electronics today

FEBRUARY 1977

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THE CN TOWER

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ALSO INSIDE:
555 TIMER CIRCUITS ■ HEADS OR TAILS CIRCUIT ■ VCT: THE NEW TECHNOLOGY ■ REACTION TESTER ■ MICROPROCESSORS

CANADA'S NEW ELECTRONICS MAGAZINE

BUILD THIS

5W STEREO AMP

15—240 Watts!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally; the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack – Multi-function equalization – Low noise – Low distortion – High overload – two simply combined for stereo

APPLICATIONS: Hi-Fi – Mixers – Disco – Guitar and Organ – Public address

SPECIFICATIONS:

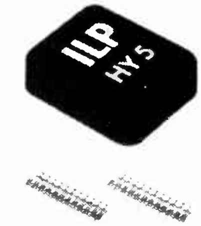
INPUTS Magnetic Pick-up 3mV Ceramic Pick-up 30mV Tuner 100mV Microphone 10mV Auxiliary 3-100mV input impedance 47kΩ at 1kHz

OUTPUTS Tape 100mV Main output 500mV R.M.S.

ACTIVE TONE CONTROLS Treble ± 12dB at 10kHz Bass ± at 100Hz

DISTORTION 0.05% at 1 kHz. Signal/Noise Ratio 68dB

OVERLOAD 38dB on Magnetic Pick-up SUPPLY VOLTAGE ± 16-50V



HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete kit – Low Distortion – Short, Open and Thermal Protection – Easy to Build

APPLICATIONS: Updating audio equipment – Guitar practice amplifier – Test amplifier – Audio oscillator

SPECIFICATIONS:

OUTPUT POWER 15W R.M.S. into 8Ω DISTORTION 0.1% at 15W

INPUT SENSITIVITY 500mV FREQUENCY RESPONSE 10Hz-16kHz – 3dB

SUPPLY VOLTAGE ± 18V

Now Available

HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion – Integral Heatsink – Only five connections – 7 Amp output transistors – No external components

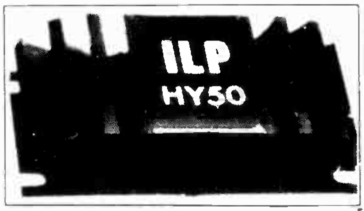
APPLICATIONS: Medium Power Hi-Fi systems – Low power disco – Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV

OUTPUT POWER 25W RMS in 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 25W at 1kHz

SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB

SUPPLY VOLTAGE ± 25V SIZE 105.50.25mm



HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection; this amplifier sets a new standard in modular design.

FEATURES: Very low distortion – Integral Heatsink – Load line protection – Thermal protection – Five connections – No external components

APPLICATIONS: Hi-Fi – High quality disco – Public address – Monitor amplifier – Guitar and organ

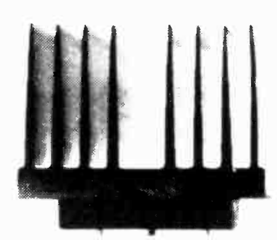
SPECIFICATIONS:

INPUT SENSITIVITY 500mV

OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 60W at 1 kHz

SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz – 3 dB SUPPLY VOLTAGE ± 35V

SIZE 114x50x85mm



HY200
120 Watts into 8Ω

The HY200, now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group, while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown – Very low distortion – Load line protection – Integral Heatsink – No external components

APPLICATIONS: Hi-Fi – Disco – Monitor – Power Slave – Industrial – Public address

SPECIFICATIONS:

INPUT SENSITIVITY 500mV

OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz

SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ± 45V

SIZE 114.100.85mm

HY400
240 Watts into 4Ω

The JY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω. It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown – Very low distormion – Load line protection – No external components

APPLICATIONS: Public address – Disco – Power slave – Industrial

SPECIFICATIONS:

OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.1% at 240W at 1 kHz

SIGNAL/NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ± 45V

INPUT SENSITIVITY 500mV SIZE 114 x 100 x 85mm

I.L.P. Electronics Ltd
Crossland House
Nackington, Canterbury
Kent CT4 7AD
Tel (0227) 63218

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electronics today international

Features

Projects

Information

Our first cover shows two aspects of the types of article that are carried by ETI. One of our features describes the technical side of the CN Tower. Our thanks to the CN Tower for supplying the photograph. Also shown is our ultra-simple stereo amplifier project.

Vol.1 No.1

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this is ETI - CANADA

'SO WHAT?' New magazines always start with a page of publisher's blurb (which few of you will read). It's always full of well-meaning intentions and pledges for the future: 'It's YOUR magazine'... you know the stuff! So, let's forget it. Or should we? We're proud of what we've done and what we plan to do and some of you may still be reading so let's tell you something about ourselves - and try to be honest.

This is our first true Canadian edition. The British edition of ETI has been shipped over here since February 1976, just to see how it sold. It sold pretty well where it was available (in ten cities); well enough, in fact, for us to increase the orders by 50% within six months. Reader reaction was monitored, advertisers were shown the figures and most were interested: with this information the plans for ETI - Canada were formed.

What did we have? A fair number of sales, a reasonable amount of encouragement but above all an overpowering feeling that Canada NEEDED a consumer/hobby electronics magazine of its own. Until we brought out this issue, Canada was by far the largest country in the industrialized world without its own magazine covering this field.

Now starting up in virgin territory may sound great - you can't fail but it brings its own problems. How do you pitch the editorial balance; experience of the existing editions of ETI doesn't help. Each edition of ETI, in Britain, Australia, France and Holland operates independently - as we do in Canada - the balance is tailored to its own market. For example in Britain ETI has seven competitors in the hobby-electronics field: this has obviously led to a degree of specialisation. ETI - Britain does not pretend to aim at the raw beginner, nor does it cover ham radio. In Australia the range is wider; there's competition but no tendency to specialise.

There, we've made an admission. We've pitched this issue at a pretty broad spectrum but we may go even wider. We're feeling our way and we can only hope that we aren't going to lose any of you on the way.

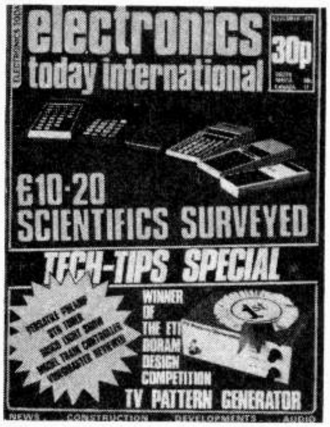
ETI is the second largest electronics magazine in the world if we add together the various editions (No.1 is south of the border!) with a combined circulation of just under 200,000 a month. All editions are unique in that every member of the editorial staff has come from the ranks of, and remains, an electronics enthusiast. It's not policy - just a fact.

We'll not explain our editorial aims too much, this issue represents the balance that we'll start off with. If you don't like it - well, take a look at us again in nine months - we may have come round to your way of thinking. If you do like it, and we obviously hope you do, we're wasting our time overselling ourselves.

ETI - Canada will contribute to, and receive material from, the other editions of ETI.

As you'll see from our cover - and from Tom Graham's page at the back - we've combined with Electronic Workshop to strengthen our arm. We hope that readers of EW find that they are still being served by this edition: we plan to have plenty of material in the servicing field.

Well, that's it. We hope we haven't bored you too much if you've read this far - all we ask is for you to judge us by the contents.



Britain

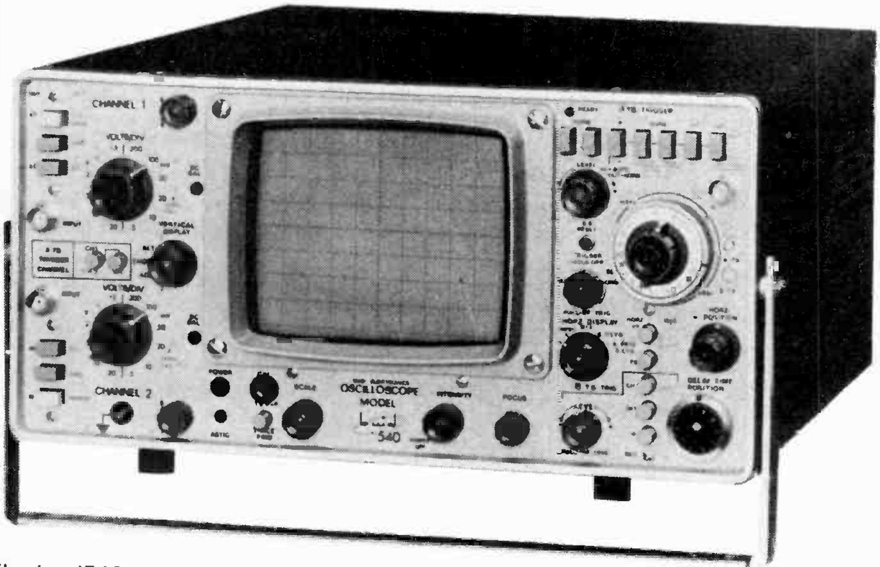
Australia

Holland

France

NEWS DIGEST

100MHz DUAL TRACE SCOPE



The bwd540 oscilloscope combines a full 100MHz specification with lab accuracy and versatility, and field portability.

The amplifier risetime of 3.5nS is suitable for all logic circuitry from DTL to ECL. The main sweep trigger extends from DC to beyond 125MHz with variable hold-off to greater than one sweep length. It can trigger on complex digital words and on virtually every waveform within the vertical amplifier's range including TV line and frame. The delayed timebase has its own trigger source switching, level and polarity selection. For full digital compatibility the Z modulation is DC coupled and requires only +2V for full blanking.

Other specifications include: 5mV to 20V/div attenuation range; 5nS to 5S/div main sweep; 5nS to 1S/div delayed sweep; DC to better than 125MHz main timebase trigger with variable trigger hold-off; identical X-Y operation; 80 x 100mm screen.

Power requirements: 120 or 240V AC or 20-30V DC. The scope measures 165 x 320 x 430mm, and weighs 9kg.

Duncan Instruments Ltd., 65 Millwick Drive, Weston, Ontario M9L 1Y4

PERTEC GETS MITS

MITS, manufacturers of the Altair range of hobby/small business computers have been bought by Pertec, who are primarily suppliers of disk and tape drives. Could be we'll see some nice Disk Operating Systems soon!

FCC PROPOSAL

The US Federal Communications Commission has drawn up a tentative list of proposals for submission to the World Administrative Radio Conference in 1979. Amongst the proposals is one that CB should share with amateur, amateur-satellite and radiolocation services in the 220 – 225MHz region. It sounds to us like a sure-fire recipe for something, probably trouble!

WATCH THIS SPACE

At the bottom end of the LED watch market the giants are preparing to slug it out. Texas Instruments retailers have been offering plastic cased watches for as little as $12.95 and both Fairchild and National Semiconductor are expected to follow TI's lead into the really low end. Meanwhile, some of the smaller companies, including Gruen, Bulova, and Time Computer, have suffered serious financial losses. Somebody's going to get burnt fingers...

SUM THING SHARP

Sharp Electronics of Canada Ltd. has introduced a new ten-digit electronic printing desk-top calculator, the EL-1052, with grand total memory register to store grand total additions, subtractions and summations.

The EL-1052 utilizes a mechanical ten-digit impact printer which prints negatives in red and can print up to 13 digits per line. Average printing speed is 2.6 lines per second. Other features include a one-touch percent key for taxes and discounts, a non-add/sub-total key for printing codes, dates, etc. and for sub-totals of calculations in progress, and a constant/add-mode selector switch and an overflow error check device.

The EL-1052 weighs just over 5lbs., operates on AC current only and is available from Sharp Dealers across Canada, price $139.95.

Heathkit Modulus™ ...The totally flexible hi-fi system for today...and tomorrow!

Heath solves the problem of obsolescence with the incredible Modulus hi-fi system! Housed in a single unit, the AN-2016, is a superb stereo/4-channel preamplifier with the features and specifications of the finest separates — an advanced AM-FM tuner with digital frequency readout, and first-class AM too — complete sound control facilities and four peak-responding output level meters. With one of its matching amplifiers, it's a superb stereo system with your choice of power outputs. With two matching amplifiers, it's deluxe 4-channel. With the addition of "build-in" modules, it's SQ, Dolby FM and CD-4. No waste, no replacement, no "black box" wiring hassles. It's all you need for a lifetime of listening! Find out about Modulus and the over 400 superb electronic kits from Heath in our new catalog. Send for it today!

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- Input Diode Protected
- Selectable Gate Times, 1ms and 1 sec. Provision for 10 sec.
- High Stability 10 MHz Crystal Time Base
- Plug-in Time Base
- Plug-in Prescaler

SPECIFICATIONS	BASIC	WITH PRESCALER
Frequency	60 MHz	600 MHz
Input Z	1 Meg/20pf	50 ohm
Sensitivity	30 mv @ 60 MHz 10 mv @ 25 MHz	150mv @ 600 MHz
Range	1 Hz to 60 MHz	10 MHz to 600 MHz
Max. Input Voltage	120v RMS to 10 MHz	2.5V
Time Base	10MHz XTAL ± 2 ppm 15° to 55° C	
Power	117V 50/60 HZ 15W	
Size	8.8"x8"x2.8" (223.5x203.2x71.12 mm)	
Weight	3 lbs., 10 oz. (1.64 k.g.)	

KIT PRICES

Kit	CTR-2X 60K	$339.00
Kit	CTR-2X 600K	$549.95
Assembled		
	CTR-2X 60	$519.00
	CTR-2X 600	$669.95

Ontario residents add 7% Sales Tax

Kits include all parts, drilled and plated PC boards, cabinet, switches, hardware and a complete instruction manual including calibration instructions.

Factory assembled units are tested and calibrated to specifications.

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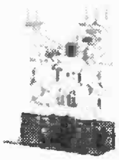
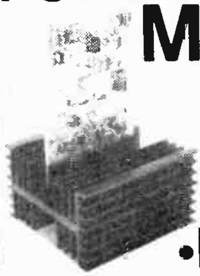
PROFESSIONAL POWER AMPLIFIER MODULES





FEATURES:
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FULL 2 YEAR GUARANTEE.

•NEW•100w MODEL

Power Output	70watts RMS 7.5 ohms	110 watts RMS 7.5 ohms	170 watts RMS 7.5ohms
Frequ. Response	10-30 kHz - 0.5dB	10-30 kHz - 0.5dB	10-30 kHz - 0.5dB
Slewing Rate	7.3V per microsec.	8V per microsec.	8.4V per microsec
T.H.D.	0.05% @ 1kHz	0.05% @ 1kHz	0.05% @ 1kHz
Damping Factor	200	400	400
Hum & Noise	115dB below 70 watts	115dB below 110 watts	115 dB below 170 watts
Input Sensitivity	0dB (0.775V) 70 watts	0dB (0.775V) 110 watts	0dB (0.775V) 170 watts
Input Impedance	47k	47k	47k
Power Requirement	± 35Volts	± 45Volts	± 55 Volts
Overall Dimens.	5.8" Long x 3" Wide x 1" High.	5.8" Long x 3" Wide x 1" High	4.8" Long x 3" Wide x 1" High Heat Sink 6" x 5" x 1"

POWER SUPPLIES I.P.S. 60 $89.95 100 $109.50 150 $139.50

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Bill my Chargex Master Charge
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NEWS DIGEST

HOBBY–WRAP TOOL

The new BW-630 Hobby Wrap is a revolutionary battery powered tool for wire-wrapping 30AWG wire onto standard DIP socket terminals (0.25" square). The tool comes complete with a built in bit and sleeve for producing the preferred 'modified' style wrap.

A built-in device to prevent overwrapping is standard. Carefully designed and developed for the serious amateur, the tool weighs only 11oz. and runs on any standard or rechargeable 'C' size batteries. Pistol grip design of rugged ABS, positive indexing mechanism and quality construction assure exceptional performance. Price: $48.75 (batteries not included). *Len Finkler Ltd., 25 Toro Rd., Downsview, Ontario, M3J 2A6.*

VARIABLE PERSISTENCE/ STORAGE OSCILLOSCOPE

A new variable persistence/storage oscilloscope from Hewlett-Packard includes a number of features not normally found in instruments in this price range. Selling for $2576.00, the Model 1223A includes a burn-resistant CRT and automatic storage control to make it easy to capture low rep-rate and single-shot waveforms for stored display. The 15MHz bandwidth and 2mV sensitivity make it ideal in education, medical, electromechanical, and many other applications. *INQUIRIES MANAGER, Hewlett-Packard (Canada) Ltd., 6877 Goreway Drive, Mississauga, Ontario.*

IMSAI UPDATE

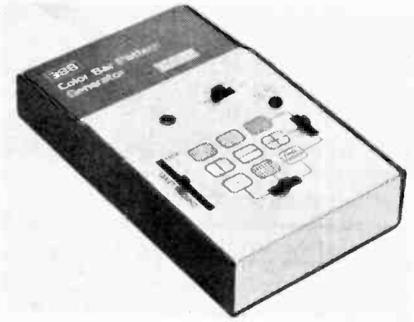
IMSAI have released a new version of their editor-assembler for the 8080. It's yours in the form of paper tape and manual for $40, US price. Biggest part of the update is multiple device driver routines and a larger symbol table space. Also featured is an improved debugger.

NEW CATALOGUE FROM UNIVERSITY

Illustrating a comprehensive line of speakers, horns, drivers and microphone accessories, the new 1977 University Sound 16-page catalogue has now been released.

Featuring sectionalized product information on University's Life-Safety Speakers, Explosion-Proof Drivers, Column Speakers, Horns, Multiduty Speakers, Underwater and Weatherproof Speakers, and a wide range of Paging/Talk-Back Speakers, the catalogue is designed to provide both technical and application information. Copies are now available by writing to *John R. Tilton Ltd., 1200A Eglington Avenue East, Scarborough, Ontario.*

COLOUR-BAR PATTERN GENERATOR



Eico has introduced a new IC digital colour-bar generator, model 388. The new unit, housed in a hand-sized case, weighs only 12 ounces yet delivers accurate signals for test and alignment of any colour or black-and-white television receiver.

The unit provides the following displays on channels 2,3, or 4: gated rainbow pattern for chrominence adjustment with ten standard colour bars, single dot for static convergence adjustment, dot raster for final convergence, nonlinearity correction, pincushion, single vertical line for horizontal centering, eight vertical lines for width and nonlinearity adjustment, single horizontal line for vertical centering, eight horizontal lines for height and nonlinearity adjustment, single crossbar for centering and positioning and crosshatch pattern for final convergence.

Model 388 operates from two standard 9-volt batteries or nickel-cadium cells. The unit also features an LED for power-on indication, crystal-controlled oscillator and timing circuits for greater stability. *Eico Canada Ltd., 20 Millwick Dr., Weston, Ontario.*

VOTES CASHED IN

A preset cash register, normally found in cafeterias and fast food outlets, turned out to be 'as speedy as a large computer' in processing election night returns for the City of Brampton.

It's believed to be the first time in North America that a cash register has been used to tally election results. Two machines were used by the city—both NCR 225 preset electronic cash registers – with one handling Council results, the other School Board results.

The principle of a preset machine is simple. The price of a hamburger for example, is established at 69c and this price is preset into system memory and a 'Hamburger' key is assigned. Every time this key is depressed, the register recalls the preset price and adds it to the total sale. To order 5 hamburgers, depress item quantity (5) and Hamburger; the rest is automatic.

The preset machine also allows for the use of 'open' keys, that is a key with no preset price to record miscellaneous items. For the election all keys were made open keys, thus allowing the city to index the number of votes instead of a price.

Substitute Joe Smith, Mayoral candidate, for Hamburger and each time the Joe Smith key was depressed it activated the inventory counter to count the number of polls reporting and record the votes.

As the polls closed in Brampton, Deputy Returning Officers tallied up their votes and telephoned the results to Brampton's Centennial Centre, where the poll number and the total number of votes for each candidate were then entered on color-coded slips (different color for each cash register). The slip was handed to the appropriate operator and a duplicate copy was given to a clerk whose job was to keep track of those polls that hadn't been reported.

The 225 operator indexed the number of votes and then depressed the button for the candidate. Each time the candidate's button was depressed, the system's memory recorded that another poll had been accounted for. System readouts were taken periodically during the evening, recording a candidate's total votes by the number of polls reporting to date; this information was then transmitted to the municipality's main offices for entry on a large election board. It took only 10 minutes from the time a DRO phoned in his totals to the results appearing on the election board.

NEWS DIGEST

CB EXPANSION

Effective from April 1, 1977, the GRS will be expanded to 40 channels from 22. This is in line with the US expansion. At the same time, more stringent standards have been introduced with regard to unwanted radiation from CB rigs. The new standards are given in Radio Standards Specification 136, Issue 5, which should be obtained by anyone wishing to submit equipment to the DOC for type-approval.

Equipment for 40 channel operation may be sold before April 1, unlike the situation in the US, where several distributors were warned by the FCC for selling 40-channel rigs before January 1. However, all such equipment must carry a label which incorporates the statement 'Licensable under Issue 5 for 40 channels after April 1, 1977 and consequently fully compatible for licensing under Issue 4 for 22 channel operation until April 1, 1977'.

Other quotes from Telecommunications Regulation Circular 40:

'GRS licensees making use of the new 17 channels after April 1 should be aware that this spectrum is presently occupied by licensees in the private Commercial Land Mobile Service. Although encouraged to apply for new frequency assignments they have been given the option of remaining on their present assignments until they find it convenient or necessary to relocate. Inter-sevice interference protection will not be provided be the Department. In the interim period GRS licensees are requested to co-operate where possible with existing licensees on these frequencies.

The Department will continue to monitor the growth of the General Radio sevice and its impact as a source of interference to broadcasting and other radio services with a view to the application of more stringent technical standards should they become necessary. In addition it may be desirable in the future to gradually phase out the double sideband mode in favour of single sideband transmissions thus eventually doubling the number of channels available in this Service. Should such measures become necessary, purchasers of equipment are assured that there would be a reasonable amortization period to allow conventional AM double sideband equipment to obsolesce.'

ELECTRONICS CONFERENCE

The International Electrical Electronics Conference and Exposition will be held on September 26, 27 and 28, 1977 at Exhibition Place, Toronto, it was announced by Conference Chairman Douglas M. Hinton of Bell Canada. The three-day, biennial event, sponsored by the IEEE, combines international government and industry exhibits with the presentation of technical papers on the latest developments in the field. It attracts decision-makers and researchers in business, education, government and industry from Canada, the US and abroad.

The technical papers, which will be published in digest form for world-wide distribution, will cover such diverse areas as telecommunications, media electronics, standards, safety, components, EMC, power and bio-medical electronics. Chairman of the Technical Program is Geoffrey Bedingham of Canadian Motorola.

A highlight of the Conference and Exposition is expected to be the traditional banquet at which the Tanner Lecture will be delivered.

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

CANADIAN COMPUTER CRAZE

The hobby computer mania which has swept America now seems to be hitting Canada. In Toronto alone, 3 stores have opened selling computers in kit or assembled form. Most popular seemto be the IMSAI 8080 and the Processor Technology systems. In Toronto at least, it seems that you can now shop locally when you go to the computer store!

First Canadian Computer Store, Ltd.,
44 Eglinton Ave. W.,
Toronto, M4R 1A1.

The Computer Place,
186 Queen St. W.,
Toronto, M5V 1Z1.

Computermaster Systems,
67 Gloucester St,
Toronto.

SAY, WHAT'S THE TIME?

An electronic wristwatch that talks has been patented by Robert Lester, president of Intersonics Corp. in New York. The Sonatime watch will have a conventional LCD display, and will also pronounce the time through a miniature speaker fed from a Read Only Memory containing digitised speech. How long before we have a 'Slimmers' Watch' that speaks your weight?

CGE USE VIR

Canadian General Electric has introduced a domestic colour TV set which incorporates – for the first time in a Canadian-made set – a circuit to detect and decode a special tint and colour intensity reference signal as it was actually produced at the studio.

The introduction of this special circuit into a home TV receiver marks the first time that a fully automatic colour TV has been made available to the consumer.

Today most colour TV programs originating from the mjor US networks are broadcast with this reference, called a Vertical Interval Reference (VIR) signal. Many of these programs are reproduced on Canadian TV with the VIR signal.

The Canadian Radio and Television Commission has approved in principle the use of the VIR system in Canada. Within the next year or so most TV stations in Canada are expected to include the VIR signal on domestically produced programs.

An on/off switch on the TV set's function panel controls the VIR circuit. If the signal is not being broadcast with a particular program, the set can be adjusted for colour level just like a conventional TV.

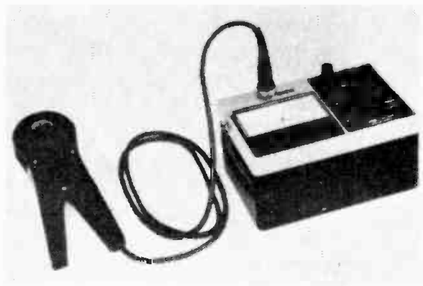
The VIR system is being introduced in a 20-inch model and plans are to add the feature to other models in the line within the next year, according to Bill Sinclair, Manager-Marketing, CGE Home Entertainment Products.

CB SPEAKER

Philips Electron Devices has just released the AD555, an extension speaker for all mobile or fixed CB stations. The AD555 uses a 4 inch weather-proofed cone speaker in a moulded high-temperature plastic case. The unit is rated at 6W, and the response curve is tailored to voice frequency response. The unit comes with an adjustable tilt metal bracket and mounting hardware.

The AD555 has a suggested list price of $19.95 and is available through authorized Philips Deforest distributors and dealers.

FREQUENCY COUNTER



A new frequency counter, model FM-7 is available from Metermaster. Manufactured by Non Linear Systems, the FM-7 uses CMOS construction. Sensitivity is 30mV with the 7-digit LED display having a resolution of 1Hz. The battery-powered unit is ideal for audio, broadcast, amateur, CB and industrial frequencies.

Also from Metermaster is a new clamp-on ammeter capable of measuring DC, AC and AC superimposed on DC. The YEW model 3228 is a portable clip-on ammeter designed to measure DC and AC current from 50mA up to 20 Amps without breaking the circuit under test.

The instrument will measure current with excellent linearity and has a flat frequency response up to 2kHz. It is unaffected by position of the current-carrying conductor in the clamp and has an accuracy of ±2.5%. Battery operation is standard, with options including use on AC line and a 100mV recorder output. *Metermaster, 214 Dolomite Dr., Downsview, Ontario M3J 2P8.*

FM BOOSTER

Now from Magnum Electronics Inc., of 72-74 Stafford St., Toronto, Ontario M6J 2R8, is the Magnum 85FM Power Antenna. This is basically (or at least seems so to us) a VHF preselector with a gain of 35dB and 7dB noise figure. The tuning on the unit we tried was extremely sharp - spurious rejection and image rejection are quoted as 90dB and 85dB minimum respectively. This unit will give a worthwhile improvement in areas of fringe reception.

AM BROADCAST RF AMPLIFIER

National Electrolab Ltd. has introduced their new model RFA-5AM RF amplifier for off-air monitoring. Features include a built-in carrier-level meter which provides an accurate indication of transmitter radiated power. An Automatic Gain Control circuit keeps RF output constant for up to 30dB variations in day/night signals.

The amplifier also has an optional alarm package providing audible and visual alarms in the event of a carrier or audio failure. In addition, an optional audio output package will provide a balanced 600 ohm output for an off-air audio feed to studio monitors as well as a high-fidelity signal for distortion and frequency-response measurements. *National Electrolab Ltd., 1536 Columbia St., North Vancouver, BC. V7J 1A4.*

BATTERIES BOOSTED

Canadian General Electric are promoting sales of their "Recharge Battery System" with this counter display. Rechargeable batteries are an attractive proposition because they can be recharged up to 1,000 times and can generally be expected to last as long as the product in which they are used, whether that be a movie camera, photo flashgun, tape recorder, CB or ham radio, calculator or any other battery operated product.

C.G.E. N.–Cad batteries are available in AA, D.C., and 9 Volt sizes. In addition, the BC–3 can be used in conjunction with battery holder modules to recharge the cells. At local dealers now.

SCIENCE BOOK

'Scientific Models for Experimenters' by Dr. Harry E. Stockman is written for first year college students, but more than 60 models are described which can be built by high-school students participating in a Science Fair. Included are novel Electric Motors, Newton-Law demonstrators, Network Models and Theorems, extending to the new General Twoport Theorem, Amplifiers, etc. A considerable part of the book deals with Medical Electronics, Biophysics, Helmholz' ZETA Potential, Heart and Brain-Wave Monitors, extending into Parapsychology. The 400-page book sells for $10.95 plus postage. *SERCOLAB, P.O. Box 78, Arlington, Mass. 02174.*

COLOURFUL VTRS

International Video Corp. of Canada Ltd., has developed a new add-on for its IVC 700 and 800 video tape recorders which will improve the colour quality. Chromacon, as the system is called, operates by down-converting the chrominence signals and recording them directly.

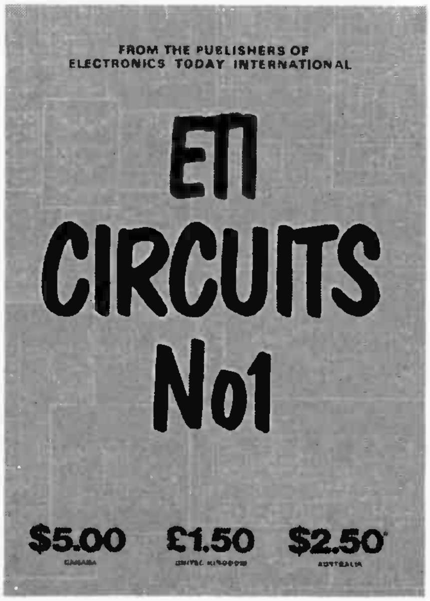
NEW SOUND CATALOGUE

Argos Sound of Genoa, Ill., has just released a new 12-page, three color catalogue with photos and descriptions of their complete line of sound systems and components. Included is a large selection of sound columns, as well as portable sound systems, baffle/speakers, wall baffles and CB base and mobile speakers. Specifications include weights and measures in the standard and metric systems. Each product is described according to its acoustical application to specific market areas. For further information, write:*Argos Sound, 600 South Sycamore, Genoa, Illinois 60135, or their Canadian agents, Leigh-Marsland Engineering Ltd.*

CB BONANZA

23 channel CB transceiver prices are plummeting as suppliers find themselves stuck with more sets than they can sell. The introduction of 40 channel sets in the States means that would-be customers are holding off buying, and so manufacturers are cutting prices, planning free extras, and some are considering pushing their sets in Canada where we still have only 23 channels. Watch for a price drop!

PUBLICATIONS FROM ETI



CIRCUITS No. 1:
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 qnd 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!

TOP PROJECTS No. 4:
A collection of 28 constructional projects reprinted from ETI. This is the fourth in a series published by the British edition (Nos. 1,2, and 3 are not available). Projects are complete and include: Sweet Sixteen Stereo Amp, Waa-Waa, Audio Level Meter, Expander/Compressor, Car Anti-Theft Alarm, Headlight Reminder, Dual-Tracking Power Supply, Audio Millivoltmeter, Thermocouple Meter, Intruder Alarm, Touch Switch, Push-Button Dimmer, Exposure Meter, Photo Timer, Electronic Dice, High Power Beacon, Temperature Controller, Electronic One-Armed Bandit plus many more.

$5.00 FOR CIRCUITS No.1
$2.50 FOR TOP PROJECTS No.4

ELECTRONICS — IT'S EASY:

Volumes 1 and two of the best introductory series to electronics ever published in a magazine. Volume three, completing the series, will be available in a few months.

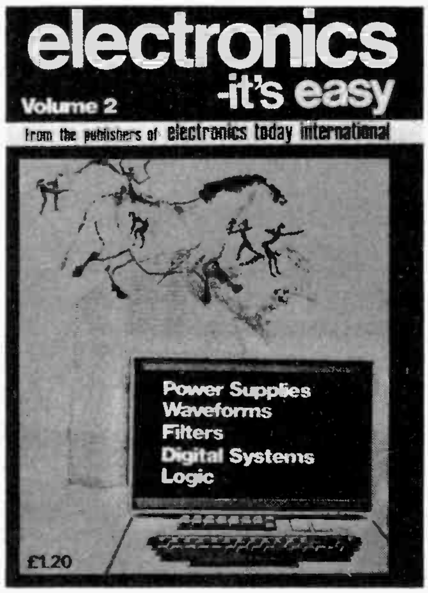
Electronics - It's Easy! takes a fresh look at electronics: it avoids the usual introductions to the subject which mostly seem designed to frighten you away before you reach page 10!

Volume one leads the raw beginner from a gentle introduction, explaining circuits in 'black-box' form up to the use of operational amplifiers.

Volume two deals with more advanced techniques, and deals with digital and logic circuits.

These books have sold extremely well in Australia and in Britain. In Holland they form the basis for a correspondence course.

$6.00 FOR BOTH, $3.50 INDIVIDUALLY



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ETI project 444

FIVE WATT STEREO

This simply-constructed amplifier gives high quality reproduction for surprisingly low cost. The five watts per channel output is sufficient for the average listening room even when inefficient loudspeakers are used.

THIS PROJECT UTILISES A NEW advance by IC manufacturers. A few years ago no one would have believed a complete stereo hi-fi amplifier could be made from just two ICs plus a few passive components. Today more and more components are contained within the IC so a power amplifier is as easy to use as an op-amp.

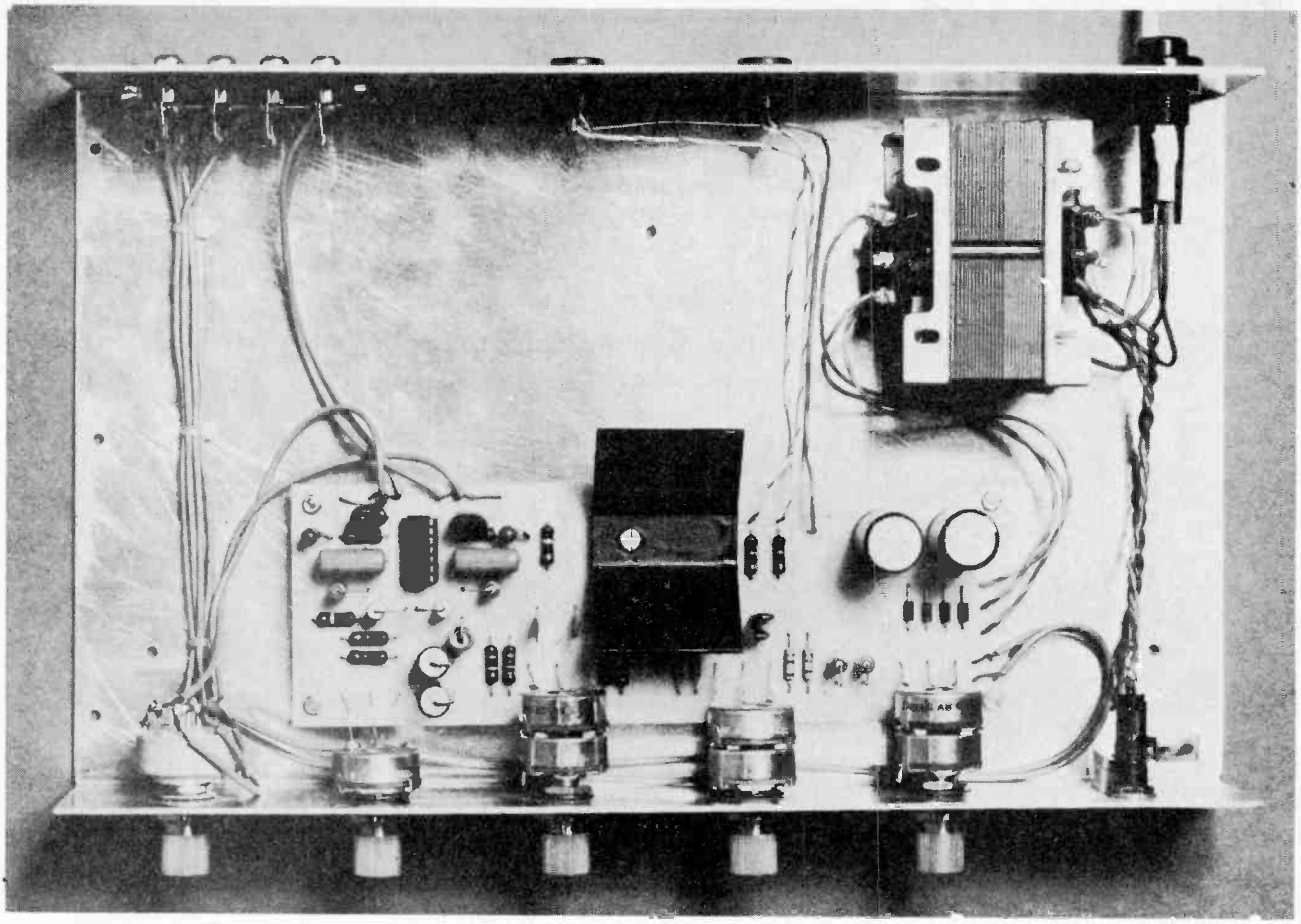
Easy to build — Readers who were previously apprehensive about building audio power amplifiers should have no trouble with this design — there is little to go wrong.

Adequate Power — The output is unlikely to be found lacking unless the loudspeakers are very inefficient. Speakers of this type usually belong to the hifi enthusiast who spends lots of money on his system; the inefficiency of the speakers is compensated for in the amplifier. In an average set-up it is unlikely that you would, under normal listening conditions, be able to tell the difference between the ETI444 and a twenty watt amplifier.

Specification

MEASURED PERFORMANCE OF PROTOTYPE ETI 444

POWER OUTPUT	
Into 8 ohms	5 watts per channel
DISTORTION	
At 3 watts out	0.15%
At 4 watts out	0.5%
At 5 watts out	3.0%
FREQUENCY RESPONSE	
High-level input	+10 dB, −3 dB 4 Hz to 200 kHz
SENSITIVITY	
Magnetic input	1.5 mV
High level input	190 mV
LOAD IMPEDANCE	8 ohms or higher
INPUT IMPEDANCE	
Magnetic input	approx. 100 k
High level input	approx. 10 k
SIGNAL TO NOISE RATIO	
High level input	67 dB
Phono input (ref 10 mV in)	64 dB unweighted



FIVE WATT HI-FI AMPLIFIER

LM379 — National Semiconductor recently supplied ETI with samples of their new dual five-watt audio amplifier IC — the LM379. The circuitry around the IC is very simple in comparison to most of those previously available. The gain is set in a similar way to that for an operational amplifier: by the ratio of two resistors in the feedback network. In addition the IC features internal stabilization, current limiting and thermal protection.

Preamp — We decided to try the IC in conjunction with the dual low-noise preamplifier IC also from National Semiconductor — the LM382. The combination results in a simple stereo amplifier which works very well indeed.

Whilst tone control could be achieved very simply it was decided that the performance of the amplifier deserved good treatment. So we use more effective tone controls.

The result is a five-watt stereo amplifier, ETI444, simple and inexpensive to build, and with a surprisingly high performance.

CONSTRUCTION

As with most straightforward projects the use of a printed circuit board is not only desirable from an ease of construction point of view, but it also helps to ensure identical results to those of our prototype.

The components may be assembled to the board in any order but we find it preferable to assemble the low-height components first, ie, resistors, diodes. Before installing IC2 make sure that a hole of about 6 mm diameter is drilled in the board at the end where the heatsink is to

How it works

THE OUTPUT OF a magnetic cartridge is normally of the order of 5mV at 1kHz. However, in the recording process the high frequencies are recorded at a higher amplitude than the low frequencies (in order to reduce noise). The curve of amplitude-versus-frequency that is used is known as the RIAA curve. When the record is replayed the reverse characteristic of gain-versus-frequency must be applied to restore a flat frequency response. This process in the amplifier is known as equalization.

The first stage of the ETI 444 amplifier uses an LM382 dual low-noise preamplifier IC. This stage is designed to amplify and to equalise the output of a magnetic cartridge. Note that many of the resistors needed to bias the IC (and to provide equalization) are provided within the chip and very few external resistors are reqired to make it function as an RIAA compensated amplifier.

The second IC is an LM379 – a dual stereo power amplifier which provides six watts RMS per channel with supply rails of ±13 volts. The IC is unusual amongst power amplifiers in that it can be used in a similar fashion to conventional op-amps (except that it is capable of driving a low impedance load of 8 ohms).

The gain-versus-frequency response of the power amplifier is set by the bass and treble controls. The overall gain is set by the ratio of 1 + R15 / (R17 + RV4). The part of RV4 corresponding to a particular amplifier is that between the wiper and the outside tag connected to the amplifier. Thus the gain of the two amplifiers may be varied differentially by varying RV4 (which acts as a balance control). The level of the input to the power amplifier is set by RV1 (which acts as a volume control). Switch SW1 selects the input to the power amplifier from either the RIAA power amplifier or from tuner tape or auxiliary inputs as required.

