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HP67 REVIEW

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WE TAKE A LOOK AT

COMPUTERS

FOR SMALL BUSINESSES

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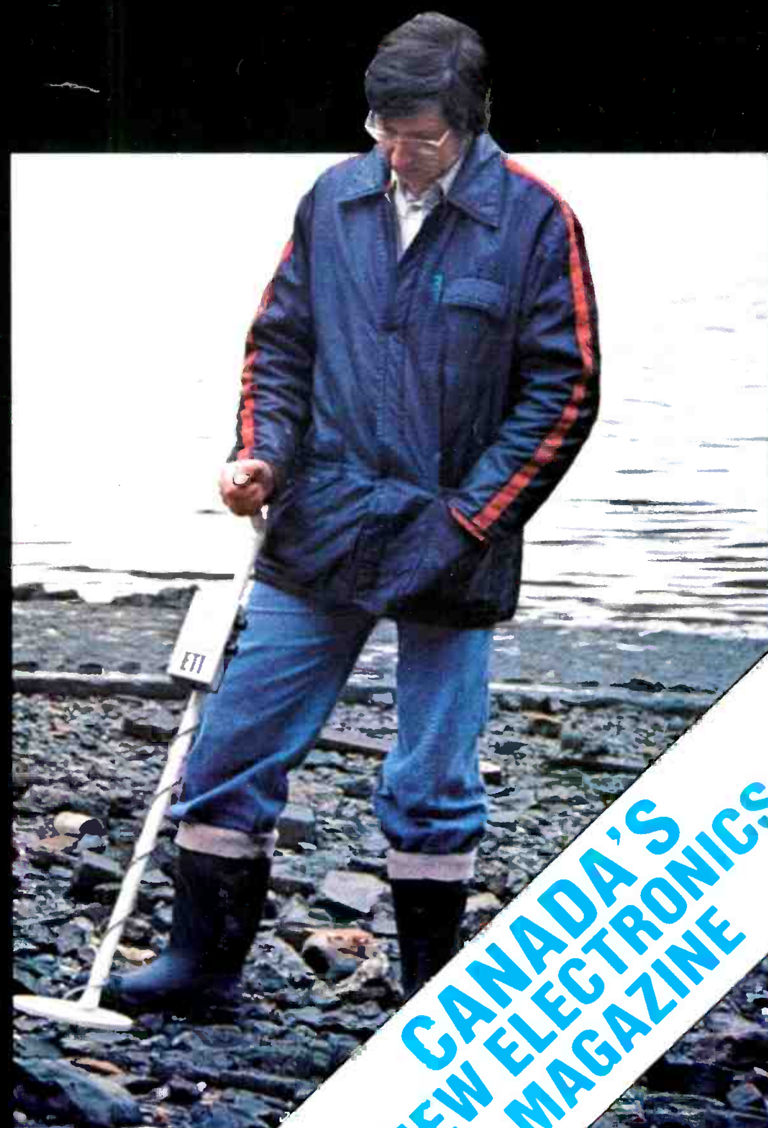

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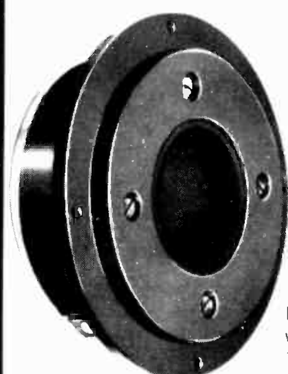

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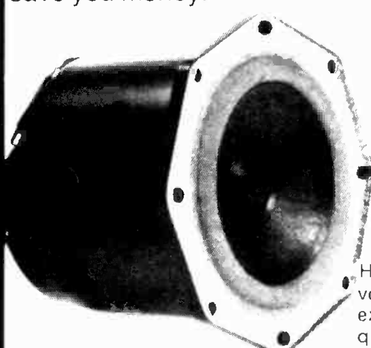

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NEWS DIGEST

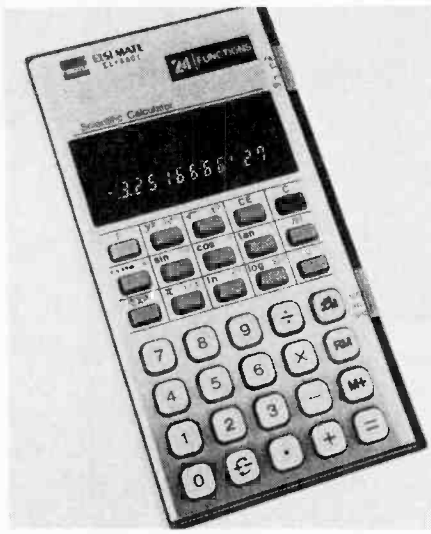
WHO NEEDS NICADS?

Sharp Electronics of Canada Ltd. recently unveiled a solar battery-operated calculator, the EL-8026, which carries a suggested retail price of $99.95 (or less). The solar batteries can be used 50 hours continuously without receiving any light. Recharging time is 10 minutes under direct sunlight. The EL-8026 performs six functions including square root and percentage. Dimensions are 9mm thin, 66mm wide, and 109mm deep enabling it to fit into the inside pocket of a jacket, or a small purse.

Also new from Sharp is a new pocket scientifice calculator with memory. The EL-5801 has an eight-digit exponent and two-digit mantissa, and an interesting function is the cube root key. This calculator weighs less than half-a-pound and features separate command keys for scientifice functions plus an independently addressable memory and bright fluorescent display, Degree/Radian/Grad switch and power from AC (with optional adaptor/charger), dry cells or rechargeable Ni-Cad batteries (optional). Suggested list price for the EL-5801 is $29.95 (or less). Units are available from Sharp dealers across Canada.

SONY'S ELCASET

Sony of Canada Ltd. have just announced the introduction of two new tape decks utilizing the jointly developed Elcaset tape format. "We fully expect," said Sony of Canada President, Albert D. Cohen, "that the Elcaset will provide an ideal format for those people who wish to upgrade the sound quality of their stereo systems but wish to retain the convenience of a cassette-loading format." So what else is new; see page 22.



THE CONTINUING SAGA . . .

of the videodisc must be near the end now. A small company called Magnetic Disc Recording, in Luxembourg, has a magnetic disc system planned for introduction in July with a price tag of $700.00 approximately. The magnetic discs, which can carry up to two hours of video on each side, cost about $11.00 each, and the unit is compatible with PAL, SECAM and NTSC.

The problem is that the video disc, if any companies ever seriously market it, will probably go the way of quadraphonic records, because of the different standards in use. In fact both these topics have been more or less shunned by the electronics press of late . . . 'Not another system?' is the cry constantly being heard.

Meanwhile, RCA has disclosed that there is no possibility of its video disc player being introduced in 1977, but it may be ready in late 1978.

DOC NO-NO ON LINEARS

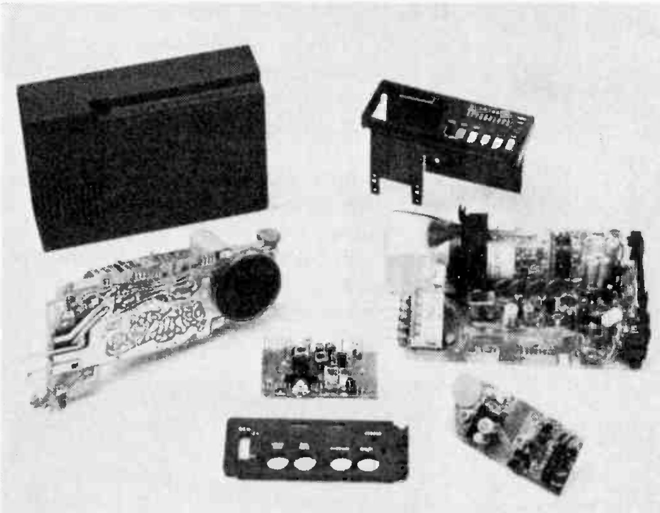
The Department of Communications in Ottawa is apparently concerned about the use by GRS licensees of RF linear amplifiers, capable of boosting the output of CB rigs to 1000 watts or more. Accordingly, they are proposing amendments to the Radio Interference Regulations, so that anyone buying a linear will have to sign a declaration that they are aware that its use on GRS frequencies renders them liable to a fine of up to $1,000 or up to six months imprisonment. Similarly, the vendor will have to send a description of the equipment, along with the declaration, to the DOC. The Department is inviting manufacturers, users, associations, groups and interested persons to make any submissions they wish concerning these proposed regulations. Submissions should be addressed to the Director, Operations Branch, Telecommunications Regulatory Service, 300 Slater Street, Ottawa, Ontario, K1A 0C8. Comments received will be made available for public inspection at various offices of the DOC whereupon you may comment on the comments. Contact the DOC for any further information you may require, quoting Notice No. DGTR-001-77.

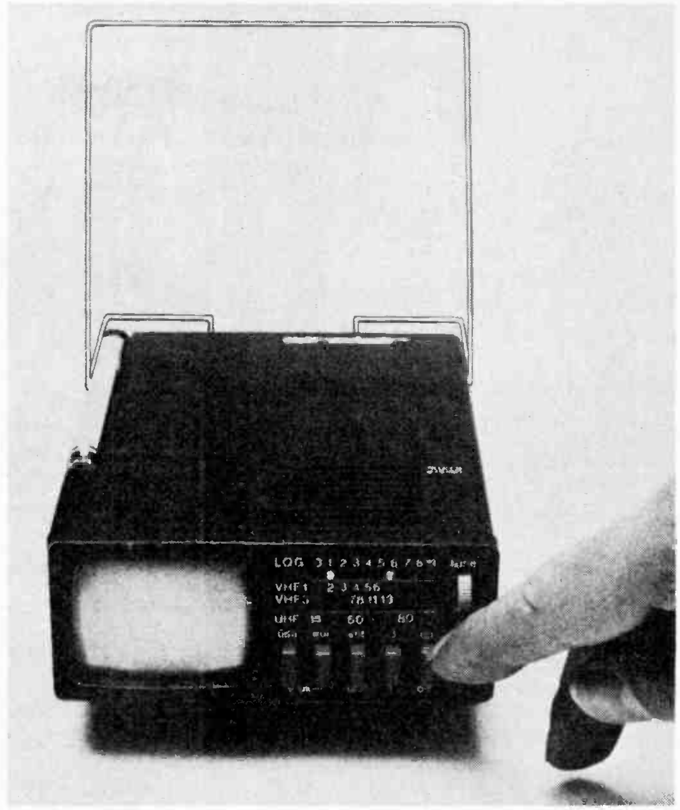
XCR 30 MARK 2

The XCR 30 Mark 2 is probably the most deceptive looking radio around; a regular wolf in sheep's clothing. It is really an honourable communications receiver covering 500 kHz to 30 MHz continuously, using the Wadley triple mix design developed by Racal and used in the RA 219 receivers. This gives superb stability and dial accuracy; there are in fact two dials — one sets the MHz, the other kHz, using a phase locked loop frequency synthesizer. Other features include a BFO for receiving CW and SSB, 2μV sensitivity, ceramic IF filters, S meter, external antenna earphone, and power jacks, and steel case with die cast aluminum front panel. At $299.00, it's good value for a go-anywhere, listen to anything radio. *WSI Sales Co., 18 Sheldon Ave. N., Kitchener, Ontario N2H 3M2.*

ON A CLEAR DAY . . .

Scientists at the Jet Propulsion Laboratory in Goldstone, California are mapping the rings of Saturn using high-power radar. The setup consists of a 64m tracking disk, Cassegrain fed with 400kw of RF from two Varian klystrons. The maps they produce will be used to guide a space probe as it passes the planet in 1980. Maybe those cruise missiles aren't so "smart" after all. . . .





AT LAST

After several false starts, as long ago as 1968, Britain's Sinclair Radionics have produced what is claimed to be the world's first pocket T.V. Despite its tiny size, the Microvision is quite sophisticated; it is the only TV set able to receive transmissions throughout the world. No Canadian price yet, but the UK price is roughly $300.00.

MICROFLOPPY

The ICOM division of Pertec is marketing a plug-compatible micro floppy disk that works with the Altair 8800, Imsai 8080 and Poly 88 microcomputers. Although Pertec competes with Shugart Associates in the standard-size floppy market, they are buying their drives from Shugart.

The system comprises the disk drive, controller/interface card, power supply, cables and iCOM's FDOS-M software. Pricing is US $1,096.00 in one-off. A kit version will be available shortly.

ELECTRONIC GAMES

We noticed with interest that the well-known game manufacturer, Milton Bradley Co., of Springfield, Mass. are advertising in an electronics trade journal for people to work in Microprocessor software development, as they are "expanding into Microcomputer programming of game ideas into video and non-video units". Deduction: it's going to be hell Christmas shopping with kids this year.

CHOMP, CHOMP

Acoustic Emission Technology Corp. of Sacramento, California have developed equipment which listens for corrosion before it is visible. The technique is especially valuable in testing aircraft, the sonic effects of rust having been discovered by Lockheed Aircraft Corp.

HELLO . . . HELLO? . . . HELLO??

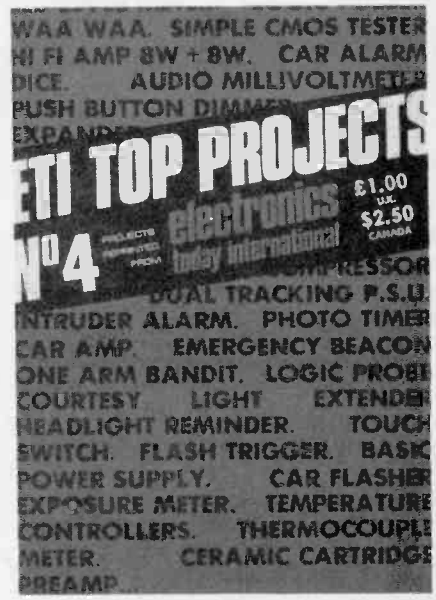
Philips Electronics Ltd. has introduced two new automatic telephone answering machines, Code-A-Phone 1400 and Code-A-Phone 1200. These are the first such devices designed for the home appliance/consumer market from Philips and certified by the Federal Department of Communications. Units will initially be available across Canada from major department and stationery stores including Simpsons and The Bay at the manufacturer's suggested retail price of $229 (or less) for Code-A-Phone 1200 and $395 (or less) for Code-A-Phone 1400. Code-A-Phone 1400 is a remote telephone answering system offering the user remote control message retrieval from any telephone in the world. A compact sonic coder (about the size of a cigarette pack) beeps into the telephone mouthpiece to trigger message playback.

Utilizing CMOS circuitry, the 1400 records announcement greetings and incoming messages. If the user is home but doesn't wish to take calls, he can still hear the calls by turning up the volume. The simple turn of a dial replays messages. Both units record 20 messages of 30 seconds each with variable length announcement up to 20 seconds. Other features include a call counter that indicates the location of each message on the tape, a fast-forward control button to by-pass messages and a rewind button to repeat messages. Both units are in a plastic housing and operate from regular AC outlets. *Philips Electronics Ltd., Office Products Division, 601 Milner Ave., Scarborough, Ont. M1B 1M8.*

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:

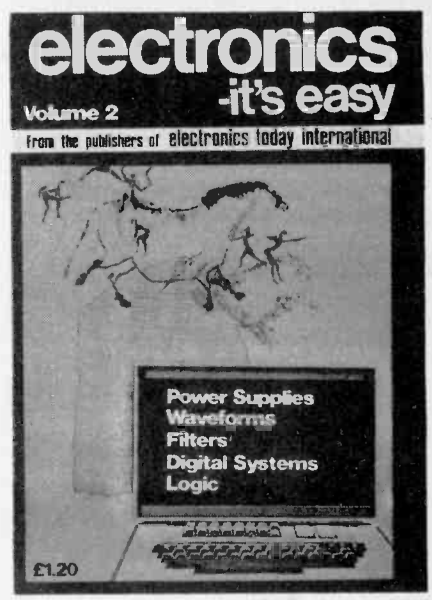
Volumes 1 and two of the best introductory series to electronics ever published in a magazine. Volume three, completing the series, will be available in a few months.

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.



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NEWS DIGEST

BASIC SOFTWARE

Attention, all you computer hackers out there who speak BASIC! We've just come across several volumes of what is called the Basic Software Library. Volume 1 comprises Business & Personal Bookkeeping Programs and Games & Pictures. These are all good programs, including some interesting things like PERT network analysis, cash flow predictions and a variety of not-so-well-known games and pictures. Vol. II, Math & Engineering and Plotting & Statistics, consists of some very heavy stuff indeed, Gaussian Quadratures, Interpolations by Spline Fits, T-Distribution, that kind of thing. Both these volumes are $24.95. Vol. III is entirely Advanced Business Programs, i.e. Billing, Inventory, Payroll, Shipping, and this volume is $39.95. Vols. IV and V contain general interest programs for experimenters and are $9.95 each. The longest business programs will run in 24K bytes, and many will run in a lot less. The programs are written in plain, simple BASIC and will run on virtually any machine, requiring only minor software modifications. Your local computer store may stock, or add $1.50 for postage and handling and order from: *Scientific Research, 1712 Farmington Court, Crofton, MD 21114.*

A THREE-LEGGED CAP

A single ended, tubular aluminum electrolytic capacitor that incorporates a rigid third lead for mechanical support is now offered by International Components Corporation.

The construction of these PDA-T Series radial lead capacitors minimizes vibration problems associated with printed circuit boards where higher capacity × voltage radial capacitors are required. An added advantage is that where the rigid lead is used as a locating lead, polarity insertion is accomplished without error.

Delivery is from stock to 12 weeks. Average price is $0.50 each in production quantities.

For additional information, write or call *Mr. Mel Karasik, International Components Corporation, 105 Maxess Road, Melville, New York 11746, (516) 293-1500.*

VIDEO CASSETTES

Although we lament elsewhere about the non-standardisation of video discs, some nice things seem to be happening in the video cassette field. Sony, Toshiba and Sanyo have jointly developed a two-hour video cassette cystem called Dataformat, so that cassettes will be interchangeable between the different companies' machines.

ANOTHER PROGRAMMABLE?

The new 26-pound HP 9831A desktop computer, priced at $8352, can be used as a stand-alone, BASIC language computer or linked with peripherals to form systems. The 9831 also serves as the heart of the new HP 9896 business information management system also being introduced.

The HP 9831 comes with 8K bytes of memory, expandable to 32K bytes in 8K byte increments. BASIC language commands for String Variables, Input/Output (for peripheral control), and Advanced Programming II operations are built in. Optional Matrix/Plotter Flexible Disk ROMs are also available.

The new desktop computer can work with master and slave flexible-disk drives for additional, fast access memory; plotters; thermal- and character-impact printers; and CRT terminals. It features a built-in, high performance bi-directional tape drive. With 90 ips search-and-rewind speed and a 22 ips read/write speed, the tape cartridge drive gives an average access time of six seconds.

"The 9831 brings powerful computingcapability at a reasonable price for applications in structural and construction engineering, in clinical laboratories, and in general statistics," Fred Bode, marketing manager of HP's calculator products division, Loveland, Colorado, said. "An important part of the product is a group of extensively tested software we are able to offer for each of these fields."

String Variables programming permits handling of string arrays as large as the total memory of the machine. Input/output to a plotter and flexible disks and other peripherals are provided. These capabilities are built-in. The optional Matrix ROM provides such standard matrix operations as inversion, transposition and multiplication, and two-dimension array operators.

Through as many as three interface cards, the 9831 will work with standard HP peripherals, such as the 9866 B thermal line printer, the 9871A character impact printer/plotter, plotters, paper tape readers, and the new 9885 flexible disk.

The 9831 uses second generation N-MOS (LSI) circuits designed by HP to provide high speed performance. In addition to the four bipolar chips for the display, the desktop computer contains a processor chip, an input/output chip, and an extended math chip. ROM memory is based on HP's 16 × 1024-bit ROM.

Initial customer deliveries will begin in March. *Inquiries Manager, Hewlett-Packard (Canada) Limited, 6877 Goreway Drive, Mississauga, Ontario.*

NEW CATALOGUE

Just arrived on our desk at ETI (what, only one desk for all of you, we hear you cry) is the latest catalogue from Canmos Electronics. Listed is a good selection of TTL, CMOS and linear ICs, transistors and diodes, Rs and Cs, pots, LEDs, data books, PCB gear, cases, transformers, prototyping hardware etc, etc. All good stuff, but we still think the best page is the one that mentions us!! . . . *CANMOS, Box 1690, Peterborough, Ontario K9J 7S4.*

NEWS DIGEST

'TOUCH-HOLD' DMM

This new battery/AC portable 4½ digit, five-function digital multimeter from Hewlett-Packard is low cost and has a unique 'touch-hold' probe available as an accessory. It lets the user 'freeze' the reading on the display — a convenience when probing closely-packed circuit boards.

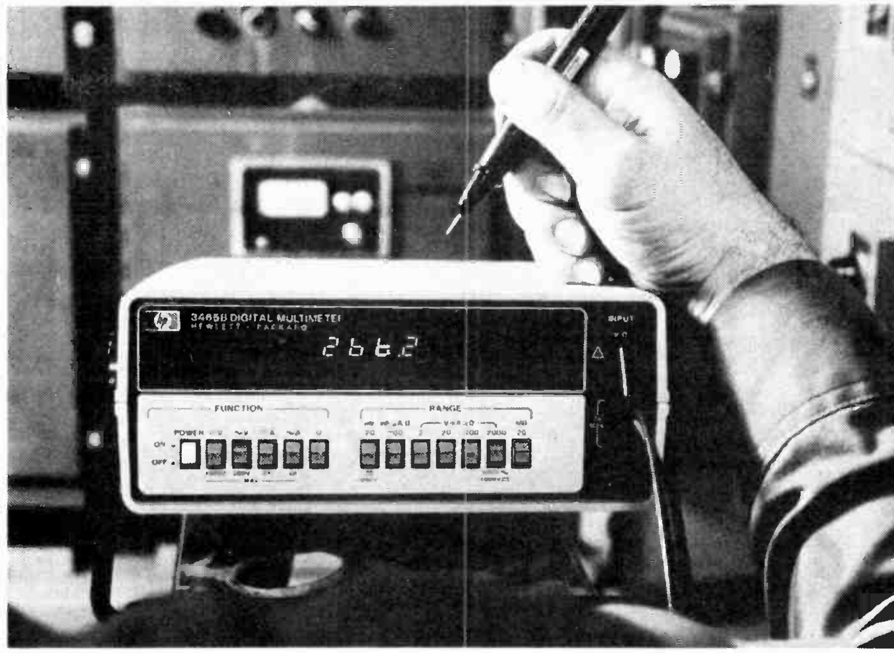
Called the Model 3465B, the $575.00 DMM has a DC measurement range from 1mV to 1kV with a mid-range accuracy of ± (0.02% of rdg. + 0.01% of range) for one year. AC measurement range is 10 V to 500V with a mid-range accuracy of ± (0.15% of rdg. + 0.05% of range) over a 40 Hz to 20 kHz bandwidth. AC and DC current measurement range is from 10 nA to 2 A. DC current accuracy for the 10 mA range is ± (0.1% of rdg. + 0.01% of range). AC current measurements are made over a frequency band of 40 Hz to 20 kHz with a mid-band accuracy of ± (0.25% of rdg. + 0.25% range).

Resistance range is 10 m   to 20 M with a mid-range accuracy of ± (0.02% of rdg. + 0.01% of range). Open circuit voltage on the ohms terminal when set to its lowest range does not exceed 5V, preventing damage to most solid-state devices.

Input protection is provided to 1 kV on any DC range, 500 V RMS on any AC range, and 350 V peak on any resistance range. A front-panel fuse protects the instrument from overload when measuring current.

The HP 34112A touch-hold probe accessory ($46), provides greater utility by allowing the operator to focus his attention on the point of measurement in hard to reach circuits. The touch-hold probe, which plugs into the front panel input connectors, holds the DMM reading at the touch of a button.

Inquiries Manager, Hewlett-Packard (Canada) Ltd., 6877 Goreway Drive, Mississauga, Ontario.



ANTI-THEFT DEVICE

The problem of care tape deck thefts has prompted a Canadian company to come up with a device to deter thieves. Any unauthorized attempt to remove a tape deck or similar device sets off a spring switch, resulting in the destruction of circuits in the equipment so that it is unusable. Fortunately, decal warnings are supplied to be mounted on the windshield and the equipment itself, but me, I'd rather not chance it on an expensive CB, although the company says destruction by attempted theft would be covered by insurance policies.

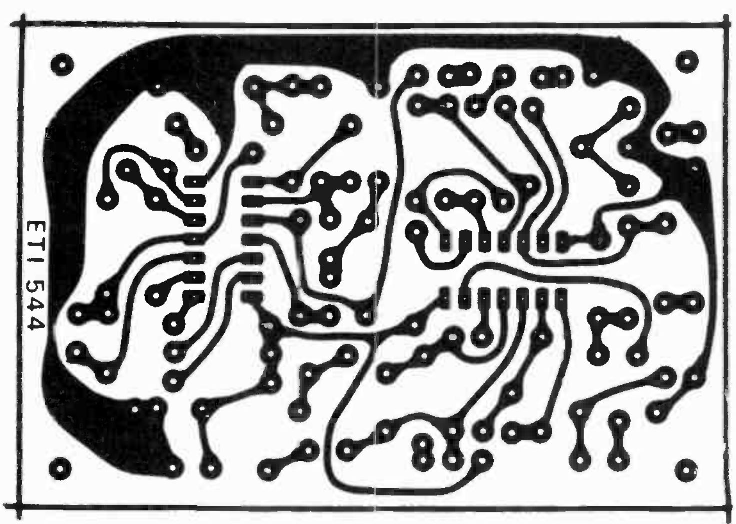
Master Developments Ltd., North Vancouver, B.C.

HIGH-CURRENT THYRISTOR

The Toshiba Co. in Japan has developed a new thyristor which can switch up to 600A at 1,300V. This is three times better than the previous best of 200A for gate-turn off thyristors. So if you have a 780kw load that needs switching. . . .

MINIATURIZATION?

A 12-foot-high electron tube that weighs half a ton is being developed by Valvo Gmbh of Hamburg, West Germany. The V75sk klystron is designed to supply up to 600kw to a new positron-electron tandem-ring accelerator being built in Hamburg.



Full size 91 x 64mm.

BOARDING PARTY

Readers who bought the December issue of ETI which was imported from the UK, may have noticed the absence of the PCB track pattern for the Heart-Rate Monitor, ETI Project Number 544 (whaddya mean, you didn't notice?). In case you've been cursing us and messing around with pieces of Vector board, we apologise profusely and reproduce it herewith.

LM379S

We have been advised as we go to press that National Semiconductor are now shipping a part called the LM379S, which has a different heatsink arrangement and, more importantly, 0.3" width rather than the 0.6" in the version we used in the ETI 444 Five Watt Stereo last month. If you buy this part, it looks like you'll have to build a bit of a spider's nest to get it in, or possibly modify the PCB design.

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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.)	

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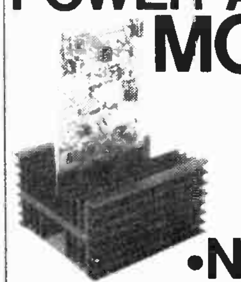

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T.H.D.	0.05% @ 1kHz	0.05% @ 1kHz	0.05% @ 1kHz
Damping Factor	200	400	400
Hum & Noise	115dB below 70 watts	115dB below 110 watts	115 dB below 170 watts
Input Sensitivity	0dB (0.775V) 70 watts	0dB (0.775V) 110 watts	0dB (0.775V) 170 watts
Input Impedance	47k	47k	47k
Power Requirement	± 35Volts	± 45Volts	± 55 Volts
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INDUCTION BALANCE METAL DETECTOR

A really sensistive design operating on a different principle from that of other published circuits. This Induction Balance circuit will really sniff out those buried coins and other items of interest at great depths depending on the size of the object.

"ANOTHER METAL LOCATOR," some of you will say. Yes and no. Several designs have been published in the hobby electronics magazines; some good, some downright lousy but they have invariably been Beat Frequency Oscillator (BFO) types. There's nothing wrong with this principle — they are at least easy to build and simple to set up. The design described here works on a very different principle, that of induction balance (IB). This is also known as the TR principle (Transmit-Receive).

First a word of warning. The electronic circuitry of this project is straightforward and should present no difficulty even to the beginner. However, successful operation depends almost entirely upon the construction of the search head and its coils. This part accounts for three-quarters of the effort. Great care, neatness and patience is necessary and a sensitive 'scope, though not absolutely essential, is very useful. It has to be stated categorically that sloppy construction of the coil will (not may) invalidate the entire operation.

IB VERSUS BFO

The usual circuit for a metal locator is shown in Fig. 2a. A search coil, usually 6in or so in diameter is connected in the circuit to oscillate at between 100-150kHz. A second internal oscillator operating on the same frequency is included and a tiny part of each signal is taken to a mixer and a beat note is produced. When the search coil is brought near metal, the inductance of the coil is changed slightly, altering the frequency and thus the tone of the note. A note is produced continually

and metal is identified by a frequency change in the audio note.

The IB principal uses two coils arranged in such a way that there is virtually no inductive pick-up between the two. A modulated signal is fed into one. When metal is brought near, the electromagnetic field is disturbed and the receiver coil picks up an appreciably higher signal.

However, it is impractical for there to be no pickup — the two coils are after all laid on top of each other. Also our ears are poor at identifying changes in audio level. The circuit is therefore arranged so that the signal is gated and is set up so that only the minutest part of the signal is heard when no metal is present. When the coil is near metal, only a minute change in level becomes an enormous change in volume.

BFO detectors are not as sensitive as IB types and have to be fitted with a Faraday screen (beware of those which aren't — they're practically useless) to reduce capacitive effects on the coil. They are however, slightly better than IB types when it comes to indentifying exactly where the metal is buried — they can pin-point more easily.

Our detector is extremely sensitive — in fact a bit too sensitive for some applications! For this reason we've included a high-low sensitivity switch. You may ask why low sensitivity is useful. As a crude example, take a coin lying on a wooden floor: on maximum sensitivity the detector will pick up the nails, etc., and give the same readings as for the coin, making it difficult to find.

Treasure hunting is an art and the dual sensitivity may only be appreciated after trials.

Table 1 gives the distances at which various objects can be detected. These are static readings and only give an indication of range. If you are unimpressed with this performance you should bear two things in mind: first compare this

ETI Project 549

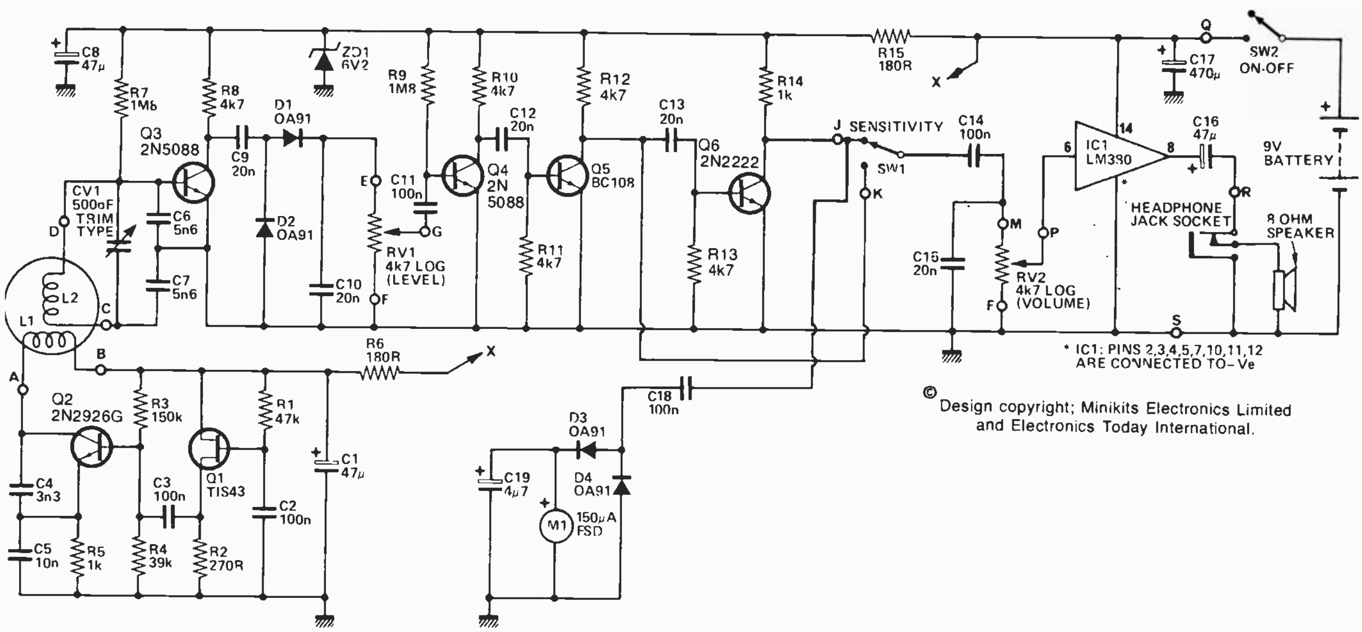


Fig. 1 Complete circuit of the metal locator. Note that though the electronics is simple using very common parts, the whole operation depends on the coils L1 and L2 which must be arranged so that there is minimal inductive coupling between the two. Note also that the leads from the circuit board to the search head must be individually screened and earthed at PCB.

TABLE 1
Table showing sensitivity of the metal locator in free air. (Buried objects can usually be detected at greater depths.)

OBJECT	HIGH SENS	LOW SENS
2p COIN	8"	6"
BEER CAN	17"	14"
6" SQUARE COPPER	22"	16"
6" STEEL RULER	12"	9"
MANS GOLD RING	8"	6"

with any other claims (ours are excellent and honest) and secondly bear in mind how difficult it is to dig a hole over 1ft of ground every time you get a reading. Try it — it's hard work!

COMPONENT CHOICE

The unijunction Q1 is *not* the normal 2N2646; we found several examples of these erratic in their level — we are talking about tiniest fractions of one per cent which would normally not matter, but it *does* in this circuit. Even some examples of the TIS43 did not work well — see the note in How it Works. Secondly Q2 is deliberately a plastic type. Metal canned transistors usually have the collector connected to the case and due to the nature of the circuit we noted a very small change in signal level due to capacitive effects when metal can types were used.

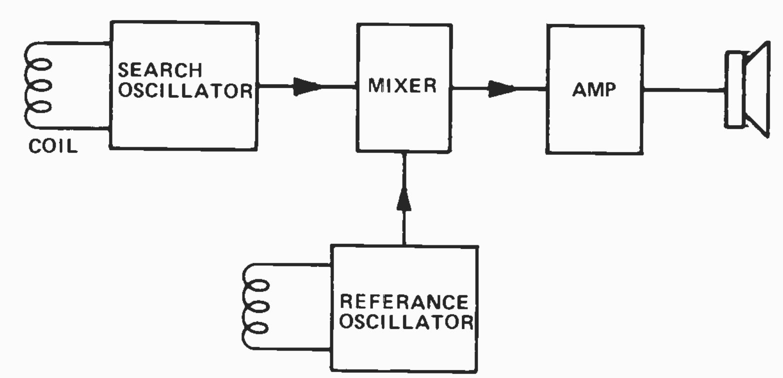


Fig.2a Block diagram of the common BFO type metal locator.

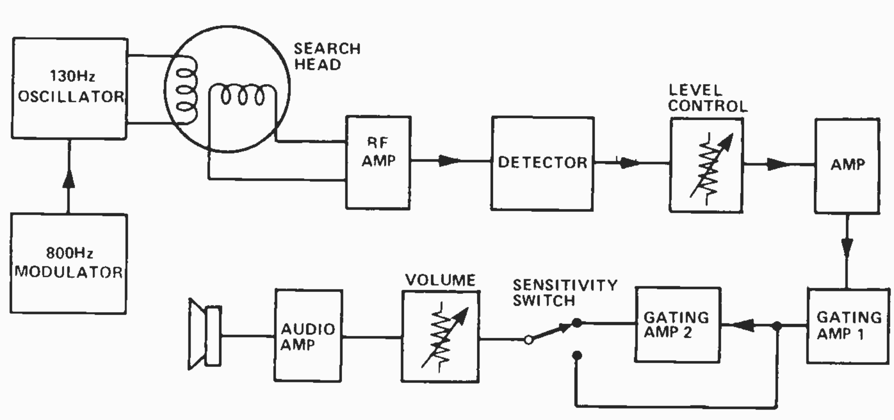


Fig2b Block diagram of our IB design.

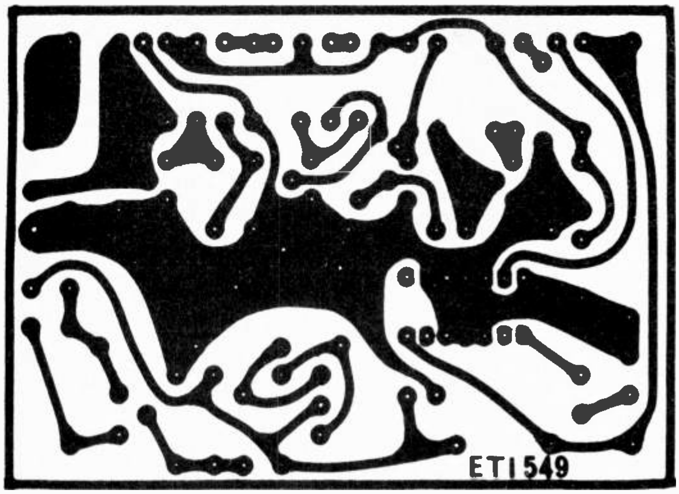


Fig.3 The PCB pattern. Most components other than the meter circuitry is built on this.

