currently feature exposes of previously 'proven' situations. In the light of this recent background, ETI was extremely interested to learn of a UFO magnetic anomaly detector recently developed by one of our contributors.

The basis of this device is that many UFO sightings are claimed to have coincided with major magnetic disturbances. In many reported situations, electrical equipment is claimed to have ceased to operate whilst the UFO was in the vicinity.

Thus, claim some ufologists, it may well be possible to sense the approach of a UFO by detecting abnormal perturbations of the earth's magnetic field. The unit described here has been designed by Mr F C Gillespie who has considerable expertise in this field.

UFO literature indicates that magnetic disturbances associated



Internal shot of the UFO Detector.

with some UFO activity are of such a magnitude that they should be detectable by relatively simple equipment. Naturally the more sensitive the equipment the further away a disturbance could be detected — however, an upper practical limit for sensitivity is set in most areas by the generally high level of background noise associated with civilisation — and which, ironically, is often postulated as attracting UFOs to this planet.

It is not at all difficult to detect the magnetic disturbance caused by a light switched on 20m away — or a car 100 or more metres distant, but one can rarely find a sufficiently magnetic-noise-free environment in which to set up an instrument of such sensitivity. The detector described here has adjustable sensitivity and in all but the very 'quietest' of areas the sensitivity can be set so that the noise just fails to trigger it. It is only in very rare and remote locations that the detector itself is the limiting factor.

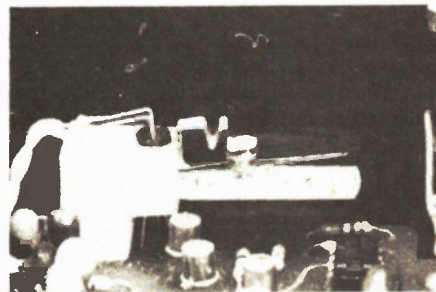
CONSTRUCTION

The unit has been designed in such a way that either or both detecting circuits may be used, or indeed, duplicated if required. Circuit

construction is relatively straightforward, especially if the printed circuit board is used. The solenoid can be any large coil with a resistance of about 5k. We used the coil out of a hefty old relay, but many coils would do. Many people will have such a device in their junk boxes — otherwise it can be obtained from shops handling surplus bits and pieces. The solenoid is located external to the unit and connected to it by a screened cable.

The block holding the LED and phototransistor associated with the compass mechanism is a little tricky to make. It may be built up from pieces of wood or plastic — or if you have the facilities it may be milled out of a block of brass or other non-magnetic material. The main requirements are that the LED and phototransistor must be very rigidly located and that the compass needle should just — but only just — block the light from the LED. The simplest way to make this section is to rebuild an old compass. We suggest that you build the unit in sections checking out each section as it is completed.

No matter how you build the device it is absolutely essential to make sure that the compass assembly is mounted very rigidly — if there is any freedom of movement random mechanical disturbances will be registered as alarms.



The perspex block which holds the compass assembly.

SETTING UP

The compass circuitry is quite straightforward. Provided it has been made correctly the phototransistor should be blocked by the compass needle when the complete detector assembly has been aligned precisely along the magnetic

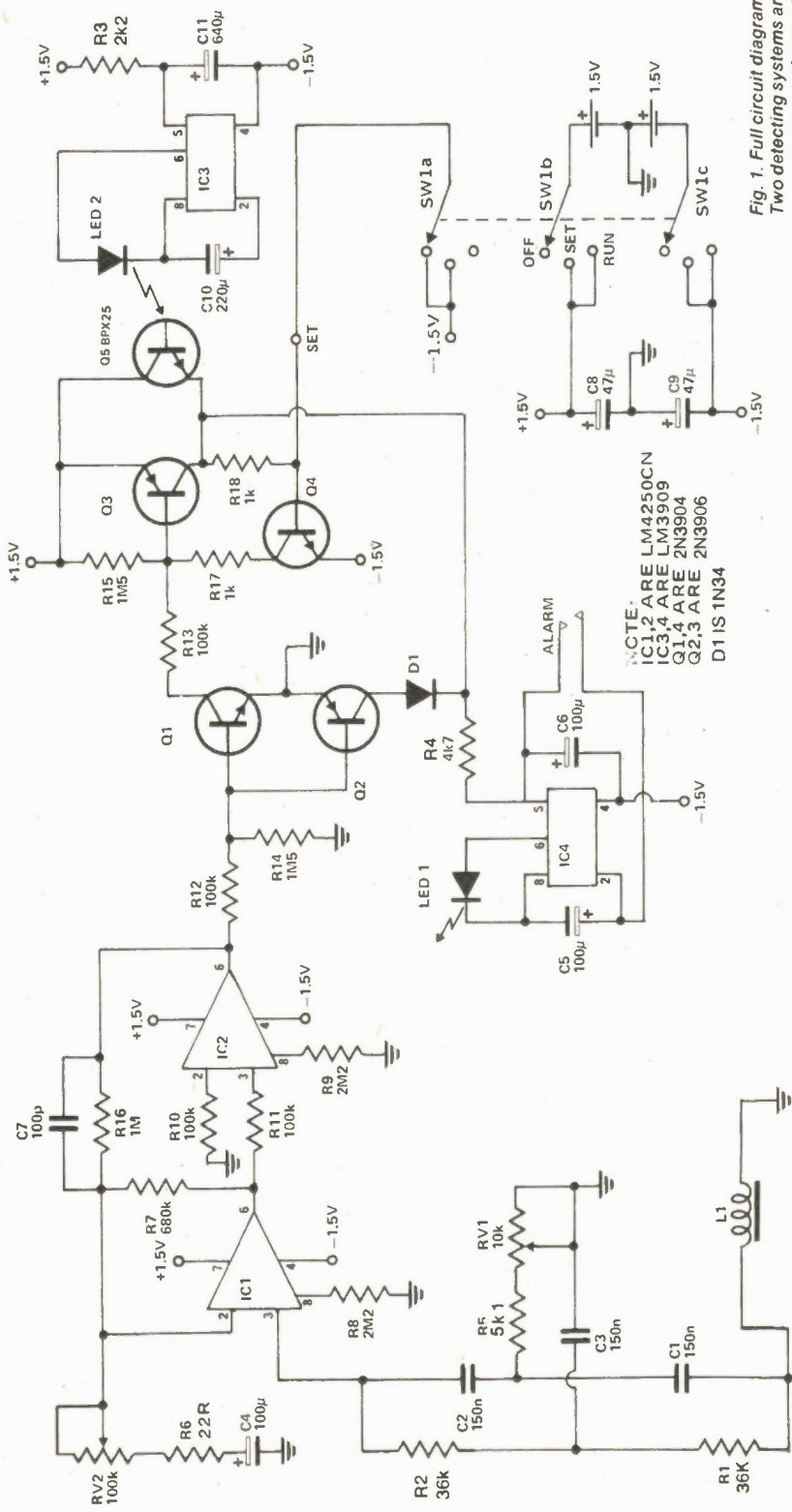


Fig. 1. Full circuit diagram of the UFO detector. Two detecting systems are provided, one based on a compass system and the other on coil L1.

HOW IT WORKS

There is anecdotal evidence that the magnetic disturbances associated with UFOs may be transient in nature or may build up and decay over a period of time or may also be of an oscillatory nature. For this reason the magnetic anomaly detector has two detecting systems capable of responding to all three types of disturbance.

The simpler of the two systems responds to minor movements of a very sensitive compass. The compass needle is set up so that when undisturbed it blocks the passage of light from a flashing LED, the light output from which would otherwise fall on a sensitive phototransistor. The phototransistor output is then amplified, latched and passed to a second flasher circuit which in turn can trigger alarms.

A second and more complex circuit monitors a solenoid (L1) across which a voltage would be generated if it were subjected to a changing magnetic field. A twin-T notch filter is incorporated in this circuit to null out

Any voltage output resulting from a changing magnetic field around L1 is passed to the two-stage amplifier formed by IC1 and IC2. 50 Hz background noise is greatly attenuated by the twin-T notch filter formed by the components between L1 and the amplifier. The frequency of the notch is adjustable by RV1.

The gain of the amplifier IC1/IC2 is varied by RV2. Output signals from the amplifier are passed to Q1/Q2/Q3/Q4 which form two

latching circuits (each functioning depending on the polarity of the output signal). The output of the latching circuitry is then passed to IC4. This is a National LM3909 LED flasher. This causes the alarm LED to flash at about 3 Hz. An external alarm output is also provided.

The compass circuitry is quite straightforward. IC3 is used to extend battery life. Any output from the phototransistor Q5 triggers the latching mechanism thus initiating the alarm sequence.

North/South line. Bringing a magnet or iron bar near the assembly should cause the needle to move slightly, thus allowing light to pass from the LED to the phototransistor, triggering Q3 and Q4, actuating the alarm.

The solenoid circuit is slightly more complex in that the twin-T rejection filter must be adjusted to optimise 60 Hz rejection. This may be done by observing the output from IC2 on a CRO while adjusting RV1 for maximum rejection. If a 'scope is not available, then RV1 must be adjusted so that the circuit is not triggered by 60 Hz — increasing circuit gain via RV2 until the optimum setting is obtained. There is no need to inject 60 Hz into the circuit whilst setting up — in most places there's more around than you'll need!

Once the initial adjustments are made there will be little need to change anything except the sensitivity (gain) control RV2. This should be adjusted so that the unit is just short of triggering under normal conditions.

Local thunderstorms may occasionally trigger the unit but this is inevitable unless you use the unit on low sensitivities.

Well, there it is — the device will detect magnetic anomalies. Whether it

will consistently detect UFOs is another matter — we were unable to obtain a CSA approved UFO for calibration purposes! Until we do, we refrain from making any claims as to the efficacy of this device!

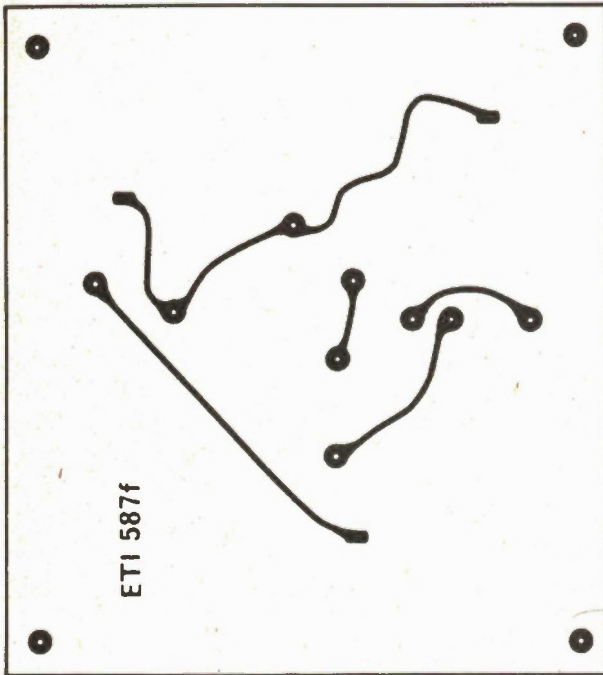
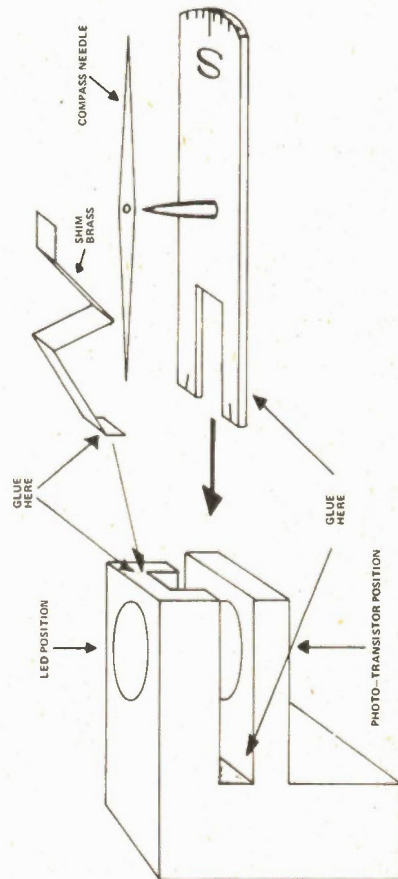


Fig. 2. Foil pattern for top side of UFO PCB.

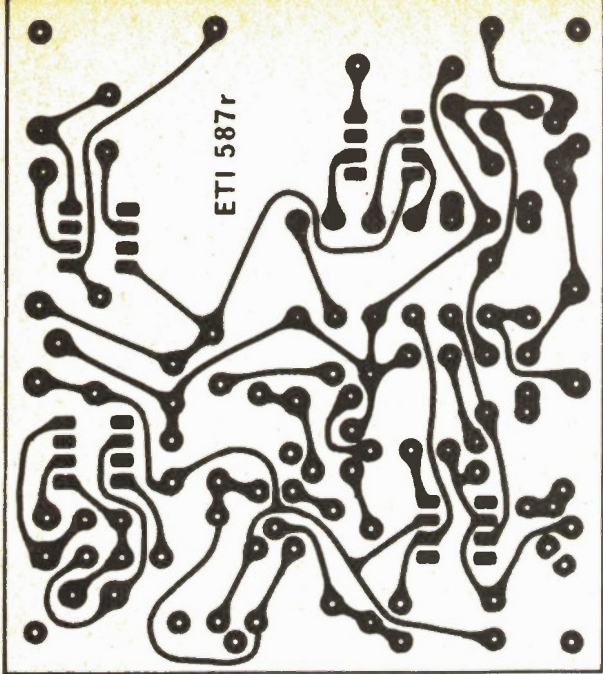


Fig. 3. Underside foil pattern.

PARTS LIST

RESISTORS (all 1/4 W 5%)

R1-R2 36k
R3 2k2
R4 4k7
R5 5k1
R6 22R
R7 680k
R8, 9 100k
R10-R13 2M2
R14, R15 1M5
R16 1M
R17, 18 1k

SEMICONDUCTORS

IC1, 2 LM4250CN Op-Amp
IC3, 4 LM3909 Flasher
Q1, 4 2N3904
Q2, 3 2N3906
Q5 BPX25
D1 1N34A or similar germanium diode
LED 1, 2 Red LED with mounting clip

POTENTIOMETERS

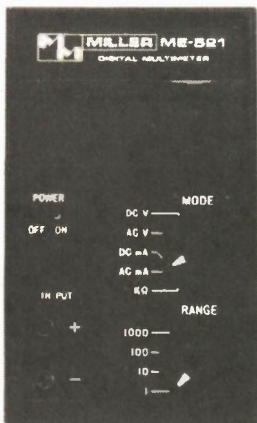
RV1 10k Trimpot
RV2 100k Trimpot

C1-C3 polyester 150n
C4-C6 3V6 Tantalum 100u
C7 polyester 100p
C8, 9 47u
C10 6V3 Tantalum 220u
C11 10V Electrolytic 640u
16V Electrolytic

MISCELLANEOUS

L1 Solenoid (see text)
S1 3p 3w switch
Compass (40mm max. needle length)
Connectors
PCB as pattern
Knob, Case, Batteries and holder, cable.

ME-521



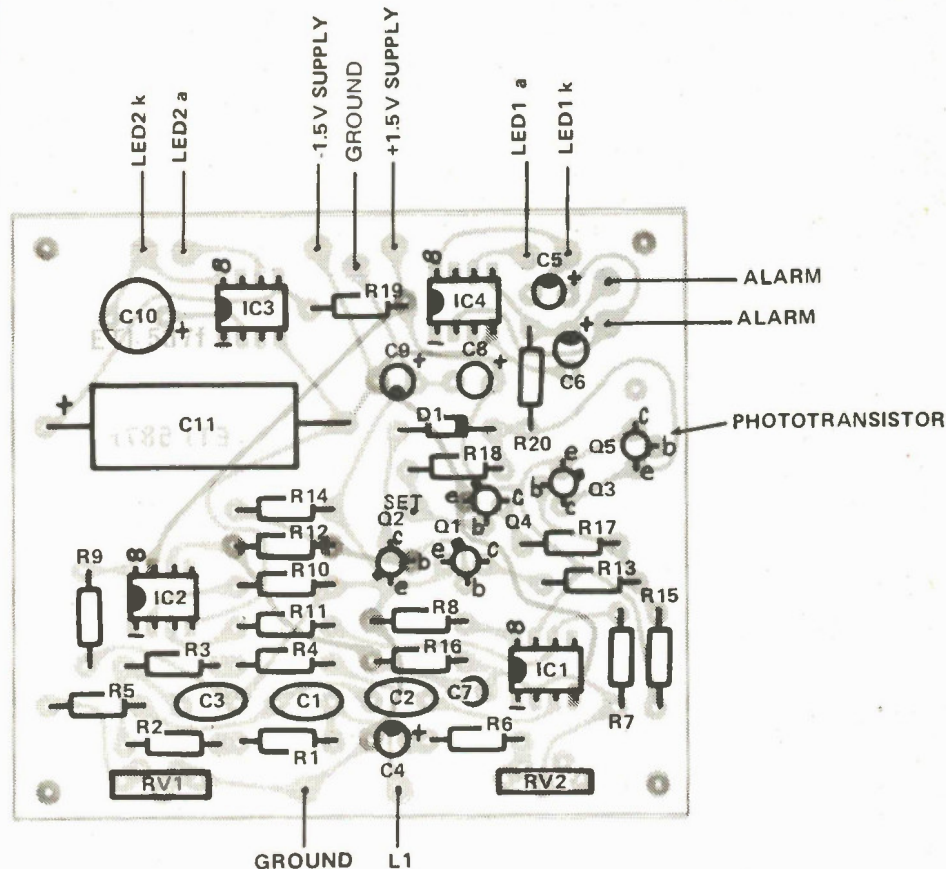
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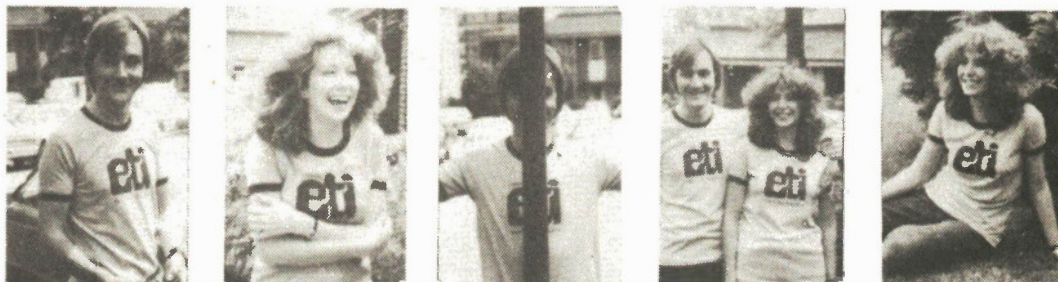
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CCD Phaser Unit

Astound your ears with this solid-state phaser using CCD technology. Designed by David (White Noise) Vorhaus, inventor of the musical drainpipe!

PROBABLY THE MOST sought after effect in rock music is 'jet plane' sound — or phasing as it is properly called. The effect is very distinctive, and lots of companies have produced units that imitate it. The reason we say imitate is because of the way 'real' phasing is produced — which up until recently required three tape decks, a lot of skill and even more patience!

THE REAL McCOY

To produce phasing in a studio you record a sound onto two tapes, then replay both tapes simultaneously via a mixer onto the third machine. Because of slight variations in playback speed (usually introduced by physical slowing of a spool), the two signals shift slightly relative to each other — this produces phase differences over the entire spectrum of the sound.