The power supply is simply a bridge rectifier and centre-tapped transformer arrangement which provides ±12Vdc. With both channels driven this is adequate to provide an output of 5W per channel before clipping.

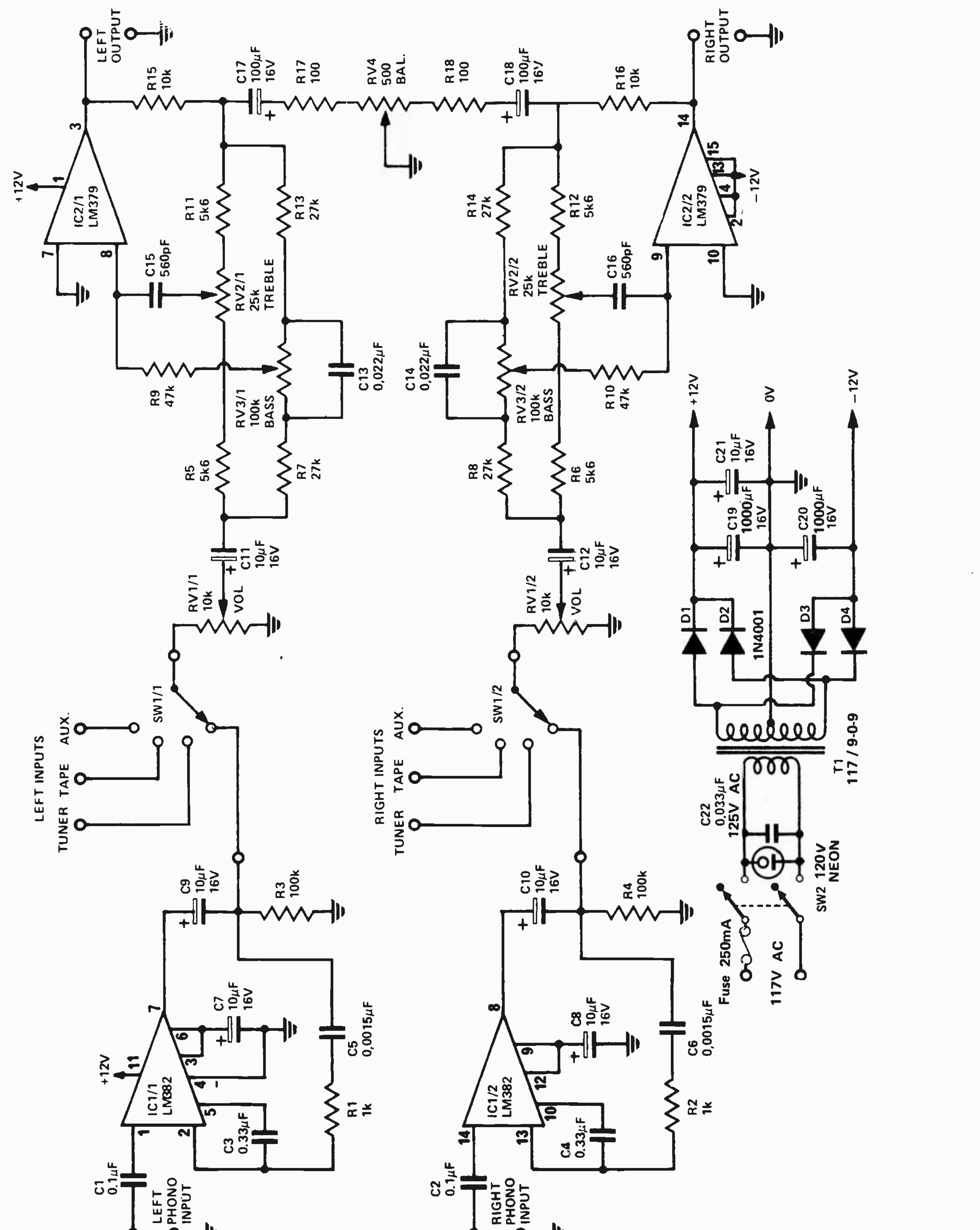


Fig. 1. Complete circuit diagram

be mounted (after the IC is installed). Take care that all polarized components, such as diodes, ICs, electrolytic capacitors and integrated circuits, are mounted with the correct orientation.

Solder 25 to 50 mm lengths of tinned wire to each of the lugs the potentiometers and then mount the potentiometers in the appropriate position by threading the tinned copper wires through the holes provided in the printed-circuit board. Pull the wires down so that the lugs are almost flush with the board and the potentiometers are all in line. Then solder the wires.

The heatsink may now be mounted onto IC2 using a single nut and bolt. Care must be taken to ensure that the heatsink does not touch any of the potentiometers as it is at a potential of —12 volts.

The unit may now be mechanically assembled by securing it to the front panel by means of the potentiometer shafts and nuts, and by fitting two 6.4 mm spacers between the rear of the board and the chassis.

Finally wire the unit as shown in the component overlay diagram. ●

continued overleaf

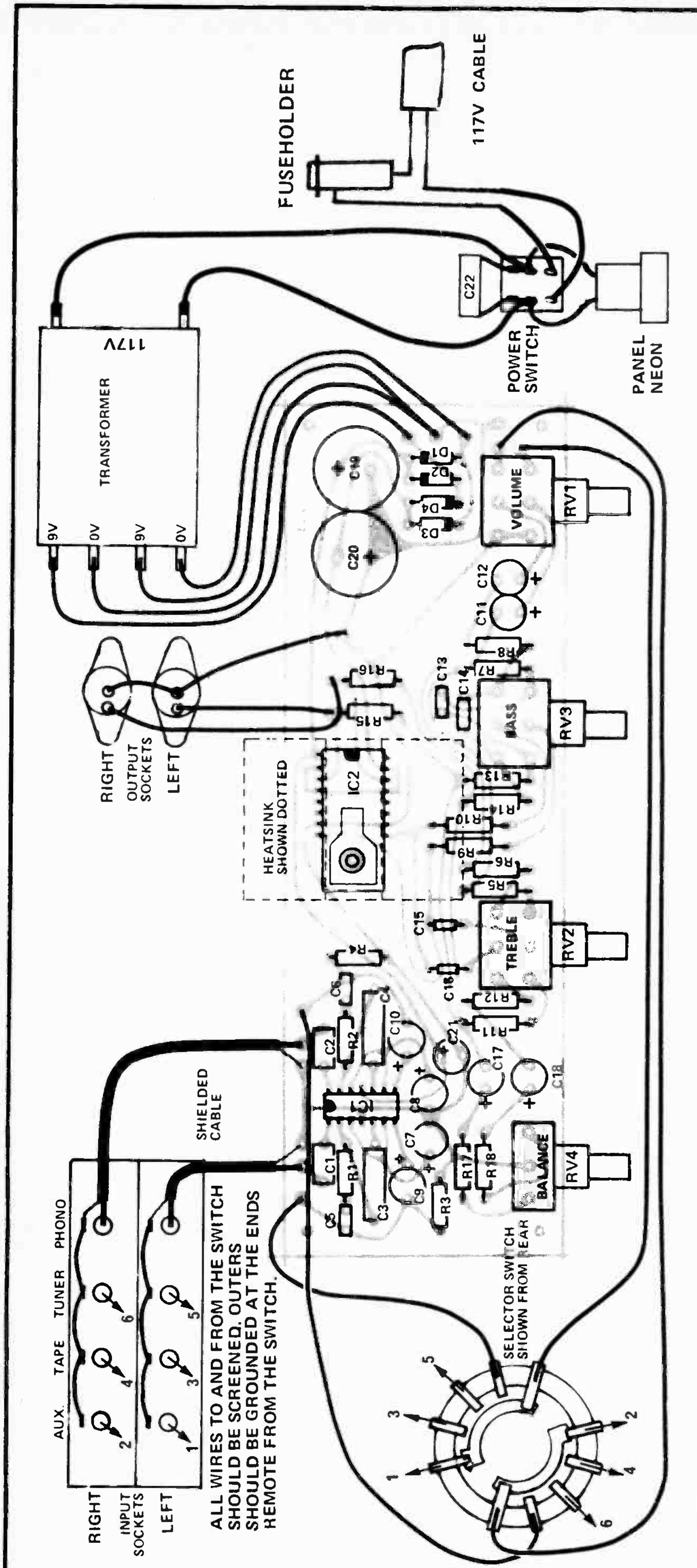


Fig.2. PCB overlay and interconnection diagram.

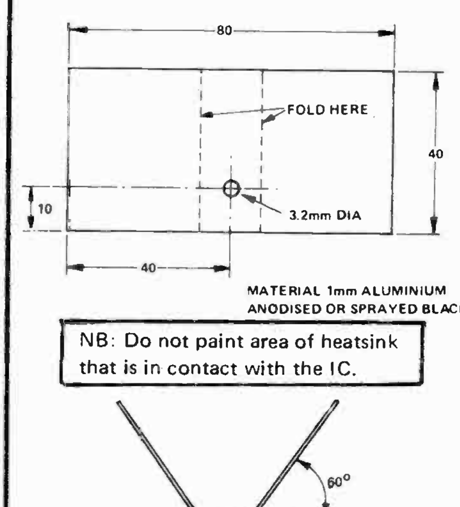


Fig.3. The heatsink for the LM379. The heatsink described will get quite hot when the amplifier is run at full output. If it has been blackened by painting it may smell a little at first but this will soon pass away. For normal domestic listening this size heatsink will be found to be entirely adequate but if the amplifier is to be run continously at full sinewave output it would be advisable to increase the size of the heatsink. No damage can be caused by using the smaller heatsink however as the IC is thermally protected and will simply shut down if it gets too hot.

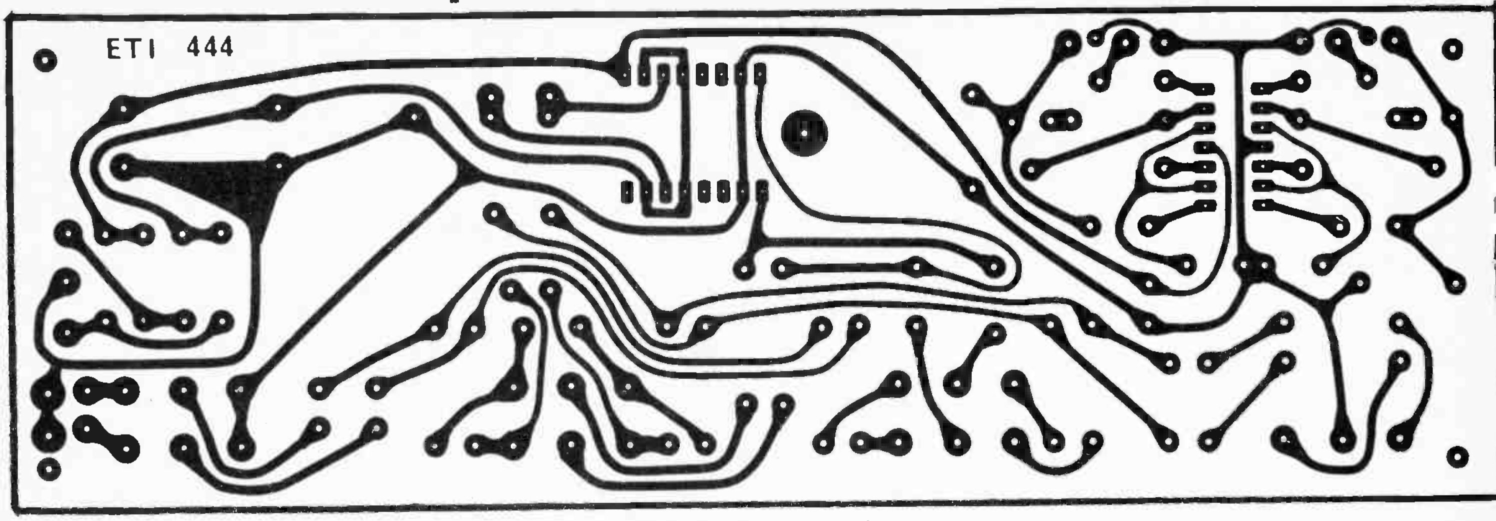


Fig.4. PCB Pattern (full size).

Parts List

Resistors

R1,2	1 k	¼W	5%
R3,4	100 k	"	"
R5,6	5k6	"	"
R7,8	27 k	"	"
R9,10	47 k	"	"
R11,12	5k6	"	"
R13,14	27 k	"	"
R15,16	10 k	"	"
R17,18	100	"	"

Potentiometers

RV1	10 k log rotary dual
RV2	25 k lin rotary dual
RV3	100 k lin rotary dual
RV4	500 ohm lin rotary wirewound

Capacitors

C1,2	0.1 μF poly
C3,4	0.33 μF poly-
C5,6	0.0015 μF poly/ceramic
C7-C12	10 μF 16 V
C13,14	0.002 μF poly/ceramic
C15,16	560 pF ceramic
C17,18	100 μF 16 V
C19,20	2200 μF 16 V*
C21	10 μF 16 V
C22	0.033 μF 125V AC

* 1000μF 16 V will do if 2200 μF is not available.

Semiconductors

D1-D4	1N4001 or similar
IC1	LM382
IC2	LM379

Switches

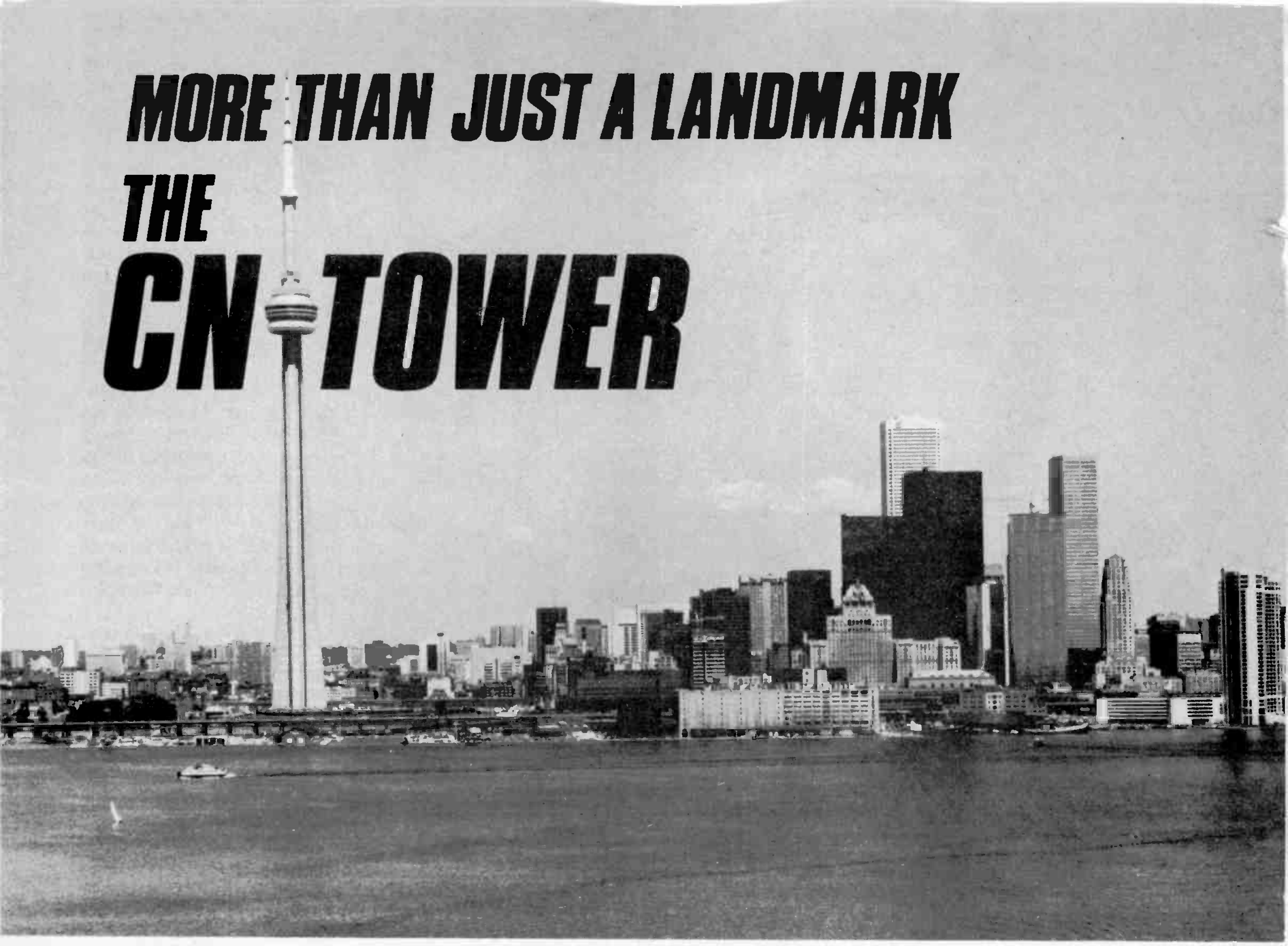
SW1	2 pole 4 position rotary
SW2	2 pole rocker

Miscellaneous

2 Two pin speaker sockets
2 Four way phono sockets
4 Rubber feet
2 6.4 mm spacers
5 Knobs
2 Core flex, plug, clamp, grommet
Chassis and wooden sleeve to suit.
Panel mounting fuseholder & 250 mA fuse to suit.
Screened cable
Heatsink to Fig. 3.
120V Neon indicator
Transformer 117V to 9-0-9V at 1.5A
PCB ETI 444 – $6.00 post paid from CANMOS, PO Box 1690, Peterborough, K9J 7S4.

MORE THAN JUST A LANDMARK

THE CN TOWER



PARIS HAS THE EIFFEL TOWER, Rome, the Colosseum and now, Toronto has its own landmark. All one thousand eight hundred and fifteen feet of it. The CN tower - the world's tallest free-standing structure. Massive, breathtaking - a Canadian engineering showcase. But the tower is more than a public attraction; it is a working tower, designed as a transmission facility for the city's broadcast media.

The tower, which is located in Toronto's south-west section, about one-third of a mile from Lake Ontario, was built primarily to improve signal strength for the local television and FM radio stations. Severe ghosting and weak FM signal problems had existed throughout the city. High-rise apartment and office buildings combined with the city's topography, impeded broadcast signals, distorted their transmission and consequently limited coverage. With its 1,815-foot height, the tower eliminates ghosting for the local stations and extends television coverage up to 50 percent with no increase in power. By increasing the radio horizon or line-of-sight, the tower has also extended and improved FM reception.

CENTER OF A CENTER

The tower was originally conceived to be the centre-piece for Metro-Centre, a billion-dollar redevelopment project for downtown Toronto, covering 190 acres of land owned by Canadian National and Canadian Pacific. Programed for completion over a 15-year span, the centre was to have included an integrated transportation facility, a commercial office area and a residential section. Early in 1973 with civic support for the centre ebbing, CN began construction of the tower in an effort to keep the total project alive, but a year later Metro-Centre was shelved.

Work on the mammoth structure began in February, 1973. To accomodate the foundation, 62,000 tons of grey Dundas shale were removed. In the final stages of excavation, about 50 feet below ground, the shale was smoothed and a one-foot thick blanket of concrete was poured over the rock base. On top of this blanket, a 22-foot thick concrete foundation was formed. For added strength, the foundation included a maze of 500 tons of steel and 40 tons of tensioning cables. With the foundation completed, workers began pouring concrete into a slipform which was used to form the tapered Y-shaped tower. A special concrete mixture was poured 24 hours a day, five days a week for eight months, to form 1,464 feet of the tower. In total 53,000 cubic yards of concrete were used with over 80 miles of steel cable. The cable increased the strength of the concrete to 6,000 pounds per square inch. An additional 5,000 tons of re-inforcing steel and 600 tons of structural steel were used before the structure was complete.

BOBBING BOMBSIGHTS

To make sure the tower was being built straight, engineers used three German-made optical plumbs or 'bombsights' as well as the traditional plumb bob. The plumb bob consisted of a 250-pound steel cylinder attached to a steel cable. Every measurement was checked and cross-checked: The result: the concrete portion of the tower varies from absolute vertical plumb by a maximum of 1.1 inches.

In August 1974, 45-foot steel angle brackets were bolted to the tower at the 1,100 foot level. The brackets were used to support the Sky Pod, a seven-storey circular structure which houses the public observation areas, the revolving 416-seat dining room and the broadcast transmission equipment. The brackets were in place for over a year while workmen used more steel and concrete to mate the Sky Pod to the tower.

Above the Sky Pod, at the 1,464-foot level, another 16 feet of special concrete was poured to serve as base for the transmission mast.

TOWERING OVER THE USSR

In early March 1975, a giant Sikorsky Skycrane helicopter topped the tower off by putting into place the 335-foot steel transmission mast. With the last section in place, the CN tower surpassed, by more than 67 feet, Moscow's Ostankino Tower, which previously held the record.

To control the sway and vibration caused by heavy winds, two dampers, or absorbers, were installed two-thirds of the way up the mast. Designed by a team of Canadian engineers, the dampers are finely tuned to two different frequencies to counter the motion of the mast and tower.

SNOWED UNDER

Radome, a 1½-inch thick glass reinforced plastic cover was installed to enclose the mast. Used to combat heavy winter icing caused by freezing rain, the shape and surface of the radome will cause any major ice build-up to break up and fall like snow.

MAST-ERY OF THE AIR

On the mast itself there are four arrays. The CBC, on channel 5, has an 8 gain, single channel directional VHF antenna. The 55-foot tall array is at a mean height of 1,572 feet.

CFTO-TV Ltd., channel 9, also uses a directional VHF antenna with a gain of 11. The 49-foot high array is at the 1,635-foot level.

Channel 19, CICA and CBLFT channel 25, form an omnidirectional UHF array. Set up as a dual 31 gain antenna, the array is 60 feet tall and is located at the 1,695-foot mark.

CITY TV, channel 79, has a 25-foot long by 5-foot diameter omnidirectional UHF array, while provision has been made to accomodate UHF channels 45, 51, and 57 on a 50-foot three channel array.

Along with the arrays for TV, there is a master FM antenna. Measuring 60 feet high by 26 feet in diameter, the antenna enables CHFI, CKFM, CHIN-FM, CHUM-FM, and CBC-FM to transmit simultaneously. The array is a high power circulary polarized antenna using cross-dipoles. The array is at the lowest end of the mast. Each station using the tower has its own set of transmitters which are located on the uppermost floors of the Sky Pod.

PUBLIC MICROWAVES

On the lower section of the Sky Pod are CN's microwave facilities. Part of a national network, microwave is used by CN for point-to-point transmissions of business information, high speed computer data, and network TV broadcasting. In addition to the broadcast and microwave facilities, the tower also has a land mobile system which greatly improves two-communications around the city. The public has not been completely ignored when it comes to the electronic features of the tower. At the reception area located in the entrance to the tower, is a wall of television monitors, digital weather display devices and the first computer portrait printer in Canada. It can teletype a visitor's picture in less than two minutes.

Built at a cost of 57 million dollars, the tower, which has an expected lifespan of 200 years, is expected to attract three million visitors a year. For most of them, the tower means a breathtaking ride on the high-speed elevators to the observation decks, or the revolving restaurant. But for Toronto's broadcasters and their audiences, the tower is much, much more.

AUTHORS!

OK, all you budding authors, we know you're out there. ETI, as you may have noticed is the only Canadian magazine for the electronics hobbyist and enthusiast. Now, we like to think of you all frantically rushing about buying components for, and building, our projects. But we know you won't all do that – it would be very boring if you did, because some of you are doing your own things, designing your own projects, and sometimes, getting them to work.

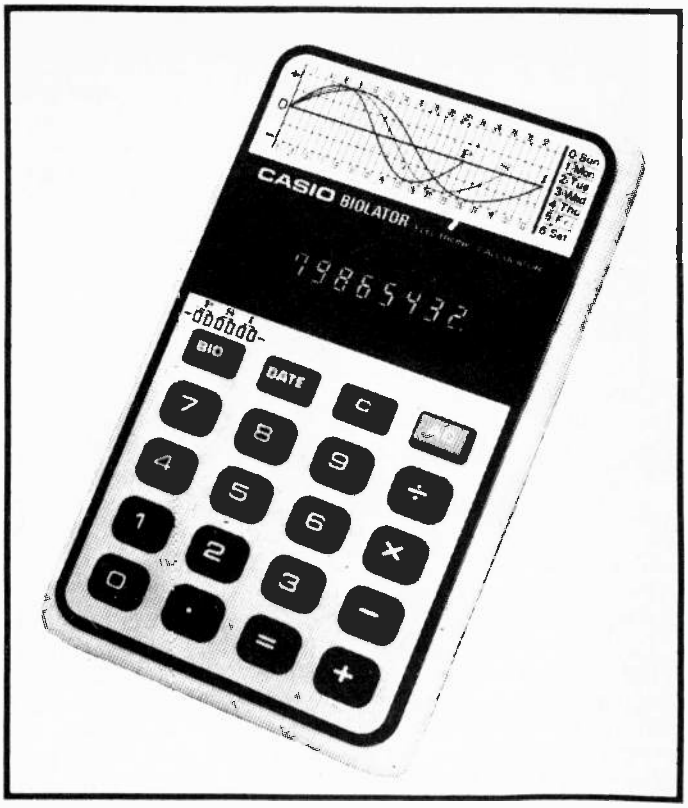
So, if you've built something interesting, and it works, perhaps you would like to see it as an ETI project. We even pay you for the privilege of seeing your pride and joy in print. Or, perhaps you haven't built anything you feel worthy of the accolade, but you could write an interesting feature article.

Either way we'd like to hear from you. This is your magazine in many ways – and by the way, if you've just designed a computer-controlled hi-fi based on three chips, please telephone!

Is this a high, low or a critical day in your life? Find out on this

BIORHYTHM CALCULATOR

The Casio Biolator is an eight-digit calculator with built-in 99 year calendar and digital biorhythm computer.



We all know of the monthly cycle of hormones in women, but did you know there are similar cycles in all people, irrespective of age or sex? At the beginning of this century a German doctor discovered that the body is regulated according to three cycles of differing periods. The 23-day cycle is the one that describes variations in physical health, strength, endurance, etc. In the first half of the cycle (days 2 to 11) the stamina is high and the body is in good shape. In the second half of the cycle (days 13 to 23) the body is more tired and prone to illness.

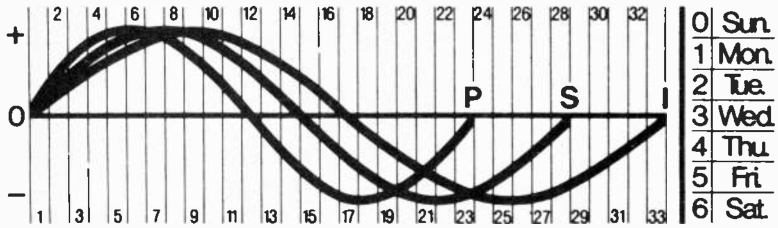
The theory puts special importance on the crossover days, the days between the positive and the negative halves of the cycle. On these days the condition of the body is undergoing its fastest rate of change and the likelihood of an accident or sudden worsening of an illness is higher than at any other time of the month. Days 1 and 12 of the physical cycle are critical days.

The two other cycles concern the condition of one's mental performance and this is looked at from two viewpoints — activity in the subconscious regions of the brain and activity in the fully-conscious regions.

The theory holds that there is a 28-day cycle in the activity of the mind's emotional, or instinctive, processes. For the first fourteen days of the cycle one's intuition is keenest, the artistic side of your personality is at its most creative and your natural charm is at a maximum. However for the next fourteen days life is more humdrum and you are advised to be careful with your relationships with other people. On the critical days (1 and 15) your non-rational side is likely to dominate your normal restraints, resulting in 'irresponsible' behaviour, slips of the tongue, quarrels, etc. On the Casio machine this cycle is called the sensitivity cycle.

The third rhythm is the intellectual cycle of 33-day period. When the cycle is high, thinking power is at its greatest; judgement, wit and concentration are at their best. When the cycle goes low it is the time for mundane work, for activities low in their demands on concentration. Days 1 and 17 are the critical days when errors are likely, when the memory might fail, when accidents might result from silly mistakes.

These then are the three biorhythms, the physical (23-day) the sensitivity (28-day), and the intellectual (33-day). According to the theory all three rhythms start their upward half-cycle on the day you are born. And in the first 58 years of your life each day will be under the influence of a unique combination of these three variables.



The biorhythm graph as printed on the front of the calculator. The P, S, and I waveforms represent the body's physical, sensitivity (emotional) and intellectual cycles.

How the Biolator works

The Biolator is based on a 4-function, 3-register, 8-digit, calculator with automatic constant. Readout is on a green digitron tube display. This section works just like an ordinary calculator of this type: algebraic logic is used, there is an overflow indicator, the decimal point is fully-floating and leading zeroes are suppressed.

Now to the interesting bit. This can be examined from two aspects: calendar calculation and biorhythm calculation. The calender covers all dates from 1901 to 1999 inclusive. It is accessed by inputs in the format: 76.10. 21. (for 21st October 1976) where the three decimal points are lit by pressing the DATE button after entering each pair of figures. The calendar then replies (instantaneously) by displaying 76.10. 21-4, the 4 after the - signifying that the 21st of October 1976 lands on a Thursday. By this method the day of the week for any given date can be calculated.

If after one date has been entered the operator presses the — (minus) button and enters another date, then he can find the number of days between these two dates by pressing the = button. So 76.10.21.-4 minus 73.02. 09.-3 equals 1716 days. This facility has obvious uses in calculating daily, weekly, or monthly rates when you

THE DESIRABLE AFFINITY CONDITIONS

	Physical	Sensitivity	Intellectual
SPOUSE	High	Medium	High
LOVER	–	High	–
FRIEND	–	High	High
CO-WORKER	High	Medium	High
TEACHER	–	High	High
SPORTS MATE	High	High	–
CO-ADMINISTRATOR	High	High	Medium
CO-RESEARCHER	–	—	High
SECRETARY	–	Low	High

know a specific quantity of a resource was expended between two given days.

Biorhythm calculation

To find a person's biorhythms on a given day you first enter that date and subtract the date of birth of the person in question (as if you were calculating their age in days). However, instead of pressing the equals button after entering the second date, you press the BIO button. The biorhythm computer now replies by displaying –PP.SS.II–, where PP gives the status of the physical rhythm, SS the status of the sensitivity rhythm, and II the status of the intellect rhythm. These numbers correspond to the day of the cycle for each rhythm, they do not show amplitude. To interpret the numbers there is a graph above the display and a chart on the back of the calculator.

The product of 23, 28, and 33 is 21252 which means that there are this many possible permutations of the three rhythms, and these permutations follow the same sequence for all people.

No matter when you were born your biorhythms on day 14610 of your life will be -06.23.25-. The Biolator works by calculating your position on its 21252-day biorhythm sequence.

Using the Biolator

In calculating your own biorhythms you can arrange your diary to avoid disappointment. Picking a day for a wedding, for an interview or a driving test, planning an expedition or training for sportsmen, warning your friends or family in advance of your 'off' days, etc., can be done with a simple calculation.

The Biolator can be used to calculate the daily condition of other people, too. Businessmen can forecast the good days for their key personnel (or the bad days of their rivals!), team managers can pick players as soon as they know fixture dates, and so on.

Interesting conclusions can be drawn when you consider the biorhythms of two people, with respect to each other. The time difference between the individual rhythms of two people will always remain constant – if two people's emotional rhythms are in phase they'll always stay in phase. The difference between the rhythms can be calculated easily by finding the condition of the older person on the day the younger one was born. This then can be used to map the affinity of the two people: High affinity for one cycle is when the two waveforms are in phase (the difference numbers are high or low), low affinity is when the waveforms are out of phase (difference numbers around half a period), and medium affinity corresponds to a phase difference of about ninety degrees. On the physical biorhythm, for example, high affinity is shown by difference numbers like 1 to 5 and 20 to 23, low affinity is shown by numbers 9 to 16, and other numbers show medium affinity.

To interpret the significance of affinity the table above has been drawn up.

The Biolator comes with an instruction booklet and a simulated leather case. It is attractively styled in a plastic case with a brushed aluminum front panel. Typical discount price is $29.95.

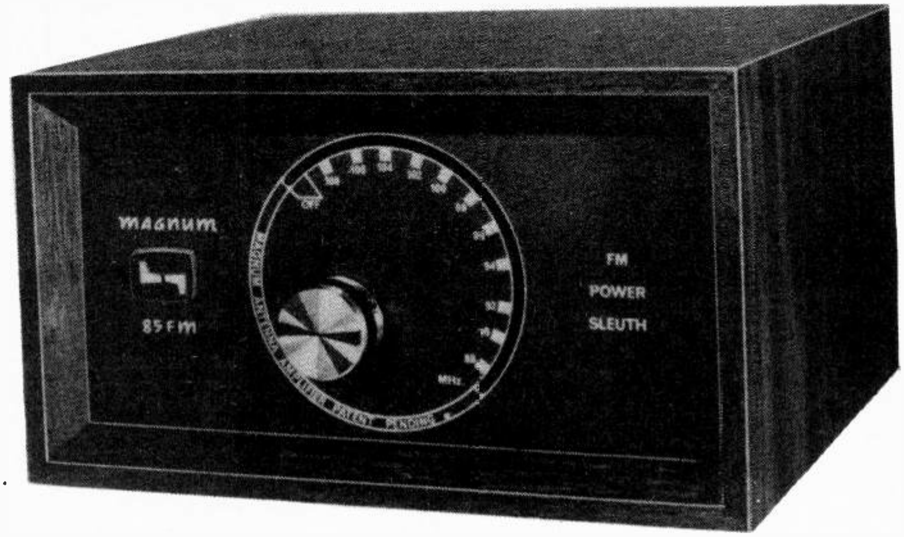
EVERYBODY NEEDS....
AN FM POWER SLEUTH

DIMENSIONS

Height: 4½"
Length: 8½"
Depth: 8"

Color: Walnut

CSA approved



* No matter how much you paid for your receiver. . . we guarantee to improve FM performance.

RF Gain 35 db max. deviation ± 5 db.
RF Stages: 3 (L and C tuned)

Noise Figure 7 db max.
Transistors: 1 Fet J type and 3 bi-polar types

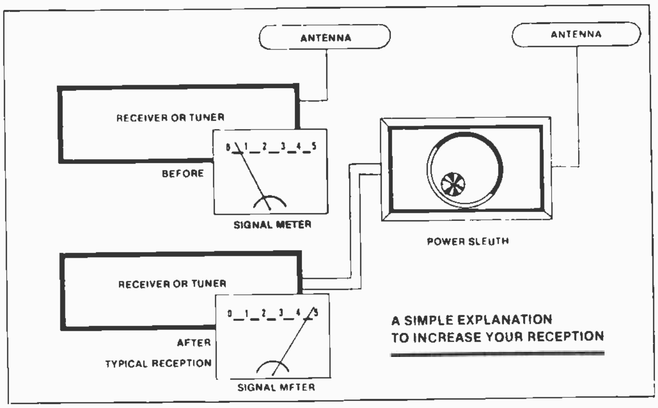
Spurious Rejection 90 db min.
Indicator Dial: "Led"

Image Rejection 85 db min.
Power Supply: Continuous 'ON" Type

Input 75/300 Ohm   Output 75/300 Ohm

Suggested Retail Price **$98.50**

HERE'S HOW IT WORKS



Its uses range from improving reception of FM signals in problem-ridden city cores (apartments) all the way to fringe areas (up to 150 miles) where FM reception may now be impossible. Canadian and foreign patents pending.

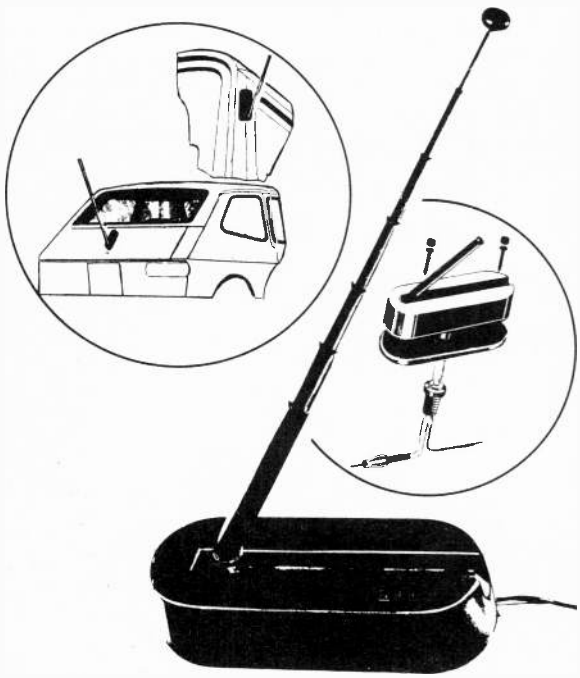
The 85 FM is the world's first tunable FM power antenna.

It also serves to sharply separate signals, and to prevent overloads on receivers or tuners.

The FM 85 is easy to install and operate. All that is required is a screwdriver.

The 85 FM is guaranteed forever against defects in workmanship, and parts are guaranteed for 5 years.

FTE MOBILE SLEUTH



Also available in AM/FM shortwave automobile antenna. The FTE Mobile Sleuth does for your car what the FM Power Sleuth does for your home.

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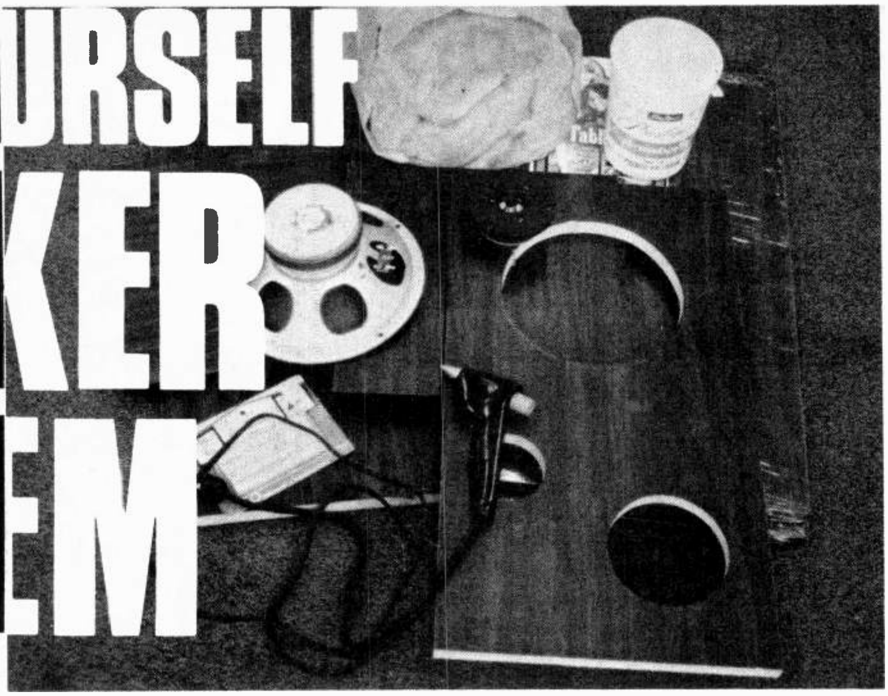
DO-IT-YOURSELF SPEAKER SYSTEM



by Peter J Thorne

LOUDSPEAKER ENCLOSURES - the wooden boxes that make or break the sound quality - are not easy for the hobbyist to make unless he's a real carpentry nut. However, the enclosure decribed here can be easily built by anyone (famous last words?!). We simply used prefinished shelving, available at Simpsons or most lumber stores across Canada, held together with glue from a hot-glue gun. The result - an attractive looking unit, for which we selected a pair of top quality loudspeakers.

Using four pieces of 12" x 24" and one piece of 12" x 36" costs $18 to $36 (depending on the source of shelving). For this you get all corners square and all edges veneered, so the box is easy to make and also looks good, thus solving the two major problems of home construction.

Now let's add to this mixture with a really good measured design, and some top quality speakers. The Philips DeForest 9710MC is an 8" wide-range 20 watt speaker that is available internationally and is used in monitors for some CBC stations. Optionally we can add one of the latest Philips dome tweeters, an AD0162T15. With a very simple crossover capacitor this adds sparkle at the high frequency end. The overall response characteristics are shown in Fig.1: these curves were made on the prototype enclosure by the Philips Loudspeaker laboratories in Dendermonde, Belgium. The tweeter response is omitted from these curves, but you can see that the live room response is very smooth. This test, using pink noise, corresponds well with actual home listening conditions.

