ETI for Electronics & Computing Enthusiasts

Electronics Today INTERNATIONAL

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March 1983

A pair of new Apples

Voice Prints
The truth . . . the whole truth?

Digital Kitchen Scales
A weighty project
PROJECT

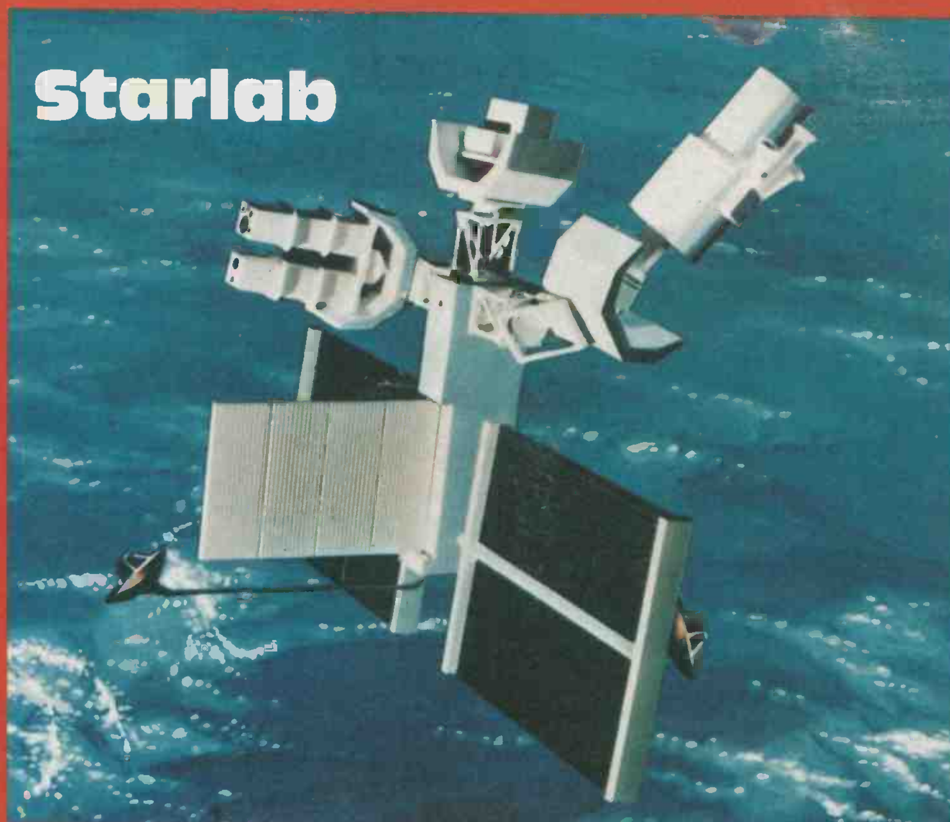
Close Captioning TV
For the hearing impaired.

Logic Probe
Highs and lows
PROJECT

dbx
The sounds of silence.

Designer's Notebook
Unusual Techniques

Starlab



Zenith Z-100 Computer Reviewed

0 57438 70924 03

Circle No. 7 on Reader Service Card.

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Components & Computing Inc.

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Multiflex Keyboard (55 key)

With connector wired in for external keypad. This keyboard uses 2716 to store the ASCII characters, therefore can be customised to suit your needs (all drawings and codes supplied).

Unbeatable **$99**

Great for 6502 boards assembled & tested (even has auto repeat)

Optional case $29

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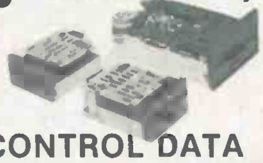
This Month Only!



SA400L $259
(5¼" SS Shugart)

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(5¼" Slimline SS Shugart)

SA801 . . . . $595
(8" SS Shugart)

SA851 . . . . $849
(8" DS Shugart)

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CDC 9409 . . . . $399
(5¼" DS DD)

CDC 9406 . . . . $589
(8" DS DD)

MEMORY
SPECIALS

4164 - 150 ns (1x64k single (+5V) supply) 8.95

4116 - 150 ns (1x16k) — 1.95

4116 - 200 ns (1x16k) — 1.75

2114L - 200 ns (1kx4 static) — 1.89

6116 - 150 ns (2kx8 static RAM) — 8.95 (Pin compatible with 2716 uses negligible amount of power)

2016 - 150 ns (2kx8 static) — 8.75

2102L - 200 ns (1kx1 static) — 1.95

5101 - CMOS RAM — 3.85

2708 - (1kx8) EPROM — 5.75

2716 - (2kx8 EPROM single +5V) — 4.89

2732 - (4kx8 EPROM single +5V) — 8.69

2532 - (4kx8 EPROM single 5V) — 8.95

2764 - (8kx8) EPROM single 5V) — 13.95

For quantity discounts contact us for best pricing.

Note: (a) we have good stock of the above memory chips.
(b) Prices in red are this months specials only -don't miss it.

New Improved Multiflex
Great for beginners or pros

$349 A&T $395

Comes with a motherboard and a S100 CPU card. Standard features:

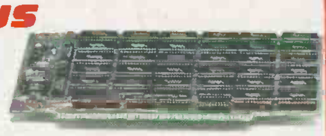
Motherboard

Includes 32 keypad with 16 HEX and 16 control keys; HEX display; Cassette Interface; EPROM Programmer for 2708, 2716, 2732, 2532, 2764, 27128; Wire-Wrap area (space for about fifty 14-pin chips); Parallel Port (8255); S100 Connector (with space for three more).

CPU card includes

Z80A CPU, 2732 (EPROM with our monitor), 6116 (2K x 8 RAM) and all the circuitry. The CPU card has provision (but kit does not include the parts for) 64K of RAM, 4 sockets for EPROM/RAM (2732, 2764, 6116, 8255), parallel port and 8253 timer. Also piggyback board is available for this CPU with 2 serial ports, real time clock and much more.

MULTIFLEX STATIC 64K RAM BOARD S100 BUS



(with provision for battery back up)
Special: (using 6116 150 ns RAMS)
16K version = $289 A&T = $350
32K version = $349 A&T = $395
64K version = $485 A&T = $519

INTELLIGENT TERMINAL
(with 4 page memory)

This multiflex intelligent terminal comes with a keyboard, and 8k of RAM. 80x24 character composite video display and RS232 output (uses 6845 CRT controller and Z-80A CPU) has many attributes, works at 75 to 9600 baud rate). This product is one of our best sellers and you can't afford not to have it at our low price.