This gives the 'real' phasing that musicians know and love. Too much
Text continues on p. 44

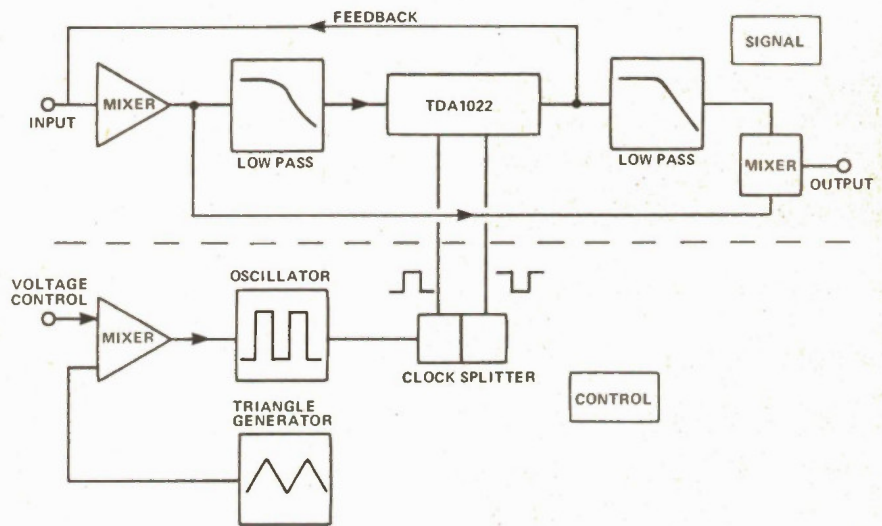
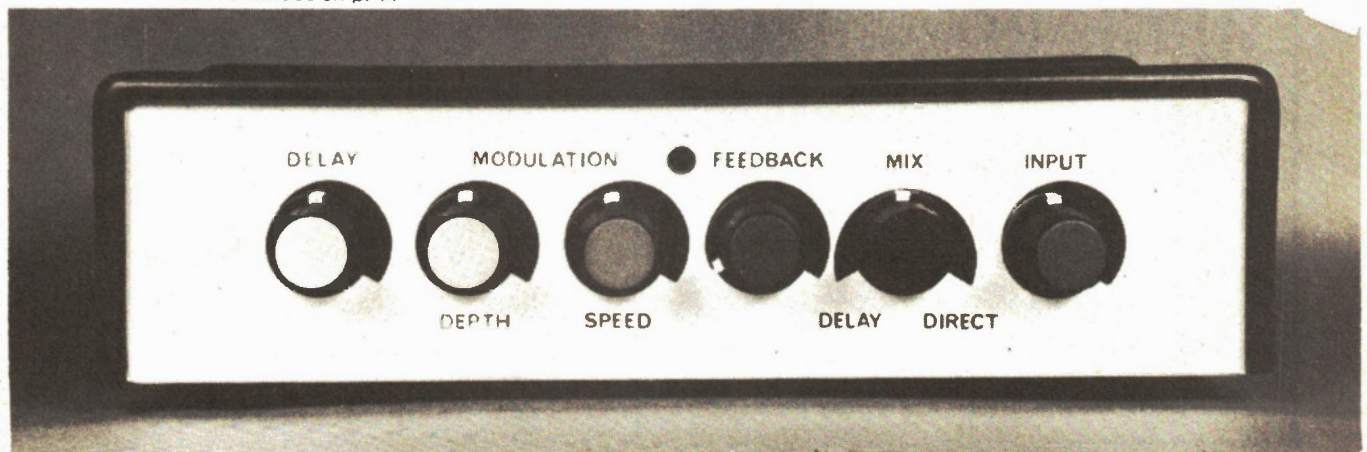


Fig. 1. Block diagram of the unit, note how it can be broken into signal path and control section.



HOW IT WORKS

The heart of the unit is a 512 stage CCD (Charge Coupled Device) type TDA1022. Theory of CCDs was covered in the September 1977 edition. Reference should be made to this article for a description of the TDA 1022 operation. However, even though the TDA 1022 is the heart, the rest of the circuitry is the body and will be described in detail.

Figure 1 shows a simplified block diagram of the whole unit, as can be seen, the circuit can be divided into two sections — signal path and control circuitry.

SIGNAL PATH

First the signal path starting with RV1 which is a straightforward 100 k logarithmic level control. From its wiper the signal passes into IC1a, which is connected as an inverting amplifier with a gain of ten (set by the ratio of R1, R3). RV3 (feedback) is also connected to IC1a — the reason will be explained further on.

The output of IC1a is fed into IC1b and also to RV4b (direct level). IC1b is connected as a second order Butterworth low pass filter.

with its upper —3dB point at 10kHz and a gain of approximately 4 dB in its passband. There are two reasons for this configuration. Firstly, if the input to the delay line has a frequency greater than half the delay line's clock frequency, the result is distortion. The delay line will operate with clock frequencies as low as 5 kHz — as this would limit input frequencies to below 2.5 kHz a tradeoff has to be made. The clock (described later in the control section) works in the range of 5 kHz to 400 kHz, but as the most useful effects are above 20 kHz, 10 kHz was chosen as the input cut-off frequency.

The 4dB gain is required because the delay line has a typical loss of 4dB — if the gain is introduced before the CCD the signal to noise ratio at the output is improved by 4dB.

The input of the delay line is pin 5 which IC1b feeds via C4. The resistor chain R9, RV2, R10, R11 is to hold pin 13 approximately 1V above OV which produces maximum dynamic range in the delay line. RV2 is used to set the DC voltage at pin 5 for class A operation, which minimises distortion. Pins 1 and 4 of the CCD are its clock inputs, which must be 180° out of phase. R13 loads the output, as the line likes a nice standard load

CONSTRUCTION.

1, 2, 3...

Install the seven links and six terminal pins first. Follow with all the resistors and capacitors — double check polarities on the electrolytic capacitors. Soldercon sockets or moulded sockets should be used for the 4013 and TDA1022, and for the hell of it the other three ICs — ever tried to unsolder one? Put them in now anyway.

Cut the control spindles to length **before** you mount them.

The six front panel controls can

to ensure consistent operation. The output feeds via C5 to RV3 (feedback) and IC3a.

The feedback control (RV3) is to enable recirculation of the delayed signal output fed back to the input, via R2. The output filter is IC3a, which is similar to the IC1b filter, in that it is again a second order Butterworth low pass filter, but has unity gain and a —3 dB point of 20 kHz. The cut-off frequency is chosen to eliminate any clock frequency that may be present in the output from the delay line, and hence prevent HF overload of any subsequent equipment.

The output control RV4a,b, enables the user to mix from delayed signal to normal signal, the output from the twin control is resistively mixed by R16, I7. A log/antilog control is used to give a smooth transition with no 'dead band' in the centre of rotation.

CONTROL CIRCUITRY

All of the second section has one purpose — to alter the clock frequency, and hence the delay time, of the CCD. IC4b is a D flip-flop which is wired to give the required two phase input to the delay line. Pin 11 is the clock input to IC4b, this is fed a stream of pulses from IC5 via C10. IC5 is a 566 voltage con-

trolled oscillator, except it is wired as a current controlled oscillator! Pin 5 (the voltage input) is held at 10.5 volts by R31, 32 and pin 6 is fed a variable current provided by Q2. With the values shown the 566 will oscillate over the range 10 kHz to 800 kHz, which produces a clock frequency (after the divide by two of IC4b) of 5 kHz to 400 kHz.

The current injected by Q2 into the 566 is dependent on the voltage from IC3b, fed to its base. This voltage is controlled in two ways. Firstly from the delay control (RV5), the 56 k resistor R18 is to ensure that the control is useful over most of its travel — otherwise the 566 (IC5) could stop oscillating when RV5 was at its positive end.

IC4a and Q1 also control the frequency of the 566 via RV6 (modulation depth) and RV7 (modulation speed). They are connected up as a triangle generator, the frequency being controlled by RV7. The timing function is dependent on the rate of charge (and discharge) of C8, which is directly controlled by R22 and RV7. The triangle waveform produced is mixed with the voltage from RV5 via RV6 and hence changes the voltage at Q2 base — and therefore the delay time.

which should be fully clockwise. Feed in an audio signal (preferably a sine wave) and put the output through an amplifier.

Rotate the level control (on the extreme right) clockwise until the signal comes through at the same level it is going in. If all is well rotate the mix control anti-clockwise — as you do so the sound should 'phase'. With the mix control fully turned, adjust RV2 for either 6V at its wiper, or symmetrical clipping of the output when viewed on an oscilloscope with 2V5 peak to peak going into the delay line.

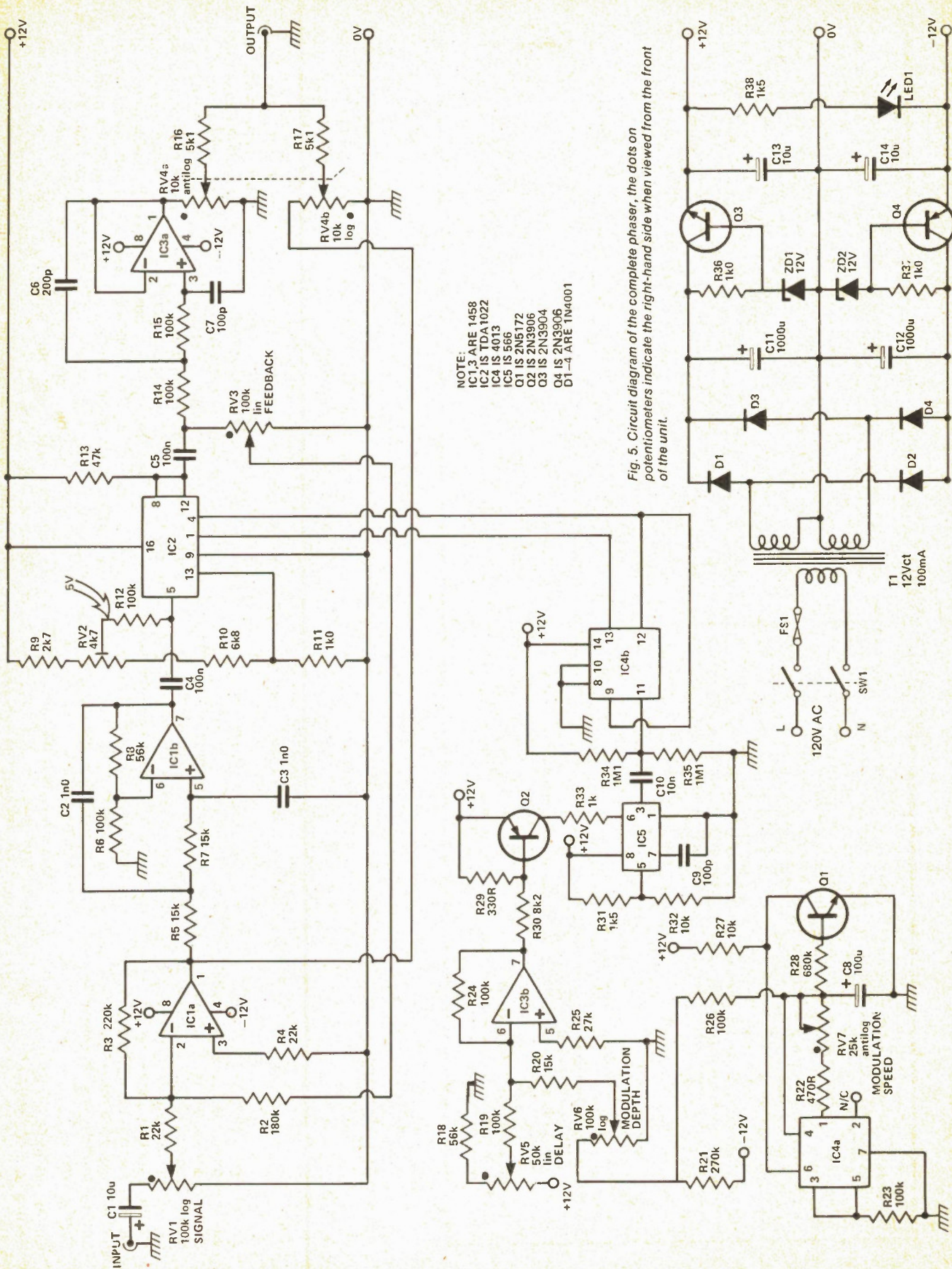
When RV2 has been set the delay line is operating at its optimum bias point.

The delay control can now be checked, turning it clockwise

should alter the output signal and near the end of its range a whistle should break through — and the signal should deteriorate into a very 'crunchy' sound, but not disappear completely. If it does stop increase R18 until it appears again.

The modulation control comes into effect when turned clockwise. Modulation speed is increased by clockwise rotation of the speed control. Make sure the delay control is set clockwise initially. With the mix control halfway a regular 'phasing' will occur as the modulation depth is increased, faster as the modulation speed is increased.

Now you can play with a real signal — white noise is particularly nice to feed into the system (fuzz guitar has a lot going for it as well).



NOTE:
 IC1,3 ARE 1458
 IC2 IS TDA1022
 IC4 IS 4013
 IC5 IS 566
 Q1 IS 2N5172
 Q2 IS 2N3906
 Q3 IS 2N3904
 Q4 IS 2N3906
 D1-4 ARE 1N4001

Fig. 5. Circuit diagram of the complete phaser, the dots on potentiometers indicate the right-hand side when viewed from the front of the unit.

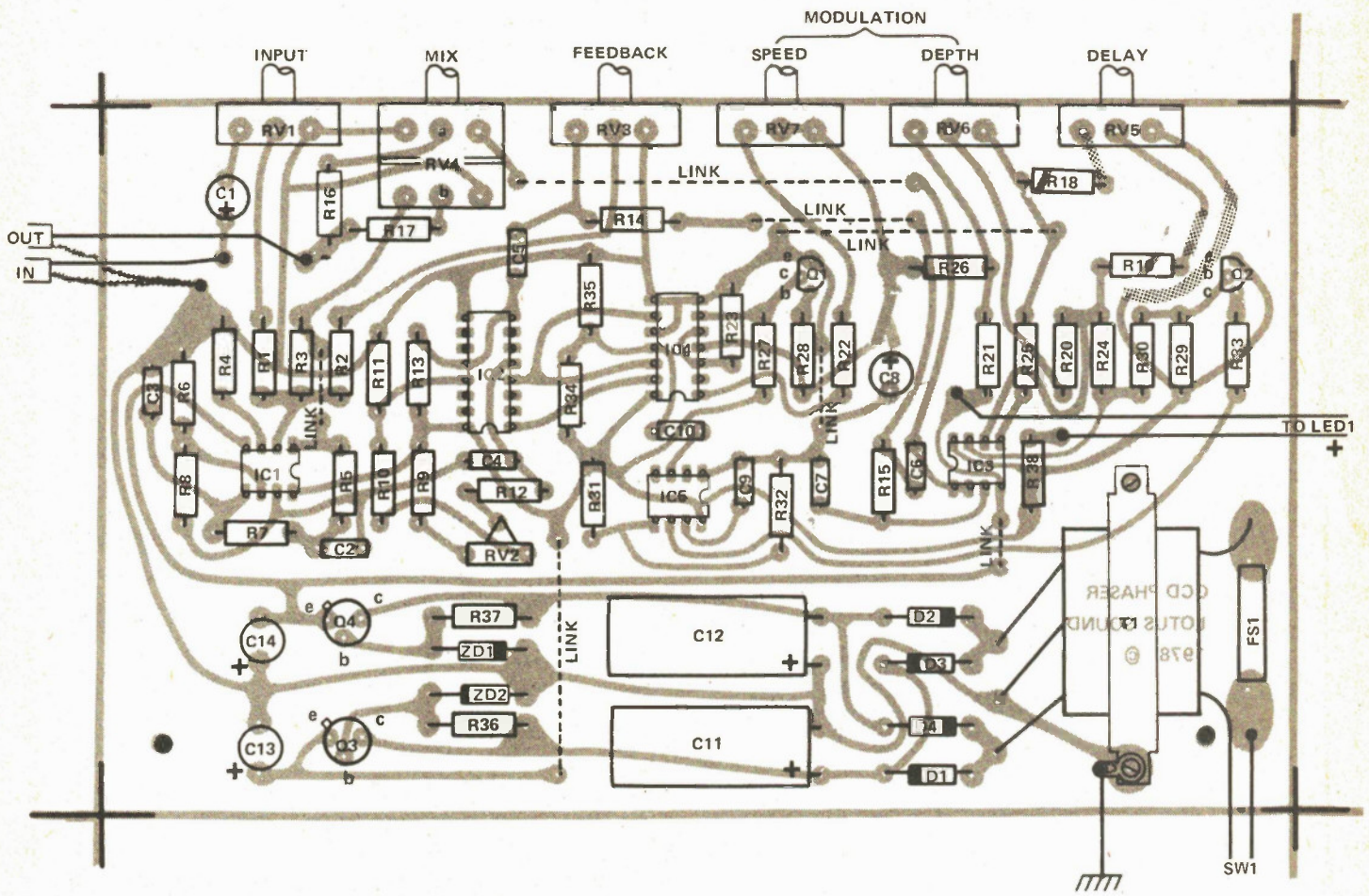


Fig. 2. Component overlay for the phaser.

slowing of a spool results in echo. Obviously you cannot use this technique in real time on stage, so various other ways have been devised to produce a similar effect. However, none of the imitations are as good as the real McCoy!

TO THE RESCUE

With the advent of analog delay lines came the opportunity to produce phasing in real time. By feeding the signal through a delay line and mixing the output with the undelayed input you get instant real phasing.

By adding various controls, such as input/output mix and delay length, the versatility of such a unit is increased enormously.

This phaser unit is capable of producing numerous effects — the controls permit variation of all the possible parameters. Phasing, flanging, stereo simulation are just some of the things you can do with it.

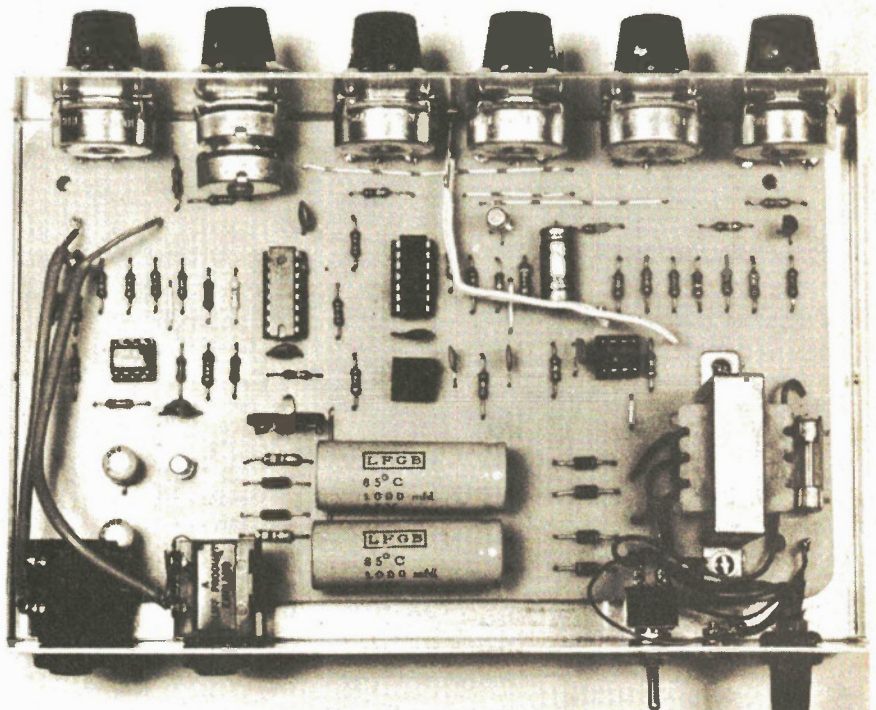


Fig. 3. Internal view of one of the proto-types, note that the control spacing has been changed on the final version.