HOW IT WORKS — ETI 549

Q1, Q2 and associated components form the transmitter section of the circuit. Q1 is a unijunction which operates as a relaxation oscillator, the audio note produced being determined by R1 and C1. The specified components give a tone of roughly 800Hz. R1 can lie in the range 33k to 100k if a different audio frequency is desired.

Q2 is connected as a Colpitt's oscillator working at a nominal 130kHz; this signal is heavily modulated by C3 feeding to the base of Q2. In fact the oscillator produces bursts of RF at 800Hz. L1 in the search head is the transmitter coil.

L2 is arranged in the search head in such a way that the minimum possible signal from L1 is induced into it (but see notes on setting up). On all the prototypes we made we reduced this to about 20mV peak-to-peak in L2. L2 is tuned by C6 and C7 and peaked by CV1 and feeds to the base of Q3, a high gain amplifier. This signal (which is still modulated RF) is detected by D1, D2 providing the bias for D1. The RF is eliminated by C10 and connects to the level control RV1.

The signal is further amplified by Q4 which has no DC bias connected to the base. In no-signal conditions this will be turned off totally and will only conduct when the peaks of the 800Hz exceed about 0.6V across R11. Only the signal above this level is amplified.

On low sensitivity these peaks are connected to the volume control RV2 (any stray RF or very sharp peaks being smoothed by C15) and fed to the IC amplifier and so to the speaker.

The high sensitivity stage Q6 is connected at all times and introduces another gating stage serving the same purpose as the earlier stage of Q5. This emphasises the change in level in L2 even more dramatically. Note that RV1 has to be set differently for high and low sensitivity settings of SW1.

Whichever setting is chosen for SW1, RV1 is set so that a signal can just be heard. In practice it will be found that between no-signal and moderate-signal there is a setting for RV1 where a 'crackle' can be heard. Odd peaks of the 800Hz find their way through but they do not come through as a tone. This is the correct setting for RV1.

The stage Q6 also feeds the meter circuit. Due to the nature of the pulses this need only be very simple.

Since we are detecting really minute changes in level it is important that the supply voltage in the early stages of the receiver are stabilised, for this reason ZD1 is included to hold the supply steady independent of battery voltage (which will fall on high output due to the current drawn by IC1).

It is also important that the supply voltage to Q1 and Q2 does not feed any signal through to the receiver. If trouble is experienced (we didn't get any) a separate 9V battery could be used to supply this stage.

IC1 is being well underused so a heatsink is unnecessary.

Battery consumption is fairly high on signal conditions — between 60mA and 80mA on various prototypes but this will only be for very short periods and is thus acceptable. A more modest 20mA or so is normal at the 'crackling' setting.

Stereo headphones are used and are connected in series to present 16 ohms to IC1 reducing current consumption.

Selection of Q1 and Q2

We found that Q1 and to a lesser extent Q2 required careful selection. Q1 should be chosen for the minimum possible 'crackle' — so that the transition from no-signal to hearing the 800Hz is as definite as possible. Some transistors for Q1 and Q2 can produce higher odds peaks than others.

We have specified Q3 and Q4 types as 2N5088 (a high gain type) for although lower gain transistors worked for us, they left little reserve of level on RV1 and really low gain types may not work at all.

RV1 is the critical control and should be a high quality type — it will be found that if has to be set very carefully for proper operation.

The choice of an LM380 may seem surprising as only a small part of its power can be utilised with battery operation. It is however inexpensive and widely available unlike the alternatives (note it does not require DC blocking at the input).

Output is connected for an 8ohm speaker and to headphones. Stereo types are the most common and the wiring of the jack socket is such that the two sections are connected in series presenting a 16ohm load (this reduces current consumption from the battery).

METER CIRCUIT

Since the circuit is basically sensing a change in audio level, a meter circuit can be incorporated. For the very first indication from the 'crackle' (see later) to heavy crackle your ears are likely to be more sensitive than the meter but thereafter it will come into its own.

This part of the circuit is optional and the components are not included on the board.

CONSTRUCTION: CONTROL BOX

The majority of the components are mounted on the PCB shown in Fig 3. Component overlay and the additional wiring is shown in Fig. 4.

Exceptional care should be taken to mount all components firmly to the board. The trimmer capacitor CV1 is mounted at right angles to the board, its tags being bent over and soldered firmly to the copper pads. This enables it to be trimmed with the box closed. A plastic trimming tool should be used if possible. Poor connections or dubious solder joints may be acceptable in some circuits — not in this one. Take care to mount the transistors, diodes and electrolytic capacitors the right way around.

The PCB is fitted into the control box by means of long screws and pillars. The control box has to be drilled to take the speaker, the pots, switches, headphone jack and the cable from the search head.

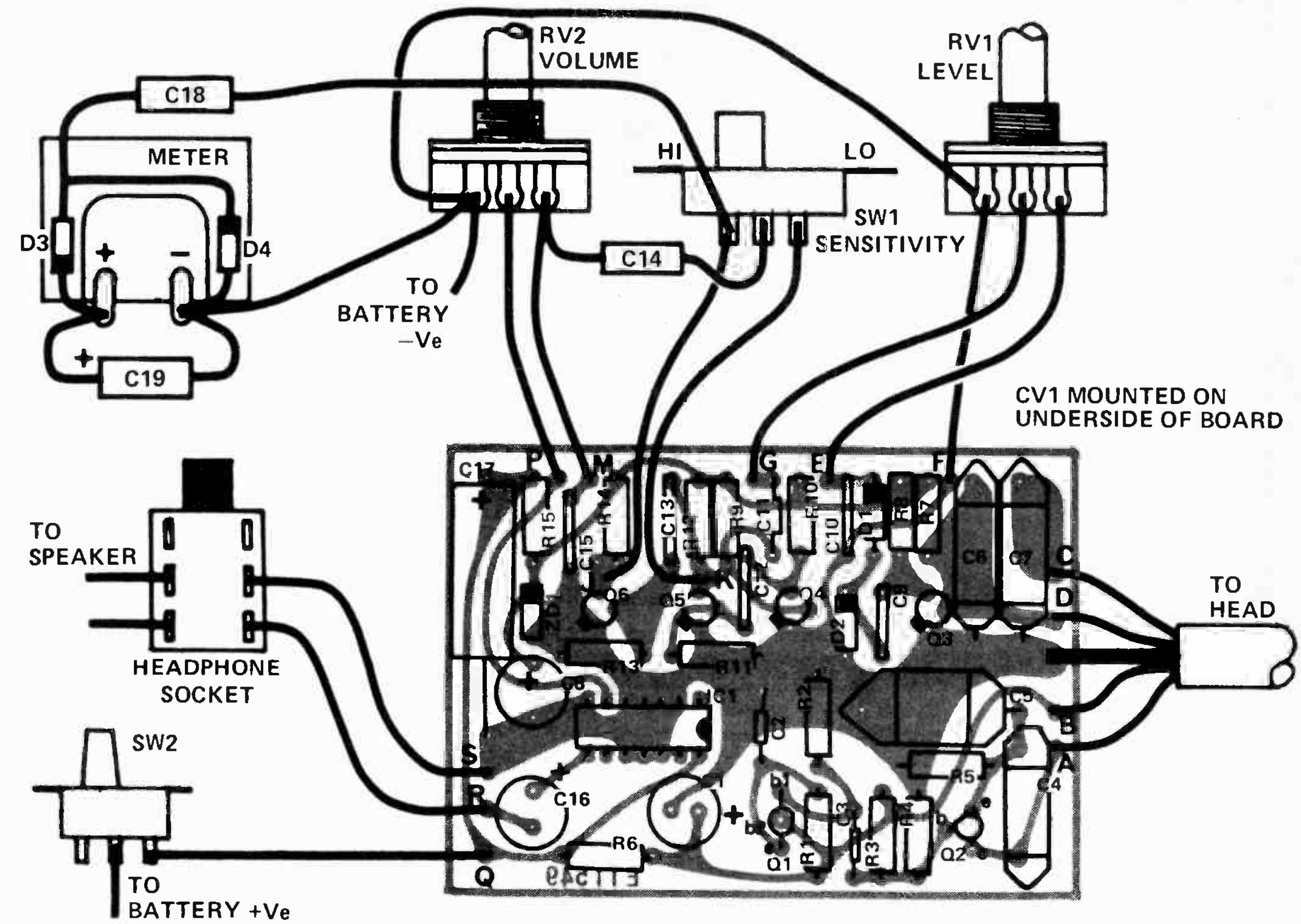


Fig. 4. The component overlay and wiring diagram to other parts of the circuit not on the PCB.

PARTS LIST — ETI 549

Resistors

R1	47k	¼W, 5%
R2	270R	¼W, 5%
R3	150k	¼W, 5%
R4	39k	¼W, 5%
R5, 14	1k	¼W, 5%
R6, 15	180R	¼W, 5%
R7, 9	1M8	¼W, 5%
R8, 10,11,12,13	4k7	¼W, 5%

Potentiometers

RV1	4k7	log rotary
RV2	4k7	log rotary

Capacitors

C1,8,16	47µF 16V electrolytic
C2,3,11,14,18	100nF ceramic etc
C4	3n3 polystyrene 5%
C5	10n polystyrene 5%
C6,7	5 n 6 polystyrene 5%
C9,10,12,13,15	20n ceramic etc
C17	470µF 16V electroytic
C19	µF 16V electrolyric
CV1	500p trimmer

(Note 1n = 1000pF

Semiconductors

Q1	TIS43 Unijunction
Q2	2N2926 – see text
Q3, 4	2N5088
Q5, Q6	2N2222
IC1	LM380 14 pin DIL
D1, 2, 3, 4	OA91
ZD1	6.2 volt 400m W Zener diode

MISCELLANEOUS

SW1 SW2, 2 pole, 2 way slide switches
Stereo jack socket
Miniature (2¼in etc) 8ohm loudspeaker
L1, L2 – See text and drawings
4 core, individually screened cable, 1.5 metres
Battery clip
Battery
Wood and laminate for search head
2 Control knobs, Nylon Nut Bolt
M1 Signal level meter, 150µA movement
Cold Water Plumbing (see text)
Bicycle Grip

THE HANDLE ASSEMBLY

The handle is made totally from standard parts. The general construction can be seen in Fig. 5. This is made from cold water plumbing available from many plumbing shops. The hand grip is that for a bicycle — also easily available and a perfect fit onto the plastic pipe. A right-angled elbow and two sleeve connectors are specified. The elbow should be glued firmly and one end of each of the connectors should be glued also. The reason for the con-

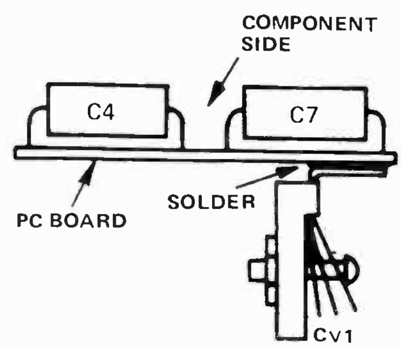
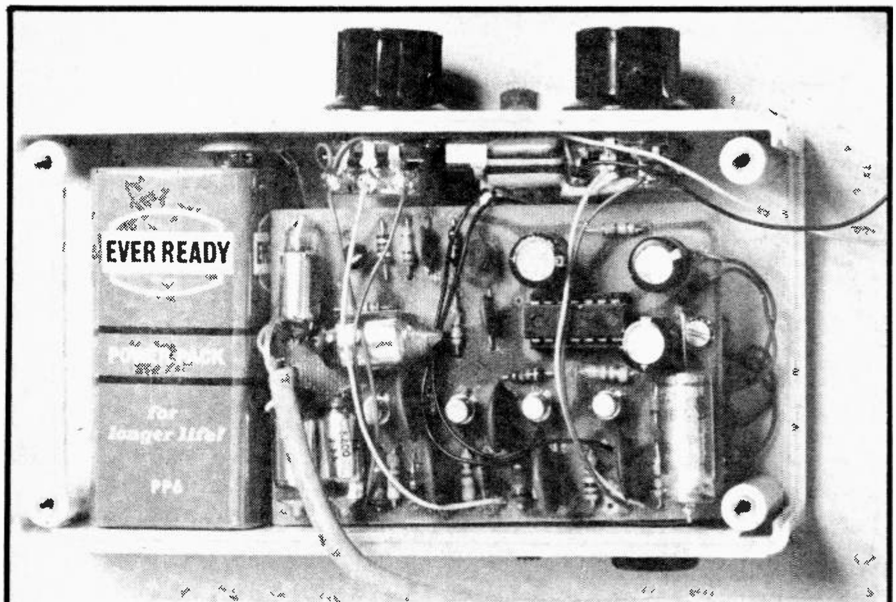


Diagram showing Cv1 mounted on copper side of P C Board



Internal photograph of metal locator control box.

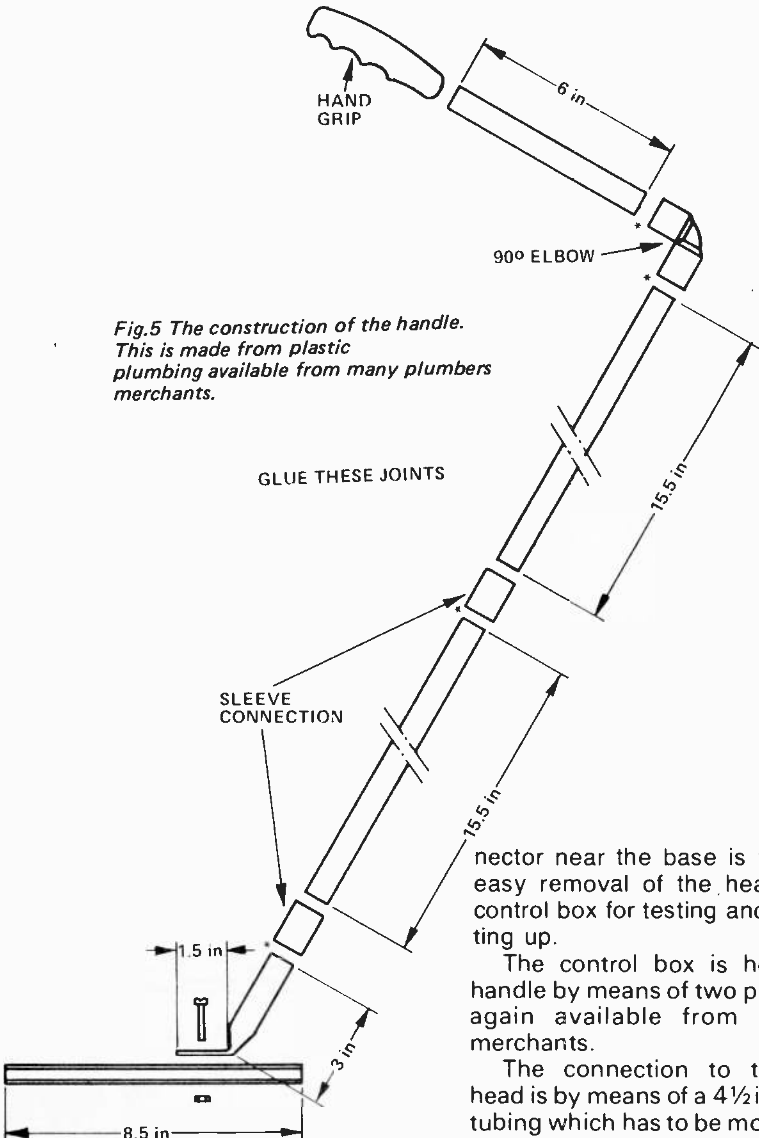


Fig.5 The construction of the handle. This is made from plastic plumbing available from many plumbers merchants.

nector near the base is to facilitate easy removal of the head and the control box for testing and initial setting up.

The control box is held to the handle by means of two pipe clips — again available from plumber's merchants.

The connection to the search head is by means of a 4½in length of tubing which has to be modified. Put 2½in of this tube into boiling water for about half a minute to soften the plastic, take it out and quickly clamp it into a vice to flatten half the length, at the same time bending the flat to about 30°. This will now lie across the top of the search head and is glued into position and held by a single nylon nut and bolt through the top of the search head.

THE COIL

Remember this is the key to the whole operation. The casing of the coil is not so critical but the layout is.

It is best first to make the 6mm plywood circle to the dimensions shown in Fig. 5. A circle of thinner plywood or hardboard is then firmly clued onto this — it's fairly easy to cut this after glueing. Use good quality ply and a modern wood glue to make this.

This now forms a dish into which the coils are fitted. The plastic connector to the handle should be fitted at this stage.

You'll now have to find something cylindrical with a diameter of near enough 140mm (5½in). A coil will then have to be made of 40 turns of 0.280mm enamelled copper wire. The wire should be wound close together and kept well bunched and taped to keep it together when removed from the former. Two such coils are required: both are identical.

One of the coils is then fitted into the "dish" and spot glued in six or eight places using quick setting epoxy resin: see photogaraph of the approximate shape.

L2 is then fitted into place, again spot gluing it *not* in the area that it overlaps L1. The cable connecting the coil to the circuit is then fed through a hole drilled in the dish and connected to the four ends. These should be directly wired and glued in place, obviously taking care that they don't short. The cable must be a four-wire type with individual screens — the screens are left unconnected at the search head.

You will now need the built up control box and preferrably a 'scope. The transmit circuit is connected to L1. The signal induced into L2 is monitored; at first this may be very high but by manipulating L2, bending it in shape, etc., the level will be seen to fall to a very low level. When a very low level is reached, spot glue L2 until only a small part is left for bending.

Ensure that when you are doing this that you are as far away from any metal as possible but that any metal used to mount the handle to the head is in place. Small amounts of metal are acceptable as long as they are taken into account whilst setting up.

Now connect up the remainder of the circuit and set RV1 so that it is *just* passing through a signal to the speaker. Bring a piece of metal near the coil and the signal should rise. If it falls in level (i.e. the crackling disappears) the coil has to be adjusted until metal brings about a rise with no initial falling. CV1 should be adjusted for maximum signal, this has to be done in conjunction with RV1.

Monitoring this on a scope may mean that the induced signal is not at its absolute minimum: this doesn't matter too much. Now add more spot gluing points to L2.

You should now try the metal locator in operation. If RV1 is being operated entirely at the lower end of its track, making setting difficult, you can select a lower gain transistor such as a BC108 for Q4.

When you are quite certain that no more manipulation of the coils will improve the performance, mix up plenty of epoxy resin and smother both coils, making certain that you don't move them relative to each other.

The base plate can then be fitted to enclose the coil, this should be glued in place.

Photograph showing coil being adjusted.

USING THE METAL LOCATOR

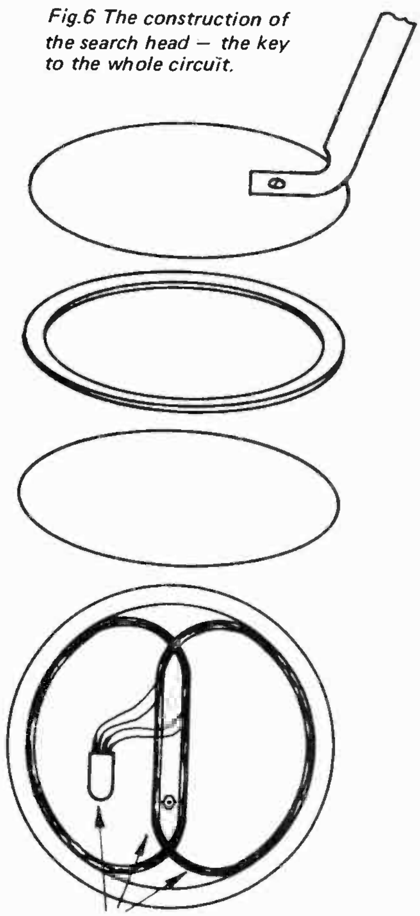
You will find that finding buried metal is rather *too* easy. 95% will be junk — silver paper being a curse. The search head should be panned slowly over the surface taking care to overlap each sweep: the sensitive area is somewhat less than the diameter of the coil.

This type of locator will also pick up some materials which are not metal — especially coke and it is also not at its best in wet grass.

Think very carefully about where you want to search: this is more important than actually looking. The area you can cover thoroughly is very, very small, but is far more successful than nipping all over the place. As an example of how much better a thorough search is, we thoroughly tried on 25 square feet of common ground (5ft x 5ft); we found over 120 items but a quick search initially had revealed only two!

Treasure hunting is growing in popularity and those who do it seriously have adopted a code; essentially this asks you to respect other people's property, to fill in the holes you dig and to report any interesting finds to museums. ●

Fig.6 The construction of the search head — the key to the whole circuit.



Sinclair Programmable

ETI REVIEW

THIS YEAR EVERYBODY is buying scientific calculators, and it looks like next year everyone will want to buy programmable scientifics. Sinclair Radionics have scooped the field by producing a programmable for under $50 and ETI have had one in operation for a while.

What is a programmable? Basically it is a standard calculator — usually a mathematical or scientific type with extra memory space — which can memorise the sequence of keystrokes needed to solve a particular problem. Hence it can be used to find the values of "x" which satisfy $ax^2 + bx + c = 0$ for several sets of values of a, b and c. The sequence of operational keystrokes needed is stored in the extra memory. When the program is run the values of a, b and c are fed in as data (via the keyboard) and the calculator replays the mathematical operations required to extract the roots of the equation. The same program may be run many times with different values for the variables. Thus many long and repetitive calculations may be carried out in a short time. The era of cheap programmable calculators is now with us, giving everybody access to the powerful problem-solving and decision-making machines that were until now available only to the privileged few in the computer industry.

The program memory may be either an interchangable magnetic card, as found in the Hewlett-Packard HP67 ($575), or it may be a separate IC as in other HP models (HP55: $425; HP25: $179) and National Semiconductor (Novus 4515: $39.95; Novus 4525: $49.95). Several other manufacturers plan to introduce programmables within the next few months. The basic difference between the capabilities of the various machines is the maximum number of program steps that may be stored. These range from 24 steps to 224 steps in the machines mentioned. The ability of the machine to make decisions ($x>0, x=0$ etc) and to make branches and conditional branches from the main program are other factors to consider.

THE SINCLAIR PROGRAMMABLE

Well how does the Sinclair fit in? Being the cheapest programmable calculator on the market at the moment it lacks some of the features of the more sophisticated machines The program memory (which is a semiconductor memory) has a capacity of 24 keystrokes which although not as many as one might desire still makes the Sinclair a powerful machine capable of solving quite complex problems.

The calculator is mounted in the same case as the Oxford range with the same keyboard layout of 19 keys plus the on/off switch, mounted in five rows of four keys. The display is a green, fluorescent type having a total of nine digits mounted at an angle to the plane of the keyboard so that the display is easily read over a large angle. The basic calculator, is very similar to the Sinclair Scientific with Reverse Polish Notation on input and all answers displayed in scientific notation only (separate mantissa and exponent). The display gives a five digit mantissa and a two digit exponent with signs for each. Fifteen of the keys are dual function with the following direct functions available: sin x, cos x, arc tan x, $\sqrt{x}$, antilog x, log x, 1/x, and x^2. There also are keys for the separate data memory: store, recall, and x-memory interchange. Because the machine uses RPN there is no = key but there is a "enter" key (the second function of the zero key — of which more later). There are also four keys which will only be found on a programmable calculator: ",B/E, EXEC, and VAR. Thus there are several useful keys missing from the usual scientific repertoire: arc sin, arc cos, tan and the constant π (all to be found on the Sinclair Oxford 300 scientific). The logarithms are all to base 10 as in the original Scientific, whereas in the Oxford 300 the base is e. The loss of arc sin, arc cos, and tan is certainly a disadvantage. The handbook does give routines to find them but these take between 9 and 12 keystrokes instead of the usual one or two. All trigonometric functions are in radians only and are limited in argument range to 0 to π /2.

APPRAISAL

As a standard scientific calculator the machine was a little disappointing because of the lack of functions and the compromises which had to be made to the key layout to incorporate the programming controls. The lack of a separate "enter" key means that a simple multiplication (2x3, for instance) requires 5 keystrokes: "2", "▲", "enter", "3" and "x" (although a key stroke may be saved by using the "+" key as an enter key). Any calculator, even one with the additional feature of programming must first and foremost be a calculator. Why then did Sinclair not make the "enter" key a separate "first function" key — perhaps combined with the execute key as its second function? After all they have a lot in common. When data is entered the key marked ./EE/- has an interesting function. When first pressed during number entry it will set the decimal point in the mantissa. When pressed again during the entry of the same number it will set any further digits in the exponent range of the number. With the third or subsequent operation of the key it will change the sign of the exponent.

As a programmable calculator the Sinclair is good, although some features are rather disappointing. With only a 24 step program, memory keystrokes are at a premium. Yet any constants that may be required to be entered must be preceded, and followed, by a quote mark: each of which counts as a keystroke. Because only integer constants can be entered (ie no decimal points or exponents) there are problems if the constants "e" or π are used in a program. The constant "e" is entered as 878 ÷ 323 and (because each digit counts as a separate keystroke) this uses 12 steps of program space (",8,7,8,", enter, ",3,2,3,", ÷) or half the total program capacity.

The program to tabulate the function e^x for any x will occupy 14 steps of memory (B/E, enter, ",8,7,8,",x,",3,2,3, ÷ ,VAR). This function is available as a single keystroke on many scientifics. If the function being tabulated is $f(x) = \sinh x = e^x - e^{-x}/2$ then there is not enough program space to allow direct calculation of sinh x. The program given in the program library first calculates e^x and then $1/e^x$ $(=e^{-x})$. These are then subtracted and then the sign of the answer is changed. The last two operations require double operation of the '-' key and then finally this intermediate answer is returned to the control of the program (operate the "Exec" key again) where it is divided by two and the displayed answer is at last "sinh x".

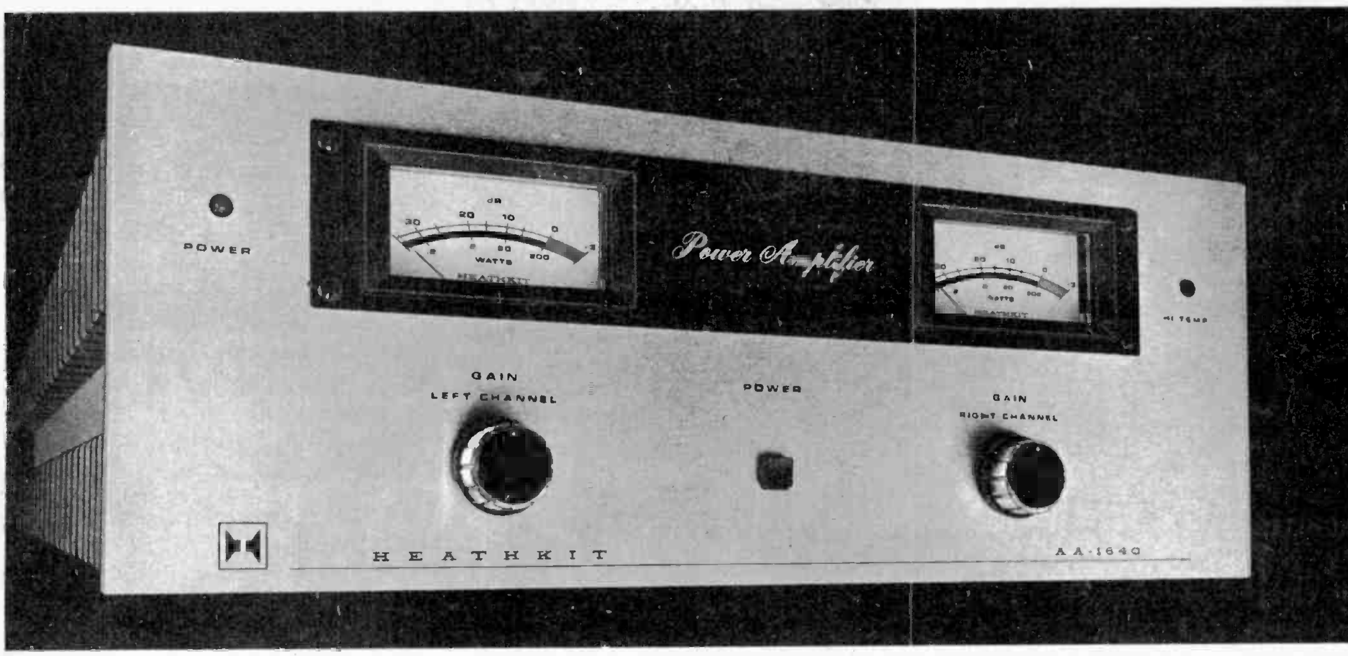
Thus by adding the programmable feature to a fairly basic scientific calculator Sinclair give the option of having access to several functions only available on scientifics several times the price of the programmable. However these additional functions will have to be programmed in whenever required and may still need several keystrokes before they are evaluated.

PROGRAM LIBRARY

The program library supplied with the machine covers a fairly wide range of subjects and is impressively printed on high quality cards. The only criticism of the library is that the given programs are rather short on explanation. The lack of program memory space has been compensated for by some very ingenious programs but the owner will need to spend considerable time with pencil and paper working out the relevance of each program step or he will feel like the "trained monkey" just following the given instructions knowing that at the end he will get the reward of a correct answer. If the calculator is to be widely appreciated by its owners then more explanation is needed for program writers.

The handbook supplied with the machine is reasonably good although here again more program examples would be welcome. The machine is generally well constructed; the keyboard has a good positive feel to it although the on/off switch was almost impossibly stiff on our example. The machine is advertised as a mains/battery device but the current drain from a PP3 battery is nearly 100mA. The handbook statement that only occasional use on battery is recommended must be emphasised. Low battery volts show up as either "rubbish" answers or as a lock-up into the program mode with data fed in never reappearing.

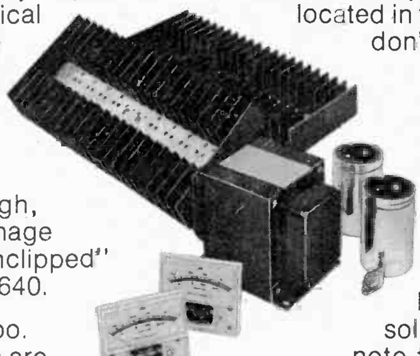
Summing up then the Sinclair Programmable Scientific is a very good attempt to produce a programmable at the lower end of the price range. Because of the attempt to stay under $50.00 some of the facilities are rather limited and operation can be somewhat inconvenient. For all our criticism however, Sinclair are to be congratulated on this model which will no doubt prove a useful introduction to programmable calculators for many people and it will act as a spur to other manufacturers to produce low price programmables (just as the original Sinclair Scientific acted as a spur to both sales and design of standard scientifics). The year ahead should prove very interesting for observers of the calculator market. ●



Heathkit "Super-Amp"

The Heathkit AA-1640 is one powerful stereo amplifier — 200 watts, minimum RMS, per channel into 8 ohms with less than 0.1% total harmonic distortion from 20-20,000 Hz.

That massive power virtually eliminates one of the most common forms of distortion — clipping. Driving low or medium-efficiency speakers (like acoustic suspension) to a moderate listening level may require 20 watts per channel. But a momentary musical peak twice as loud as the average level requires 10 dB more power — that's 200 watts per channel. If your amplifier can't deliver that much, the peak is "clipped" off. That destroys the music's dynamic range, making it sound dull, constricted and unrealistic. It also produces rough, raspy harmonics that can actually damage tweeters. You won't believe how good "unclipped" music can sound until you hear the AA-1640.



And what you don't hear sounds good, too. Harmonic and intermodulation distortion are under 0.1% at any power level from 0.25 watts to full power. We think that makes them absolutely inaudible. Hum and noise are also inaudible — 100 dB below full output. And you can enjoy all that quiet because the AA-1640 requires no fan. Even as a PA amplifier, its massive heat sinks need only normal ventilation.

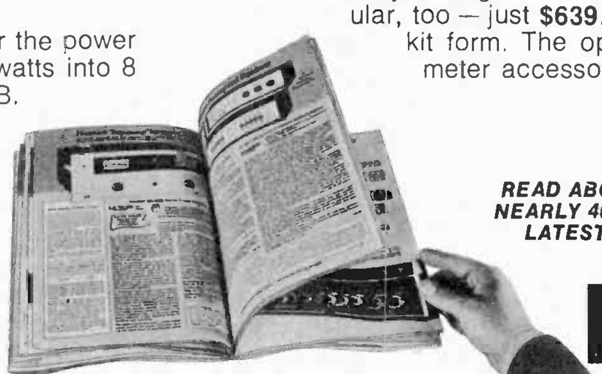
Optional peak-responding meters monitor the power output directly in watts from 0.2 to 200 watts into 8 ohms and in decibels from −30 to +3 dB. Expanded scales provide a highly-visible meter indication, even at low-power levels. Special ballastic circuitry allows the meters to respond to peaks as short as a record click, making them extremely effective overload indicators.

It almost takes an engineer to appreciate the AA-1640's conservative, reliable design — direct-coupled, differential input amplifier, 16 output transistors (8 per channel) in parallel, quasi-complementary configuration, 12 pounds of diecast heat-sinking, a 25-pound power supply transformer, dissipation limiting, automatic thermal shutdown, and output compensation make it unconditionally stable with any load.

A special relay prevents power on/off thumps from reaching your speakers and protects them from DC and extremely low frequency AC. Speaker fuses are located in the primary feedback loop where they don't degrade bass clarity by lowering the damping factor — a Heath exclusive. Its 1.5V input sensitivity is compatible with most stereo amplifiers.

But it doesn't take an engineer to hear how great the AA-1640 sounds. Its massive power and incredibly low distortion make a big difference. For the first time you'll hear how good your system really is — solid bass, free from "boom" and distinct, note for note... spacious, effortless midrange... realistic, high-definition treble. Combine that with the exciting dynamic range that rivals a live performance plus inaudible distortion and you've got sound that's nothing less than spectacular.

And when you compare performance and reliability, we think you'll agree that the price is spectacular, too — just **$639.95** in easy-to-build kit form. The optional AAA-1640-1 meter accessory kit is just **$99.50**



READ ABOUT THE AA-1640 AND NEARLY 400 OTHER KITS IN THE LATEST HEATHKIT CATALOG. SEND CARD TODAY!

FREE

Prices quoted mail order only - F.O.B. Mississauga

This new tape format combines the performance potential of open-reel with the convenience of the cassette.

THE SONY ELCASET

THE COMPACT CASSETTE FORMAT introduced by Philips some years ago has been responsible for a number of remarkable developments in the field of tape recording. Major tape manufacturers have refined and improved oxide formulations and coating processes, equipment manufacturers have researched and developed new head designs using improved materials, and of course a number of noise-reduction systems have come into being.

Even so, the Compact Cassette has inherent restrictions. Even with the finest heads and tape, it is still not possible to record the highest audio frequencies on cassettes to give useful output levels; at extreme low frequencies problems still occur with replay equalisation and this gives audible performance deficiencies. It is clear the Compact Cassette is stretched to its performance limits at the present time, and whilst we can expect to see a continuation of the present trend of gradual improvement, it also seems unlikely that any major breakthrough is imminent that will solve the problems still remaining.

Compact Cassettes therefore remain a definite 'poor relation' to other signal sources for listeners requiring highest reproduction quality. Yet cassettes are undeniably easier to use than records, in the sense they are less easily damaged by handling and playing, and this no doubt accounts for a great deal of their popularity. Realising this, a number of manufacturers have researched the possibility of producing a new format embodying the convenience of Compact Cassettes with the quality potential of open-reel. One such format, which seems to have fallen by the wayside, was BASF's Unisette. Another is the Elcaset, the result of intensive research by a consortium of interested Japanese manufacturers.