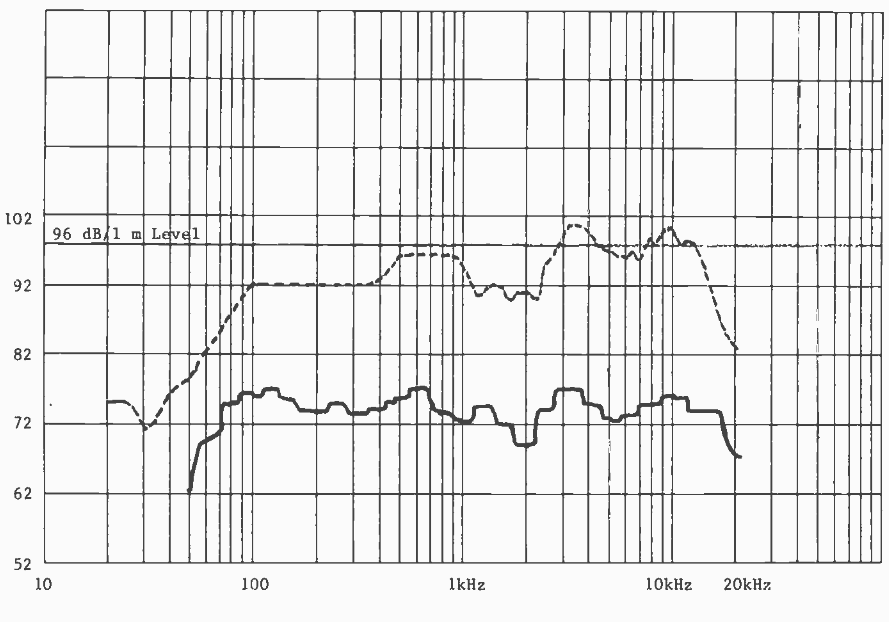


Fig.1. Frequency responses. The upper curve shows the anechoic response with 1.12 watts input, microphone 1 metre from speaker, on axis. The lower curve gives the energy response in a reverberant room, with 1.12 watts input of pink noise and the microphone 3.5 metres from the speaker. The integration time was sixteen seconds.

CONSTRUCTION

Fig.2 shows how the cabinet is assembled: sides A and B are 12"x 24" shelves as bought. The back and baffle are the same, but with 2" cut off one end. The top, C, and bottom, D, are cut from each end of a 36" long shelf so they are just over 12" wide in order to avoid the back and baffle being a too-tight fit.

We put the box together with hot glue, using a USM Thermogrip Model 204 glue gun. This came from Simpsons at less than ten dollars including glue sticks and caulk. The advantage of using hot glue is that it only takes a minute or so to bond after pressing the glue-coated edges together. We used no battens, nails or screws to hold the cabinet together, except the two 2" offcuts from panels E and F. These were glued to the inside of the cabinet shell as baffle supports.

Note that a manufacturer would not assemble an enclosure in this manner, because there probably isn't enough strength to withstand shipping shocks. However in most homes this is not a problem!

D-I-Y SPEAKER

Parts List

Prefinished shelving:
4 pieces 12 x 24ins., 1 piece 12 x 36ins.

Loudspeaker* 8in. wide-range:
Philips DeForest 9710MC.

Tweeter* 4in. dome:
Philips DeForest AD0162T15, or also suitable: AD0161T15.

Crossover Capacitor*:
2.2uF or 2uF paper, or bipolar electrolytic type.

Glass fibre batt, approx 2ins. thick: 15 x 48ins.

Terminal strip: 2 connection type, for cabinet rear.

Wire, insulated, stranded: 6 feet.

Tools required: jig-saw, drill (for pilot hole for saw blade), hot-glue gun with glue stick and caulk, soldering iron (for speaker wires).

*Available from Dominion Electronics or Gladstone Radio in Toronto; Addisons TV Parts Ltd., or Payette Radio in Montreal.

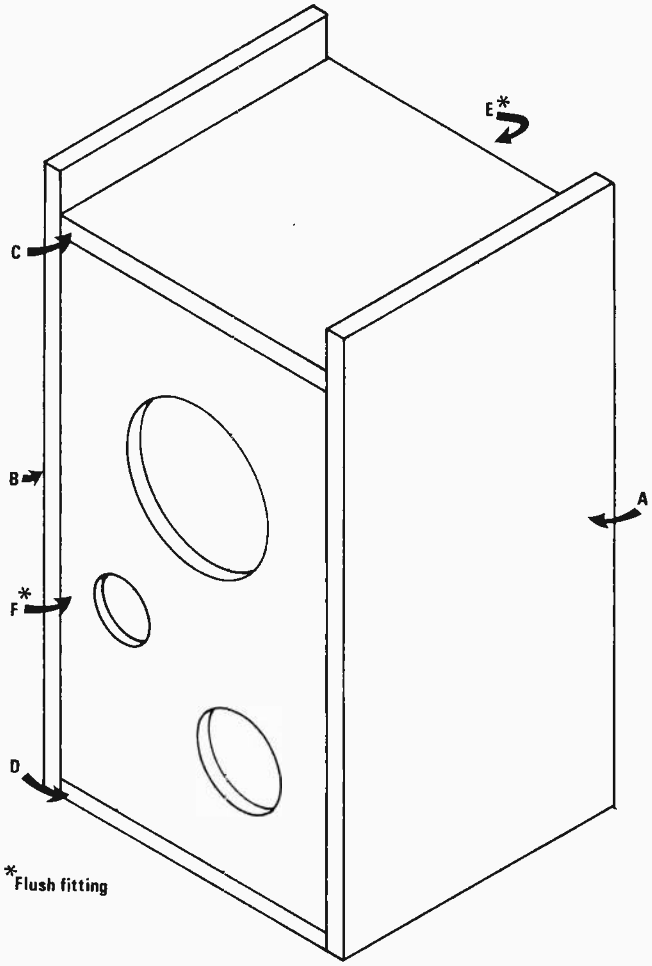


Fig.2.

THE BAFFLE BOARD

The enclosure is ported (hole B, Fig.3). This enhances the bass output, and makes sealing of the internal cabinet edges less important, though the caulking supplied with the glue gun should be used for this purpose. The port used was a quart plastic ice-cream container, with the bottom cut off. This gives an almost perfectly proportioned tube for this cabinet size (1.25 cubic feet). When you cut hole B, measure your carton first to make sure it doesn't fall through the hole!

The holes for the 9720M speaker and the AD0162T15 are cut using a jig-saw or a router. If you have neither the lumber yard can be conned into cutting them when they're not busy. The exact location on the board of all three holes is not too critical. We screwed the big speaker and hot-glued the other speaker and the port in position, but be careful with the port, since the glue is nearly hot enough to melt the plastic. Wire up the speakers to a pair of terminals mounted on the back panel. Don't forget the crossover capacitor (see Fig.4).

Opposing surfaces of the cabinet interior should be lined with acoustically absorbent material. We used a single R7 glass fibre insulation batt, (sneaked from the attic - or often a lumber yard has a burst bag around, from which one batt can be 'liberated'). This can be glued or stapled in position. Wear gloves when doing this, as glass fibre can temporarily irritate the skin. Snip off a piece of the glass fibre and wrap and tape it round the outside of the plastic port. This will dampen any resonance of the plastic.

Test the enclosure - at fairly low volume - before glueing, screwing, or caulking the baffle in position. This ensures the speakers are okay and wired up. When reassured, fit the baffle and relax to good sound.

NOTES ON MATERIALS

The best shelving to use is veneered wood. This is also one of the cheapest (the source is Taiwan). Be careful if using vinyl, as we're not sure about the long term adhesion of some materials, and some vinyls easily split from the chipwood core. If you're hung up on rosewood vinyl, or some similar exotic finish, we'd suggest scraping off the vinyl at the edges to be glued.

You can of course use plain chipboard, but watch dimensions; some nominal 12" chipboard we checked was only 11½" wide. Chipwood edges can be filled with polyfilla, sanded smooth and then primed and painted.

You can use other speakers than the Philips DeForest units specified: if so, the response curves will be very differant.

RATING

This enclosure is quite efficient, i.e. it puts out considerable sound at quite low powers. The speaker ratings are a conservative 20 watts RMS continuous and the enclosure is suitable for use with amplifiers from 5 to 30 watts RMS (per channel). ●

Peter J. Thorne is the author of 'Practical Electronics Projects for Model Railroaders' published in the U.S.A. and distributed in Canada by Kalmbach Publishing Co., Milwaukee.

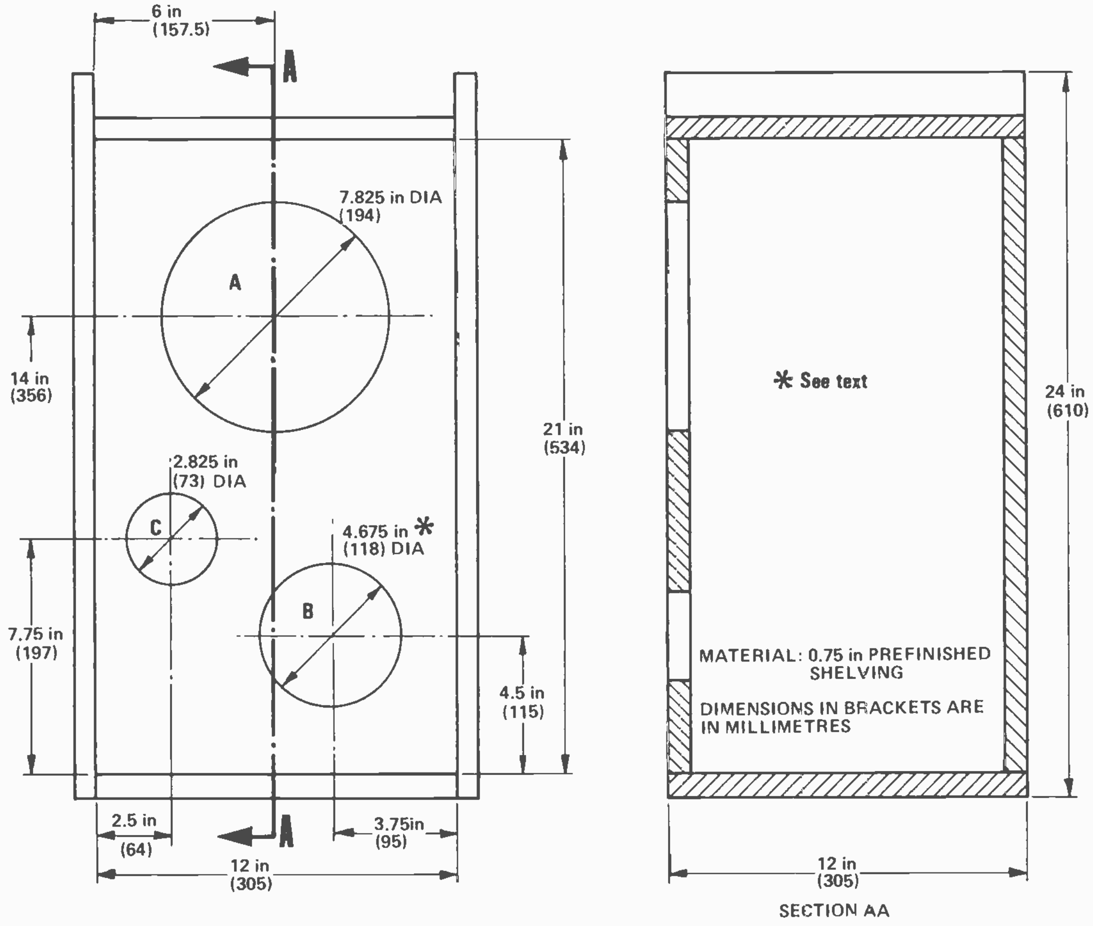


Fig.3.

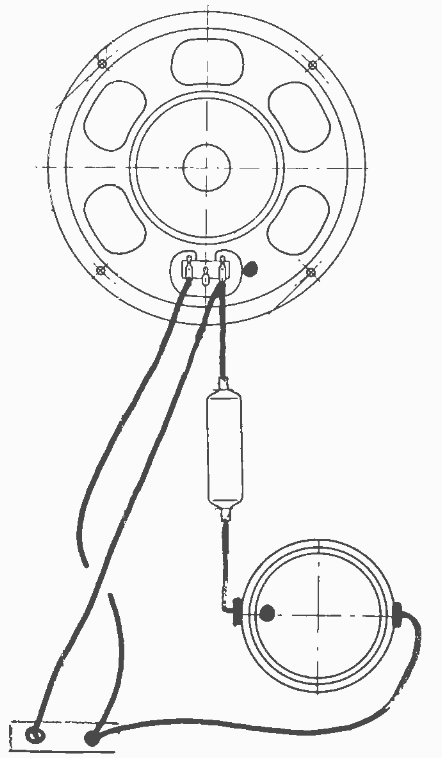


Fig.4. Wiring diagram

electronics today international

What's in the March issue

INDUCTION BALANCE METAL LOCATOR

PRODUCE A CIRCUIT which feeds a modulated 100kHz signal into a coil of about six inches diameter. Lay another coil of similar diameter next to, and slightly overlapping that coil so there is virtually no inductive pick-up. Amplify greatly the small signal that is picked up but gate it so that an audio amplifier will just not produce an output.

When the coils are brought near metal the electro-magnetic fields are disturbed and an output is produced. That's the theory behind our induction balance metal locator which will be described in next month's issue. We don't pretend it's easy to build (though the electronics present few problems) but our prototype will sniff out a quarter at nine inches and that's very much better than any design published up until now!

Microfile

Microprocessor at work

DATA SHEET

TTL REFERENCE GUIDE

Computers for small Businesses

MINICOMPUTERS continue to fall in price and increase in performance. Once the exclusive companion of the large corporation, computers are now finding their way into smaller and smaller companies, reducing drudgery and improving efficiency (when properly used). The day will soon be with us when any company big enough to have a telephone switchboard will boast its own computer.

SHORT CIRCUITS

WE CONTINUE our series which began in this issue with another three Short Circuits:

1. **Test-bench Amplifier.** Useful by itself but ours has been modified simply to act as an audio millivoltmeter as well.
2. **LED Dice Unit.** An electronic dice using only two ICs and six inexpensive LED's.
3. **Two Tone Doorbell.** Another straightforward project for the home — this time using a 555.

DISCO MIXER

This article describes a general purpose mixer which can be tailored by the reader to meet a specific application. Prefade 'listen' is included as a facility and allowance is even made for balanced inputs.

The articles described here are in an advanced state of preparation but circumstances may necessitate changes in the issue that appears.

Ron Harris reports on

VCT AN INVENTION THAT WILL CHANGE THE FACE OF ELECTRONICS

MANY READERS will have heard whisperings of something big brewing in the semiconductor industry - talk of a new device. It is big; and here for the first time in North America ETI takes the wraps off VCT. The Voltage to Current Transactor will get its commercial launch from Texas Instruments early in 1977, no doubt accompanied by the usual choir of angels and 200-piece brass band.

So before all the shouting begins we went to talk to the co-inventor, Professor W.Gosling of Bath University where the device was initially developed. If you're sitting comfortably we'll begin!

The basic op-amp has been with us since the days of the tube, and when semiconductors crept up on us, it was simply re-designed to use transistors. This, in the opinion of many designers, means that the advantages of transistors are not being fully exploited.

BASIC IDEAS

One of the better improvements to the basic op-amp was the comparator input designed by Carl S. Brinkler - a name to which we shall return - and patented in April 1965. However Mr. Brinkler was still dissatisfied with the op-amp and some years ago began discussions with Professor Gosling, with a view to producing a totally new circuit block. The basic guidelines were finally set as being that
1. No feedback should be needed to stabilise the device by limiting the high frequency response, or to define the stage gain.
2. Both the input and output ports must be totally floating - a true four terminal device. This leads to much greater freedom with respect to the output - it can quite simply be fed into anywhere!
3. The output should be a constant current source i.e. very high impedance. Then, should a voltage output be required at any time, a resistor need only be inserted across the port.

TEXAS AND THE PROTOTYPES

In 1974 Texas Instruments authorised Carl Brinkler to undertake research into producing such a device. Because of the scope and magnitude of the task, it was to be a joint undertaking with Bath University i.e. Professor Gosling. In the autumn of 1974 the microcircuit design was breadboarded up for the first time with discrete components, and early in 1975 the first I.C.s rolled out of the ovens. The first vast improvement over the op-amp to become apparent was the slewing rate, up to 20V per microsecond, as compared to 0.5V/microsecond for the 741

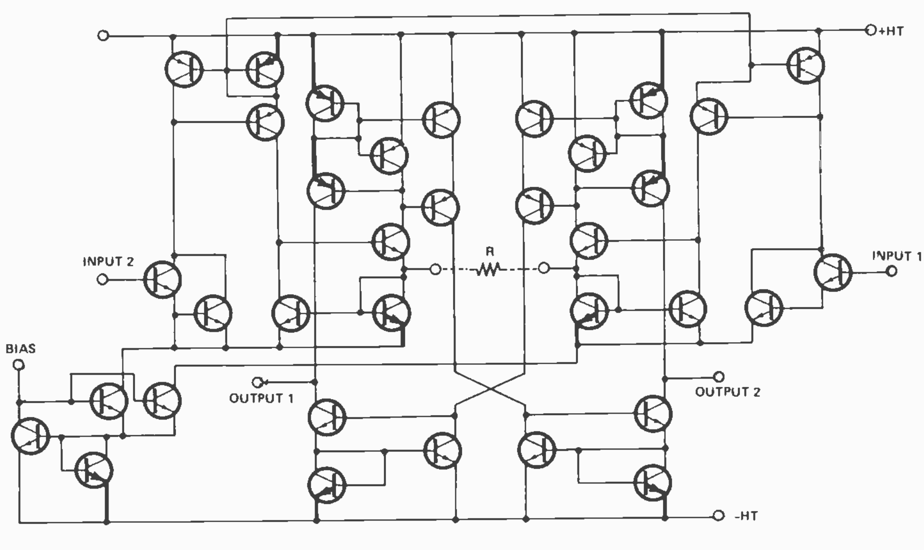
The offset on these prototypes was ≏10mV due to the layout not being totally symmetrical. Production models, when they appear, will have a much much lower offset. Up to this point in the proceedings, the project had been running on a shoe-string. But with the prototypes showing this incredible potential, Texas whipped the whole show off to Dallas for development. They feel the VCT is the greatest advance in circuit design for a long time, and we have to agree with them.

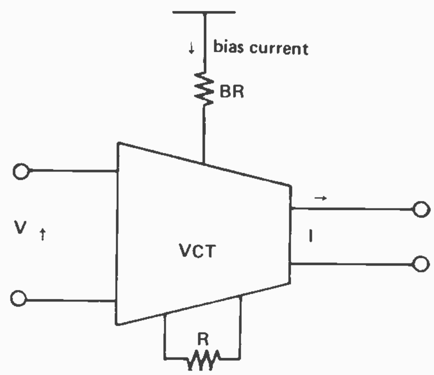
ABILITIES IN CIRCUIT

Let's take a look at what the VCT will do. Figure 1 shows the internal circuit of the Mark 1 VCT. The thick lines represent multiple emitters, and these provide the current gain. You may recognise the current mirrors around the top centre of the circuit.

The agreed symbol for the VCT is shown below, the circuit is that used

Fig. 1. Internal circuit of the prototype VCT. The 'R' in the middle is external.





The agreed symbol for VCT.

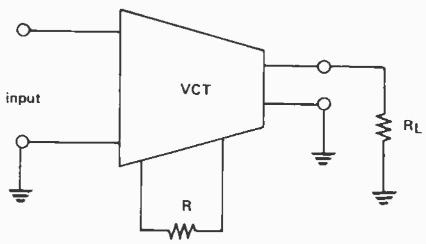
VCT

for all linear applications. For a voltage input, we get a pure constant current output. Both input and output impedances are very high, around 10s of Megohms in the production devices.

There is a fixed ratio between V_{in} and I_o, which is set by one fixed resistor R. i.e. $I_o = k\ 1/R\ V_{in}$. The constant k can be designed to be any value - it will be four in the Texas VCTs. A bias current is applied down BR, and the device can only output twice as much current as it draws through BR. Early devices will be 20mA output VCTs, but later marks will be up in the amps range. A ±15V rail is used with the VCTs, and a 13V signal is quite permissable!

Some circuits now, for instance an amplifier:

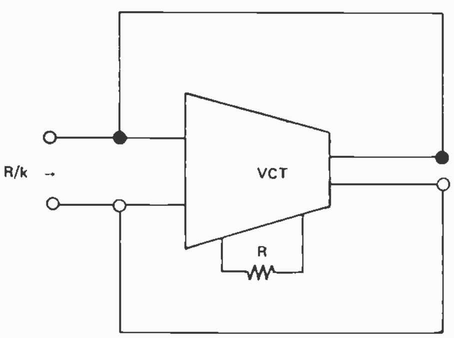
Non-inverting:



VCT as an amplifier.

Voltage gain = k. RL/R

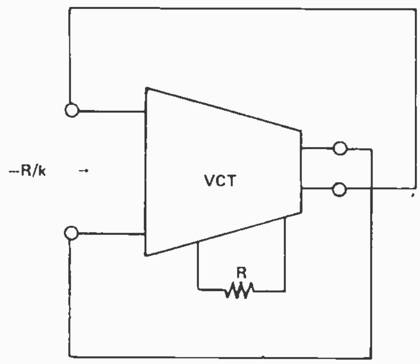
The simplicity of gain inverting arises because the output port naturally has a fixed phase relationship to the input. Since we get a current out for a voltage in, a VCT connected thus:



VCT as a simple resistor.

will look like a resistance, value R/k ohms.

Consider however a device cross connected:



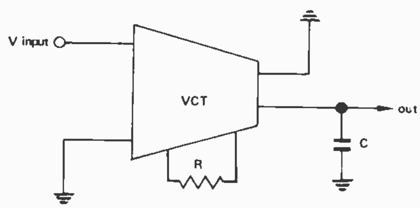
VCT working as a negative resistance.

What we have now, looking in at the input terminals, is no less than a negative resistance! i.e.

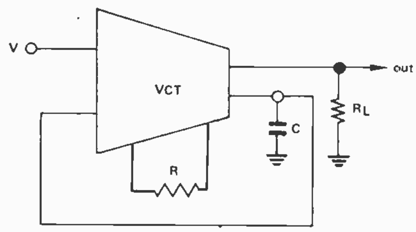
$$V_{in} = -\text{const.} I_o.$$

What's more, the transfer characteristic is perfectly linear!

Applications are literally infinite. Anything an op-amp can do, so can a VCT - only usually it does it better! For instance an integrator:



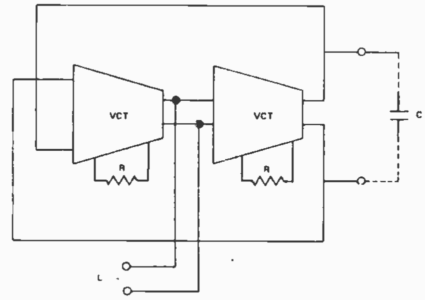
At point A we have $\int V_{in}\,dt$ since the output is a constant current which follows the input voltage. If we feed back this integral to the input so:



VCT differentiator.

the output will be the differential of V_{in}.

Gyrators are by now quite common place, but what about one which can reach inductor values of 10s of Henrys and with a Q of well over 100? Easy! Values of Q up to 200 have been achieved experimentally. This circuit introduces the concept of using two VCTs together. Texas are packaging the VCT in a 16-pin DIL dual package. There are more pins to a VCT than a

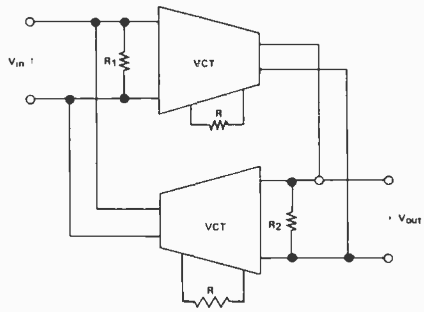


A VCT gyrator.

741, since we have those already mentioned, plus a centre tap on the output which is not always used, but extends the versatility.

AMAZING GRACE

The application we found initially most amazing is the VCT's ability to replace a transformer, better than a transformer! All transformers exhibit some power loss, but this circuit has a selectable loss factor, which naturally can become a *gain* if so desired.



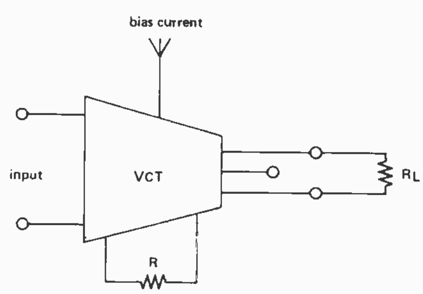
VCT as a transformer.

Transformer Ratio = $(R_1/R_2)^{1/2}$.

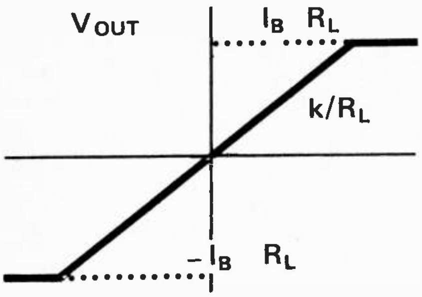
Choose R such that $R^2 = R_1R_2$ to give no loss/gain in circuit i.e. a perfect transformer.

NON-LINEAR

We will consider just one non-linear application to show it can be done - that of a limiter. Since the VCT can output only 2x bias current with



we will get a characteristic



very simply indeed with only two resistors.

It is apparent from the preceeding circuits that one of the biggest gains when using VCTs, is in reducing external component count over a similar op-amp or discrete circuit. In industrial applications this will lead to less P.C.B. design and assembly complications, with resultant reduction in costs.

Another gain is the fact that when used as an inverting amp, no input resistor is used to drop the signal, as it is in op-amp circuits. In these circuits, since the input is usually a virtual earth, most of the signal is dissipated in the resistor, with a resultant poor signal-to-noise ratio upon amplification at the output. With VCTs no resistor is required, and this gives a distinct improvement in S/N ratio, with the attendant gain in dynamic range.

THE PRICE OF A FUTURE

One question remains - how much? Well, this depends entirely on Texas Instruments, and the marketing policy they persue. No doubt the price will be high at first, falling as the volume of sales climbs, as it surely must. Interestingly, the VCT occupies only half the chip area of a 741 op-amp, but whether this affects pricing remains to be seen. We'll keep you informed of developments, as we're convinced you'll be hearing much more of VCT in the years to come. ●

OUR THANKS and congratulations to Professor W. Gosling of Bath University, England, who provided the information for this article.

CIRCUITS 1: $5

CONTENTS BY CATEGORY

What can we add to that?

555 TIMER APPLICATIONS

DESCRIBED BY R. M. MARSTON

THE 555 TIMER is a highly versatile low-cost IC that is specifically designed for precision timing applications, but which can also be used in a variety of monostable multi-vibrator, astable multivibrator, and Schmitt trigger applications. The device was originally introduced by Signetics, but is now available under the '555' designation from many other manufacturers.

The 555 has many attractive features. It can operate from supply voltage in the range 4.5V to 16V. Its output can source (supply) or sink (absorb) any load current up to a maximum of 200mA, and so can directly drive loads such as relays, LED's, low-power lamps, and high impedance speakers. When used in the 'timing' mode, the IC can readily produce accurate timing periods that can be varied from a few microseconds to several hundred seconds via a single R-C network. Timing periods are virtually independent of actual supply rail voltage, have a temperature coefficient of only .005% per °C, can be started via a TRIGGER command signal, and can be aborted by a RESET command signal.

When used in the monostable mode, the IC produces output pulses with typical rise and fall times of a mere 100nS. It can be made to produce pulse-width modulated (PWM) pulses in this mode by feeding fixed frequency clock pulses to the TRIGGER terminal and, by feeding the modulation signal to the CONTROL VOLTAGE terminal.

When used in the astable mode both the frequency and the duty cycle of the waveform can be accurately controlled with two external resistors and one capacitor. The output signals can be subjected to frequency sweep control, frequency modulation (FM), or pulse-position modulation (PPM) by applying suitable modulation signals to the CONTROL VOLTAGE terminal of the IC.

THE 555: HOW IT WORKS

The 555 is available under a variety of specific type numbers but is generally referred to simply as a '555 timer.' The device is available in a number of packaging styles, including 8 and 14-pin dual-in-line (DIL) and 8-pin TO-99 types. Throughout this article all circuits are designed around the standard 8-pin DIL versions of the device.

Fig 1 shows the outline and pin notations of the standard 8-pin DIL version of the 555, and Fig 2 shows the functional block diagram of the same device (within the *double* lines), together with the connections for using it as a basic monostable generator. The following explanation of device operation assumes that the 555 is used in the monostable configuration shown in Fig 2.

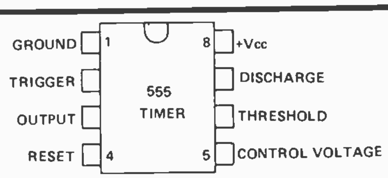


Fig. 1: Outline and pin notations of the standard 8-pin dil version of the 555 timer I.C.

The 555 houses 2 diodes, 15 resistors, and 23 transistors. These components are arranged in the form of one voltage-reference potential divider, two voltage-comparator op-amps, one R-S flip-flop, a low-power complementary output stage, and a slave transistor. The voltage-reference potential divider comprises three 5kΩ resistors in series, and is connected across the supply lines. Consequently, 2/3 V_{cc} appears at the junction of the upper two resistors of the potential divider, and is fed to one input terminal of the upper voltage-comparator op-amp and 1/3 V_{cc} appears at the junction of the two lower resistors of the potential divider, and is fed to one input terminal of the lower voltage-comparator op-amp. The outputs of the two comparators control the R-S flip-flop, which in turn controls the states of the complementary output stage and the slave transistor. The state of the flip-flop can also be influenced by signals applied to the pin 4 RESET terminal.

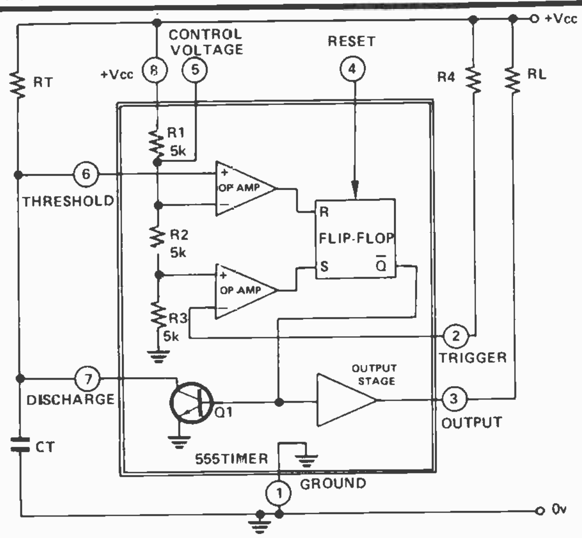


Fig. 2: Functional block diagram (within the square) of the 555 timer i.c., together with the connections for using the i.c. as a basic monostable generator or timer.

When the monostable or timing circuit of Fig 2 is in its quiescent state the pin 2 TRIGGER terminal of the chip is held high via R1. Under this condition Q1 is driven to saturation and forms a short circuit across external timing capacitor C_T, and the pin 3 output terminal of the IC is driven to the low state. The monostable action can be initiated by applying a negative-going trigger pulse to pin 2. As this pulse falls below the 1/3 V_{cc} reference value of the built-in potential divider the output of the lower voltage comparator op-amp changes state and causes the R-S flip-flop to switch over. As the flip-flop switches over it cuts off Q1 and drives the pin 3 output of the chip to the high state.

As Q1 cuts off it removes the short from timing capacitor C_T, so C_T starts to charge exponentially towards the supply rail voltage until eventually the voltage across C_T reaches 2/3 V_{cc}. At this point the upper voltage comparator op-amp changes state and switches the R-S flip-flop back to its original condition, so Q1 turns on, rapidly discharging C_T, and simultaneously the pin 3 output of the IC reverts to its low state. The monostable operating sequence is then complete. Note that, once triggered, the circuit cannot respond to additional triggering until the timing sequence is complete, but that the sequence can be aborted at any time by feeding a negative-going pulse to pin 4.

The delay time of the circuit, in which the pin 3 output is high, is given as

$$t = 1.1\ R_T\ C_T$$

where t = mS, R_T = kΩ, and C_T = uF. Fig 3 shows how delays from 10 µS to 100 seconds can be obtained

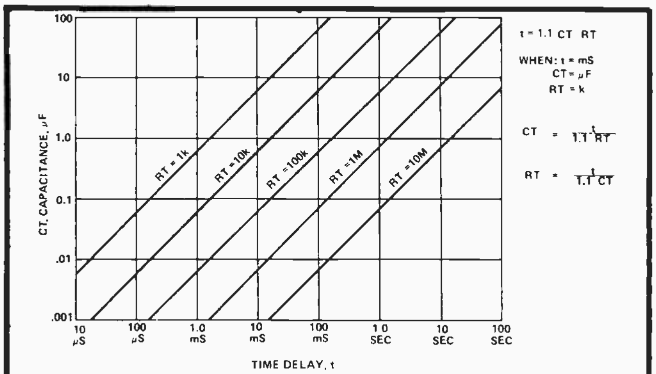


Fig. 3: 555 time delays for different values of resistance and capacitance.

by selecting suitable values of C_T and R_T in the range .001 uF to 100 uF and 1kΩ to 10MΩ. In practice, R_T should not be given a value less than 1kΩ or greater than 20MΩ, and capacitor C_T must always be a low-leakage component. Note that the timing period of the circuit is virtually independent of the supply voltage but that the period can be varied by applying a variable resistance or voltage between the ground and pin 5 CONTROL VOLTAGE terminals of the chip. This facility enables the periods to be externally modulated or compensated.

The pin 3 output terminal of the IC is normally low, but switches high during the active monostable sequence. The output can either source or sink currents up to a maximum of 200mA, so external loads can be connected between pin 3 and either the positive supply rail or the ground rail, depending on the type of load operation that is required. The output switching rise and fall times are typically about 100 nanoseconds. Having cleared up these points, let's now go on and look at some practical applications of the 555 timer I.C.

50 SECOND TIMER

This 50 second timer or pulse generator gives a direct voltage output at pin 3 which is normally low, but goes high for the duration of the timing period. Optional components R_4 and LED (shown dotted) give a visual indication of the timer action. The circuit works in the same basic way as already described, except that the timing action is initiated by momentarily shorting pin 2 to ground via START switch S_1. Note from the circuit waveforms that a fixed-period output pulse is available at pin 3 and an exponential sawtooth with an identical period is available at pin 7: The sawtooth waveform has a high output impedance.

The basic timer circuit of Fig 4 can be varied in a number of ways. The timing period can be made variable between approximately 1.1 seconds and 110 seconds by replacing R_1 with a 10kΩ fixed resistor and a 1MΩ variable resistor in series.

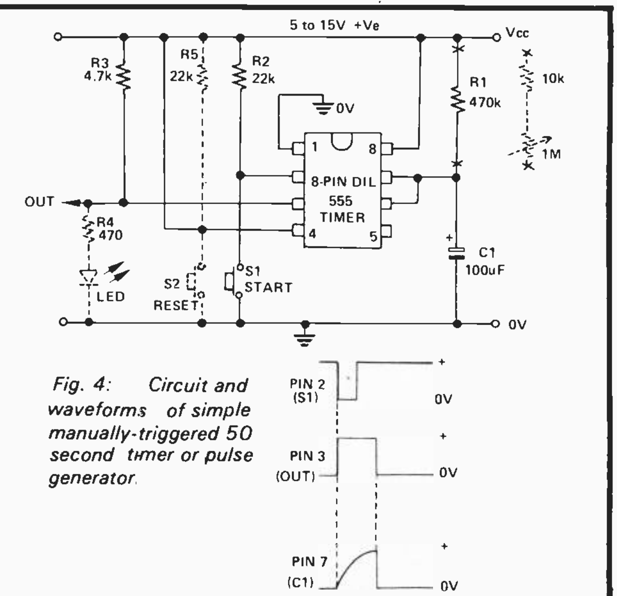


Fig. 4: Circuit and waveforms of simple manually-triggered 50 second timer or pulse generator.

The period can be further varied, if required, by switch-selecting decade values of timing capacitance. The dotted section shows how the circuit can be provided with a RESET facility, so that a timing period can be aborted at any time, by taking pin 4 to the positive supply rail via resistor R_5 and wiring RESET switch S_2 between pin 4 and ground.

The timing circuit of Fig 4 can be used to drive non-inductive loads at currents up to 200mA directly. They can be used to drive inductive relay loads by using the basic connections shown in Fig 5.

The Fig 5 circuit is designed to apply a connection to a normally-off external load for a pre-set period of 50 seconds when START switch S_1 is momentarily closed. The relay is normally off, but turns on for the 50 second period when the timing cycle is initiated. D_2 is wired in series with the relay coil to counteract the slight residual

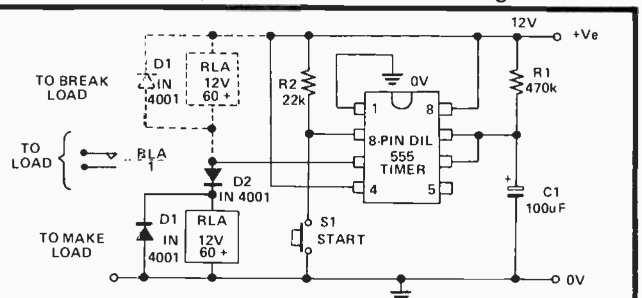


Fig. 5: Relay-output timer makes or breaks connection to load for pre-set period of 50 seconds when S, is momentarily operated.

voltage that appears at pin 3 of the IC under the OFF condition and thus ensure that the relay turns fully off. The dotted section shows how this circuit can be used to switch off a normally-on load.

Note in Fig 5 and all other relay-output circuits described here, that the relays used can be any 12 volt types that draw ON currents of less than 200mA, e.g., that have coil resistances greater than 60Ω.

The basic relay-driving timer circuit of Fig 5 can be adapted for use in a variety of useful applications. Some typical examples are shown in Figs 6 to 9.

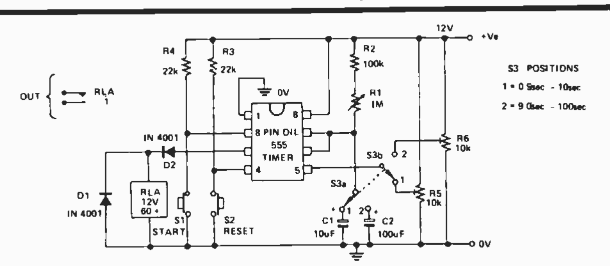


Fig. 6: Relay-output general-purpose timer covers 0.9 sec to 100 sec in two decade ranges.

Fig 6 shows the practical circuit of a relay-output general-purpose timer that covers 0.9 seconds to 100 seconds in two decade ranges: The circuit has a RESET facility provided via S_2, so that timing periods can be aborted part way through a cycle if necessary. A noteworthy feature of this circuit is that the maximum timing periods of each decade range of the timer can be precisely pre-set via R_5 or R_6, which effectively shunt the built-in potential divider of the 555 and thus influence the timing periods: This facility enables the circuit to give precise timing periods even when wide-tolerance timing capacitors are used.

To set up the Fig 6 circuit, first set R_1 to maximum value, set RANGE switch S_3 to position 1, activate START switch S_1, and adjust R_5 to give a timing period of precisely 10 seconds. Next, set S_3 to position 2, activate START switch S_1, and adjust R_6 to give a timing period of precisely 100 seconds. All adjustments are then complete, and the timer is ready for use.

DELAYED HEADLIGHT TURN-OFF

Fig 7 shows the practical circuit of an automatic delayed-turn-off headlight control system for automobiles. This facility enables the owner to use the car lights to illuminate his path for a pre-set time after parking as he leaves the garage or walks along a driveway, etc. The circuit does not interfere with normal headlight operation under actual driving conditions. It works as follows.

When the ignition switch is turned to the ON position current is fed to the coil of the relay via D_3 and the 12 volt supply rail, so the relay turns on and contacts RLA/1 close. As the contacts close they connect the 12 volt supply to the timer circuit and to the headlight switch. Thus, under this 'ignition on' condition the headlights operate in the normal way. Note that, since one side of C_2 is connected directly to the positive supply rail and the other side is taken to the positive rail via R_2, the capacitor is fully discharged under this condition.

The moment that the ignition switch is turned to the OFF position the D_3-derived current supply to the relay coil is broken, and simultaneously a negative-going trigger pulse is fed to pin 2 of the 555 as the C_2-R_3 junction drops to ground volts and C_2 charges up. Now, relays are inherently slow-acting devices, so contacts RLA/1 do not open instantaneously as the ignition switch is turned off. Conversely, the 555 is a very fast triggering device, and the instant that the trigger pulse is generated via the turn-off action of the ignition switch a timing cycle is initiated and current is fed to the relay coil via output pin 3 of the IC as it goes high. Thus the relay remains on for a pre-set period after the ignition switch is closed, and the positive supply rail remains connected to the headlight switch for the duration of this period. With the component values shown this period is roughly 50 seconds.

At the end of the 50 second timing period, pin,3 of the 555 switches to the low state and the relay turns off. As it does so, contacts RLA/1 open and remove the supply from the timer and the headlight switch, and the headlights turn off. The operating sequence is then complete.