PARTS LIST

RESISTORS (all 1/4W 5%)

R1, 4	22k
R2	180k
R3	220k
R5, 7, 20	15k
R6, 12, 14, 15, 19, 23, 24, 26	100k
R8, 18	56k
R9	2k7
R10	6k8
R11, 33, 36, 37	1k0
R13	47k
R16, 17	5k1
R21	270k
R22	470R
R25	27k
R27, 32	10k
R28	680k
R29	330R
R30	8k2
R31, 38	1k5
R34, 35	1M1

POTENTIOMETERS (all PCB mounting)

RV1, 6	100k log
RV2	4k7 trim pot
RV3	100k lin
RV4a, b	10k log/antilog
RV5	50k lin
RV7	25k antilog

CAPACITORS

C1	10u 10V tantalum
C2, 3	1n0 polyester
C4, 5	100n polyester
C6	200p ceramic
C7, 9	100p ceramic
C8	100u 12V electrolytic
C10	10n polyester
C11, 12	1000u 25V electrolytic
C13, 14	10u 16V electrolytic

SEMICONDUCTORS

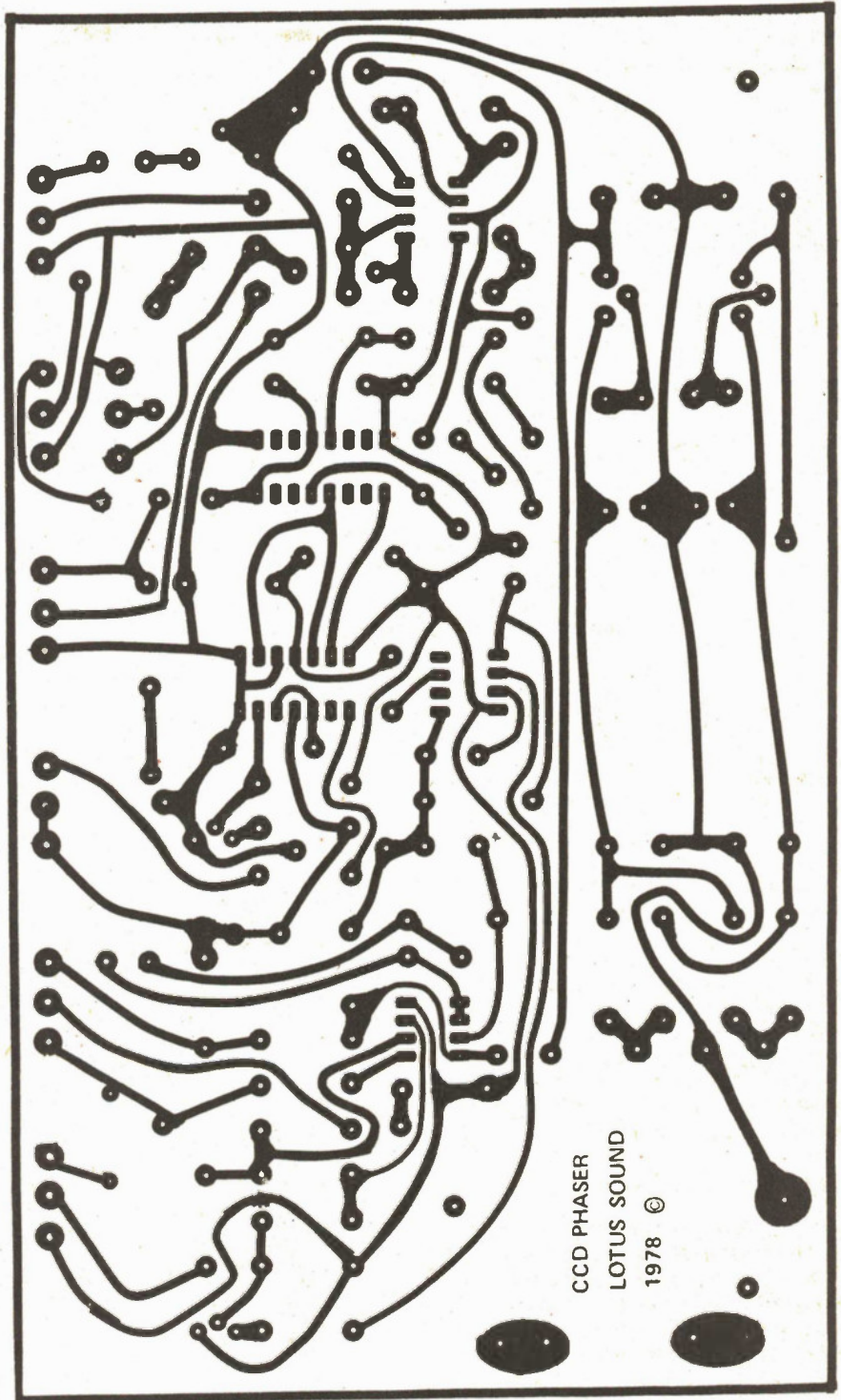
Q1	2N5172
Q2	2N3906
Q3	2N3904
Q4	2N3906
IC1, 3	LM1458
IC2	TDA1022
IC4	CD4013
IC5	NE566
D1-4	1N4001
2D1, 2	12V 400mW
LEP1	TIL 209

MISCELLANEOUS

FS1	100mA 20mm+ holder
SW1	DPST 120V
T1	24Vct 100mA
PCB, Case, 6 collet knobs, 1C sockets, 2 jack sockets, etc.	

BUY LINES

The only device that might be tricky to get hold of is the Philips TDA 1022. However this should be obtainable through any Philips components distributor at a cost of around \$15.



CCD PHASER
 LOTUS SOUND
 1978 ©

Fig. 4. Full size PCB layout for the phaser (195mm x 115mm).

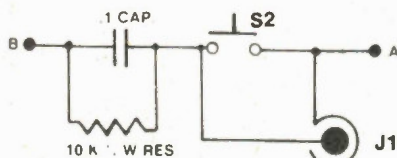
Simple Strobe

This circuit uses a xenon strobe to give single or variable rate multiple flashes.

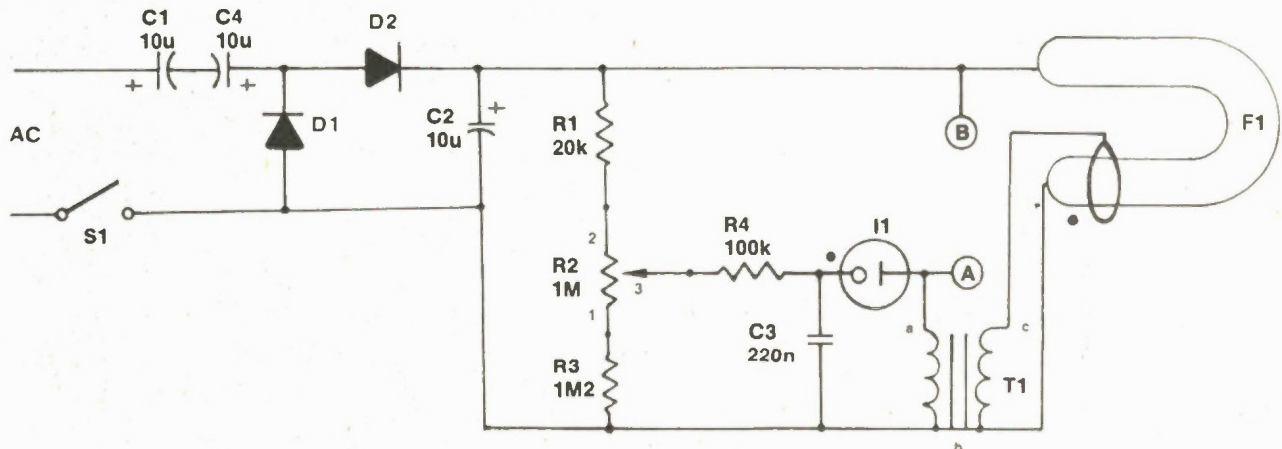
PARTS LIST

RESISTORS all ½W 5%	
R1	20k
R2	1M Potentiometer
R3	1M2
R4	100k
CAPACITORS	
C1, C2, C4	10u 450V
C3	220n 250V
SEMICONDUCTORS	
D1, D2	1A 600V
MISCELLANEOUS	
I1	neon bulb
F1	Xenon flash tube
S1	part of R2
T1	trigger transformer (Jana LJ 12150)

A kit of parts is available from Jana — see their ad in this issue.



To get a single flash, for example for photographic use, connect this circuit between A and B in the main circuit. With R2 in the position for slowest flash rate (ie no flashes!) S2 will provide the desired single flash. Alternatively J1 can be used to allow the camera's flash contacts to trigger the strobe.



The stroboscopic effect, where a flashing lamp is used to illuminate some moving process, is extremely useful for stopping the action. For example, a dripping tap observed using a strobe allows the viewer to see

the drops apparently suspended in the air. Similarly, the bending of fan blades may be seen as the fan is in action. This simple strobe project provides the basics needed for experimentation in this area.

HOW IT WORKS

Initially the neon and xenon lamps are not conducting and act like a very high (almost infinite) resistance. Capacitors C1 and C4 in conjunction with D1 and D2 act as a "voltage doubler" circuit, which can charge C2 up to about 300V DC after several AC cycles. (See if you can figure out how this action occurs.)

Meanwhile, back at C3, the voltage is increasing as current is supplied through R1 and R2. Neon bulb I1 has the characteristic that at a certain voltage (varies from bulb to bulb) it will all of a sudden start to conduct (conduction through the neon gas causes the orange glow). While conducting the resistance of the bulb

will be relatively low.

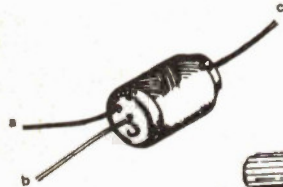
Due to this sudden conduction a pulse of current will pass through the primary of T1. The turns ratio is such that about 4000V will be developed at the secondary. The xenon tube is similar to the neon bulb in that it produces light when the gas ionizes and conducts. However, it is designed so that an external signal (the 4kV on the metal ring around the tube) ionizes the gas and initiates the conduction.

When F1 conducts it discharges C2. At this point the whole cycle starts over again. The purpose of R2 is to vary the rate at which C3 charges, and hence the repetition rate of the strobe.

DANGER

This strobe project can be a very useful and educational project if built and operated with care. There are two dangers to be aware of and to take into account.

The first hazard is that associated with the fact that this project is directly connected to the AC line and hence all wires if touched can give a lethal shock. Hence this project should be built into and operated only in an insulated (plastic) box, with the

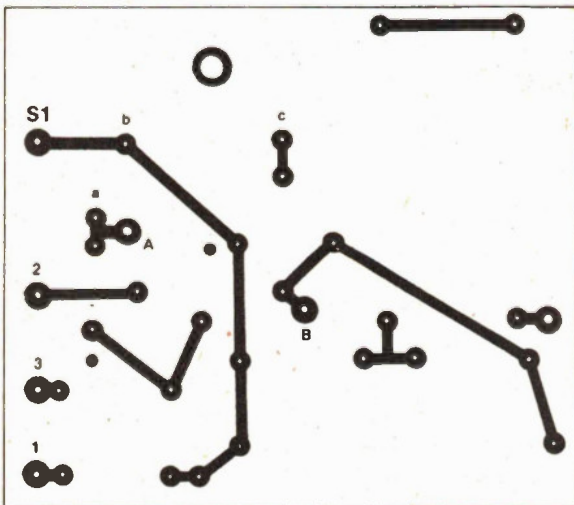


Transformer identification

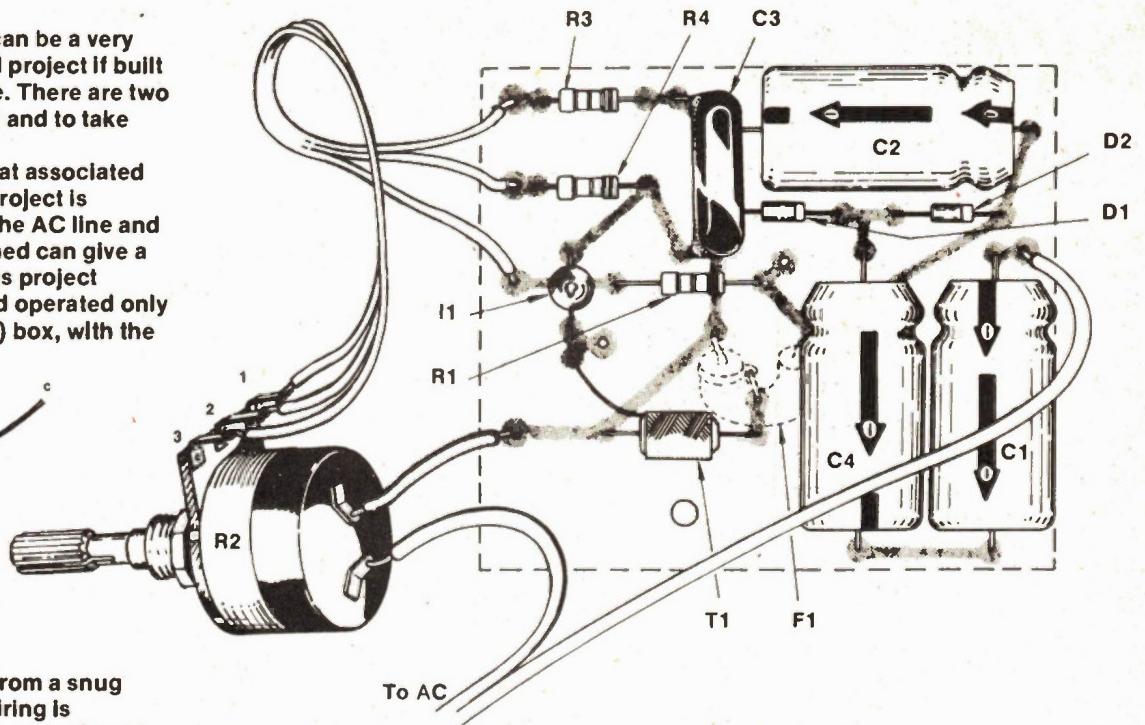
flash tube protruding from a snug hole. Ensure that no wiring is exposed. The potentiometer should preferably have a nylon shaft, or a plastic knob, so that in the event of the shaft coming in contact with the electrical part of the pot no human failure results.

The second danger is less obvious. A stroboscope can bring about epileptic fits in people with and even without any previous history of such trouble. The frequency rates which are dangerous in this respect are from 5 to 12 flashes per second, especially if the strobe is the sole source of illumination.

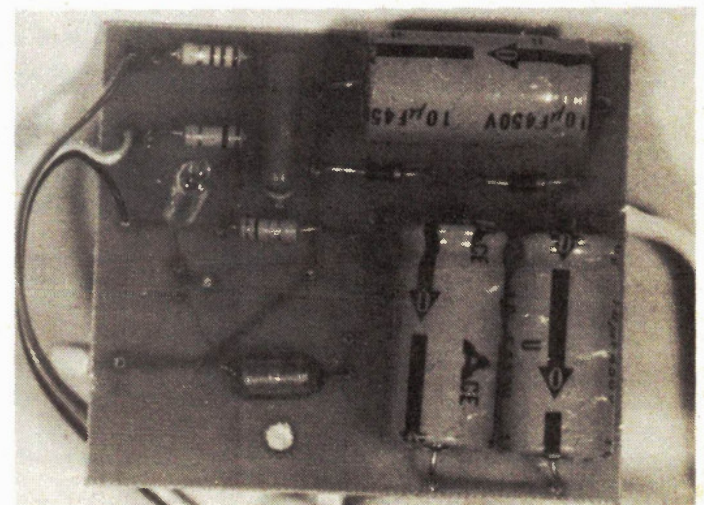
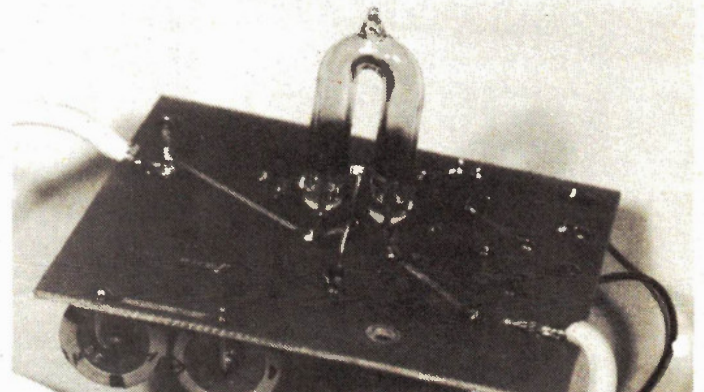
Circuit board foil pattern



Component layout



F1 mounting on foil side of PC board.



History of Electronics in Medicine

Electricity has long been used for medical purposes, here's the story of the past and a look into the future. By Peter Sydenham.

THE USE OF ELECTRICITY FOR medical purposes dates back to the Ancient Greeks who used the electric eel to treat various maladies. In 1759 Wesley collected case histories of the use of electricity. The first recorded use of electricity for treatment in a hospital in London was in 1767.

Not quite 200 years ago, in 1786 to be precise, Professor Luigi Galvani — an anatomist at the University of Bologna, Italy — discovered by chance that the muscles of a dead frog contracted under the influence of an electrical quantity.

He wrongly assumed that animal electricity stored within the muscle caused this to happen. It was, in fact, the result of dissimilar metals forming a primary electric cell which energised the nerves of the muscle. Volta of the Uni-



Fig. 1. Artist's idea of Galvani experimenting with frogs' legs in the 1780s. Note the friction electrostatic generator on the left and the Leyden jar on the right (Funk and Wagnells).

versity of Paris proved it and subsequently gave the world the voltaic battery, in 1800.

The contribution of these two men provided, in the simple primary cell, a workable basis for using electricity in

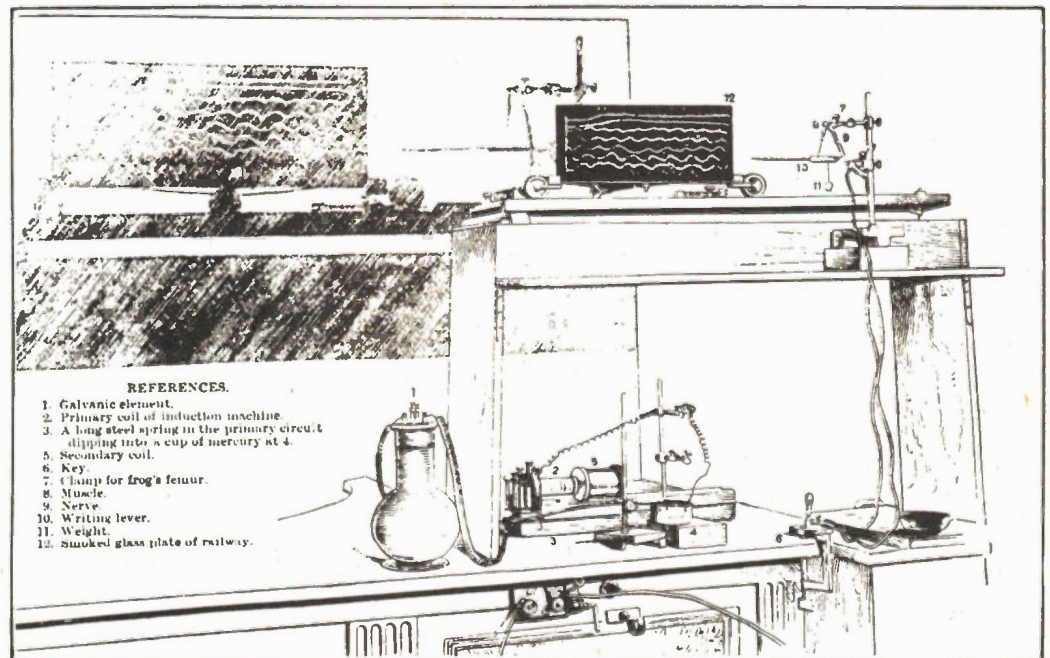


Fig. 2. Apparatus used by McKendrick to give lectures on life in motion to Royal Institution, London, audiences around 1890.

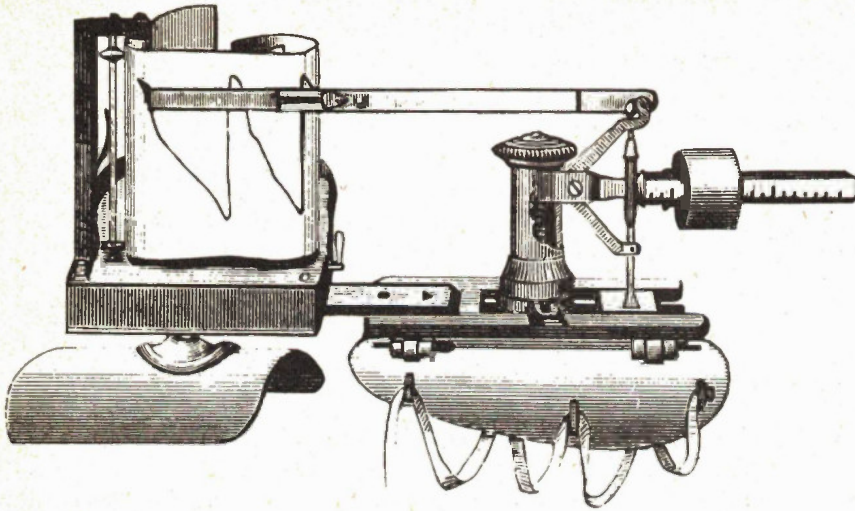


Fig. 3. Verdin's apparatus of the 1890s for recording action of the pulse.