MEASURED PERFORMANCE OF SONY ELCASET DECK MODEL EL-7

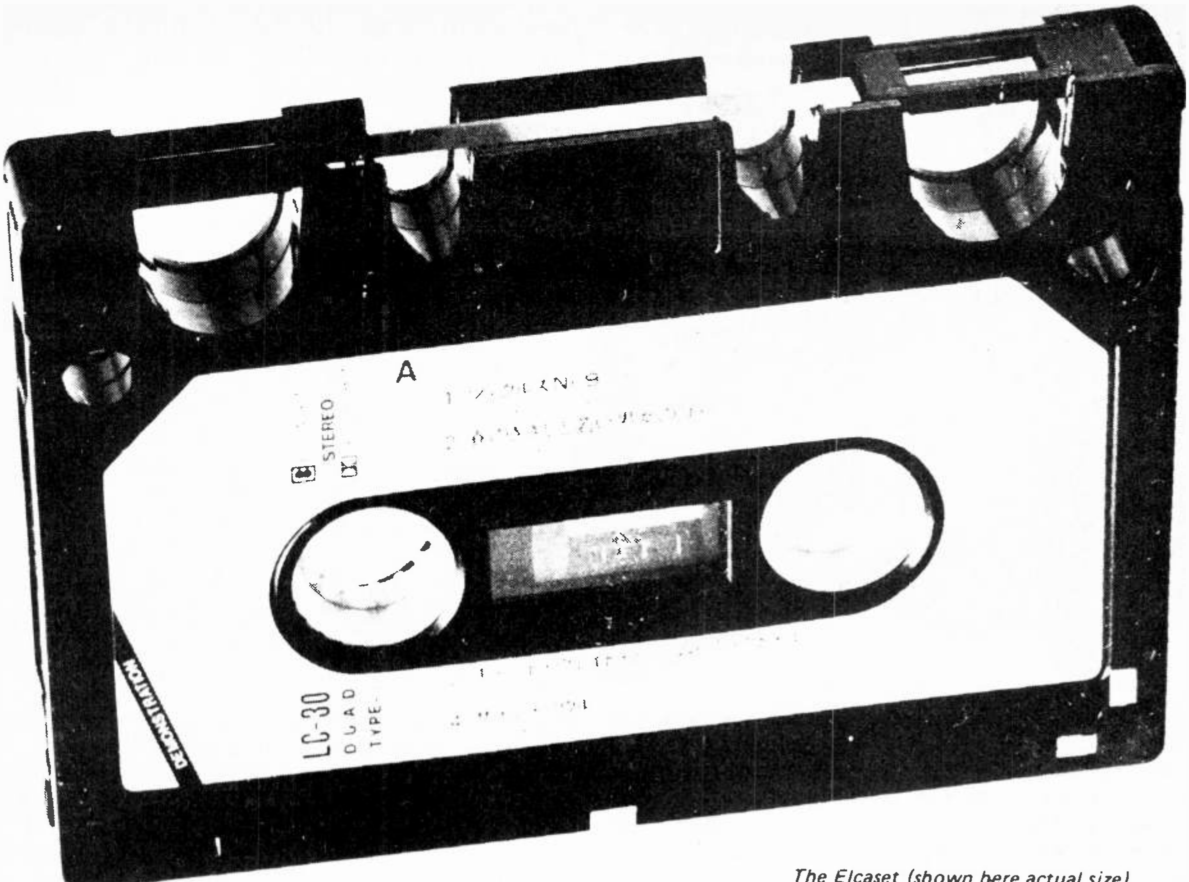
Frequency	20 Hz to 20 kHz $^{+0}_{-3}$ dB (−10 VU)			
Response:	20 Hz to 15 kHz $^{+0}_{-3}$ dB (0 VU)			
Total Harmonic		**100 Hz**	**1 kHz**	**6.3 kHz**
Distortion	0VU	0.6%	1.0%	2.3%
	−10VU	<0.6%	<0.8%	<1.1%
Noise:	−52 dB (lin);	−59 dB (A)	Dolby Out	
	−54 dB (lin);	−64 dB (A)	Dolby In	
Wow & Flutter: (record to replay)	0.1% RMS Unweighted			
Sensitivity:			**Input Impedance**	
(for 0 VU)	Line	66 mV	86 kΩ	
	Mic	0.205 mV	4.5 kΩ	
Outputs:			**Source Impedance**	
	Line	830 mV	3.3 kΩ	
	Phones	2.6 V	136 Ω	
Crosstalk:	**100 Hz**	**1 kHz**	**6.3 kHz**	
	−40 dB	−46.4 dB	−48 dB	

THE ELCASET SOLUTION

The Elcaset uses standard-width audio tape running at a speed of 9 5cm/sec. Like the compact cassette and unlike open-reel, the quarter track configuration is used to give mono compatibility – stereo pairs of signals are recorded on adjacent tracks, not alternate ones. The cassette itself looks basically similar to the familiar compact and miniature (dictating machine) types.

The differences, apart from size, are confined mainly to detail design aspects For example, erase prevention is by means of retractable lugs rather than break-off tabs, the spooling hubs are fitted with ratchet locks to prevent tape spillage when the cassette is removed from the recorder. The hubs are released by a recessed spring-loaded linkage operated by an appropriate bar fitted to the machine. Pressure pads are not used, tape being lifted out of the full-width aperture by moving guide posts.

The head assembly is fixed and, in the instance of the sample Sony EL-7 machine supplied for examination, uses a 'wrap-around' curved tape path. Tension on the tape is applied by two hinged guides on the cassette itself, working in conjunction with pinch roller/capstan assemblies to give intimate tape-to-head contact.



The Elcaset (shown here actual size) is more than twice the size of the Compact Cassette (and that's two-dimensionally – it's even bigger if we talk about volume).

THE SONY EL-7

The drive system uses three motors; Sony has incorporated its well-known closed-loop dual capstan system for constant-speed tape motion. All transport control functions are carried out using finger-touch push-buttons and use of servo-control enables a remote control unit to be added. Auto-stop, memory rewind and memory rewind/auto start facilities are incorporated and unattended automatic record and playback can be carried out using an optional timer control.

Outwardly, the review sample resembles a front-loading Compact Cassette unit. The obvious difference is a larger cassette compartment, fitted with a hinge-down transparent window with damped movement applied by a mechanical governor. To the left of the compartment is the power on/off switch, a three position toggle for use in conjunction with the optional timer, a further three-position toggle covering memory rewind functions and the three-position digit tape counter with push-button zero reset.

Transport controls are fitted to an angled projecting strip below the compartment.

REMOTE AND OTHERWISE

The optional remote control unit, also supplied, duplicates all these functions but does not render the built-in controls inoperative. A feature of the remote control unit is a 'record-mute' push-button which, when depressed, reduces the level of a signal being recorded to zero — obviating the need for operation of the machine's master level control on completion of a recording.

The remaining controls are fitted to the area on the right of the cassette compartment. A pair of large VU meters, calibrated from – 20 to + 5 VU, are placed close to the top edge of the front panel and are bounded on their right by a master lever control effective on both channels simultaneously and fitted with an adjustable detent preset system. Below this are dual concentric level controls for microphone and line inputs, flanked to the left with a pair of three-position toggles for bias and equalization adjustment.

Next is a further toggle controlling the multiple FM filter and alongside is a three-position rotary covering Dolby on/off and calibrate functions. Screwdriver presets are provided for Dolby record level calibration, using an inbulit 400 Hz oscillator.

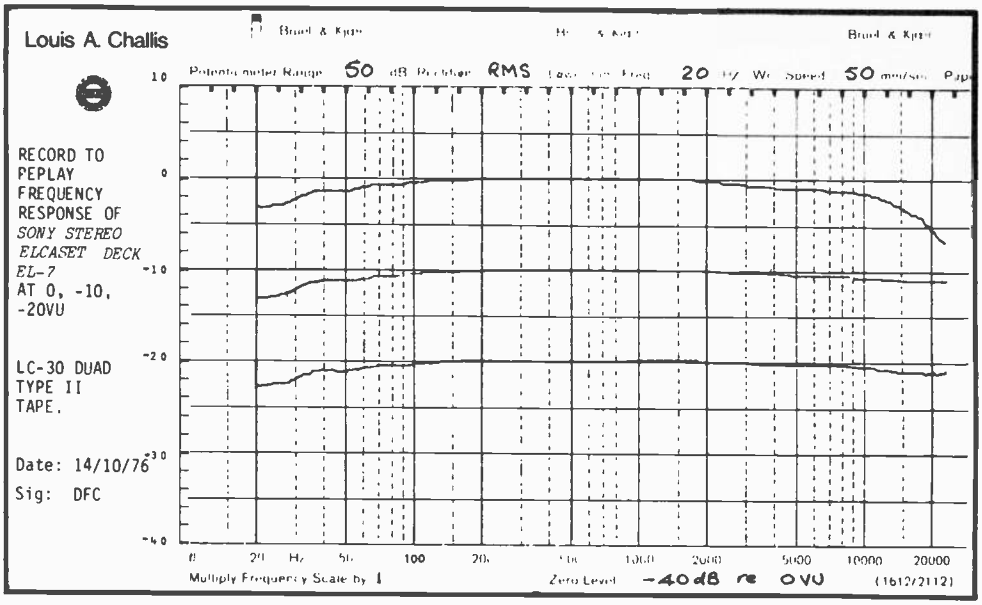
Remaining controls include a push-button for eject, a microphone attenuation control giving a choice of 15 or 30 dB reduction of level, an output level control for use with headphones and a tape/ source monitor switch. Front panel sockets (standard jacks) are provided for microphone inputs (via tip and sleeve plugs) with an auxiliary line in socket and a headphone output — both using stereo tip, ring and sleeve plugs.

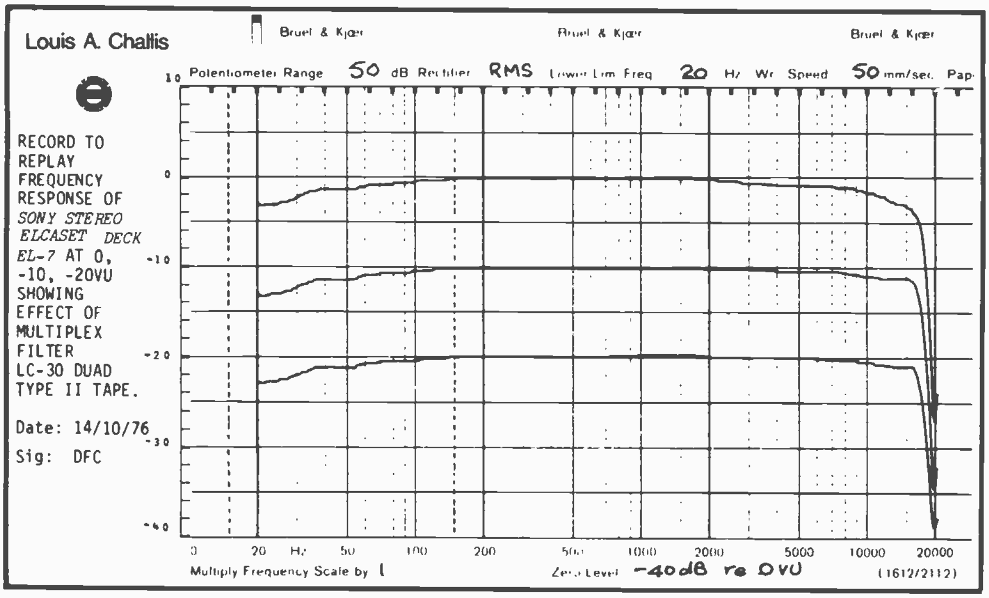
BRINGING UP THE REAR

Rear panel complement includes RCA-phone sockets for line inputs and outputs, a standard octal valve-base socket for connecting remote control or timer units, a pair of AC outlets and an output level preset. A screw-type earthing post is also provided.

Standard of construction and finish appear to be excellent, the front panel having a brushed aluminium overlay. The perforated metal cover is painted grey; removal of the cover reveals easily accessible circuit boards linked by slightly untidy wiring runs.

THE SONY EL 7 ELCASET





These graphs show the results of tests made in the laboratory of ETI's acoustical consultants.

The Sony EL-7 retails for $1,195.00 in Canada, with EL-5 lower cost version at $795.00. 60 min. tapes are $6.95 for SLH low noise types, $9.95 for Ferrichrome. (All prices Canadian suggested list)

TAPES AND CONTROLS

One aspect needing clarification was the tape selector controls. Three types of tape were covered — type I, type II and type III. The sample tape supplied was dual-layer ferrichrome and was designated type II. We presume, therefore, but cannot confirm (no instruction manual or relevant literature was supplied with the machine) that type I refers to low-noise tape and type III to chromium dioxide.

The demonstration tape supplied was recorded on one side with the usual spectacular sounds we have come to expect from such tapes. The remaining tracks were left unrecorded.

DOLBY GIVES AN EDGE

Overall record/replay performance was considered excellent, subjectively. The Sony electronics perform extremely quietly and with little audible distortion. Recordings, by direct comparison with source signals using the source/tape monitor switch, seemed only marginally inferior to the originals. The chief characteristic was a slight and barely audible loss of high frequency detail — a deficiency which we feel could only be noticed by direct comparison. With Dolby switched out, tape hiss was negligible and audible only during silences between musical sequences. With Dolby in use, no tape hiss was audible at average volume levels although the sound became slightly but noticeably edgy.

CONCLUSIONS

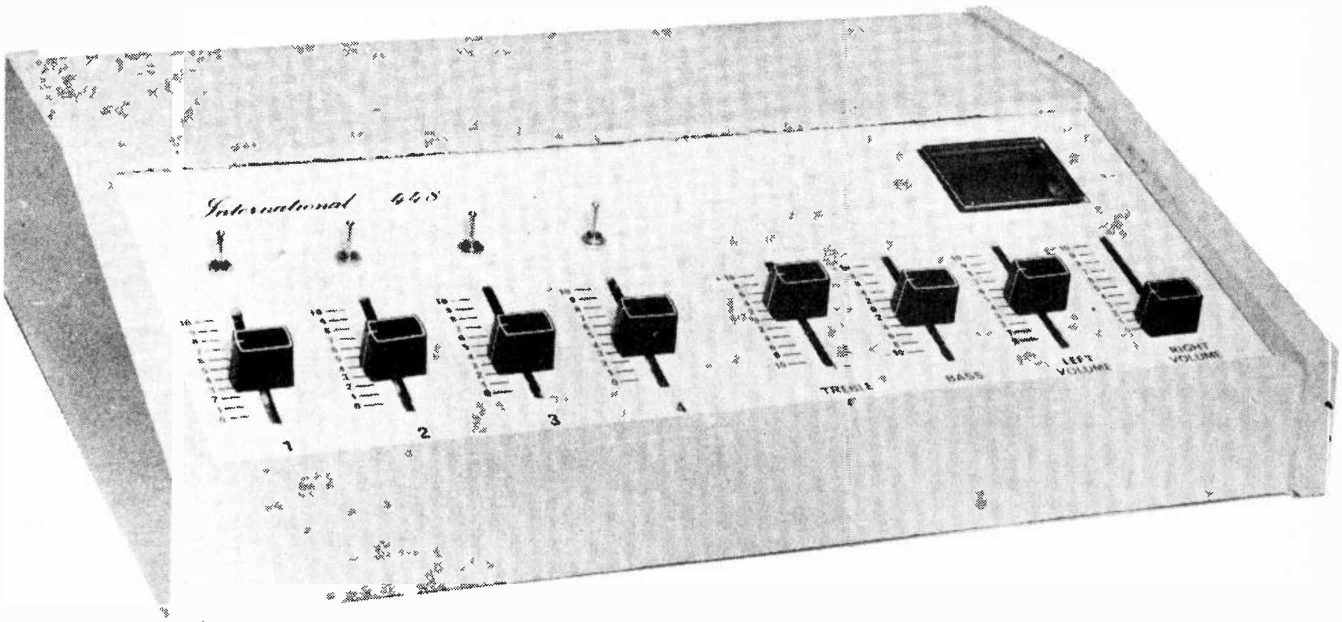
Assuming this sort of performance to be typical, it would seem that Dolby noise reduction is superfluous with this machine; we preferred to tolerate the small amount of noise heard with Dolby switched out than the distortion heard with noise reduction switched in.

No obvious frequency non-linearities were observed during listening tests. Even at low and high frequency tonal balance was well maintained at all levels except when incoming signals caused severe record overload. There was no evidence of diminished high frequency response when high record levels were used.

The Sony EL-7 was judged to be a very good performer, and certainly convinced us that the Elcaset format is a welcome introduction to the hi-fi field. Combining the performance potential of good open-reel machines, and the operating convenience of cassettes, the Elcaset system is likely to have enormous appeal to critical hi-fi enthusiasts.

ETI Project 448/9

DISCO MIXER



This is a general-purpose mixer project that can be tailored by the constructor to meet specific needs. This modular design uses several boards:

Disco mixer board (448) (with stereo mixing and power supply) mono headphone amplifier (448A) for prefade monitor, balanced microphone preamplifier (449) and stereo VU circuit (449A). Also a simple ceramic cartridge preamp is shown — so simple it can be built on the input sockets!

SPECIFICATION	ETI 448
No. of inputs	Nominally 4
No. of outputs	2 main signal outputs 1 headphone amplifier output
Tone controls	Overall bass and treble
Output noise (Mixer stage only)	1 mV (mainly hum)
Maximum output voltage	6 V

Using the boards listed above virtually any audio sources can be mixed by the operator, to provide a stereo signal suitable for driving power amplifiers directly. The mixed signals can also of course be used to feed tape recorders etc. The inputs from turntables, tape recorders, microphones etc must be correctly matched to the inputs of the mixer board. To do this the correct preamplifiers must be selected and constructed.

Our prototype was constructed for use with twin stereo magnetic cartridges, balanced low impedence microphone and stereo cassette recorder. However, the permutations are virtually limitless!

Before beginning construction, decide which preamplifiers you will need (tape recorders do not need any and connect direct to the mixer). Decide what type of sockets you want to use and how many channels you want (although shown as four input the mixer can be expanded by adding extra control pots and mixer resistors).

BALANCED MICROPHONE PREAMPLIFIER

The beauty of this circuit is that it eliminates a costly line transformer! Although designed for 600 ohm input and 40dB gain other impedances and gains can be handled R1 = R4 = input impedance divided by two

R5 = R11 = voltage gain times the value of R3.

The first equation works for impedances up to about 5k. Above this value R2 + R3 must be included in the calculation.

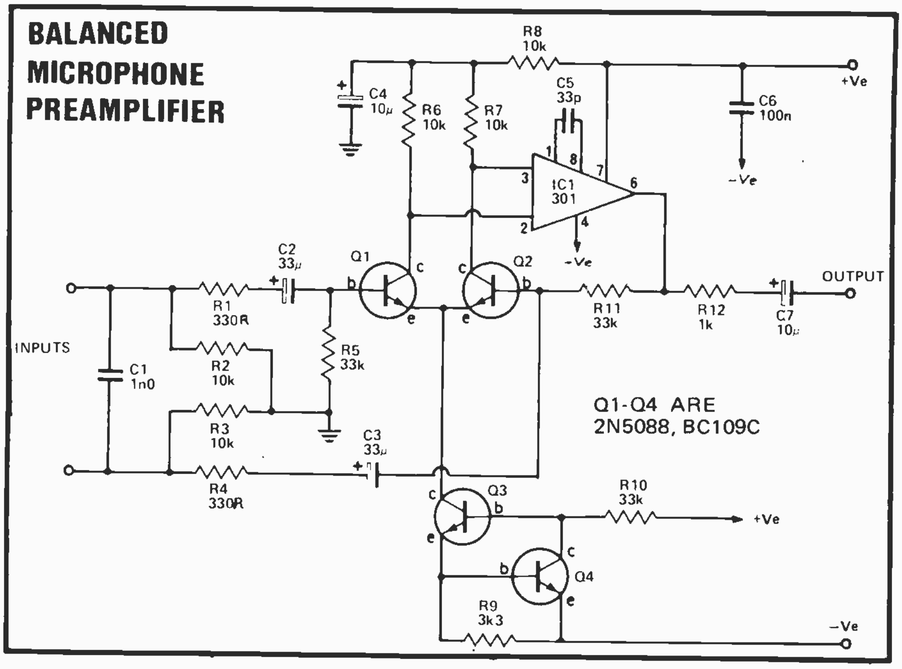
As most people have only one mouth, the output from this circuit can be used to pan the output from stereo by using two 10k resistors or a 20k linear pot with the wiper connected to the output can be used to pan the output from left to right.

MIXER AND POWER SUPPLY

Because of the high ripple rejection of the integrated circuits, used in the various modules, the power supply requirements are simple. A straightforward bridge rectifier, large smoothing capacitors with a RF bypass capacitor and we have an adequate power source.

(cont on P.29)

BALANCED MICROPHONE PREAMPLIFIER



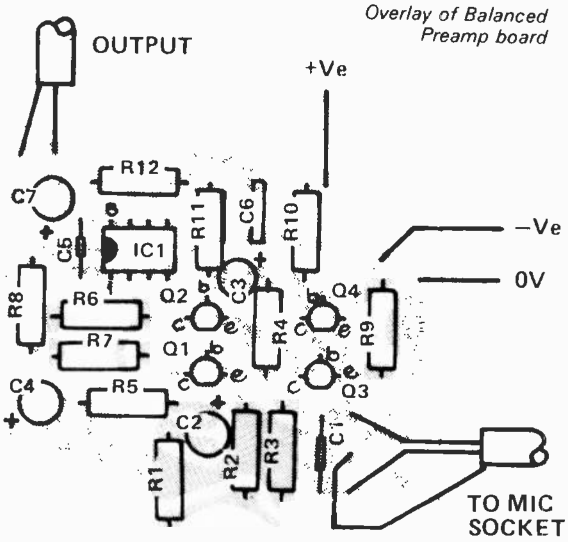
Frequency Response	10 Hz – 20 kHz (<5 V output) +0 −3 dB
Gain	40 dB
Equivalent Input Noise	−123 dB (0.5 μV)
Distortion	0.05% 300 mV – 5 V output 100 Hz – 10 kHz
Max Input Voltage	100 mV
Common Mode Rejection Ratio	60 dB
Maximum Common Mode Signal	3 V

Connection of Cannon plug for microphones

Pin 1	EARTH
Pin 2	BLACK INPUT connect to R1
Pin 3	RED INPUT connect to R4

FOR UNBALANCED INPUT CONNECT PIN 1 AND 2 TOGETHER ON MICROPHONE PLUG.

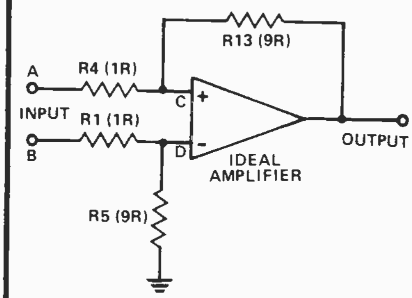
Overlay of Balanced Preamp board



PARTS LIST ETI 449

Resistors all 1 W 5%		Capacitors	
R1	330R	C1	1n0 polyester
R2,3	10k	C2,3	33μ 10v
R4	330R	C4	10μ 16v
R5	33k	C5	33p ceramic
R6,7,8	10k	C6	100n polyester
R9	3k3	C7	10μ 16v
R10,11	33k	Q1-Q4	2N5088, BC109C
R12	1k	IC1	LM301A
		PC Board	ETI 449

HOW IT WORKS ETI 449



A "balanced" amplifier or differential amplifier has two separate inputs and only the difference between these inputs is amplified. To explain how this works refer to figure, which is a simplied version of the actual circuit. To make the maths easier we will reduce the gain to nine by making R1 = R4 = 1 and R5 = R11 = 9. The actual units are not important, only the ratio.

We will start the explanation by looking at the case where point B is at 0V and A is at +100mV. An ideal amplifier does two things — it does not take any current into the input terminals and it adjusts the output to maintain no voltage difference between the input terminals. We therefore must have 100mV across R4 and consequently a voltage of 900mV across R11 (it has 9 times the resistance and the same current as R4). This gives a gain of nine. The output is therefore —900mV.

In the case when point A is at 0V and point B is at +100mV, point D will be at

$$(VB \times \frac{R5}{R1 + R9}) = 90mV$$

Therefore point C will also be at +90mV. The voltage across R4 will be 90mV and voltage across R1 will be 810mV (9 x 90mV).

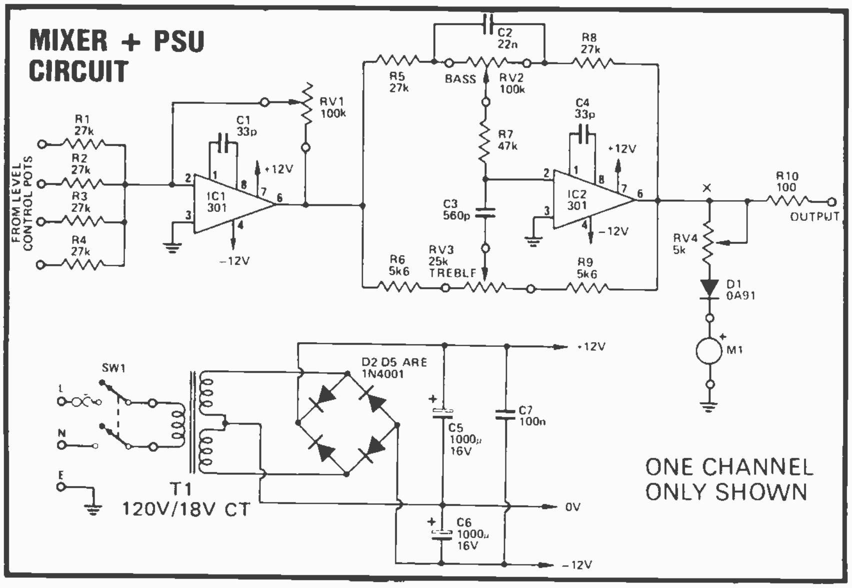
This means the output voltage must be +900mV. This is also a gain of nine. Notice, however, that the polarity (or phase) is different.

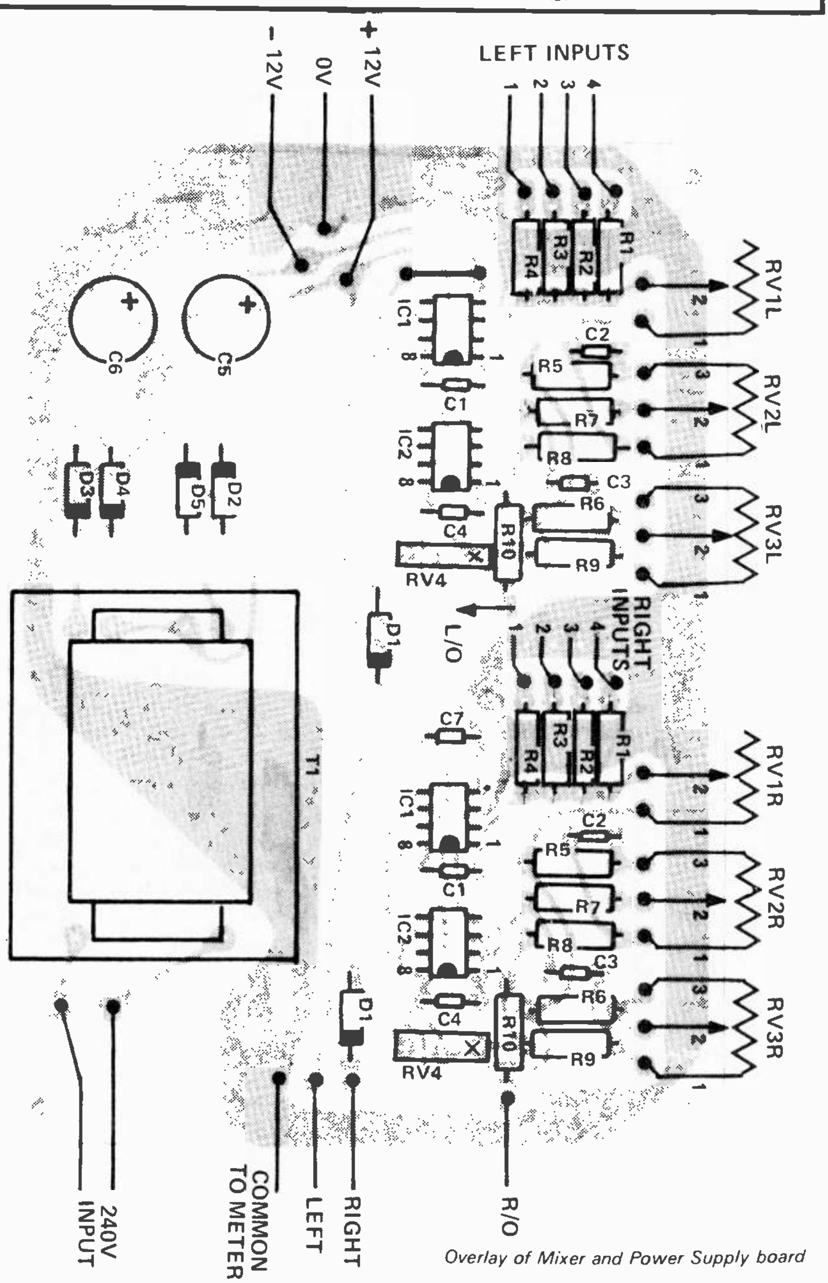
Now suppose both inputs are at, say, +1V, point D will be at +900mV and so will point C. The voltage across R4 is 100mV and R11 900mV. This gives an output voltage of 0V. The common signal is not amplified in any way. If, however, one input (B) is at 1V and the other (A) is at 1.01V the difference is amplified and the output will be —1V.

Getting back to the actual circuit, we have used an LM301A with two low-noise transistors in the front stage. These transistors are supplied with a constant current by Q3 and Q4. A constant current is needed as this allows the inputs to move up and down without changing the voltage across R6 or R7.

The resistors R2 and R3 refer the inputs to 0V but are high enough not to affect the operation in any way.

DISCO MIXER





Overlay of Mixer and Power Supply board

HOW IT WORKS ETI 448

The inputs from the turntables, tape recorders microphones, etc, must be amplified, and if necessary equalized, by a preamplifier before any of the controls can handle them. The output of each of these preamps adjustable, by means of a volume control or fader, before being mixed in IC1. The overall gain of the mixer stage is adjusted by means of RV1. If different preamps have widely differing output voltages the value of R1-R4 can be changed to make them match.

The output of IC1 goes then to the tone control stage, IC2, which normally has a unity gain when the controls are centered. However, this gain is adjustable, with respect to frequency, if the tone controls are not centered. The output of the tone control stage directly drives the main power amplifiers. This output is also rectified by D1 to drive the meter circuitry.

The mixer gives stereo outputs — this is achieved by duplicating the circuitry for the second channel. The exception is the tone controls which are dual gang potentiometers. Note that the volume controls are individual units.

The power supply is simply a full wave rectified supply with a centre tap giving about ±12VDC.

PARTS LIST - ETI 448

Resistors all ¼w 5%

R1-R5	27k
R6	5k6
R7	47k
R8	27k
R9	5k6
R10	100R

Potentiometers

RV1	100k log single gang slide 45mm
RV4 *	5k trim

Capacitors

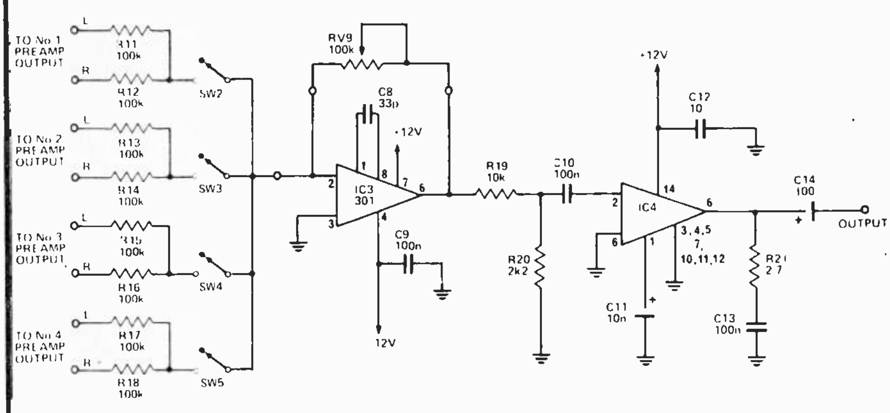
C1	33p ceramic
C2	22n polyester
C3	560p ceramic
C4	33p ceramic
IC1, 2	LM301A
D1 *	OA91
M1 *	VU Meter

Two of all the above components are required for stereo operation.

RV2	100k lin dual slide
RV3	25k lin dual slide
RV5-RV8	10k log dual slide
C5, 6	100u 16V
C7	100n polyester
D2 – D5	IN4001 or similar
Transformer	120V-18V CT
pc board	ETI 448
Fuseholder	250mA fuse to match
Switch	2 pole 2 position 240 V toggle

*See text

HEADPHONE AMPLIFIER



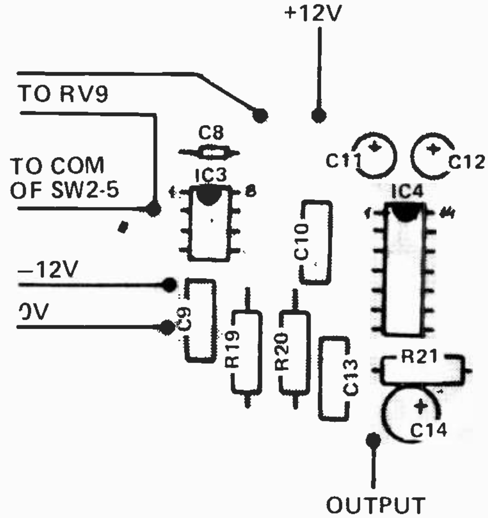
HOW IT WORKS ETI 448A

The resistors bridging Left and Right channel outputs are to provide a composite mono signal, without seriously degrading the main mixer stereo separation. The signal is selected by SW2-SW5 and fed to a buffer with variable gain (IC3). The output is then fed to a LM380 power amplifier which drives the monitor headphones.

As with the mixer the input resistors can be increased, to reduce high signals to the level of the other channels.

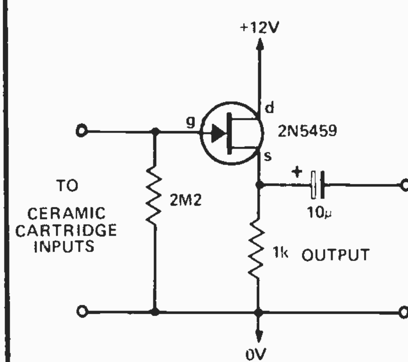
PARTS LIST — ETI 448A

Resistors all ½w 5%	
R11-R18	100k
R19	10k
R20	2k2
R21	2.7R
Potentiometer	
RV9	100k log rotary
Capacitors	
C8	33p ceramic
C9, 10	100n polyester
C11, 12	10µ 16 V
C13	100n polyester
C14	100µ 16 V
IC3	LM301A
IC4	LM380
SW2-SW5	single pole toggle
pc board	ETI 448A



Overlay of Headphone board

CERAMIC CARTRIDGE PREAMP



The mixer is a conventional summing amplifier with variable feedback (ie: gain), followed by a Baxandall tone control network.

If input levels are not of the same magnitude, the 27k input resistors can be changed; to lower the highest signals, increase resistor value. Don't reduce below 27k as this will reduce overall sensitivity of the mixer.

The VU circuit can be used, but we recommend the alternative VU board (see VU text).

UNIVERSAL PREAMPLIFIER

Response and gain can be selected from the chart by the components list.

HEADPHONE AMPLIFIER

The output from each preamplifier can be switched into this circuit, so that you can cue signals before mixing them into the output. It is suggested that if headphones only are to be used a 100ohm 1 watt resistor be fitted in series with the output. This is to protect your ears and reduce the power dissipation of the LM 380 — otherwise a small heatsink would be required. The volume control can be mounted on the rear of the mixer as it is not adjusted very often.

VU CIRCUIT

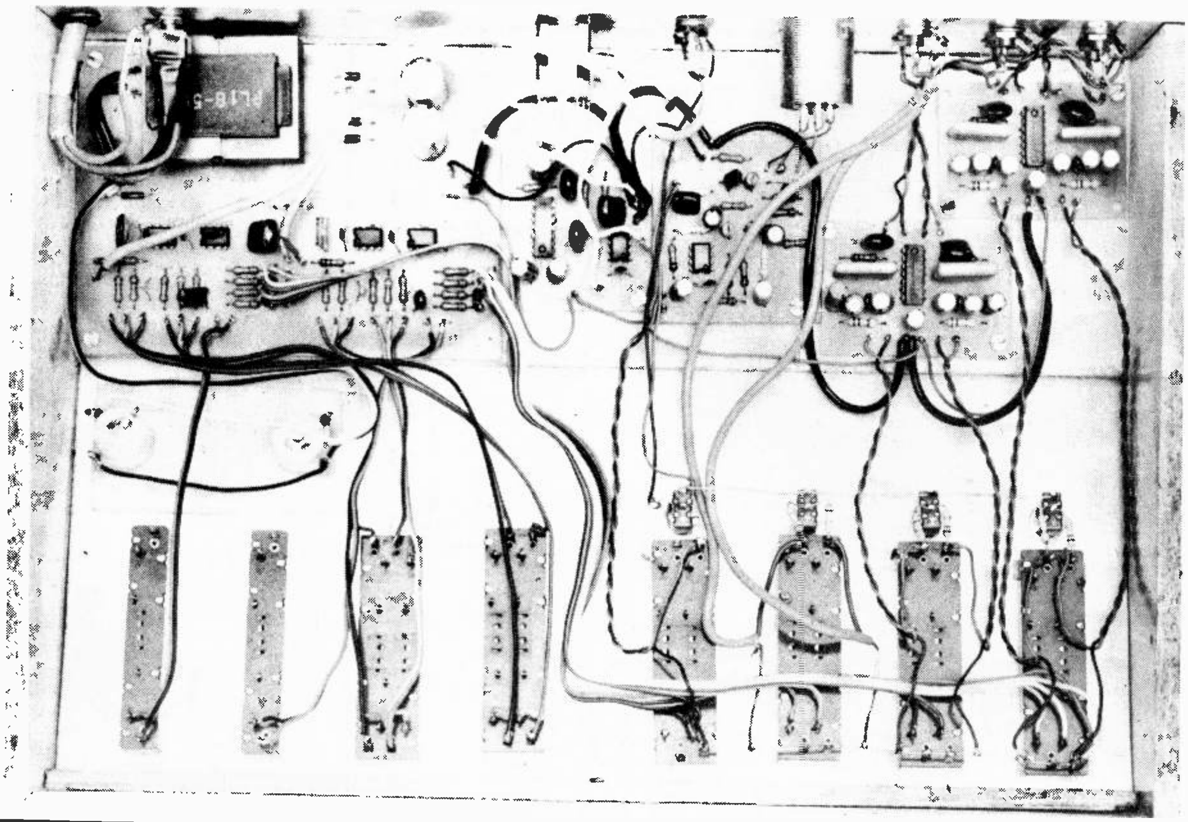
The meter circuit used in the mixer board is very basic — although suitable for some applications — distortion introduced into the output signal is as much as 2% THD.