Readers may care to note that the above system of operation is consistent with the practice adopted in many modern vehicles of feeding the headlight switch via the ignition switch, so that the headlights operate only when the ignition is turned on. On older types of vehicle, where headlight operation is independent of the ignition switch, a manually-triggered delayed-turn-off headlight or spotlight control facility can be obtained by using the circuit shown in Fig 8. The action of this circuit is such that, if the vehicle is parked with its lights off, they turn on for a pre-set 50 second period as soon as a push-button START switch is momentarily closed, and at the end of this period turn off again automatically.

The Fig 8 circuit uses a relay with two sets of normally-open relay contacts. The timing sequence is initiated by momentarily closing push-button switch S_1. Normally, both S_1 and the relay contacts are open, so zero power is fed to the timer circuit and the lights are off. C_2 is discharged under this condition.

When S_1 is momentarily closed power is fed directly to the relay coil, and the relay turns on. As the relay

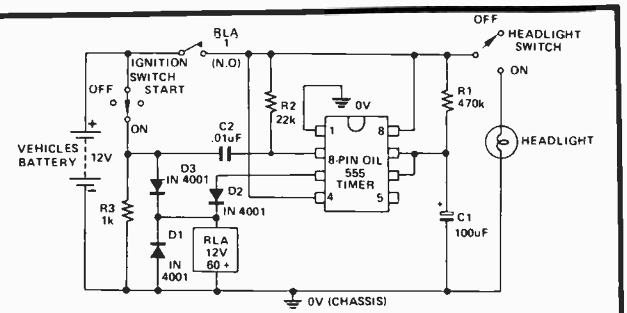


Fig. 7: Automatic delayed-turn-out headlight control system for automobiles.

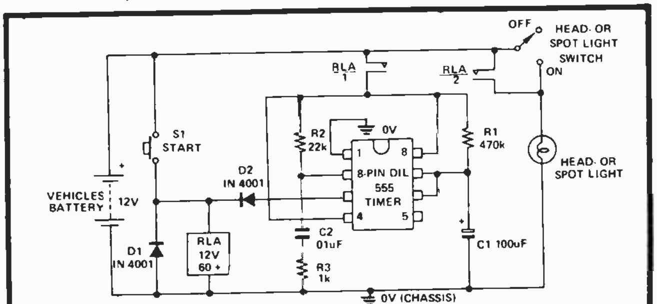


Fig. 8. Manually-triggered delayed-turn-off head- or spot-light control system for automobiles.

555 TIMER APPLICATIONS

turns on contacts RLA/2 close and apply power to the vehicle lights and contacts RLA/1 close and apply power to the timer circuit, but pin 2 of the IC is briefly tied to ground via C_2 and R_3 at this moment, so a negative trigger pulse is immediately fed to pin 2 and a timing cycle is initiated. Consequently, pin 3 of the 555 switches high at the moment that the relay contacts close, and thus locks the relay into the ON condition irrespective of the subsequent state of START switch S_1, so the lights remain on for the duration of the 50 second timing cycle. At the end of the timing cycle pin 3 of the I.C. switches to the low state, so the relay turns off and contacts RLA/1 and RLA/2 open, disconnecting power from the timing circuit and the lights. The operating sequence is then complete.

PORCH LIGHT

Finally, to conclude this 'Timer Circuits' section of the 555 story, Fig 9 shows the circuit of a relay-output automatic porch light control unit that turns the porch lights on for a pre-set 50 second period only when suitably triggered at night time or under 'dark' conditions: The circuit is triggered via switch S_1, which may take the form of a microswitch activated by a porch gate or a pressure-pad switch activated by body weight and concealed under a porch mat or rug.

The operation of the Fig 9 circuit relies on the fact that for correct timer operation the negative-going trigger pulse that is fed to pin 2 of the IC must fall below the internally-controlled '1/3 V_{cc}' voltage value of the 555. If the trigger pulse does not fall below this value, timing cycles can not be initiated by the trigger signal.

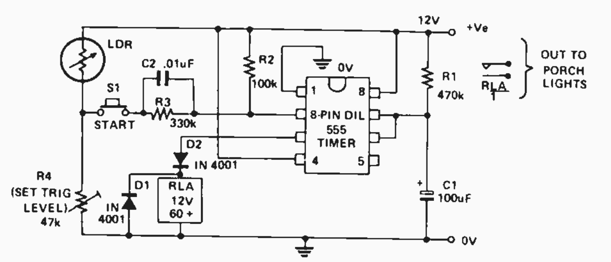


Fig. 9. Automatic porch light turns on for a pre-set period only when triggered at night.

In this design, light-dependent resistor LDR and preset resistor R_4 are wired in series as a light-dependent potential divider. One side of switch S_1 is taken to the output of this potential divider, and the other side of the switch is taken to pin 2 of the IC via the C_2-R_3 combination. Under bright or daylight conditions the LDR acts as a low resistance, so a high voltage appears at the output of the potential divider. Consequently, the act of closing S_1 causes a voltage pulse much higher than '1/3 V_{cc}' to be fed to pin 2 of the chip, so the timer is not triggered via S_1 under the 'daylight' condition.

Conversely, the LDR acts as a high resistance under dark or 'night' conditions, so a low voltage appears at the output of the potential divider. Consequently, the act of closing S_1 causes a voltage pulse much lower than '1/3 V_{cc}' to be fed to pin 2 of the IC, so the time circuit is triggered via S_1 under the 'night' condition.

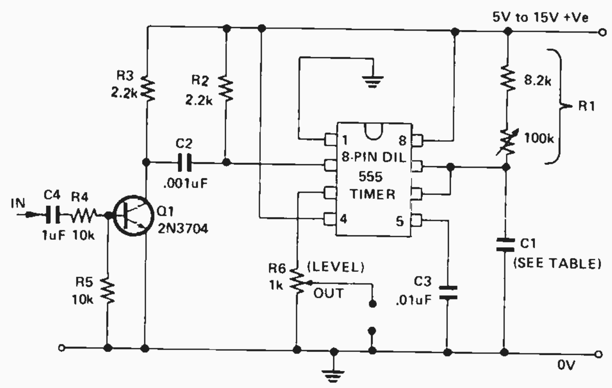
In practice, the LDR can be any cadmium-sulphide photocell that presents a resistance in the range 1kΩ to 100kΩ under the required minimum 'dark' turn-on condition, and R_4 can be adjusted to preset the minimum 'dark' level at which the circuit will trigger. Note that the trigger signal is fed to pin 2 of the IC via the C_2-R_3 combination, which act as a trigger signal conditioning network that effectively isolates the d.c. component of the LDR-R_4 potential divider from the trigger pin of the IC.

MONOSTABLE PULSE GENERATOR CIRCUITS

All the 555 timer circuits that we have looked at so far act essentially as monostable multivibrators or pulse generators. The 555 can be used as a conventional electronically-triggered monostable multivibrator or pulse generator by feeding suitable trigger signals to pin 2 and taking the pulse output signals from pin 3. The IC can be used to generate good output pulses with periods from 5µS to several hundred seconds. The maximum usable pulse repitition frequency is approximately 100kHz.

The trigger signal reaching pin 2 must be a carefully shaped negative-going pulse. Its amplitude must switch from an OFF value greater than 2/3 V_{cc} to an ON value less than 1/3 V_{cc} (triggering actually occurs as pin 2 drops through the 1/3 V_{cc} value). The pulse must have a width greater than 100nS but less than that of the desired output pulse, so that the trigger pulse is removed by the time the monostable period terminates.

One way of determining a suitable trigger signal for the 555 monostable circuit is to convert the input signal to a good square wave that switches between ground volts and the full positive supply rail voltage, and then couple this square wave to pin 2 of the IC via a simple short time-constant C-R differentiating network, which converts the leading or trailing edges of the square wave into suitable trigger pulses. Fig. 10a shows a practical circuit that uses this basic principle, but is intended for use only with input signals that are already of square or pulse form.



C1 VALUE	PULSE WIDTH RANGE		
10uF	90mS	–	1.2sec.
1uF	9mS	–	120mS
0.1uF	0.9mS	–	12mS
.01uF	90uS	–	1.2mS
.001uF	9uS	–	120uS

Fig. 10a: Simple add-on pulse generator is triggered by rectangular input signals: circuit can be used at trigger frequencies up to 100kHz.

Here, transistor Q_1 converts the rectangular input signal into a signal that switches between the ground and positive voltage rails, and the resulting signal is fed to pin 2 via the C_2-R_2 differentiating network. The circuit can be used as an add-on pulse generator in conjunction with an existing square or pulse generator. Variable-amplitude output pulses are available from pin

3 via variable potential divider R6. The output pulse widths can be varied over more than a decade range via R_1, and can be switched in overlapping decade ranges by using the values of C1 listed in the table. With the component values shown the pulse width is fully variable from 9 μS to 1.2 seconds. Note that C3 is used to decouple the pin 5 CONTROL VOLTAGE terminal and improve the circuit stability.

Fig 10b shows how the above circuit can be modified so that it can be driven from any type of input waveform, including sine waves. Here, IC1 is connected as a simple Schmitt trigger, which converts all input signals into rectangular output signals, and these rectangular signals are used to drive the IC2 monostable circuit in the same way as described above. The Fig 10b circuit can thus be used as an add-on pulse generator in conjunction with an existing waveform generator of any type that produces output signals with peak-to-peak amplitudes greater than 1/2 V_{cc}.

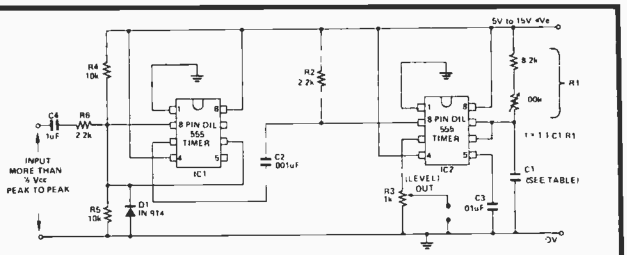


Fig. 10b: Improved add-on pulse generator is triggered by any input waveform.

Fig 11 shows how two basic monostable pulse generators can be connected in series to make a delayed pulse generator, in which IC1 is used as a Schmitt trigger and IC2 controls the delay width and IC3 determines the output pulse width: The final output pulse appears some delayed time after the initial application of the trigger signal. This circuit can be made into a self-contained instrument by building it into the same cabinet as a simple square wave generator, which can be used to provide the necessary drive signals.

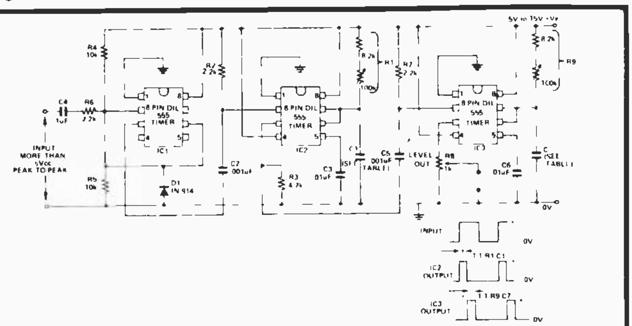


Fig. 11: Add-on delayed pulse generator is triggered by any input waveform. For C1 (and C7) values, see table in Fig. 10a.

Any number of basic monostable pulse generators can be wired in series to give a sequential form of operation. Fig 12 for example, shows the circuit and wave-forms of a 3-stage sequential generator, which can be used to operate lamps or relays, etc., in a pre-programmed time sequence once an initial START command is given via push-button switch S_1. Note that the pin 4 RESET terminal of all ICs are shorted together and positively biased via R7, and that these terminals can be shorted to ground via SET switch S2: This SET switch should be closed at the moment that power is

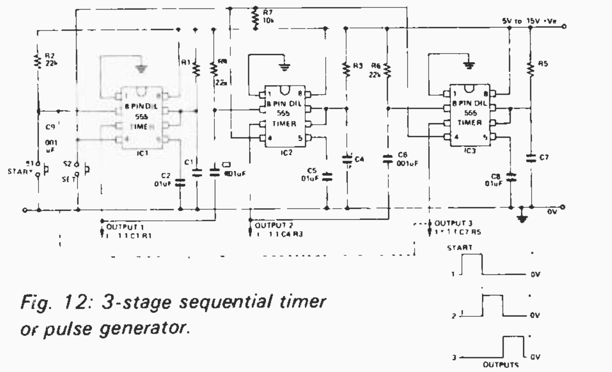


Fig. 12: 3-stage sequential timer or pulse generator.

first applied to the circuit, to ensure that none of the ICs are falsely triggered at this moment.

Finally, three or more monostable circuits can be connected, via C9, in a continuous loop, with the output of the last monostable feeding back to the input of the first monostable, to form a 'chaser' circuit in which the sequential action repeats to infinity. This type of circuit can be used to drive lamp or LED displays, etc. Note that the circuit is again provided with the S_2 SET facility, so that the circuit can be emptied at the moment that power is first applied.

ASTABLE MULTIVIBRATOR CIRCUITS

Fig 13 shows the practical circuit of a basic 1 kHz astable multivibrator, together with the formulas that define the timing of the circuit. Note that TRIGGER pin 2 of the chip is shorted to the pin 6 THRESHOLD terminal, and that timing resistor R2 is wired between pin 6 and DISCHARGE pin 7.

When power is first applied to the circuit C1 starts to

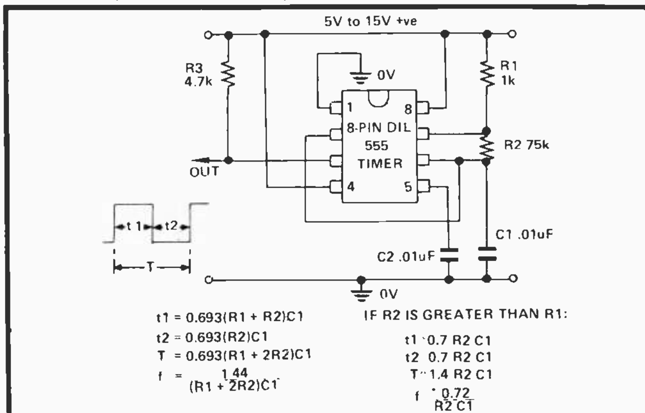


Fig. 13: Basic circuit of 1KHz astable multivibrator, with timing formulas.

charge exponentially (in the normal monostable fashion) via the series R1-R2 combination, until eventually the C1 voltage rises to 2/3 V_{cc}. At this point the basic monostable action terminates and DISCHARGE pin 7 switches to the low state. C1 then starts to discharge exponentially into pin 7 via R_2, until eventually the C1 voltage falls to 1/3 V_{cc}, and TRIGGER pin 2 is activated. At this point a new monostable timing sequence is initiated, and C1 starts to recharge towards 2/3 V_{cc} via R1 and R2. The whole sequence then repeats add infinitum, with C1 alternately charging towards 2/3 V_{cc} via R1-R2 and discharging towards 1/3 V_{cc} via R2 only.

Note in the above circuit that, if R2 is very large relative to R1, the operating frequency of the circuit is determined essentially by the R2 and C1 values, and that a virtually symmetrical output waveform is generated. The graph of Fig 14 shows the approximate relationship between frequency and the C1-R2 values under the above condition. In practice, the R1 and R2 values of the circuit can be varied from 1kΩ up to tens of megohms. Note, however, that R1 has a significant

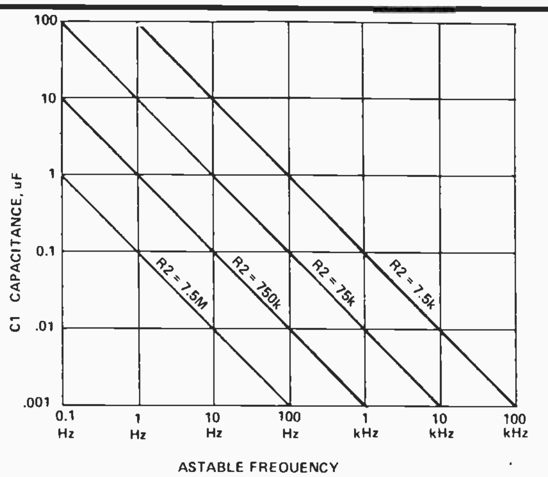


Fig. 14: Approximate relationship between C1, R2, and frequency when R2 is large relative to R1.

effect on the total current consumption of the circuit, since pin 7 of the IC is virtually grounded during half of the timing sequence. Also note that the duty cycle or mark/space ratio of the circuit can be pre-set at a non-symmetrical value, if required, by suitable choice of the R1 and R2 values.

The basic circuit of Fig 13 can be usefully modified in a number of ways. Fig 15, for example, shows how it can be made into a variable-frequency square wave

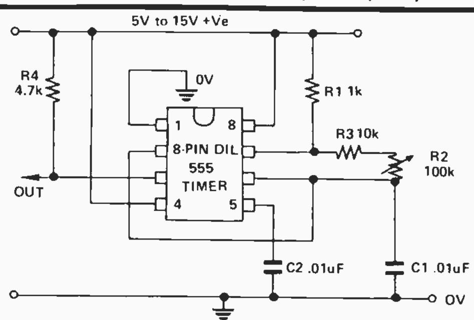


Fig. 15: Variable frequency square wave generator covers the range 650Hz-7.2kHz approximately.

generator by replacing R2 with a fixed and variable resistor in series. With the component values shown the frequency can be varied over the approximate range 650Hz-7.2kHz via R2.

Fig 16 shows how the circuit can be further modified

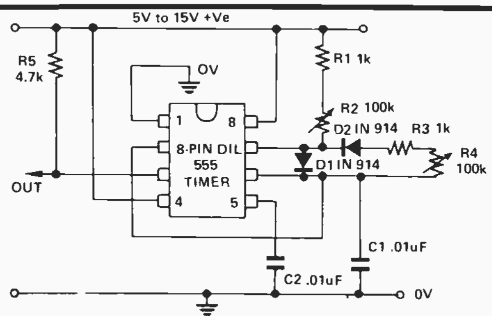


Fig. 16: Astable multi with mark and space periods independently variable over the approximate range 7.5μs to 750μs.

so that its MARK and SPACE periods are independently variable over the approximate range 7.5μS to 750μS. Here, timing capacitor C1 alternately charges via R1-R2-D1 and discharges via R3-R4-D2.

Fig 17 shows how the circuit can be additionally modified so that it acts as fixed-frequency square wave generator with a mark/space ratio or duty cycle that is fully variable from 1% to 99%. Here, C1 alternately

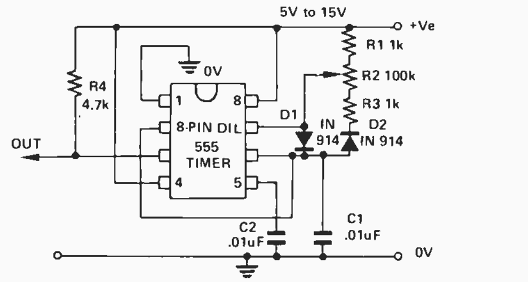


Fig. 17: Astable multi with duty cycle variable from 1 to 99% with frequency approximately constant at 1.2kHz.

charges via R1 and the top half of R2 and via D1, and discharges via D2-R3 and the lower half of R2. Note that the sum of the two timing periods is virtually constant, so the operating frequency is almost independent of the setting of R2.

GATING A 555 ASTABLE

The 555 astable circuit can be gated ON or OFF, via either a switch or an electronic signal, in a variety of ways. Figs 18 and 19 show two basic ways of gating the IC via a switch.

In Fig 18 the circuit is gated via the pin 4 RESET

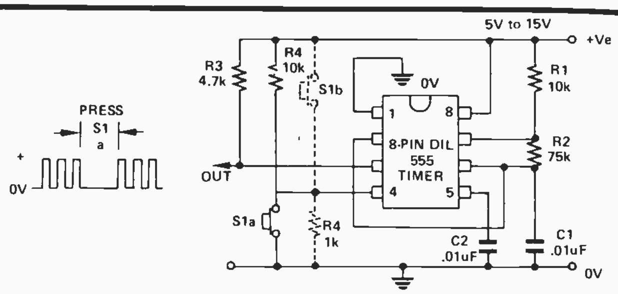


Fig. 18: Gated 1kHMZ astable with 'press to turn-off' or 'press to turn-on' operation.

terminal. The characteristic of this terminal is such that, if the terminal is biased significantly above a nominal value of 0.7 volts, the astable is enabled, but if the terminal is biased below 0.7 volts by a current greater than 0.1mA (by taking the terminal to ground via a resistance less than 7kΩ, for example) the astable is disabled and its output is grounded. Thus, the Fig 19 circuit is normally on but can be turned off by closing S1 and shorting pin 4 to ground, while the circuit shown in dotted lines is normally gated off via R_4 but can be turned on by closing S_2 and shorting pin 4 to the positive supply rail. These circuits can alternatively be gated by applying suitable electronic signals directly to pin 4.

The Fig 19a and 19b circuits are gated via the pin 2 TRIGGER and pin 6 THRESHOLD terminals. The characteristic here is such that the circuit functions as a normal astable only as long as pin 6 is free to swing up to 2/3 V_{cc} and pin 2 is not biased below 1/3 V_{cc}. If these pins are simultaneously driven below 1/3 V_{cc} the

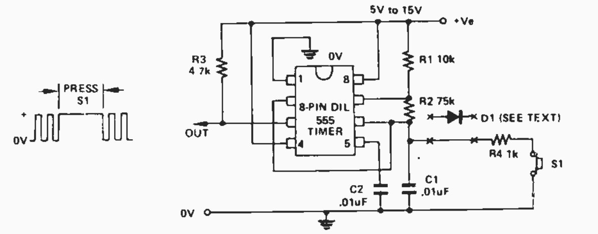


Fig. 19A: Alternative gated 1kHz astable with 'press to turn-off' operation.

astable action is immediately terminated and the output is driven to the high state. Thus, the Fig 19a circuit is normally on but turns off when S1 is closed. Note that an electronic signal can be used to gate the circuit by connecting a diode as indicated and eliminating S_1. In this case the circuit will gate off when the input signal voltage is reduced below 1 / 3 V_{cc}.

The Fig 19b circuit is connected so that it is normally gated off by saturated transistor Q1, but can be gated

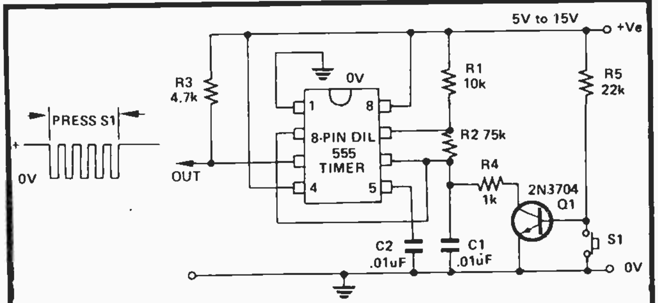


Fig. 19B: Alternative gated 1kHz astable with 'press to turn-off' operation.

on by closing S1 and thus turning the transistor off. This circuit can be gated electronically by eliminating R5 and S1 and applying a gating signal to the base of Q1 via a 10kΩ limiting resistor. In this case the astable turns off when the input signal is high, and turns on when the input signal is reduced below 0.7 volts or so.

All the 555 astable circuits that we have looked at can be subjected to frequency modulation (FM) or pulse-position modulation (PPM) by simply feeding a suitable modulation signal to pin 5. This modulation signal can take the form of an A.C. signal that is fed to pin 5 via a blocking capacitor, as in the case of Fig 20a or a D.C. signal that is fed directly to pin 5, as in the case of Fig 20b. The action of the chip is such that the voltage on pin 5 influences the width of the 'mark' pulses in each timing cycle, but has no influence on the 'space' pulses. Thus, since the signal on pin 5 influences the position of each 'mark' pulse in each timing cycle, this terminal provides pulse-position

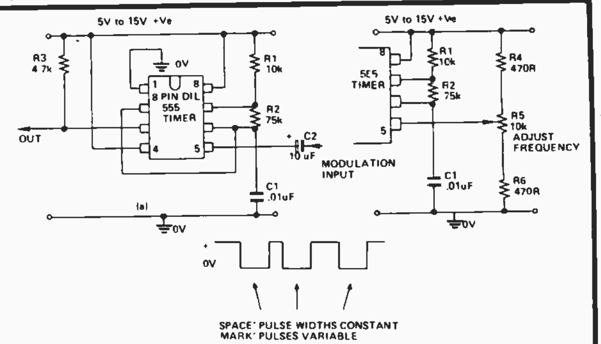


Fig. 20: Alternative ways of obtaining frequency or pulse-position modulation (FM or PPM) from the 555 astable circuit.

modulation (PPM), and, since the signal influences the total period of each cycle (and thus the frequency of the output signal), the terminal also provides frequency modulation (FM). These facilities are useful in special waveform generator applications, as is shown in the next section.

MISCELLANEOUS ASTABLE APPLICATIONS

The 555 astable multivibrator has three outstanding advantages over other types of astable circuit. First, its frequency can be varied over a wide range via a single resistive control. Second, its output has a low impedance and can source or sink current up to 200mA. Finally, its operating frequency can readily be modulated by applying a suitable signal to pin 5 of the IC. These features make the device exceptionally versatile, and it can be used in a vast range of practical applications of interest to both the amateur and professional user.

MORSE PRACTICE OSCILLATOR

Fig 21 shows how the 555 timer I.C. can be used as a morse-code practice oscillator. The circuit acts as a

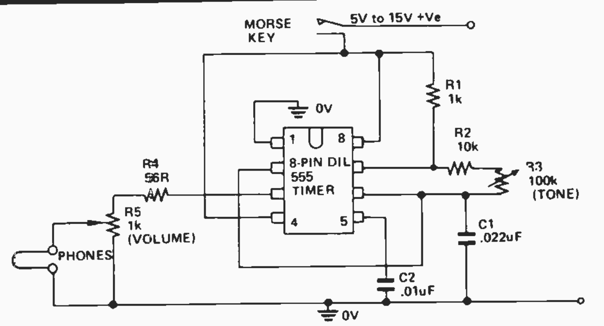


Fig. 21: Code-practice oscillator with variable tone (300Hz..3kHz) and variable volume.

normal astable, with frequency variable over the approximate range 300Hz — 3kHz via TONE control R3. The 'phone volume is variable via R5, and the 'phones can have any impedance from a few ohms up to megohms. The circuit draws zero quiescent current, since the normally-open morse key is used to connect the circuit to the positive supply rail, which can have any value in the range 5 volts to 15 volts.

Fig 22 shows how the 555 astable circuit can be used in LED flasher applications. This circuit operates at approximately 1 Hz, and has a single LED. The Fig 22 circuit has a single LED output; the dotted section shows how a second may be added, such that one LED is on while the other is off, and vice versa. Any types of LED's can be used in this circuit. Series resistors R_1 or

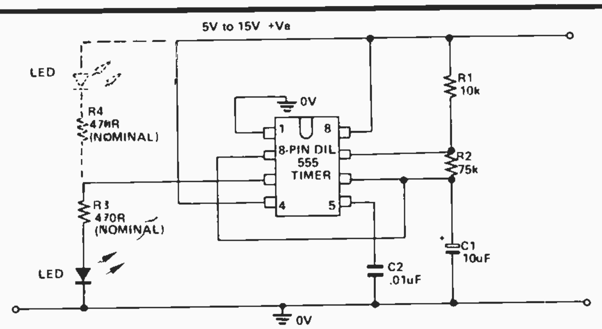


Fig. 22: Single and dual output led flashers give symetrical 1Hz outputs.

R_4 determines the ON current of each LED.

Fig 23 shows how the Fig 22 circuit can be modified to give automatic dark-activated operation. Here, R4 and R5 are wired as a fixed potential divider that sets $1/2\ V_{cc}$ on the emitter of Q1, LDR and R7 are wired as a light-sensitive potential divider that applies a variable voltage to the base of Q1, and the collector of Q1 is taken to RESET pin 4 of the IC, which is normally biased to ground via R6.

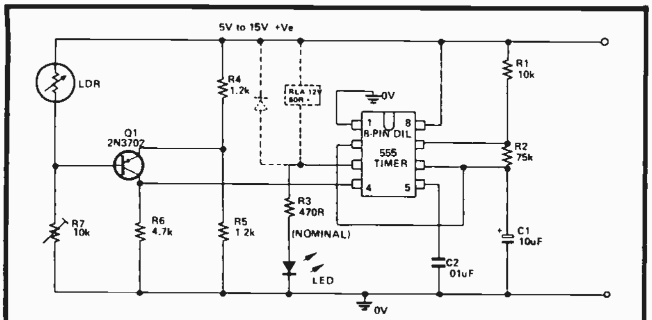


Fig. 23: Automatic (dark-activated) flasher.

In use R7 is adjusted so that the voltage to the base of Q1 is greater than $1/2\ V_{cc}$ under 'daylight' conditions, so Q1 is cut off, but under 'dark' conditions Q1 base is biased below $1/2\ V_{cc}$, so it is driven on. thus, under daylight conditions Q1 is cut off, so the 555 astable is disabled, with its output driven low, by 4.7kΩ resistor R6 which is wired between pin 4 and ground. Under 'dark' conditions, on the other hand, Q1 is biased on, so pin 4 is positively biased, and the astable operates normally and activates the LED.

The LDR used in the above circuit can be any cadmium-sulphide photocell that presents a resistance in the approximate range 470Ω to 10kΩ under the minimum 'dark' turn-on condition.

The dotted section shows how the 555 astable circuit can be used as a 12 volt relay pulser, which turns the relay on and off at a rate of one cycle per second. The relay can be any type with a coil resistance greater than 60Ω.

ALARM GENERATOR

Fig 24 shows the connections for making an 800Hz monotone alarm-call generator. The circuit can be used with any supply in the range 5 to 15 volts, and with any speaker impedance. Note, however, that R_x must be wired in series with speakers having impedance less than 75Ω, and must be chosen to give a total series impedance of at least 75Ω, to keep the peak speaker currents within the 200mA driving constraints of the 555. The available alarm output power of the circuit depends on the speaker impedance and supply voltage

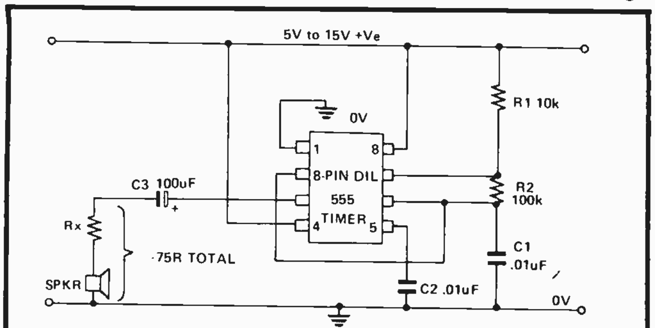


Fig. 24: 800Hz Monotone alarm call generator.

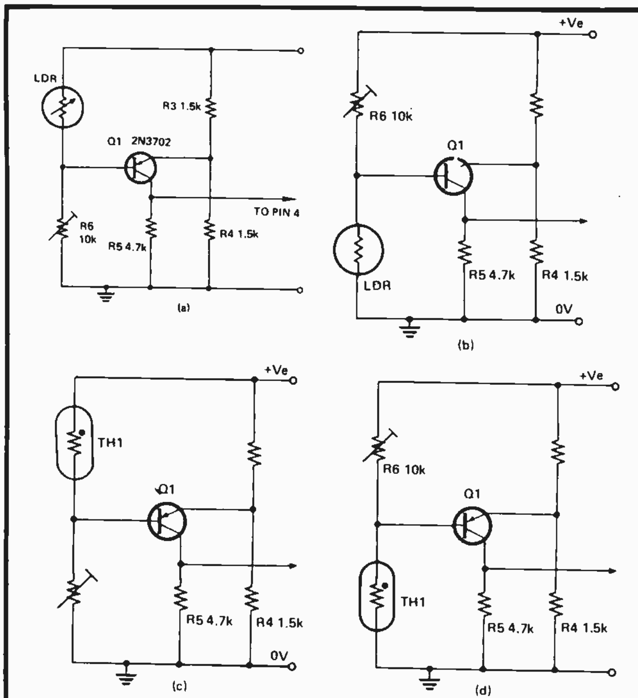


Fig. 24 a, b, c, d: Monotone alarm activated by dark (2), light (b), under-temperature (c), or over-temperature (d).

used, but may be as great as 750mW when a 75Ω speaker is used with a 15 volt supply.

The above circuit can be modified so that it is activated by darkness (a), by brightness (b), by an under-temperature (c), or by an over-temperature (d). Pin 4 is disconnected from the + Ve supply, and connected to the triggering circuit, which is designed around Q1. This works in the same way as already described for the automatic (dark-activated) LED flasher. The LDR used in the light-activated versions of this circuit can be any cadmium-sulphide photocells that present resistances in the approximate range 470Ω to 10kΩ at the desired turn-on levels. The thermistors used in the temperature-activated versions of the circuit can be any negative-termperature-coefficient types that present resistances in the same range at the required turn-on temperatures.

ALARMS AND SIRENS

The next 4 diagrams show a variety of useful alarm-call generator circuits. The Fig 25 circuit generates an 800Hz pulsed tone alarm call. Here, IC1 is wired as an 800Hz alarm generator, and IC2 is wired as a 1Hz astable which gates IC1 on and off via D1 once every second, thus causing a pulsed-tone output signal to be generated.

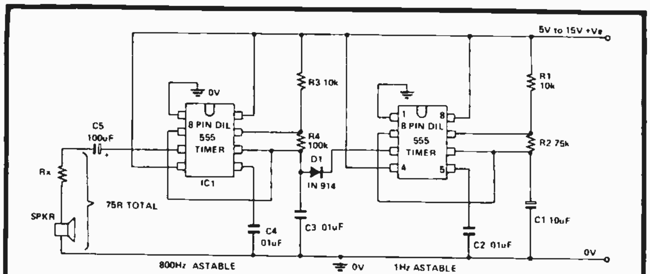


Fig. 25: Pulsed-tone (800Hz) alarm call generator.

The Fig 26 circuit generates a warble-tone alarm signal that simulates the sound of a British police siren. Here, IC1 is again wired as an alarm generator and IC2 is wired as a 1Hz astable multivibrator, but in this case the output of IC2 is used to frequency modulate IC1 via R5. The action is such that the output frequency of IC1 alternates symmetrically between 500Hz and 440Hz, taking one second to complete each alternating cycle.

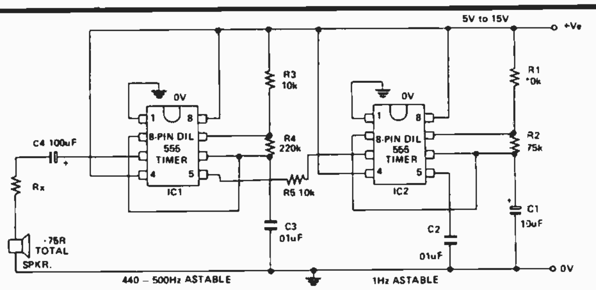


Fig. 26: Warble-tone alarm-call generator simulates British police siren.

The circuit of Fig 27 generates a 'wailing' alarm that simulates the sound of an American police siren. Here, IC2 is wired as a low frequency astable that has a cycling period of about 6 seconds. The slowly varying 'ramp waveform on C_1 of this chip is fed to pnp emitter follower Q1., and is then used to frequency modulate alarm generator IC1 via R6. IC1 has a natural centre frequency of about 800Hz. The circuit action is such that the alarm output signal starts at a low frequency, rises for 3 seconds to a high frequency, then falls over 3 seconds to a low frequency again, and so on add infinitum.

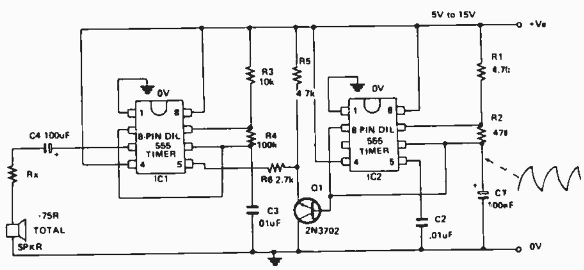


Fig 27: 'Wailing' alarm simulates American police siren.

Finally, to complete this quartet of alarm generator circuits, the Fig 28 circuit generates a siren alarm signal that is a simulation of the 'Red Alert' alarm used in the STAR TREK T.V. programme: This signal starts at a low frequency, rises for about 1.15 seconds to a high frequency, ceases for about 0.35 seconds, then starts rising again from a low frequency, and so on add infinitum. The circuit action is as follows:

IC_2 is wired as a non-symmetrical astable multivibrator, in which C1 alternately charges via R1 and D1, and discharges via R2, thus giving a rapidly rising and slowly falling 'sawtooth' waveform across C1. This waveform is fed to pnp emitter follower Q1, and is thence used to frequency modulate pin 5 of IC1 via R6. Now, the frequency modulation action of pin 5 of the IC1 astable circuit is such that a rising voltage on pin 5 causes the astable frequency to fall, and vice versa; consequently the sawtooth modulation signal on pin 5 causes the astable frequency to rise slowly during the falling part of the sawtooth and collapse rapidly during the rising part of the sawtooth. The rectangular pin 3 output of IC_2 is used to gate IC1 off via npn common emitter amplifier Q2 during the collapsing part of the signal, so only the rising parts of the alarm signal are in fact heard, as in the case of the genuine STAR TREK 'Red Alert'.

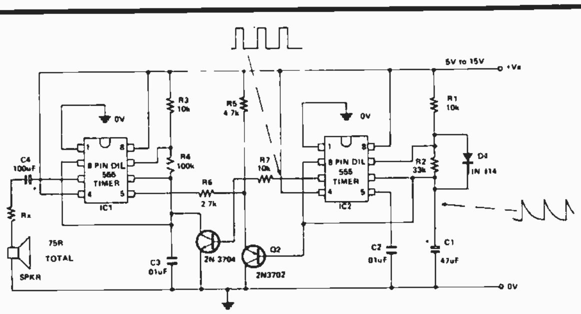


Fig. 28: 'Red alert' siren alarm simulates Star Trek alarm signal.

MISCELLANEOUS APPLICATIONS

To complete the 555 story, this final section shows a miscellany of 555 applications, of varying degrees of usefulness. Fig 29 shows how a single 555 can be used as the basis of an event-failure alarm or a missing-pulse detector, which closes a relay or illuminates an LED if a normally recurrent event fails to take place.

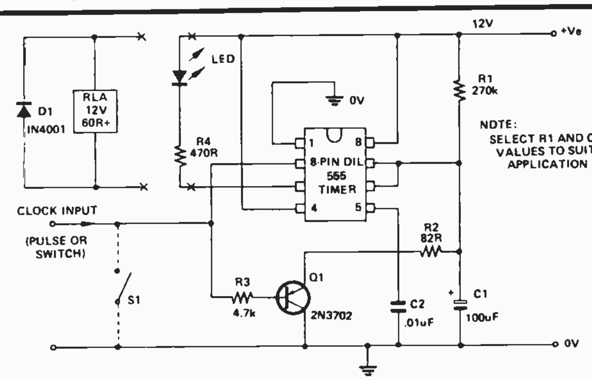


Fig. 29: Event-failure alarm or missing-pulse detector has relay or LED output.

The operating theory of the circuit is fairly simple. The 555 is wired as a normal monostable pulse generator, except that transistor Q1 is wired across timing capacitor C1 and has its base taken to TRIGGER pin 2 of the IC via R3: The TRIGGER pin is fed with a train of pulse- or switch-derived clock input signals from the monitored event, and the values of R1 and C1 are selected so that the monostable period of the IC is slightly longer than the repetition period of the clock input signal.

Thus, each time a clock pulse arrives, a monostable timing period is initiated via pin 2 of the IC, and C1 is discharged and the pin 3 output is driven high via transistor Q1. Before each monostable period can terminate, a new clock pulse arrives, and a new monostable period is initiated, so the pin 3 output terminal remains high so long as clock input pulses continue to arrive within the prescribed period limits. Should a clock pulse be missed, or the clock period exceed the pre-determined limits, however, the monostable period will be able to terminate normally, and pin 3 of the IC will go low and drive the relay or LED on. The circuit thus functions effectively as an event-failure alarm or missing-pulse detector. With the component values shown, the monostable has a natural period of about 30 seconds. This period can be varied via R1 and C4 to satisfy specific requirements.

Fig 30 shows how a couple of 555s can be used to make a pulse-width modulation (PWM) circuit. This circuit can be used for transmitting coded messages, or for applying variable power to a load at maximum efficiency.

Here, IC1 is wired as a 1kHz astable multivibrator, which is used to feed a continuous train of clock pulses

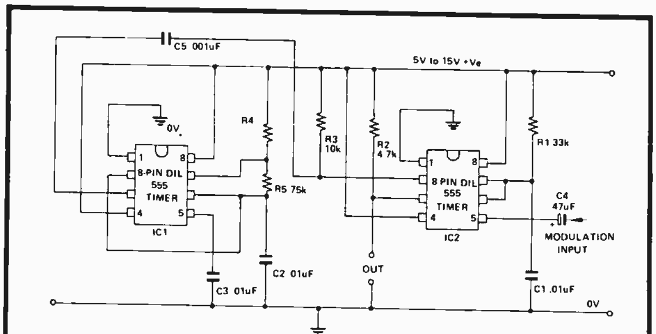


Fig. 30: Pulse-width modulation (PWM) circuit.

to the pin 2 TRIGGER terminal of IC2, which is wired as a normal monostable multivibrator or pulse generator and has a natural monostable period of approximately 0.36mS. The external modulation signal is fed to the pin 5 CONTROL VOLTAGE terminal of the monostable via C4, and determines the instantaneous widths of the generated pulses. Thus, the circuit generates a train of pulse-width modulated (PWM) pulses at a fixed repitition frequency of 1kHz.