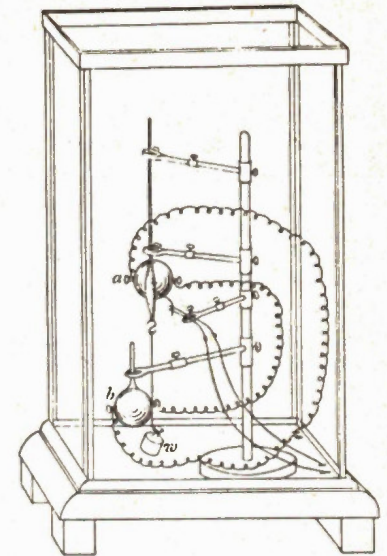


Fig. 4. Schematic of McKendrick's 1891 method for measuring heat generation in muscle.

practical ways not previously possible with the electro-static form of electricity. Galvani's work on "animal fluid" was amongst the earliest electro-medical studies. The apparatus he used was crude by today's standards — see Fig 1.

Research into physiological electric quantities gradually became more sophisticated as the 19th century passed. This development, however, had to wait for suitable experimental inventions such as the electro-magnetic

galvanometer which became available in its crudest form around 1830. A typical laboratory electro-medical instrumentation set-up of the 1890 s is shown in Fig 2. A smoked glass plate moved steadily across the end of a mechanical pen secured to the end of a frog's leg muscle. The muscle was energised by high-voltage generated from a vibrating induction coil which was energised by a chromate primary single cell of the Grenet kind. Smoked screen recorders are still in use today

in some medical research measurements, blood flow parameters being one example.

The sphygmometrograph (as a pulse measuring instrument was known in that time) was originated by Marey in 1860. A later design by Verdin is shown in Fig 3. Electronic method was little used in medicine in early times, as powerful electric signal amplification was not obtainable until the beginning of the 20th century — when the thermionic valve was invented by Fleming (in 1904).

Figure 4 shows experimental equipment for measuring heat production of muscular contraction around 1880. Thermocouples, forming a thermopile, drive the crude galvanometer.

Another aspect of medicine where electricity is used is for therapeutic treatment. Since the very early 1800s output of the various kinds of electric current generator, namely the Faraday induction coil, the galvanic chemical battery, the sinewave rotating generator and the friction statical generator have been applied to appropriate parts of the body to provide a cure for all sorts of ailments. The bath shown in Fig 5 was in use around 1910 in conjunction with equipment such as, perhaps, the hand-cranked generator shown in Fig 6. Electronic forms of this equipment are still being designed and used today.

X-ray equipment was born in 1895 when Roentgen discovered X-rays in a chance situation using photographic plates. There is probably no case in instrument history where application

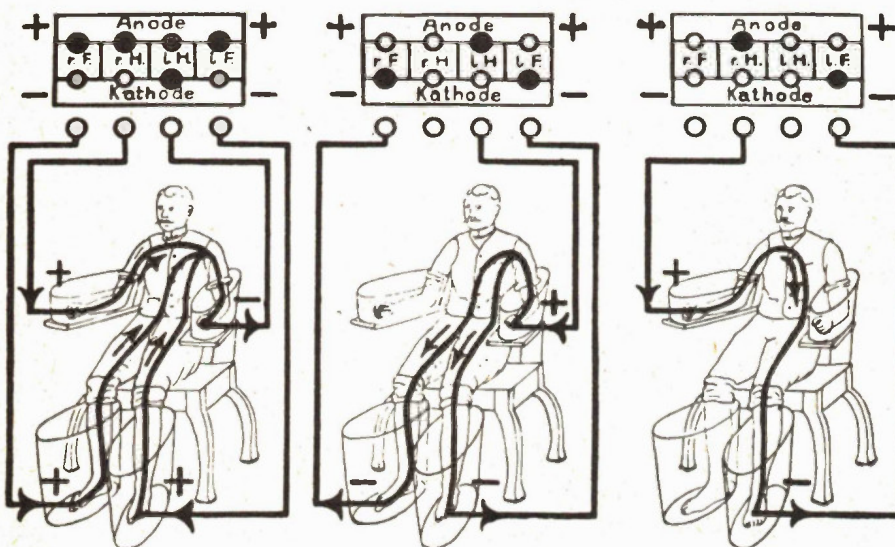


Fig. 5. Anyone for an electric bath? Contemporary sketch of routine therapeutic practice around 1910.

was more rapid. Edison, and others, had equipment in use in hospitals within months. Figure 7 shows contemporary American X-ray plant of 1899.

Measurement and recording of heart performance also began around 1900. Professor Einthoven of Holland devised a rapid response, high sensitivity detection instrument in 1903 — the string galvanometer. Soon after this was coupled to a photographic recording system, by the Cambridge Instrument Co., to produce an electrocardiograph. The first installation of this was made in 1909. By 1945 cardiographs were available in portable form. Figure 8 shows the interior of a 1930s Both Brothers portable electro-cardiograph invented and made in Adelaide, South Australia — possibly one of the first portable units devised anywhere. It used a loud speaker drive unit (right) to mark a rotating smoked disk. The record was viewed by the physician using an optical magnifier. Amplification to drive the stylus from skin electrode signals was obtained by thermionic tubes.

As with all disciplines, electronic method opened the door to new accomplishments. In medical electronics it happened from the 1920s onward. Equipment for researching physiology at Oxford University, in 1949, is shown

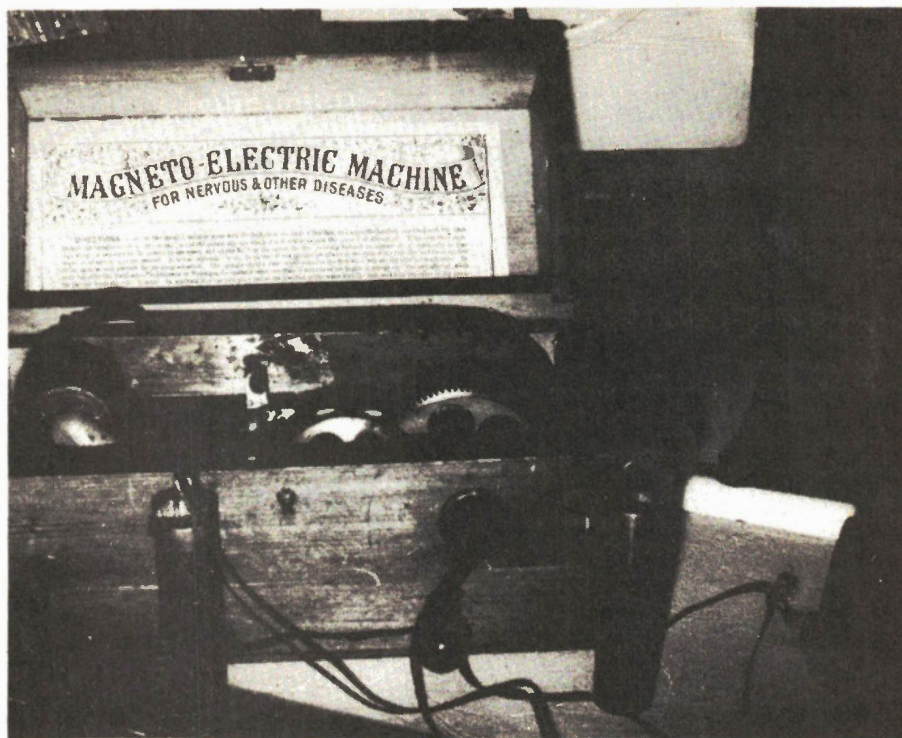


Fig. 6. In medical sine-wave generators a bobbin of wire is rotated in front of a permanent horse-shoe magnet. The design is almost identical with Clarke's 1830's original design and was still current around 1900.

in Fig 9. This unit, advanced for its time, incorporated amplifiers, a temperature control unit, stimulators to induce responses, a time base and a cathode ray tube display unit.

Electronic equipment used in medi-

cine has come a long way during the past 50 years. This can be seen by comparing the apparatus pictured above, which covers the 1800s to 1930s period, with modern equipment such as that used in pathological testing and nuclear medicine.

FUTURE

Against this background let me now suggest developments we can expect to experience over the next quarter century.

MONITORING

The largest proportion of electro-medical equipment is concerned with measurement; for detection of abnormal states. At present comparatively few of the incredibly great range of medical measurements needed can be made in situ on the body and without disturbing its functions. Samples of tissue, blood, urine, etc. are removed for analysis in the pathological laboratory. This process, although performed faster today than ever before, can still take several hours before a diagnosis is available to the physician in order that he or she can decide corrective action. Analysers now exist that handle many measurements of a sample entirely automatically once the sample is loaded into the analyser.

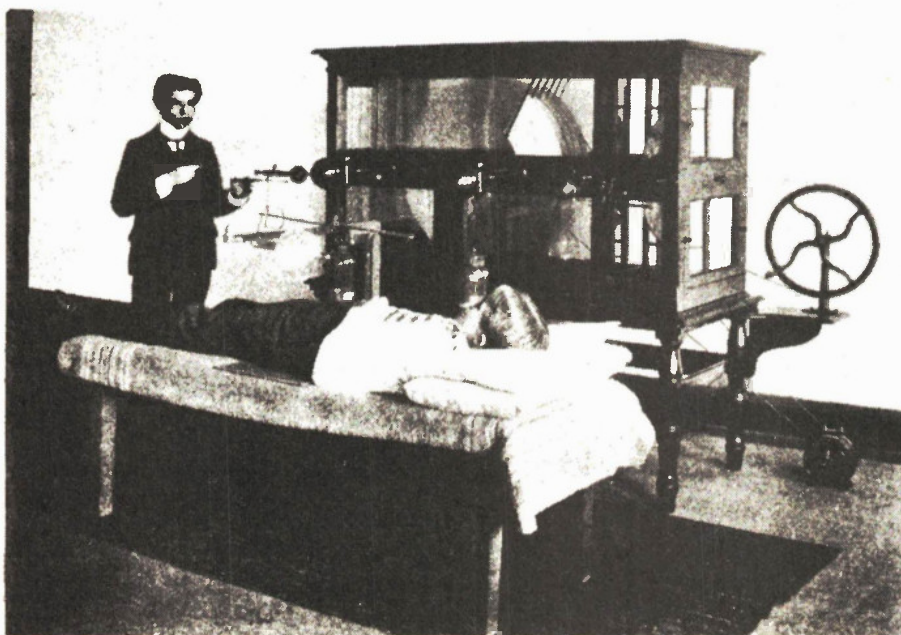


Fig. 7. Complete X-ray apparatus in use in America around 1900. Note the lack of safety devices and precautions.

History of Electronics in Medicine

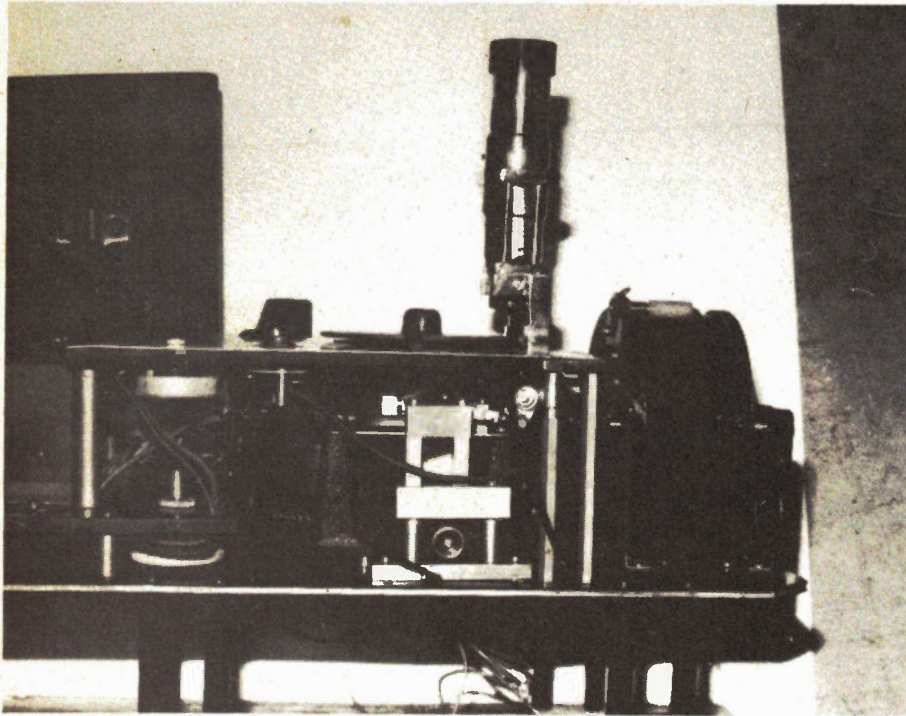


Fig. 8. Interior view of a Both portable electrocardiograph machine made in Adelaide around 1930.

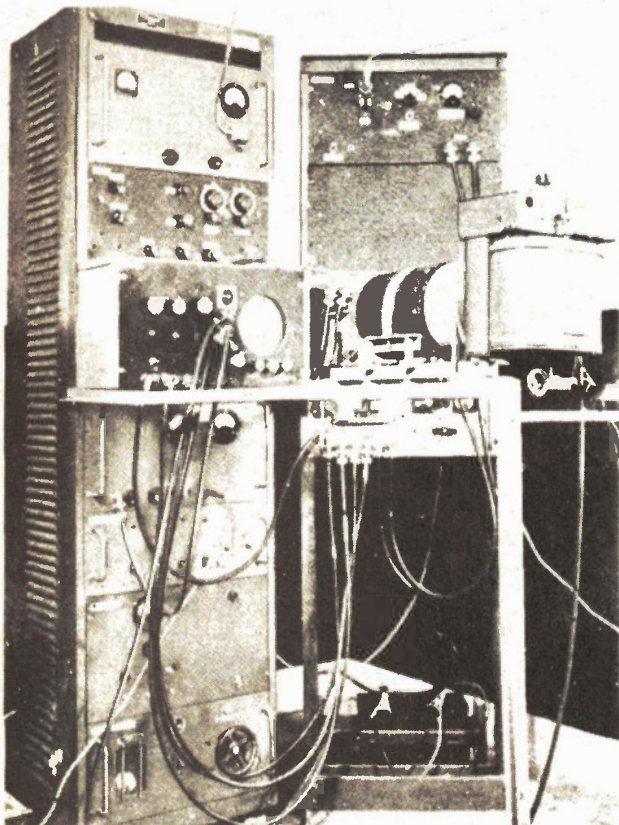


Fig. 9. Electro-physiological research equipment used by Dickin-son at Oxford University in 1949.

But the sample must first be extracted from the body and then be transported to the machine, processes which consume time and in some circumstances alter the sample from its original state.

It is realistic to expect the transport step to be eliminated in the future with most local clinics having their own units for analysis of samples. The next stage in progress will come about by the invention of units that measure parameters such as blood count, albumin, etc. by contact externally to a suitable vein or artery. Direct measurement like this would also provide more accurate measurement as the blood would be in its normal working state. Furthermore, it would then be possible rapidly to optimize drug dosage and to investigate changes in parameters as they happen. The concept of in-situ measurement will apply to numerous other tests.

In special cases some people have already been equipped with sensors of critical body parameters. The outputs are telemetered to a remote observer.

Examples of this are in space-medicine, in fitness studies and in a few heart disease cases.

Considering the low-cost data processing power already available, and coupling this with inexpensive micro-miniature sensors we can expect to see developed in the future, it is possible that individuals will one day be able to obtain self-monitors that provide warning when body parameters exceed allowable limits.

Better measurement always leads to better control. As an example, respiratory tract problems, such as hay fever and asthma, are hard to combat effectively because of the lack of detailed data about each individual's characteristics in the various circumstances encountered. Not all people are allergic to the same pollens — we could benefit greatly if an easy way existed that determined the allergic pollens involved.

At present, a pollen count is usually taken by drawing the ambient air over a sticky surface for many minutes — hours sometimes. The surface is then observed with a microscope, the technician counting all pollen grains together to obtain the total pollen count. This process is now sometimes carried out using computer-controlled video tv camera systems, but the systems are still barely able to group the various kinds of pollen grain. (They are typically a micrometre in diameter or smaller — counts of a few grains per

cubic metre can cause unwanted symptoms).

A development that could help is a sensor that provides a virtually instant count of the individual kinds of pollen grain present — a real-time sampling analyser. With such a device the sufferer could test for the hostile situation *before* symptoms arise and take remedial action in time. Technologically such an instrument appears feasible. It is, however, cost and physical size that holds up its development and its practical everyday use at present.

A likely parallel already existing is the Coulter counter that analyses the size and number of cells in a blood sample. Blood-cell counting of several years ago required the blood to be smeared on a microscope slide and the cells counted by eye under a microscope. Today the machine makes the measurements in a few seconds by counting particles as they pass a small orifice — but it is neither portable nor inexpensive. Figure 10 shows a Coulter counter installation as used in the larger pathological laboratories.

Development of personal monitors will almost certainly pass first through a telemetry method in which a central computer processes the data, perhaps with the help of the trained physician to begin with. A direct self-contained method will then be developed in which the specific data processing requirements that have emerged from experience, are integrated into the unit.

REPLACING THE SENSORS AND ACTUATORS OF THE BODY

The human body is a vastly complicated chemical process plant. It has sensors feeding information to the brain for central processing. In turn, the brain sends signals to actuators — the muscles which cause the body to function and to do work. Nerves are the hardwired data channels for receiving and sending control information.

Slight deficiencies in the senses of sight and hearing have been aided using instruments — spectacles and hearing aids. The latter began as acoustic horns which provided sound pressure gain without active amplification. The advent of the telephone led to amplifierless hearing aids in the 1900's which used several mouthpieces coupled to the ear pieces (Fig 11). Then came electronic units which provided active signal gain from miniature thermionic tubes. Today we have integrated semiconductor circuitry. We have still a

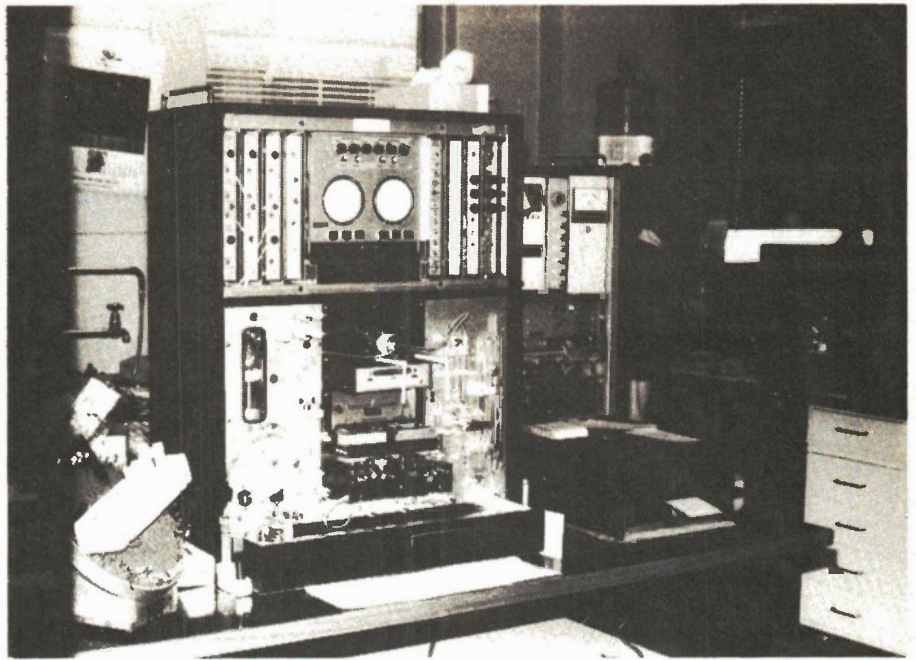


Fig. 10. Coulter counter unit of today that analyses blood sample particles providing a print-out (IMUS, Adelaide).