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Case - 39.00, Power supply - 45.00, TV option - 29.00

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Complete terminal with power supply & case assembled & tested **$350**

With every terminal you buy you get 10% discount on a Zenith 12" green screen monitor.

U OF T 6809 BOARD
(Used in courses at U of T)

Requires any RS232 terminal (Multiflex terminal works great with it). Includes 6809 CPU, 2(6522) parallel ports, 2(6551, serial ports) 48K of dynamic RAM, 4k of monitor and 8k of assembler. This month only save **$160.00**

6809 Kit with assembler & editor & full documentation only **$375.00**

Multiflex Modem Kit
300 and 800 works great
(See catalogue page 30) **$149**

MULTIFLEX LOGIC STATE ANALYSER
(see pg. 24 catalog)

This instrument is a must for debugging complicated digital & microprocessor circuitry.
-16 channel inputs (low loading)
-1k of storage memory

Special
Kit (with case) **$289**
A & T — **$349**

MULTIFLEX S100 FLOPPY CONTROLLER

Features 1) S100 Compatible. 2) DMA. 3) Based on 1793 — capable of handling up to four 8 inch of 5¼ inch drives in double sided double density or SS, SD.

Special kit **$295**
with DMA
A&T **$375**

S100 VIDEO BOARD BY MULTIFLEX

Based on 8275 CRT controller and Z80A CPU processor, and 8K of RAM, you get a 80x24 composite video, output with features comparable, if not better, to a board twice more expensive. Special Kit **$289** A&T **$349**

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Circle No. 7 on Reader Service Card.

ETI

The Magazine for Electronics & Computing Enthusiasts

MARCH 1983
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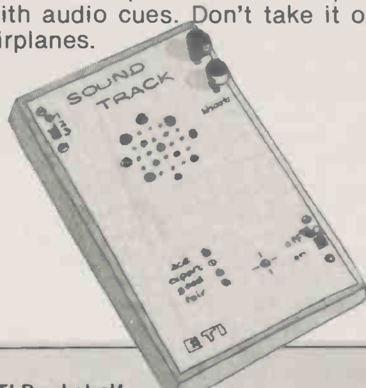
Features

Our cover: The Starlab orbiting telescope solves the problem of atmospheric interference, and launch date is tentatively in the early '90's. Artist's rendition courtesy of the NASA Marshall Space Flight Centre. See page 35. The Zenith Z-100 Computer features 8085/8088 16-bit architecture. Photo by Steve Rimmer. See page 43.

Projects



Columns, News and Information

ADVERTISERS' INDEX

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Previous issues of ETI Canada are available direct from our offices for $3.00 each; please specify by month, not by feature you require. See order card for issues available.

We can supply photocopies of any article published in ETI Canada; the charge is $2.00 per article, regardless of length. Please specify both issue and article.

COMPONENT NOTATION AND UNITS
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms is 5R6.

PCB SUPPLIERS
ETI magazine does NOT supply PCBs or kits but we do issue manufacturing permits for companies to manufacture boards and kits to our designs. Contact the following companies when ordering boards.

Please note we do not keep track of what is available from who so please don't contact us for information on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

K.S.K. Associates, P.O. Box 266, Milton, Ont. L9T 4N9
B—C—D Electronics, P.O. Box 6326F, Hamilton, Ont., L9C 6L9.
Wentworth Electronics, R.R.No.1, Waterdown,Ont., L0R 2H0.
Danocinths Inc., P.O. Box 261, Westland MI 48185, USA.
Arkon Electronics Ltd., 409 Queen Street W., Toronto, Ont., M5V 2A5.
Beyer & Martin Electronic Ltd., 2 Jodi Ave., Unit C, Downsview, Ontario M3N 1H1.
Spectrum Electronics, Box 4166, Stn 'D', Hamilton, Ontario L8V 4L5.
Dacor Limited, P.O. Box 683, Station Q, Toronto, M4T 2N5.

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News

Microcomputer Courses

Seneca College of Toronto has a variety of microcomputer courses to choose from, including BASIC on the Apple II, personal applications (budgetting, mortgages, bookkeeping, etc.), and business applications such as VisiCalc and word processing.

In addition, there is also "Microcomputers for Children", a course for young people 10 to 16 which demonstrates the various applications of microcomputing, and includes an introduction to BASIC and LOGO programming.

All the courses have been very popular so far, and Seneca suggests that you find out about them well in advance by telephoning the main switchboard at (416) 493-4144.

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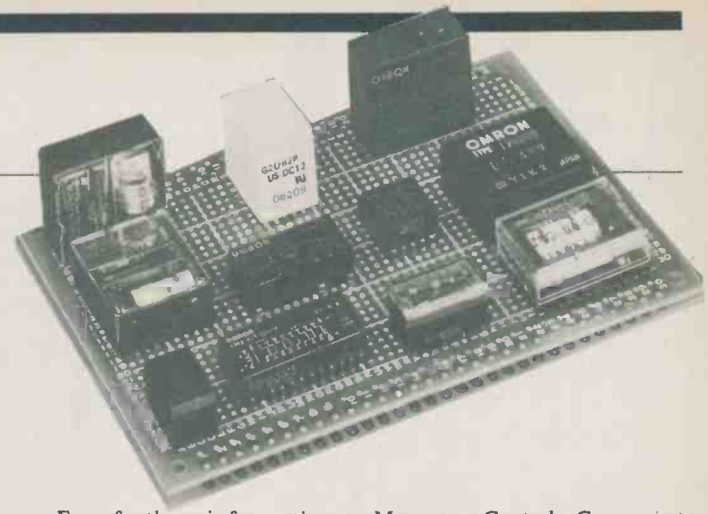
Low-Profile, Space-Saving PCB Relays

Schaumburg (IL), Dec. 30, 1982 — An expanded line of low-profile and space-saving PCB relays, including general-purpose, power and signal types for use in a variety of industrial and consumer electronic product applications, is now being marketed by the Control Components Division of Omron Electronics, Inc.

Optional sealed and latching types are available in some families, in addition to a variety of contact configurations, coil ratings and switching capacities.