SCOPE TIMEBASE

Fig 31 shows how a basic 555 monostable multivibrator can be modified so that it generates a

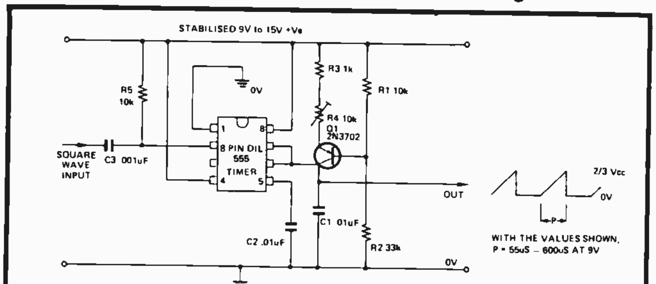


Fig. 31: Triggered linear-ramp generator can be used as the basis of an oscilloscope timebase.

linear ramp waveform of fixed duration each time it is triggered: This circuit can form the basis of an excellent oscilloscope time-base generator. The circuit works just like a normal monostable circuit, except that timing capacitor C1 is charged via constant-current generator Q1 during each timing cycle, thus causing a linear ramp voltage to be generated across C1.

When a capacitor is charged via a constant-current generator, the voltage across the capacitor rises linearly at a predictable rate that is determined by the magnitudes of the charging current and the capacitance. The relationship can be expressed as:

Volts-per-second = I/C, when I is expressed in Amps and C is expressed in Farads.

In this circuit the charging current can be varied over the approximate range 90μA to 1mA via R_4, thus giving rates of rise on the .01μF capacitor of 9V-per-mS to 100V-per-mS. Now, remembering that each monostable period of the 555 circuit terminates at the point when C1 voltage reaches 2/3 V_{cc}, and assuming that a 9V supply is used (giving a 2/3 V_{cc} value of 6V), it can be seen that the monostable cycles of the Fig 32 circuit have periods variable from 666μS to 60μS. Periods can be increased beyond these values by increasing the C1 value, or vice versa. Note when using this circuit that its supply rail must be stabilised if stable timing periods are to be obtained.

If the circuit of Fig 31 is to be used as the basis of an oscilloscope timebase, note that the input driving signal must first be converted to a good square wave, from which suitable trigger pulses can be derived via C3 and R5. The minimum useful ramp period that can be obtained from the circuit is about 5μS, which, when expanded to give full deflection on a ten-division 'scope screen, gives a maximum timebase speed of 0.5μS-per-division. Flyback beam-suppression signals can be derived from the pin 3 OUTPUT terminal of the IC.

The 'timebase' circuit gives superb signal synchronisation at trigger frequencies up to about 150kHz. If the timebase is to be used with input signal frequencies greater than this, the input signals should be divided down via a single- or multi-decade digital divider. Using this technique, the timebase can be used to view input signals up to many MHz.

Fig 32 shows how a 555 can be connected for use as a simple but effective Schmitt trigger or Sine/Square converter. The circuit acts as a good converter at input frequencies up to 150kHz or more. It works by changing its output state each time the pin 2 input signal swings from above the 2/3 V_{cc} level to

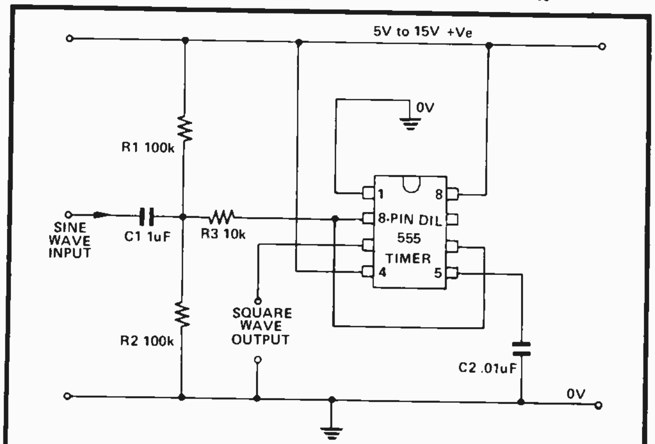


Fig. 32: 555 Schmitt trigger circuit acts as excellent sine/square converter up to about 150kHz.

below the 1/3 V_{cc} level, or vice versa. Resistor R3 is wired in series with pin 2 of the chip to ensure that the input signal is not adversely influenced by the transition action of the IC.

Fig 33 shows how the basic Schmitt circuit can be adapted to a dark-activated relay driving application by wiring light-dependent potential divider R1-LDR to the pin 2 input terminal of the IC. This circuit has an inherently high degree of input backlash, and is likely to be of value in only very specialised applications.

A far more useful relay-driving switching circuit is shown in Fig 35. This circuit has negligible input backlash, and can be used as either a light- or

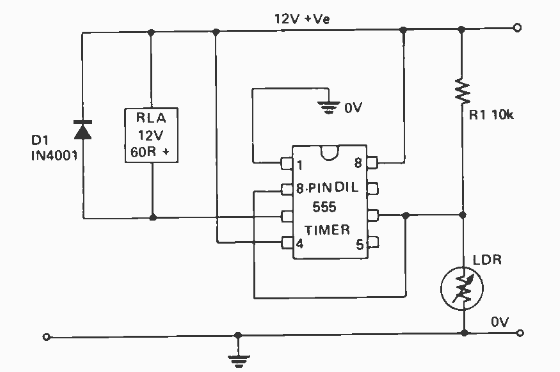


Fig. 33: Dark-activated relay switch has built-in backlash.

temperature-activated switch. In light-activated applications R1 is wired in series with a cadmium-sulphide photocell that presents a resistance in the approximate range 470Ω to 10kΩ at the required turn-on level. Dark-activated operation can be obtained by using the connections shown in Fig 34a or light-activated operation can be obtained by using the connections shown in Fig 34b.

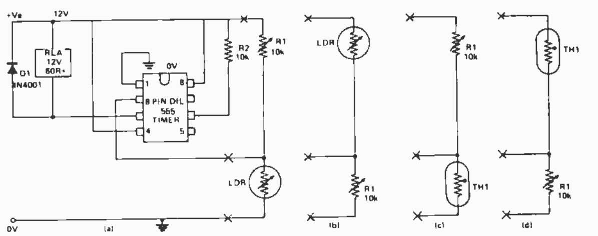


Fig. 34: Minimum-backlash relay switch can be activated by dark (a), light (b), under-temperature (c), or over-temperature (d).

For temperature-activated operation, R1 must be wired in series with a negative-temperature-coefficient thermistor. This thermistor must present a resistance in the range 470Ω to 10kΩ at the required turn-on level. Under-temperature operation can be obtained by using the connections shown in Fig 34c, or over-temperature operation can be obtained by using the connections shown in Fig 34d.

1kHz ANALOGUE FREQUENCY METER

This circuit needs a square-wave input driving signal with a peak-to-peak amplitude of 2 volts or greater. In this circuit the 555 is wired as a standard monostable multivibrator or pulse generator, and is powered from a regulated 6V supply. Transistor Q1 is used to amplify the square wave input signals to a level suitable for triggering the monostable stage, and the output of the monostable is fed to 1mA fsd meter M1 via multiplier resistor R5 and offset-cancelling diode D1. This meter gives a reading that is directly proportional to the frequency of the square wave input signals, and its operating theory is as follows:

Each time the monostable multivibrator is triggered it generates a pulse of fixed duration and fixed amplitude. If we assume that each generated pulse has a peak amplitude of 10V and a period of 1mS, and that the pulse generator is triggered at an input frequency of 500Hz, it can be seen that the pulse is high (at 10V) for 500mS in each 1000mS (one second) total period, and that the MEAN value of output voltage measured over this total period is 250mS/1000mS x 10V = 5V, or 50% of 10V. Similarly, if the input frequency is 250Hz the pulse is high for 250mS in each 1000mS total period, so the mean output voltage equals 250mS/1000mS x 10V= 2.5V, or 25% of 10V. Thus, the mean value of output voltage of the pulse generator, measured over a reasonable total number of pulses, is directly proportional to the repitition frequency of the generator.

Normal moving coil meters are 'mean' reading instruments, and in the Fig 35 circuit a 1mA f.s.d. moving coil meter is wired in series with voltage multiplier resistor R5, which sets the meter sensitivity at about 3.4V fsd, and is connected so that it reads the

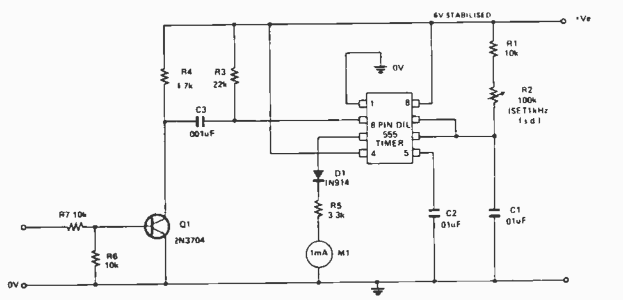


Fig. 35: Simple 1kHz linear-scale analogue frequency meter.

mean output voltage of the pulse generator. This meter thus gives a reading that is directly proportional to frequency, and the circuit thus acts as a linear-scale analogue frequency meter. With the component values shown the circuit is intended to read fsd at 1kHz. To set up the circuit initially, simply feed a 1kHz square wave signal to its input, and then adjust R2 (which controls the pulse lengths) to give full-scale reading on the meter; all adjustments are then complete.

The full-scale frequency of the above circuit can be varied from about 100Hz to about 100kHz by suitable choice of C1 value. The circuit can be used to read frequencies up to tens of MHz by feeding the input signals to the monostable circuit via a single- or multi-decade digital divider, thereby reducing the input frequencies to values that can be read by the monostable circuit. The circuit can form the basis of an excellent and inexpensive multi-range linear-scale analogue frequency meter. ●

"Do you think we should bring in the generating boys before we hit the market with these."

ETI DATA SHEET

MC 1312/15/14P CBS SQ LOGIC SYSTEM — MOTOROLA

A complete SQ decoder system in three chips. The MC1312P is the decoder and consists of two high input impedance pre-amplifiers which are fed with left total, L_T, and right total, R_T, signals. The preamplifiers each feed two all-phase networks which generate two L_T signals in quadrature and two R_T signals in quadrature. The four signals are matrixed to yeild left front, left back, right front and right back signals (L_F', L_B', R_F', R_B').

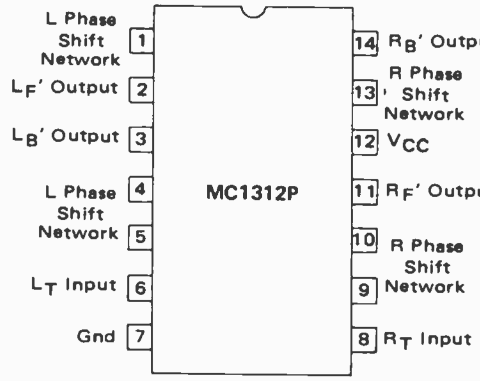
The MC 1314P is a voltage controlled attenuator, a gain control and balance adjustment unit for use with any quadraphonic system. It has four channels whose gain can be varied by an external dc voltage. In addition, the relative gain between channels can be set by three external dc voltages. Thus with four variable resistors the master volume L_F/R_F, L_B/R_B and F/B balance may be controlled.

The logic circuitry for the system is in the MC1315P which provides the basic logic function to enhance the front to back separation in the CBS SQ four channel decoding system. This device is designed to interface with the MC1312 decoder and MC 1314. The MC1315 provides dc logic enhancement control signals which extend the performance of the basic SQ system to the levels desired for top-of-the-line systems.

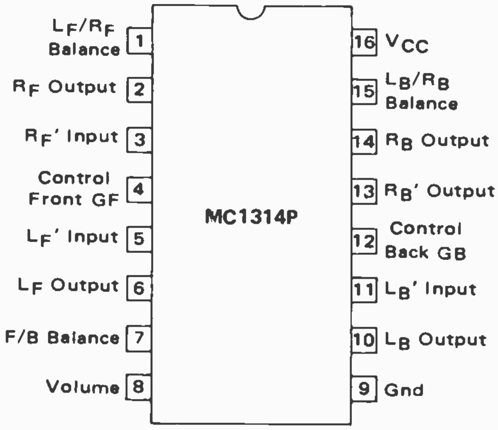
Power Supply Requirements:	60 mA at 20 V
Nominal Signal Level:	0.5 V
Maximum Input Voltage:	1.9 V
Input Impedance:	2 MΩ
Output Impedance:	2 kΩ
Total Harmonic Distortion: at 1 Hz	0.2% at nominal input 1.0% at maximum input
Voltage Gain (at quiescent):	1.0
4 Channel Volume Control:	Range 70 dB
4 Channel Balance Control:	Tracking — within 3 dB —35 dB at —20 dB gain

ELECTRICAL CHARACTERISTICS

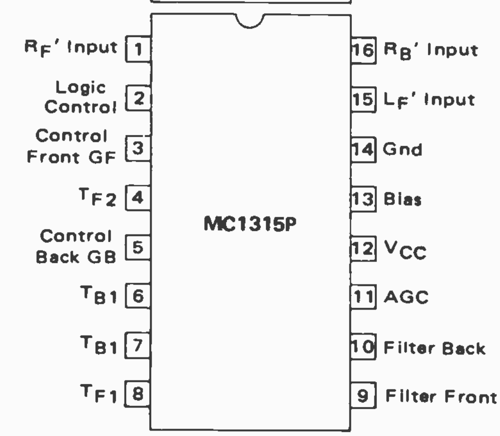
Characteristic	Typ
Supply Current Drain	16 mA
Input Impedance	3.0 MΩ
Output Impedance	5.0 kΩ
Channel Balance (L_F/R_F)	0 dB
Voltage Gain L_F/L_T or R_F/R_T	0 dB
Relative Voltage Gain L_B'/L_F', R_B'/L_F', L_B'/R_F', R_B'/R_F' L_F' measurements made with L_T input, R_F' measurements made with R_T input	-3.0 dB
Maximum Input Voltage for 1%THD at Output R_T or L_T	2.0 V(RMS)
Total Harmonic Distortion R_T or L_T	0.1 %
Signal to Noise Ratio (Short-Circuit Input V_O = 0.5 V(RMS) with Output Noise Referenced to Output Voltage, V_O) (BW = 20 Hz to 20 kHz)	80 dB



Characteristic	Typ
Maximum Gain (V_8 6 V)	1.0 dB
Minimum Gain (V_8 = 0 V)	0.5 dB dB
Gain Spread @ Gain Max	1.0 dB
Total Harmonic Distortion (V_{in} = 0.4 Vrms, max gain)	0.2 %
Signal Noise Ratio (20 Hz 15 kHz Bandwidth) Note 1 V_{IN} · 0.4 Vrms (ref)	80 dB
Channel Separation	60 dB
Balance Control Range V_8 - 6.0 V (≈ Max Gain)	20 dB
Gain Reduction (V_4' - V_{12}' = 3.12 Vdc compared to V_4' V_{12}' ≑ 0.60 Vdc, V_{CC} - 25 Vdc)	14 dB
Supply Current (max gain) (V_{IN} 0 V) (min gain) (V_{IN} · 0 V)	19 mA 9.0 mA
Input Impedance	13 kΩ
Output Impedance	2.0 kΩ
Control Current I_4 or I_{12}	-20. µA
Intermodulation Distortion (f_1 = 7 kHz, f_2 = 60 Hz)	0.6 %



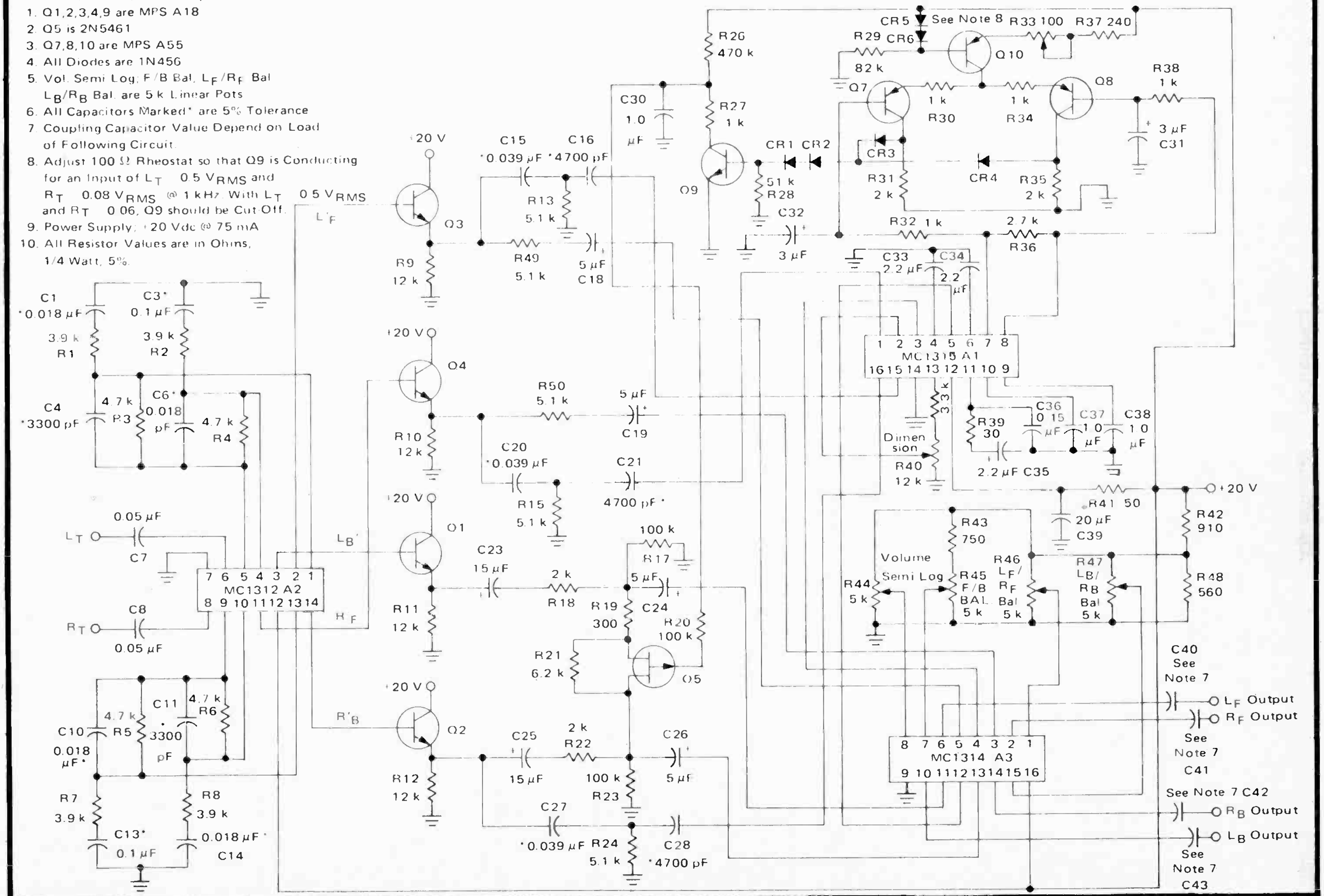
Characteristic	Typ
Supply Current (Pin 12) @ V_{IN} 0 @ V_{IN} = 1.4 Vrms	7.0 mA 15 mA
Input Resistance @ Pin 1, 15, 16	20 kΩ
Output Resistance @ Pin 3, 5	1.5 kΩ
Paraphase Filter Resistance @ Pin 9, 10	4.0 kΩ
Front-Back Logic Discharge Resistance @ Pin 7, 8	5.0 kΩ
Bias Voltage (10 k to ground) @ Pin 13	1.4 Vdc
Logic Control Input Current @ Pin 2 (V_2 - V_{13} or V_2 = 0)	±0.5 mA
Relative Output Change Front output with L_B or R_B inputs or back output with L_F or R_F inputs	2.8 V/V



CBS LOGIC SYSTEM WITH VARIABLE BLEND

NOTES: (Unless otherwise specified)

1. Q1,2,3,4,9 are MPS A18
2. Q5 is 2N5461
3. Q7,8,10 are MPS A55
4. All Diodes are 1N456
5. Vol. Semi Log; F/B Bal, L_F/R_F Bal L_B/R_B Bal. are 5 k Linear Pots
6. All Capacitors Marked* are 5% Tolerance
7. Coupling Capacitor Value Depend on Load of Following Circuit
8. Adjust 100 Ω Rheostat so that Q9 is Conducting for an Input of L_T 0.5 V_{RMS} and R_T 0.08 V_{RMS} @ 1 kHz. With L_T 0.5 V_{RMS} and R_T 0.06, Q9 should be Cut Off.
9. Power Supply: +20 Vdc @ 75 mA
10. All Resistor Values are in Ohms, 1/4 Watt, 5%.

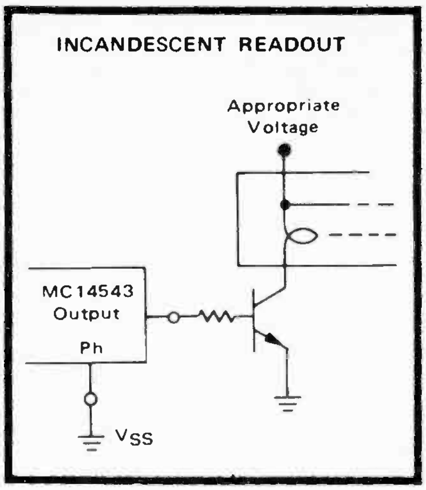


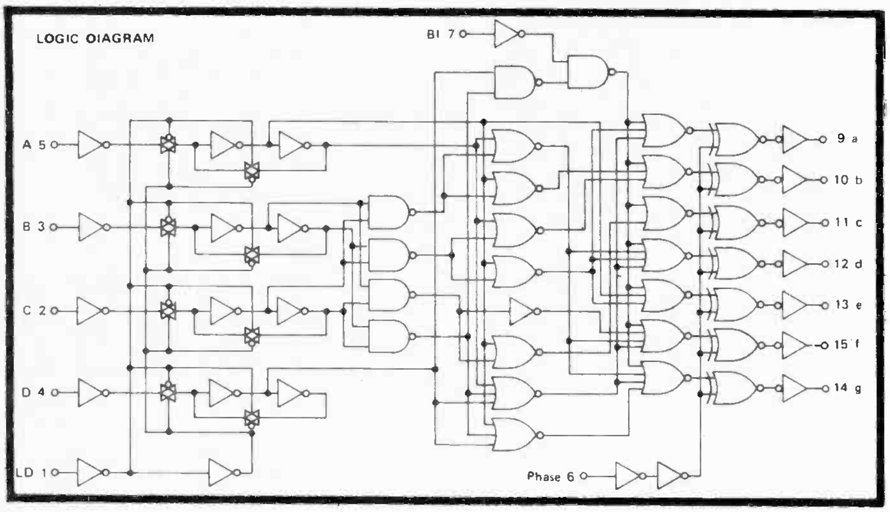
The MC1453 BCD-to-seven segment latch/decoder/driver is designed for use with liquid crystal readouts, and is constructed with complementary MOS (CMOS) enhancement mode devices. The circuit provides the functions of a 4-bit storage latch and an 8421 BCD-to-seven decoder and driver.

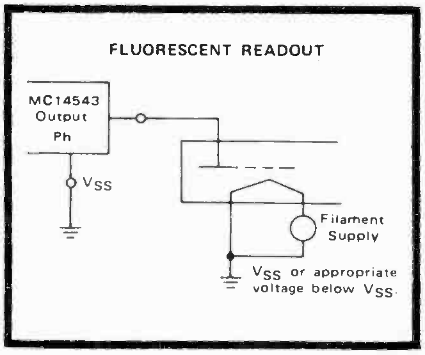
In order to drive LCD displays, which require a non-polarised drive, the MC 14543 has a 'phase' input. With a square wave applied to this pin, the output phase reverses in step, thus satisfying the requirement. To drive common anode LED displays, Ph input should be held high, and low for common cathode LEDs. Other display types can be driven, but with transistor interface.

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leqslant (V_{in}$ or $V_{out}) \leqslant V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

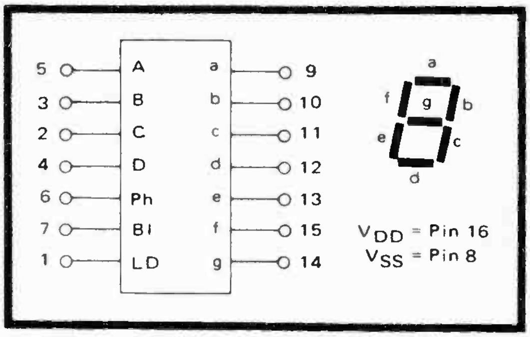






ELECTRICAL CHARACTERISTICS

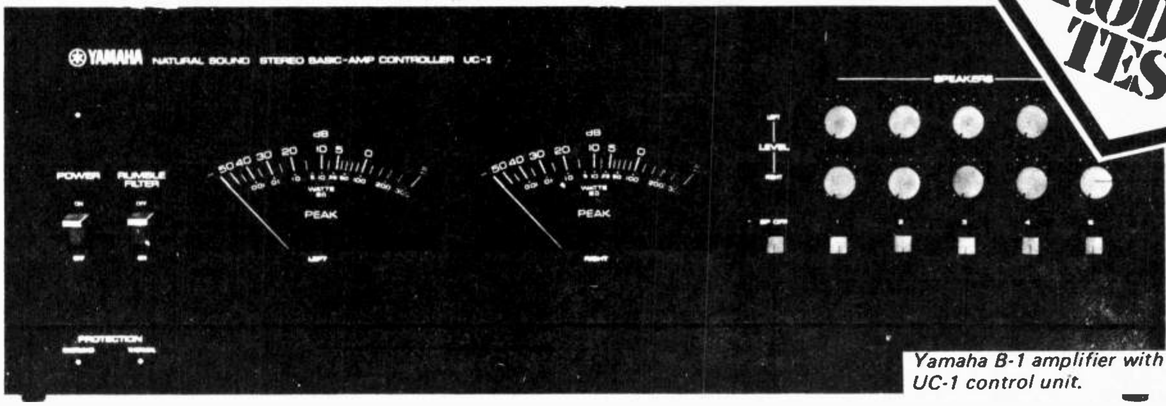
Characteristic	V_{DD} Vdc	MC14543CL/CP +25°C Min	Typ	Max	Unit
Output Voltage "0" Level	5.0	–	0	0.01	Vdc
	10	–	0	0.01	
	15	–	0	–	
"1" Level	5.0	4.99	5.0		
	10	9.99	10		
	15		15	–	
Noise Immunity*					
($V_{out} \geqslant$ 3.5 Vdc)	5.0	1.5	2.25	–	Vdc
($V_{out} \geqslant$ 7.0 Vdc)	10	3.0	4.50		
($V_{out} \geqslant$ 10.5 Vdc)	15		6.75	–	
($V_{out} \leqslant$ 1.5 Vdc)	5.0	1.5	2.25	–	Vdc
($V_{out} \leqslant$ 3.0 Vdc)	10	3.0	4.50	–	
($V_{out} \leqslant$ 4.5 Vdc)	15		6.75		
Output Drive Current					
(V_{OH} = 2.5 Vdc) Source	5.0	-0.20	-1.9		mAdc
(V_{OH} = 9.5 Vdc)	10	-0.20	-1.0		
(V_{OH} = 0.5 Vdc)	10		-9.7		
(V_{OH} = 13.5 Vdc)	15		-3.9		
(V_{OL} = 0.4 Vdc) Sink	5.0	0.20	0.78		mAdc
(V_{OL} = 0.5 Vdc)	10	0.50	2.0		
(V_{OL} = 9.5 Vdc)	10		11.4		
(V_{OL} = 1.5 Vdc)	15		7.8		
Input Current			10		pAdc
Input Capacitance			5.0		pF
Quiescent Dissipation**†					mW
(C_L = 15 pF, f = 0 MHz)					
P_D = (4.8 mW/MHz) f + 0.000025 mW	5.0		0.000025	0.25	
P_D = (19 mW/MHz) f + 0.00010 mW	10		0.00010	1.0	
P_D = (43 mW/MHz) f + 0.00023 mW	15		0.00023		
Minimum Latch Disable Pulse Width (Strobing Data)					ns
	5.0		125	375	
	10		50	150	
	15		40		



INPUTS LD	BI	Ph*	D	C	B	A	OUTPUTS a	b	c	d	e	f	g	Display
X	1	0	X	X	X	X	0	0	0	0	0	0	0	Blank
1	0	0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	1	1	0	0	0	0	1
1	0	0	0	0	1	0	1	1	0	1	1	0	1	2
1	0	0	0	0	1	1	1	1	1	1	0	0	1	3
1	0	0	0	1	0	0	0	1	1	0	0	1	1	4
1	0	0	0	1	0	1	1	0	1	1	0	1	1	5
1	0	0	0	1	1	0	1	0	1	1	1	1	1	6
1	0	0	0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	0	0	1	1	1	1	1	0	1	1	9
1	0	0	1	0	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	0	1	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	1	0	0	0	0	0	0	0	Blank
0	0	0	X	X	X	X	**							**
↑	↑	↑	↑				Inverse of Output Combinations Above							Display as above

YAMAHA B-1

ETI PRODUCT TEST



Yamaha B-1 amplifier with UC-1 control unit.

VERTICAL FET POWER AMPLIFIER

PRODUCES OVER 200W PER CHANNEL — AND IT'S CLEANER SOUNDING THAN VALVES

CONVENTIONAL POWER OUTPUT transistors produce a fairly high level of distortion as a result of the non-linearity of their transfer characteristics. In fact transistor manufacturers have been searching for many years for a solid state device which would have characteristics more nearly equivalent to the hitherto ubiquitous tube.

Professor J. Nishizawa's development of the field effect transistor provided the break-through that had long been sought. The characteristics of these FET s, when compared with the conventional bipolar transistor, are firstly the elimination of carrier storage effects, reducing switching or notch distortion when used in Class AB or B power stages, and extremely rapid rise and decay times. High order harmonic distortion is dramatically reduced because of the squareness of the transfer characteristics and the power drive requirements are extremely low.

Unlike bipolar transistors, when the temperature rises the quiescent current decreases and so the big drawback of bipolar transistors, thermal runaway, is very conveniently avoided. When placed in a power output stage of a power amplifier this provides the opportunity to develop extremely low open loop distortion and, in theory, almost the ultimate in power amplification characteristics.

The B-1 Power Amplifier is a braggart's delight! It's bigger, heavier, more powerful (within limits) and has better performance than any other power amplifier in its class that we have ever tested. It also has many most valuable features that are not commonly encountered.

The B-1 unit is a big ventilated black box on which are mounted a power ON/OFF switch, two speaker level controls and three LED s indicating the operation of the overload protection, the state of the thermal overload protection and power ON/OFF.

These controls are set in an anodised aluminium panel which is readily removeable to enable it to be interchanged with a Basic Amp Controller UC-1 which includes two large peak level meters with the unusually wide dynamic range of −50 dB to +5 dB. These are also calibrated in terms of watts into an 8 ohm load; i.e., a range of up to 0.01 W to 300 W. This unit allows the connection of any one or more of up to five pairs of stereo speakers each with its own pair of individual pre-set level controls, the load terminals for which already exist on the rear panel of the main amplifier.

PROTECTION RACKET

Main amplifier features include completely separate power supplies for left and right channels and a third power supply for the relay control functions.

These are activated via a relay from the front panel power switch such that when the power is switched on the speaker protection muting circuit operates to disconnect the speaker loads until the amplifier voltage conditions have stabilised.

There are two separate protection circuits whose operation is indicated on the front panel. These are, firstly, thermal protection — designed to cut off the power supply if there is any danger in any circuit elements rising to a temperature exceeding 100^{o}C: simultaneously, the speaker protection circuit will be activated cutting off the sound. This circuit is self re-setting when the internal temperature returns to a safe level. A second protection circuit operates on overloads resulting from three distinct conditions. Firstly, the speakers are disconnected if a DC level exceeding ±2 volts is detected at the out output terminals. Secondly, the muting circuit already mentioned is activated immediately following power turn-on to eliminate loudspeaker thumps and thirdly, the power supply is disconnected whenever an abnormal voltage or current is detected in the output

YAMAHA B-1
VERTICAL FET POWER AMPLIFIER

circuitry. This provides amongst other things protection against short circuits on the output or loads of less than 4 ohm impedance. This feature may preclude the amplifier being used with some 4 ohm speakers — the impedance of which falls to well below 4 ohms at some frequencies.

A rumble filter with a 12 dB per octave filter (below 10 Hz) protects the loudspeakers from low frequency transients. The control switch for this filter is at the back of the unit.

MEASURED PERFORMANCE

Our past experience with Yamaha products has been that the manufacturer's specification is generally bettered. The Yamaha B-1 was no exception. It has a frequency response which was +0 −0.4 dB from 10 Hz to 122 kHz, a straight line on a level recorder. The manufacturer's power ratings were easily exceeded, both with 8 ohm and 4 ohm loads, being 210 watts into an 8 ohm and 220 watts into 4 ohm with both channels driven. The power bandwidth was 5 Hz to 50 kHz — precisely as stated by the manufacturer.

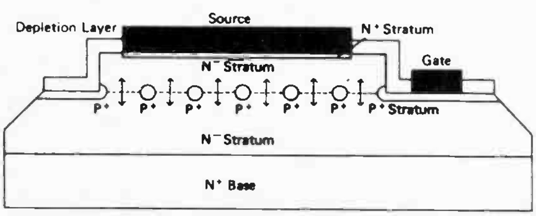
Distortion is very low indeed — over most of the frequency and power output range the unit introduced no

MEASURED PERFORMANCE OF YAMAHA B-1 POWER AMPLIFIER – SERIAL NO. 2869

Frequency Response:	−0.4 dB at 10 Hz and 122 kHz			
	−3.0 dB at 2.3 Hz and 122 kHz*			
Power at Clipping Point:	210 watts (8 Ω 1 kHz)			
(Both channels driven)	222 watts (4 Ω 1 kHz)			
Power Bandwidth:	5 Hz:	144 W	8 Ω	0.13% THD
	50 kHz:	105 W	8 Ω	0.3% THD
Total Harmonic Distortion:			100 Hz	0.03%
(Both channels driven)	100 W	8 Ω	1 kHz	<<0.01%
			6.3 kHz	0.07%
			100 Hz	<0.03%
	1 W	8 Ω	1 kHz	<0.03%
			6.3 kHz	0.04%
Noise:	−99 dB re max. power i.e. 0.46 mV			
	−106 dB (A) " "			
Hum	−126 dB " "			
Sensitivity:	60 mV input gives 1 watt (8Ω)			
Input Impedance:	92 kΩ at 1 kHz			
Output Impedance:	0.08 Ω at 1 kHz			

*Max measurable frequency with test gear used.

YAMAHA VERTICAL FET CONSTRUCTION

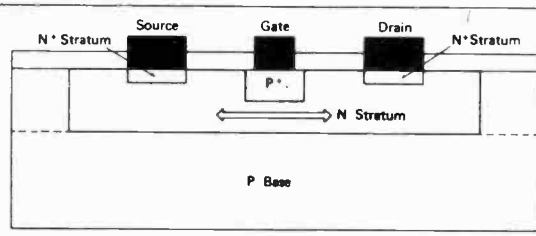


Arrows show current flow direction

As the vertical FET illustration below shows, the source, gate and drain are aligned vertically, permitting much higher power capacity. Each element of the mesh is, in effect, equivalent to an independent FET; a single Yamaha vertical FET contains tens of thousands of such elements.

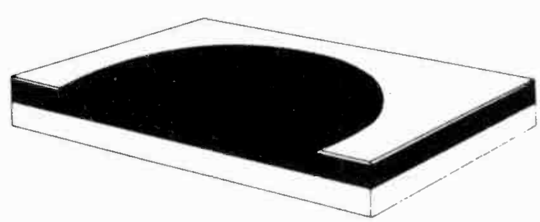
The mesh itself measures 5-10μ across. To assure highest possible drain-source and drain-gate breakdown voltage, impurity concentration is reduced to a level far below any previous semiconductors, through a special epitaxial layer formation method.

Conventional FET Construction



Arrow shows current flow direction

Yamaha Vertical FET Mesh Configuration



increase in distortion beyond the inherent distortion of our measuring system.

Yamaha conservatively state that at one watt output, the distortion at 1 kHz is 0.03%—and 0.04% at 20 kHz. Our findings indicated that under those conditions the distortion was respectively less than 0.02% and less than 0.03% respectively. At 100 W output the distortion was very much less than 0.01% (being typically less than 0.005%) and at 6.3 kHz it was a precise 0.07%.

Until recently it was generally believed that ultra-low distortion levels were irrelevant.

Nevertheless there is increasing evidence that basic design improvements such as those incorporated in the Yamaha B-1 amplifier result in audible improvements — even though these improvements are not necessarily measurable by standard steady-state test methods.

Noise was found to be −99 dB with respect to maximum output or, if you prefer it, less than half a millivolt at the output terminals. Hum was an extraordinarily low −126 dB with respect to maximum power output.

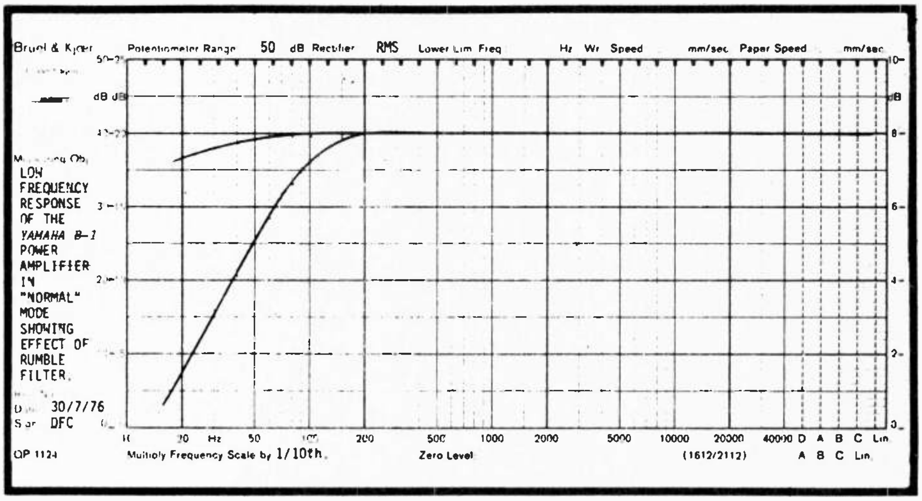
SUMMARY

As hard as we tried we could in no way fault the performance of this unit, except lamely to say that when we picked it up we found it too heavy!

Currently research shows that amplifiers offering higher linearity with lower levels of inverse feedback offer very good transient performance.

We think, but cannot prove, that the subjective performance of this unit is better than other amplifiers using conventional bipolar transistors but must honestly say that we have not positively proven it so, on the basis of instrumental measurements.

Let's just say that we believe the B1 is the cleanest performing amp we have ever heard. ●



KNOW IT ALL, HUH?

We are looking for someone to work on the editorial of ETI-Canada in Toronto.

As it's far easier to teach someone the journalistic side than the electronics side, it's an electronics person we're looking for.

Prime qualifications are a genuine interest in electronics with a bias towards the hobby side. A fair knowledge of modern circuitry, components and developments is also necessary but we're not looking for a designer and many enthusiasts have the necessary knowledge.

The work will consist of some writing, some research, some working on other people's originals. The name of the game is accuracy: presenting information in the most readable form and making sure it's correct.

We've no strong views on age but guess the successful applicant will be in his/her twenties. Salary is negotiable. Incidentally, this is not just a 'prestige' ad — it's genuine and it certainly isn't just put in to fill an odd space!

Apply in writing, with resume, as soon as possible to:

The Publisher,
Electronics Today International,
Unit 6,
25 Overlea Boulevard,
Toronto,
Ontario,
M4H 1B1.

Then we'd like to have a word with you.

ETI project 570

REACTION TESTER

Measuring the speed of your reactions can be fascinating. Our project not only allows you to do this to a considerable degree of accuracy, but allows for competition between two players.

THE MOST NOTICEABLE EFFECT of a night on the town, apart from the revolving universe, is the immediate slowing up of a person's reaction time. The project to be described here will give an indication of that time, measured to 1/100ths of a second.

There are two possible versions of the project; which one you build depending on the usage or abusage you intend to subject the unit to. The 'standard' version if you like, is the TTL circuit of Fig.1, which can be run from a battery pack as a portable unit.