We strongly recommend the VU board. If used omit RV4 and D1 from the mixer board and connect point X to the input of the VU board. Calibration is by the preset on the VU board, feed a signal through the mixer until the output is just distorting the amplifier, and adjust the preset to indicate +3VU.

CONSTRUCTION

Assemble the boards with the aid of the overlay drawings, for your convenience we have put all the PCB layouts together, on page 22. The photograph on page 21 shows the general layout we used, but this is very flexible, ours was built into a wooden box with metal front and base but a metal box would be more suitable in an electrically noisy environment.

Interboard connections can be worked out from the individual circuits and overlays. All connections should be as short as possible and kept away from the mains wiring. We in fact moved the power switch to the back panel to reduce hum pickup (a metal box, with an aluminium shield around the mains transformer will ensure minimum hum pickup) If this is done unscreened cable can be used internally.



GENERAL PURPOSE PREAMPLIFIER

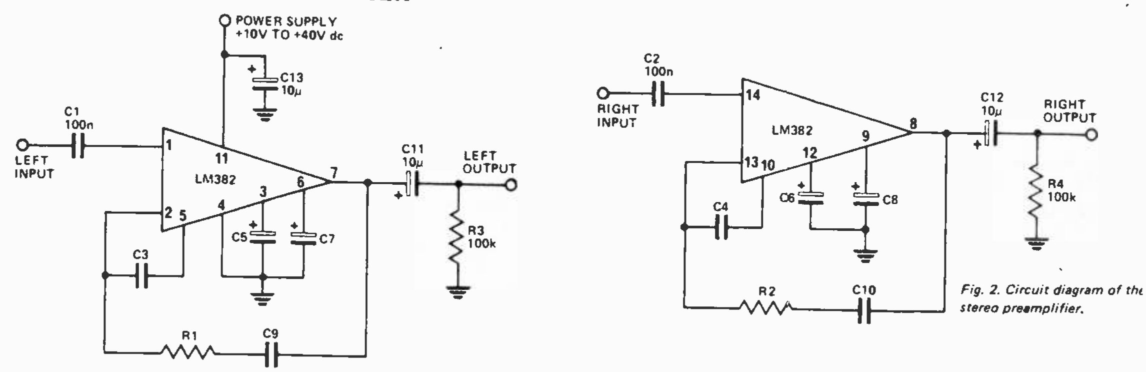


Fig. 2. Circuit diagram of the stereo preamplifier.

PARTS LIST — ETI 445

Resistors

R1, 2	see table		
R3, 4	100k	½watt	5%

Capacitors

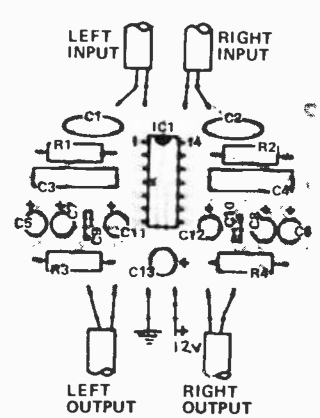
C1, 2	100nF polyester
C3 – C10	see table
C11-C13	10μF 25V
IC1	integrated circuit LM382
PC board	ETI 445

HOW IT WORKS ETI 445

Not much can be said about how the LM382 works as most of the circuitry is contained within the IC. Most of the frequency-determining components are on the chip - only the capacitors are mounted externally.

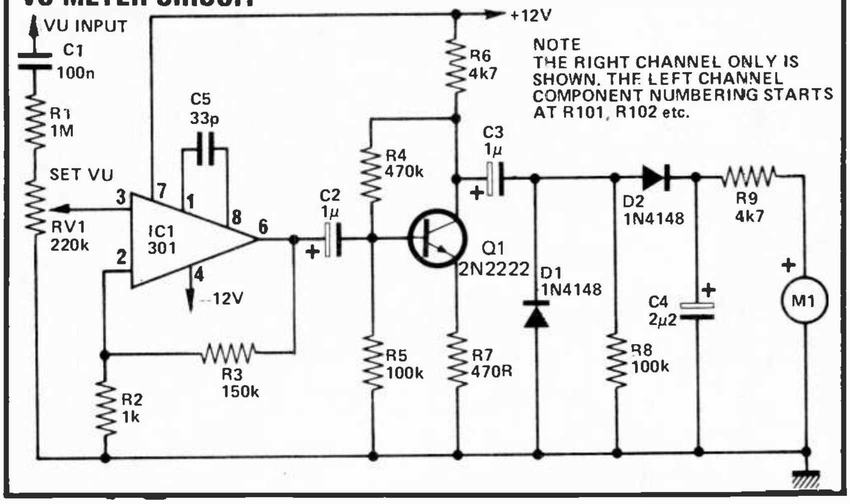
The LM382 has the convenient characteristic of rejecting ripple on the supply line by about 100 dB, thus greatly reducing the quality requirement for the power supply.

FUNCTION	C3, 4	C5, 6	C7, 8	C9, 10	R1, 2
Phono preamp (RIAA)	330n	10μF	10μF	1n5	1k
Tape preamp (NAB)	68n	10μF	10μF	–	–
Flat 40dB gain	–	–	10μF	–	–
Flat 55dB gain	–	10μF	–	–	–
Flat 80dB gain	–	10μF	10μF	–	–



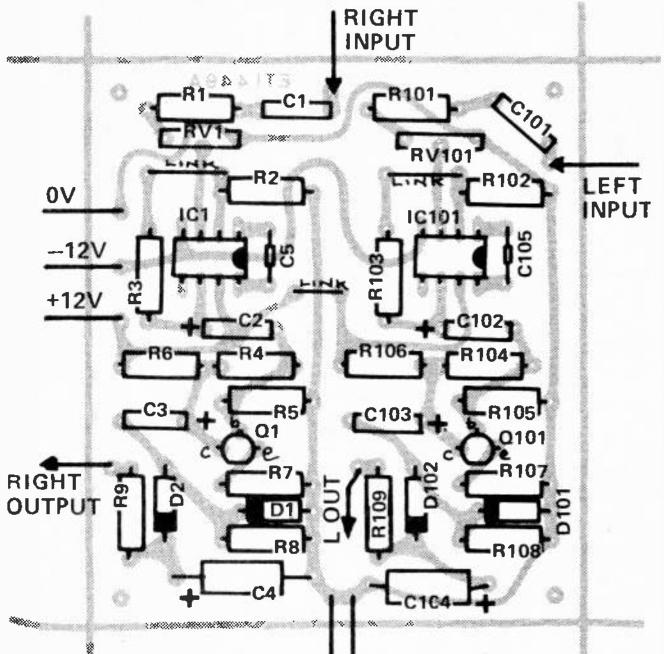
Overlay of General Preamp board

VU METER CIRCUIT



HOW IT WORKS ETI 449A

This VU circuit has an input impedance in the region of 1M and therefore will not load the mixer output by any discernable amount. The IC has a gain of 43dB, the signal is then amplified again by Q1 to get enough level to drive the VU meter. Under no signal conditions the voltage at the junction of D1, D2 falls to OV because of R8. When a negative going signal appears at collector of Q1, C3 will discharge on the negative peak. Difference between negative and positive peaks is transferred through D2 to C4, and hence to the VU meter.



Overlay of VU meter board

PARTS LIST — ETI 449A

Resistors all ¼w 10%

R1	1M
R2	1k
R3	150k
R4	470k
R5,8	100k
R6,9	5k7
R7	470R

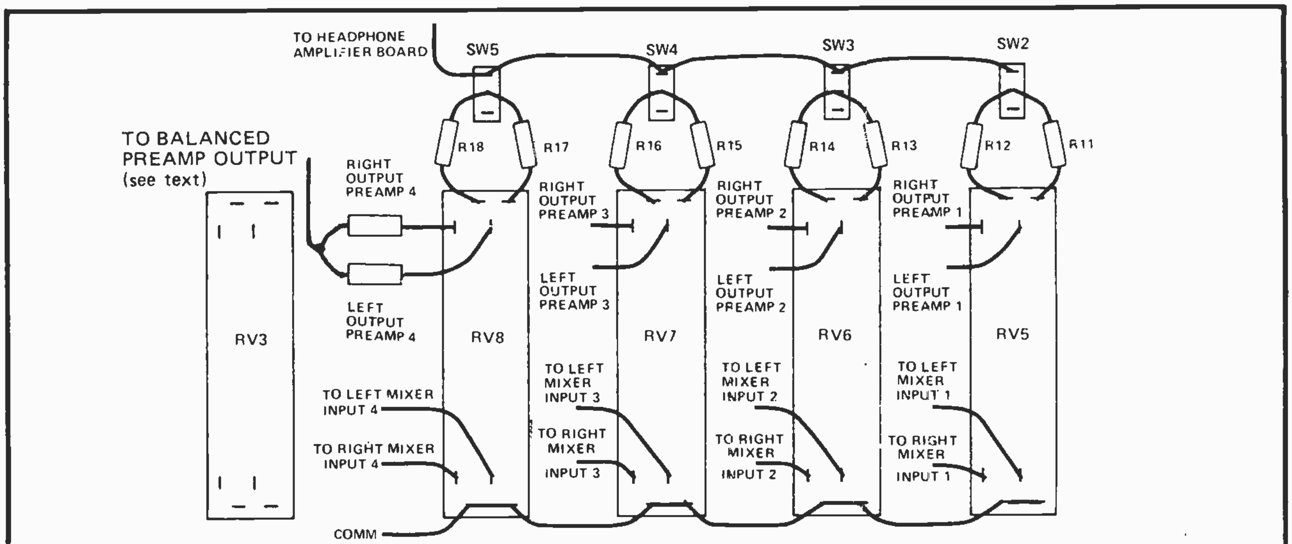
Potentiometers

RV1	220k preset

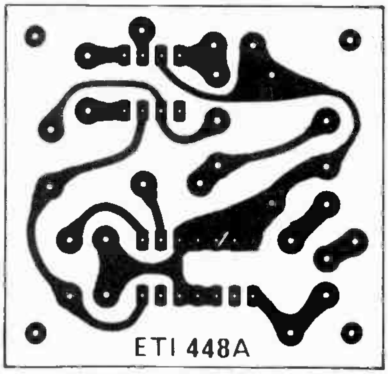
Capacitors

C1	100n polyester
C2,3	1μ 16V
C4	2μ2 16V
C5	33p ceramic
1C1	LM301
Q1	2N2222
D1,2	IN4148
M1	VU meter

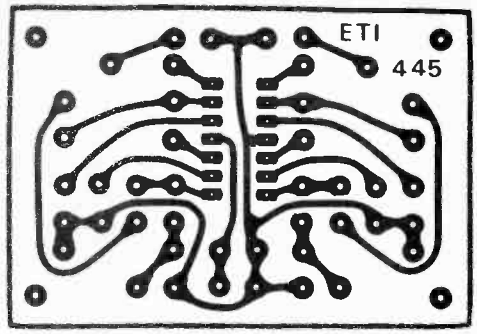
Two of each required for stereo
PC Board ETI 449A



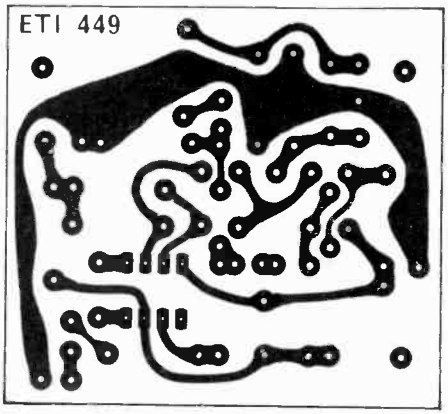
Interconnection diagram of individual volume controls and headphone amplifier selector switches.



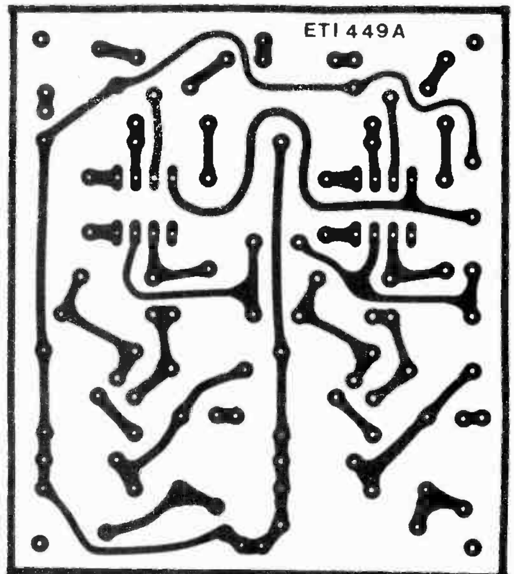
HEADPHONE AMPLIFIER



GENERAL PREAMPLIFIER

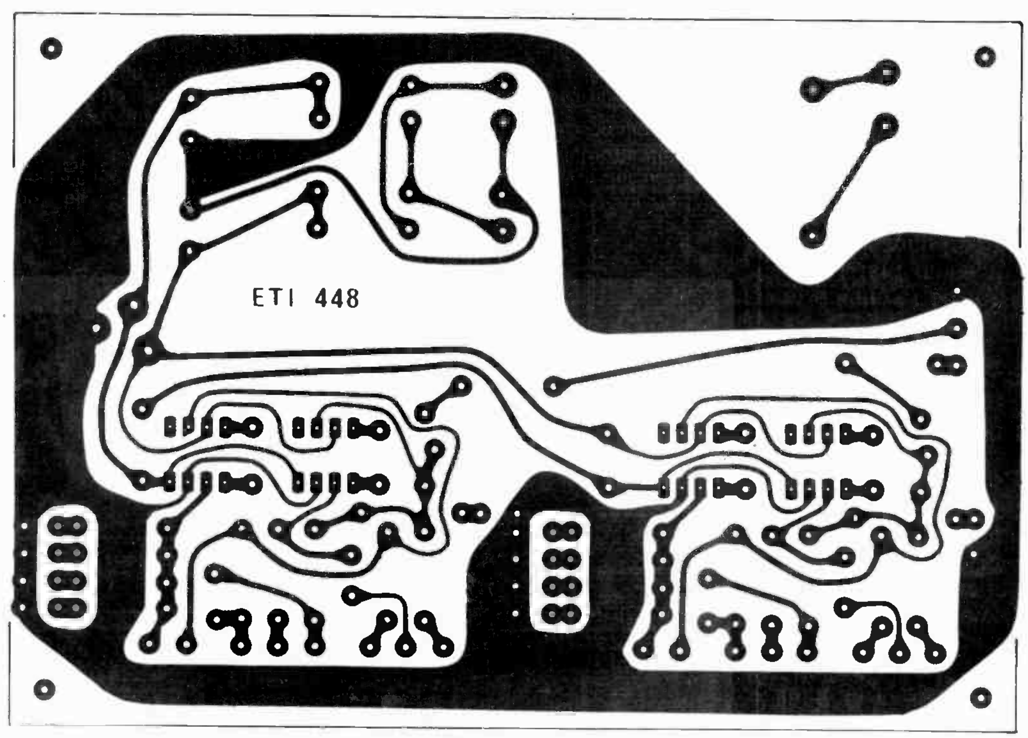


BALANCED PREAMPLIFIER



VU METER

PCB DRAWINGS FOR THE DISCO MIXER.
CHECK WITH CANMOS FOR PRICE AND DELIVERY.



MIXER AND POWER SUPPLY

UNWANTED AUDIO SIGNALS

Breakthrough of unwanted broadcasts into audio systems can be infuriating — here's how to stop them.

PERHAPS THE MOST infuriating form of RF pollution is breakthrough of unwanted broadcasts into audio systems.

With the current proliferation of broadcasting stations, radio amateurs, taxi companies, walki-talkies etc the problem is now a major headache to manufacturers and users of hi-fi systems, public address systems, hearing aids — even electronic musical instruments may be affected from time to time.

The 'fault' that results in audio breakthrough is almost invariably within the 'interferees' audio equipment. It is hardly ever caused by a fault within the transmitter or even faulty operational procedures.

The phenomenon is now becoming generally known as 'audio rectification'. In essence the unwanted RF energy is picked up by some part of an audio system — which acts as an antenna. The energy is then rectified by an element operating non-linearly in the equipment. This can take the form of a valve, transistor, IC — or even a poorly soldered joint! The rectified signal is then amplified by the remainder of the audio system (although in at least one instance personally known to the author the unwanted signal was picked up on the leads between the power amplifier and speakers on a large PA installation — and then rectified by a faulty connection on one of the speakers).

Hopefully audio rectification will be only a short term problem because cases are now becoming so numerous that audio equipment may soon have to be designed with suitable rejection circuitry included..

In the meantime the USA's Federal Communications Commission and the Electronics Industries Association have devised a number of procedures for identifying the specific part of the circuit into which the signal is introduced — and a number of ways by which the interference may be eliminated or substantially reduced. This article is based on these procedures.

Ninety nine times out of a hundred the offending RF content will be introduced into the early stages of a pre-amplifier, or will be picked up and introduced by the mains power supply leads. To check that this is in fact so just turn down the volume control next time interference occurs. If the interference *is* reduced then it is being introduced before the volume control (which will be in the output stage of the pre-amplifier — or its equivalent in an integrated unit). If the level remains constant — then it is being picked up *after* the volume control.

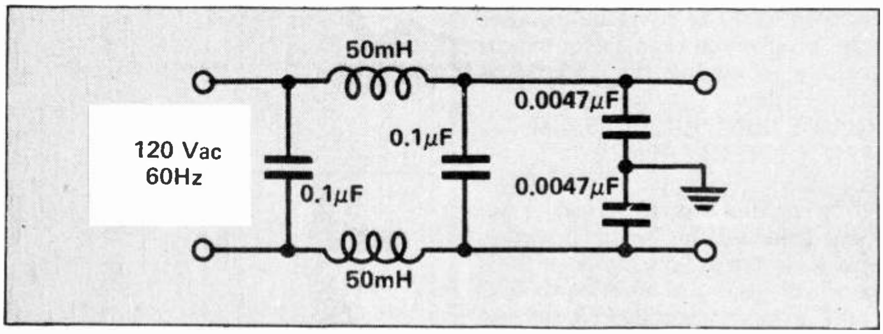
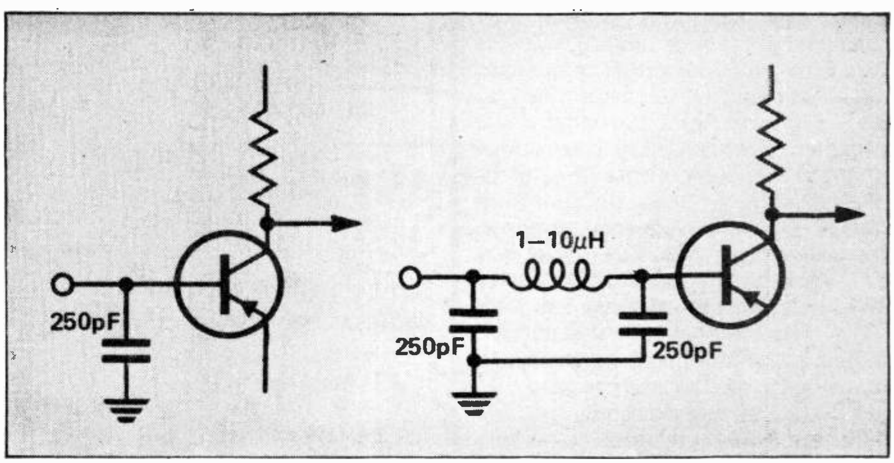


Fig. 1. Mains filter, available commercially or can be home-constructed. If you make it yourself it is essential to use capacitors rated for ac mains operation.



Figs. 2/3. These simple filters, connected in series with the pre-amplifier input, will prove effective in many cases.

VOLUME CONTROL AFFECTS INTERFERENCE

The most common causes of this type of interference are signals introduced via the mains power leads, via interconnecting cables between main amplifier and auxiliary equipment, or via the speaker leads themselves.

It may also be caused by a poor or non-existent earth connection and this should be checked before looking any further.

Having checked out the earth connections it is advisable to next check the speaker leads. At first sight it might seem that RF picked up by the speaker leads would produce a constant level signal — or that the level itself would be very low because of the low impedances involved. But this is not *necessarily* so, for the RF signal is fed back via the negative feedback loop. And whilst feedback is applied *after* the volume control, some of the RF signal may be radiated into the earlier stages of the pre-amplifier.

It is not unknown for speaker leads to be of such a length that they actually resonate at the interfering frequency — in which case an instant cure can often be effected merely by lengthening or shortening them. Murphy's Law can operate here though. One person we know eliminated interference from a local TV station that way — only to pick up his local taxi radio service at Strength 9!

Twisting the speaker leads or using shielded cable is also generally effective. Connecting a capacitor across the amplifier output terminals

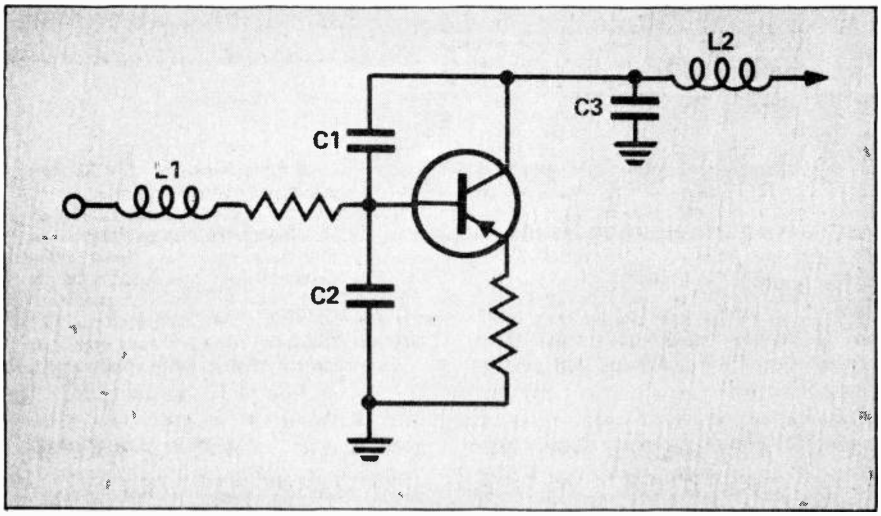


Fig. 4. Although more complex than the circuits shown in Figs. 2/3 the RF filter shown here will almost invariably eliminate unwanted signals. We regret that it is impracticable to show component values as they depend totally on the circuitry of the amplifier to which it is to be installed. Note two similar filters are required – one for each channel. The filters should be wired in series with the input to the power amplifiers.

or from each terminal to earth is also effective. Note that high frequency response will not be degraded as impedance is very low at this point in the circuit.

A capacitance of about 0.1 μF is generally sufficient to remove most RF. Use the smallest value that fixes the problem and always use a ceramic capacitor for the purpose.

If the above checks don't cure the problem the next thing to check is whether or not the signal is being introduced via the signal leads. Here the quickest check is to disconnect all externally connected units – such as the turntable, cassette recorder, radio tuner etc. If disconnecting a unit eliminates the interference then the cable connecting that unit to the amplifier is not properly screened Lastly check for mains-borne interference by connecting a line filter in series with the incoming power line.

These Filters are made commercially by several companies and are available from distributors or some retailers, or can readily be made as shown in Fig. 1. If you make this filter yourself do not under any circumstances increase the values of the capacitors shown — and make absolutely sure that the capacitors are rated for at least 120V AC operation, preferably more.

In areas where the strength of the unwanted signal is very high (as it may well be if, for instance, you live close to a TV transmitting antenna) the signal may still find its way into the input circuitry despite the precautions suggested. This is particularly likely if the amplifier has a non-metallic case – or if it has a metal case that is not earthed satisfactorily. The cure here is obvious – aluminium foil makes a good shield – make sure it's earthed correctly.

If, despite all the precautions outlined, the RF signal is still finding its way into the pre-amplifier, more drastic treatment will be necessary.

Firstly check that there are no poorly soldered joints – for a dry joint can act as an almost perfect rectifier. Resolder any joints that look at all suspicious.

Electrolytic capacitors tend to have high inductive reactance at RF frequencies thus preventing them by-passing unwanted RF to ground. Check them out by temporarily wiring an 0.01 μF ceramic in parallel. Wire in permanently if this cures the problem. If the problem still remains it will be necessary to modify the amplifier as outlined below.

VOLUME CONTROL DOES NOT AFFECT INTERFERENCE

Sometimes unwanted level signals will be heard at a constant level – not affected at all by volume control settings. If this is your problem (or if unwanted signals are breaking through in the manner described in the last paragraph) it will be necessary to use RF filtering at the input to the power amplifier. Figure 4 shows one way of doing this that has proved very satisfactory. Unfortunately it is impossible to quote actual component values as these will be determined by the circuitry of the individual amplifier. The main thing to remember is that the components should be selected so as to cause no significant change in audio frequency response. (In really severe cases however it may be necessary to trade off frequency response against interference removal).

The capacitors used for this purpose should be ceramics – not paper types. Inductor L1 may be a ferrite bead.

If despite all the foregoing you *still* have problems there seem to be only two remaining solutions.

Dynamite the offending source – or move! ●

ETI DATA SHEET

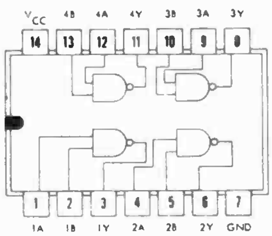
WHEN CMOS CRACKLED its static-laden path onto the market, the demise of TTL was widely forecast indeed eagerly awaited in some quarters. Well CMOS is still around, but so is TTL. The ease of handling and operation seem to have ensured a reasonably bright future for the old boy.

The idea of this Data Sheet Special is to provide the man at home with some useful information in a storable form. Quite often logic diagrams and circuits are given in articles, ours included, with no reference to pin connections etc. These four pages should make most circuits buildable, if taken with a good dose of the notes at the end!

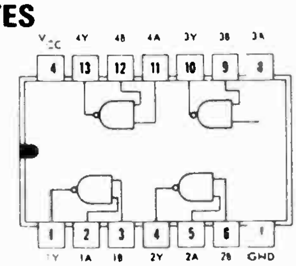
Only the pin-outs are provided, we didn't intend to get any deeper than this - although we may well do so later. Next month's Data Sheet will provide similar information on the newcomer, CMOS, and will be presented in a uniform manner.

Our thanks to Texas Instruments (they invented TTL you know!) for permission to reproduce the drawings for their 7400 series. All ICs are shown from a top view, as is standard, and no reference is made to either the low power 74L series, or the 74S Schottky Clamped series. These are not really of concern to the home constructor,

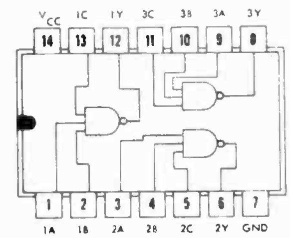
SN7400 QUADRUPLE 2-INPUT POSITIVE NAND GATES



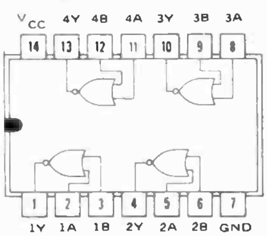
SN7401 QUADRUPLE 2-INPUT OPEN-COLLECTOR NAND GATES



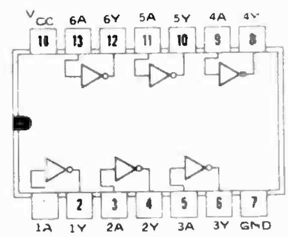
SN7410 TRIPLE 3-INPUT POSITIVE NAND GATES



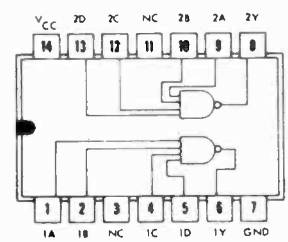
SN7402 QUADRUPLE 2-INPUT POSITIVE NOR GATES



SN7404 HEX INVERTERS



SN7420 DUAL 4-INPUT POSITIVE NAND GATES

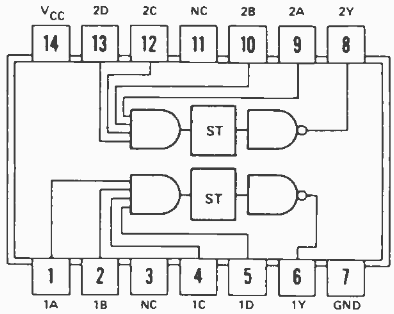


TTL to CMOS. Functionally Equivalent Types

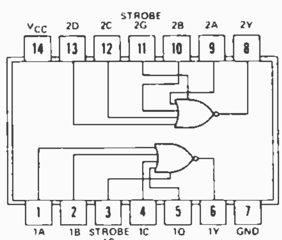
TTL	CMOS		TTL	CMOS		TTL	CMOS	
7400	4011		7475	4042		74150	4067	
7401	40107		7476	4027		74151	4051	4097
7402	4001		7477	4042		74152	4051	4097
7404	4009	4049	7478	4027		74153	4052	
7406	4009	4049	7483	4008		74154	4514	4515
7407	4010	4050	7485	4063		74155	4555	4556
7408	4081		7486	4030	4070	74156	4555	4556
7410	4023		7490	4518		74157	4019	
7411	4073		7491	4015	4094	74164	4015	
7420	4012		7493	4520		74165	4021	
7425	4002		7494	4035		74166	4014	
7427	4025		7495	40104	40194	74167	4527	
7428	4001		7499	40104	40194	74173	4076	
7430	4068		74100	4034		74178	4035	
7432	4071		74104	4095		74179	4035	
7437	4011		74105	4095		74180	40101	
7440	4012		74107	4027		74181	40181	
7442	4028		74110	4095		74182	40182	
7445	4028		74111	4027		74190	4510	
7446	4511	4055	74121	4047	4098	74191	4516	
7447	4511	4055	74122	4047	4098	74194	40104	40194
7448	4511	4055	74123	4098		74195	4035	
7449	4511	4055	74125	4502		74198	4034	
7450	4085		74126	4502		74200	4061	
7453	4086		74132	4093		74251	4051	4097
7454	4086		74136	4030	4070	74279	4044	
7470	4096		74141	4028		74283	4008	
7472	4095		74145	4028		74290	4518	
7473	4027		74148	4532		74293	4520	
7474	4013							

TTL PINOUTS

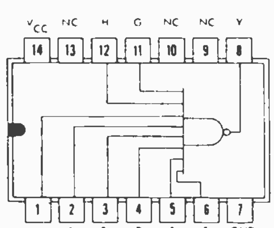
SN7413 DUAL NAND SCHMITT TRIGGERS



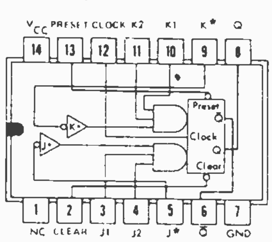
SN7425 DUAL 4-INPUT NOR GATES WITH STROBE



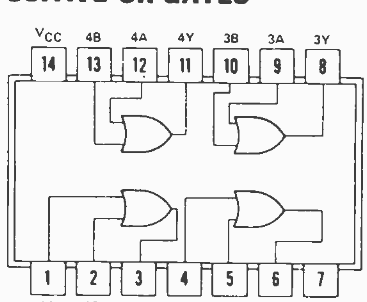
SN7430 8-INPUT POSITIVE NAND GATES



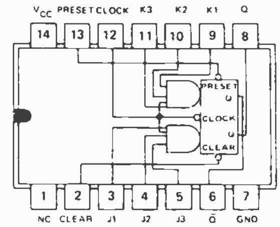
SN7470 EDGE-TRIGGERED J-K FLIP-FLOPS



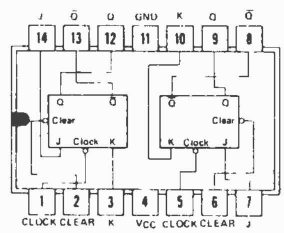
SN7432 QUADRUPLE 2-INPUT POSITIVE-OR GATES



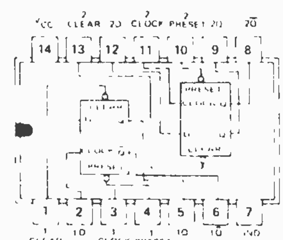
SN7472 J-K MASTER SLAVE FLIP-FLOPS



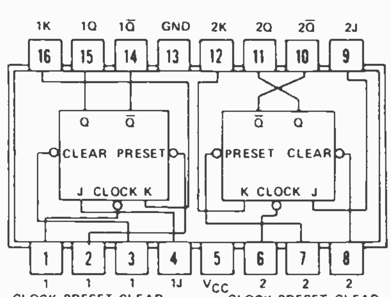
SN7473 DUAL J-K MASTER-SLAVE FLIP-FLOPS



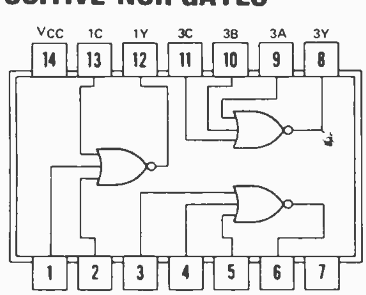
SN7474 DUAL D-TYPE EDGE-TRIGGERED FLIP-FLOPS



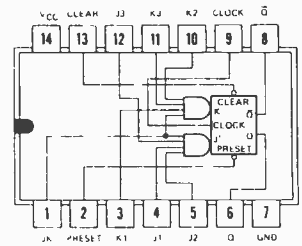
SN7476 DUAL J-K MASTER-SLAVE FLIP-FLOPS WITH PRE-SET AND CLEAR



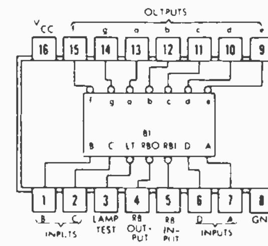
SN7427 TRIPLE 3-INPUT POSITIVE-NOR GATES



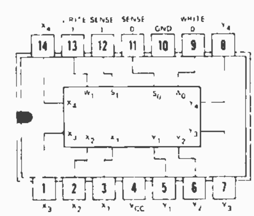
SN74104 GATED J-K MASTER-SLAVE FLIP-FLOPS



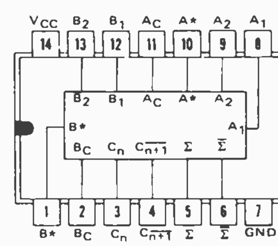
SN7447A BCD-TO-SEVEN-SEGMENT DECODER/DRIVE



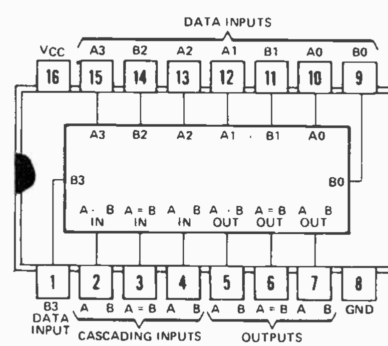
SN7481, SN7484 16-BIT ACTIVE-ELEMENT MEMORIES