For further information regarding Omron's low-profile and space-saving PCB relays, contact Joanne Sullivan, Marketing Manager, Control Components Division, Omron Electronics, Inc., 650 Woodfield, Schaumburg, IL 60195. Telephone: (312) 843-7900.

Commodore Computers

Commodore International has announced the Spring release of three portable systems. All have 64K of memory, a 5-inch display monitor, two of which are in colour, one or two floppy disk drives, and compatibility with the Commodore 64 computer software and peripherals. Expected retail prices are $995 (U.S.) for a monochrome display with single disk to $1495 (U.S.) for a colour display and dual disks.

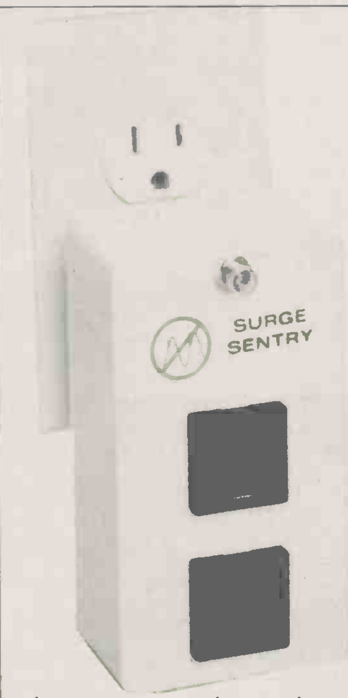
Also announced was the initial shipping of the Commodore 128, a P500 series microcomputer, to regular computer dealers. It has 128K of memory and a suggested retail price of $795 (U.S.).

Every purchaser of a Commodore 1541 disk drive will now receive a program pack at no charge from authorized Commodore dealers. The pack includes a disk and a manual, and covers education, games, sound, graphics and utilities categories.

Finally, Commodore owners who would like to run CP/M software can obtain the Madison Z-Ram PC card which is easily installed without tools. It has Z-80 and 6502 CPU's, and in addition to CP/M adds 64K of additional RAM. This increases Commodore applications ten-fold, giving access to word processing, VisiCalc, and high level languages such as Pascal. It's available through Commodore dealers, or contact Computer Workshops Ltd., 465 King St. E., Unit 9, Toronto, Ont. M5A 1L6, (416) 366-6192.

Transient Suppressors

CSA, Canadian Standards Association, has approved Surge Sentry power line transient suppressors, manufactured by RKS Industries of Scotts Valley, California. The unit protects devices such as computers, medical electronics, word processors and other sensitive equipment from high-speed, high-energy transient impulses occurring daily on virtually all power lines. The Surge Sentry line, which includes models



that protect against voltage dropout, is distributed in Canada by Morley Agencies, Ltd., 71 Clanton Park Road, Downsview, Ontario, M3H 2C9; (416) 633-6903.

Versatile New Video Switch

The Winegard Model VS-6004 video switch provides an inexpensive way to control, from one convenient location, all TV or video signal sources connected to a TV set.

The VS-6004, at a list price of $41.75 U.S., eliminates aggravating cable connecting and disconnecting and does away with messy behind-the-set cables. By simply flipping a switch, up to four signal sources may be attached to a TV set and two to a VCR.

Viewers will have, at their fingertips, easy access to off-the-air or cable programs, video games, VCRs, video discs, satellite receivers or home computers.

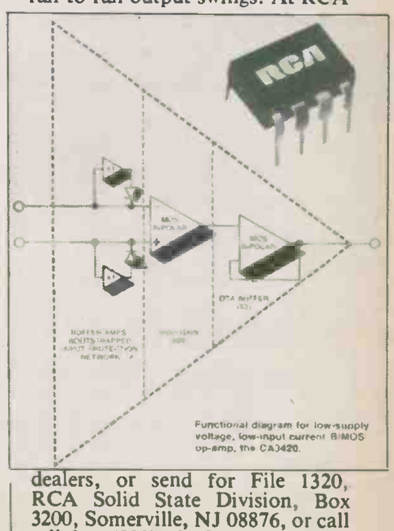
Winegard's new switch also allows the viewer to monitor and edit programs being recorded on a VCR or copied from one VCR to antoher.

High isolation switching circuits reduce interaction between signal sources and prevent interference.

The completely passive device requires no AC power to operate and is compact and lightweight. Bandpass is Channel 2 through 83. All connections are 75 ohm type.

New BiMOS Operational Amplifier

RCA's new CA3420 BiMOS operational amplifier solves design problems with notable features such as 1 pA bias current over the operating temperature range, supply voltage down to 2 V and an output that generates essentially rail-to-rail output swings. At RCA



Functional diagram for low-supply voltage, low-input current BiMOS op-amp, the CA3420.

dealers, or send for File 1320, RCA Solid State Division, Box 3200, Somerville, NJ 08876, or call toll-free (800) 526-2177.

Continued on page 10

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THE "FDD-810" MINIFLOPPY DISK DRIVE IS A HIGH PERFORMANCE AND ECONOMICAL MINI TYPE DISK DRIVE WHICH IS SPECIALLY DESIGNED FOR APPLE II™ PERSONAL COMPUTER.

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Sinclair ZX81 Computer Etc . . .

ASSEMBLED $129.95

ZX81

$169.95

The ZX81's advanced capability.
The ZX81 uses the same fast microprocessor (Z80A), but incorporates a new, more powerful 8K BASIC ROM — the "trained intelligence" of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays. And the ZX81 incorporates other operation refinements — the facility to load and save named programs on cassette, or to select a program off a cassette through the keyboard.

New, improved specification.
*Unique 'one-touch' key word entry: eliminates a great deal of tiresome typing. Key words (PRINT, LIST, RUN, etc.) have their own single-key entry. *Unique syntax-check and report codes identify programming errors immediately. *Full range of mathematical and scientific functions accurate to eight decimal places. *Graph-drawing and animated-display facilities. *Multi-dimensional string and numeric arrays. *Up to 26 FOR/NEXT loops. *Randomize function. *Programmable in machine code. *Cassette LOAD and SAVE with named programs. *1K-byte RAM expandable to 16K. *Full editing facilities. *Able to drive the new Sinclair ZX Printer (to be available shortly).