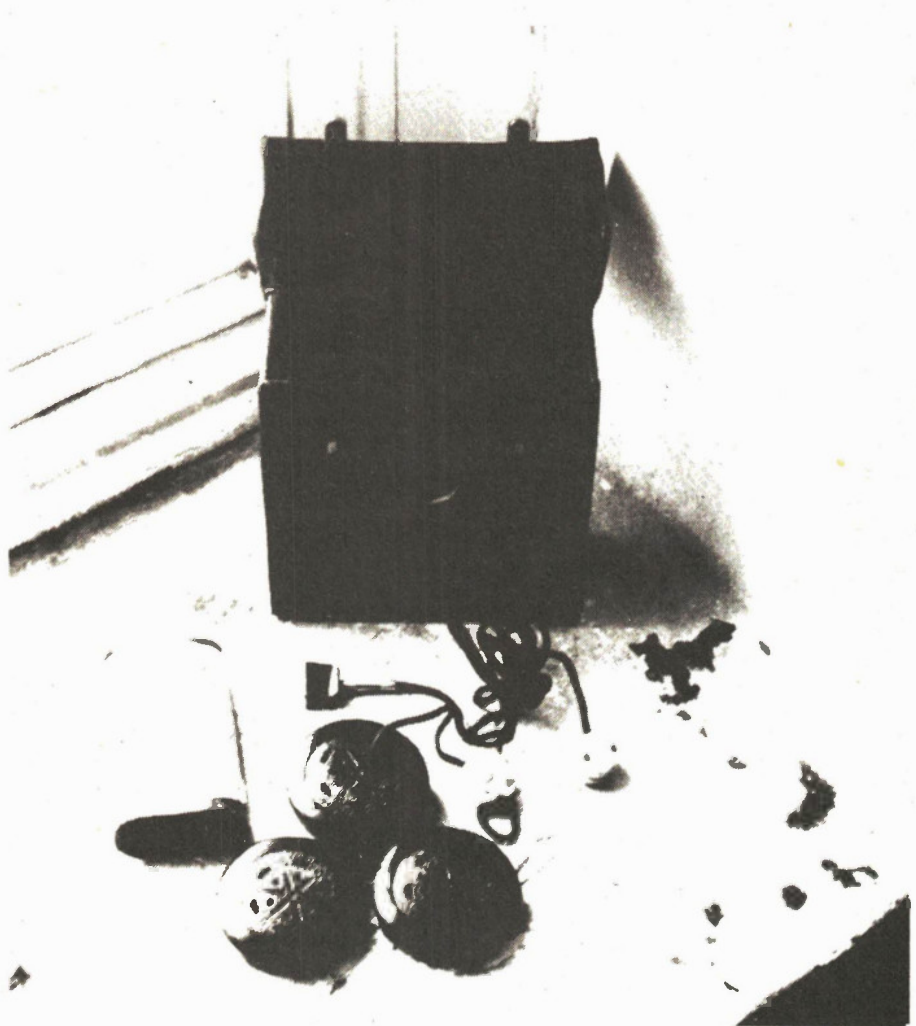


Fig. 11. 1900's hearing aid. The three receivers, which fit into the case, provide signal to the two earpieces. No active amplifier was involved. (Birdwood Mill Museum, S.A.)

way to go, however, before we are able to compensate for a failed action of the inner ear mechanisms.

Vision, until very recently, was aided only by optical lens compensation. But this applies only where the eye is still largely operative as an optical-to-electrical transducer. Quite recently experiments have been reported in which a miniature video camera provides electronic signals that drive cells in the brain to provide illusion of sight. The method is still crude compared with the performance of natural process. Given time for research it seems reasonable to assume that quite compact and useful artificial eyes will soon be available for blind people. Bionic man is not so fantastic! Interestingly, once the bionic eye is developed it is an easy matter to provide greater than natural visual acuity and to offer sensitivity to other than the visible light band — infra-red for instance.

Providing electronic replacements for the sense of smell will most likely be a much later development. We know too little about the olfactory senses and have no really compact and cheap smell sensors at this time to expect great progress to occur in the near future. Animals, such as dogs, possess a sense of smell vastly much more sensitive than humans. Ants track each other by a scent trail! Yet man has not yet produced small and inexpensive chemical analysers (smell is a largely chemical process) that can meet the complex sensing requirements of smell detection.

MATHEMATICAL MODELLING OF BODY FUNCTIONS

Medicine is basically a discipline of analysis in which the physiological functions are slowly analysed as their operation becomes better known. Once the parameters of the situation are discovered, control can be brought about by synthesis of man-made chemicals and structures. Much of medical knowledge is the result of experimental observation and trials.

A more recent approach, added to the methods used, makes use of mathematical models. These models are block-diagrams, generated by the operator, in which suitable mathematical equations define the input-output relationship of the black boxes thought to be a suitable realisation. As models are raised, they are tested overall by entering input data and equation con-

stants and comparing the output to the real-life situation. Interaction of equation forms and constants continue until close agreement with reality results.

Many complex processes, especially in medicine, are only measurable at various points in the process. For example, the effect of an administered drug is known in terms of certain output behaviours. But there are points within the physiological process that are not measurable due to the nature of the process. Mathematical modelling is valuable here because the data within the model, that is equivalent to the real process, may be available. It is not quite as easy as that for within the model the operation, although analogous, may not be quite the same in nature. Nevertheless, information learned about the interior structure of the model may provide useful insight and even suggest other parameters that *can* be measured on the living body.

At present, considerable research is being undertaken on such models as those of the respiratory system — oxygen input, oxygenated blood output; and on the sugar-urine process involving kidney action. In areas such as these we find multi-disciplinary teams at work — mathematicians, process engineers, measurement systems analysts, chemists and medical practitioners.

Far into the future we should possess computers with vast memory holding a mammoth mathematical model of the human body. Unusual complaints will be studied painlessly and safely by operating upon the model, not the patient, and at a speed in which the computation process speed is vastly faster than the real-time effects in the body.

SCANNERS

X-ray and nucleonic diagnostic methods have the valuable feature that certain internal structures of the body can be seen. But all such methods lack the spatial resolution we obtain by visual examination with the unaided eye or through a microscope. A nuclear radiation source set-up within the body provides a rather diffuse output picture. Resolution is improved by increasing the number of individual elements at the sensing stage. The gamma camera, for example, provides two-dimensional pictures using over thirty scintillometers connected in such a way as to provide many more picture elements. The latest development senses the body area by

scanning multiple sensors thereby collecting yet more data in a given time. Sophisticated processing is then used to provide video screen outputs which contain much more useful information than ever before. Similar techniques apply to X-ray, nucleonic and ultrasonic signal transmission. Now that vastly more powerful data processing capability exists the future development will be to incorporate many more sensors of the same kind and make more effective use of three-dimensional data. Other variables, such as, say, thermal emission will also be incorporated along with systematic experience gained into the processing, all this to providing data conversion for a more meaningful measurement process.

SURGERY

Electrical methods in surgery traditionally include endoscopes with which to see into inaccessible places and cauterizing probes for sealing blood flow, cutting and destroying cells where need be. The recent introduction of the laser as a cutting tool has most valuable properties. Selection of the appropriate wavelength decides which kind of body tissue will be cut. For example, it is possible to weld the retina of the eye through the pupil without need for surgery. The radiation is only absorbed by retinal material, the pupil and fluid of the eye ball being transparent to the wavelength used.

The selective property of narrow-band radiation will enable some highly precise surgical operations in the future. An operation might go as follows: a rigid framework holds the patient fixed with respect to an x-y-z translating pulsed laser operating head. Wired to the control unit of the translator are electrodes fixed to the body. These sense when low-power sensing pulses are energising the specific part of the body required to be operated upon. The unit scans until sensing signals (operated by a non-cutting wavelength source) verify the location of the beam. Once at such a point the laser is switched to full cutting power continuing to cut as the time-multiplexed sensing signals indicate position is satisfactory.

Looking back, electro-medical apparatus has only been with us for a mere 50 years. In the last 10 years of that time we developed inexpensive and very powerful data processing methods. The next 25 years are likely to unfold undreamed of aids to medicine many of which we would regard as miraculous if we heard about them today.

DIODES/ZENERS				SOCKETS/BRIDGES				TRANSISTORS, LEDS, etc.							
1N914	100v	10mA	.05	8-pin pcb	.20	ww	.35	2N2222	NPN (2N2222 Plastic)	.10	.15	2N2907	PNP		.15
1N4005	600v	1A	.08	14-pin pcb	.20	ww	.40	2N3906	PNP (Plastic - Unmarked)		.10	2N3904	NPN (Plastic - Unmarked)		.10
1N4007	1000v	1A	.15	16-pin pcb	.20	ww	.40	2N3054	NPN		.35	2N3055	NPN 15A 60v		.50
1N4148	75v	10mA	.05	18-pin pcb	.25	ww	.75	T1P125	PNP Darlington		.35	LED Green, Red, Clear, Yellow			.15
1N4733	5.1v	1 W Zener	.25	22-pin pcb	.35	ww	.95	D.L. 747	7 seg 5/8" High com-anode		1.95	MAN72	7 seg com-anode (Red)		1.25
1N753A	6.2v	500 mW Zener	.25	24-pin pcb	.35	ww	.95	MAN3610	7 seg com-anode (Orange)		1.25	MAN82A	7 seg com-anode (Yellow)		1.25
1N758A	10v	"	.25	28-pin pcb	.45	ww	1.25	MAN74A	7 seg com-cathode (Red)		1.50	FND359	7 seg com-cathode (Red)		1.25
1N759A	12v	"	.25	40-pin pcb	.50	ww	1.25								
1N5243	13v	"	.25	Molex pins	.01	To-3 Sockets	.25								
1N5244B	14v	"	.25	2 Amp Bridge		100-prv	.95								
1N5245B	15v	"	.25	25 Amp Bridge		200-prv	1.95								

C MOS		- T T L -									
4000	.15	7400	.10	7473	.25	74176	.85	74H72	.35	74S133	.40
4001	.15	7401	.15	7474	.30	74180	.55	74H101	.75	74S140	.55
4002	.20	7402	.15	7475	.35	74181	2.25	74H103	.55	74S151	.30
4004	3.95	7403	.15	7476	.40	74182	.75	74H106	.95	74S153	.35
4006	.95	7404	.10	7480	.55	74190	1.25			74S157	.75
4007	.20	7405	.25	7481	.75	74191	.95	74L00	.25	74S158	.30
4008	.75	7406	.25	7483	.75	74192	.75	74L02	.20	74S194	1.05
4009	.35	7407	.55	7485	.55	74193	.85	74L03	.25	74S257 (8123)	1.05
4010	.35	7408	.15	7486	.25	74194	.95	74L04	.30		
4011	.20	7409	.15	7489	1.05	74195	.95	74L10	.20	74LS00	.20
4012	.20	7410	.15	7490	.45	74196	.95	74L20	.35	74LS01	.20
4013	.40	7411	.25	7491	.70	74197	.95	74L30	.45	74LS02	.20
4014	.75	7412	.25	7492	.45	74198	1.45	74L47	1.95	74LS04	.20
4015	.75	7413	.25	7493	.35	74221	1.00	74L51	.45	74LS05	.25
4016	.35	7414	.75	7494	.75	74367	.75	74L55	.65	74LS08	.25
4017	.75	7416	.25	7495	.60			74L72	.45	74LS09	.25
4018	.75	7417	.40	7496	.80	75108A	.35	74L73	.40	74LS10	.25
4019	.35	7420	.15	74100	1.15	75491	.50	74L74	.45	74LS11	.25
4020	.85	7426	.25	74107	.25	75492	.50	74L75	.55	74LS20	.20
4021	.75	7427	.25	74121	.35			74L93	.55	74LS21	.25
4022	.75	7430	.15	74122	.55			74L123	.85	74LS22	.25
4023	.20	7432	.20	74123	.35	74H00	.15			74LS32	.25
4024	.75	7437	.20	74125	.45	74H01	.20	74S00	.35	74LS37	.25
4025	.20	7438	.20	74126	.35	74H04	.20	74S02	.35	74LS38	.35
4026	1.95	7440	.20	74132	.75	74H05	.20	74S03	.25	74LS40	.30
4027	.35	7441	1.15	74141	.90	74H08	.35	74S04	.25	74LS42	.65
4028	.75	7442	.45	74150	.85	74H10	.35	74S05	.35	74LS51	.35
4030	.35	7443	.45	74151	.65	74H11	.25	74S08	.35	74LS74	.35
4033	1.50	7444	.45	74153	.75	74H15	.45	74S10	.35	74LS86	.35
4034	2.45	7445	.65	74154	.95	74H20	.25	74S11	.35	74LS90	.55
4035	.75	7446	.70	74156	.70	74H21	.25	74S20	.25	74LS93	.55
4040	.75	7447	.70	74157	.65	74H22	.40	74S40	.20	74LS107	.40
4041	.69	7448	.50	74161	.55	74H30	.20	74S50	.20	74LS123	1.00
4042	.65	7450	.25	74163	.85	74H40	.25	74S51	.25	74LS151	.75
4043	.50	7451	.25	74164	.60	74H50	.25	74S64	.15	74LS153	.75
4044	.65	7453	.20	74165	1.10	74H51	.25	74S74	.35	74LS157	.75
4046	1.25	7454	.25	74166	1.25	74H52	.15	74S112	.60	74LS164	1.00
4049	.45	7460	.40	74175	.80	74H53J	.25	74S114	.65	74LS193	.95
4050	.45	7470	.45			74H55	.20			74LS367	.75
4066	.55	7472	.40							74LS368	.65

4069/74 C04	.25
4071	.25
4081	.30
4082	.30
MC 14409	14.50
MC 14419	4.85
4511	.95
74C151	1.90

LINEARS, REGULATORS, etc.							
MCT2	.95	LM320T5	1.65	LM340K15	1.25	LM723	.40
8038	3.95	LM320T12	1.65	LM340K18	1.25	LM725N	2.50
LM201	.75	LM320T15	1.65	LM340K24	1.25	LM739	1.50
LM301	.45	LM324N	1.25	78L05	.75	LM741 (8-14)	.25
LM308 (Mini)	.95	LM339	.75	78L12	.75	LM747	1.10
LM309H	.65	7805 (340T5)	.95	78L15	.75	LM1307	1.25
LM309K (340K-5)	.85	LM340T12	.95	78M05	.75	LM1458	.65
LM310	.85	LM340T15	.95	LM373	2.95	LM3900	.50
LM311D (Mini)	.75	LM340T18	.95	LM380 (8-14 PIN)	.95	LM75451	.65
LM318 (Mini)	1.75	LM340T24	.95	LM709 (8-14 PIN)	.25	NE555	.35
LM320K5 (7905)	1.65	LM340K12	1.25	LM711	.45	NE556	.85
LM320K12	1.65					NE565	.95
						NE566	1.25
						NE567	.95

9000 SERIES			
9301	.85	95H03	1.10
9309	.35	9601	.20
9322	.65	9602	.45

MICRO'S, RAMS, CPU'S, E-PROMS			
74S188	3.00	8214	8.95
1702A	4.50	8224	3.25
MM5314	3.00	8228	6.00
MM5316	3.50	8251	8.50
2102-1	1.45	8255	10.50
2102L-1	1.75	8T13	1.50
2114	9.50	8T23	1.50
TR1602B	3.95	8T24	2.00
TMS 4044	9.95	8T97	1.00
		2107B-4	4.95
8080	8.95	2708	9.50
8212	2.95	Z80 PIO	8.50

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Data Sheets Explained

The data sheets which we publish regularly are very popular, but from time to time we receive requests for a fairly simple explanation of the terms and abbreviations which one finds in semiconductor device data sheets. This article has been prepared to satisfy your requests. **by Brian Dance**

THE INFORMATION contained in semiconductor device data sheets is often grossly misunderstood. Great care must be taken to ensure that the exact meaning of a term or abbreviation is clear. As an example, we can quote the following conversation which actually occurred between two people who should both have known better.

A representative of a semiconductor distributor was showing data on a new power device to a lecturer. The lecturer said that the device data was wrong, since the maximum collector current was quoted as 12A and the maximum collector-emitter voltage (V_{CEO}) as 80V; this is a power level of $12 \times 80 = 960W$, but the maximum permissible dissipation quoted in the data sheet is only 90W. The representative could provide no answer!

The data was, of course, perfectly correct. The problem arose because neither of the people concerned had appreciated the exact meaning of V_{CEO} which signifies the collector-emitter voltage *with the base open circuited*. Under these conditions (with zero base current) the collector current will be very small and the power dissipation in the transistor will also be quite small. Thus there is a great deal of difference between V_{CE} (the collector-emitter voltage under any conditions) and V_{CEO} (the collector-emitter voltage with the base open circuited). If still more information is required, one must look into the SOAR (Safe Operating Area) graph to ascertain the regions of the collector voltage/collector current curve where the device can be safely operated for limited or unlimited times.

This is a very simple example of the pitfalls one can encounter if one does not really understand the exact meanings of the terms and abbreviations used in data sheets. Such misunderstandings are very common, but not (we hope!) amongst the devices covered in our data sheets, since it is equally important that our readers understand the exact meanings of abbreviations used in data sheets on relatively simple devices such as ordinary diodes and transistors.

LETTER SYMBOLS

Three of the most important symbols used in semiconductor device data sheets are V, I and P for voltage, current and power respectively. Various subscripts are added to these three letters to indicate the electrode(s) to which the symbol is being applied and possibly certain circuit conditions. Some of the most commonly used subscripts are listed below.

A	anode
AV	average
B	base
BO	breakover
BR	breakdown
C	collector
D	drain or delay
E	emitter
F	forward
G	gate
H	holding
I	input
J	junction
K	cathode
M	peak value of a quantity
O	open circuit or output
R	reverse or repetitive
S	source, short circuit, series or shield
T	in the on state (that is, triggered)
W	working
X	specified circuit
Z	impedance

Thus i_E is the instantaneous value of the total emitter current, i_e the instantaneous value of the alternating component of the emitter current, and $I_{E(AV)}$ the average (dc) value of the total emitter current. Other subscripts can be used in a similar way, I_F being the forward dc current with no signal, i_F the instantaneous forward current and I_{FM} the peak forward current.

ORDER OF SUBSCRIPTS

In most cases more than one subscript is needed; the subscripts are usually placed in a definite order governed by the following rules:

The first subscript indicates the electrode at which the current or voltage is measured.

The second subscript denotes the reference terminal or circuit mode. (This subscript is often omitted if it is felt no ambiguity will arise.)

The letter O may be used as a third subscript to show that the electrode not indicated by any previous subscript is open circuited. Similarly the letter S can be used as a third subscript to show the third electrode is shorted to the reference electrode of the second subscript, whilst the letter R as a third subscript indicates that a specified resistance is connected between the third electrode and the reference electrode.

The supply voltage to a collector is indicated as V_{CC} , the second suffix being a repetition of the first in the case of supply voltages. Similarly, one often meets the symbol V_{DD} for the positive supply to a CMOS (or COS/MOS) device, this being the supply to the drain. The negative supply to CMOS devices is normally represented by the symbol V_{SS} .

It should now be clear why V_{CEO} is the steady collector emitter voltage with the base open circuited. Similarly I_{CER} is the collector cut off current with a specified resistance between the base and emitter. It is current with the base and emitter joined, since either the base or emitter can be used as the reference electrode without any change when they are joined.

The parameters of individual devices vary from one device to another of the same type number. The typical value of a parameter such as transistor current gain is often quoted in data sheets by the abbreviation 'typ' after the quantity, but minimum and maximum values are also often quoted. In economical devices no maximum and minimum values may be quoted. In the case of breakdown voltages, the minimum value applicable to any device of that type number is usually quoted so that the circuit designer knows that he can apply that value of voltage without danger of the device junction breaking down.

The above discussion gives the general principles of the way in which the symbols for various parameters are chosen. It is not complete, since we have not yet covered such items as current gain of a transistor or thermal characteristics of a device. However, these and other quantities will be covered in the following tables.

THERMAL CHARACTERISTICS

The symbols used for the following thermal quantities apply to all types of semiconductor device.