PLAYING THE GAME

The tester provides an intriguing party game which will cause many an argument. It is set up as a contest between two people, with indication of who has won - and the winning time. It might be an idea to take some readings on the known drinkers at the start of that party - and when their reactions have slowed to half, pack 'em off in a taxi!

Playing the game is simple. The contestants man the switches on the front panel, and a 'referee' takes the remote start switch. By pressing this he lights the 'GO' lamp on the panel, and starts the timer. Whichever of the players pushes his button first, lights his own 'WIN' lamp, and stops the count at his/her reaction time.

CONSTRUCTION

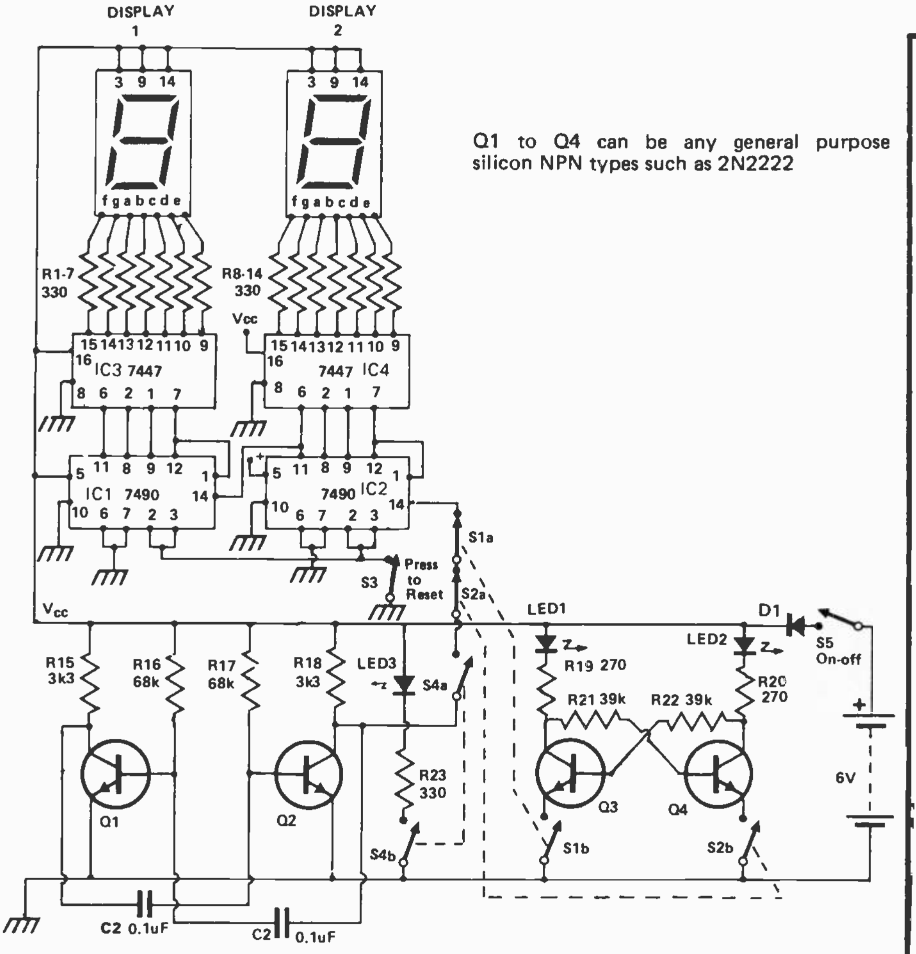
Building up the 'standard' version is best done by constructing the display and counter sections first. Check the former by applying a high level to pins 7, 1, 2, 6, in turn of ICs 3 and 4. The numbers 1, 2, 4 and 8 will appear on the display if all is well.

Remove the 'decimal point' pin on the displays, this will vary from type to type, ours were DL707s. This aids location on the P.C.B. The lead from the hand-held unit to the main unit *must* be screened - four-core individual screen recording lead is ideal - otherwise stray capacitance can 'clock' the 7490 without the switch being operated. Ground one end to pin 2 of the socket on the unit, and the switch end to the output (ground) side.

We used a plastic box for the remote button. If you are going to use a line supply, check the output of this before applying Vcc to the circuitry. Too high (>7V) will send the logic to join its ancestors on that great breadboard in the sky.

Possible modifications and additions to the basic unit are legion. We originally used a 7400 as the oscillator, but settled on the discrete circuit for simplicity. No doubt the logic hounds will return it, but watch out for resistance values, no higher than 20k with TTL. The frequency is a little low for TTL to be entirely at home in any case.

A 'self-test' facility could be added, using an 'almost random' start circuit employing say, a 7413 device. Wire three of the inputs to the gate high, by a potential divider, and the fourth goes to the mid-point of a series R-C combination across the supply. Make the R variable, then if the C is large enough, an appreciable time will elapse until the voltage at the fourth input rises enough to turn on the gate. When it does the Schmitt will turn hard on, and provide a suitable pulse to gate the output of the oscillator into the counter. Leave the pot uncalibrated, and there really is no way of knowing



Q1 to Q4 can be any general purpose silicon NPN types such as 2N2222

Fig. 1: Circuit Diagram of the Tester.

How it works

If we begin with the display driver/counter section, we see that the counting is done by two cascaded 7490 devices. These are working as ÷10 BCD counters, and the outputs feed two 7447 BCD decoders/display drivers. The input pulses, 4.2V p-p square waves, are generated by Q1 and Q2 in a multivibrator mode at a frequency of approximately 100Hz. Greater accuracy can be obtained by making one of the charging resistors (R16 or R17) variable, and tuning the oscillator to exactly 100Hz. In this way the tester will read exact reaction times, ±.01 secs.

When the 'Go' button is pressed, green LED3 in the front panel lights, and pulses are fed into the counter chain. When either contestant's switch (S1a, S2a) is pushed, the link between oscillator and counter is broken and the counter will 'hold' the number of pulses that have entered i.e. time in 100ths of a second.

At the same time S1b and/or S2b operate the 'Windicator' circuit comprising Q3 and Q4. Either one of the LEDs can lock on turing off the other transistor, and so ensuring only one light can be on at any given time - that corresponding to the first button pushed. Diode D1 serves both as a voltage dropper to bring Vcc down to a logic supply level (5.4V) and also to prevent damage due to supply reversal.

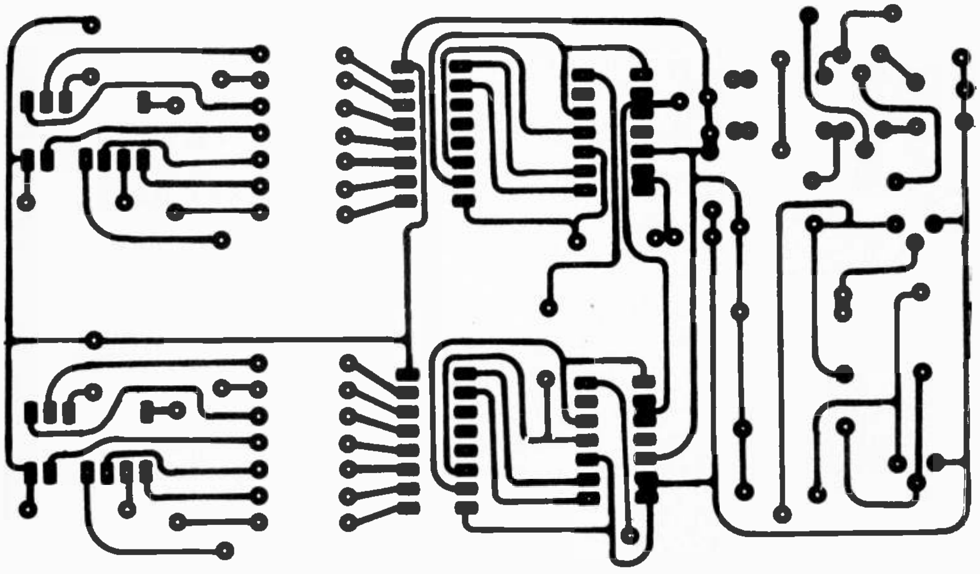
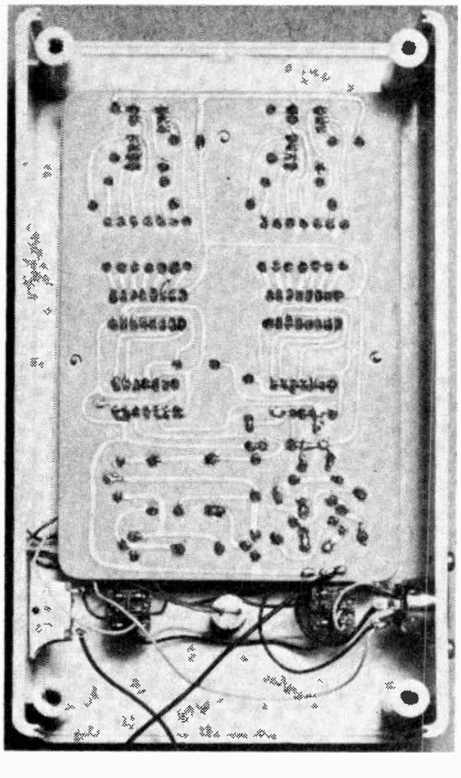


Fig. 2: PCB foil pattern — full size.



REACTION TESTER

Parts List

Resistors
R1-14, 23 330R
R15, 18 3K3
R16, 17 68K
R19, 20 270R
R21, 22 39K
All ¼W 5%

Capacitors
C1, 2 0.1μF minifoil etc.

Transistors
Q1,2,3,4 2N2222 or similar

Diodes
D1 IN 4001 or equivalent
LED 1, 2 RED 0.2"
LED 3 GREEN 0.2"

Integrated Circuits
IC1, 2 7490
IC 3, 4 7447

Switches
SW1, 2 Double Pole Changeover—Push On, Push Off.
SW3 Single Pole, Single Throw—Push to Break, non locking.
SW4 Double Pole Changeover—non locking.
SW5 Single Pole, Single Throw—rocker type.

PCB ETI 570 – $5.85 post paid from CANMOS, PO Box 1690, Peterborough

Misc
I.C. sockets
Battery holder to suit
(Use 4 x Type C Alkaline version)
Boxes to suit

5 pin chassis skt
5 pin in-line plug
1m 4 core individual screened lead
Board spacers etc.

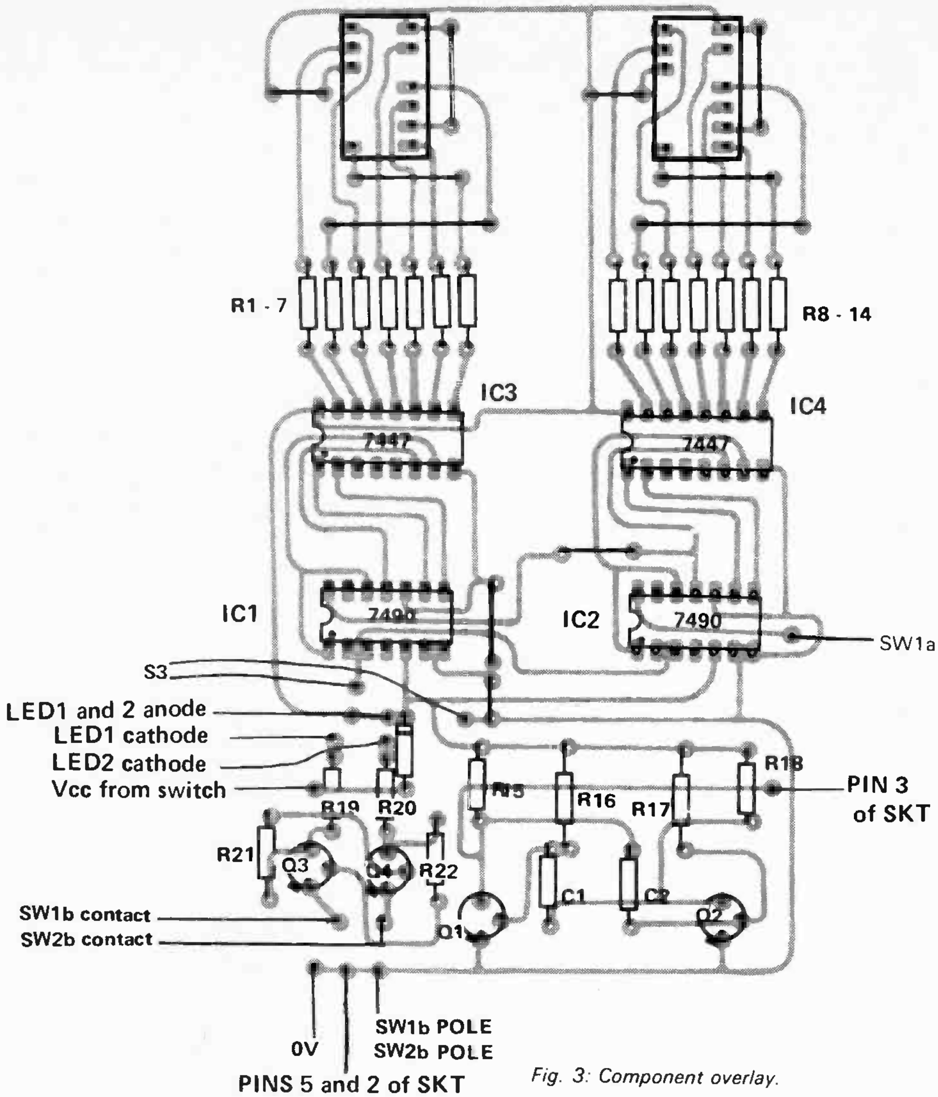
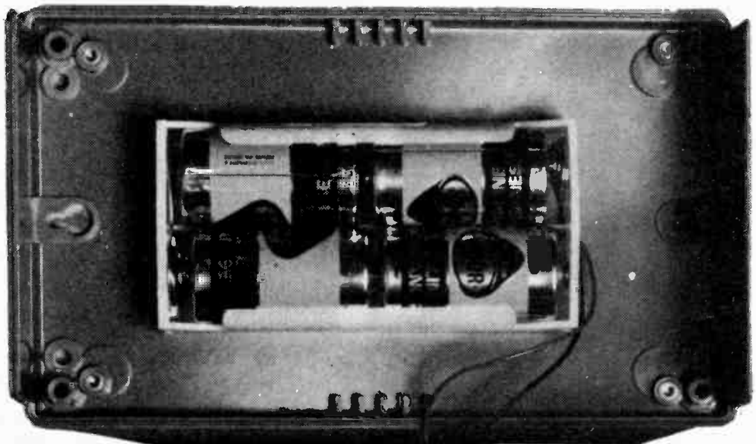


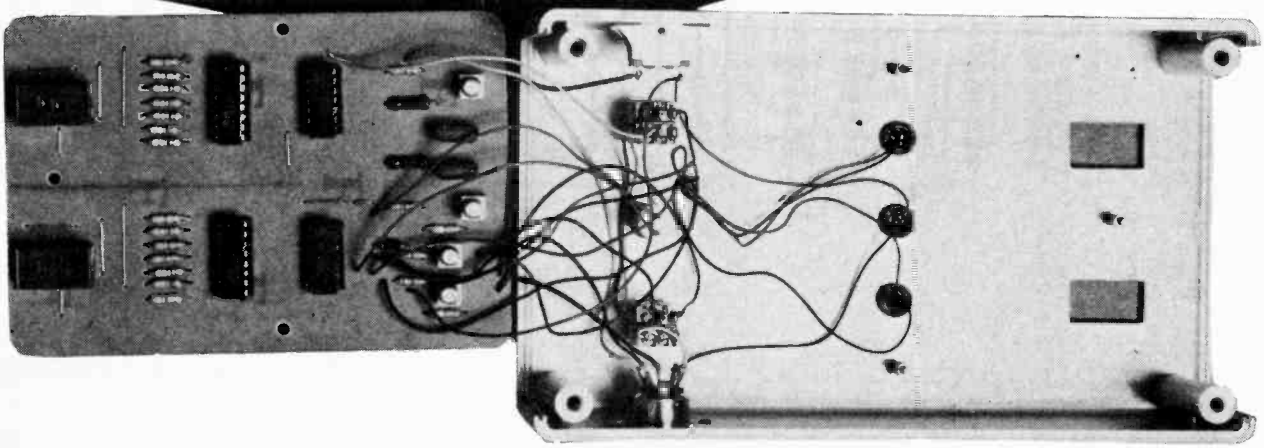
Fig. 3: Component overlay.



exactly when the circuit will fire the LED Anyway we offer the idea for experiment - no guarantees!

By speeding up the clock oscillator to 1kHz, and adding a third 7490/7447 stage, timings can be taken in 1/1000ths of a second, or up to 9.99 seconds, depending on which end you add it! If anyone takes 9 seconds to find the button - call the undertaker.

Many more ideas will undoubtedly occur to the constructor - it is a case of knowing where to stop.



NEW SERIES

SHORT CIRCUITS

This new series will describe straightforward projects but they are not necessarily simple in their operation or aimed at the beginner. We plan to carry between two and four such projects each month.

PATCH DETECTOR

THERE IT STANDS: gleaming. On the surface, a secondhand car in really good nick but think! Modern materials, especially resin body filler and a quick paint job with the spray gun can make a rusty heap look like a new car.

Our Patch Detector will quickly find areas of the body-work which have been filled — or even patched with aluminum.

Only a handful of components are used. The key to the operation is the transistor output transformer; we used several types and they all worked without any difficulty.

It is necessary to modify the transformer. First remove the shroud over the laminations. Then, using a pair of fine-nosed pliers carefully remove the laminations, These are held together by wax: the first lamination may be

Parts List

Q1	Transistor	2N2222 etc
R1	Resistor	47k ¼W
C1	Capacitor	0.1µF disc ceramic etc
C2	"	0.018µF "
C3	"	100µF 12V electrolytic
T1	Armaco AT 49 (Electrosonic)	

Earphone: 8Ω type, 3.5mm jack plug
Earphone socket, 3.5mm
PCB to design shown
Small plastic box
Eveready 216 and connector

How it works

The circuit is a Hartley oscillator using an AT49 as the inductor. The primary of T1 is tuned by C1 and feedback is provided by C2. The secondary of T1 connects via the socket/switch to the earphone.

Due to the modification of the transformer, when metal is brought near to the open end of the E laminations this alters the inductance of the primary and consequently the frequency of the note produced.

C1, C2 and R1 all affect the note produced and as long as R1 is not reduced below 33k, these may be modified to give the desired frequency. Current drain from the battery will be between 5 and 10mA.

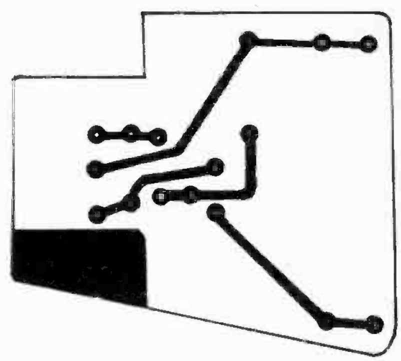


Fig. 3. PCB foil pattern — full size.

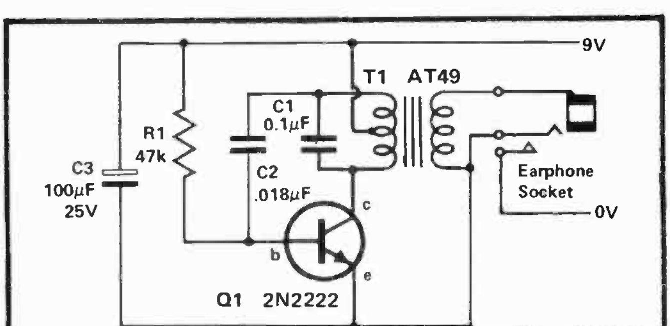


Fig. 1. Circuit diagram of the detector.

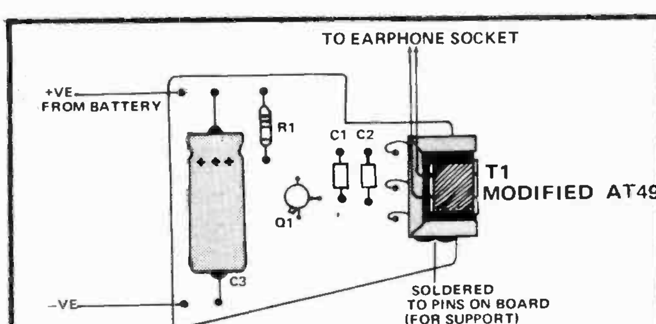


Fig. 2. Component overlay.

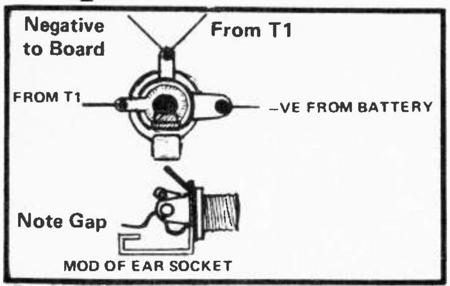


Fig. 4: The wiring and modifications to the earphone socket

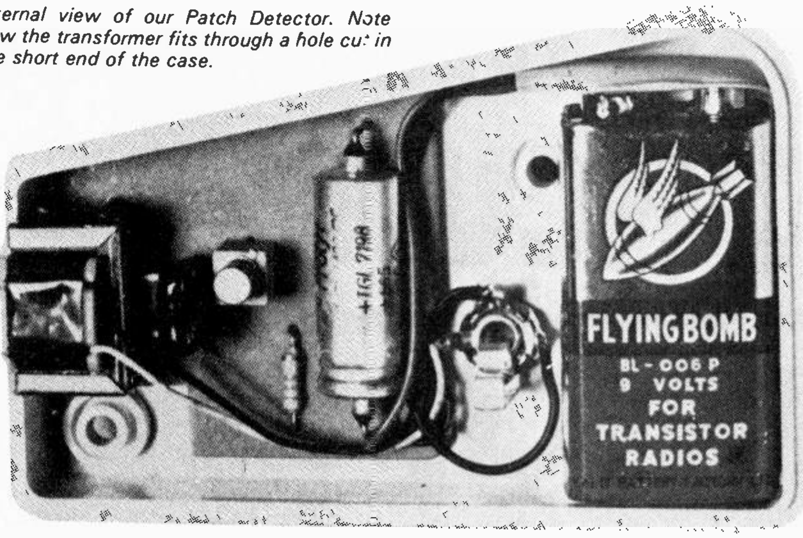
tricky to remove but thereafter you won't have any difficulty. The laminations in the AT49 (and the others we tried) are E shaped with a bar enclosing the exposed end, they are layed alternately.

When all the laminations have been removed reassemble them all the same way round to form an E. Fit this back into the transformer and replace the shroud.

We used a small plastic hand - held box and built a small PCB to hold the components. The transformer can't fit directly onto the PCB so two thick wires are soldered to the shroud, these in turn are soldered to the PCB, this effectively stands the transformer away from the board.

A hole is necessary in one end of the plastic box to take the transformer's face; the open ends of the E should face out.

Internal view of our Patch Detector. Note how the transformer fits through a hole cut in the short end of the case.



The circuit is simple and will only be used with an earphone so an on-off switch will just complicate matters Instead the switch section of the earphone socket is bent so that it switches on when the earphone is inserted.

An Eveready 216 will fit nicely across the end of the box if one of the plastic buttresses on the pillar and two pips inside the same area are cut away.

The circuit is really a simple metal locator. In free air an audio tone is heard but when run along the body of a car the note is lower. When filler is encountered the note rises: even aluminium causes note change. There is no danger of the unit scratching the paintwork as the only thing to touch the bodywork is the soft plastic of the transformer's former.

A change in note can be detected when sheet steel is about 10mm (3/8in) from the laminations. Greater sensitivity is not an advantage incidentally. ●

HEADS OR TAILS

THE MULTIVIBRATOR IS ONE OF the most commonly-used circuit blocks in electronics – especially in digital circuitry. And the multivibrator forms the basis of this 'head or tails' project.

The multivibrator is a basic form of square-wave oscillator which in our design runs at about 700Hz whenever the push-button is pressed. When the button is released the oscillator will stop and the circuit will assume one of the two possible stable states. Either Q1 will be conducting and Q2 will be cut off, or Q2 will be conducting and Q1 will be cut off. Whichever transistor is conducting draws enough current down through the resistor and the light-emitting diode (in series with its collector) to cause the LED to light.

Notice that the circuit is symmetrical and that the two transistors are cross-coupled between their collectors and bases (via R3, C1 and R4, C2). If corresponding components on each side are matched there is equal probability of either transistor being on when the button is pressed. However, electronic components do not have exactly the values they are supposed to have so it is necessary to include potentiometer RV1 to adjust for equal probability. Alternatively it may be useful to maladjust RV1 so that the effect of bias on the results can be assessed.

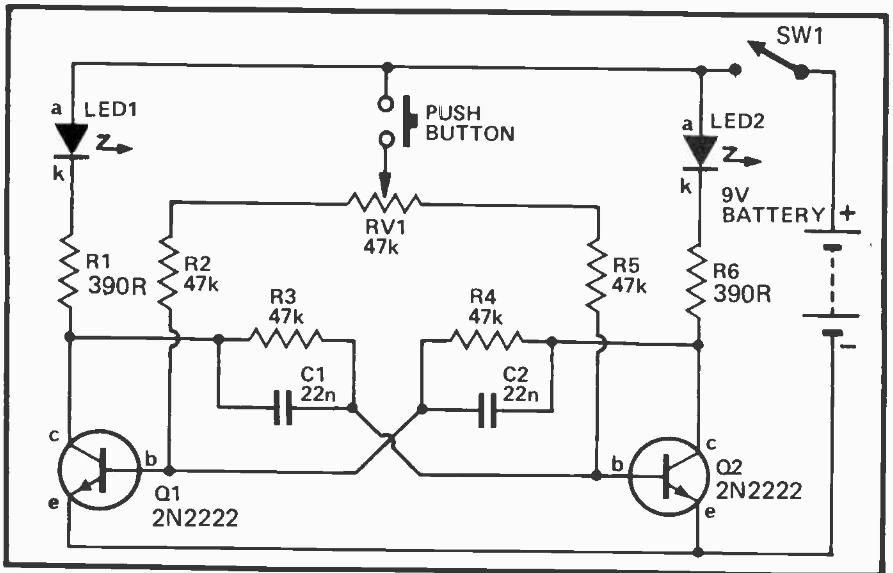
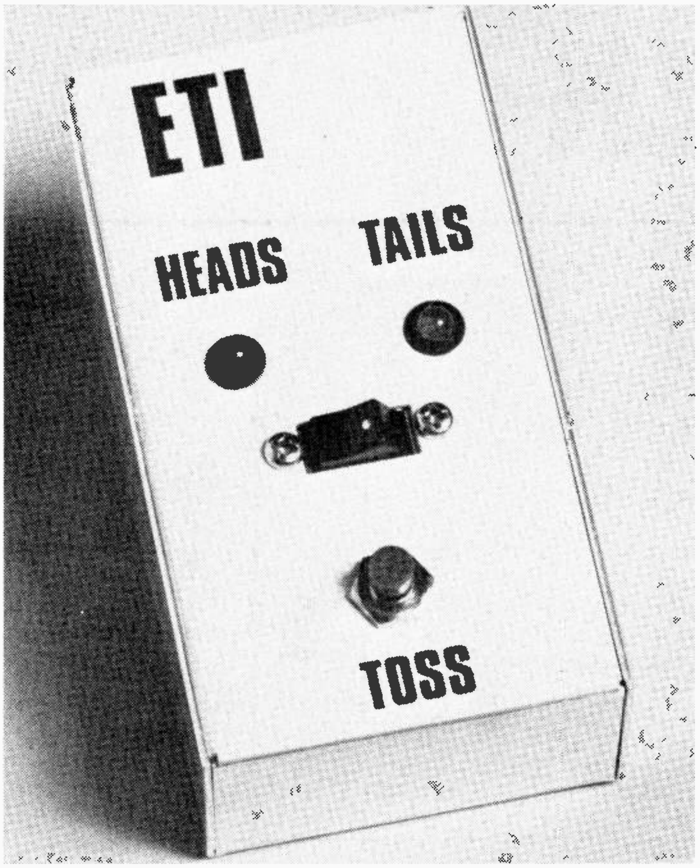
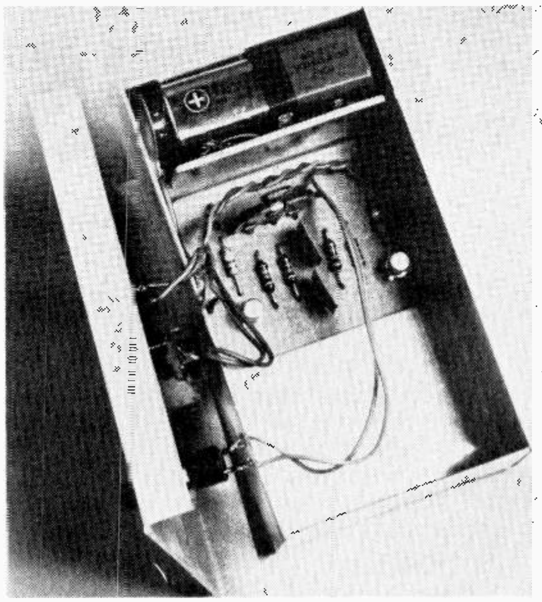


Fig 1: The circuit of our Heads-or-Tails unit.

When either Q1 or Q2 is on, as said before, the associated LED will be on





Internal view of the completed unit.

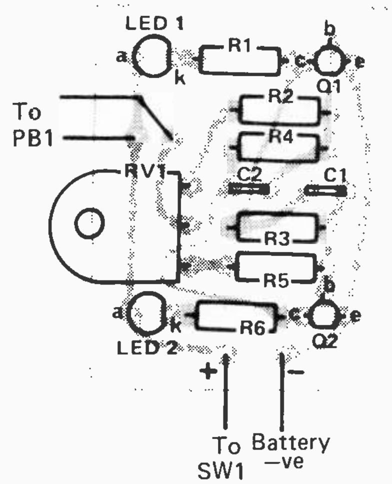


Fig. 3: The component overlay.

Parts List

R1	Resistor	390R ¼w 5%
R2-5	Resistor	47k ¼w 5%
R6	Resistor	390R ¼w 5%
RV1	Potentiometer	47k trim
C1,2	Capacitors	22nF polyester
Q1,2	Transistors	2N2222
LED 1,2	Light emitting diodes (large type)	
P.B.1	Press to make	
S.W.1	On/off switch	
Battery	PP3	
Battery clip		

Aluminum box 4 x 2 x 1½ ins.
PCB to design shown.

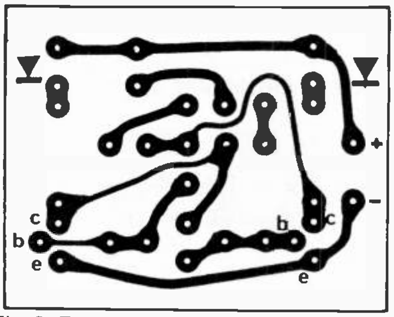


Fig. 2: The PCB layout. Full size 50 x 40mm.

How it works

This circuit may be considered as a multivibrator, when the button is pressed, and as a flip flop when the button is released. If initially we consider the circuit with R2, R5, C1 and C2 deleted we have a standard flip flop. If Q1 is on, it robs current from the base of Q2, thus turning it off. Transistor Q1 will be held on by the current through R6 and R4. However, if Q2 is on, the reverse is the case. Thus only one of the transistors can be on at any time - never both.

The addition of R2, R5 and C1, C2, will not alter the above, providing the push button is not pressed. However if the button is pressed the current through R2 and R5 will try to turn on both transistors.

Take the case where initially Q1 is on and Q2 is off. The voltage on the collector of Q1 will be about 0.5 volts and the voltage on Q2 collector, about seven volts. We therefore have about 6.4 volts across C2 (as the base of Q1 is at about 0.6 volts). When the button is pressed Q2 will turn on and its collector will drop to 0.5 volts.

However a capacitor cannot instantly change its voltage and the base of Q1 will therefore be forced to −5.9 volts which turns off the transistor. Capacitor C2 then discharges via R2 and R4 until the base voltage is again at +0.6 volts when Q1 will turn on again. This however forces the base of Q2 to −5.9 volts (due to C1) thus turning Q2 off. This process continues back and forth until the push button is released. The circuit then stops in the state it was at the instant of releasing the button.

To add bias to the circuit RV1 can be adjusted to change the discharge time of C1 or C2 by up to 50%. In this case the two transistors will not be on for equal times and the results will be biased towards one side.

LEDs are included in the collector circuits of each transistor to indicate which transistor is on. If, for display purposes, a slower-running unit is required the values of C1 and C2 may be increased. If both are 10 microfarad electrolytic capacitors the rate will be about 1.5 seconds. Make sure if electroytics are used that the positive terminal is connected to the collector of the transistor.

and this gives us our 'heads' or 'tails' indication. When the button is pressed, however, the LEDs are switched on and off alternately at a rate of 700Hz. The switching cannot, of course, be seen due to the limited flicker-frequency response of the eye. Both LEDs will therefore appear to be illuminated.

CONSTRUCTION

The unit can be assembled onto a small printed-circuit board such as that illustrated.

The main points to watch are that the transistors are correctly orientated and that the LEDs are wired correctly.

The unit should be thoroughly checked — a transistor or LED can be destroyed if it is wrongly connected. Double-check the battery connection — a reversed battery can also destroy semiconductors. ●

Short Circuits

SCR TESTER

SCRs ARE INCREASINGLY being used for power control in mains circuitry (e.g. sound-to-light converters and drill speed controllers) and also in battery circuits (e.g. flash triggers). Testing any semiconductor can be a bit of a problem if you have to set up a test board to do the job, so that there are now many circuits available for transistor testers. Now, here's a simple SCR tester which will give an instant indication of a faulty device.

CONSTRUCTION

As can be seen from the circuit there are only a handful of components but we opted to mount most of these onto a small tag-board; there are almost as many components on the front panel, however.

SCRs come in a variety of encapsulations; the small ones are usually in TO5 cans and a socket is fitted to the front panel to accept these directly. Other types are not suitable for plugging in so the connections to the socket are taken to three sockets into which extension leads with alligator clips can be plugged.

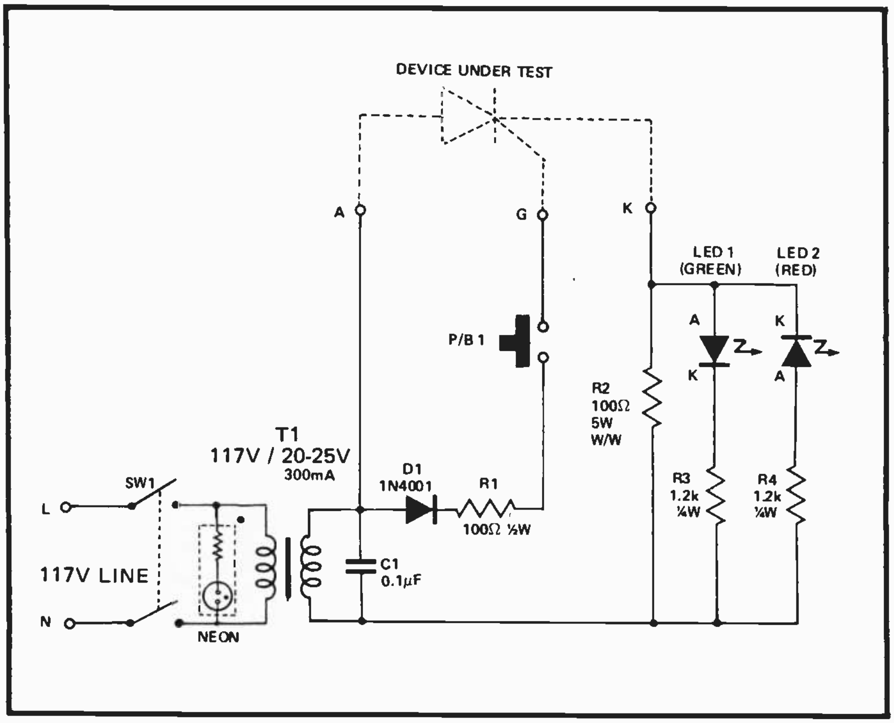


Fig. 1: Circuit of the SCR Tester.

How it works

On switch on, assuming a good SCR, there is approximately 20V AC across the SCR, but it does not conduct so that with no current flowing through R2, no volts are dropped across it, hence neither LED will light. When P/B1 is pressed, thyristor gate current will flow, and the thyristor will turn on when the anode is positive with respect to the cathode. Thus, for half of each cycle, current will flow through R2, so that LED1 will light up.

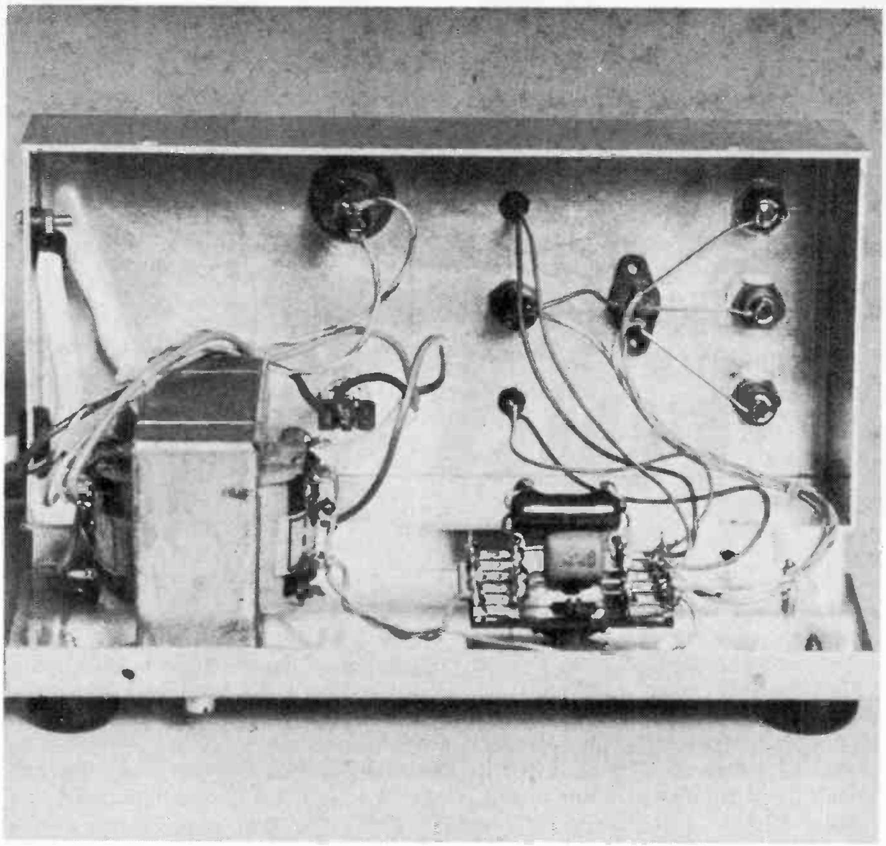
If both LEDs light up, this means that the SCR is conducting both ways, i.e. internally short circuiting. If neither LED lights up, when PB1 is pressed, the SCR has failed open circuit.

Parts List

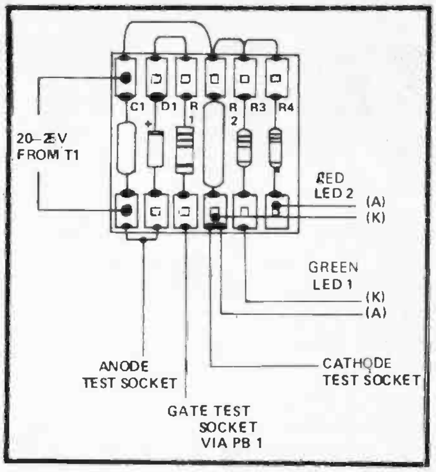
T1	117V — 25V .3A min. trans		
NEON	240V TYPE		
C1	0.1μF 160V		
D1	1N4001		
R1	100R	½W	
R2	100R	5W	W/W
R3, 4	1k2	¼W	
LED 1	GREEN	TIL 209 TYPE	
LED 2	RED	TIL 209 TYPE	
PB 1	Push to test type		
SW1	OFF/ON mains toggle		

TO5 Transistor test socket, banana sockets, mains cable, miniature tag board, feet.
Aluminum case (6 3/8" x 2 7/8" x 1 7/8") (162 x 73 x 48mm)
2 'standoffs' ½in.
Nuts and bolts.

The completed unit is built into a strong aluminum box.



The majority of the components can be wired to a small tag board.



Test gear tends to be mishandled and a nice strong aluminum case is advisable in view of the propensity of small test gear to disappear under piles of components at the back of the workbench.

In a no-go condition, both LEDs will light under a short-circuit condition so don't be misled by the green light being on.

OPERATION

1. Insert SCR.
2. Switch on. If either or both LEDs come on, reject the SCR.
3. Press button 1. LED1 *only* should come on; if anything else happens, reject the SCR.

'Scope test your car

How to use your 'scope to check out a car's carburetion and ignition systems.