If you own a ZX80...
The new 8K BASIC ROM as used in the ZX81 is available as a drop-in replacement chip. (Complete with new keyboard template and operating manual). With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 — including the ability to drive the Sinclair ZX Printer.

16K Memory Expansion Kit (No P.C. Board) $69.95

Sinclair's new 8K Extended Basic offers features found only on computers costing three or four times as much. *Continuous display, including moving graphics. *Multi-dimensional string and numerical arrays. *Math and scientific functions accurate to 8 decimals. *Unique one touch entry of "key words" (i.e. basic and system commands). *Automatic syntax error detection. *Randomize function. *Built-in interface for ZX Printer. *Connects to standard TV and cassette recorder. *164 page manual included. *Power supply (9V at 650 ma) optional for $14.95. *1K of memory is included.

Designed exclusively for use with the ZX81 (and ZX80 with 8K basic ROM), the printer offers full alphanumerics and highly sophisticated graphics. COPY command prints out exactly what is on screen. At last you can have a hard copy of your program listing and results. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch. Connects to rear of ZX81 — using a stackable connector so you can use a RAM pack as well. A 65 ft paper roll, instructions included. Requires 9 volts, 1.2 amp power supply (option extra).

Machine Language Software

ZXAS Machine Code Assembler. A full specification Z80 assembler. Standard mnenonics are written directly into your BASIC program. **$13.95**
ZXDB Disassembler/Debugger. Perfect complement to ZXAS, also provides single step, string search, block transfer, hex loader. **$13.95**

Etc . . .

Software

GAMES (Arcade, Adventure, Strategy)

KRAKIT - Win $20,000	$24.95
1K GAMES PACK - 11 games for 1K ZX81	13.95
GOBBLEMAN - Famous arcade game.	19.95
ZX GALAXIA - SYNC said this ZX81 version was the best	19.95
ZOMBIES/SWORD OF PEACE Two exciting games	19.95
GUNFIGHTER/3D TIC TAC TOE/LIFE - 3 For 1	15.95
RUN THE COUNTRY - What would you do if you were in power?	15.95
MOVIE & SUPERHERO HANGMAN - Guess the names before the hangman comes	13.95
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BACKGAMMON -	19.95
FLIGHT SIMULATION -	19.95

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1K CHESS (ZX81)	13.95
2K CHESS (TS1000)	19.95
ZX CHESS I (Master-16K)	19.95
ZX CHESS II (Enhanced – 16K)	29.95

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ZX ASSEMBLER - Two pass assembler for MC programs	19.95
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Z-AID 1.0 - A must for MC programmers	19.95
FASTLOAD* - LOAD programs up to 6 times faster	24.95

*TM

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MATHEMATICS - GRADE FOUR	29.95
MATHEMATICS - GRADE FIVE	29.95
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*All Mathematics series includes two tapes, holder & workbook.

ADDITIONAL SOFTWARE FOR SINCLAIR AVAILABLE.

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COMPLETE ZX81 BASIC COURSE - Inc. 2 tapes	39.95
NOT ONLY 30 PROGRAMS: 1K	16.95
MACHINE LANGUAGE MADE SIMPLE	19.95
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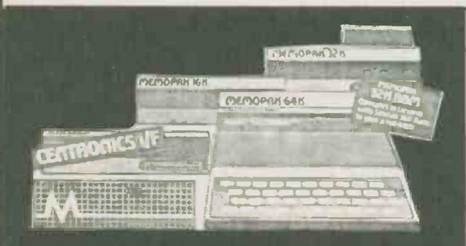
T/S 1000 USERS GUIDE (Vol 1)	16.95
EXPLORERS GUIDE TO THE ZX81	16.95
ZX81 POCKET BOOK	16.95
GETAWAY GUIDE	16.95
GETTING AQUAINTED WITH YOUR ZX81	16.95

Hardware

ZX81 Ass.	129.95
ZX Print	169.95
64K - RAM (Memotech)	249.95
32K RAM (Memotech)	179.00
16K RAM (Memotech)	109.50
16K RAM (Sinclair)	99.50
16K RAM (Kit no PC board)	59.95
Power Supply (650 M.A.)	14.95
Power Supply (1 AMP)	19.95
Keyboard (uncased) - 47 Keys. Assembled no soldering req.	119.95
Metal Case for above	29.95
ZX99 Automatic tape control	219.95

* Interface for any serial printer & 4 cassette recorders; includes plugs, cords and a detailed manual.



MEMOPAK 64K MEMORY EXTENSION

The 64K Memopak extends the memory of the ZX81 by 56K, and with the ZX81 gives 64K, which is neither switched nor paged and is directly addressable. The unit is user transparent and accepts commands such as 10 DIM A(9000).
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MEMOPAK 32K $179.00 and 16K $109.50 MEMORY EXTENSIONS

These two packs extend and complete the Memotech RAM range (for the time being!) A notable feature of the 32K pack is that it will run in tandem with the Sinclair 16K memory extension to give 48K RAM total.

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Main Features — ● Interfaces ZX81 and parallel printers of the Centronics type ● Enables use of a range of dot matrix and daisy wheel printers with ZX81 ● Compatible with ZX81 Basic, prints from LLIST, LPRINT and COPY ● Contains firmware to convert ZX81 characters to ASCII code ● Gives lower-case characters from ZX81 inverse character set **$159.95**

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FEATURES • Compact desk-top dot matrix printer • 136-column print • Light-weight • Low power-consumption • High-quality print • Bit image graphics • Graphic Symbols • Prints in six different languages • High reliability • Low cost • Friction and tractor feed • High speed, 120 C.P.S. • Logic seeking, Bi-directional • Self diagnostic capability

Tec-Writer III Daisy Wheel Printer $2499

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VP—3303 Interactive Data Terminal (RF & Video/Audio)
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VP-3303 - Connects directly to TV set	498.95
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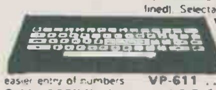

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APS-2 Switching Power Supply for APPLE II; +5V @ 3 amps, +12V @ 2 amps, −5V @ ½ amp, −12V @ ½ amp; c/w on-off switch & connecting wires	$129.50
AAA-2 (Siemens) Low Profile Disc Drive, 5¼", APPLE II Compatible, Excluding Controller Card	$499.00
ADC-1 Disc Drive Controller Card for two drives; Apple II Compatible	$129.00
AXT 14.31818 MHz Crystal for APPLE II; HC-18/U package	$ 5.50