P_{tot}	total power dissipated within the device
T_{amb}	ambient temperature
T_c	temperature of the case of the device
T_j	temperature of the junction in the semiconductor material

T_{mb}	temperature of the mounting base of the device (= T_c)
T_{stg}	storage temperature
θ_h	thermal resistance of heat sink. (Units: $^{\circ}C/W$)
θ_i	contact thermal resistance between the case of the device and the heat sink
θ_{j-amb}	junction to ambient thermal resistance
θ_{j-c}	junction to case thermal resistance

SYMBOLS USED MAINLY WITH DIODES

C_d	diode capacitance with reverse bias
C_f	diode capacitance with forward bias
C_j	capacitance of the junction itself
C_{min}	minimum capacitance (which occurs at the rated breakdown voltage)
C_o	diode capacitance at zero bias
f_{co}	cut off frequency of a varactor diode
I_F	total dc forward current
i_F	instantaneous forward current
$I_{F(AV)}$	average forward current
I_{FM}	peak forward current
I_{FRM}	repetitive peak forward current
I_{FSM}	non-repetitive peak forward current occurring under surge conditions
I_R	continuous reverse leakage current
i_R	instantaneous reverse leakage current
I_{RRM}	repetitive peak reverse current
I_{RSM}	non-repetitive peak reverse current
I_Z	zener diode continuous operating current
I_{ZM}	zener diode peak current
t_{on}	turn on time
t_{off}	turn off time
t_r	rise time
t_{rr}	reverse recovery time
t_s	storage time
V_F	steady forward voltage
v_F	instantaneous forward voltage
V_R	steady reverse voltage
v_R	instantaneous value of the reverse voltage
V_{RM}	peak reverse voltage
V_{RRM}	repetitive peak reverse voltage
V_{RSM}	non-repetitive peak reverse voltage (on surges)
V_Z	zener diode working voltage

SYMBOLS USED MAINLY WITH TRANSISTORS

C_{ob}	transistor output capacitance in the grounded base circuit
C_{oe}	transistor output capacitance in the grounded emitter circuit
f_T	transition frequency or gain-bandwidth product in common emitter circuit
h_{FE} (h_{FB} , h_{FC})	current gain in the grounded emitter circuit (or in the grounded base or grounded collector circuit).
h_{fe}	the increase in collector current divided by the small increase in the base current which produces it. (Small signal current gain.)
I_B , I_C or I_E	the steady base, collector or emitter current.
$I_{B(AV)}$, $I_{C(AV)}$ or $I_{E(AV)}$	the average value of the base, collector or emitter current.
I_{CEX}	collector cut off current in a specified circuit
I_{CM} , I_{BM} or I_{EM}	peak value of collector, base or emitter current

I_b, I_c or I_e	rms value of the alternating component of the current
I_{bm}, I_{cm} or I_{em}	peak value of the alternating component of the current
I_C, I_B or I_E	instantaneous value of the total current
i_c, i_b or i_e	instantaneous value of the alternating component of the current
I_{CBO}	collector cut off current with the emitter open circuited
I_{CBS} or I_{CES}	collector cut off current with emitter shorted to the base
I_{CEO}	collector cut off current with the base open circuited
I_{CER}	collector cut off current with a specified value of resistance between the base and the emitter
I_{EBO}	emitter cut off current with the collector open circuited
$V_{BE(SAT)}$	base-emitter saturation voltage
$V_{(BR)}$	breakdown voltage
$V_{(BR)CBO}$	collector to base breakdown voltage with emitter open circuited
$V_{(BR)CEO}$	collector to emitter breakdown voltage with base open circuited
V_{CB}	collector-base voltage
V_{CBO}	collector to base voltage with emitter open circuited
V_{CC}	collector supply voltage
V_{CE}	collector to emitter voltage
V_{CEO}	collector to emitter voltage with base open circuited
V_{ce}	collector to emitter rms voltage
$V_{CE(SAT)}$	collector to emitter saturation voltage
V_{EB}	emitter-base voltage
V_{EBO}	emitter-base voltage with collector open circuited
V_{eb}	emitter-base rms voltage

SYMBOLS USED MAINLY WITH FETS

I_D	steady value of the drain current
I_{DSS}	steady value of the drain current with the gate connected to the source
I_{DM}	peak drain current
I_G	steady gate current
I_S	steady source current
r_{DS}	drain to source (or channel) resistance
V_{DS}	steady drain to source voltage
V_{GS}	steady gate to source voltage

SYMBOLS USED MAINLY WITH THYRISTORS

I_{FRM}	repetitive peak forward current
I_{FSM}	non-repetitive peak (surge) current
I_{GD}	gate current which does not trigger the device
I_{GT}	gate trigger current
I_{GQ}	gate turn off current
I_H	holding current required to maintain conduction
I_R	steady reverse leakage current
I_{RG}	reverse gate current
I_{RRM}	repetitive peak reverse current
I_{RSM}	non-repetitive peak reverse current (in surge conditions)
I_T	steady anode-cathode 'ON' state current
P_G	gate power
t_{gt}	gate controlled turn-on time
t_{gq}	gate controlled turn-off time
$V_{(BO)}$	breakover voltage
V_D	continuous off state voltage

V_{FG}	forward gate voltage
V_{GT}	gate trigger voltage
V_R	steady reverse voltage

OPERATIONAL AMPLIFIER TERMS

Bandwidth, Δf . The frequency at which the gain falls by a factor of 0.7 relative to the gain at low frequencies.

Common mode rejection ratio, CMMR. The gain when a signal is applied to one of the inputs of the amplifier divided by the gain when the signal is applied to both the inverting and non-inverting inputs. It is usually expressed in dB.

Frequency compensation. An operational amplifier requires a capacitor to enable it to be used in circuits which are stable over a wide frequency range. Internally compensated operational amplifiers have this capacitor fabricated on the silicon chip, but an external capacitor must be used with other types of operational amplifier which do not contain an internal capacitor.

Input bias current, I_{bias} . The mean value of the currents at the two inputs of an operational amplifier.

Input offset current, I_{OS} . The difference in the two currents to the inputs of an operational amplifier. Normally much smaller than the input bias current.

Input offset voltage, V_{OS} . The voltage which must be applied between the two input terminals to obtain zero voltage at the output.

Open loop voltage gain, A_{VOL} . The amplifier gain with no feedback applied.

Output resistance, R_O . The small signal resistance seen at the output when the output voltage is near zero.

VOLTAGE REGULATOR TERMS

Dropout voltage, V_{DO} . When the difference between the input and output voltages falls down below the dropout voltage, the device ceases to provide regulation.

Foldback current limiting. In regulators with foldback current limiting, the current will 'fold back' to a fairly small value when the output is shorted.

Line regulation. The change in the output voltage for a specified change in the input voltage.

Load regulation. The change in output voltage for a change in the load current at a constant chip temperature.

Quiescent current, I_Q . The current taken by the regulator device when it is not delivering any output current.

Ripple rejection. The ratio of the peak-to-peak ripple at the input of the regulator to that at the output. Normally expressed in dB.

MONOLITHIC TIMER TERMS

Comparator input current. The mean current flowing in the comparator input connection during a timing cycle.

Timing capacitor, C_T . This capacitor is normally connected between the comparator input and ground. The time taken for it to charge controls the delay time.

Timing resistor, R_T . This is the resistor through which the timing capacitor charges.

Trigger current. The current flowing in the trigger input connection, at the specified trigger voltage.

Trigger voltage. The voltage required at the trigger pin to initiate a timing cycle.

Conclusions

Data sheets must be used intelligently and with much thought. Information on the conditions under which an entry in the data sheet is applicable is often stated in small print, but is of great importance. Data should always be thoroughly studied before a device is used for the first time; only then will you be able to fully understand the potential applications of the device.

Data Sheets Explained

CAPITALS AND LOWER CASE Both the quantity being shown and the subscript may appear as a capital or lower case letter in order to differentiate between instantaneous and rms values. The basic rules are given in the following table:	
	MEANING
Capital quantity symbol plus capital subscript [V,I,P] + [C,E,B]	The steady current (no signal) value. The subscript (AV) may be added to indicate the total average value with signal or (M) for the total peak value.
Capital quantity symbol plus lower case subscript [V,I,P] + [c,e,b]	The rms value of the alternating signal component. The subscript (av) may be added to indicate the average value of the varying signal component or (m) to indicate the peak value of this component.
Lower case quantity symbol plus capital subscript [v,i,p] + [C,E,B]	The instantaneous total value of the quantity concerned.
Lower case quantity symbol plus lower case subscript [v,i,p] + [c,e,b]	The instantaneous value of the varying signal component.

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Easy I&O In CMOS

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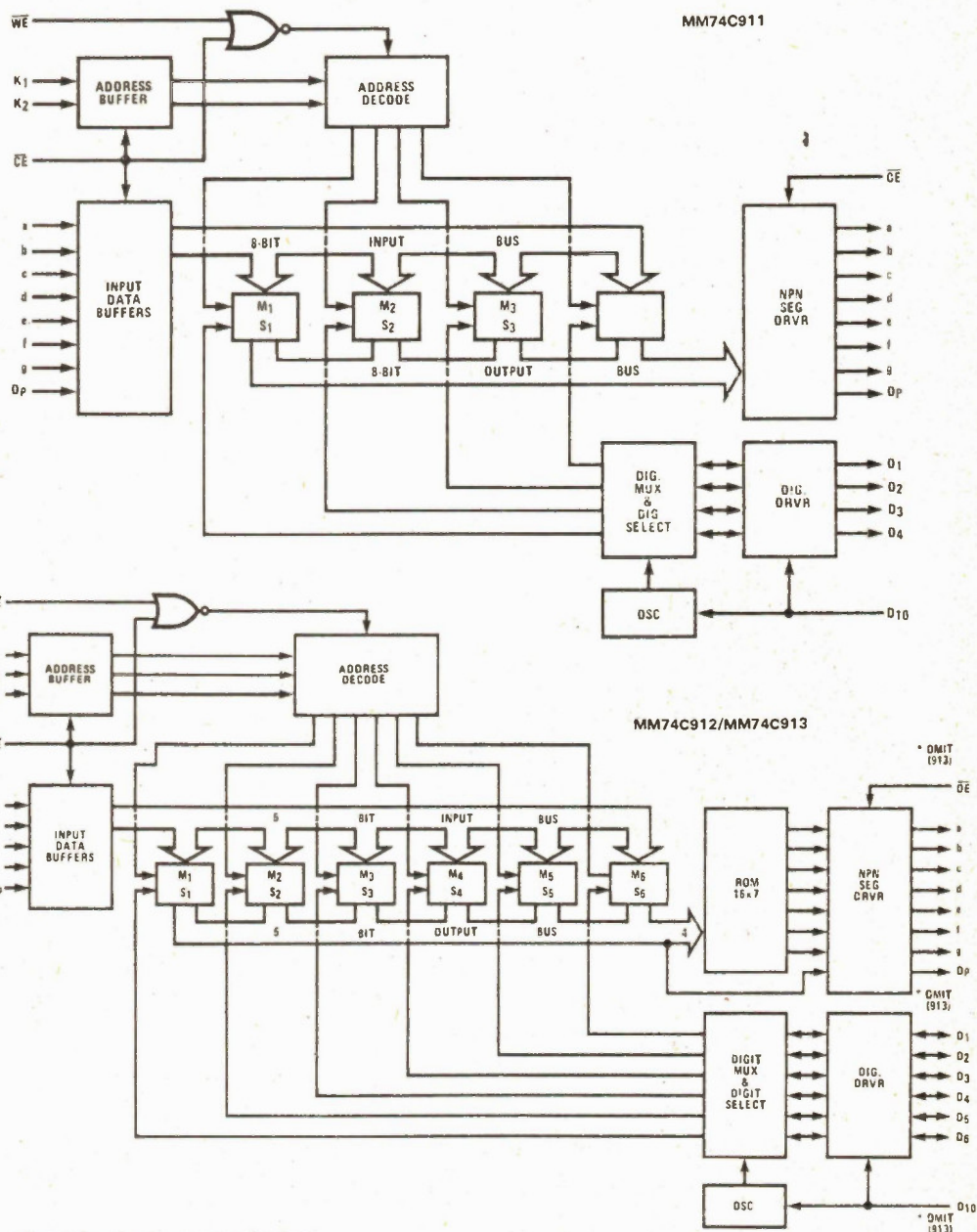
THE 74C911 (4-DIGIT, 8-BIT) AND 74C912 (6-DIGIT, 4-BIT) DISPLAY CONTROLLERS

The display controller serves as an interface element between the bare machine and the controlled display. The display controller normally receives input data and digit address information and then controls a seven-segment display, providing direct segment drive and internal multiplexing of all digits. The display controller provides a random access to the master portion of an internal register selected by an address operation. Normally an internal oscillator will sequentially address the slave portion of the internal registers; however, it is also possible for the user to randomly address the slave portion of the internal registers via the digit I/O control pin. The display controller will be capable of both segment and digit expansion, extending its use to alphanumeric 16-segment displays or 12-digit calculator stick displays.

The display controller is a CMOS circuit constructed on the buffered guard band process, limiting it to five-volt operation. The segment outputs has an NPN source transistor and an N-channel sink transistor. The segment outputs can be tri-stated by use of the output enable pin. The digit I/O port is controlled by the digit I/O pin. Used as an output the digit lines are sequentially strobed by the internal oscillator and the data multiplex to the segment outputs. Used as an input only one digit line at a time can be high. Data information from the selected digit appears at the segment output. The internal oscillator is inhibited. The register being addressed by the input address and input data is completely independent of the register being addressed by the digit input and segment output information. The digit output drive is a standard B series specification.

Three versions of the display controller will exist. The MM74C911 will multiplex four digits with 8 bits of input information and comes in a 28-pin package. The MM74C912 will multiplex six digits with ROM information with the ROM addressed by 4 data bits. The decimal point input does not address the ROM and goes directly to the output. The MM74C912 is capable of digit expansion. The MM74C911 is capable of both digit and segment expansion. A third version, the MM74C913, will be identical to the MM74C912 except that the decimal point input and output and the digit and segment tri-state controls will be omitted. The MM74C912 will be housed in a 24-pin package and is intended for the electronic pinball market.

Two input protection diodes will be present at all inputs. The diode to Vcc may be omitted via a simple metal option.



electrical characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V _{CC}	Supply Voltage	4.5		5.5	V
	Standby Voltage	3.0		5.5	V
V _{IN(1)}		V _{CC} - 2.0			V
V _{IN(0)}				0.8	V
I _{OS}	Segment Output Current	40	80		mA
I _{SINK}		All Outputs = 2 LP TTL			

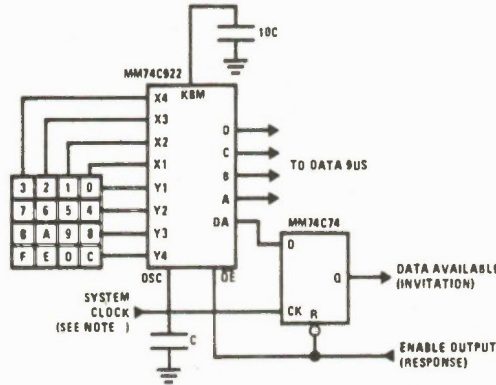
THE 74C922 (16 KEY) AND 74C923 (20 KEY) ENCODERS

These CMOS key encoders provide all the necessary logic to fully encode an array of SPST switches. The keyboard scan can be implemented by either an external clock or external capacitor. These encoders also have onchip pull-up devices which permit switches with up to 50 kilohm on resistance to be used. No diodes in the switch array are needed to eliminate ghost switches. The internal debounce circuit needs only a single external capacitor and can be defeated by omitting the capacitor. A Data Available output goes to a high level when a valid keyboard entry has been made. The Data Available output returns to a low level when the entered key is released, even if another key is depressed. The Data Available will return high to indicate acceptance of the new key after a normal debounce period; this two key roll over is provided between any two switches.

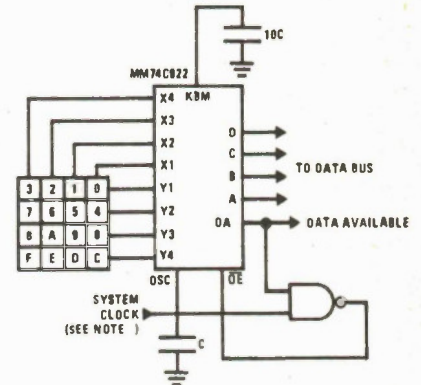
An internal register remembers the last key pressed even after the key is released. The tristate outputs provide for easy expansion and bus operation and are LPTTL compatible.

typical applications

Synchronous Handshake (MM74C922)

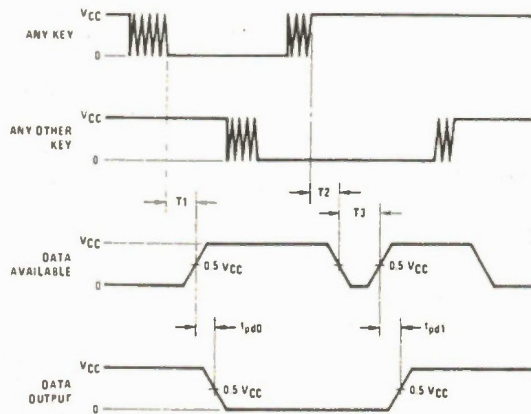


Synchronous Data Entry Onto Bus (MM74C922)



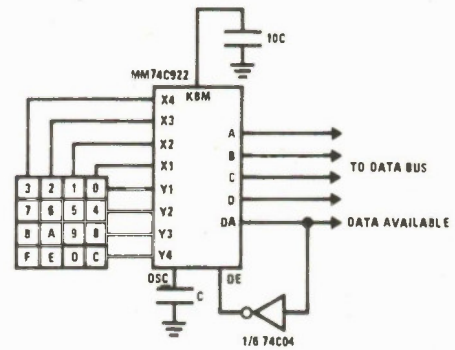
Outputs are enabled when valid entry is made and go into TRI-STATE when key is released.

switching time waveforms



$T_1 = T_2 \approx RC$, $T_3 \approx 0.7 RC$ where $R = 10k$ and C is external capacitor at KBM input.

Asynchronous Data Entry Onto Bus (MM74C922)



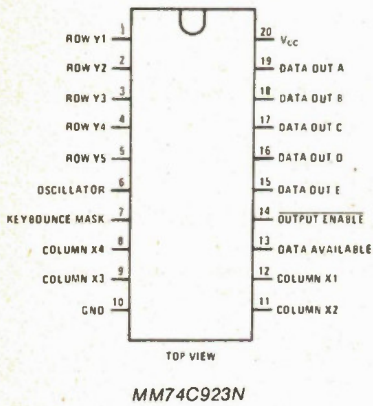
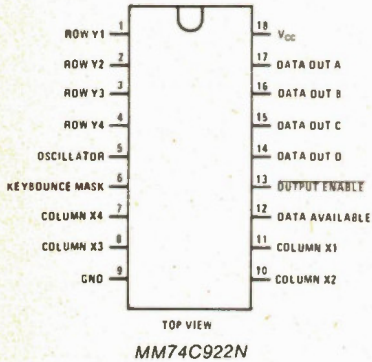
Outputs are in TRI-STATE until key is pressed, then data is placed on bus. When key is released, outputs return to TRI-STATE.

Note: The keyboard may be synchronously scanned by omitting the capacitor at osc. and driving osc. directly if the system clock rate is lower than 10 kHz.