AUTOMOBILE ENGINE TUNING IS A grossly misused and misunderstood operation. To many it implies some esoteric knowledge or ability — of listening to an engine and somehow deducing that the ignition must be advanced — or the mixture strength richened a bit on the front carburettor.

In reality it consists almost entirely of ensuring that ignition and carburetion is adjusted to the vehicle manufacturer's specifications.

No more — no less.

But to do this it is virtually essential to use at least some basic instrumentation; a dwell meter, a tachometer, a good exhaust gas analyser — and preferably an ignition analyser.

Many car enthusiasts have at least a tacho/dwell meter — but few have access to an ignition analyser for such devices are costly indeed. Nevertheless if a few limitations are accepted virtually *any* standard oscilloscope can be used as an ignition analyser simply by making a couple of very simple capacitive probes — which can be as simple as clothes pegs and a few square inches of aluminium foil.

An ignition analyser displays waveforms from the primary or secondary side of the vehicle's ignition system. Surprisingly perhaps, this waveform provides information not only about the ignition system in general but also about carburetion, and a number of mechanical conditions.

The analyser can do this because the voltage required to fire a petrol/air mixture in an engine is affected by many different variables including air/fuel ratio, cylinder compression, ignition timing, ignition polarity, spark plug gap and condition etc, etc.

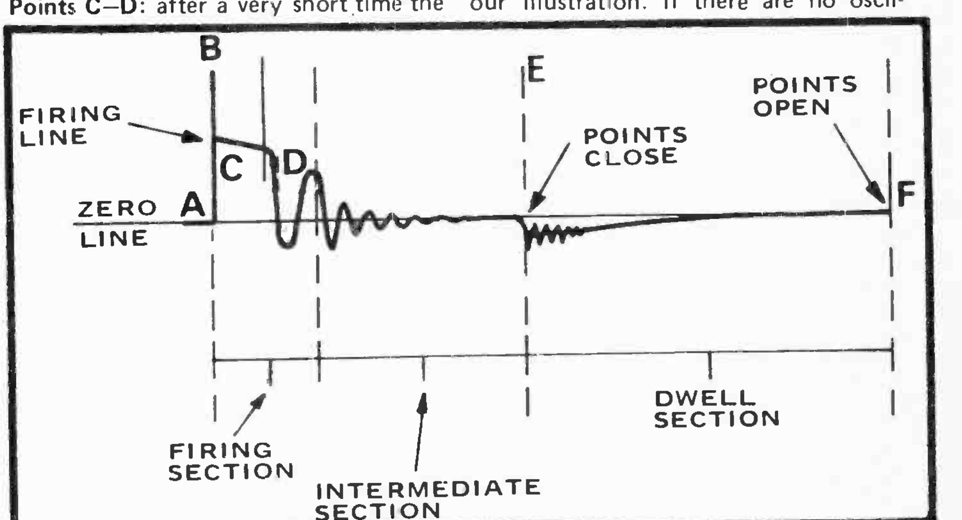
THE SECONDARY WAVEFORM

The simple waveform shown at the beginning of this article is a typical secondary waveform that is derived from the secondary (or high voltage) side of the ignition system. This waveform is the one most commonly used since phenomena occuring in the primary side of the system will be reflected through the coil windings and appear in the secondary pattern.

Point A: is the instant at which the contact points open thus causing the magnetic field to collapse through the coil's primary winding. A very high voltage is thus generated in the secondary winding and this continues to rise — until a spark jumps across the distributor rotor gap and the spark plug gap (point B). The voltage at which this occurs is known as the 'ionization' or the 'firing' voltage and may be anywhere between 5 kV and 15 kV depending on the factors outlined above.

Points C–D: after a very short time the voltage drops substantially but the arc is maintained (point C). The subsequent section from point C to point D is known as the spark line and when viewed on a 'scope the amount by which this line slopes away from the horizontal is directly related to resistance in the plug and coil ht leads (ignition suppression). A slope of 30° or so is OK — if it's more than that then it's worth checking lead resistance with an ohmeter. The total resistance between the centre terminal of the coil and the centre electrode of the plug should not exceed about 20 k assuming the rotor gap is shorted out of course! Actual resistance is not critical but anything more than 30 k may cause problems. Resistance over 50 k almost certainly will.

Point D: the section immediately following the end of the spark line (point D) should be a series of diminishing oscillations. These should appear as our illustration. If there are no oscil-



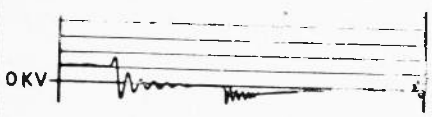
'Scope test your car

lations — or just or or two — then it's a safe bet that there's a shorted turn in the coil. It may not have broken down completely yet but it's a safe bet it shortly will. (See also below).

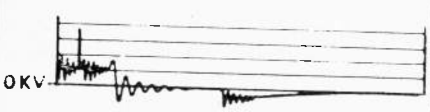
Point E: is where the contact breaker points close. It is essential that there is a gap between the last oscillation of the preceding section and point E for otherwise the diminishing coil energy will be fed into the now closed points thus preventing the coil re-building its magnetic field for the next cycle of ignition.

A great deal may be learnt by studying point E carefully, point misalignment, point bounce, burnt points etc may be spotted at this part of the waveform. The correct waveform at point E should be a short downward line followed by six or so diminishing oscillations.

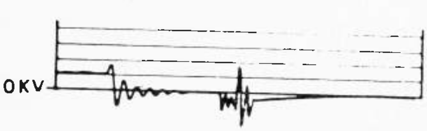
CONTACT POINT INDICATIONS



Unusual point opening signal (note hash extreme right of picture) burnt or arcing points.



Spike on spark line. Point arcing caused by faulty capacitor.



Points bouncing probably caused by weak closing spring.

Points misaligned — or dirty.

Point F: magnetic energy will now build up in the coil until Point F. This is in effect the same point as our previous point A but in the next firing sequence. The section from points E to F is known as the dwell section and should occupy roughly the proportion of the total waveform as shown in our main drawing. Dwell is adjusted by varying the contact breaker gap and should be set using a dwell meter.

SPECIFIC INDICATIONS

Firing waveforms should be observed with the engine warm and running at about 1000 rpm — that is about 400 rpm higher than normal tickover speed.

Check each section of each firing sequence slowly and carefully. The various figures shown in this article indicate how specific faults will show up.

FIRING LINE

All firing lines should be of roughly equal height. If any plug is 10-15% or more higher than the rest, connect a jumper lead to earth and short out at the plug terminal. If the firing line now decreases the fault lies within that cylinder — either a faulty plug or unusually weak mixture (probably caused by a leaking inlet manifold gasket). If the firing line does *not* decrease there is a partial open circuit in the associated plug lead or that lead is not making firm contact with the connector within the distributor cap.

If the firing lines are unequal on a multi-carburettored engine check to see if the lines which are higher correspond to those cylinders fed by one common carburettor. If so it is probable that the mixture from the carburettors is unbalanced. A further but less common fault that may be spotted this way is an eccentric distributor cap — the gap between rotor and distributor contacts being wider on one side than the other.

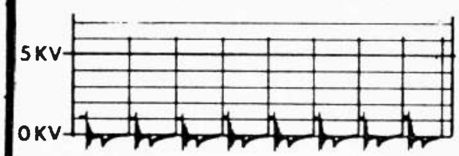
At some time during the check 'snap' the throttle wide open momentarily, meanwhile watching the firing lines. They should all rise by about the same amount. If one or more lines rise substantially higher than the others then there is an open circuit plug lead or resistor, a wide plug gap or badly deteriorated plug electrode.

One or more lines staying lower than normal indicates spark plug breakdown or insulation breakdown in the circuit concerned.

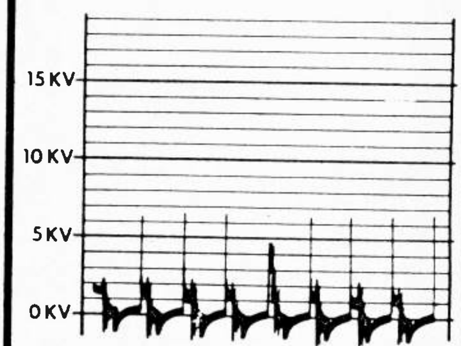
COIL OUTPUT AND INSULATION TEST

While the engine is running disconnect a plug lead and observe the firing pattern for that cylinder. The firing line should rise to about two to three times its previous level (to about 20 kV) and

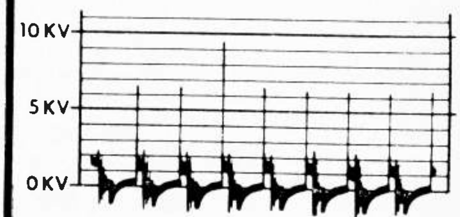
SNAP THROTTLE INDICATIONS



All lines should rise but remain even.



One line breaks up. Insulation break down — probably spark plug fouling. Extreme cases will show similar signal under normal steady running.



One line rises above rest. Wide plug gap, partial break in suppression resistor, plug lead etc.

should extend below the base line by about half the upward distance.

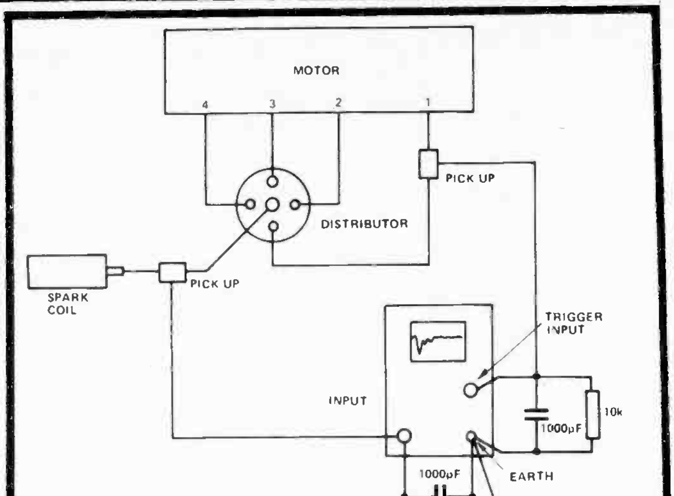
If the firing line is short or intermittent — or if the lower section does not appear — then there is an insulation breakdown in the distributor cap, plug leads, rotor or coil.

COIL AND CAPACITOR

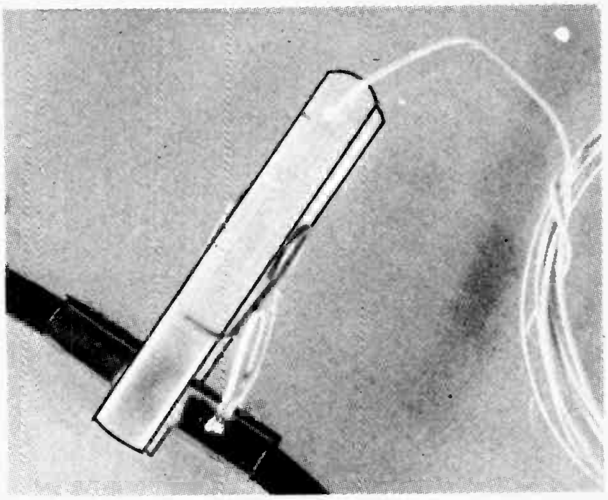
A series of diminishing oscillations should be observed at point D in the waveform. If these do not appear, or are truncated, there is either a shorted or crossed turn in the coil — or the capacitor is breaking down.

BREAKER POINTS

Point E on the main waveform. The drawings accompanying this article show various fault indications. Note however that faulty point action may also show up at the point opening position (A). Check breaker point action with the engine running at all speeds. Weak or incorrect breaker



Connect the 'scope to the vehicle's ignition system like this.



A simple pick-off can be made by glueing short lengths of split metal tube to a clothes peg.

A motor vehicle's ignition system produces output voltages varying from 3kV to 20kV or more. These high voltages must be reduced to a workable level before coupling into an oscilloscope.

The simplest way of doing this is via a resistive voltage divider - however a capacitive divider will work equally well (we are dealing with ac signals) and is simpler to connect.

We can make one of the capacitors by wrapping a piece of Alfoil - about 50mm long - around the required lead and connecting this foil to the scope. A more professional approach is to glue a short length of split tube to a clothes-peg - as shown in the accompanying photograph. This will have a capacitance of about 1pF - not much but ample for the massive signals we are sampling.

A second capacitor of about 1000pF should be connected as shown. The capacitive divider thus formed divides the input signal by about 1000:1 thus reducing the input signal to a workable 3 - 20 volts. A 1M resistor should be connected across the 1000pF capacitor to provide a dc load.

The technique in use: Place the 1pF capacitor over the main lead from the coil to the distributor and connect it to the 'Y' input of the scope.

If the scope has a trigger input, this may be used to lock in the ignition signal. Just make up a second capacitive pick-up and place this around number 1 plug lead. Once again use a 1000pF capacitor as a divider but bridge this capacitor with a 10k resistor - not 1M as previously.

Start the motor and adjust the 'Y' gain and timebase frequency to give four (or six or eight) complete firing sequences across the screen. The first complete pattern will be number 1 cylinder and the rest will follow in the engine firing order.

All waveforms may be superimposed by expanding the trace and triggering via the X input.

If the scope does not have a trigger input, synchronization is slightly harder to achieve. Number 1 cylinder may be identified simply by shorting out that cylinder momentarily.

When the scope is connected as described above, the ignition waveform will appear inverted relative to that seen on a commercially produced ignition analyser - and the waveforms shown in this article. It is surprisingly easy to adapt to an inverted picture, however, if this is found to be a problem, it can be remedied simply by coupling the signals into the scope via a simple 1:1 transformer. Details will vary from one scope to another but all that is basically needed is two coils of wire taped together. It may be necessary to reduce the 1000pF capacitor/s to 470pF. Just connect the secondary to give the correct picture.

If possible, arrange to calibrate the scope's vertical axis so that the magnitude of the signals may be measured. This is best done simply by taking average indications from several vehicles and 'calibrating' by transferring data from the graphs in this article. The result may not be accurate, but only a rough guide is required.

springs will cause the points to bounce — and this is readily seen on the scope pattern.

COIL

With very few exceptions — notably on some Citroens — the high voltage side of a vehicle's ignition system is designed to have positive earth — *regardless of overall vehicle battery polarity.*

The reason for this is that electrons are emitted more readily from a hot surface than a cold one so as a spark plug centre electrode always runs hundreds of degrees hotter than the side electrode the ignition system is devised so that a negative potential is applied to the centre electrode.

If this polarity is reversed, the plug will require an extra 5 kV or more to fire it — and that voltage may not be available from the coil under heavy load — or when running at light throttle at high speed (remember a weak mixture needs a higher voltage to ignite it than a rich one).

If you are checking polarity on a specialist ignition analyser then the polarity is correct if the pattern is as shown in the illustrations in this article. If you are checking it with a standard scope (with no inverting device) then the pattern should be upside down if polarity is correct. (See inset for full explanation).

Polarity is corrected simply by reversing the coil terminals. (Incorrect polarity is usually caused by a mechanic replacing a coil intended for a negative earth vehicle with a coil meant for a positive earth vehicle — or vice-versa. It may also, but less probably, be caused by an incorrectly manufactured coil, or less likely, by the vehicle's polarity being accidentally reversed by the battery being connected the wrong way round).

MIXTURE STRENGTH

This section is intended for the lucky man who has access to an exhaust gas analyser and tachometer as well as a scope.

If cylinder compression pressures are identical, plugs in good order and evenly gapped, and plug leads and distributor in good order — then any significant difference in firing line heights will almost certainly be caused by differing mixture strength from one cylinder to another.

The voltage required to fire a rich mixture is substantially less than for a weak mixture: for instance a 12:1 ratio may need 3 to 4 kV — whilst a 15:1 ratio may need 7 to 9 kV (typically). Thus even quite small differences in mixture strengths will be reflected quite dramatically in firing line height.

The only accurate way to adjust mixture strength is as follows:

Connect a tachometer to the engine and adjust slow running to 1000 rpm. *Without looking at the gas analyser* adjust mixture strengths so as to produce the highest tickover speed whilst maintaining the firing lines at an even height. If necessary reduce the tickover speed to keep it around 1000

Continued on p.77

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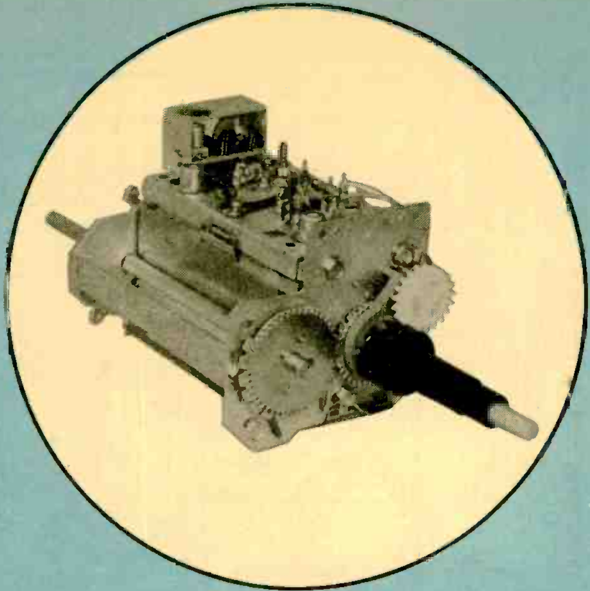

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MICRO COMPUTERS

Operating and programming your own digital computer.

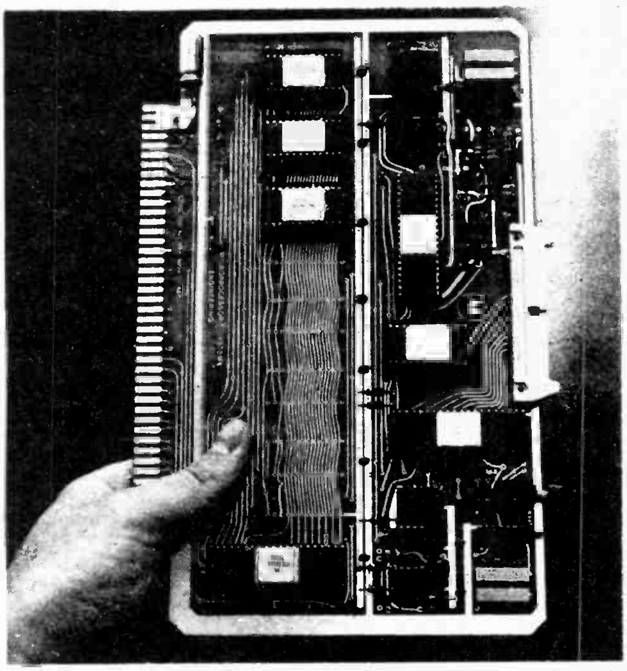
By Kevin Barnes

THANKS TO TECHNOLOGICAL advance in LSI manufacturing and the low costs of mass production, the microcomputer is now within the reach of the average person. At a cost of only two or three weeks wages, these machines are giving private individuals in America the means to exploit and enjoy a pastime that only two years ago was restricted to the very rich or privileged (i.e., those working in the industry).

It all started when minimum system microcomputers appeared on the market. They were more specifically aimed at companies that needed systems, but didn't want the expense and worry of design and development. But many were sold to individuals who wanted first-hand experience of a new technology, or who were dedicated builders who had worked their way through radios, oscilliscopes, digital clocks and television sets and now relished the challenge of a digital computer. Realising the potential of a new market, several companies developed systems they thought would be suitable, and offered them for sale. The response was for thousands of Americans to buy and install them in their homes, boats and cars. Because of their high speeds (in excess of 100,000 operations per second) and versatility, owners found uses almost too numerous to mention, and were rewarded with fun and profit. Some used their computers to run train sets. By having a number of train manoeuvers pre-programmed in the computer, they were able to direct their trains to more complex and realistic operations. Routines in the program were used to create hills, slopes, etc: conditions closely approaching those in real life.

The computer also allowed operation by one pair of hands where several pairs were needed before. For example,

No, you can't use it for your homework . . . I'm loading in tomorrow's runners.



This is what an evaluation card looks like. This is built up from the Motorola evaluation kit (the MEK). You can see space on the board for adding extra memory or developing a system.

one man used his computer to control the stage lighting for his local drama club. With all the lighting set-ups pre-programmed, the transition from one set-up to another required pressing just one switch where before several switches were needed. This allowed more lighting changes with less chance of error.

There is also a growing group of amateur radio operators who communicate to one another via their computers. Their machines allow them to translate directly from morse to written text and from the keyboard to a modulating signal. They are also using program routines to look for errors and improve readability. With their high speed, these same devices monitor the operation of the radio shack and keep the log. Amateurs have also gained permission from the FCC to exchange information using the ASCII code (the most common general purpose code used in the computing industry). And there has been at least one report of a pair of amateurs communicating via their computers and ASCII through the OSCAR orbiting satellite.

Complex games

Many people are using their microcomputers to play games. The computer can be used to play against or as a means of playing (as one would use a monopoly board or a pair of dice). The variety of games range from simple ones like Two Up or Roulette to more complex games like Poker or Checkers. But the most interesting games are the simulation games, where the program makes the computer behave as if it was a completely different machine, such as a car or an aeroplane. Here the switches on the front panel of the computer become the controls of the car or spaceship and the operator becomes the driver or astronaut whose skill must now be put to the test.

Simulation is not limited to mimicry of machines. It has also been used to reconstruct events. Popular games of this type include running horse races or playing a game of basketball. Then there are the popular war games like 'Tanks and Artillery'.

The hobbyists are also finding practical uses for their systems. The system used for playing poker during leisure time can become an elaborate burglar or fire alarm at night. Or it can be used to teach children maths. The computer can put a question to the student and later correct his answer before going to the next question. It can also keep a record of what questions could not be answered. Valuable feedback to act upon!

Business

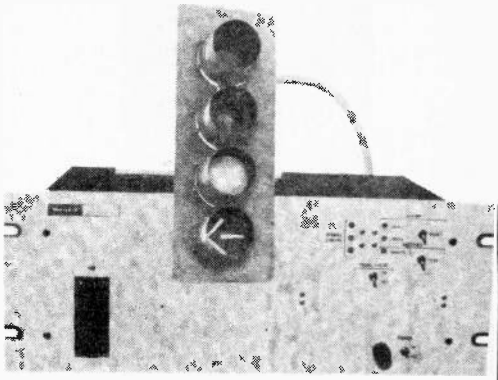
Business and engineering programs suitable for home machines are now starting to appear. They vary from simple programs to calculate interest to elaborate ones that are almost a complete accounts system. This allows the computer owner a chance to recover some of the cost of his machine. The engineering programs are equally varied and range from a simple random number generator to programs capable of performing circuit analysis of groupings of over 100 components.

As the numbers of hobbyists have increased, computer clubs have sprung up to help them. Here individuals get together to share ideas and to swap software (programs) and to compare their efforts with those of others. Clubs have also been formed where all the members own the same brand of computer; this is a characteristic of the computer industry where they are called 'users groups'.

Three applications for microcomputers . . . these examples are taken from a Motorola ad which appeared in a US magazine. All these systems use the Motorola 6800 microprocessor.

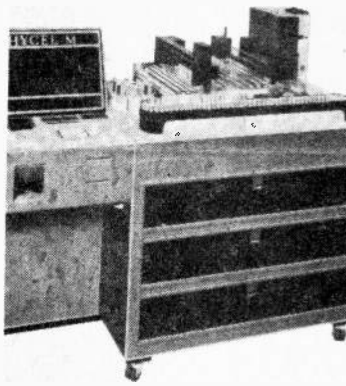
HONEYWELL

Vehicular traffic management is recognised as one of the great practical transportation problems. Honeywell attacked this problem with the programmable, multi-purpose, Type 140 controller for both intersection and freeway ramp applications. It has the speed, capacity, and versatility for uses from simple, fixed, time control to sophisticated, traffic responsive, centrally directed operation, yet it's low cost. The central processing unit is Motorola's MC 6800 microprocessor.



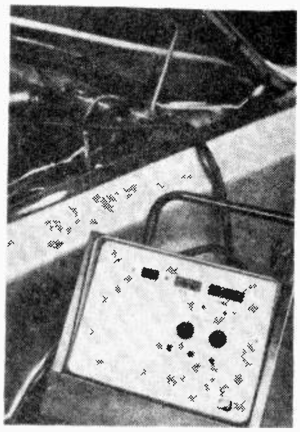
HYCEL

It's a desk-size, 30-channel, automated blood analyzer for medical laboratories. It performs over 3,000 tests per hour, selectively and sequentially, while continuously tracking patient identity and sample status. Maximum test time is ten minutes, from sample pickup to completion. The HYCEL M is big news in the medical test instrument field, and HYCEL calls it the "ultimate analyzer". All machine functions are automatically controlled by the instrument's Motorola's MC6800 microprocessor.

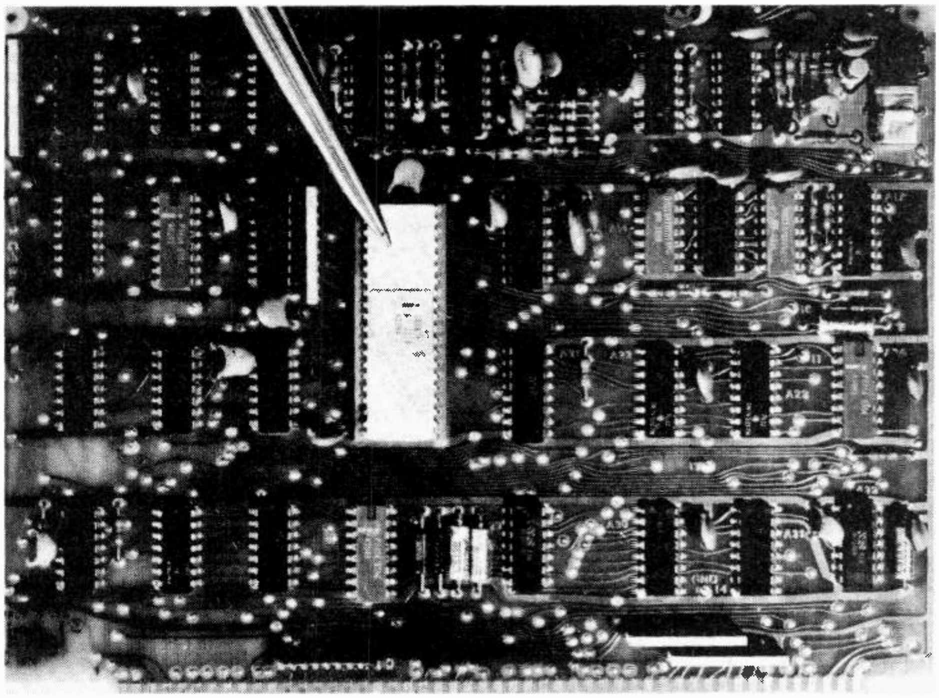


CHRYSLER

Chrysler developed the lean burn system to permit engines operating in their cars to meet emission standards without catalysts, while giving improved fuel economy on either leaded or unleaded gas. Servicing this innovative system also called for an innovative new concept in diagnostic testing. Chrysler has called the MC6800 microprocessor based portable diagnostic tester they designed to meet this challenge "an ideal service tool " for its veratility and economy.



These clubs are having an important effect on the hobby. Many people who want to own a computer come from outside the computer industry, and don't know what to ask for when shopping. They also find the jargon used very perplexing at first. By going to club meetings they meet people who are able and willing to answer their questions and advise them on things they should know. This is important because the initial purchase is almost always the Central Processing Unit (CPU) and its design and limitations dictate the development of the system.



A close up of the CPU board with the actual microprocessor (in this case an Intel 8080) indicated by a pen. This board also has the clock on it and the clock crystal may be seen in the upper right hand corner.

LITERATURE

on the chip, the system and programs.

Why are manufacturers putting their marketing effort into distribution of this literature?
Because before you buy an evaluation board you're going to need lots of information . . .

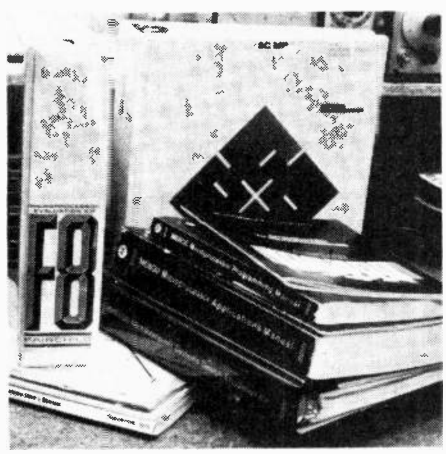
EACH KIT COMES WITH A PILE OF information, designed to offer assistance in three main areas:

1. Details on how to put the kit together and how to operate it.
2. Technical details on the microprocessor and the support chips supplied to make the microcomputer. Such information usually includes details on the microprocessor instruction set, timing diagrams, and loading rules as well as application information.
3. Programming manuals with detailed explanations of the software support available. These programming manuals go beyond evaluation boards and deal with commercial time sharing services and developmental systems. The cost of such systems is an order of magnitude greater than the price you pay for your evaluation kit.

To the hobbyist the first two listed above are the most important, especially the technical details and application notes. It is this information you will have to use to interface to your computer. It is strongly recommended that you at least have a look through this material before buying an evaluation board for two reasons:

First, to give a measure of the difficulty involved in making the system work so you can decide whether your knowledge and experience is up to such a project.

And second, to learn what the evaluation board involves; this information can help you decide which system to choose. ●



The documentation that came with the evaluation boards we are looking at this month. You can see the different amounts of information offered by each manufacturer. However, much of this information will be of little practical use to the amateur.

WHAT IS A MICROPROCESSOR?

There is no shortage of technical information on microprocessors but most of it is rather daunting when you first see it. We asked Dr Tim Hendtlass of the Royal Melbourne Institute of Technology briefly to explain these devices to our readers, assuming only a basic knowledge of logic circuitry.

MY AIM IS TO SHOW WHAT A microprocessor is and how it relates to a microcomputer. I make no apology for treating the subject in a simple way and in particular for using analogies to non-electronic situations. When the general idea of what a microprocessor can do has been grasped then you can read the manufacturers' literature and some of it at least should make sense. As you get more familiar with a particular device (and nothing can beat hands-on experience for this) more and more will fit into place. Those strange letter groupings which seem so daunting at first are in reality a concise and powerful way of conveying information amongst the initiated .The problem,as usual, is how to be initiated.

One more thing before I get down to it: microprocessor is a long word and it just calls out to be abbreviated. The most common short form is MPU and I will use this often in the rest of the article. An MPU is a super logic chip that can be any one of a number of ordinary logic chips at any given time; this is not the same thing as having separate chips. It's rather like some children's tool sets which consist of one handle and several attachments, each of which fits into the handle to give a particular tool: a hammer, a saw, etc. You can, in principle at least, do any job with this combination tool set that you could do with separate tools — but it will take longer because every time you want to use a different tool you have to take the old attachment off and put a new one on. The MPU is an electronic combination set.

Impersonating digital circuits

The number of digital electronic tools you can make out of an MPU is fixed at the time of manufacture, but it will almost certainly include the ability to be an AND gate, an OR gate, a NOT or inverting gate, an ADDER, or a SHIFT REGISTER. (In order to be useful an MPU must be able to perform other types of operation, but we will meet these later when the need for them has become apparent.)

The type of digital circuit an MPU will impersonate at any time is determined by a set of voltages applied to certain of the pins on the IC. This set of voltages (each of which can have either of two levels and is one **bit** of information) is referred to as the **instruction.** A typical MPU might have eight voltages (eight bits) to its instruction **word**, or **byte**, which gives 256 possible instructions (not all of which are used). Fifty to eighty instructions would make up a normal **instruction set**. Before I leave the tool kit analogue I must caution you not to take it too far. In particular, combination tool sets are often of inferior quality to the tools they replace; but an MPU is every bit as good as the individual logic ICs it replaces (except for speed).

One difference between using individual logic ICs and using an MPU is that the former are supplied in hardware form,often in parallel, and several operations can be happening at the same time. Consequently the solution is obtained very quickly — the only limit is gate propagation delay. The MPU can do only one thing at a time so the logic must be performed sequentially and this requires some extra steps compared to hardwired logic. Both Figure 1 and Figure 2 show ways of arriving at a decision about whether it is safe to cross the road at traffic lights.

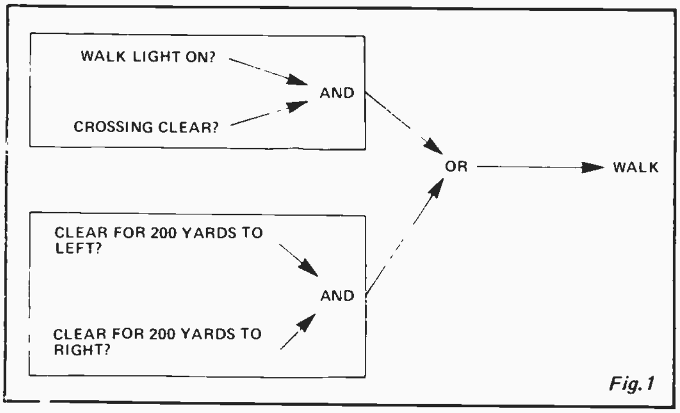


Fig. 1

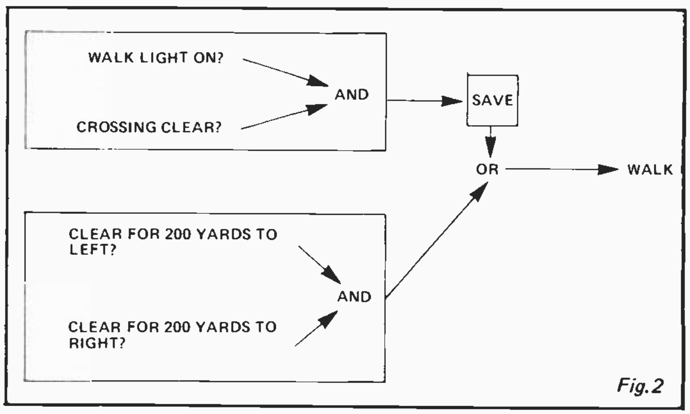


Fig. 2

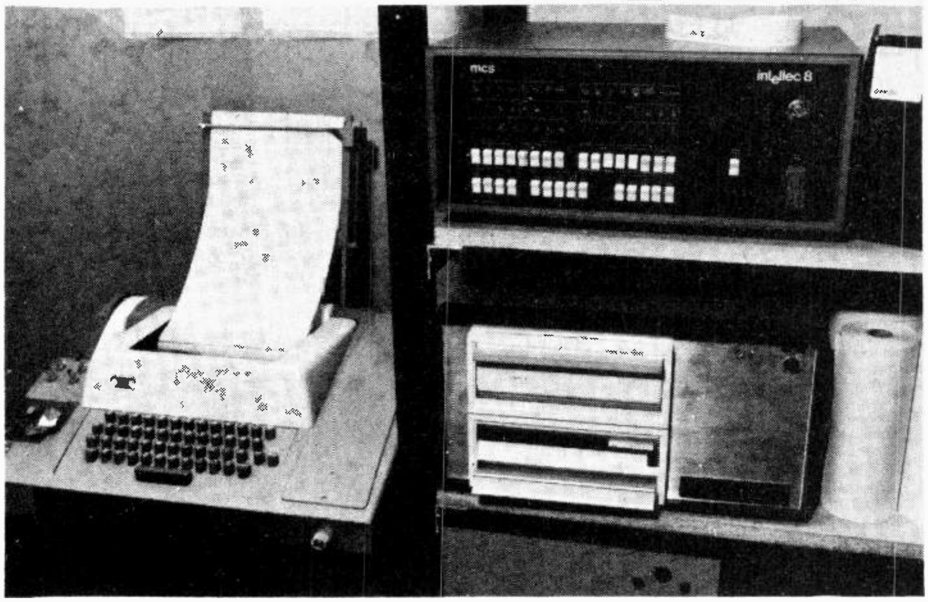
MPU or hardwired logic

Figure one uses parallel logic and we consider 'is the walk light on?' AND 'is the crossing physically free of obstructions?' The resulting bit of information is ORed with the result of the less legal 'is the road clear for 200 yards to the left?' AND 'is the road clear for 200 yards to the right?' Note both AND functions are performed at once.

In Figure 2 we see that the MPU can't dò two functions at once; we have to save or store the result of the first operation while we perform the second. This bit of information is recalled after the second AND operation has been completed and then the OR operation can be carried out as in Figure 1.

This storing and recalling , or generally moving around bits of information internally is a very important type of operation to a microprocessor.

The storage room inside the chip is very limited and often it is necessary for an MPU to store information outside and bring it back later.



A complete microcomputer system comprising microcomputer, teletype, a twin floppy disk store and a EPROM programmer. The single diskette holds as much information as would be contained on 1.5 km of paper tape of the type shown on the top of the microcomputer (about 2.5 million bits).

The IF instruction

When we looked at Figure 2 you might have noticed a redundancy in the logic. If the answer to the first ANDing is yes then there is no need to perform the second AND function at all, as the output from the OR gate is already decided. However we must still have the ability to perform the second AND , in case the answer to the first one is no. After the first AND we need to make a decision (based on the result) as to what to do next.

This is a **jump on condition** instruction — IF the answer is yes, go to the output; but IF the answer is no go to the second AND. This is shown diagrammatically in Figure 3; note there are two exits from the decision box, one showing the path taken if the answer is yes, the other showing the path if the answer is no. Also note we have told the microprocessor what to do if the answer to both ANDs is no (go back to the beginning and go through it all again and keep doing this until the answer to one of the ANDs is yes). What we have just drawn is called a **flow chart**.

MPU or Hard-wired logic?

Up to now it may seem that I have been stressing the overheads involved in using an MPU and you may be feeling that it wouldn't be worth it just to replace a few ICs. You would be quite correct; an MPU would be more bother than help. Remember, though, that this same MPU can, with the help of a set of instructions, do the same job as hundreds or thousands of ICs. Also, if you wanted to change the function performed by that array of hardwired ICs you would probably have a long job with the soldering iron and side cutters ahead of you. With the MPU the hardware changes will be minimal, if indeed any. Instead you change the series of instructions (in honesty let it be said that it can take a surprising amount of time to get the instruction sequence correct so that the MPU does what you want it to!).

Once these series of instructions (called **programs**) are written they can be stored and one program can be changed for another in almost no time. Finding when it becomes profitable to use a microprocessor then is quite a complicated decision based on how many ICs it replaces and how many different jobs you would like the same hardware to do. As a rough rule of thumb, if you need thirty to fifty SSI and MSI packages to do the job — and you don't need the whole job done in microseconds but can afford milliseconds — then you should seriously look at using a microprocessor.

The idea of a program consisting of a series of instructions presented to the pins of the chip leads us to realise that a microprocessor chip is an incomplete unit on its own. Where do we store program for example? A microprocessor then is only a part of a greater whole and this greater whole is called a microcomputer.