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4164-20		$12.50
6116P	200nS 2Kx8 Static CMOS	$12.50
	NMOS 2Kx8	$ 9.75
EPROM		
2708		$ 5.95
2716		$ 5.95
2732		$ 8.75
2532		$ 9.75
2764-45		$17.50

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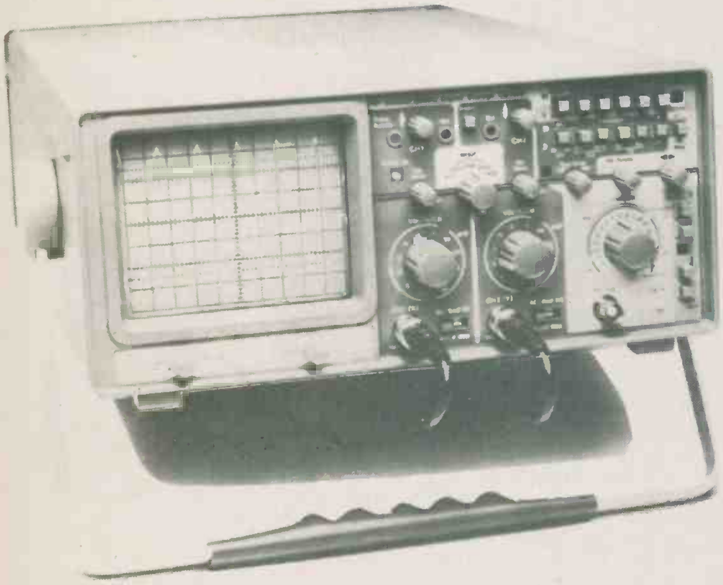
Continued from page 6

Digital Storage Scopes

Gould has three new low-cost storage scopes in their 1400 series units. These are portable, lightweight, quality instruments which draw on technology used in Gould's more expensive storage oscilloscopes. All feature 20 MHz bandwidth, 2 mV/cm sensitivity, dual trace display, and comprehensive panel controls for baseline compensation and differential voltage measurements. The digital storage mode has a 2 MHz conversion rate and display modes such as roll, refreshed, single shot, display hold, and pretrigger storage. Contact Mrs. Debbie Muraca, Allan Crawford Associates Ltd., 6503 Northam Drive, Mississauga, Ont. L4V 1J2, (416) 678-1500.



Wrist Watch Radio

Sony has unveiled the prototype of their one-chip wrist watch radio, featuring alarm and sleep settings, frequency synthesised AM radio,

four station presets and a display that shows the AM frequency. This technology applied to cars would solve your parking problem. No price or production date is available.

Toronto Computer Show

The Toronto Computer Show will be running concurrently with the Data '83 conference at the Automotive Building, Exhibition Place, Toronto, Ontario on June 22 and 23. Last year the show drew 51 exhibitors, and features many types of hardware and software. The Data '32 conference will be a state-of-the-industry meeting of North American experts reviewing concepts such as the electronic office and new solutions to data processing. For information call Laurie Whitsed at (416) 967-6200.

Production Show '83

Three shows are to run concurrently at the Coliseum Complex, Exhibition Place, Toronto: The National Industrial Production and Machine Tool Show, The Canadian Welding Show and The Plastics Show of Canada. their theme is "solutions to Canada's productivity crisis" and the idea is to extend and improve the use of technology in manufacturing. The shows will be from May 9 to 13, and further information can be obtained from Industrial Trade Shows at (416) 252-7791, or from Jim Myles, 20 Butterick Rd, Toronto M8W 3Z8.

IC Master

This tome is to integrated circuits as the Oxford English Dictionary is to words. It lists 35,000 devices in its 3300 pages, including sources, key specifications, discontinued devices and 55,000 substitutes. You'll find linears, interfaces, micros, micro supports, custom IC's and PROM programmers, all organized according to key specifications. Available at branches of Active Component Sales Corp., or contact them at 5651 rue Ferrier St., Montreal, Quebec H4P 2K5, (514) 731-7441.

Also...

A report by the Evans Research Corp. says that sales of computers costing over $500,000 could drop by as much as 44%, and the best forecast for 1983 is a repeat of 1982's performance. Software and microcomputer sales, however, should make the total computer sector growth about 13% (compared to 25% in previous years).

•

Each subscriber to SATN, the bimonthly journal for VisiCalc users published by Software Arts, 224 Clarendon St., Boston, MA 02116, will spend $30,000 on computer hardware in the next six months. Subscribers responding to a Software Arts survey also claimed that they will purchase 14,000 new microcomputers during the next six months, as well as other hardware and software.

•

Northern Telecom Limited have presented awards totalling $40,000 to four Irish universities, to provide seed money for the expansion of Canadian studies programs in their curricula. The awards are part of Northern Telecom's international contributions program through which it attempts to provide the broadest possible support to artistic and educational activities in the countries in which it operates. Northern Telecom employs 300 at their plant in Galway.

•

Orcatech Inc, the Ottawa developer and manufacturer of high resolution graphic workstations for the computer-aided design industry, have announced the signing of a major supply agreement with Cadtec Corporation of San Jose, California.

Under the contract, Orcatech will supply some 200 workstations to Cadtec for inclusion in its computer-aided engineering products for the silicon design industry. The agreement is valued at $5.5 million over a two year period.

•

Sony has a new 5 inch colour TV, the KV-5300, that is an ideal monitor for the portable Betamax VCR. Battery pack and input/output connectors make it easily portable.

•

Allan Crawford Associates, 6503 Northam Drive, Mississauga, announce an add-on system for the Apple II which converts it into a real-time industrial control and measurement processor. Complete hardware and software requires no previous computer experience and handles process control, data logging, running pilot plants, R&D, etc. Cost is about $6000 when used with an existing Apple.

Job openings for accountants, executives, engineers, scientists and other professionals plunged to another record low at the end of December, according to the Technical Service Council in Toronto, a national industry-sponsored placement service and personnel consulting firm.

Vacancies decreased 30% in the last three months, and 81% in the last year, TSC's quarterly survey reported. Only 659 vacancies were recorded, compared to 3,414 a year ago and 4,328 in June, 1981.