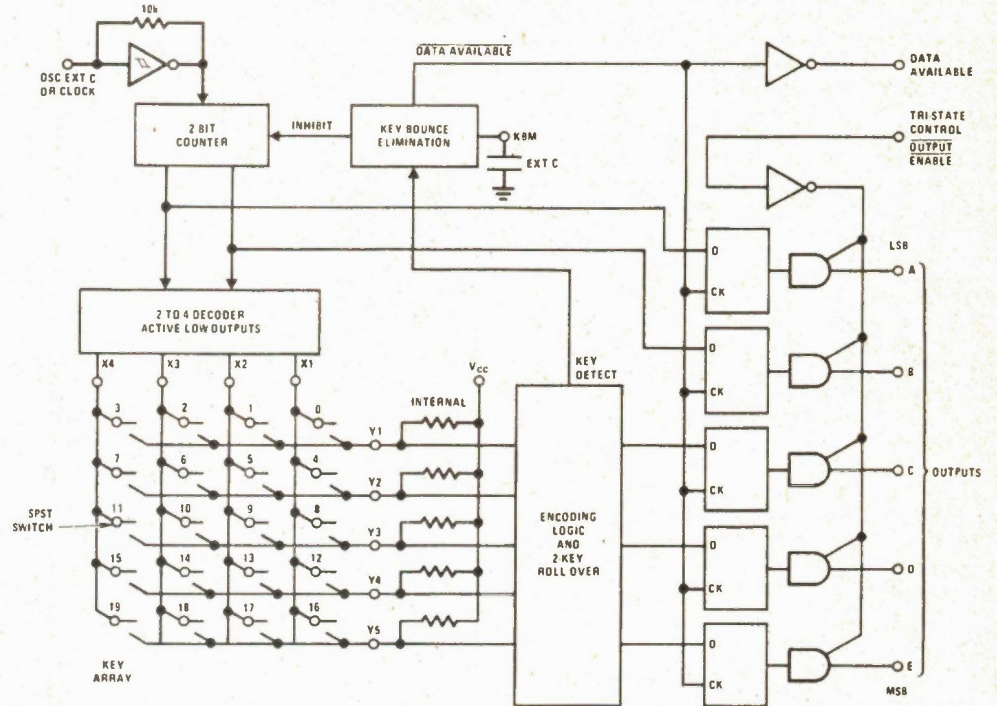
dc electrical characteristics Min/max limits apply across temperature range

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
CMOS TO CMOS					
I_{rp}	Row Pull-Up Current at Y1, Y2, Y3, Y4 and Y5 Inputs	$V_{CC} = 5V, V_{IN} = 0.1 V_{CC}$	-2	-5	μA
		$V_{CC} = 10V$	-10	-20	μA
		$V_{CC} = 15V$	-22	-45	μA
R_{on}	Column "ON" Resistance at X1, X2, X3 and X4 Outputs	$V_{CC} = 5V, V_O = 0.5V$	500	1400	Ω
		$V_{CC} = 10V, V_O = 1V$	300	700	Ω
		$V_{CC} = 15V, V_O = 1.5V$	200	500	Ω
I_{CC}	Supply Current	$V_{CC} = 5V, Osc \text{ at } 0V$	0.55	1.1	mA
		$V_{CC} = 10V$	1.1	1.9	mA
		$V_{CC} = 15V$	1.7	2.6	mA

connection diagrams



block diagram



features

- 50 k Ω maximum switch on resistance
- On or off chip clock
- On chip row pull-up devices
- 2 key roll-over
- Keybounce elimination with single capacitor
- Last key register at outputs
- TRI-STATE outputs LPTTL compatible
- Wide supply range 3V to 15V
- Low power consumption

BINDERS



In response to many requests from our readers we have arranged for binders to be made so that you can keep ETI's first Canadian volume together and protected from damage. The binders are covered in attractive leather-look black plastic and are designed to hold twelve issues. The ETI design is printed in gold letters on the spine.

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Service News

R.C. with commentary on the electronic servicing scene.

BECAUSE OF manufacturers' vacation times, and possibly even due to the luckily short-lived mail strike, we have had no replies as yet to our letter requesting information on upcoming seminars, technical tips, new products, etc. However I have spent the last two weeks talking to service technicians, both in the private sector and in manufacturing, about the future of the service industry. One word seemed to come up in all of my conversations, certainly on the manufacturing side, and that is "digitalizing". To be quite honest, this is something I know very little about, and I will quite possibly have to take one of the many courses that will be offered over the next year in technical schools, collegiates, etc., right across the country.

RCA DIGITAL

R.C.A. made it very clear that the computer is already in use in the television receiver industry. Various manufacturers are already planning on digital processing in their RF and IF circuits. All manufacturers left no doubt in my mind that the individual who makes no attempt to learn the basics of digital sciences will in all probability be looking for a new line of employment within the next 10 years. The days of the tube jockey and his successor, the module pusher, are rapidly coming to an end, and although we can expect tube and hybrid sets to be in service for many years to come, the increased cost of service will tend to drive the consumer to the nearest retail outlet, where he will be able to buy one of the latest very reliable products at an

extremely competitive price, making the repair uneconomical.

LABOUR COSTS

The cost of service today is already, in the public's eye, becoming prohibitive. Labour alone on a major shop job is already around \$75-\$80, and when you add the greatly increased cost of tubes, flybacks, filters, etc., a major breakdown very rarely goes back to the customer under \$100, and when you consider that a new set can be purchased for less than \$400, and in some cases with a 3-year complete warranty, it does not take a genius to figure which way the general public is apt to jump.

It was pointed out to me that the only way to keep costs down is by increased productivity, and this can only be accomplished by greatly increased efficiency, and perhaps by specializing in only one or two makes of set.

ZENITH VS. THE REST

In my investigations I was somewhat surprised at two completely different schools of thought, with the Zenith Radio Corporation on one side, and the rest of the manufacturers on the other. I have had the opportunity to examine somewhat cursorily the Zenith System III chassis, and was most impressed with its accessibility and obvious ease of service. The set was undoubtedly designed with the serviceman in mind, but the surprising thing to my way of thinking was that every other manufacturer has left the module system, and a number of reasons were given for this: previous contact trouble;

inadvertent damage done to modules while replacing; etc., but whatever the reason, we are left with one manufacturer only adhering to the modular principle.

There seems to be no earthly reason why the Zenith set would ever have to be taken back to the shop, while in most cases I can see no way that the other manufacturers' products will be serviced (other than the most rudimentary adjustments) in the home. Mind you, in fairness I would like to point out that the amount of service required is calculated to be extremely low, and the designers feel that by returning to the single board method of construction, properly anchored and supported, this alone will keep the service incidence low.

What is going to happen in the future? If you, the practising technicians, do not fully understand this new science of digitalizing, again quoting the experts, you would be well advised to sign up immediately for one of the many courses being offered. The modern television set does not lend itself to the hit and miss method of servicing that most of us have practised (albeit occasionally) over the past 25 years, and though the manufacturers themselves are doing their best to keep us all appraised of the latest servicing techniques, equipment, etc., it is up to the individual to keep his theoretical knowledge on a par with recent developments or he will be unable to assimilate even the simplest facts the instructors will be endeavouring to instil at their seminars.

Don't be left behind!

CDE

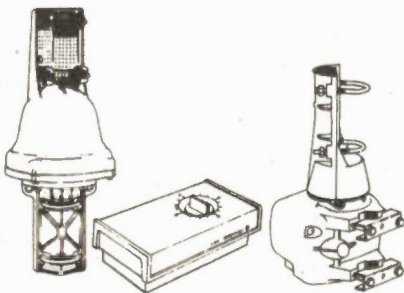
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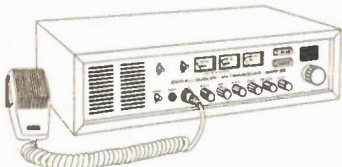
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Simple Transistor SCR
SCR Tester
Crystal Check
Crystal Checker
Good Bad Battery Tester
Battery Tester
Op-Amp Tester
Op-Amp Checker
Cheap Logic Probe
Audible TTL Probe
Audible Slow Pulses
Logic Probe
Logic Analyser
I and O Display Probe
Simple High Impedance Voltmeter
Audio RF Tracer
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Simple Frequency Meter

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741 Timer
Self Triggering Timer
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Door Chime Delay

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Touch Sensitive Switch
Electronic Switch
Sound Operated 2 Way
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Two Signals on one Wire

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3 Step Level
Light Level
Barograph Display
Fuse Failure
Blown Fuse
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Current Flow
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FLASHERS

Dancing Lights
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Floodlamp Control
Zero Crossing Sync
Train Controller
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Simple Temperature Control
Full Wave SCR Control

AUTOMOBILE

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Courtesy Light Delay
Simple Hazard Light
Light Extender & Reminder
Four Way Flasher
Headlamp Dipper
Wiper Delay
Suppressed Zero Voltmeter
Rev Counter Tachometer
Auxiliary Battery

DETECTORS & COMPARATORS

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Window Detector
Peak Program
Positive Peak
Reaction Comparator

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100 kHz Marker
RF Voltmeter
RF Detector
LED RF Indicator
RF Amplifier Protection
FET Radio
Op-Amp Radio

MISCELLANEA

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Touch Doorbell
Phase Lock Control
Audio Mixer
Virtual Earth Mixer
Pop Eliminator
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Tinning With Solder Wick
PCB Stencils
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DIL Drilling
Fluorescent Starting
Avoiding Insulated Heat Sinks
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Boost Your Mains
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High Voltage Electrolytics
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Template & Heat Sink for Power Transistors
Transistor Socket
Solder Flow Problems
Odd Resistor Values
Resistors in parallel
CMOS DIL Handling
Identifying Surplus ICs
Extending Battery Life
Battery Snaps
Power Supply or Battery
Battery Checking
Muck Remover
Transformers in reverse
Loudspeaker Checking
Improving UJT Linearity
Signal Tracer
Crystal Earpieces
Zener Varicaps
Zener Lifts Capacitor Rating

DATA

741 Op-Amp Data
BC 107-109 Data
BC 177-179 Data
CMOS & TTL Data
2N3055 Data
M2955 Data
Bipolar Data Tables
Bipolar FETs Rectifiers
Diodes Pinouts Zener Misc

ALARMS

Basic Alarm
Photo Intruder Alarm
Intruder Alarm
Photo Electric Relay
Low Temperature Lights out
Temperature Sensor
Coolant level
Water Level
Electronic Lock
Car Battery Watchdog
Simple Car Alarm
Simple Lock

AMPLIFIERS & PREAMPLIFIERS

High input impedance
High impedance Buffer
Low Output Impedance
High input impedance
Low Frequency Extender
Virtual Earth Preamp
IC Tape Head Preamp
Simple Stereo Tape Player
2.5 Watt
20 Watt Slave
10 Watt
Loudspeaker Microphone
Voltage Controlled Amp
Wide Band Amplifier
Video Power Amp
Broadband Amp

SIGNAL PROCESSORS

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Guitar Fuzz
Fuzz Box
Waa Waa
Voltage Autolode
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Information Transfer
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TV Sound Pickup
Crackfree Potentiometer
Voltage to Frequency
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Fast Half Wave
Simple Chopper
Noise Rejecting SCR Trigger
Phase Shifter

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Club Call

Vancouver Petters

The Vancouver PET Users Group recently held their second meeting. The success of the PET has caught us all by surprise. The attendance at our second meeting was over double the first, with some 40 owners and 15 PETs. The Commodore dealers indicate that there are many more Petters who are not aware of our group. The fourth meeting will be held on September 20th. Interested persons should phone Rick Leon at home (604) 734-2060, work (604) 324-0505, they can also write to Vancouver PET Users Group, Box 35353 Station E, Vancouver, BC.

The club format includes a short presentation by a PET owner on programming or PET hardware, plus news from Commodore and other sources.

Richard Leon

ACE

The Association of Computer Experimenters is a group of hobbyists in the Hamilton-St. Catherines area

who are working on RCA-1802 based systems. They have two cross-assemblers written in FORTRAN, they have developed a memory-expansion board, and are working on interfacing with a calculator chip and memory-mapped video displays (for use with the single-board evaluator).

The club has over 500 paid-up members after a year of operation. The membership fee (\$10) covers the cost of the newsletter, 'Ipso Facto', which appears to come out at a frequency between monthly and bimonthly.

For more information write George York, Secretary/Treasurer, ACE, 60 Chester Road, Stoney Creek, Ontario, Canada L8E 1Y2. George would like to arrange contact with other computer clubs — to exchange newsletters, minutes, etc.

If you know about any clubs that haven't been announced in these pages please write and tell us. All clubs are looking for new members and thousands of ETI readers could get a lot more out of their hobby if they knew the address of a club in their area. Just write a short note saying how prospective members can approach you.

Club call can also be of assistance to people who want to start a club.

Previously Listed Clubs

TRACE: Computer Club, Toronto. See p7 Jan 78 ETI.

CSWLI: SWL Club, Thunder Bay. See p7 Mar 78 ETI.

TRAC: Amateur Radio Club, Thornhill. See p7 Mar 78 ETI.

ODXA: SWL Club, Don Mills. See p61 Apr 78 ETI.

CCCC: Computer Club, Montreal. See p61 Apr 78 ETI.

ECEC: Electronics Club, Elphinstone. See p61 Apr 78 ETI.

CHSSCC: (Computer Club, Houston. See p37 May 78 ETI.

WIARC: Amateur Radio Club, Dorval. See p37 May 78 ETI.

OSWCC: SWL Club, Prescott. See p37 May 78 ETI.

LARC: Amateur Radio Club, London. See p. 61 June 78 ETI.

FGARC: Amateur Radio Club, Prince George, See p. 61 June 78 ETI

BARC: Amateur Radio Club, Burlington. See p71 July 78 ETI.

MARC: Amateur Radio Club, Montreal. See p71 July 78 ETI.

ROMS: Computer Club, Regina. See p66 Aug 78 ETI.



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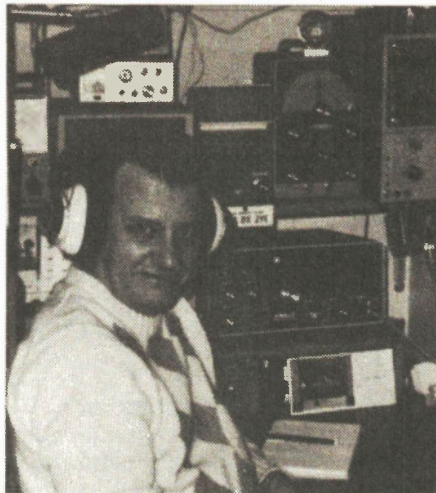
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John Garner checks into the ham bands.



AMATEUR RADIO is a hobby as old as radio itself. As a matter of fact, amateurs, through their interest in radio electronics, have developed new and better equipment for all of us interested in radio. It is only in fairly recent years that ready built amateur equipment has been available. The early hams (a name generally used to describe amateur operators) had to build and maintain their own receivers and transmitters, and many still do so. When manufacturers discovered that they had to perfect their rigs before amateurs would buy them, all of us, as short wave listeners, benefitted by having better receivers made available.

SSB

One requirement for the short wave listener is a receiver that is capable of receiving Single Side Band (SSB) transmissions, since almost all amateur work is done in this mode or in Morse Code. Without this feature on your receiver, the signals will be garbled and sound something like the voice of Donald Duck.

DISASTER LISTENING

During times of disaster, such as floods, earthquakes, etc., amateur radio is often the only form of communication available and the hams are ready to serve at such times. Hams frequently arrange for servicemen in remote areas of the world to talk to their families back home via radio. All services offered by amateurs are free of charge since although they are strictly amateurs they are "professional" in their actions, and besides are compelled by law not to charge.

RAG CHEWING

Most of the ham communications you will hear in the short wave bands will be friendly discussions between two radio enthusiasts, sometimes a few miles apart or maybe half way around the world. They will be discussing the weather or the type of equipment they are using and letting each other know how his signal is being received. Frequently one will adjust his antenna or tuning while the operator at the other end is monitoring him and telling him how these adjustments affect

reception. A good way to check on propagation conditions is to tune into the ham bands and see what they have to say about conditions at the time.

EXPERIMENTING

Besides radio, hams also experiment with radioteletype and television (both slow scan and fast scan). Some bounce signals off the moon. At the present time there are two satellites circling the globe for the use of amateur operators. Signals are received by the satellites, called OSCAR (Orbiting Satellite Carrying Amateur Radio), on one frequency and transmitted back to earth in a different frequency range. OSCAR 7 and OSCAR 8 are presently in operation. These and their predecessors were mainly designed and built by and for amateurs. They are put in orbit by riding piggyback on regular NASA launches.

HAM SPOTTING

A short wave listener can help the amateur by sending accurate reception reports to him. Amateurs identify themselves generally only by their callsigns. For the newcomer to the ham bands this presents several problems — Where do you send reception reports? What country is he transmitting from? The callsign used by the ham indicates the origin of the transmission

The International Telecommunications Union (ITU) has allocated blocks of letters for callsigns to all countries. Each country's government agency responsible for radio, such as Canada's Department of Communication (DOC), or the Federal Communications Commission (FCC) in the USA, assign each ham a distinctive callsign after the amateur has passed a stringent test which includes sending and receiving Morse Code and a practical knowledge of radio theory. Canada's amateurs use callsigns beginning with the letters VE

Chart 1: Canadian callsigns.

- VO1 Newfoundland
- VO2 Labrador
- VE1 Nova Scotia, New Brunswick, Prince Edward Island
- VE2 Quebec
- VE3 Ontario
- VE4 Manitoba
- VE5 Saskatchewan
- VE6 Alberta
- VE7 British Columbia
- VE8 Yukon and Northwest Territories
- VE0 Canadian Amateurs on the high seas

Chart 2: American callsigns.

- Call area 1 — Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
- Call area 2 — New Jersey, New York
- Call area 3 — Delaware, District of Columbia, Maryland, Pennsylvania
- Call area 4 — Alabama, Florida, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia
- Call area 5 — Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma, Texas
- Call area 6 — California
- Call area 7 — Arizona, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming
- Call area 8 — Michigan, Ohio, West Virginia
- Call area 9 — Illinois, Indiana, Wisconsin
- Call area 0 — Colorado, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota

Note: the last call area is usually referred to as call area 10 although only the 0 is used in callsigns. In addition to the above, Alaska uses prefix KL7 and Hawaii uses KH6.

or VO followed by a number indicating the area of the country (see Chart 1) which is followed by two or three letters. Example — VE3ABC would be a ham operator in Ontario.

In the United States, callsigns start with the letter K or W, sometimes followed by a second letter. Next is a single number indicating the area of the USA (see Chart II) and this is followed by two or three letters. Example W1AB or WA6ABC.

Addresses for Amateur operators may be found in the Radio Amateur Callbook. This is a two volume set — one for the USA, and one for the rest of the world. These books are similar to your local telephone directory listing all licensed hams by callsign. If you don't wish to purchase one of these books,

perhaps you could find a ham in your area who would help you obtain addresses of the calls you hear. The Callbook is published each year with quarterly supplements. When requesting a QSL from an amateur don't forget to include return postage.

NORTH AMERICA

Following are the frequencies used by hams in Canada and the USA. Most of the rest of the world also use these same bands. As in international broadcasting, the bands are referred to by wavelength. The same principles of times of day for best reception also apply, that is, higher frequencies provide reception in daylight hours and the lower frequencies are better during darkness hours.

160 metres — 1800-2000 kHz — This band is not very active at present. Some local stations may be heard.
 80 metres — 3500-4000 kHz
 40 metres — 7000-7300 kHz
 20 metres — 14000-14350 kHz
 15 metres — 21000-21450 kHz
 10 metres — 28000-29700

Morse Code (CW) transmissions are allowed in all these frequency ranges while voice transmission is allowed only in the higher end of each band.

Amateurs also use higher frequency bands but these are not in the short wave spectrum and are not considered in this article.

Here's hoping you will enjoy listening to the Hams. Until next month 73 and good listening.

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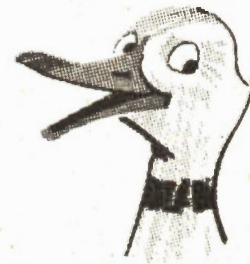
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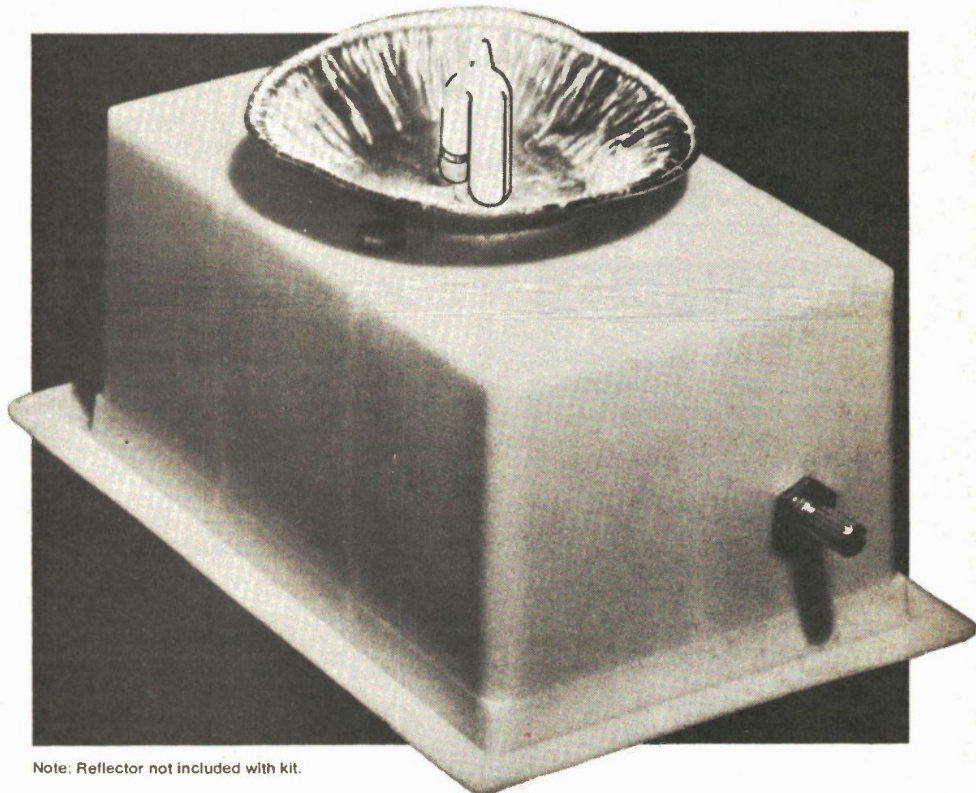
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Jana Xenon Strobe Kit

Jana Electronics is pleased to participate in Electronics Today International and hopes everyone who builds projects like the Xenon Strobe Kit in this issue receives as much enjoyment from constructing and using them as the Jana Engineers had in designing them.