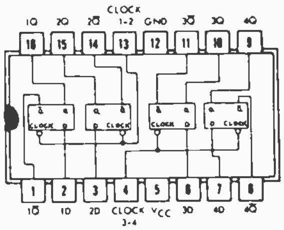
SN7480 GATED FULL ADDERS



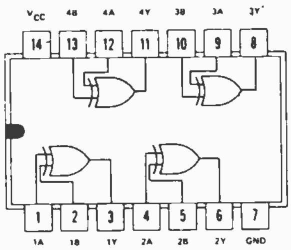
SN7485 4-BIT MAGNITUDE COMPARTORS



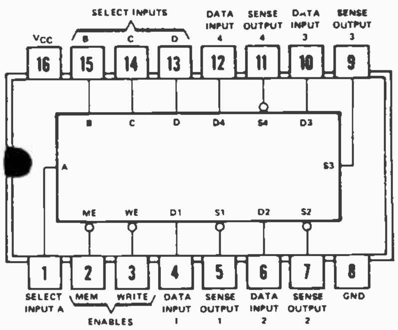
SN7475 4-BIT BISTABLE LATCHES



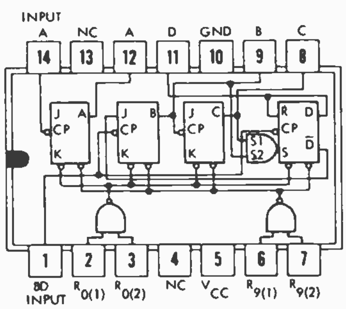
SN7486 QUADRUPLE 2-INPUT EXCLUSIVE-OR GATES



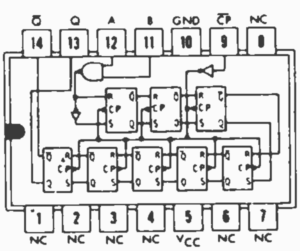
SN7489 64-BIT READ/WRITE MEMORY



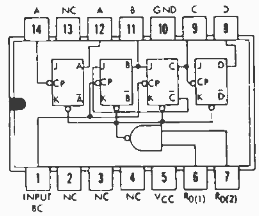
SN7490 DECADE COUNTERS



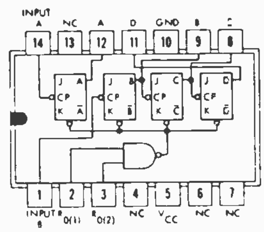
SN7491A 8-BIT SHIFT REGISTERS



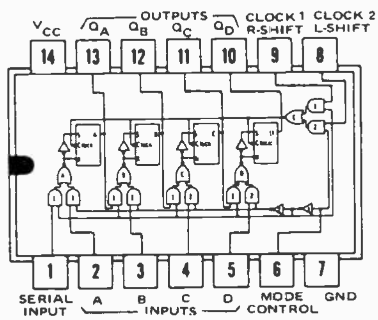
SN7492 DIVIDE-BY-TWO AND COUNTERS



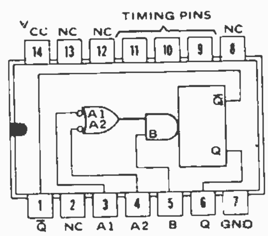
SN7492 4-BIT BINARY COUNTERS



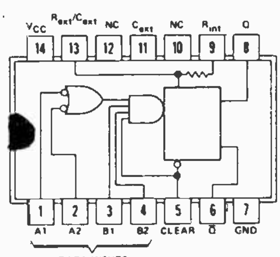
SN7495A 4-BIT RIGHT-SHIFT LEFT-SHIFT REGISTERS



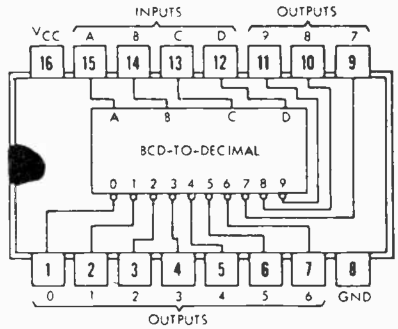
SN74121 MONOSTABLE MULTIVIBRATORS



SN74122 RETRIGGERABLE MULTIVIBRATORS WITH CLEAR

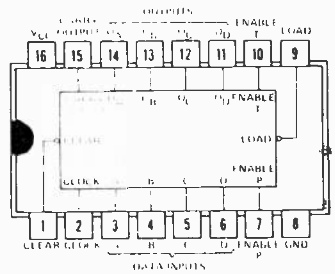


SN7445, SN74145 BCD-TO-DECIMAL DECODER/DRIVERS

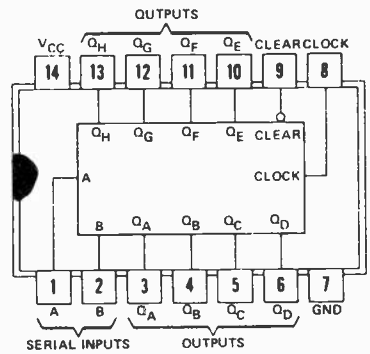


SN74160 THRU SN74163 SYNCHRONOUS 4-BIT COUNTERS

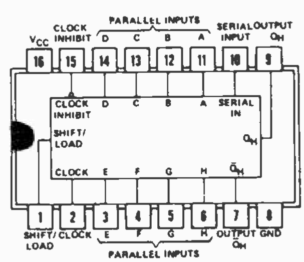
SN74160, SN74161 SYNCHRONOUS COUNTERS WITH DIRECT CLEAR
SN74162, SN4162 FULLY SYNCHRONOUS COUNTERS



SN74164 8-BIT PARALLEL-OUT SERIAL SHIFT REGISTERS

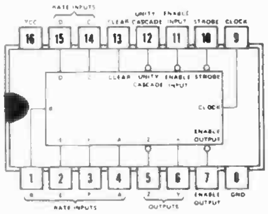


SN74165 PARALLEL-LOAD 8-BIT SHIFT REGISTERS

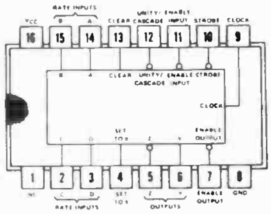


SYNCHRONOUS RATE MULTIPLIERS

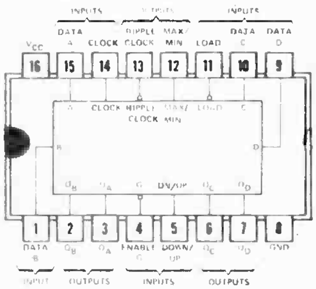
SN7497



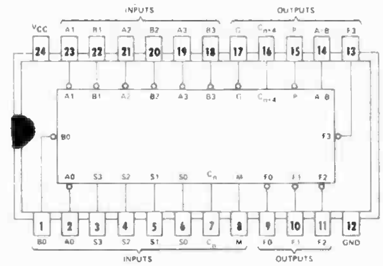
SN74167



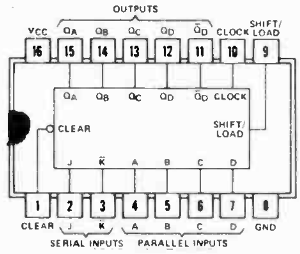
SN74190, SN74191 SYNCHRONOUS UP/DOWN COUNTERS WITH MODE CONTROL



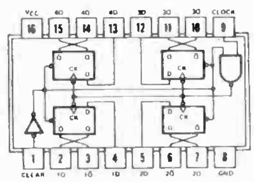
SK74181 ARITHMETIC LOGIC UNITS



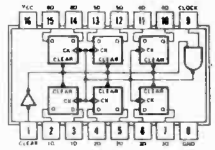
SN741954- BIT PARALLEL ACCESS SHIFT REGISTERS



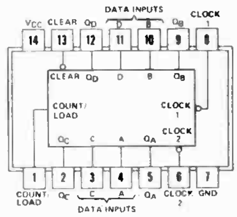
SN74175 QUAD D-TYPE FLIP-FLOP



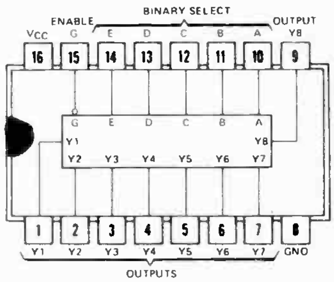
SN74174 HEX D-TYPE FLIP-FLOP



SN74176 & SN74177 PRESET DECADE & BINARY COUNTER



SN74184, SN74185A CONVERTERS



USING TTL:- SOME NOTES ON THE 7400 SERIES

MAXIMUM RATINGS

Temperature Range 0 → 70°C (7400) : –55 → 120°C (5400)
Supply voltage Absolute max. 7V. *Never* use on more than 5.5V, or on less than 4.5V.
Input Voltage Max. 5.5V, best kept below 5V. To make sure a gate recognises the level, keep to 'LO' states below 0.4V, and 'HI' states above 2.4V.

UNUSED INPUTS ON 'AND' GATES & 'NAND' GATES

Don't leave these floating, if you can help it. Switching time and noise immunity are both helped greatly by either:-
(i) connecting any unused inputs to a used input - but watch that the drive capacity of the preceding gate is not exceeded.
(ii) taking the unused terminals to V_{CC} through a 1k resistor (this is so that any incoming step which exceeds the max. input voltage meets a high enough impedance to protect the gate). One resistor will tie up to 25 such inputs.

DRIVING INPUTS WITH OUTPUTS

At low level each standard TTL output can sink current from 10 standard loads, and at high level can source into 10 or 20 standard loads.

Certain devices have special inputs/outputs and as such have a different drive capability to that mentioned. Generally though, a figure of 10 is safe to assume.

Since low level input current is a function of the internal base resistors (nearly!), at a low level up to four inputs of the *same* NAND/AND gate can be taken as one load when tied together.

DECOUPLING

On the layouts with quite a few chips involved, it is helpful to decouple the supply rails every three chips or so, just to keep things stable. A 0.1uF will do.

Is that you?

-a computer that checks signatures

A growing need to check people's identity automatically has led to the development of a computer that verifies signatures by the speed and sequence of pen movements as well as by the finished sample – this report by R. S. Watson & P. J. Pobgee of Britain's National Physical Laboratory.

MODERN TECHNOLOGY HAS, ironically, increased the opportunities for crime and its rewards. Easier and more widespread facilities for getting goods on credit and the introduction of electronic fund transfer systems have made it possible to make money directly by fraud.

Nowadays, too, there are many places where people cannot be allowed to enter unless they are authorised.

There are two ways of tackling the problem. First is the method of providing tokens such as credit cards or pass cards or even secret codes. But tokens can be lost or stolen or lent to other people. The second method is to make use of some human property such as fingerprints, body weight, or other physical dimension. Unfortunately, people often object to such things being used and, in any case, measurement can be expensive to automate. Together with voice 'prints' these visible attributes can still be imitated, another drawback.

PEN MOVEMENTS

Signing is the traditional method for authorising documents, and signatures represent a well practised human behaviour pattern. Although the visible mark can be easily copied or traced, the *way* in which it is written is also characteristic of the writer. This means that additional information can be obtained by measuring the *speed* and *sequence* with which the pen is moved across the paper.

It follows that, in any automatic system for recognising signatures as they are written, the first requirement is for an economic way of obtaining this hidden information without upsetting the writer's natural rhythm. This was obtained by inventing a simple electronic notepad that produced a sequence of electrical signals corresponding to the signing action without being connected to the writer's pen. This pad has been further developed commercially and is marketed by Quest Automation as a data entry device under the name Datapad.

The second stage was the study of a great number of signatures to choose a method of measurement that could ignore minor variations between samples from the same writer, while preserving his distinguishing features. Over 10 000 signatures were collected from more than 500 writers from all walks of life. When we examined these with a view to isolating the variables, four rather obvious factors emerged. These were name, style, context and noise.

The *name* forms the basic structure. It may be short, such as B. Nye or long, with 30 letters or more – Sir Frederick Marmaduke Bertwhistle. The name may be written in different languages, or scripts such as Roman, Russian, Arabic, Japanese, Hebrew or for that matter any well practised group of symbols. In some cases a person's initial are acceptable.

By *style* we mean the variations about the name form. Many people have a repertoire of styles which they use on various occasions. A number of common examples which we met were a 'working or everyday use'style, a 'cheque book' style and what might be called an 'impress the boss' style.

Context is the modification to a given style caused by what the individual is doing at the time. The rhythmic properties of a person's signature can vary according to his attitude to the transaction. The signing of an important document will affect the way he writes more than a trivial event such as the receipt of articles worth a few cents.

All the other influences that may affect the signing behaviour we have called the *noise* factor. The weather may be included in this category and a number of signatures were collected from people arriving at the laboratory in midwinter. Other samples were obtained from people in various states of health. In one case drugs were being taken to alleviate the symptoms of a nervous condition. Then there is the 'after business lunch effect' which can influence the signing rhythms!

Our large data bank of signatures was supported by other experiences of interaction between man and machine. This enabled a team led by Dr J. Parks of NPL to develop powerful techniques to overcome many of the difficulties.

Peter Hawkes of the UK's National Research Development Corporation and Stephen Dennis of Inter-Bank Research Organisation had been following progress with interest, and a joint venture was formed between NRDC, INRO and NPL to construct a prototype machine for VERIfication of SIGNatures (VERISIGN).

Diagram 1 illustrates the basic building blocks of the Verisign machine. A user first enters his personal identity

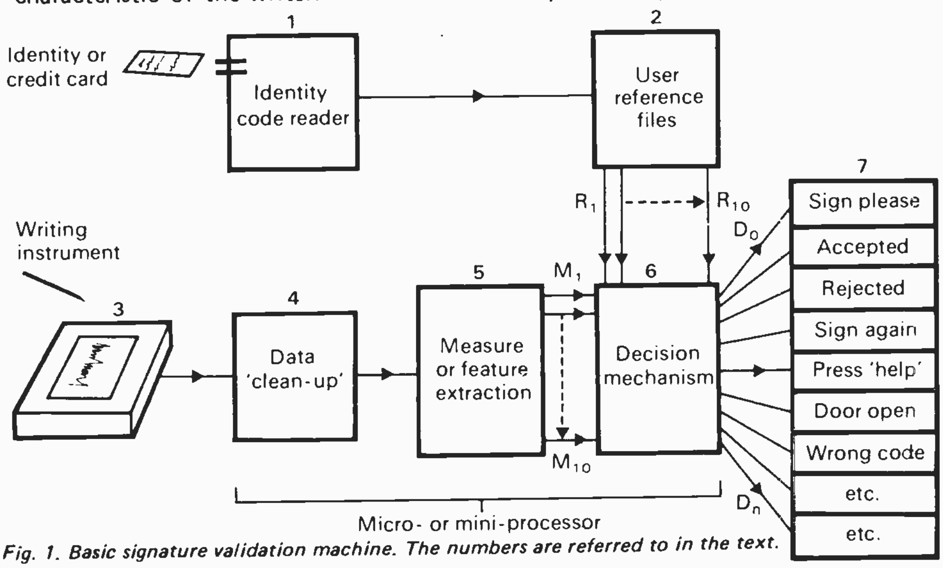


Fig. 1. Basic signature validation machine. The numbers are referred to in the text.

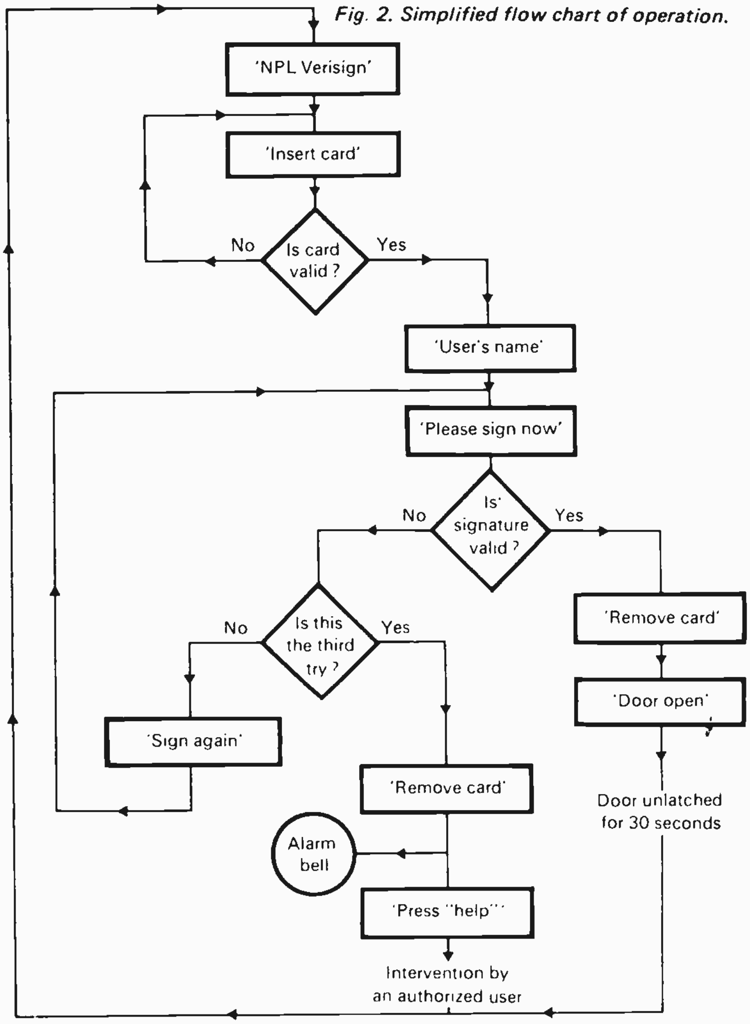


Fig. 2. Simplified flow chart of operation.

code either through keyboard or badge reader(1). The code, which in our case is a four digit number, is used to extract the user's reference file (2) containing a set of 10 reference parameters (R1-R10). These are passed to the decision mechanism (6) and a request flashed to the output display (7) for the person to sign his name on the Datapad (3).

The Datapad has an electro-sensitive surface on which movements of the writing stylus are converted into a 'string' of interleaved x, y co-ordinates showing how far across and up or down particular points are. This 'data string' is then processed (4), to remove artifacts such as marks made accidentally by the user.

Analysis of the 'cleaned up' data occurs at (5) in which measurements are made on certain properties which characterise the signing pattern. Examples of possible measurements are the number of crossings made by the x or y co-ordinates over a datum line or the total time spent in writing. Many other functions of position and time may be chosen.

The properties or parameters can be selected 'locally', that is within certain areas, or 'globally', with the measurements taken over the whole signature.

Over 100 measures were tested for their ability to discriminate between writers, while remaining insensitive to each person's own variation. From these, ten measures were selected and used to generate the values M1-M10 which are passed to the decision mechanism (6). Here a comparison is made with those obtained from the claimed reference set (R1-R10). The degree of similarity or closeness of fit in relation to a set threshold value determines one of a number of decisions (D1-Dn). A close fit, that is below the threshold value, is accepted. A poor fit causes the signature to be rejected and displays a request for further samples.

A hierarchy of decision procedures is used allowing 'context' factors such as customer importance or the value of the transaction to be incorporated. The decision mechanism can be easily organised in a number of different ways to suit individual requirements.

Anyone who will be using the machine is first asked to submit five specimen signatures. The spread of this group is then examined by the machine for any gross inconsistencies. Signatures that lie outside a given tolerance band are rejected and further samples requested to make up the number. The variation in the reference group (variability factor, VF) provides a useful means of assessing what the chances are for successful impersonation by unauthorised users. The lower this factor the higher the security and, of course, the reverse is true.

The basic flow chart of the Verisign machine is shown in diagram 2. Three attempts at writing a signature are permitted before some form of alert is given.

The computer program, apart from a few modules, is written in standard Fortran IV language and occupies about 12 000 words of core store. Twenty words are required for each person's reference parameters plus an extra 10 for performance logging.

We used a 16K mini-computer which provided reference file space for up to 120 people. The time to verify a signature was less than 100 milliseconds. This meant that a complete transaction, including the entry of a personal identity code, could be completed inside 20 seconds.

The system was tested in various situations including remote operation over public telephone lines. In addition, two full-scale experiments were carried out. For the first, in the entrance hall at our laboratory, the participants identified themselves as they entered and left the building. The 71 people who took part included typists, security officers, members of the services, professional engineers and scientists. Out of 2000 attempts made at identification by signing, 96 per cent were successful.

It is, of course, one thing to ensure that the genuine person is identified correctly with the minimum fuss or bother. It is another to prevent the less scrupulous their practising art! With this in mind, at the end of both experiments we displayed a number of target signatures and invited everyone to try his hand at copying them. With the first experiment at NPL, although one or two came very close, no-one was able to obtain a 'signature valid' signal. A lower threshold was used for the second experiment and the decision scores were displayed as an incentive. No limit was placed on the number of attempts, allowed and under these less rigorous, unrealistic conditions a few people were eventually successful.

No security system is perfect but the hierarchy of this one allows the degree of security to be balanced against the possibility of rejecting an authorised user. ●

COMPUTERS FOR SMALL BUSINESSES

We look at

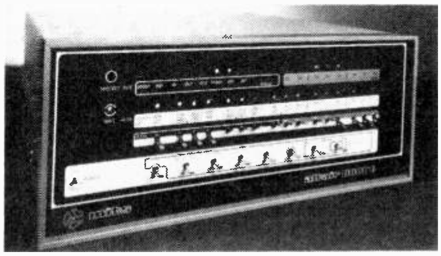


Fig. 1 The Altair 8800b is a well-known microcomputer.

THE LAST DECADE'S ADVANCES in computing technology have had two effects. Firstly, in the ease with which large volumes of data may be handled, and secondly, in the accuracy with which calculations may be performed. Although these effects have been in evidence for ten years, it is only now that a final factor is combining with these to fire a revolution. Recently MOS LSI technology has begun to bring down the price of processing power and make it available to everyone.

Although large companies have long used computers, (the corporate computer centre is almost a cartoon character), these monolithic monsters have always been screened from the user by a staff of programmers, operators, analysts and other staff who together with the costs of special air-conditioning would place such a system beyond the financial reach of the smaller organization. Then along came the minicomputer, and things started to change. But for a long time, the mini was regarded mainly as a scientific tool and not developed to handle large databases. The need was there, however, and so such systems have been developed and refined to the point where they are now efficient and simple to use.

Fig. 2 This Altair business system can perform a wide range of accounting tasks.

SMALL BEGINNINGS

The next development was a generally unforeseen one — the simple pocket calculator. Although the computer can digest vast quantities of data, the calculator is the tool which has affected accuracy so much. If you are offered a 14% discount on $600.00, the chances are that you don't say "around $500.00"; you take your calculator from your pocket and say $516.00 exactly. The pocket calculator is an instant-access, simple to operate, tool for decision making. It can give you instant, accurate figures wherever you are. Fairly sophisticated analysis can be performed on a pocket calculator, such as mean and standard deviation, curve fitting, linear regression, trend line analysis etc. Some financial or business calculators are pre-programmed with these functions as well as loan repayment and investment functions.

The programmable calculator can be used to solve all of the above problems. In addition, the programmability feature may be used to solve optimization problems. For example, a model may be prepared which relates costs to certain variables, such as raw materials costs, production volumes, warehousing etc. This is then programmed into the calculator and run repeatedly until a combination of variables which minimizes costs is found. This trial and error method of solution is both simple to use and intuitively helpful.

The pocket calculator is the best value in computing power available today. Used to its full capability, even the simple four-function machine can perform amazing feats.

MICROCOMPUTERS

The next step up from the calculator is the microcomputer. The micro has been in use by hobbyists and engineers for around two years now, but it is only beginning to appear in small business systems. One of the most popular microcomputers is the Altair 8800, which uses the Intel 8080 as CPU. Because this computer uses a standardised card size and bus structure, it can carry a wide range of memory and interface cards made either by

BUSINESS COMPUTERS

MITS (who make the 8800) or other manufacturers. The latest version, the 8800b (shown in fig. 1), costs $1,100 (US price), plus extras such as memory, terminal interface, etc.

MITS have set up a new subsidiary company, the Altair Software Distribution Company, to provide Altair users with quality applications software. Their first product is a set of software packages for the small business system market, covering accounting, word processing and inventory management. The software may be licensed for use in individual packages to accommodate the needs of retail stores, small wholesale distribution centres, and other commercial and industrial users.

The hardware required for the system is fairly straightforward. The central unit in fig. 2 is the computer, and to the left is a stack of floppy disks, each of which (depending on formatting) can hold around a quarter million bytes of data. On the right is a CRT terminal which is used to control the system, and just visible on the far right is a line printer which is used for all printed output.

The important part of a business system is not so much the hardware as the software. It is fairly easy for any programmer to write code which will perform the desired calculations — the important point is the apparent simplicity of the system to the user. At this point we should point out that, though it is possible for a computer hobbyist to buy the hardware and sit down to write his own business software, the chances are that he will be the only person who could use it. If a clerk, or any non-technical staff will have to use the system, then considerable thought should be given to prompting messages, output formatting etc. This is really what you are paying for when you buy business software.

Fig. 3 This beauty contest photo shows General Automation's LSI-2 minicomputer which is typical of the types finding their way into business systems.

ACCOUNTING

The Altair Business System Software consists of modular packages which allow the user to select the components of a system that will most closely fit his needs. There are four modules in the accounting package — general ledger, receivable, payables and payroll. The General Ledger module is the central part of a financial reporting system for a small business. It allows a firm to keep a detailed monthly general ledger of all its transactions by generating a monthly balance sheet and income statement. The Payroll module prepares periodic payroll for hourly or salaried employees while accumulating the necessary information for tax reporting. The Receivables module is a complete invoicing and monthly statement generating system that keeps track of the current and aged accounts receivable. The Payables module performs the same function for accounts payable and incorporates a cheque writing feature.

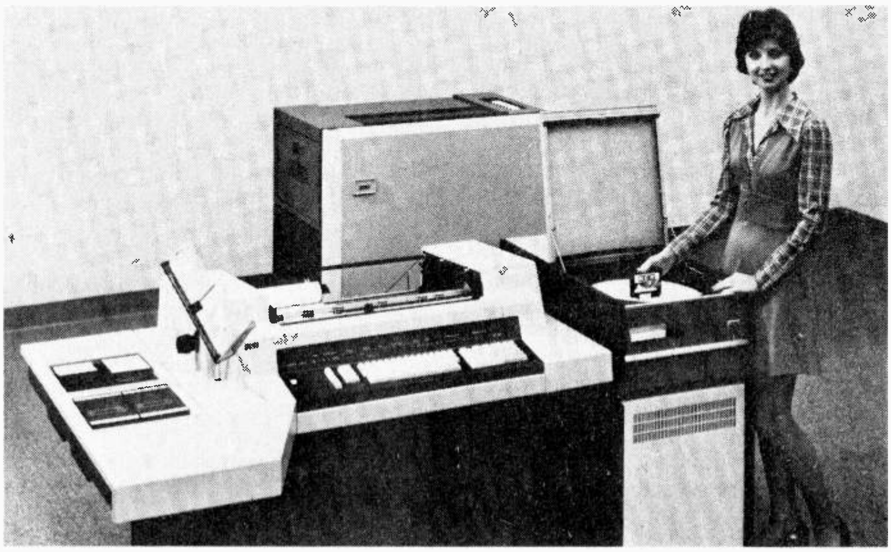


Fig. 4 NCR's 499 is a purpose-built office system.

WORD PROCESSING

Another important function which can be performed by computer is Word Processing. The Altair Software Distribution Company have available a text editor system that allows large volumes of text material, such as contracts, to be stored, easily edited or updated, and printed. Documents can also call for inserts from other files, so that repetitive letters and complicated documents can be produced. The text material is stored in a file without regard to pages or margins so that additional text material may be inserted later and page heading, number, margins, spacing and other format may be specified at the time of printing. A draft copy may be corrected and then a final printed with different margins.

A single document may contain up to 120,000 characters (that's about 35 single-spaced pages), and documents may be linked for longer text. The text editor allows simple in-line corrections and extremely powerful global editing to be accomplished. As we mentioned above, this system contains a complete set of prompts so that even an inexperienced operator can use the system with only minimum instruction.

INVENTORY MANAGEMENT

The Inventory Management package offered by Altair is a flexible system which can be configured by the user to store, and present, the information in the form required by the particular business. In its off-the-shelf form, it is structured for a typical retail store who reorder when quantities reach a minimum.

These packages, like much business software, are available under a one-time fee licensing arrangement, which includes three years of software maintenance.

TIP OF THE ICEBERG

Things are only beginning to move in the microcomputer end of the business systems market. Many computer stores are now arranging to provide their own software, and a variety of packages will be available in the near future. In particular, we can expect to see commercial computer languages like COBOL and TOTAL implemented on microcomputers, as well as hardware developments such as multi-user systems and larger disks.

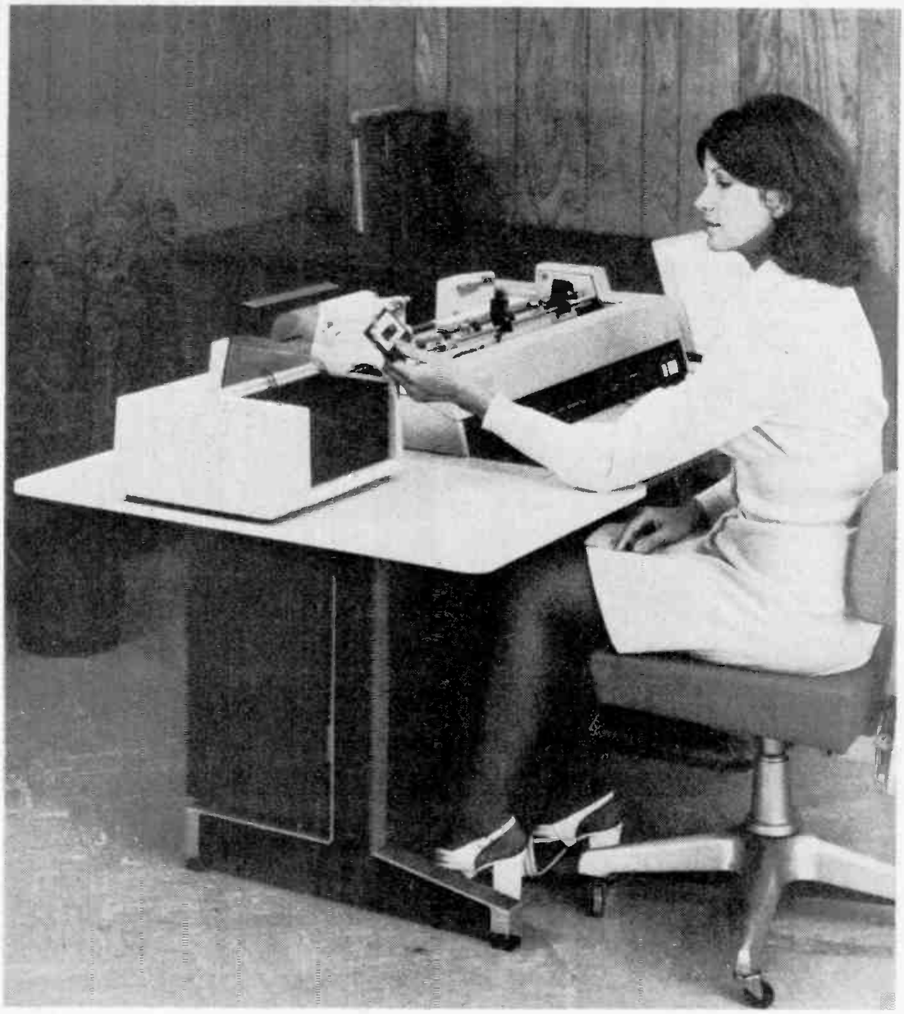


Fig. 6 Note the paper-handling hardware on this NCR 299

TIMESHARE

While we're on the subject of multi-user systems, there is a possibility open to firms who do not have to perform much in the way of invoicing, or other paper-handling, but want to use the computer as a high-level decision-making tool, by generating reports and models on a grander scale than on the calculator. General Electric, for example, offer a time-sharing computer service which enables you to use a larger computer with vast applications software without investing in hardware.

Fig. 5 This Hewlett-Packard HP9896 Business Information Management System is especially attractive to small engineering companies.

Typical of this software is FAL II, a financial analysis language which can be used to prepare forecasts, cash flow and capital structure analyses, tax analyses, operations summaries, inventory reporting and analyses, sales reporting, expense budgeting . . . the list could go on and on. GE's Mark III Information Services, as the whole intercontinental set-up is called, supports various languages, including FORTRAN, COBOL, ALGOL and BASIC.

Another big advantage is that the network extends over 500 cities in four continents so that a local sales office, for instance, could rent a terminal with modem for around $300.00 per month, do all their local computing, generate reports and these would be instantly available to head office. Charges for the system are based upon the amount of computer time and storage used, and will generally be in the region of $30-$40 per hour.

ALL IN A BOX

Another type of system, if you have got a lot of invoicing and accounting to do, is the business machine which is built into a single desk, perhaps with an

BUSINESS COMPUTERS

additional cabinet for some of the hardware. These often incorporate sophisticated paper handling hardware. For example NCR's 299 system incorporates a multi-forms handler which can process invoices, ledgers, cheques, journal rolls — you name it!

Programming on the 299 is not in a high level language — instead it's in a form of assembly code, done on special forms and then transferred to a program assembly card which is read by an optical scanner. Higher performance models such as NCR's 399 and 499 have considerably more power, incorporating such peripherals as disk units (10 million bytes of storage), punched card I/O, paper tape I/O, magnetic ledger reader, and tape cassette.

Manufacturer-supplied software at this level is very sophisticated. For example, Nixdorf Computer offer, for their 8870 computer, a system called NIDAS (Nixdorf Integrated Distribution Accounting System). This system can generate 54 different reports, including some graphic analyses. These system is rather larger than the NCR's mentioned above; the basic memory is 48K bytes and it can support up to nine terminals.

OFFICE SYSTEM 6

This is IBM's latest offering in the small business market. Primarily an information processing system rather than an accounting machine, the basic console is a desk-styled unit with a central CRT terminal which displays six lines of text and two lines of status and prompts. Extensive use of prompts and options guides the operator through each task, and in fact initial operator training is mainly conducted by the machine itself.

Text editing is very simple with the CRT display; text can be easily accessed for revision by character, word, line or paragraph. Segments of text can be moved from place to place, line endings and page lengths can be adjusted automatically to accommodate revision. Addition of headers, footers and page numbers is also automatic.

REPORTS

But word processing is only one application for this system. Another important use is in the maintenance of tabular files of data — sales reports, etc. System 6 can be programmed to work through a file, looking for any, say, sales figures below a certain value. It will then compile these into a report.

In fact we should not have used the word "programmed" above, as no program has to be written. It already exists within the system and is selected and run by responding to the system's prompts, so that no programming skill is needed.

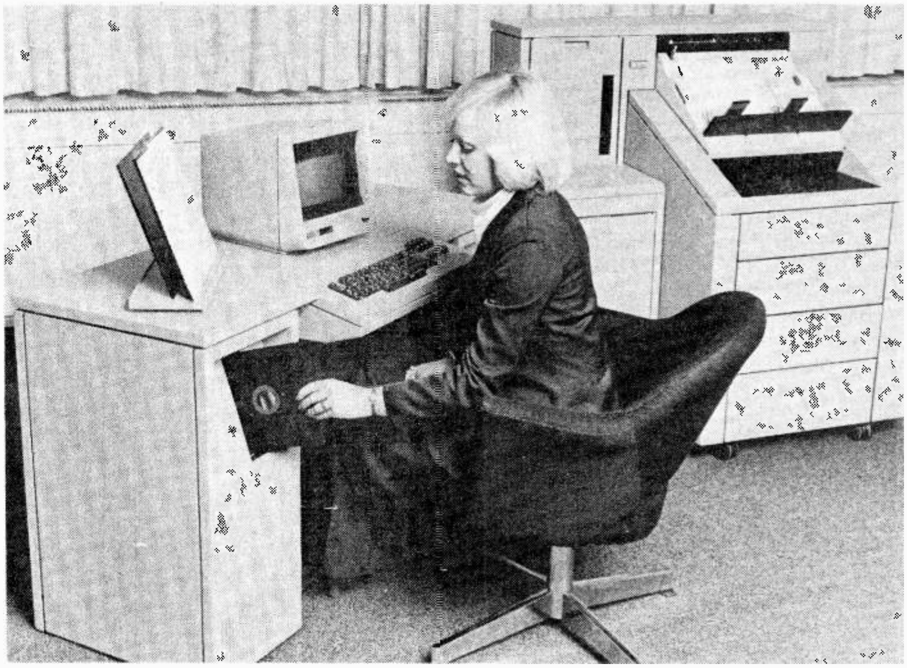


Fig. 7 IBM's Office System 6.

RECORDS PROCESSING

Personnel and inventory records, lists of customers and suppliers, schedules and reports, project or case records and many other kinds of information generated by an organization can conveniently be kept on floppy disks. Once in the form, System 6 can change, select, sequence, qualify or reformat records automatically to generate listings, reports and documents.

The printer on System 6 is IBM's high-speed ink jet printer, which can operate at up to 92 characters per second. Three pitches are available, with electronically changeable type styles. Up to five fonts can be installed at one time, with three being standard. Automatic paper handling makes possible continuous operation, so that jobs can be queued to the printer while the operator utilizes the keyboard and display for other assignments.

A magnetic card reader is available on System 6, and various sources in the industry regard this as a strategic move by IBM to keep magnetic card typewriter business going. A version of System 6 is available without the ink jet printer; in this case output could be on magnetic cards for print-out on a typewriter. The top-line IBM 6/450 would set you back over $37,000, and $28,000 for the printer.

ENGINEERING DESIGN

If your business is involved in engineering design of some kind, such as mechanical engineering, you may with to have some kind of computational facility available for design, such as stress analysis. In this case your best bet is to go for a microcomputer based system with a high level language such as BASIC, or perhaps a desk-top calculator computer like IBM's 5100, HP's 9831 or the Tektronix 4051. The latter is extremely interesting in having graphics capability, which enables the use of charts and graphs for computer-aided design. The system can then do double duty, by doing accounting or stock control part-time, and scientific work at other times. Avoid compromise situations, however. If either facility can't get enough machine time, you need another machine, and the chances are you can afford it.