•

Mitel Corporation of Ottawa have confirmed that it will begin operations at a manufacturing facility in Epinal, in the region of les Vosges, France, beginning this spring.

A 40,000 square foot plant will employ 550 people by 1987 in the manufacture of Superswitch PABX systems and sub-assemblies, a large part of which will be exported outside of the European Economic Community. Mitel will invest a total of approximately $10 million (Canadian) over five years in establishing this operation.

•

The Winegard Company, 3000 Kirkwood, Burlington, Iowa, is adding two new 8-foot earth stations to its satellite line, the SC-5000 and SC-5001. Both include receiver and all hardware, and will cost about $3000 (U.S.).

•

Those dark secrets of yours can be encoded in a secure program using a new encryption kit available from Distribution Unlimited, P.O. Box 81702, San Diego, CA 92138-1702. The kit consists of a disk or cassette and a manual, and encrypts or decrypts BASIC or machine codes.

•

Fans of robotics and artificial intelligence may be interested in the Industrial Robots/Robot 7 Conference and Exposition, April 18-21, at Chicago, Ill. Contact Tom Akas, Society of Manufacturing Engineers, One SME Dr., P.O. Box 930, Dearborn, Mich 48128.

•

Local Motorola distributors now have an 8-bit selector guide available outlining the offerings of the M6800 family of microprocessors, microcomputers, and peripherals. Devices can be reviewed by function, features, and packaging information. Also listed are pre-programmed ROM-based micros and 8-bit development systems.

"When will someone introduce high-performance scopes without the high prices?"

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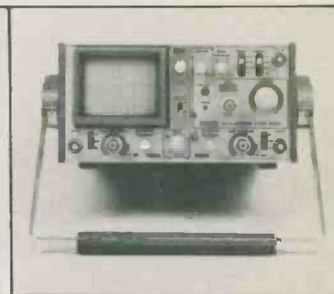
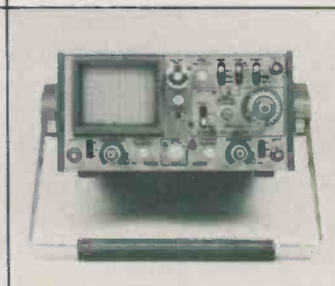


V-209 —20 MHz
$1,348

V-353F —35 MHz
$1,357

V-650F —60 MHz
$1,949



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V-152F. A 15 MHz, dual-trace scope, sensitive to 1 mV/div at 7 MHz. It has a 5″CRT. **$820.**

V-202F. A 20 MHz, dual-trace scope, sensitive to 1 mV/div at 7 MHz. It has a 5.5″CRT. **$968.**

V-302F. A 30 MHz dual-trace scope, sensitive to 1 mV/div at 7 MHz. It features signal delay and a 5″CRT. **$1,024.**

V-353F. A 35 MHz, dual-trace delayed sweep scope, sensitive to 1 mV/div at 7 MHz. It features a 5.5″square CRT. **$1,357.**

V-209. A 20 MHz, dual trace, mini-portable scope, sensitive to 1 mV/div at 5 MHz. It features AC/DC operation and has a 3.5″CRT, and weighs only 10 lbs. Battery included. **$1,348.**

V-650F. A 60 MHz, dual-trace scope, sensitive to 1 mV/div at 10 MHz. It features delayed sweep and a 6″CRT. **$1,949.**

V-509. A 50 MHz, dual-trace, mini-portable scope with optional battery pack, sensitive to 1 mV/div at 10 MHz. It features delayed sweep and a 6″CRT, and weighs 11 lbs. **$2,590.**

V-1050F. A 100 MHz, quad-trace scope, sensitive to 0.5 mV/div at 5 MHz. It features delayed sweep and a 6″CRT. **$2,973.**

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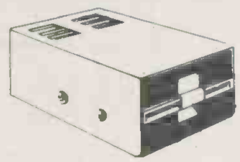

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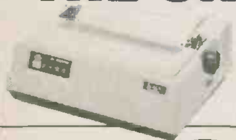

ML82A . . . . $780.
ML83A . . . . $1250.
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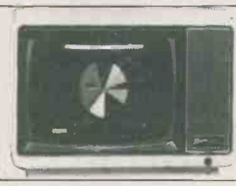

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Voiceprints

The development of the voiceprint was to have brought the accuracy of fingerprinting to audio identification. Eric McMillan looks at the technique and its courtroom controversy.

IN 1966 Lawrence G. Kersta was called to the stand in a Westchester County, New York, courtroom as a star witness for the prosecution. The fate of the accused, a policeman, hinged on Kersta's testimony. The court wanted to know whether the voice that had tipped off a bookie to a police raid belonged to the defendant.

Kersta gave his opinion that it was the officer's voice and the defendant was subsequently convicted of perjury.

Kersta had not been present during the tip-off, nor had he been acquainted with the accused. Rather, he had examined tapes of the warning to the bookie and of the policeman and testified as an expert in voice identification.

What made his testimony unusual however was his method of comparing the tapes. Instead of simply listening and making an aural judgement, Kersta had produced pictorial representations which could be measured and matched visually.

For the first time evidence from "voiceprints" was accepted in a court of law.

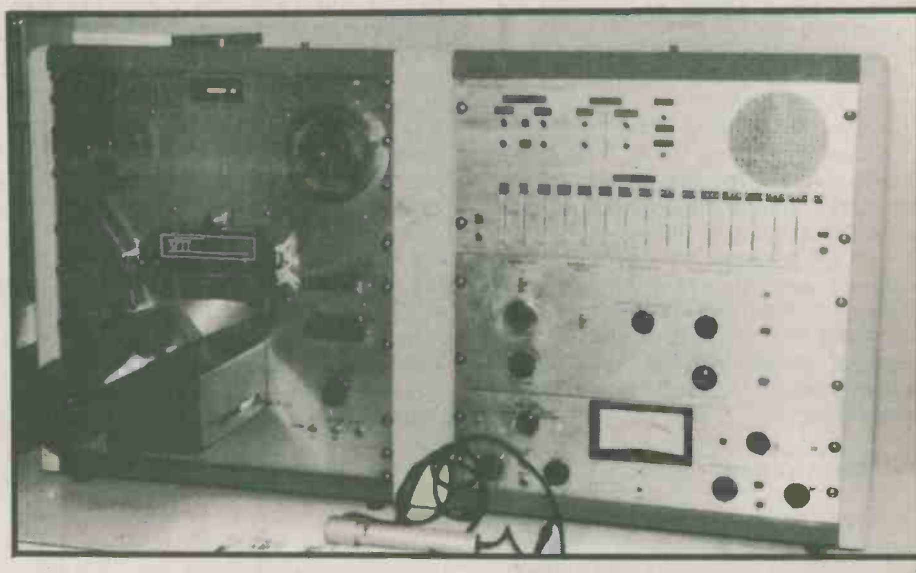
Since then voiceprinting has featured in dozens of trials and countless more criminal investigations, although not without continual controversy.