Although the designers try as much as possible to use standard, easy-to-obtain components it sometimes happens that a particular semiconductor, IC, or even the correct value of resistor isn't available.

To overcome this problem, Jana Electronics packages all of its projects complete with easy to follow instructions. These package kits are versatile and economical...for example the box becomes the chassis. As well, it is possible to purchase separately the PC board. So you can either layout and etch your own or obtain one factory complete from Jana. Pick up the Xenon Strobe kit from your nearest Jana Dealer Today and see their other fine Jana Electronic Projects:



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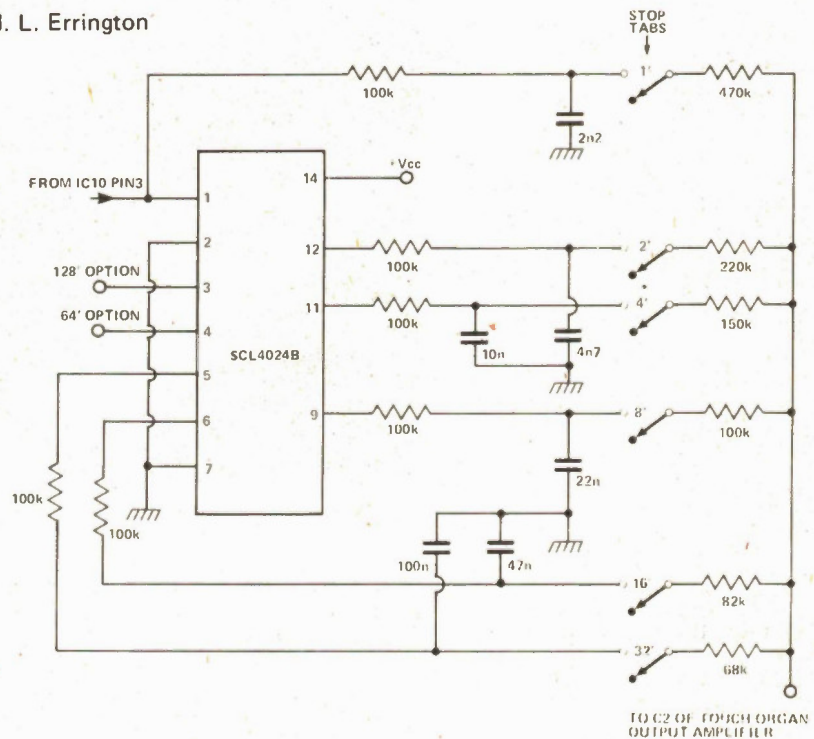
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Tech Tips

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, Electronics Today International, Unit 6, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1.

Electronic Organ Divider

J. L. Errington



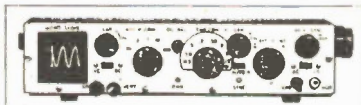
In order to improve the versatility of the ETI Touch Organ it proved desirable to enable further octaves to be used. The circuit shown uses a CMOS divider IC to produce up to seven octaves below the fundamental. To increase the upper limit of the range, the original value of C1 in the touch organ was reduced to 5n6, so that the basic two octaves were from 699Hz to 2796Hz.

This was designated as the 1' pitch, and the first five divided outputs from

the 4024 were 2', 4', 8', 16', and 32' pitches. All these were then fed via separate RC filters to stop switches, then through a resistive mixer to the existing audio amplifier. The values used in the mixer may be adjusted to suit individual requirements. The input to the divider is fed directly from the output (pin 3) of the 555. Although designed specifically to complement the Touch Organ, this circuit is also suitable for many other simple organ circuits.

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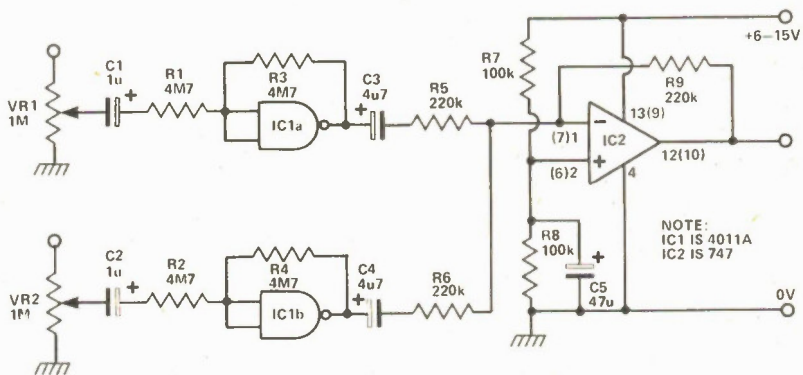
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Tech Tips



Hybrid Mixer

J. Macauley

This circuit shows one channel of a stereo mixer, the other channel being identical. The input signal is applied to the volume controls RV1&2 and from thence to the NAND gates via the blocking capacitors and R1&2. These gates are first used as inverters by strapping both their inputs together, and are biased into the linear region by the feedback resistors, R3&4. In this way the gates act as high impedance, high quality, unity gain amplifiers.

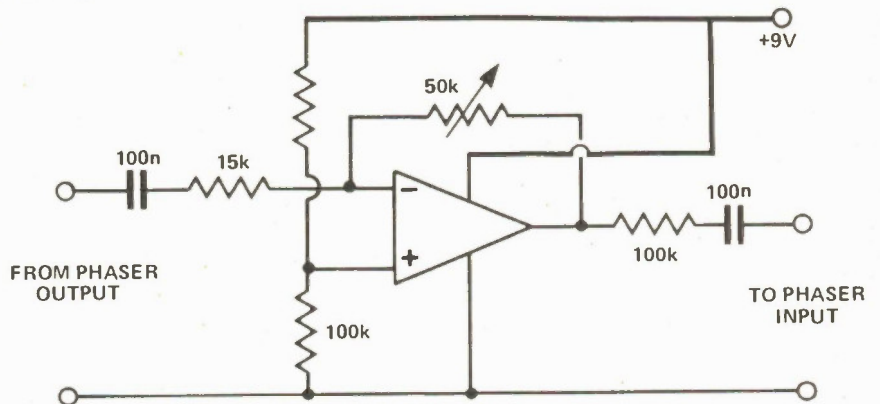
The output from the gates are summed by the mixer, IC2. This IC is a dual op-amp of the same specifica-

tion as the commoner 741, which could be used instead. As a single power supply is used the non-inverting input must be biased at half the supply voltage. This is done by the potential divider, R7&8, C5 decouples this point to earth.

The output impedance of this IC when used in the manner described is less than 1 ohm and so can be fed directly into a line socket. This circuit will only work with 'A' series 4011s as the B series contains protection circuitry which will prevent it working in the linear mode.

Phaser Mod

M. Headey



I constructed a simple variable gain op amp inverter and connected it between the output and the input.

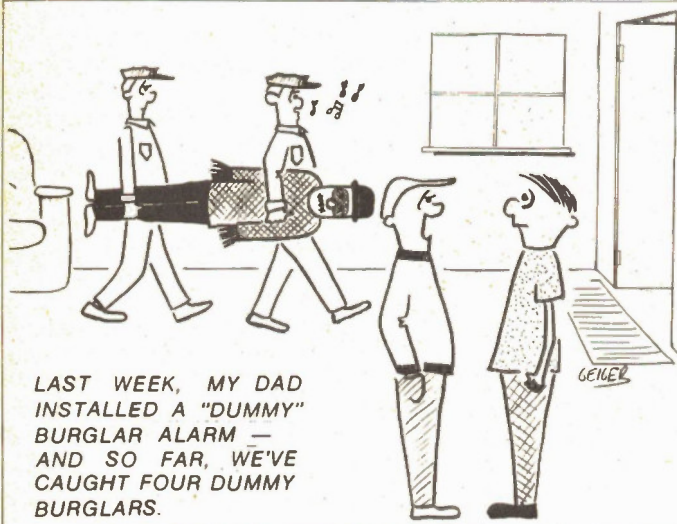
When the feedback amp was switched into circuit the effect was dramatic. The phaser sounded much deeper. The modification is simple enough

and though can be adjusted to feedback (audio) level, sounds very good if the gain is kept down.

The circuit as shown gives very good results although you may be able to suggest some component value changes.

The Fun of Electronics

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I JUST FINISHED BUILDING A NEW RECEIVER, BUT I NEED A NOISE GENERATOR TO CHECK IT OUT, SO WHY DON'T YOU INVITE YOUR MOTHER OVER FOR A VISIT?



... AND BY THE WAY, GOOD BUDDY, HOW DID YOU EVER THINK OF USING A NAME LIKE "THE MARTIAN" FOR A HANDLE?

ETI Project File

Updates, news, information, ETI gives you project support

PARTS PARTS PARTS

We are continually besieged 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 electronics 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
Oct 77	Graphic Equaliser
Feb 78	Note: D
Oct 77	Loud Hailer
Oct 77	Continuity Tester
Oct 77	Stereo Simulator
Nov 77	Digital Thermometer
Jan 78	Note: C, T, S,
Jan 78	Neg.
Feb 78	Note: S
Nov 77	3-Channel Tone Control
Jan 78	Neg.
Nov 77	Watchdog
Jan 78	Neg.
Aug 78	Note: D
Dec 77	50D50 Amplifier
Jan 78	Neg.
Feb 78	Note: T
Dec 77	Spirit Level
Jan 78	Neg.
Dec 77	Egg Timer
Jan 78	Neg.
Jan 78	Option Clock & Neg.
July 78	Note: S
Jan 78	LED Pendant
May 78	Note: C
Jan 78	Compander & Neg.
Feb 78	Tachomonitor
Apr 78	Neg.
Feb 78	LCD Panel Meter
Apr 78	Note: C
Apr 78	Neg.
Feb 78	CB Power Supply
Apr 78	Neg.
May 78	Note: N
Feb 78	Freezer Alarm
Apr 78	Neg.

ISSUE DATE	ARTICLE
Mar 78	Hammer Throw
June 78	Neg.
Apr 78	Computer PSU & Neg.
Apr 78	Audio Delay Line & Neg.
Mar 78	True RMS Meter
Apr 78	Neg.
Mar 78	Home Burglar Alarm
Apr 78	Gas Alarm & Neg.
May 78	White Line Follower
June 78	Neg.
May 78	Acoustic Feedback Eliminator
June 78	Neg.
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.
Aug 78	Porch Light & Neg.
Aug 78	IB Metal Locator & Neg.
Aug 78	Two Chip Siren & Neg.
Sept 78	Audio Oscillator
Sept 78	Shutter Timer
Sept 78	Rain Alarm
Oct 78	CCD Phaser
Oct 78	UFO Detector
Oct 78	Strobe Idea

ETI Project Chart

Oct. 77 to Oct. 78

Canadian Projects Book

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

Key to Project Notes

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

PROJECT CHART

This chart is an index to all information available relating to each project we have published in the preceding year. It guides you to where you will find the article itself, and keeps you informed on any notes that come up on a particular project you are interested in. It also gives you an idea of the importance of the notes, in case you do not have the issue referred 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 4.7 uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1 uF 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 cooperate 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.

NEWS ON ELECTRONICS SUPPLIERS

I would like to mention an electronics supplier in Ottawa by the name of Kris Electronics Division of 365781 Ontario Limited, 1070 Morrison Drive, Unit 1(B), Ottawa, Ontario, K2H 8K7. It sells IC's, semiconductors, resistors, capacitors and other supplies. The hours are Mon.-Wed., 10-6, Thurs.-Fri., 10-9, and Sat. 10-6.

Also in the August issue there was a list of semiconductor suppliers with a Future Electronics listing but no address. As of this date, Future Electronics is about to open a store with an address of 1050 Baxter Road, Ottawa, Ont.

P.S. Keep up the good work.

Donald R. Bell, Ottawa

4 ETI Publications

Projects Books 3 & 4
now sold out.

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

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Electronics Today International
Unit Six
25 Overlea Boulevard
Toronto, Ontario
M4H 1B1

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

Canadian Projects Book No. 1

\$3.00

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

Circuits No. 1

\$5.00

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

Electronics — it's easy Volume 1

\$3.50*

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

Electronics — it's easy Volume 2

\$3.50*

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

\$6.00 For Both*

Reader Service Information

Editorial Queries

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

Projects, Components, Notation

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

Sell ETI

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

Back Issues and Photocopies

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

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

1978
 January
 February
 March
 April
 May
 June
 July
 August
 September

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.)

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

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FREE ADVERTISING

We will allow you up to twenty-five words to advertise items you want to buy or sell, or to publicise meetings of clubs, etc. Advertising will be accepted at our discretion — we will not accept commercial or any form of company advertising. For more insertions mail in again.

PLEASE SEND IN YOUR ADVERTISEMENT IN THIS FORM. USE AN EMPTY SEALED ENVELOPE, WITH YOUR MESSAGE ON THE BACK.

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 UNIT 6, 25 OVERLEA BLVD,
 TORONTO, ONTARIO.
 M4H 1B1

WRITE YOUR MESSAGE HERE.
 DON'T FORGET YOUR NAME & ADDRESS & PHONE NUMBER

WANTED EXCELLENT USED HEATHKIT SB-610 AND SB-620 SCOPE. BOARDS AND INFORMATION FOR SWTP COMPUTERS AVAILABLE IN CANADA. JOHN M. CLARKE, VO1EE, P.O. BOX 92, CRESTON SOUTH, NFLD. A0E 1K0

FOR SALE — ASCII KEY BOARD (ASSEMBLED & TESTED) AND 12" B&W TV MONITOR \$110 J. LACASSE 18 STUDLEY ST. MISSISSAUGA, ONT. L4T 1J1 677-3699

MUST SELL: NEW, UNUSED MOTOROLA CHIPS — MC6800 \$15, MC6802 \$20, MC6810 2 FOR \$5, MC6820 \$10 ALSO NEW 2102-1 \$0.75 ea. (QTY 32) MR. M. ROBINSON, 14 MARKET ST., GEORGETOWN, ONT. L7G 3B7.

FOR SALE: WIRE-WRAPPED MOTOROLA MICROCOMPUTER W/4K RAM, MC6802 CPU, MC6820 FOR I/O, 2708 FOR MONITOR, ASKING \$40 — WORTH PARTS ALONE! (ALL DOCUMENTATION INCLUDED) MR. M. ROBINSON, 14 MARKET ST., GEORGETOWN, ONT. L7G 3B7.

FOR SALE: 20W PER CH. STEREO AMP. \$140 CASH. LIKE NEW, PAID \$200 — CALL 652-1378 BETWEEN 6:00PM-9:00PM. TORONTO AREA RESIDENTS ONLY.

FOR SALE: 18" SPEAKER IN FAFISA CABINET (FOR BASS OR ORGAN) WANTED DYNACO STEREO 70 OR PAIR OF DYNA III-S TEL. (416) 531-6590 EVENINGS.

ATTENTION: Personal Computer Owners

Have we got a memory for you? Read on!
Are you going to like the price? Read on!

COMPUMART, the personal computer store, features **BILL GODBOUT's** famous Econoram™ series. These high quality memories are now available in Canada at unbelievably low prices!!

8K Econoram II	Kit . . . \$199	Assembled . . . \$229
16K Econoram IV	Kit . . . \$419	Assembled . . . \$479
24K Econoram VII	Kit . . . \$639	Assembled . . . \$729

All of these S-100 memories include the following features:

- Fully static memory • Onboard regulation • Dip switch address selection and deselection (no wire jumpers)
- Guaranteed under 450 ns access time • High quality, double sided, plate through, solder masked and legended circuit board • Sockets for all ICs

Question: 3 (assembled) Econoram II memories give 24K bytes for \$687.
Why should I consider the Econoram VII at \$729 (assembled)?

Answer: 3 Econoram II memories use up 3 slots on your S-100 Motherboard and requires about 4500 ma. Econoram VII uses only 1 slot and draws less than 2000 ma. Generally speaking, we recommend Econoram II when you only need an additional 8K of memory.

HEATH H-8 OWNERS: GODBOUT's 12K Econoram VI was designed to the same high standards of quality as the above members of the Econoram family, designed especially for your H-8. This memory board draws less than 2250 ma and costs only **\$345** in kit form, **\$395** assembled.

4K TRS-80 OWNERS: Want to upgrade to 16K? It's easy (really easy), it's GODBOUT (of course), and it's only **\$295**.

**DON'T
WAIT!!**

Please send me the following:

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___ Econoram ___ Kit Assembled @ ___

___ TRS-80 Conversion Kits @ \$295

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(7% after October 8)

Shipping and Handling 5.00

Total

You may pay by check, money order, or Chargex (Sorry, No. C.O.D.).

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ADDRESS _____

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TODAY!!**

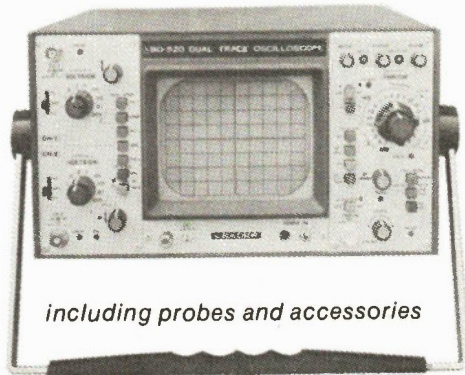
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If you live in Ottawa, visit our store at 411 Roosevelt (at Richmond). We'd like to show you some computers!

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LBO 520 30MHz DUAL TRACE OSCILLOSCOPE with signal delay line and post deflection acceleration C.R.T.

The newest addition to a growing family of Leader Oscilloscopes. This 30MHz dual trace oscilloscope has good bandwidth without sacrificing the high sensitivity — 5mV/cm. It is specially suited for display of wave forms generated in "high speed" digital circuits such as those used in computer equipment. The cathode ray tube is the high brilliancy type using the post deflection acceleration voltage. The vertical amplifier includes a delay line — a convenience in observation of the pulse leading edge. Other features are provided for a wide range of applications.

- Wide band—High Sensitivity
- Possible to observe the high speed pulse
- Large clear display with high brightness
- Equipped with various functions
- Portable compact type and improved facility

LBO 508 20MHz DUAL TRACE OSCILLOSCOPE

A brand new addition to a growing family of Leader oscilloscopes. This 20 MHz dual trace oscilloscope is small in size and light in weight. Front panel controls are logically grouped and located for fast and easy operation. The LBO 508 is a 20 MHz oscilloscope with a 10 mV/cm — 20 V/cm sensitivity in 11 calibrated steps. The high intensity CRT delivers excellent contrast while the regulated high voltage supply provides stable brightness.

The applications for this new outstanding oscilloscope are limitless. The LBO 508 is ideally suited for research and development, production, quality control, education and servicing.

- Compact, lightweight, horizontal package
- Add and subtract mode
- Front panel x-y one touch operation
- Automatic and T.V. sync. triggering

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LBO 507 20MHz SINGLE CHANNEL OSCILLOSCOPE

Yet another brand new addition to the growing family of Leader oscilloscopes. This single channel 20MHz is small in size and light in weight. Front panel controls are logically grouped and located for fast and easy operation. The LBO 507 is a 20MHz oscilloscope with a 10 mV/cm — 20V/cm sensitivity in 11 calibrated steps. A 200 mV/cm horizontal amplifier is incorporated to permit front panel x-y operation. The high intensity CRT delivers excellent contrast while the regulated high voltage supply provides stable brightness.

This general purpose oscilloscope is ideally suited for research and development, production, quality control, education and general service applications.

- Compact, lightweight, horizontal package
- DC to 20 MHz bandwidth
- Front panel x-y operation
- Automatic and T.V. sync. triggering
- Unique trigger circuit for maximum display stability

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