ADVANTAGES

Because this world is encountering what can only be described as an information explosion, it is impossible for human hands and eyes to handle all of it. The routine work now has to be done by computer, and this can be used to advantage in the preparation of reports, so that information is condensed and presented in a readable and intelligible form. Stock level control can be much tighter, and fairly rigorous procedures can be adopted. The general feeling is that introduction of computer-based systems results in a "tight-run ship" — good systems today are not so tight as to be constricting! They are also more affordable — there are going to be some interesting developments in the next few months.

●

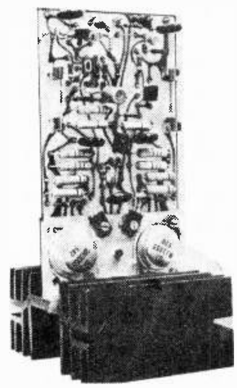
CIRCUITS 1: $5

CONTENTS BY CATEGORY

See page 34 for details of how to order this publication from ETI.

What's in the April issue

50/100W AMP



A couple of really powerful ear-drum bashers! This project is only one in fact but the output power can be chosen by selecting the output transistors and the transformer.

And the performance ain't so bad! Total distortion at 60W in the 100W circuit is only 0.1% with a very wide frequency response.

Proper protection and stability circuitry is included to look after it once it's built.

VE3RPT — Repeater Extraordinary

With the rapid growth of two metre FM, and the importation of some lovely little boxes from the East, it seems that repeaters have sprung up all over the place. But they don't just spring up, of course, and this is the story of a repeater that just won't stop growing. It seems that now it's so complex it's going to have to be computer controlled. . . .

BEAT THE BURGLAR

The average house has about $20,000 of removable valuables; don't believe us, add it up: color TV, broadloom, stereo — the list doesn't end. The financial upset of a burglary is only part of the story: the emotional disturbance is far, far worse and you can't insure against that.

This article is not on the electronic circuitry but about how to instal burglar alarms — it's not nearly as easy or as obvious as it sounds. Both mechanical and electronic aspects are discussed.

LOGIC TESTER

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SHORT CIRCUITS:

BIOFEEDBACK

Biofeedback is the art of controlling you body by knowing exactly what it's doing! Put like that it sounds simple. But it isn't. Your brain generates several sets of 'waves', all at different frequency, and all with totally different meanings and functions. Yoga may be an old-fashioned idea — but biofeedback is a modern method achieving those aims — instantly! Or so its advocates claim. Make up your own mind in next month's ETI.

Temperature Alarm:— an ingeniously simple circuit to sound an audible warning (or trip a relay) when a preset temperature is exceeded or fallen below. Will work superbly as a deep-freeze alarm, process temperature controller, etc., etc.

Function Injector:— we refuse to call this a 'signal' injector, simply because these are usually sine or square wave only. Well ours does both and triangular functions as well, and is packed in a compact hand-held box to make life easier when you're crawling around inside that amplifier you've been meaning to fix for ages.

SHORT CIRCUITS

ETI's series of straightforward projects, not necessarily simple in their operation but presenting few problems in building.

LED DICE

THIS SIMPLE DICE PROJECT IS based on a CMOS (Complementary Metal-Oxide Semiconductor) integrated circuit counter which is stepped by the output of a 555 timer integrated circuit connected to run as an oscillator at approximately 6500 Hz.

When the button on the unit is pressed the 555 oscillates and the 6.5kHz pulses which it generates at pin 3 are fed to the input of IC2 (pin 14). The integrated circuit, IC2 is a decade counter in which each of the count states (0 to 9) are brought out to separate pins. By connecting the seventh count output (pin 5) back to the reset input (pin 15), the counter is made to reset after every sixth count. The six count states of the IC which are used are each connected to a light-emitting diode (LED). As the IC counts it will switch on each of the six light emitting diodes in turn. Whilst the button is pressed the LEDs will be switched at a rate of 6.5 kHz and thus all LEDs will appear to be on due to the limited frequency response of the human eye.

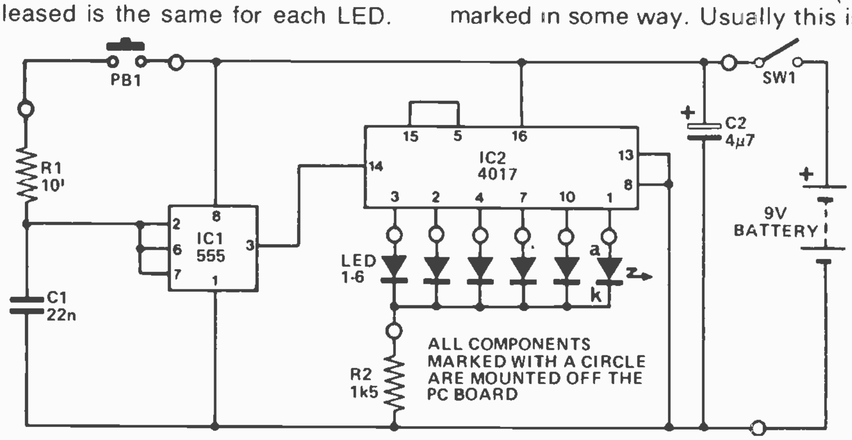
When the button is released the oscillator stops counting leaving one only of the LEDs alight. As the IC cycles through its six states the LEDs will each be on for the same interval. Thus the probability of being on when the button is released is the same for each LED. The LEDs may therefore be numbered from one to six and the device can then be used as a dice.

CONSTRUCTION

Whilst CMOS devices are fairly rugged in-circuit they are liable to be damaged by static discharges when handled out of circuit. For this reason they are supplied in either conductive foam, aluminium foil or specially-coated plastic containers which short all the pins together for protection. The CMOS should only be removed from its protective packing when you are ready to insert the device into the board. All other components should be mounted to the board first and the CMOS inserted last of all. Handle the pins of the device as little as possible and solder in place quickly and cleanly with a light-weight soldering iron.

The integrated circuits are marked by a small notch or dot at one end of the body. When inserting the IC make sure that this mark is aligned with the orientation mark provided on the component overlay. Make sure also that the electrolytic capacitor C2 in inserted with the correct polarity.

The light-emitting diodes will have their cathode terminals (k) marked in some way. Usually this is



How it works

The output of IC1 is connected to the clock input of IC2 and every time there is a pulse from IC1 the output of IC2 which was high, will go low and the next output will go high (providing that the reset input is low). Thus the "high" shifts through the ten outputs of IC2 in sequence at the same rate as the input pulses from IC1. The sequence of ten outputs recycles whilst there are input pulses.

However a dice has only six surfaces so we require IC2 to count to six, rather than to ten. This is easily performed by connecting the seventh output of the IC back to the reset input. Now when the counter is clocked from output six to output seven, seven goes high and resets the counter. Once the counter resets the high is removed from output seven and the counter, back at output one, is free to count again. The time taken to do this is only about 100 nanoseconds (0.000 000 1 sec).

The outputs one to six of IC2 are each connected to the anode of an LED. The cathodes of the LEDs are all connected in parallel, via a common current-limiting resistor, to 0 volts.

For checking purposes the action may be slowed down by putting a high value resistor across the terminals of the push button (even just the finger across the terminals will do). This will cause the oscillator to run at a low speed so that the changing of the LEDs can be seen.

by means of a small flat on the plastic body of the component adjacent to the cathode lead or the cathode lead many be shorter than the other. Make sure that the leds are inserted the correct polarity — if any LED fails to light when the button is pressed it is most likely that it is the wrong way round.

Parts List

RESISTORS
R1 10K
R2 1K5
All ½W 5%

SEMICONDUCTORS
IC1 555
IC2 4017
LED 1,2,3,4,5,6 TIL 209 or similar

CAPACITORS
C1 22n ceramic or similar
C2 4 7 16V electrolytic

SWITCH
PB1 = push to make type
SW1 = single pole / Off-On rocker

MISCELLANEOUS
PP3 battery
PP3 battery clip
Board spacers
Nuts, bolts, etc.

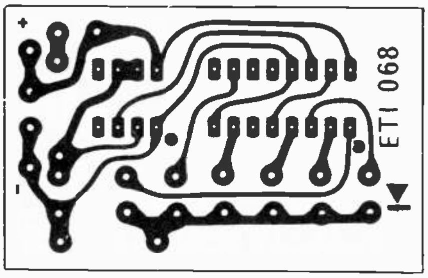


Fig. 2. Printed-circuit board layout for the LED dice. Full size 55mm x 35mm.

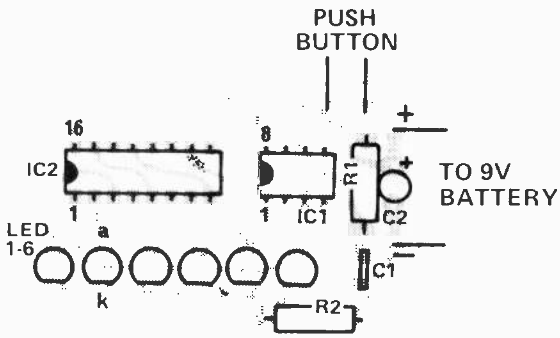


Fig. 3. How the components are mounted to the printed-circuit board.

TWO-TONE DOORBELL

THIS ELECTRONIC DOORBELL IS based on the 555 integrated circuit. The device is widely used in many types of timers and as a simple oscillator. In this project both operations are used. When the button is pressed the 555 oscillates at one frequency (tone), when the button is released the tone changes and the IC continues to produce this second tone for a predetermined period. Thus by pressing the control button once a two-tone doorbell sound is produced by the speaker driven directly from the integrated circuit.

CONSTRUCTION

Assemble the components as shown in the component overlay diagram. Note that in this diagram the copper tracks are shown dotted as they are on the opposite side of the board from the components and therefore cannot be seen.

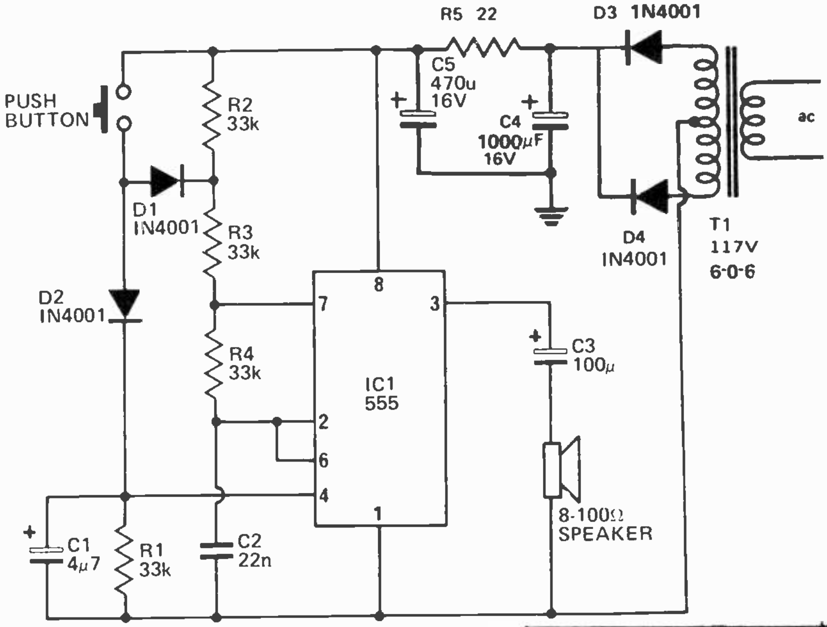
The integrated circuit, diodes, and the electrolytic capacitors, must be mounted the correct way round. The overlay shows the distinguishing marks on each component, and the component must be placed so that the marks on the component are the same way as on the overlay diagram.

How it works

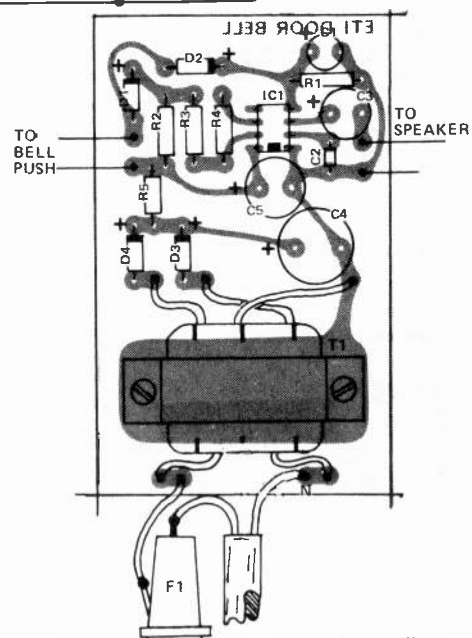
Operation of the doorbell may be described as follows: The capacitor C2 initially charges towards plus nine volts via resistors R2, 3 and 4. However, the top of the capacitor is connected to both pin 2 and pin 6 of the 555 timer IC. Hence when the voltage on the capacitor reaches 6 volts both comparators will be above threshold and the output of the 555 at pin 3 will go low and the internal transistor will switch on, shorting pin 7 to ground. However pin 7 is connected to the junction of R3 and R4 and C2 will therefore now be discharged via R4. When the voltage on C2 falls below 3 volts the output will go high again, the transistor will turn off, and C2 will commence charging again via R2, 3 and 4. This sequence continues thus producing a triangular waveform across C2 and a pulse train at pin 3. The pulse train output from pin 3 is coupled to the loudspeaker via C3 which prevents the dc component of the voltage from reaching the speaker.

The triangular waveform is produced by C2 charging from 3 to 6 volts and then discharging from 6V to 3V.

If a different pitch tone is required R2, 3, 4 or C2 may be altered in value.



Circuit diagram of the two-tone doorbell.

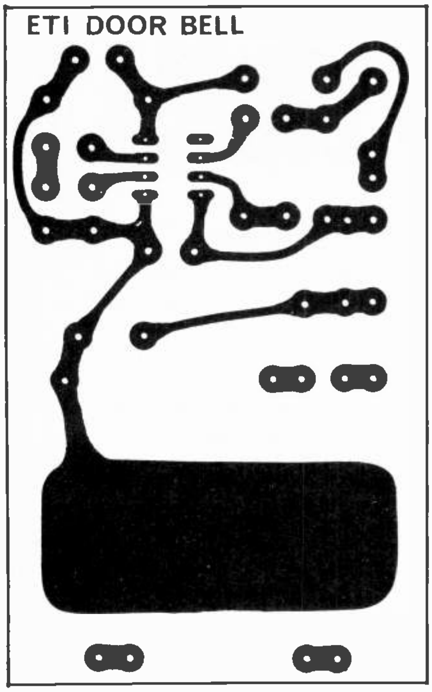


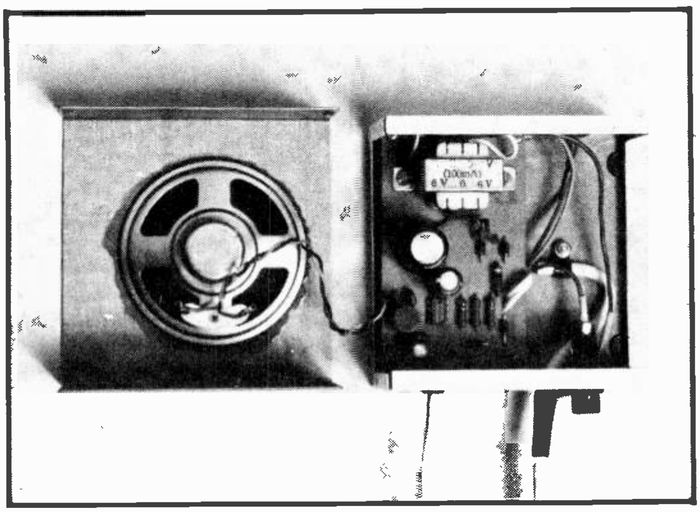
Overlay for Doorbell

Parts List

CAPACITORS		
C1	4u7	16V electrolytic
C2	22n	ceramic or similar
C3	100u	16V electrolytic
C4	1000u	16V electrolytic
C5	470u	10V electrolytic
SWITCH		
PB1	Bell push type	
SPEAKER		
LS1	2½" 8Ω type.	

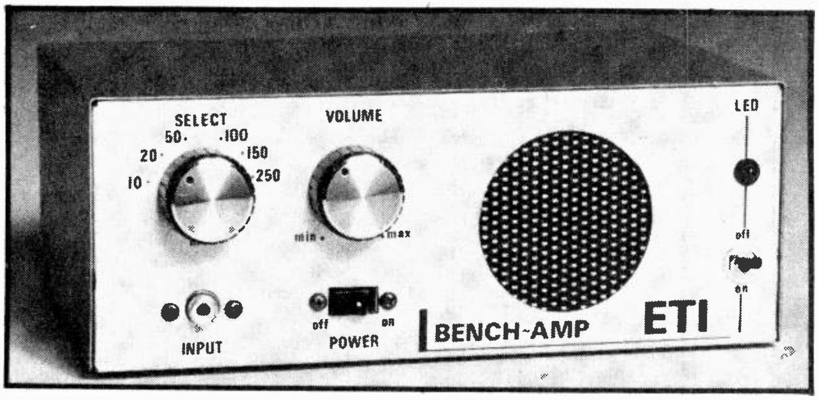
RESISTORS	
R1, R2, R3, R4,	33K
R5	22R
All at ½W 5%	
SEMICONDUCTORS	
IC1	555 timer
D1, D2, D3, D4	IN4001
TRANSFORMER	
T1 115V-6/0/6	100mA
MISCELLANEOUS	
F1 fuse holder	250mA fuse
3-core mains flax	
2-core bell flex	
Panel grommet	
4 board spacers	
Nuts, bolts, etc.	





Internal layout of Doorbell

BENCH AMP



How it works

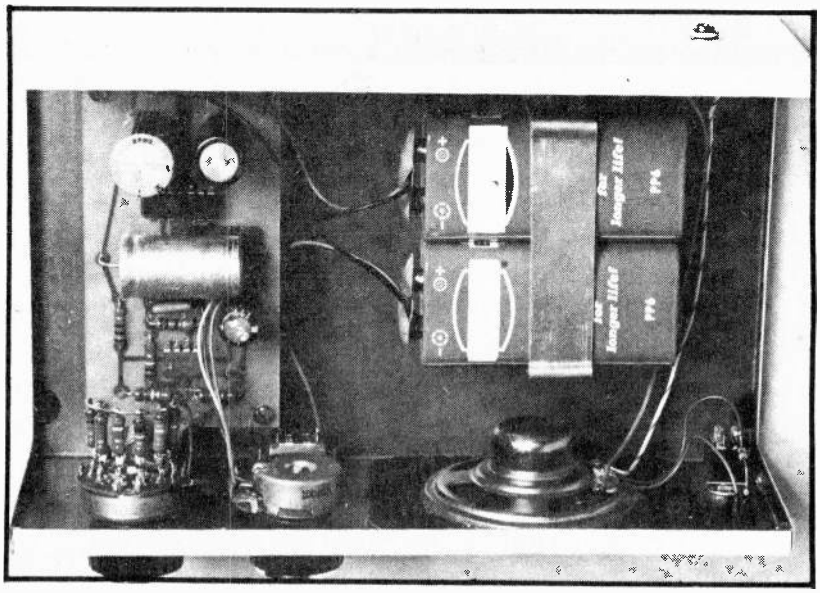
The gain of IC1 is set by the ratio R9/R1 - 6 resistors R1 - 6 vary this from ≈20 to ≈0.5. Thus to produce 100mV across RV1, inputs from 5mV to 200mV are required. R7 and R8 bias the non-inverting input to 4.5V and R10 is included to protect the chip. Since D.C. gain of the circuit is unity, the output will set at +4.5V D.C., providing maximum swing capability. To minimize output offset due to bias current, the value of R7 and R8 in parallel should be approximately the same value as R9. Bear this in mind if you intend to alter the supply voltage.

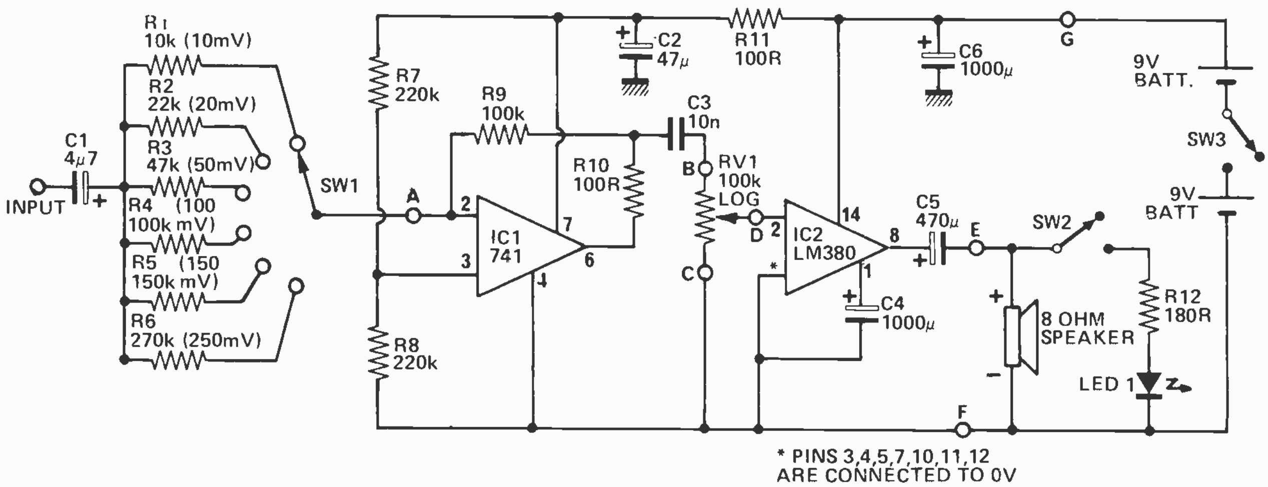
R11 and C2 provide decoupling for the 741 rail, as C6 does for the LM380. This capacitor can be increased in value to advantage with a supply not entirely stable. If another value of impedance speaker is employed, R12 will have to be altered to maintain the conditions.

THE AMPLIFIER TO BE described here differs in one major respect to most others - it can be used as an accurate millivoltmeter! One of the most awkward things to measure in a lab is an audio signal of less than a volt. Specialist meters are expensive, and rarely justifiable for an amateur: hence this project. This provides at least an 'order of magnitude' reading, and in most cases an accurate value can be assigned to the signal.

The circuit is basically an audio pre- and power amplifier combination, with switchable preamp gain. Depending on which sensitivity is selected, the gain of the 741 is so adjusted as to produce the specified input to drive the LM380 to the point of clipping. This voltage in turn is just sufficient to cause the LED to light.

To measure an A.C. signal, turn the volume control to maximum, and apply the input to the socket and work down from the lowest sensitivity until LED just comes on. The value of the input is now indicated by the switch. We tried several 380s and several dozen LEDs to see if our results were repeatable: they were. In all cases we were within 10% of the value of the signal!

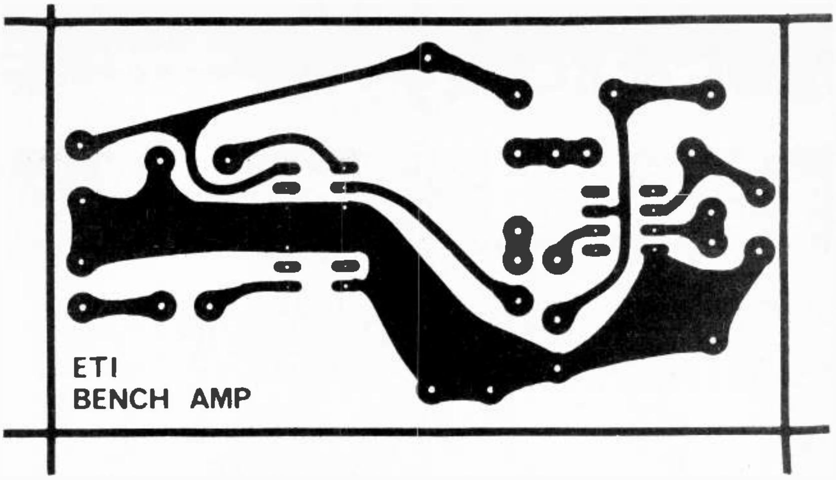




Circuit diagram of the Bench Amp

Construction is not critical, but a metal box is a good idea to help screen the amplifier from extraneous radiations etc. Ours came from Doram, and very nice they were too. Battery power was chosen so as to leave as much bench supply free as possible.

Further sensitivities can be easily added by using a larger switch with more poles, and adding the appropriate resistors. The quality of the circuit is good enough to feed an external loudspeaker, and a socket is provided to enable this to be accomplished. ●



Parts List

RESISTORS

R1	10K
R2	22K
R3	47K
R4,9	100K
R5	150K
R6	270K
R7,8	220K
R10,11	100R
R12	180R

All ½W 5%

POTENTIOMETER

RV1 100K Log rotary

SEMICONDUCTORS

IC1	741 op-amp
IC2	LM380 power amp
LED1	0.2" type

MISCELLANEOUS

Phono socket
Nuts, bolts, etc.
3.5mm jack socket

CAPACITORS

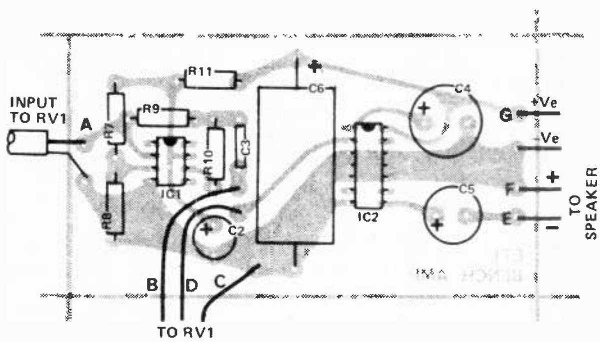
C1	4u7	16V electrolytic
C2	47u	16V electrolytic
C3	10n	ceramic or similar
C4	1000u	16V electrolytic
C5	470u	16V electrolytic
C6	1000u	25V electrolytic

SWITCHES

SW1	1 pole 6-way rotary
SW2	single pole / Off-On toggle
SW3	single pole / Off-On rocker

SPEAKER

LS1 2¼" 8Ω type



Component overlay for the Bench Amp

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MICROPROCESSOR AT WORK

This article, by Tim Hendtlass of the Royal Melbourne Institute of Technology, follows on from our Introduction to Microprocessors published last month.

BY NOW IT WILL BE CLEAR THAT A microprocessor can do many things other than just the logical and arithmetic operations of the hardwired logic it may replace. To be able to do all these things it has to be quite complex internally. It will consist of thousands of semiconductors which can be divided into a number of sections and Table One lists the names and features of some of the more common sections.

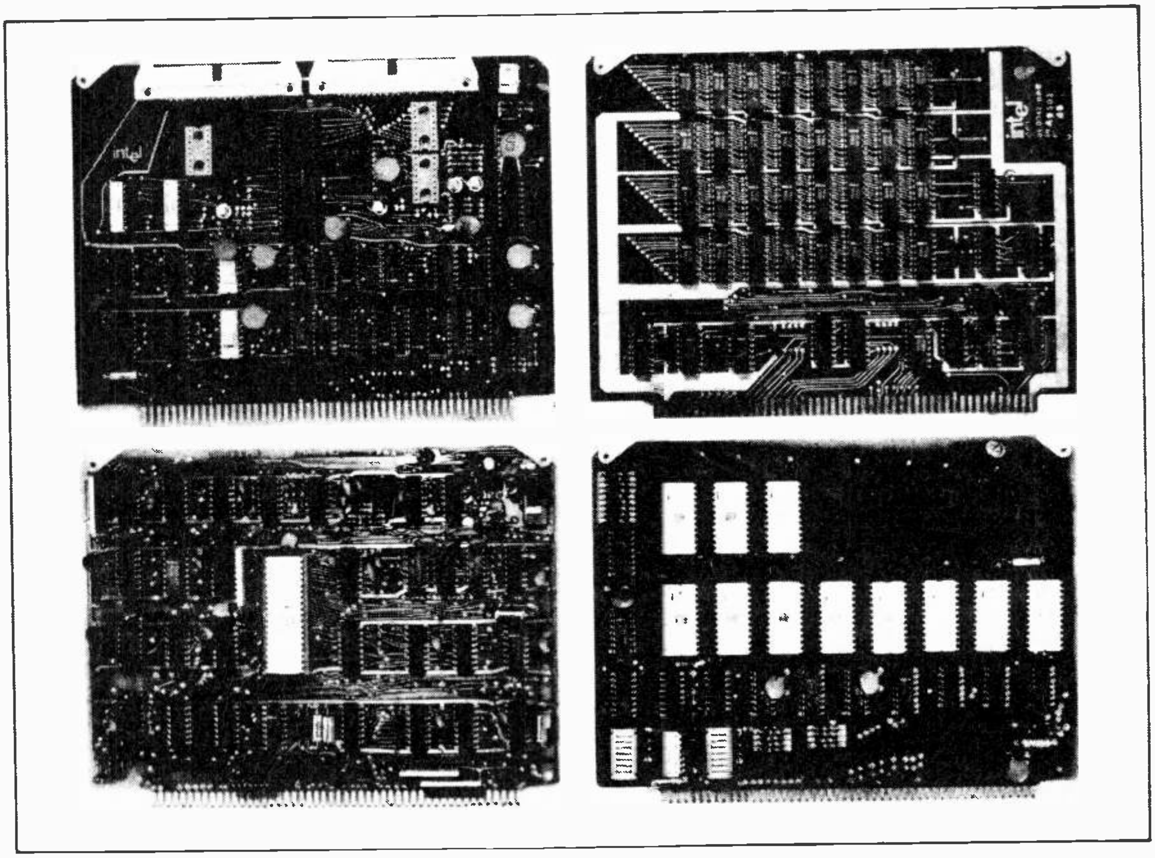
A specific operation

To follow this example you will need to refer to Table One for explanations of new terms like accumulator, register, program counter, etc. When first used these terms will be in bold type. The example will show the step-by-step approach of the MPU and show how useful mnemonics are in programming.

Three instructions in the program

Let us assume that the MPU is executing (running) a program and has reached a point at which it is to add a binary number stored at memory location 1000 Hex (or base 16) (this is a short way of writing the binary number 0001 0000 0000 0000) to the number in the **accumulator** and save the result in the **temporary register** C on the chip. This needs three instructions (for an Intel 8080 MPU) which are written:

First instruction: LXI H, 1000H;
(load the 16 bit **index register** consisting of **register** H and L together with 1000 Hex)
Second instruction: ADD A, M;
(add the byte found at the memory location specified by H and L to the accumulator)



The EBKA Familiarizor on the right of this photo is a single-board microcomputer based on the MOS Technology, Inc. MCS6502 microprocessor (the large white chip at the centre left of the board). Also on the board are 1024 bytes of RAM and a 256 byte monitor program stored in a 1702A EPROM. This chip can hold 1024 bits of information indefinitely without power, or until erased by ultra-violet light. The larger, add-on board carries 4096 bytes of RAM, a programmer for the 1702A EPROMs, 2048 bytes of EPROM, parallel and serial interfaces and a dual cassette interface.

TABLE ONE MICROPROCESSOR MICRO-DICTIONARY

Central Processing Unit (CPU): A group of registers and other logic that form the arithmetic/logic unit plus another group of registers with associated decoding logic that form the control unit.

Accumulator: A register that adds an incoming number to its own contents and then substitutes that result for the original contents. This register is accessible to the programmer.

Register: Logic elements (gates, flip-flops, shift registers) that taken together, store 4, 8, 12 or 16 bit numbers. They are essentially for temporary storage in that the contents often change from one instruction cycle to the next.

Temporary Register: A register used for very short term storage by the CPU and over which the programmer has no direct control.

Program Counter: A register whose contents normally correspond to the memory address of the next instruction to be carried out. The count usually increases by one as each instruction is carried out, since program instructions are usually drawn from sequential locations. This register is accessible to the programmer.

Instruction Register: A register used to store the binary code for the operation to be performed. This register is not normally accessible to the programmer.

Storage Register: A register used for storage which is totally under the control of the programmer.

Status Register – Flag: The status register consists of a series of flags each of which is a flip-flop that indicates some aspect of the status of the central processor. Individual flags often occur which are not grouped together into a register.

Stack Pointer: A register whose contents correspond to the memory address of the top of the stack. It is under the control of the programmer.

Index Register: A register used to hold an address. An instruction may either use the contents of this (specified) register directly or add an offset (part of the instruction) onto the contents of the specified register to produce an effective address and then use this effective address. Useful, for example, for addressing tables.

Address Bus: The collective name given to a group of signal paths along which the voltage levels of the desired address are distributed throughout the system.

Data Bus: The collective name given to a group of signal paths along which the voltage levels that make up data words are distributed from the CPU to all points in the system or from any point in the system to the CPU (but not both ways at once).

Direct Memory Access (DMA): A technique by which a peripheral device enters or extracts blocks of data from the microcomputer memory without involving the CPU

Third instruction: MOV C, A;
(move what is the accumulator (A) to **storage register** C)
(the instruction mnemonics are in capital letters, the brackets contain explanatory comments)

You should now see why mnemonics are useful – imagine writing a program if you had to write the full description in the brackets every time. The mnemonics vary from one MPU to another, the manufacturer can provide you with a list for any particular machine.

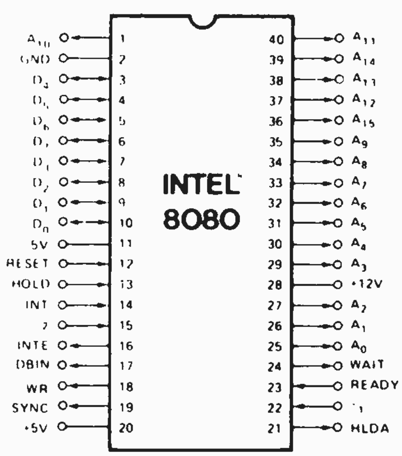


Figure 1. This is the pin diagram of the Intel 8080 microprocessor chip. D_0 to D_7 are the eight parallel lines of the data bus. A_0 to A_{15} are the sixteen parallel lines of the address bus. The other pins are used for timing, control and power supply.

How the MPU handles these instructions

Assuming that the MPU has finished processing the previous instruction and as a result the **program counter** is pointing to the start of our first instruction (in other words the program counter register contains a number which is the address of the memory in which will be found the first byte of our first instruction) the MPU does a fetch cycle. First this puts the contents of the program counter out on the **address bus.** Then the unique memory cell which has that address responds by putting its contents onto the **data bus** along which they return to the MPU. When the MPU gets the data it puts it in the **instruction register**. While the MPU was waiting for the memory to respond it incremented (added one to) the program counter so as to be ready for the next fetch cycle.

Internally the instruction register is inspected to see what kind of instruction is to be done this time and if it is complete (a one-byte instruction) or if there is more to come. In our example the first byte is the LXI H part so the MPU knows there are two more bytes to get and that when they arrive they are to go into the H and L registers. So two more fetch cycles are done similar to the instruction fetch except that when the data is received it is put into a temporary register (instead of the instruction register) and then into the final destination register. The program c counter has been incremented after each fetch so that now the first instruction has been completed the program counter is pointing to the start of the second instruction.

Again an instruction fetch is done (and the program counter then incremented) but, of course, the instruction which arrives into the instruction register is not the same. In this case when it is internally inspected it is seen that it is a complete instruction in one byte, as there is no further byte to get the MPU can start implementing the instruction. The instruction requires that the data stored in the memory location whose address is in the H and L register combined should be added to the contents of the accumulator, so first this data must be brought to the MPU.

The contents of H and L registers are put out on the address bus and the data returns as usual on the data bus and is put into the temporary register. This then is added to the accumulator. You might think that this would be the end of it, but no – one further operation takes place. Depending on the result of the addition, various **flags** are set or reset in the **status register**. If the result of the addition had been zero the zero flag would be set — if not it would be reset. If the result was too big to fit into the accumulator so that a carry out occurred then the carry flag would be set and so on.

(The main use of these flags is for those jump on condition' types of instructions we invented back crossing the road in the Introduction to Microprocessors article. Had the next instruction been jump if zero to 2000 H for example, as soon as the instruction had been received the zero flag would be checked. If zero the MPU would do a jump — replace the contents of the program counter with 2000 H and carry on. If the zero flag was not set, the rest of the jump instruction would be ignored and the next instruction fetched. The carry flag is also used in multibyte arithmetic — if there was a carry out then this carry is added onto the result obtained from the two next most significant bytes.)

The MPU has set the flags and finished the second instruction of our little program. The program counter is already pointing to the start of instruction three so a normal instruction fetch is done. Again, when inspected, this is recognized as a single byte instruction, and, even easier, in this case no further reference has to be made off chip at all. So the contents of the accumulator are copied into storage register C replacing whatever was there. The contents of the accumulator remain unchanged by the way.

. . . . . . END OF PROGRAM. . . . . . .