Proponents claim that voiceprints can be used by a trained examiner in a manner similar to fingerprints, although the reliability of positive identifications by voiceprints is lower than the near-infallibility of fingerprint evidence.

Critics however say the only similarity is in the name, "voiceprint" being coined by Kersta who later patented it for his private company **Voiceprint Laboratories.** Some prefer to call the printed patterns "voicegrams" or "spectrograms."

Since 1966 courts in North America have ruled both for and against the admissibility of voice print evidence and scientific studies have been similarly split on its reliability, with the most authoritative investigation coming down on the negative side.

It hasn't helped the case for voiceprinting that another person later confessed to tipping off the bookie in the 1966 crime.



The sound spectrograph for creating voiceprints: This model is the 7000 series produced by Voice Identification Inc. of New Jersey.

The sound spectrograph

The technique of voiceprinting is simple enough that no one disputes it creates an accurate picture of a human voice at a particular moment. The debate arises over the possibilities for identifying voices this way.

Working at the Bell Laboratories in New Jersey, Kersta theorized that since speech depends on the individual anatomy of each person's vocal apparatus (mouth, throat, vocal cords, etc), everyone's voice is unique. By 1962 he developed the use of a sound spectrograph to produce charts of the frequencies, emphasis and durations of given sounds as spoken by subjects.

Varying techniques have been employed over the years but most voice analysts have focused their attention on small units of speech such as isolated words, syllables or phonemes (single speech-sounds such a "p" or "sh").

A taped sample is placed in a recorder on a continuous loop. With each play-through, a chosen frequency is filtered out and activates a pen which makes a mark on a sheet of paper. The louder the voice at this frequency, the darker the mark. On succeeding play-throughs, slightly higher frequencies are selected and the pen marks the sheet just above the previous mark.

When all the frequencies in the voice sample have been exhausted, the result is a chart showing the frequency bandwidth for each component sound set against the duration of the sounds, with volume indicated by relative darkness.

According to Kersta's theory, certain characteristics can be found in common between the voiceprints made from the same sounds spoken by one person, although the time and conditions may change. Moreover, these characteristics are distinct enough to differentiate the voiceprints made by separate individuals speaking identical words.

In a police application this usually involves matching the voiceprint made from an anonymous bomb threat or obscene phone call against one made from a suspect. Police ask a suspect to repeat the exact words and tone of the original tape. Sometimes however they have to make do with recordings from uncooperative suspects who may not even realize they are being taped. In that case the voiceprint expert must pick out comparable sounds from differing contexts.

The expert seeks congruences of vowel frequency, consonant patterns, bandwidths, vertical streaking, duration, gaps, contours, intensity and other features. But since there are no objective rules for determining what characterizes a person's voice, the judgement lies ultimately with the examiner's perception.

A voice identification expert told a Canadian court in 1977, *"You don't look for points (of similarity) per se. You make a subjective decision based on the aural and the visual."*

In an attempt to decrease the margin of error due to fallible human senses, computers have been programmed to compare voices on the basis of voiceprints as well as on related data. The results so far have been mixed.

The "Shah of Iran" tapes

Experts considering the same voice samples have often found themselves on opposite sides in courtroom battles, but never did their findings conflict as revealingly as when they faced off with their voiceprints and computers over the controversial "Shah" tapes of 1979.

Shortly after Shah Reza Pahlavi was forced to flee the Iranian revolution, a Los Angeles TV station received a tape which purported to record the Shah advising his military aides to turn the army's guns against the people. The tape was examined by leading experts before it was pronounced authentic and reported on the CBS Evening News.

CBS' most prestigious expert was Dr. Oscar Tosi, director of the Institute of Voice Identification at Michigan State University where he had carried out a two-year study of voiceprinting. Dr. Tosi tested the "Shah" tape with a panel of five trained listeners and a computer program designed to eliminate individual variation between words and to bring out the unique features of the speaker. The listeners and the computer delivered positive identifications. *"There was no doubt"* it was the Shar's voice, said Dr. Tosi.

Another verification came from a doctoral student at UCLA who had frequently testified in court on voice identification. His judgement was based on over 50 spectrograms comparing sounds and syllables. A third check was made by a local private investigator who applied a voice stress analyzer (considered of dubious value by many scientists).