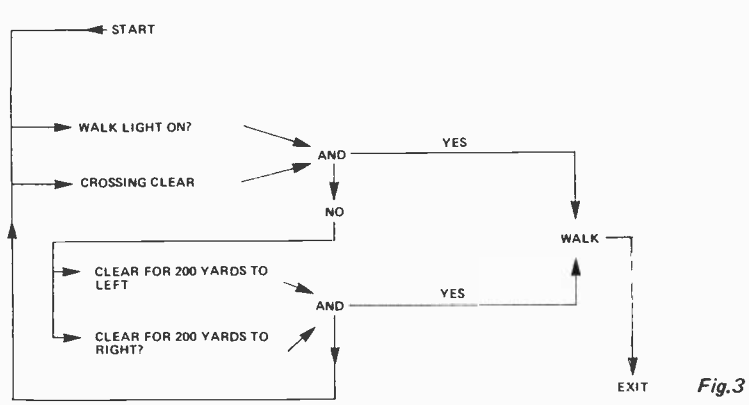


Fig.3

THE MICROCOMPUTER

Figure 4 is my personification of any digital computer in general and a microprocessor-based microcomputer in particular. I have changed my model of an MPU — now I think of it as a keen and eager clerk at a desk, able to ADD, SUBTRACT, AND, OR, X-OR, NOT, STORE, RECALL and TEST, and with baskets labelled "PENDING" to temporarily store the pieces of paper (data) on which to work. Someone has to give this MPU the input data on which to work — and take the finished

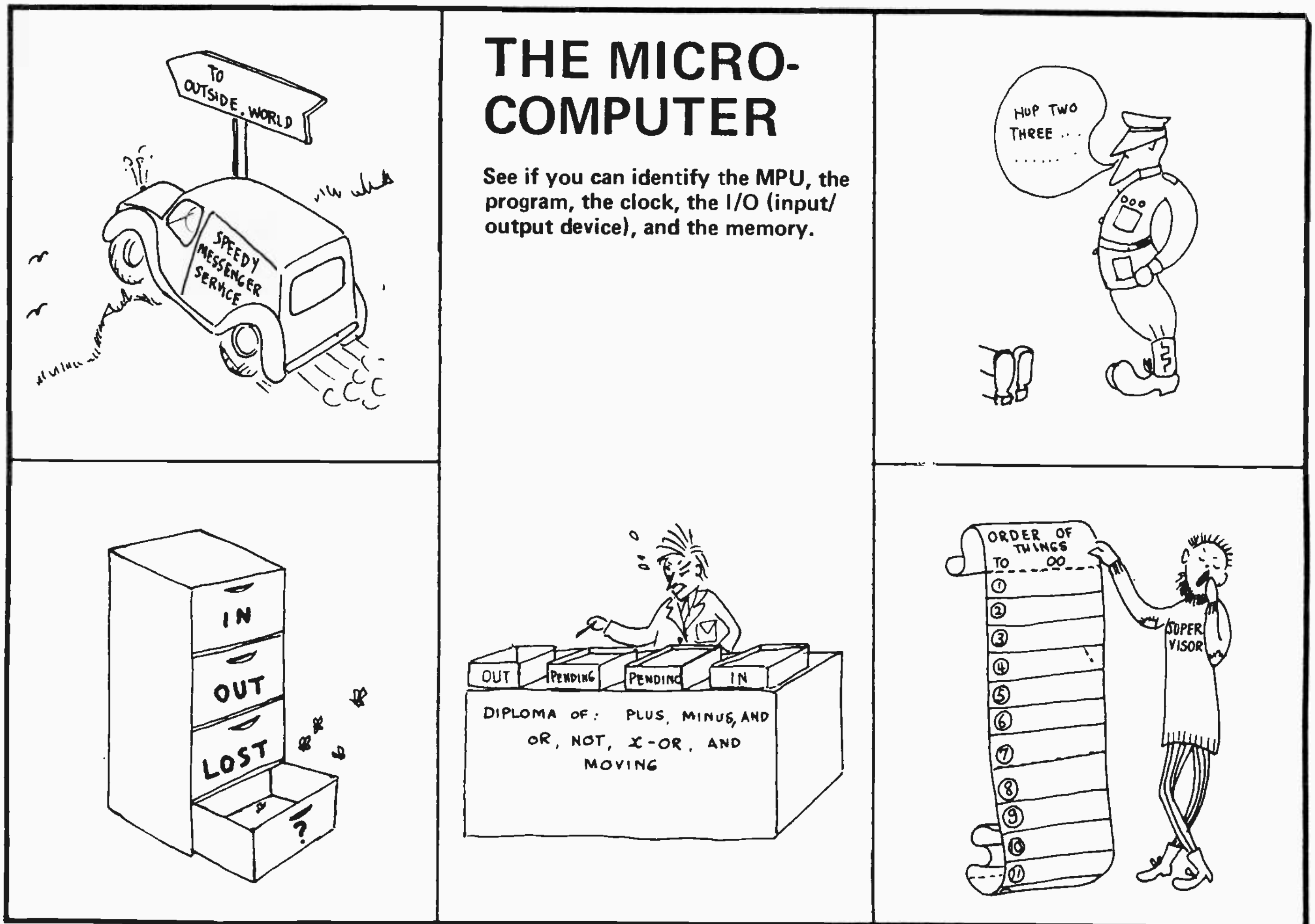


Fig.4

data away again. This is the role of the input/output, the circuits which enable the MPU to communicate with the outside world.

The Program. Also, our MPU, although keen, cannot begin until someone tells it what jobs to do and in what order. The program we referred to before is the MPU's equivalent of the office supervisor and is stored in the microcomputer's memory where the MPU can get at it by a special kind of recall instruction (program fetch). The baskets referred to before can only hold one byte of information each and soon the MPU will have run out of space to store information unless provided with auxiliary storage (filing cabinet in an office, more memory in a microcomputer).

The Master clock. Although it might seem that our computer is complete, one potential problem remains. What if the MPU is getting information from the filing cabinet while the input/output is pouring data on one end of the desk and removing some from the other end and the supervisor (who has been calling instructions out far faster than they can be done) is already into tomorrow's job? Clearly something is needed to keep everybody in step (personification — an army drill sergeant (in an office?); reality — a pulse generator called a master clock).

Memory. The program or list of instructions may be stored in read-only memory (ROM) where it is safe from being altered — in fact, if it is in ROM, you can't normally alter it even if you want to. The working memory or auxiliary storage must be in read/write memory (RWM). RWM is often (though rather confusingly) called random access memory (RAM) — we will bow to popular usage and also use this latter term.

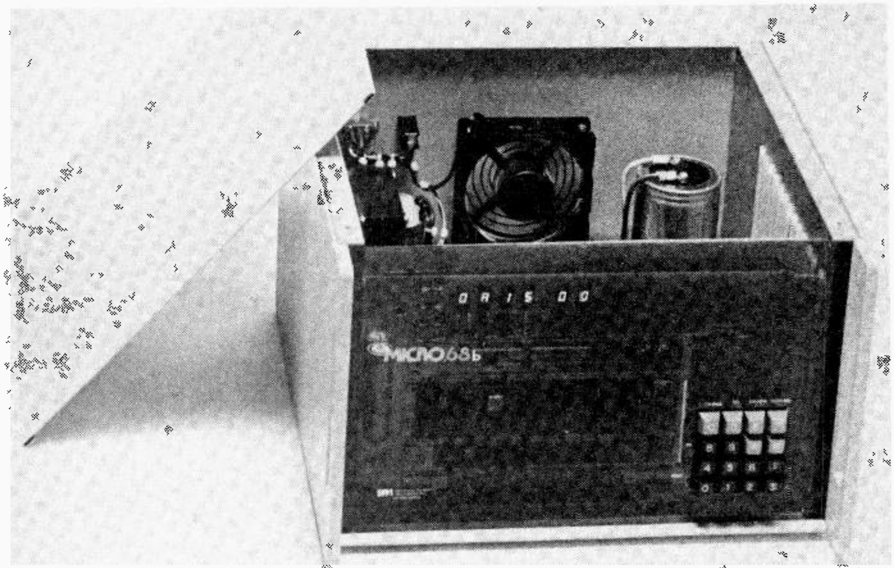
Program may also be stored in RAM along with the temporary storage — it is up to the programmer to see that the MPU does not accidentally write over its program or read some temporarily stored data thinking it to be program. If this latter should happen no physical damage will result, but it is hard to predict what the microprocessor will do — especially if the data happens to be one of the combinations of bits which does not correspond to a valid instruction. (Remember not all possible combinations of bits in the instruction word are used).

Also most, though not all, RAM is volatile — that is to say the contents are lost whenever the power supply is turned off. If you have program you will want again in a volatile RAM you must save it in some non-volatile form. (On paper tape or magnetic tape for example) before turning the power off.

RWM or RAM

Read/write memory is organised as a random access memory so you can address the various cells in it in any order (unlike a shift register, for example, where the cells must be addressed in a particular order). However, read only memory is also organised as a random access memory — hence the possibility of confusion with the common usage.

NEXT MONTH Dr Hendtlass will finish this article with 'The microprocessor at work'. He will take you through a program step by step and explain what a subroutine is and how it can save time for the programmer.



MICRO-68b

Electronic Product Associates, Inc., 1157 Vega Street, San Diego, CA 92110, announces the availability of the new MICRO-68b microcomputer. The MICRO-68b comes completely assembled with hex keyboard, 6 digit LED display, 8K RAM, 1K PROM monitor, CRT/TTY/Audio Cassette interface. It is housed in a ruggedized aluminum cabinet with a 13 slot EXORcisor-compatible mother board and 20A power supply. The 6800-based MICRO-68b lists for $1878.00 south of the border and is available from stock.

MICROCHESS

Now available is a chess-playing program for the MOS Technology 6502-based KIM-1 microcomputer. The Microchess program does not require the KIM-1 to be modified in any way, as it occupies only 1100 of the 1152 available bytes of RAM, and all moves are entered and displayed via the KIM keyboard and display. The program has several levels of play, and may be set up for 3, 10 or 100 seconds per move.

Documentation supplied covers a source listing, Player's Manual, and description of the strategic algorithms, so that it is possible to modify and expand the software. Microchess is available for $10.00 from:*Microchess, 1612-43 Thorncliffe Park Dr., Toronto Ontario, M4H 1J4.*

MICROPROCESSOR TRAINING

SDS Technical Devices Ltd. offers an evening course designed around the M6800 microprocessor. The course features a hands-on, applications oriented approach and is aimed at those who desire to gain actual hardware and programming experience. An extensive set of notes with numerous examples is provided. Demonstration models developed especially for this course provide a means for the students to relate their programming to real world situations.

The SwTPC 6800 microcomputer system is used throughout this course because its I/O structure and associated peripheral gear make it well suited to a course of this nature.

The course utilizes an evening course format rather than the usual intensive 3 or 4 day format to allow thinking time for the participants to develop, debug and test programs over an extended period of time.

The first course in this series is scheduled to start on February 8, 1977 in Winnipeg, Manitoba.

SDS are inviting enquiries from interested parties who wish to establish this training series in other cities. They can help you get started – contact them for details at:*SDS Technical Devices Ltd., 1138 Main Street, Winnipeg, Manitoba, R2W 3F3.*

GET YOUR MITS ON

MITS, the manufacturer of the Altair range of hobby computers, have announced four new products. The 88 – Mux is a 24 channel multiplexer, companion card to the 88 – Analog/Digital Converter. It features differential inputs, with independent gain setting and scale factoring on each channel. Input filtering can also be added to provide the desired roll-off characteristics. The 88 – Mux will be available within 60 days of order placement at a cost of $319 (assembled only).

The 88 – PROM Programmer will program the standard 1702A EPROM in less than three minutes. The unit consists of a separate chassis (with 24 pin zero insertion force socket) and an interface card that plugs into the 8800 bus. The software driver for the programmer is supplied on PROM. The assembled unit costs $456.

Also from MITS is the 88 – S4K, a synchronous 4K memory board which runs with no wait states at the maximum CPU speed. The memory relies solely on the CPU for timing signals – there are no single shots and no critical on-board timing. Price? $155 (kit), $255 (assembled).

Finally, the Altair 7000 Graphics/Printer is an electrostatic printer plotter and graphics hard-copy output device that is plug-compatible with the 680 and 8800 via one PIO port. It can print up to 160 characters per second (80 characters per line) in a 5 x 7 dot matrix. By means of an extra, eighth printing electrode, it can also plot and produce pictures, either in outline or shaded form.

Horizontal resolution is up to 128 dots/inch and vertical resolution is 65 dots/inch. The Altair 7000 will be available from MITS at a cost of $785. *MITS, 2450 Alamo S.E., Albuquerque, NM 87106.*

MICROCOMPUTER HARDWARE

To support M6800-based equipment development, Motorola has introduced chassis, card cages and a power supply for the MICROMODULE products.

Two card cages are available; one with 5 card slots, the other with 10. Both card cages have mother boards that are compatible with the Micromodules and all of the EXORcisor modules. In addition, the cages can be mounted on five different axes. The unit price for a 10-card cage is $147; a 5-card cage is $98. (US).

Power supply outputs are 15A at +5V DC, 2.5A at +12V DC, 1.5A at –12V DC, and 0.1A at 8V AC. Short circuit, overload and overvoltage protection are provided.

Two chassis models are available: again, 5 & 10 card cage versions. Both fit into a standard 19" RETMA rack, and include a power supply, cover and hinged front panel. Unit prices are $660 for the 10-card version and $610 for the 5-card chassis. The power supply is available separately for $295, again US price.

Technical Information Center, Motorola Semiconductor Products Inc. PO Box 20294, Phoenix, AZ 85036.

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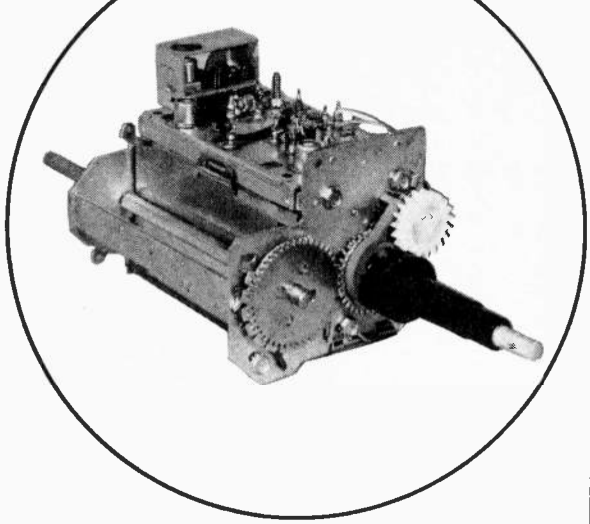

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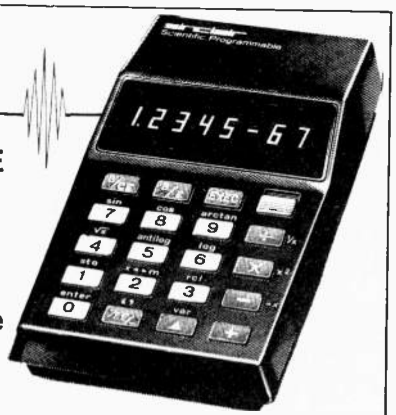

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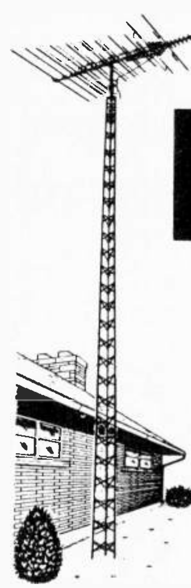

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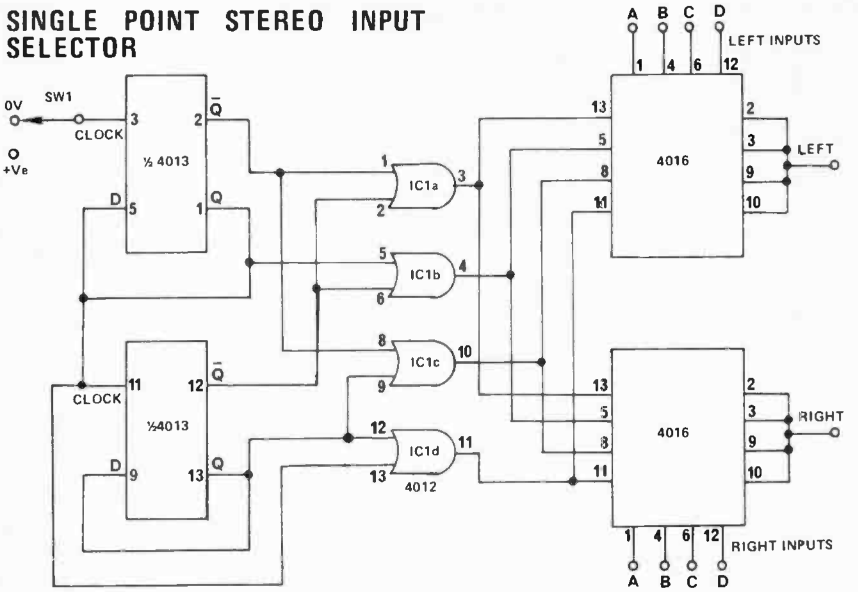
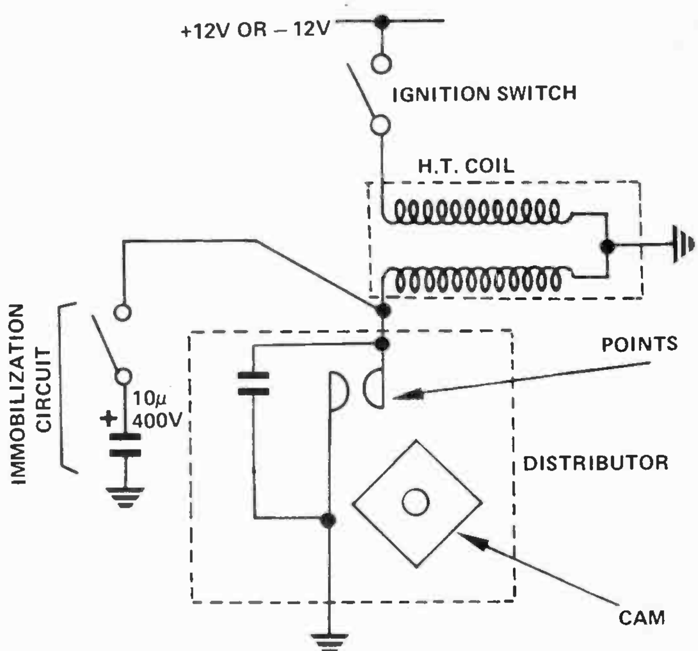


Four different inputs can be switched through by the continual pressing of SW1.

IC1 is a dual 'D' type flip flop. The Q outputs are connected to the D inputs so that the clock inputs are divided by two. The two flip flops are connected in series, giving a two-stage binary counter.

IC2 is a quad AND gate. This is used to decode the four states of the counter. The outputs are used to control the quad switches at IC3 and IC4 (4016AE).



AUTOMOBILE IMMOBILIZATION

In order to discourage theft of an automobile, many people incorporate a 'secret' switch to break the ignition circuit (usually in series with the key switch). This system is very easily by-passed using 'jumper' leads.

A more effective method of immobilisation is shown in Fig.1, also using a 'secret' switch. A 10uF/400V capacitor is switched across the points preventing the ignition being started; at the same time this prevents the use of 'jumper' leads.

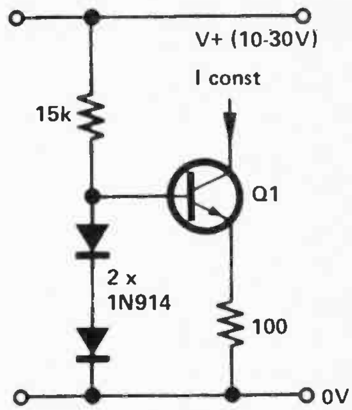


Fig. 1

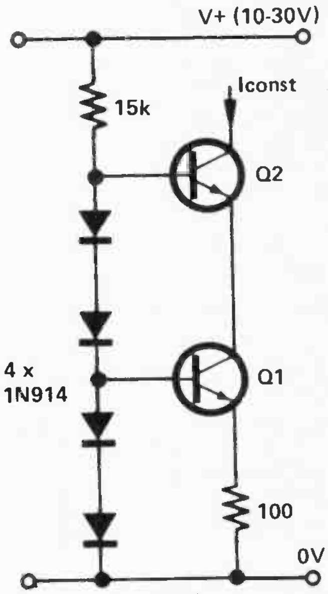


Fig. 2

DRIFT FREE CURRENT SOURCE

The conventional type of constant-current source, as shown in Fig.1, will drift in output current immediately after switch-on. This is because of the voltage drop across Q1, causing a significant amount of power to be dissipated in the transistor, heating it and its Vbe. Hence the output current slowly increases after switch-on, typically reaching a stable value about two minutes later. In tests the current increased by about 4% for a small signal transistor dissipating 100mW.

This effect is greatly reduced by the configuration shown in Fig.2, which fixes the voltage across Q1 at a very low level by virtue of the common-base transistor Q2. The main voltage drop occurs across Q2, leaving about 600mV across Q1, this being set up by the two extra diodes in the bias chain (D1, D2) which fix the emitter potential of Q2.

tech-tips

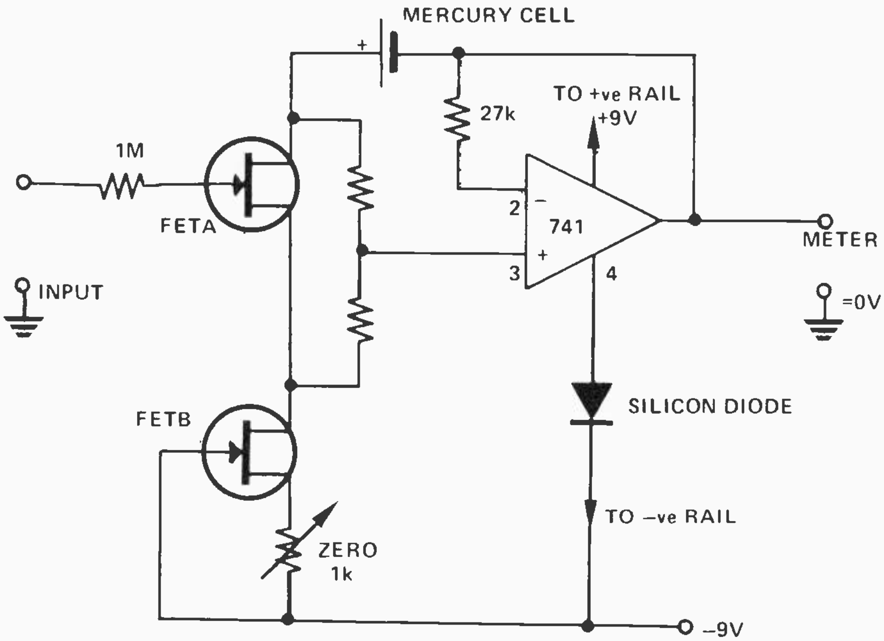
100,000 MEGOHM DC PROBE!

The input current of a junction FET, usually less than 1nA, flows out of the gate, and is constant at a particular temperature, provided the voltage across the device is constant. By making the gate positive to the source this leakage current can be made to flow back into the device, reducing the input current almost to zero.

FET A should be a low loss, low Vp device (ideally Vp should be about 0.5V). FET B must be somewhat higher but is less critical, the bargain pack is usually a good source of such devices. Forward bias should be about 150mV and current through the FETs about 400mA.

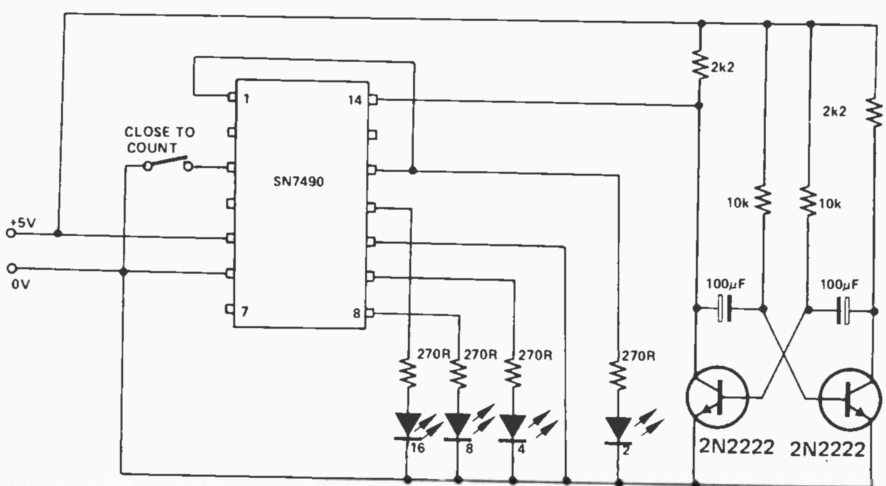
The mercury cell holds the voltage across the input FET constant at 1.5V (1.35V plus 150mV) and the silicon diode in the op amp's negative lead prevents the cell from discharging when the power is off.

By adjusting values in the potential divider it is possible to achieve input currents within a few picoamps either way and to measure the voltage on a small capacitor without changing it.



LED COUNTER

The astable multivibrator is used to generate pulses which operates the four integrated bistables. The 7490 gives a binary counting sequence and the 7490 gives a BCD count. This circuit is very useful for testing the IC's.

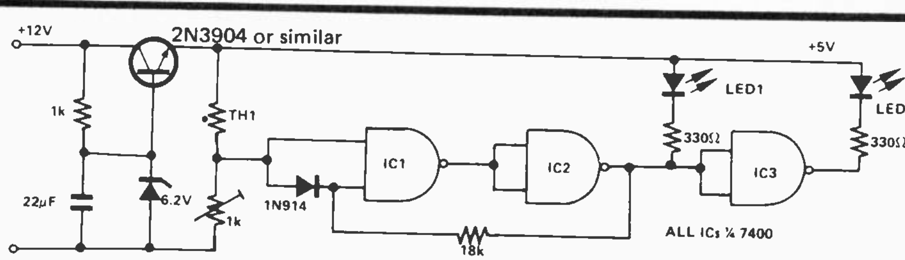


'WARMTH' INDICATOR

The sensing element used was a thermistor, attached to the outlet which is warm when the pilot light is on. A rod-type thermistor was used for cheapness, with a resistance of about 3k @ 20°C, but a bead type would work as well and with a faster response time.

Two gates of the 7400 provide a Schmitt trigger with a low hysteresis (determined by the 18k feedback resistor) and the third gate inverts that output. When the pilot light is on, the input of IC1 is high, IC3 output is logic 0 and LED2 (green) is on. If the pilot lights fails, the temperature falls, all ICs change state, LED2 goes off and LED1 (red) comes on.

The temperature at which the changeover takes place is set by the 1k preset.



tech-tips

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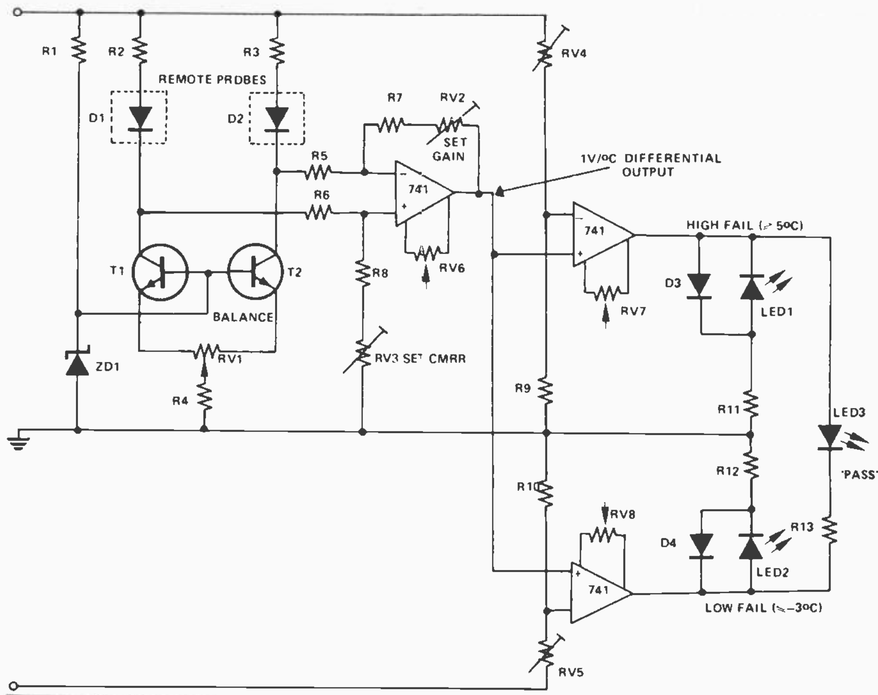
DIFFERENTIAL TEMPERATURE SENSOR AND ALARM SYSTEM

The circuit is comprised of three parts (i) the differential temperature sensor (ii) a differential amplifier to provide gain (iii) a swit circuit to monitor the output from the differential amplifier.

Two diodes D1 and D2 are used as probes for the sensor. A small preset, RV1 provides fine adjustment of the current through each branch so as to give zero differential output between D1 and D2 when they are at the same temperature.

A gain of 500 must be provided at the differential output to provide a useful voltage to switch the LED's (....ie IV corresponding to 1°C.) RV2 provides fine adjustment of the gain and RV3 adjusts the CMRR.

A potential divider network is set up by RV4, R9, R10, RV5 to provide the necessary switching voltages for the voltage comparators, thus enabling LED1 or LED2 or LED3 for voltages set up by RV4 and RV5 ..ie.. −3V and +5V.



SETTING UP

1. Adjust offset-null on all Op. Amps for zero output by connecting input terminals together and taking to ground and adjusting either RV6, RV7 and RV8.
2. Adjust CMRR for differential amplifier by shorting input terminals and connecting to +15V line, then adjusting RV3.
3. Apply probes D1 and D2 to a liquid, say at room temperature, and adjust RV1 until there is zero output across collectors of T1 and T2.
4. Apply probe D1 to a liquid at a temperature 10°C different from above, then adjust gain control RV2 until there is 10V at the diff. amplifier output. The CMRR should again be set.
5. Adjust RV4 and RV5 so that the comparators switch at −3V and +5V corresponding to −3°C and +5°C.

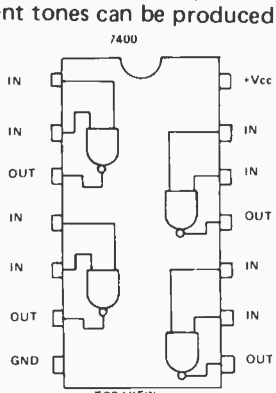
COMPONENT LIST

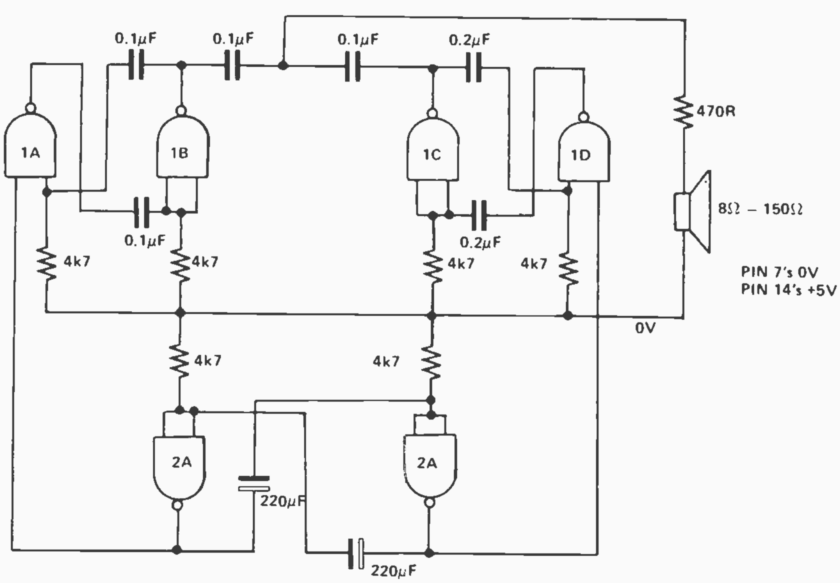
RESISTORS		RV4,RV5	2.2k
R1	2.2k	RV6,RV7,RV8	10k
R2,R3	51k	**TRANSISTORS**	
R4,R10,R13	1k	T1,T2	2N2222
R5,R6	2k	**DIODES**	
R7,R8	910k	D1,D2	1N4004
R9	390Ω	D3,D4	1N914
R11,R12	1.2k	LED1,LED2	miniature RED
PRESETS		LED3	miniature GREEN
RV1	100Ω	ZD1	400mW,3V3
RV2,RV3	100k	3 Operational Amplifiers	741

7400 SIREN

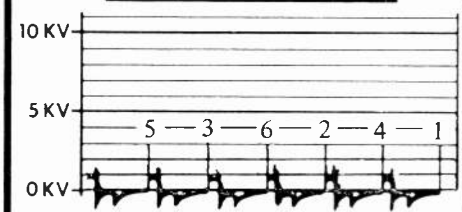
The siren consists of two oscillators which generate the tones. A third oscillator is used to switch the others on and off alternately, giving the two tone effect

By changing the capacitor values different tones can be produced.

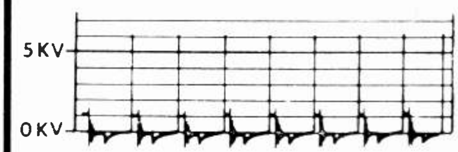




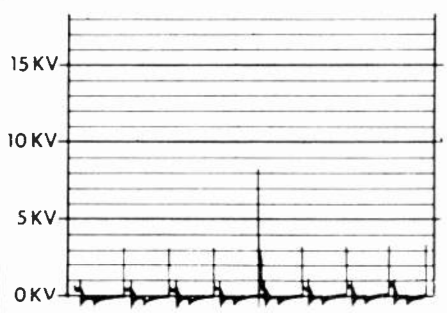
FIRING LINE INDICATIONS



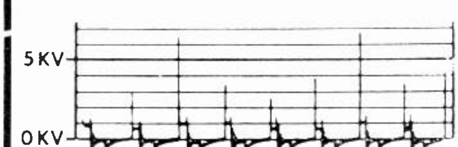
Normal pattern:
Note that the firing line for cyl. 1 appears at the extreme end of the trace. The remaining cylinders then appear in engine firing sequence.



Firing lines even but high:
Excess plug gaps, rotor gap, break in coil ht lead, mixture too lean ignition retarded.



Firing line high on ONE cylinder:
Break in plug lead, broken electrode in spark plug. To test short plug — if line drops, problem is within cylinder.



Firing lines uneven:
Break in plug leads, worn plugs, burnt distributor cap contacts, uneven air/fuel mixture.

continued from p. 63

rpm. Finally richen the mixture a shade until tickover speed drops by about 50 rpm.

Then *and only then* — look at the gas analyser. You should now have a reading somewhere between 14:1 and 15:1. If you haven't then there's something wrong with the carburetion system — an air leak in the induction manifold: incorrect float chamber level: blocked slow running jet or *something*. ●

ADVERTISER'S INDEX

OPEN CIRCUIT

Technician's column

by Tom Graham

Here it is!

As this new format is designed to please everybody interested in electronics from the veriest beginner to the electronic technician level, we would appreciate your comments, pro and con, as this is **your** magazine and we want to do everything in our power to please everybody as best we can. Be assured that we will carefully scrutinize each and every letter; especially the ones with adverse comments so that we can try to serve you better.

OTEA revisited

We got quite a lot of feedback from my editorial in the Fall issue of the **electronic workshop** wherein we discussed the fact that all electronic servicemen and Companies should join the Ontario Television Electronics Association. Most of what we got were phone calls from small, independent servicemen across the province saying that they never even received an application in the mail from the OTEA asking them to join.

Of course the prime reason for this just naturally has to be that they don't have your name on the mailing list. Furthermore, even we probably don't have all of the names of every service shop on our mialing list. Undoubtedly, now that we are on general newsstands, a lot of previously unknown companies and independents will be seeing this for the first time. So in case you fall in either of the latter categories, here is where you write for information.

Norman W. Matthews, Managing Director,
Ontario Television Electronics Assn.,
13 Queen St. S., Elmira, Ont. N3B 2S5.
Telephone: (519) 669-8410.

While on this subject, a new member of the OTEA wrote me from Cornwall, asking how he could go about getting the information on where to go to write the exams in order to obtain his Ontario Certificate of Qualification. Seems he got a rather brusk brush-off from the local Community College. Previous to this I thought that all of the Ontario Colleges could give this exam. Not so, it appears. However, members of the OTEA are having negotiations with the Ontario Ministry of Educational Programs to try to clear up this matter and, hopefully, to get some sort of standardization throughout the province.

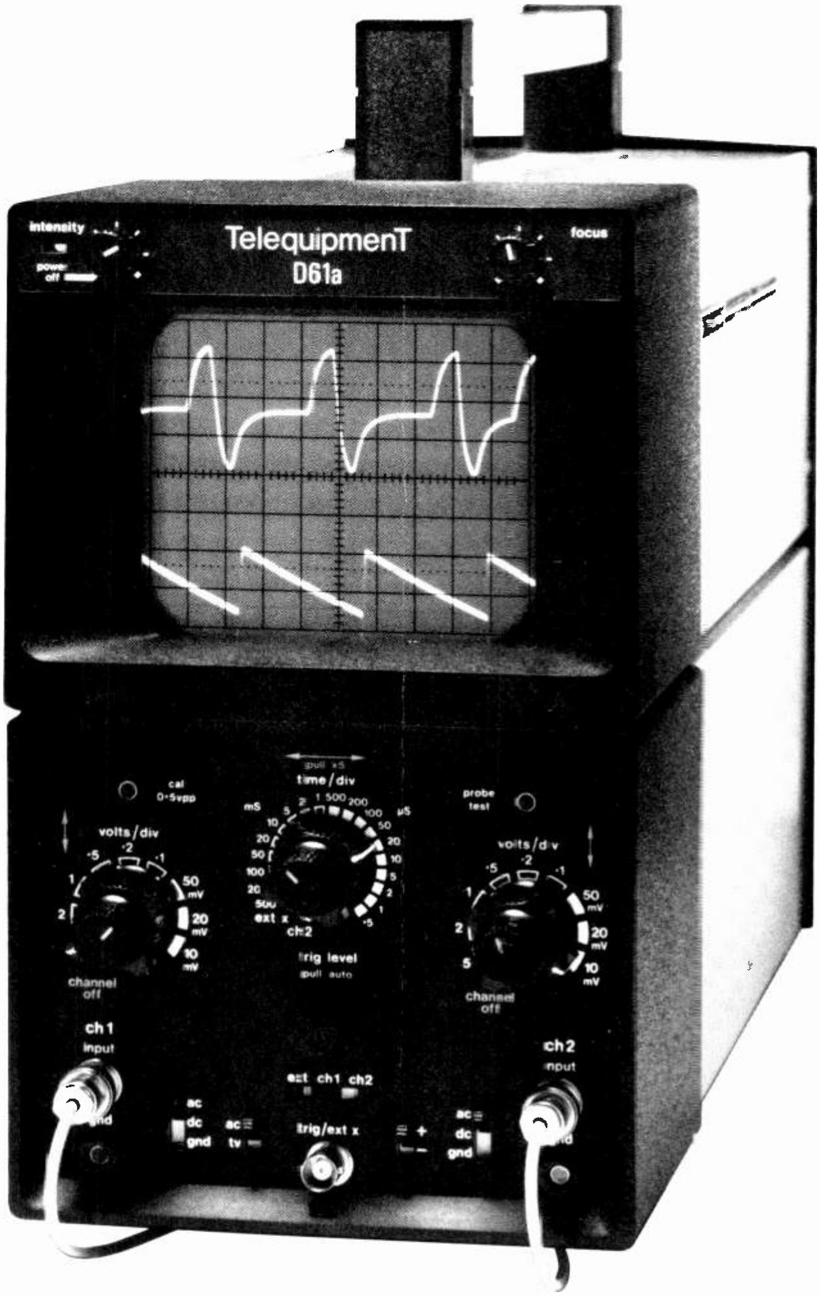
In the meantime, it appears that once again Ontario, with 40% of Canada's population within its borders is lagging way behind Quebec and Alberta to name just two provinces that I know of for sure that are working very closely with their provincial electronic associations to not only provide excellent educational programs, but also putting some teeth into laws designed to practically eliminate the 'moonlighters'.

But of course this is the reason in both cases; **both** of these provinces have very strong provincial associations. And it is the prime reason why Ontario needs a strong provincial association itself.

I'm very pleased to hear from Norm that they are already starting to do something about this situation. But they need every member they can get. It's an old adage of course that there is strength in numbers, but it is so very true in the case of the television and radio serviceman. Because there are so many people reading this that never saw that article I wrote; (this issue has 30,000 circulation as compared to our former 10.561 . . .) I'll repeat part of that editorial titled "You can win a million". I made the point that a lot of servicemen stopped reading the notice from OTEA when they saw the price. Then I likened this to the fact that just about everybody who balked at same very probably has gambled from $50.00 to $100.00 and more on the almost impossible odds of winning a million dollars on the various lotteries that are going on all the time. After making the point that joining the provincial association was betting on a sure thing and then ended the article with the following paragraph.

"For my money, if you don't join your local, provincial and national associations very soon, you may be out of business with the next 5 years.

Wanna bet?



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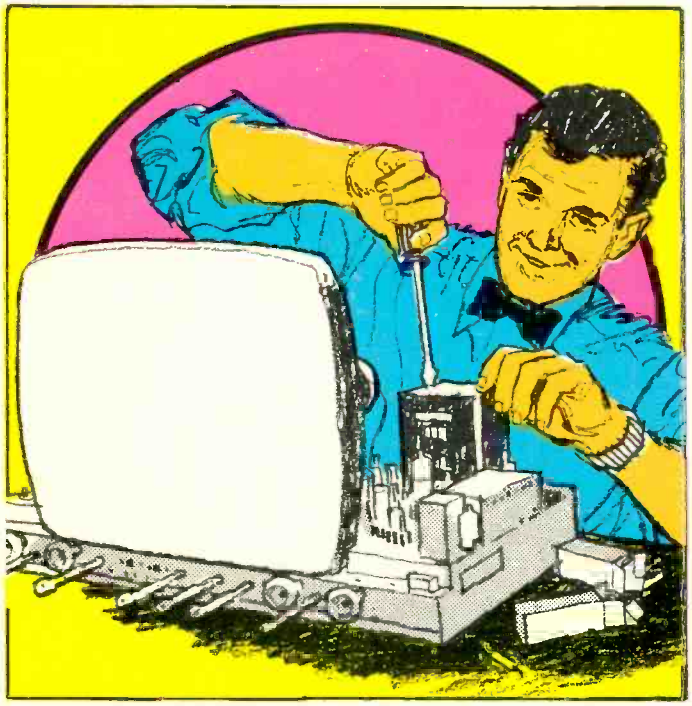

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