Our three-instruction program is finished — it took quite a few words to describe what happened (about 550!) but the 8080 would do this in twenty two machine cycles (little bursts of activity on the chip) and take about eleven millionths of a second over it. You don't have to understand what is going on blow by blow on the chip to use an MPU as long as you know the overall effect each instruction has (the sort of thing I wrote in brackets in the example program). The reason I took you through this example, though, is that it helps understanding to have at least a general idea of what is on the chip. The example was constructed to introduce you to almost all the "private parts" of an MPU. The only common one missed was the **stack pointer** and now that we have met flags and how they are set I would like to add one

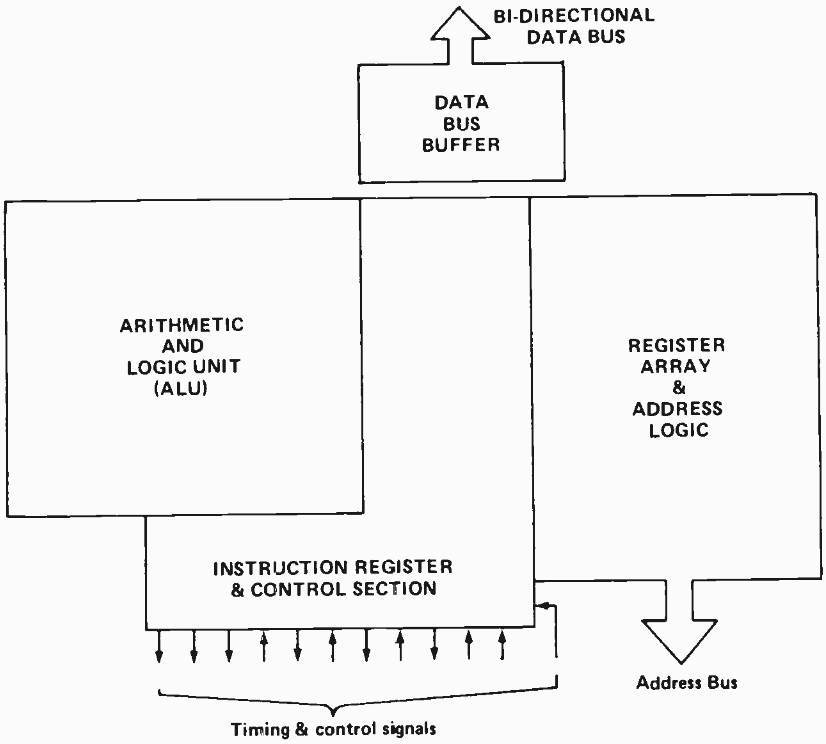


Figure 2(a). The main functional units of the Intel 8080.

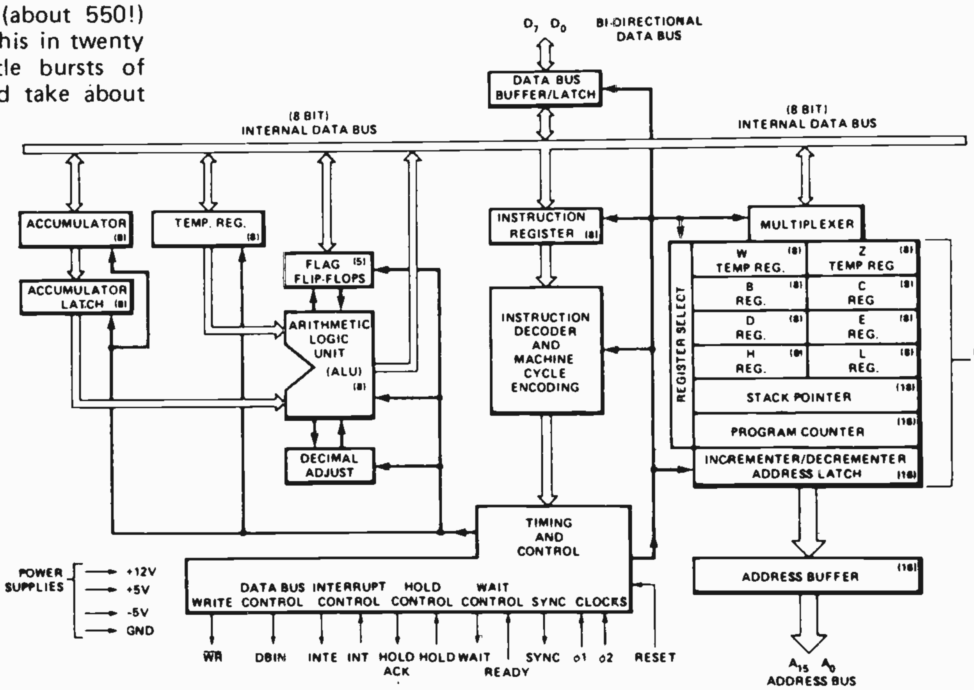


Figure 2(b). More detail on the internal organisation of the microprocessor. All the elements described in the Microprocessor Microdictionary can be located on this diagram.

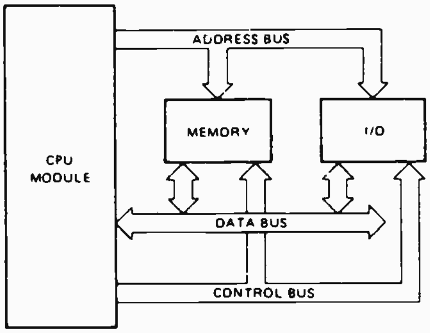


Figure 3. How the buses connect the main parts of the computer.

fourth instruction so you see what use a stack pointer has.

And now a subroutine

Our fourth instruction is going to involve a subroutine, so perhaps I had better explain what a subroutine is. A subroutine is a small program that is so useful it is going to be used very frequently. An example might be a routine to multiply two numbers. In a longer main program there might be two or three hundred times when it is required to multiply two numbers together. Obviously it would be very wasteful to repeat the same block of instructions so many times so we find a way to use the one block of code in different places in the program.

This is done by jumping to the block in such a way as to enable us to come back to the next instruction in our main program when the subroutine has been finished. Instead of an ordinary jump, we first save the address of the next instruction in the main program on the top of the **stack** and then jump to the subroutine. At the end of the subroutine is a return instruction which causes a jump to the address on the top of the stack. The stack is like a pile of cards, you can vary the number in the pile but only have ready access to the card on the top.

Our fourth instruction might be:

Fourth instruction: CNZ 3000 H;
(Call if not zero the subroutine starting at location 3000 Hex)

meaning if the zero flag is not set, go and do the subroutine which starts at location 3000 Hex, and then come back and do the next instruction. If the zero flag is set do not bother with the subroutine but go immediately to the next instruction (after all, there is no point in multiplying by zero — we know the answer will be zero).

The fourth instruction would be processed internally as follows: An instruction fetch would get the first byte (CNZ) and put it in the instruction register. The zero flag would be checked; if it were set there is no point in fetching the next two bytes (which contain the starting address of the subroutine) and so the program counter would be incremented twice to point to the start of the next instruction and operation would continue with that instruction.

Had the zero flag not been set the sequence after testing the zero flag would be different. The next two bytes (the starting address of the subroutine) would be fetched and temporarily stored. The stack pointer (which contains the address of the top of the stack) would be consulted and the contents of the program counter (which has already been incremented by the last fetch to point to the start of the next instruction) would be put onto the top of the stack. It takes two bytes to hold an address so the stack pointer would be changed by two to point to the new "top of stack". Having saved the address to return to, the address of the start of the subroutine would be moved from temporary storage into the program counter so that program execution would continue from there.

It should be obvious that it will take longer to process this instruction if a branch to the subroutine occurs than if it does not (the actual times are about 8½ and 5½ millionths of a second respectively). At the end of the subroutine would be a return instruction which would cause the address stored on the stack to be fetched, the stack pointer returned to its original value and the saved address put in the program counter so that execution continued from instruction five (execution time of a return instruction is five millionths of a second).

Where to from here?

Provided you have understood this article, you are now in a position to read the literature provided by the manufacturer of the microprocessor you are interested in. You have met the parts of an MPU, seen what extra is needed as well as the MPU to make a working system, and, most important, the types of instructions a microprocessor can do. Study the manufacturer's set of instruction types and you will have a fairly clear idea of what that MPU can do. You will find timing diagrams which tell you the exact order of occurence of the various small operations which together make up the execution of an instruction. They become important when you connect your MPU up to all those other components which are needed to produce a microcomputer.

If you have not quite followed this article, try re-reading it. Microprocessors are extremely logical in their organization (pun intended) and, with a little thought, all fits into place. Learning about MPUs is like learning about anything else — once you master it, it is hard to remember what it was that seemed so hard! ●

Figure 4. The lines from the 8080 instruction set used to write the program described in the text.

INSTRUCTION SET

Summary of Processor Instructions

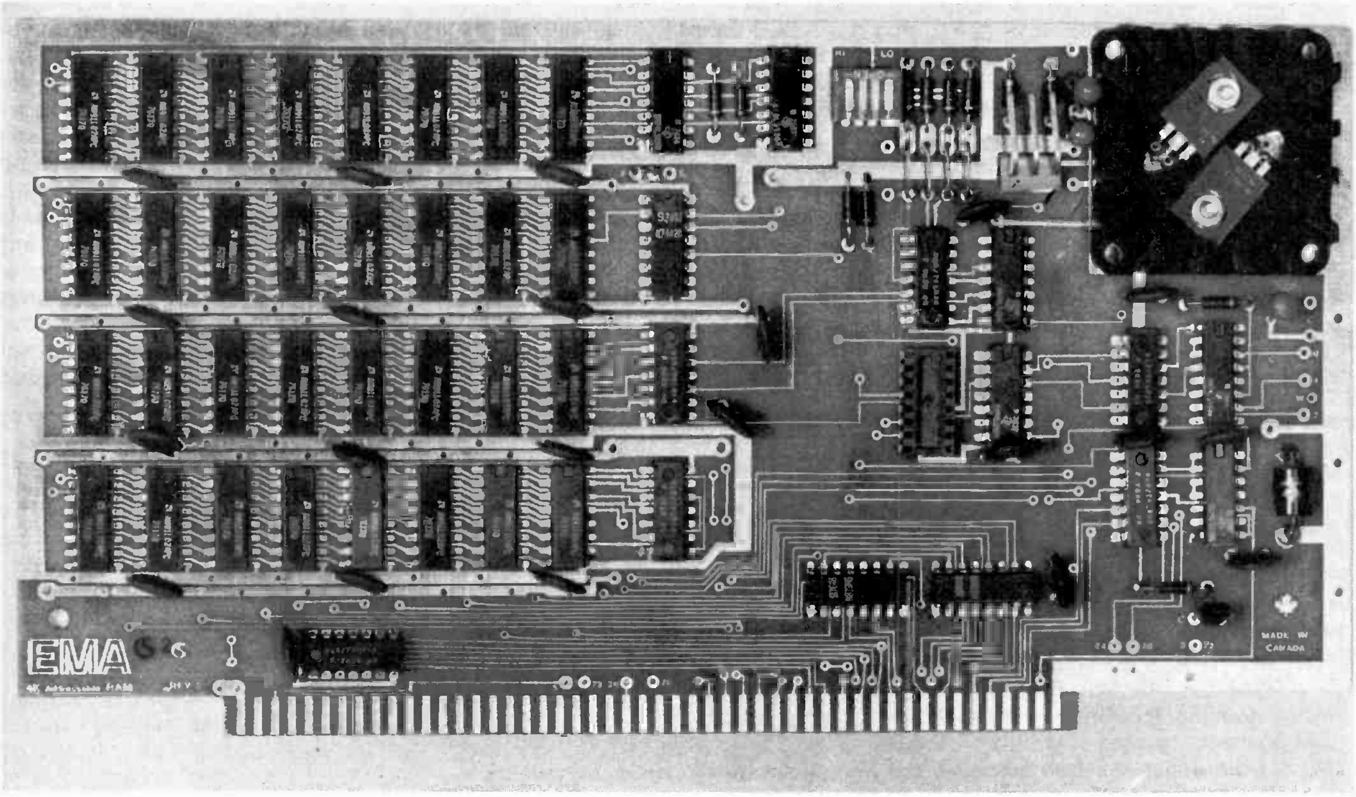
	Mnemonic	Description	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Clock Cycles
▶	MOV r1, r2	Move register to register	0	1	0	0	0	S	S	S	5
	MOV M, r	Move register to memory	0	1	1	1	0	S	S	S	7
	MOV r, M	Move memory to register	0	1	0	0	0	1	1	0	7
	HLT	Halt	0	1	1	1	0	1	1	0	7
	OUT	Output	1	1	0	1	0	0	1	1	10
	LXI B	Load immediate register Pair B & C	0	0	0	0	0	0	0	1	10
	LXI D	Load immediate register Pair D & E	0	0	0	1	0	0	0	1	10
▶	LXI H	Load immediate register Pair H & L	0	0	1	0	0	0	0	1	10
	LXI SP	Load immediate stack pointer	0	0	1	1	0	0	0	1	10
	XRA r	Exclusive Or register with A	1	0	1	0	1	S	S	S	4
	ORA r	Or register with A	1	0	1	1	0	S	S	S	4
	CMP r	Compare register with A	1	0	1	1	1	S	S	S	4
▶	ADD M	Add memory to A	1	0	0	0	0	1	1	0	7
	ADC M	Add memory to A with carry	1	0	0	0	1	1	1	0	7
	SUB M	Subtract memory from A	1	0	0	1	0	1	1	0	7
	SBB M	Subtract memory from A	1	0	0	1	1	1	1	0	7
	CC	Call on carry	1	1	0	1	1	1	0	0	11/17
	CNC	Call on no carry	1	1	0	1	0	1	0	0	11/17
	CZ	Call on zero	1	1	0	0	1	1	0	0	11/17
▶	CNZ	Call on no zero	1	1	0	0	0	1	0	0	11/17
	CP	Call on positive	1	1	1	1	0	1	0	0	11/17
	CM	Call on minus	1	1	1	1	1	1	0	0	11/17
	CPE	Call on parity even	1	1	1	0	1	1	0	0	11/17
	CPO	Call on parity odd	1	1	1	0	0	1	0	0	11/17

The complete 8080 instruction set is more than four times as big as this.

When we heard about EMA Industries' PLRAM board, we were fascinated by the potential, so we asked them to fill us in . . .

PLRAM

by S. B. Jackson*
**EMA Industries Ltd.,*
P O Box 421,
Simcoe, Ontario N3Y 4L5



EIGHT BIT MICROCOMPUTERS like the 8080 can directly address a maximum of 64 Kilobytes (KB) of memory, or 16 "pages" of four KB. Conventional memory realizations require that pages be *fixed* at one of these 16 locations, via soldered jumpers or a DIP switch.

Here we describe a Program-Locatable Random Access Memory (PLRAM) card which allows 4 KB pages to be "moved" under program control.

The PLRAM differs from conventional RAMs in that the locating switches (or jumpers) are replaced by a PORT. Hence the 8080 instruction sequence:

```
MVI   A,X
OUT   Y
```

will act to position card "Y" at location "X". Our realization will accommodate 32 values of "Y" (port addresses) and, of course, 16 values of "X". A page size of 4 KB was chosen to accommodate one (single-density) floppy disk track.

All PLRAM applications will require some form of "memory manager" software. This can range from trivial to complex as a function of the application and performance desired.

POWER-ON

At power-on, PLRAM cards are disabled by a flip-flop. This prevents conflicts with other cards, in the time interval before the cards are distributed by the memory manager. Card locations are indeterminate at power-on. This circuitry also write-protects cards during the start-up interval. This is valuable where the battery-backup provision is employed.

The *EMA Industries* PLRAM card is fully compatible with the popular "S-100" bus employed by Altair and Imsai 8080 microcomputers. The card is fully buffered to minimize capacitive bus loading. Schmitt gates receive critical strobe signals.

The PLRAM concept will allow a machine to address more than 64 KB of memory. The upper limit is determined by the number of port addresses, for a maximum of 128 KB. One of the sixteen available locations can be chosen for "storage" of inactive cards. Any number of inactive pages can be stacked there.

TIMESHARE APPLICATIONS

Conventional software can easily be extended for multi-user applications. A real-time interrupt triggers the termination of one user and the transfer to the next. When a user change occurs it is necessary to store all data needed to re-establish operation at a later time. This will involve all registers, the stack contents, stack pointer, program counter, and any critical buffer locations. The stack and buffers should be positioned in a standard format within the PLRAM pages associated with each user. Where this is done, no special effort is required to store this data when users change.

Pages holding instruction and data fields for inactive users are stacked at the storage location. As users become active in rotation, the relevant pages are transferred to the "working" locations. The overhead for a user change can be kept under 100 microseconds.

Where table or data field lengths are unknown, PLRAM pages can be appropriated from storage when excess length occurs. Indeed, an arbitrarily long table can be made to *appear* to occupy only one 4 KB page location. When such a table is searched, all of the component pages are examined in sequence. Here the card number (port address) effectively augments the machine address.

When pages are loaded from secondary storage — e.g., a disk track, this operation can be made to occur with the page positioned in any convenient standard location. For example, a disk track can be loaded into (or from) a page at B000 Hex, for eventual use at 4000 Hex at the *same time* that data at 4000 Hex is being processed by the 8080 CPU. Hence time can be saved through the avoidance of location conflicts.

The PLRAM offers a unique opportunity for memory resource economy, since there is no need to duplicate resources that are mutually exclusive in use. Memory resources are positioned where needed, and only for as long as needed.

With all forms of secondary storage a penalty is incurred for access and I/O times. With the PLRAM, recent accesses can be retained. The last four (say) accesses can be stored. Before any access is made, it is determined that the data is not already in PLRAM storage. This technique can yield significant time performance benefits in some applications.

FAIL SAFETY

A final application involves automatic maintenance for secure systems. When a RAM failure is detected, either by anomalous performance or by an explicit memory test routine, the defective page can be retired and a spare card brought into service.

All systems employing PLRAMs must include at least one conventional (fixed location) memory card, or PROM. This is required to hold the memory manager software which performs the initial distribution of the PLRAM cards. The PLRAM may be jumpered to perform as a conventional RAM, with DIP switch locating.

The microcomputer environment presents an opportunity to rethink traditional minicomputer structures and approaches. We present the PLRAM concept as a potent new element in the microcomputer arsenal. ●

HP67

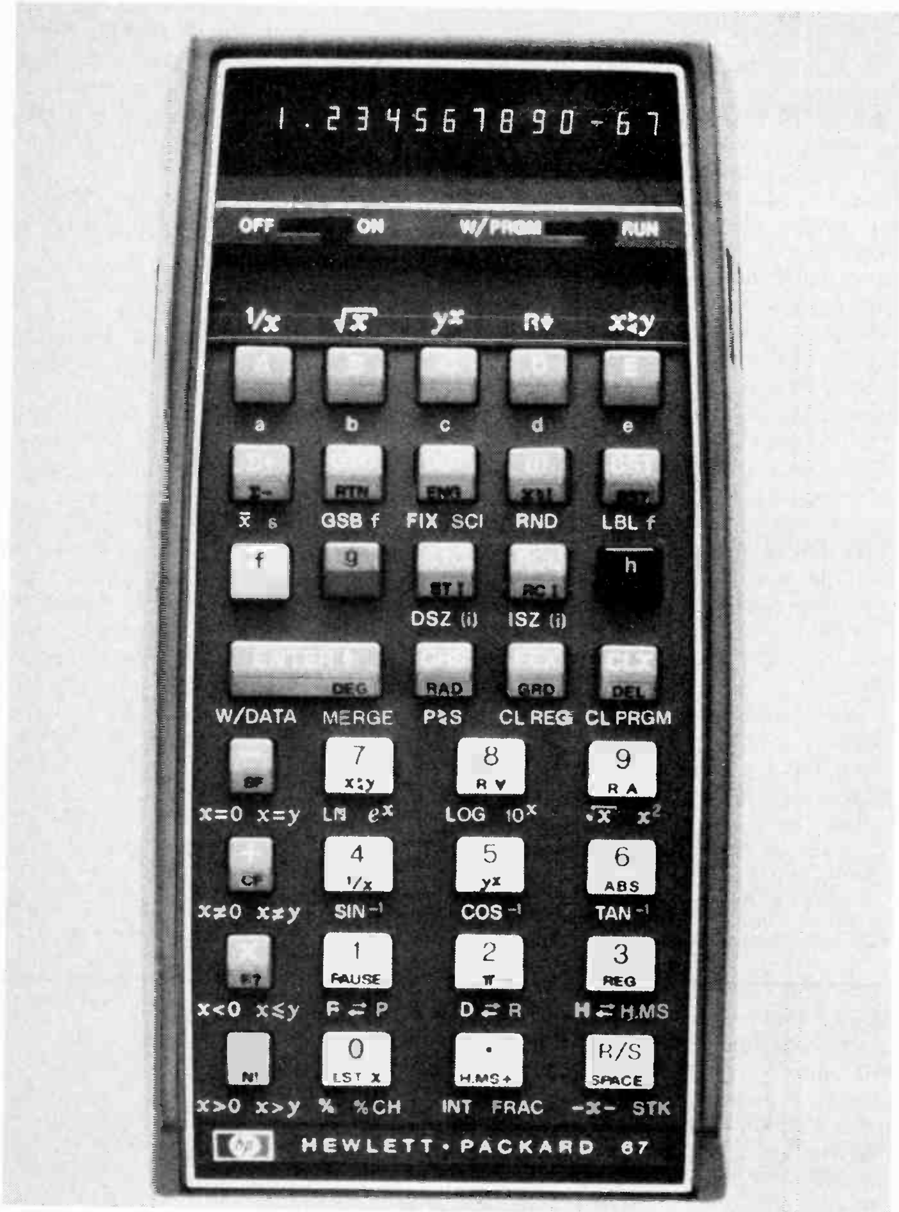


Fig. 1 The HP67 keyboard is rather complex, but logically arranged. You can have the pleasure of tickling its keys for $575.00. (I wonder why dealers don't like demonstrating it?)

IT IS NOW three years since Hewlett Packard released the HP65 fully programmable pocket calculator, and that is a long lifetime for any calculator by today's standards. Although the HP65 represented a considerable advance in personal computing, technology has progressed somewhat since then; specifically, the level of integration which can be achieved in LSI logic has gone up, along with improvements in IC packaging and tricks like pin multiplexing etc. In addition, users quickly came to appreciate the new approach to problem-solving afforded by the programmable calculator and now want more powerful machines.

The HP67 is the latest in the HP line of programmable calculators, and is by far the most powerful. It has 224 steps of program memory and 26 data register, with indirect addressing. An important feature is the "smart" card reader, which permits the loading or recording of data, as well as angular mode, display and flag settings, so that initialization routines are not needed.

PREPROGRAMMED FUNCTIONS

The HP67 seems to have been designed, keyboard-wise, at least, with existing HP65 users in mind. Most of the HP65's pre-programmed functions are duplicated with the same keyboard layout. Gone is the NOP (no-operation) function: the PAUSE facility is more useful for program debugging as you can see intermediate results without single-stepping. The HP67's program memory is line-numbered, not a rotating shift register as in the 65. Each line of memory contains a complete keyphrase, so that all prefixes are merged, e.g. LBL f a (three key strokes) is one memory step. By contrast, the LBL A instruction on the 65 is two keystrokes, two memory steps. The same applies to TI's SR 52; a label occupies two steps.

Several new functions have been implemented on the HP67 — many of them prompted by the desire for software compatibility with the printing HP97. The -x- or "flash x" command halts the calculator for five seconds, allowing output of data (analagous to PRINT x). The REG and STK instructions are similar functions for reviewing the contents of the registers or opera-

HP67

tional stack. An HP97, encountering this instruction in a program, would print them.

The HP67 also includes functions which have been found useful in recent HP calculators — the PAUSE instruction, % functions, ENGineering display format, mean and standard deviation with automatic accumulation. The only major new keyboard function is RND, which rounds off the display to the number of digits displayed. This is important in financial calculations.

PROGRAMMING FACILITIES

With the W/PRGM-RUN switch in the RUN position, programs may be loaded from magnetic cards, or the machine may be used as a conventional calculator.

In the W/PRGM mode, when a key is pressed, that function is not immediately executed, but is instead stored in the program memory, and a keycode is displayed. For example, the code 31 would represent the first key in the third row (f). Similarly, the complete code 001 31 52 11 would represent f LBL A and would be the first step of the program.

A major advance on the HP65 is the ability to nest subroutines three deep. This is achieved through use of the "GSB" instruction, and the program will then jump to the designated label to continue execution until it encounters a RTN command, when it will return to the instruction following the GSB. This function can be used with the I-register for indirect addressing.

The I-register is the key to the indirect addressing facility. When the number in the I-register is between 0 and 19, GTO (i) or GSB (i) unconditionally jump to the label specified (0-9, A-E, or a-e). If the I-register contains a negative number, GTO (i) or GSB (i) will branch backwards the number of steps specified.

The I-register can also be used to control STO and RCL operations on the data register, i.e. STO (i) and RCL (i), where the I-register contains a value between 0 and 26. 0-9 refers to the primary register, 10 to 19 refers to the secondary storage registers, which are not directly accessible by STO and RCL, and 20-25 represents registers A through E. An (i) value of 26 accesses the I-register itself.

As we have said, the 10 secondary storage registers, R_S0-R_S9, are not accessible through the STO and RCL commands, except indirectly, and also the Σ+ key, which accumulates statistical information. In order to get at the secondary registers, you have to swap them with the primary registers using the P⇆S function. At first we were slightly bemused by this method of addressing storage in comparison with the SR52's 00 to 19 (and 60 to 99, if they're unused by program), but in practice it turned out to be no problem at all.

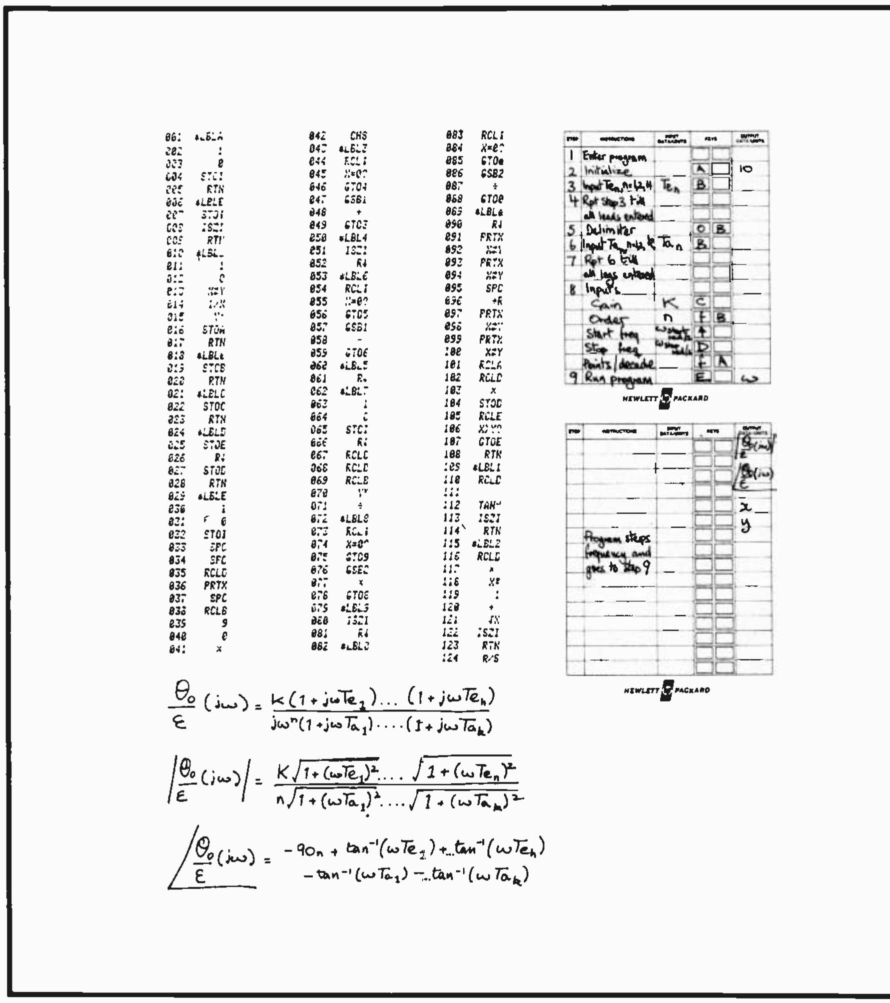


Fig. 4 This program listing was produced on an HP97, but the program will produce a print-out of the open loop amplitude and phase response (Nyquist plot) of a control system. The various time constants are entered serially, leads first, then a zero to separate them from the lags, then the lags. The program pulls data from the secondary registers and processes it as leads, until it finds the zero, and then continues to process the remaining data as lags.

CARD READER'S IQ

As the program memory is 224 steps, this has to be recorded on two sides of a magnetic card, using the same basic method as the HP65. When one zips a card through with the machine in the W/PRGM mode, the first 112 steps of the program are recorded in the form of a header, program and checksum. The calculator, before writing the card, checks whether the program is over 112 steps long, and if it is, it writes the appropriate 28-bit header. This identifies whether the card is (*a*) a one-sided program, (*b*) first side of a two-sided program, (*c*) second side of a two-sided program, (*d*) a one-sided data file, (*e*) first side of a two-sided data file, or (*f*) second side of a two-sided data file. If the program is over 112 steps, the card will have to be passed through again to record the second side, and the calculator will prompt the user to do this by displaying CRD. A similar process is used to read the card — the calculator will identify from the header whether the second side is required and prompt the user.

The ability to write data onto a card is very useful also. When the W/DATA key is pressed, the calculator displays CRD, and checks the contents of the secondary registers to see if any are non-zero. If they are all zero, this data is compressed and recorded, along with the registers 0-9 and A-E, on the first side; otherwise the calculator again prompts the user to insert the second side where it records the secondary register contents. When a program is running, insertion of a card will not trigger the card drive, until a W/DATA instruction is encountered; hence you can set a long program running, insert a card and forget it, knowing that your results will be recorded, even in your absence.

Finally, the card reader can merge programs or data automatically. For instance a numerical integration routine may call as a subroutine the function f(x) to be integrated. Several standard functions can be prerecorded and loaded from cards, avoiding the necessity to kay them in through the keyboard.

WHAT'S INSIDE?

The microprocessor around which the HP67 is very solidly built, is the Arithmetic, Control and Timing (ACT) chip used in the HP21, 22, 25 series of calculators. In Fig. 2, it's the 22-pin plastic package at the right of the board. This chipe carries eight general-purpose registers, four of which form the stack. In addition, the instruction decoding ROM, clock, control and timing, keyboard control, addressing and pointer logic are on this chip. It can access up to 4096 instructions by sending out a 12 bit address, least significant bits first, on the instruction/address line.

Fig. 3 If you want a print-out, the $950.00 HP97 is software compatible with the HP67.

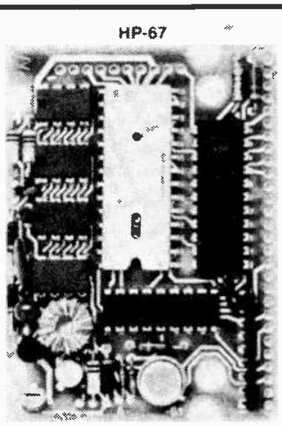


Fig. 2 The main logic board.

A new chip developed for the HP67 combines 1024 10-bit words of ROM with 16 56-bit registers in a single 8-pin package — this is why multiplexing techniques are so important. Programs are stored in these 56-bit registers in the form of 224 8-bit instructions. This allows 256 possible instructions, of which 250 are used. Another 18-pin ROM also carries the anode drivers for the display.

Whereas the HP65 used a form of DMA for card reading, with the microprocessor not involved at all, in the HP67, the card reader chip (CRC) and ACT interact. The CRC contains two 28-bit buffers which are alternately loaded while the ACT chip deals with the contents of the other buffer. Each card side carries 32 28-bit records, either 112 program steps (3½ steps per record) or 16 data registers (½ register per record), plus header and checksum. As each record is stored it is also added to a running total, which is finally compared with the checksum. If they differ, memory is cleared and "Error" is displayed.

SOFTWARE SUPPORT

An important application area for programmable calculation is the specialist user who requires a wide range of preprogrammed functions rather than a truly user-programmable machine. HP cater to this area by supplying a side range of application packs. Now available are Stat Pac 1 (21 programs), Math Pac 1 (19 programs), Electrical Engineering 1 (18), Business Decisions (22), Mechanical Engineering (23), Clinical Lab and Nuclear Medicine (19) and Surveying (19 programs). Soon to be announced is a Games Pac.

The overall impression we gain from using the HP67 is that it is a more powerful machine than the SR52 if you have really tough problems to solve. It is more efficient in using program memory, particularly STO and RCL instructions. The smart card reader is a very useful feature and gives the machine a real "data-base" of use in business applications.

We weren't terribly happy with the 67's approach to indirect addressing, particularly when trying to write a version of the computer game "REVERSE", for the calculator. No matter how we tried, we always needed a second I-register so we never did get the program to run. We suspect that it should be considerably easier on the SR52. Please, HP, give us two I-registers next time, or a similar implementation to the SR52's!

SUMMING UP

In conclusion, then, the HP67 is an extremely efficient and powerful calculator. The HP97 printing version, because of its data handling capabilities should be popular in commerce. But we can't help feeling that the efficiency has been achieved at the expense of ease and flexibility of programming, so that it's just not as much fun.

●

BUYING COMPONENTS

by Roy G. Cooper

THE CHANCES OF WALKING into your nearest electronics store clutching the parts list of your chosen project and emerging ready to plug in the soldering iron are, unfortunately, close to nil. Getting all the parts together, especially for beginners, can be a very frustrating experience.

ETI appreciates your problem and is working on it.

Wherever possible standard components are used, and suppliers are contacted to check that parts are available.

Enquiries are being mailed to likely suppliers across Canada, but it's not always an easy matter to locate them so if your dealer has a good selection of parts by all means ask him to mail a catalogue to ETI if he hasn't already done so.

Finally, for what it's worth, here are some solutions of one hobbyist who first encountered the problem when combing Toronto for a transistor (any transistor) in the days when the nearest approach to an integrated circuit was a multi-element tube.

Beginners in the hobby can take some comfort from the fact that the situation does get easier as you go along; your "junkbox" stock inevitably grows and, as you become familiar with local stores you get to know who is likely to carry the part you are looking for.

Before we start looking for parts there are two very important considerations for the hobbyist — quality and price.

FIRST THE QUALITY

In building a project there can be problems enough (solder bridges, wrong connects) without having to consider the possibility that one or more of the ICs is faulty. The average hobbyist doesn't have the facilities to check out a wide range of ICs, and projects are designed and tested using units meeting the full specifications for that part. If a faulty IC is finally found the builder may well decide that he must have "blown" it by some error. With solder on the pins that is the assumption that the dealer will make and you won't get a replacement. (If you're sure it's a "dud" clip all pins at the shoulder and remove individually.)

Whether you believe that "fallout" semiconductors are a great boon to needy hobbyists or feel strongly that they should all be collected under armed guard, finely ground, and used in landfill projects, the fact remains that nothing that even looks like a semiconductor is ever discarded. Sooner or later every unit, whether it almost met specifications or somehow got sealed up without its chip, will be offered for sale to the hobbyist.

This is fair enough if it is very clearly identified. Advertising being what it is, these parts are usually given a more glamorous treatment in the catalogues, but they are easy to spot if you have the code. Current codes are "hobby material", "for experimenters", "fallout", "barrel", "untested", "unmarked", and "yield xx%".

Quite a few dealers stock both "fallout" and "prime" material and if you read the catalogue with reasonable care and watch for the code words you'll have no problems sorting the sheep from the goats. Very rarely, fortunately, will you come across a catalogue where the goats begin to look so sheep-like it would take a sheep (or a goat) to tell the difference. Codewords here are "tested", "100% functional", and "100% functionally guaranteed". *Know your dealer!*

NOW THE PRICE

Electronics is a fast-moving field; prices of ICs can drop very rapidly. This is one of the main reasons that ICs are not readily available locally and also why those that are available vary widely in cost. The only way that you can be assured of the best deal is to know what's being offered. How? Catalogues. Lots of catalogues. Most are free and you can pick them up at local suppliers as well as through the mail.

Most parts stores have their own specialties and it pays to visit each one periodically to see what's new. In downtown Toronto there are several stores, e.g. Dominion, Radio Trade Supply, etc., who will carry quite a few ICs, readouts, etc. and, unless your project is CMOS, you might well end up with all the parts right there.

If that still doesn't do it,, look through your Radio Shack catalogue. They carry an extensive range of components and materials that will probably complete your list — again with the exception of CMOS.

For any toughies left over try Electrosonic. While they are primarily wholesalers they do retail, and their stock is very comprehensive. Their giant catalogue is a standard reference in the field; many dealers will let you look at their copy. If you find what you need there I would advise phoning to check on availability and price. Stocks and prices change faster than the catalogues.

SOUTH OF THE BORDER

You may have drooled over some of the ads of mail-order dealers in the US and decided that getting an order through customs was probably costly and difficult. Actually it's neither. Nor is it risky. Over the years I have ordered from at least a dozen such firms ranging from the "wild" surplus type to the strictly first-line components dealer — some of them many times — and have found no reason for complaint at all. Any minor mix-ups have always been quickly corrected.

As with any mail-order dealings it does take time — from two to six weeks — and the duty is not peanuts. The duty applicable for electronic parts — ICs, surplus computer boards, grille cloth, nuts and bolts, or whatever you order from an electronic parts dealer — is 15% of the total value. Total value is what you paid for the parcel — postage, handling, and any other charges included. After the duty has been added to the total value taxes are applied to the new total. For Ontario residents that's 12%. As a rough rule of thumb that will allow you to make price comparisons and avoid embarrassment at the customs counter; your extra cost will be between one third and one quarter. Don't forget to add sales tax to a local component when comparing prices.

There are literally dozens of dealers to choose from, and their number is growing rapidly. I have selcted four of those with whom I have dealt. Starting with surplus (genuine surplus) and ending with a "primes only" dealer their catalogues will give a pretty good idea of the whole field.

John Meshna Jr., P.O. Box 62,
E. Lynn, Mass. 01904
Poly Paks, P.O. Box 942,
South Lynfield, Mass. 01940
International Electronics Unlimited,
P.O. Box 3036, Monterey,
CA 93940
Digi-Key, P.O. Box 677,
Thief River Falls, MN 56701.

Waiting for several weeks to begin a project that has been decided on is too much for most of us. Besides, there is a little-known derivation of Parkinson's Law that states that if you order 100 items by mail and one of them is out of stock, the chances of it being the very one you need to finish a project are very much greater than 100 to 1.

There are two good approaches here that can be taken together. Firstly, order the items and have them waiting in your "junkbox" for your pet project to appear in ETI. You don't need a fortune teller or a spy in the ETI lab for this. There are a few items that are so versatile that they crop up again and again in all projects: 555, 741, 309, 380, 3900, and 324, are magic numbers in just about any parts list. Add some LEDs and CMOS 4001s and 4016s to be even more prepared.

Of course you can't win them all, but why not start your project anyway? DIP sockets are always a good idea, especially for the more costly ICs; if you use them the project will be complete the moment the last IC arrives. If you maintain this practice it will often be possible to borrow ICs from previous projects to check out the current one.

When ordering from the US don't forget that a penny saved is a penny and a third earned. Handling charges, postage, and discounts all favour larger orders. One large order is usually more economical than several smaller ones; if you have friends who are into electronics it makes good sense to combine your orders.

THE PROCESS

As with any mail-order, make the order crystal-clear and keep any enquiries on a separate sheet.

Now trot around to the post office and buy a money order in *US funds*. Depending on the current rate of exchange the total cost will probably be not much greater in Canadian funds. Fill out the thick sheet, seal it in the envelope, drop it in the box, and try to forget it: the flimsy sheet is your receipt.

A long time after you have decided that your order must have jammed in the mail box or that the parcel is circulating forever in a bureaucratic backwater of customs (about 3 weeks in most cases) you'll get a card in the mail from your local customs office.

Everything you need to know is on the card, but you may be worried about the instruction to bring or send "invoices or sales slips" (which you don't have). Don't panic! — they're in the parcel. If the duty and taxes section has been filled in and everything seems to be in order, you can, if you don't mind waiting a few more days, send a money order and the parcel will arrive in the mail in the ordinary way. If the duty and taxes section is blank you can still do everything by mail, but it will take a four-way trip.

COLLECTION

How long it will take to collect your parcel in person depends a great deal on where the customs office is located. The main Toronto office is a very busy place. If you have to go there, locate the US mail section and be sure to grab a number as you go in. Other offices in the city are less busy and you shouldn't have long to wait. Customs offices outside the large cities are much quieter and there's no waiting at all.

If the duty hasn't been assessed the customs officer will open the parcel and go through it with you. At this stage you may be tempted to sort out some items that you consider should not be classed as electronic parts (hoping, of course, for reduced duty). In general, this is not a good idea.

You will find that most customs officers are sympathetic to non-commercial importers and will normally interpret in your favour if an ambiguity exists. A safe exception is technical books which are tax and duty free.

Be sure to keep all the papers. Almost any mix-up you might discover afterwards can be straightened out if you have all the documents.

At this level, that's all there is to international importing.

So, in conclusion, while it's obvious that getting your parts is not a one-stop, five-minute deal, you *can* get any available electronic part, at a reasonable price, and from any location in Canada. And ETI is trying to make the process a little easier.

Soldering irons (well tinned) at the ready.

In the Toronto area:

Dominion Radio & Electronics Co.,
535 Yonge Street,
Toronto
(Good general source of supply)

W.A. Components
65 Granby Street,
Toronto
(Good for European components)

Canmos
Box 1690
Peterborough, Ontario K9J 7S4
(Can supply PCBs for ETI projects)

Electrosonic
1100 GordonBaker Rd.
Willowdale, Ontario
(Huge catalogue)

Other areas:

Coronet Electronics Supply Ltd.,
649A Notre Dame St. West
Montreal, Quebec H3C 1H8
(Many up-to-date components)

J&J Electronics
Box 1437P
Winnipeg, Manitoba

Supreme Electronics
Box 327
Victoria, B.C.

Telus Electronics
77 Leacock Drive
Ottawa, Ontario K2K 1S5

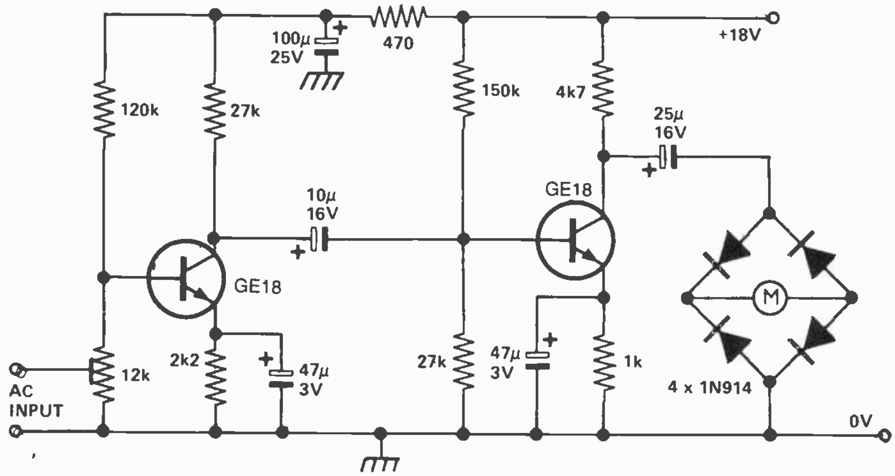
Hamilton Electronic Distributors
PO Box 6070
Postal Station "F"
Hamilton, Ontario

tech-tips

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

RECORDING LEVEL METER

The circuit shows a two-stage voltage amplifier driving a recording level meter. The AC signal input is amplified, rectified, and the resultant DC voltage shown on the meter. The circuit can be used with a tape-recorder or audio mixer and should be fed from a point early in the pre-amp. Current consumption in a no-signal state is 2.8mA. The 12K preset gives a variation in sensitivity. The meter can be any general purpose type.



SWITCHABLE RUMBLE FILTER

The circuit shown provides a cut-off at 25, 40, or 80Hz. C1 and C2 in conjunction with R3 - 9, form second order Butterworth filters with 12db/octave roll-off below the turnover frequency.

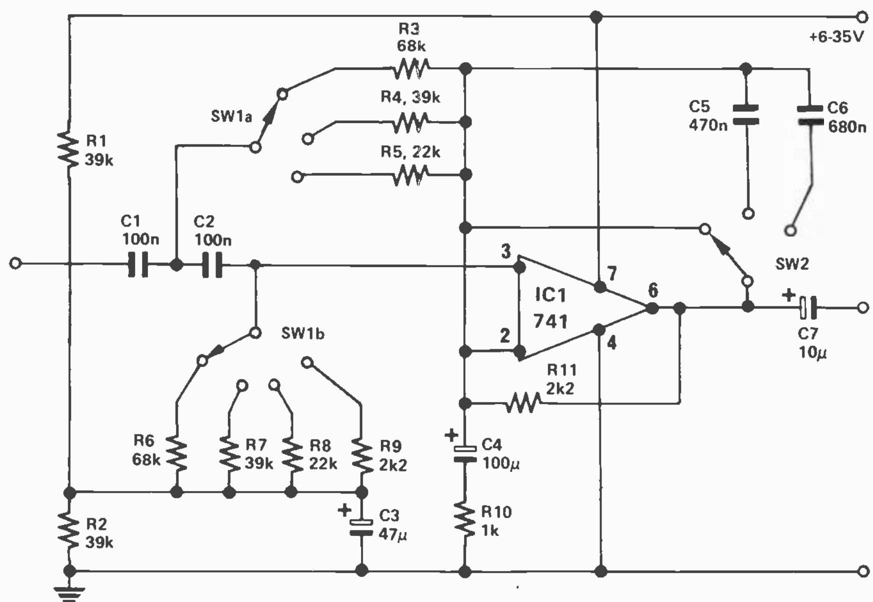
Unlike most designs, the feedback is taken from the inverting input. In practise this works well once the signal at this point follows exactly that at the non-inverting input.

A useful feature is the deep bass boost provided by the feedback loop proper.

S2 in position 3 gives a +3db point at 100Hz whilst position 2 provides a +3db point at 150Hz. A supply 6-35V DC at 10mA is required.

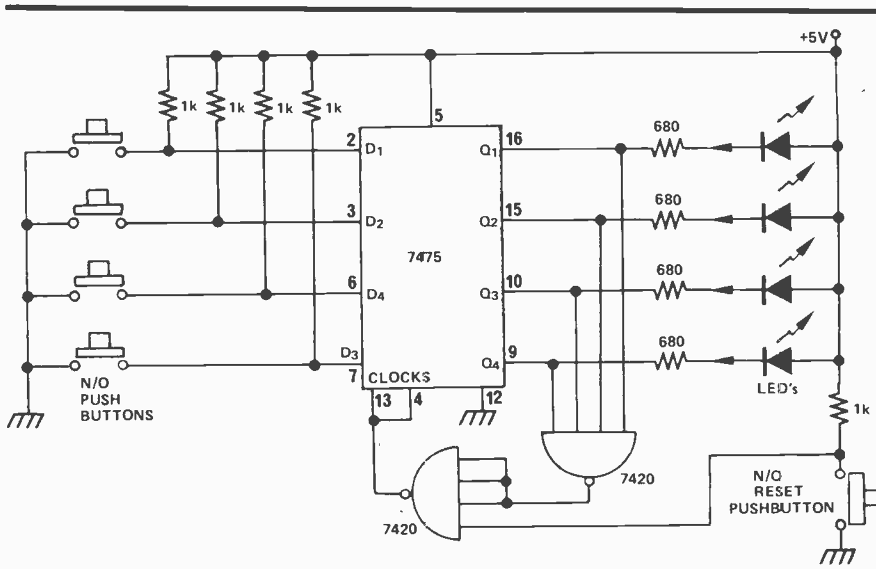
SW1	-3dB
1	25Hz
2	40Hz
3	80Hz
4	FLAT

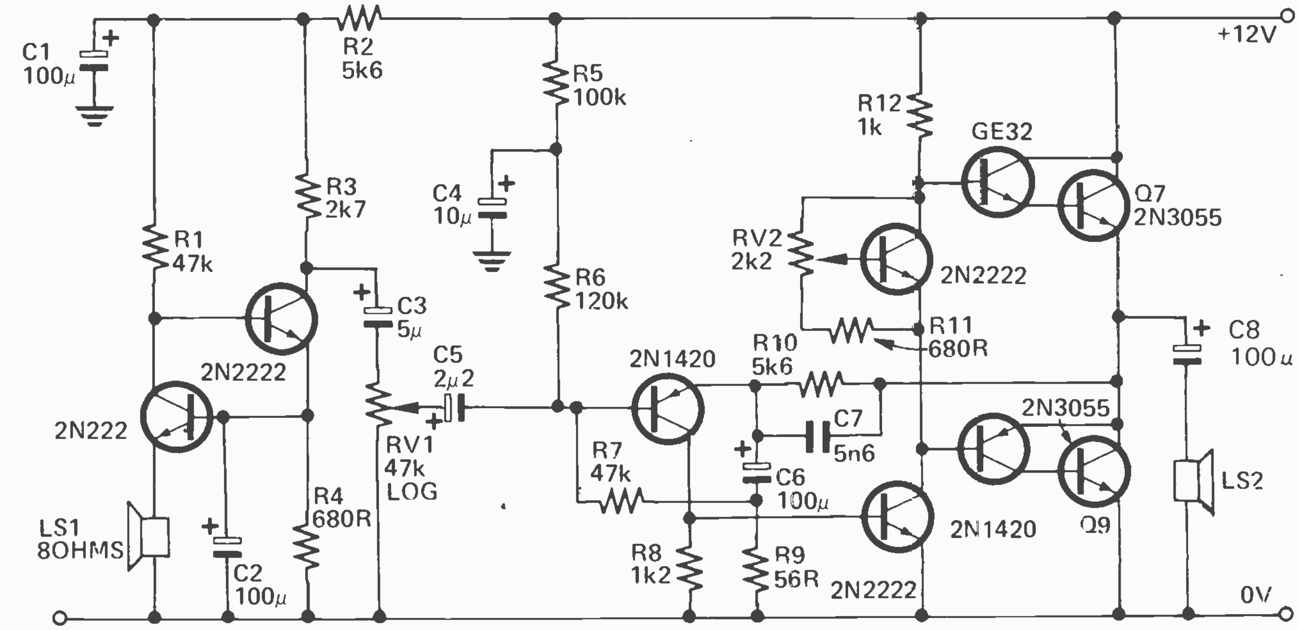
SW2	+3dB
1	Flat
2	150Hz
3	100Hz



WINDICATOR

With two TTL ICs and a handful of other components, a circuit can be constructed that will indicate which of four buttons was pressed first, as well as lock out all other entries. It is thus suitable for quizzes, games of Snap and the like. The appearance of a logic 0 at one of the Q outputs, lights the appropriate LED and locks out other entries by taking the clock input low. The TTL outputs are capable of sinking 10 TTL loads or 16mA. Running the LEDs at 5mA leaves adequate margin to sink the 1 load of the 7420 gate.





12V P.A. SYSTEM

This circuit was originally built for use in a negative earth car. A miniature speaker, impedance immaterial, is connected in the emitter circuit of Q1, and acts as a microphone.

Q1 operates in the common base mode and a highly amplified signal appears at its collector. Q2, used in the common emitter mode, provides further amplification and the signal from its collector is fed via the blocking capacitor C3 to the volume control VR1.

Overall de-stabilisation is provided by obtaining Q1's base bias from the emitter of Q2.

The power amplifier is fairly conventional and fitted with a heavy duty output stage to enable a pair of 3Ω P.A. type horns to be driven in parallel. Under these conditions 8W is available. A single 3Ω unit can be driven to 4W.

Since the unit is intended for the reproduction of speech a wide bandwidth is not required and C7 is incorporated to roll off the response above 5kHz. C6 also provides a rapid roll off in the bass region. Q7 and Q9 should be fitted to a 5" x 4" finned heatsink and the body of Q4 should be thermally in contact with this.

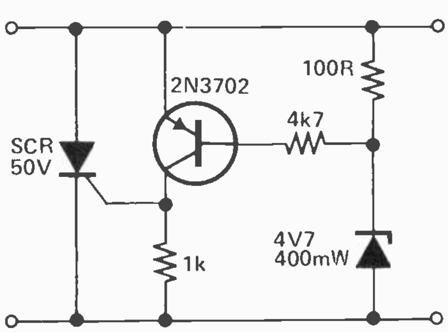


Fig. 1

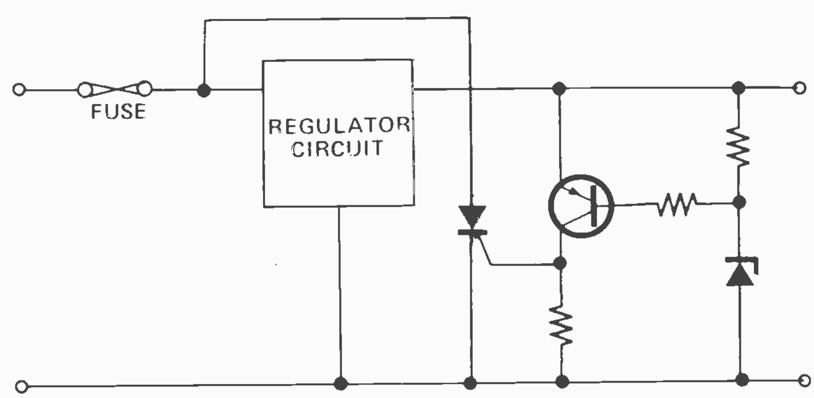


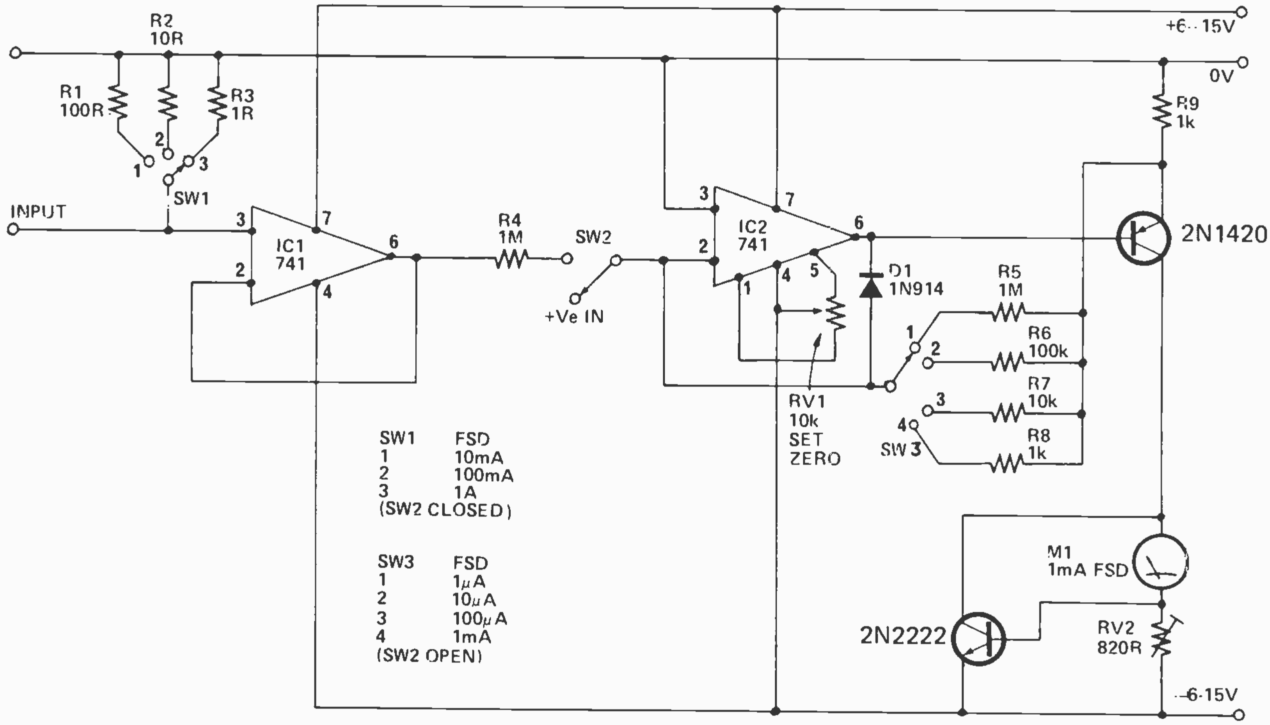
Fig 2

SIMPLE CROWBAR CIRCUIT

This circuit provides overvoltage protection in case of voltage regulator failure or application of an external voltage. It is intended to be used with a supply offering some form of short circuit protection, either foldback, current limiting or simple fuse. The circuit is less effective in the latter case however, as a good deal of damage can be done in the time taken to blow a fuse.

The most likely application is a 5V logic supply, since TTL is easily damaged by excess voltage. The values chosen in Fig.1 are for a 5V supply, although any supply up to about 25V can be protected by simply choosing the appropriate zener diode. When the supply voltage exceeds the zener voltage +0.7V, the transistor turns on and fires the thyristor. This shorts out the supply, and prevents the voltage rising any further. In the case of a supply with only fuse protection, it is better to connect the thyristor across the unregulated supply as shown in Fig.2 to prevent damage to the regulator circuit when the crowbar operates.

The thyristor should have a current rating about twice the expected short circuit current and a maximum voltage greater than the supply voltage. The circuit can be reset by either switching off the supply, or by breaking the thyristor circuit with a switch.



WIDE RANGE AMMETER

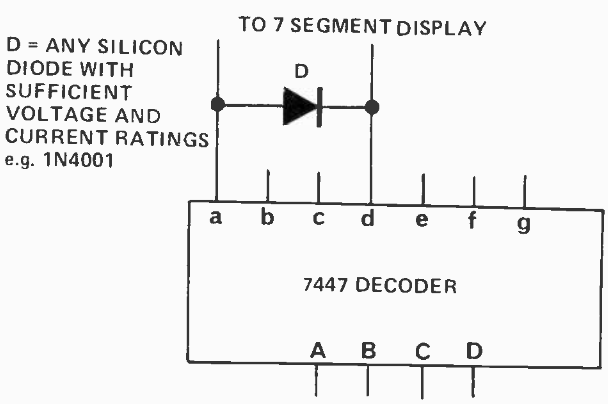
The instrument shown will measure currents from 1μA to 1A F.S.D. in seven ranges.

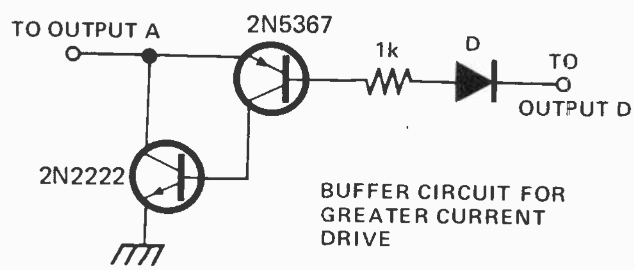
IC1 is connected as a unity gain buffer and the input current flows through the resistor selected by SW1 to earth. In so doing a voltage proportional to the input current is developed across the resistor and this appears at the output, pin 6.

Small currents are measured by IC2. In this mode the current flows into the non inverting input. Since this is a virtual earth, the output will generate a voltage proportional to the input current.

In practice, this voltage is developed across R9 and hence provides a proportional current through Q1 and M1.

Q2 and RV1 form a meter protection circuit and the latter component should be adjusted so that Q2 starts to conduct at F.S.D. D1 is included to prevent damage to the base emitter junction of Q1 in the event of an input of wrong polarity.





IMPROVING 7-SEGMENT DIGIT APPEARANCE

The display font of some 7-segment output devices produce the digit 6 without the top bar. Examination of the font reveals that whenever the bottom segment ('d' segment) is on, so is the top segment ('a' segment) for all the other digits. Hence all that is needed is a diode connected so as to light segment 'a' whenever segment 'd' is on. The diagram shows the idea applied to a 7447 decoder. The drive capability of the device may be exceeded by this addition, so a buffer circuit may be required as shown.

INFORMATION

SUBSCRIPTIONS

The annual subscription to ETI for Canadian readers is $12.00, a two year subscription is $20.00. For US subscribers, one year is $15.00, two years is $26.00. Please send orders to ETI Subscriptions Dept.

NON-FUNCTIONING PROJECTS

We cannot solve the problems faced by individual readers building our projects unless they are concerning interpretattion of our articles. When we know of any error we shall print a correction as soon as possible at the end of News Digest. Any useful addenda to a project will be similarly dealt with. We cannot advise readers on modifications to our projects.

PRICES

All prices quoted in the editorial of ETI are in Canadian dollars, except where stated otherwise. Advertisers in US may give US dollar prices. Where we only know an overseas price, e.g. in UK pounds, we convert approximately to Canadian dollars, erring on the conservative side, where possible.

COMPONENT STORES

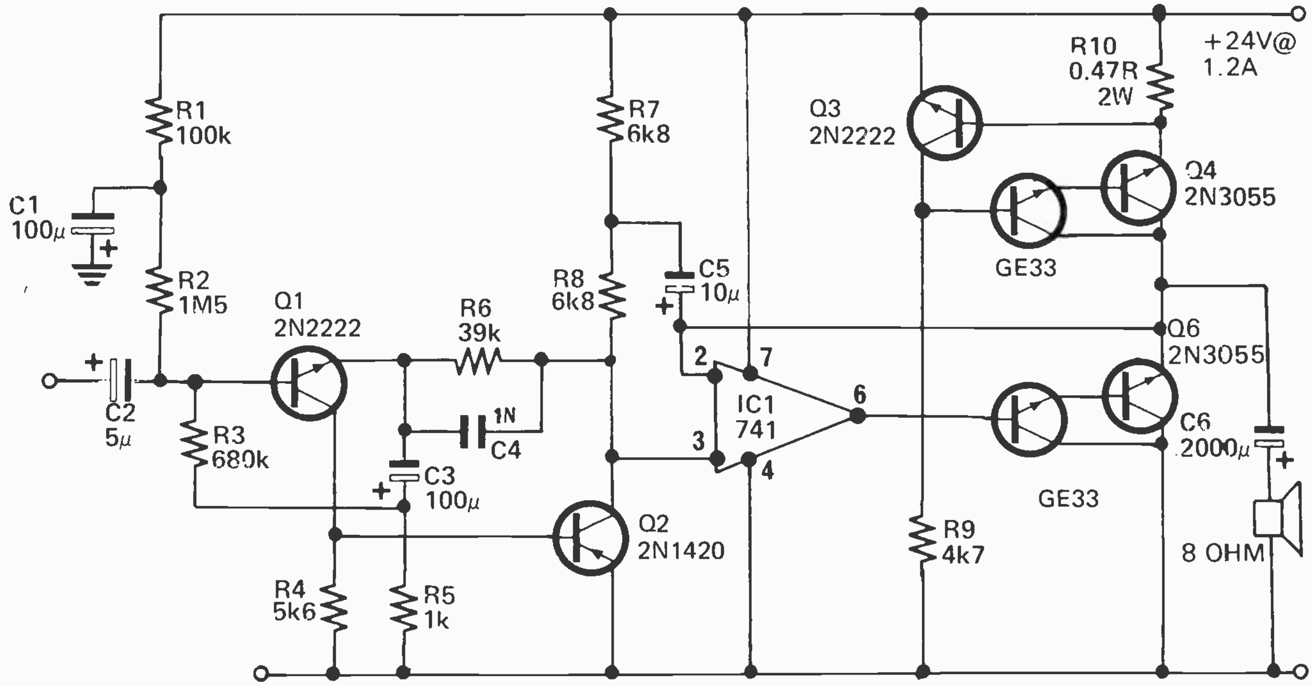
ETI is available for resale by component stores. We can offer a good discount and quite a big bonus: the chances are customers buying the magazine will come back to you to buy their components.

PUBLICATIONS

At the moment we have five special publications available — Circuits No. 1 ($5.00), Top Projects Nos. 3 and 4 ($2.50 each), and Electronics — It's Easy, Vols. 1 and 2 ($3.50 each or $6.00 the pair). Orders to ETI Specials Dept. please.

EDITORIAL QUERIES

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



CLASS A AMPLIFIER

The main advantage of class A amplifiers is the absence of crossover distortion. Against this major advantage must be weighed the disadvantage of permanently hot heatsinks and large capacity power supplies.

The circuit shown here contains several novel features and will deliver 5W of pure class A sound into an 8µ load.

Q1 and Q2 form, with the associated components, a high quality voltage amplifier with overall ac and dc feedback applied from the collector of Q2 via R6 to the emitter of Q1.

The output stage proper, consists of Q6 and Q7 connected as an emitter follower darlington pair. These transistors are driven by IC1, a 741 op amp, and are included in the latter's feedback loop.

These three form a near perfect output stage with an input impedance of several megohms and a bandwidth extending from dc to over 100KHz.

Quiescent current is provided by the constant current source Q3, Q4, Q5, R9 and R10. The use of a constant current source here effectively isolates the output from line variations and ripple.

With the components shown, the circuit has a bandwidth of 10Hz - 30KHz -3db, a distortion of less than 0.1% before the onset of clipping, an input impedence of 1.5MΩ and a sensivity of 180mV for full output.

Transistors Q4 to Q7 must be mounted on an adequate heatsink, a 5" by 4" finned type is suitable, but must be mounted vertically and in such a position as to allow ample ventilation.

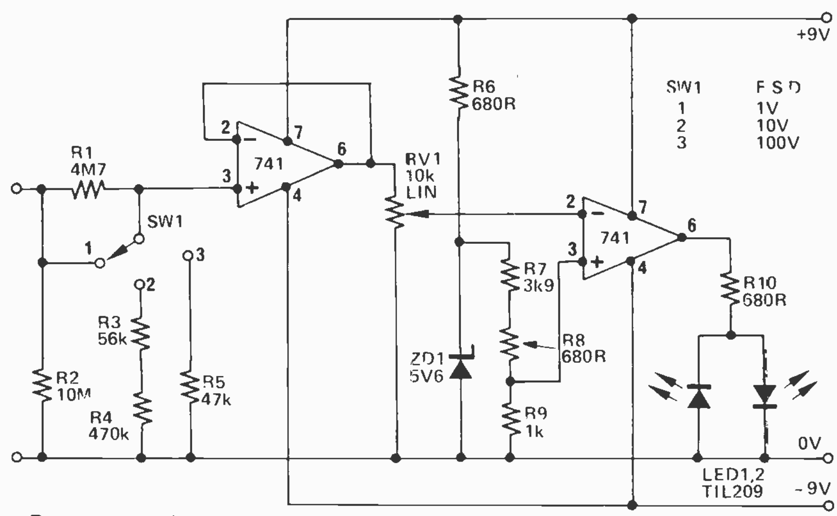
COMPARATOR VOLTMETER

This circuit, although simple, is capable of accurate voltage measurement. The input is applied to the high impedance input of IC1 via the attenuator comprising of R1 to R5 inclusive.

Since this IC is used as a unity gain buffer, the output at pin 6 is equal to the input voltage at pin 3, but at a low impedance. IC2 is connected as a comparator driving a pair of LEDs, D1 and D2.

The inverting input samples a portion of the unknown input voltage, whilst the non-inverting input is connected to a 1V reference obtained from the stable voltage across ZD1.

In use VR1 is adjusted till D2 just illuminates. At this point, if the control knob is of the 0 - 10 calibrated type, the pointer will indicate the input voltage.



For example, with SW1 in position 2, and with a reading of 2 on VR1, the input voltage will be 2V. With a little practice, the voltage can be read to ±2%, comparable to a moving coil instrument. The input impedance on all ranges is 3.2MΩ.

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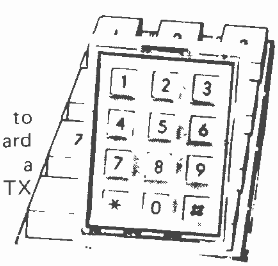

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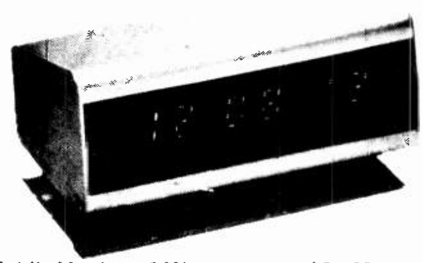

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36 Pin	1 39	1 26	1 15
40 Pin	1 59	1 45	1 30

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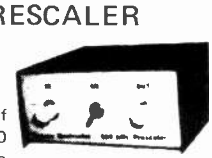

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OPEN CIRCUIT

by Tom Graham

ANOTHER MAGAZINE with which I'm associated, *Canadian Transceiver*, received a request a couple of months back for a pass to the CB Trade Show that they are holding at the Skyline Hotel, Toronto, at the end of March. The request came from a company out West who called themselves *Tackle Box*.

Since receiving this I've often joked that you can't tell by the company name if they're in the business of selling CB.

THE CHATTER BOX

I got quite a chuckle when this company actually phoned me to say that the sales of CB were going so well that they are changing their name to *The Chatter Box*!

We even had a garden nursery company call us about being listed in *CB Buyer's Guide*. It was checked out and, lo and behold, nestled between the geraniums and chrysanthemums was a CB set! Just one though.

They didn't get a listing.

NORTH BATTLEFORD FEEDS

What prompted me to write this particular column was a request for a pass from North Battleford Feeds. We had made it very clear that the Dealer must show proof that he is in the sales end of CB so this request was sent along with an accompanying full page ad that appeared in *The Advertiser-Post*, North Battleford, Saskatchewan just to prove the point that he was in fact a CB Dealer. The title of the ad said, "WHAT? C.B.s IN A FEED STORE — YOU BET!" In the ad they featured a Johnson Messenger 190, a Messenger 250 Base, a Jana Interceptor, a Jana Aggressor and a Jana Dominator. Most amusing was the fact that the ad also contained a couple of cartoons at the top. One was of a horse, the other of a cow — both holding CB microphones in their hoofs!

YOU SHOULD BE IN THE BUSINESS

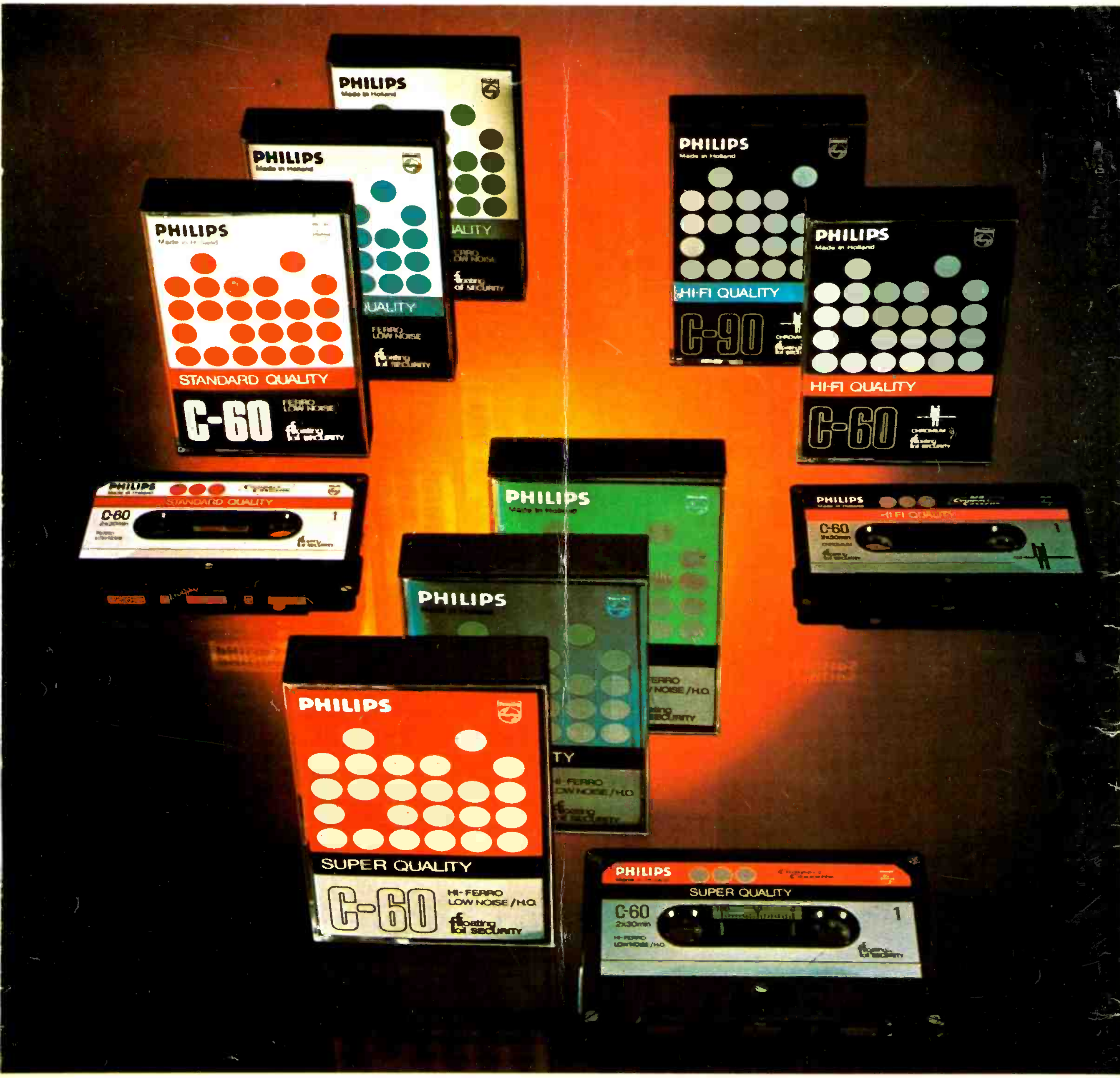
With everybody jumping aboard this, the fastest selling electronic product since the advent of TV, the electronic servicing company should be number one on the list, for marketing CB. As I've said before, you can advertise that you can service what you sell and remember that here you can service CB equipment without any special licence, unlike our friends south of the border. Even if you are just now considering the idea, you should attend this show.

To give further incentive for people to come arrangements have been made with Forest Belt's Training Workshops to hold a day seminar for the three days prior to the show to instruct anybody from the novice to the expert on how to service CBs.

For passes for the show or for more information, contact *Canadian Transceiver, P.O. Box 569, Don Mills, Ontario M3T 2T6*.

PHILIPS

PHILIPS



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