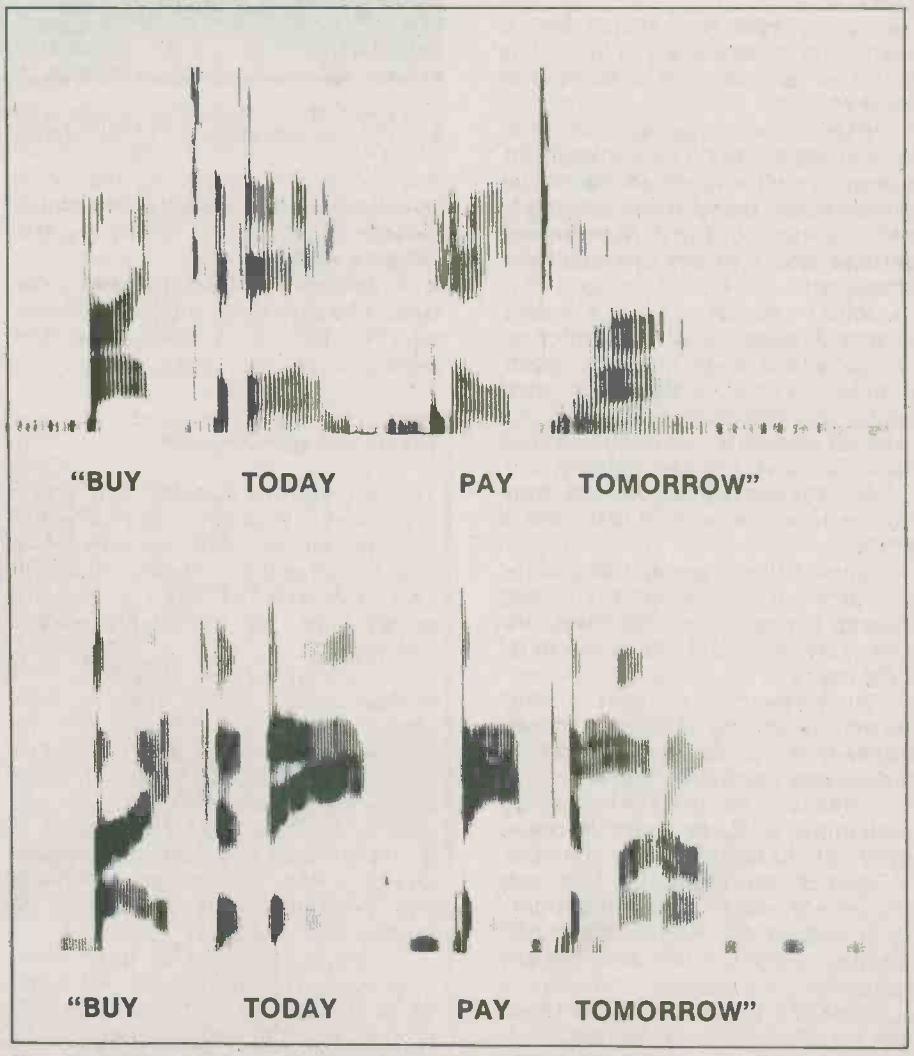
When the story broke, the *New York Times*, which had also acquired the "Shar" tape, consulted their own expert who compared voiceprints of seven words spoken on the tape in question and on a known recording of the Shah. Using both visual and computer comparison, he found at least two words containing imcompatible frequencies and he declared the tape fraudulent. A spokesman for the Shah also called it a fabrication (though this cannot be considered conclusive since many would claim it was in character for him to have given such orders to the military and later to deny it).

Quizzed in greater detail about his methods, the CBS expert Dr. Tosi admitted he really hadn't had enough time with the tapes. Possibilities were raised that the tape was a speech of the Shah edited to give an unintended meaning or that it mixed the Shah's speech with a mimic's. To make a final validation would probably take a month of fulltime study, said Dr. Tosi.

More experts were recruited but the story sank from sight under the weight of confusion and was overshadowed by new developments in Iran.

Questions linger after the episode. How objective is the analysis of voiceprints where experts can come up with different results from the same samples? Can the expert (and police and courts) be fooled by clever editing or imitations?

And a question more relevant to our topic may be asked: Without the glare of publicity that surrounded this case, raising doubts about the evidence, can the word of one (or two or three) voice identification experts be relied upon in a courtroom?



Voicegrams of two people speaking the same words with identical taping equipment show similarities as well as differences of pattern. The scientific question is how accurately prints can be identified or differentiated. In these samples time is measured horizontally for a duration of under 1.5 seconds, while frequency is scaled vertically within a range of 4,000 Hz. Relative darkness indicates intensity.

Trials and errors

Dr. Tosi had been one of the prime movers in legitimizing the voiceprint in the eyes of American and Canadian courts.

After 1966 when the father of voiceprinting, Kersta, testified for the first time, court decisions had gone both ways. In 1967 the U.S. Air Force Board of Review upheld the admissibility of Kersta's evidence from spectrograms in a court-martial.

The first civilian test in an appellate court however turned out differently. The case arose from a TV documentary on the Watts riot of 1965. An unidentified youth in the film confessed to arson. When a youth was later arrested on an unrelated charge, police suspected he might be the arsonist. The voices were compared by Kersta and the youth was convicted. But the California Court of Appeal reversed the decision on the basis of voiceprint evidence being of insufficient scientific certainty.

Dr. Tosi tried to provide this scientific basis by testing identification under a variety of conditions. In his two-year study for Michigan State University, voiceprints were made from samples taped a month apart, from sounds taken out of different contexts and from voices recorded without the speaker's cooperation. One third of the samples duplicated the kind of conditions found in forensic applications such as rapid speech, background noise and telephone recordings.

Released in 1971, the study found that under simulated forensic conditions, false identifications were made in 4.2 percent of the trials when the words were taken from identical sentences and 6.4 percent of the instances when they were taken from differing contexts. Furthermore, 60 percent of the wrong decisions were recognized as "uncertain" by the examiners at the time of decision and presumably would not be the kind of choices that would be presented to a court as positive identifications.

Parallel with Dr. Tosi's study, Lieutenant Ernest Nash carried out a survey of cases handled by the Michigan State Police. In 673 cases of voice analysis, 105 identifications and 172 eliminations were made. Of the identifications, 30 resulted in confessions.

Together, these reports initiated a period of general acceptance of voiceprints by the courts. Not surprisingly, both Dr. Tosi and Lt. Nash soon joined Kersta as familiar figures on witness stands.

Up to 1975 a total of 14 out of 15 US federal judges and 35 of 37 state courts in the US admitted evidence from spectrographic analysis of voice.

The first Canadian case followed suit. Lt. Nash was called up from Michigan to Ontario to compare the voice on an extortion attempt to the voice of a defendant. Lt. Nash made a positive identification at the preliminary hearing but was not needed at the trial because the accused admitted through his counsel that he was the anonymous caller.

But in the latter half of the 1970s the higher level courts began taking a more sceptical look at voiceprint evidence. The Michigan Supreme Court ruled that both Lt. Nash and Dr. Tosi lacked the necessary impartiality because their *"reputations and careers have been built on their voiceprint work."* Supreme Courts in Maine and Massachusettes, who found that the analysis of voiceprints had "general acceptance", were balanced by those in California and Pennsylvania who discovered that it did not.

In this context of uncertainty, the only Canadian case to come to trial was decided. A bomb scare had been received and recorded at a Manitoba school. The accused willingly gave samples of his voice for comparison by a sergeant who has taken over from Lt. Nash as the Michigan police's star witness in voiceprint cases.

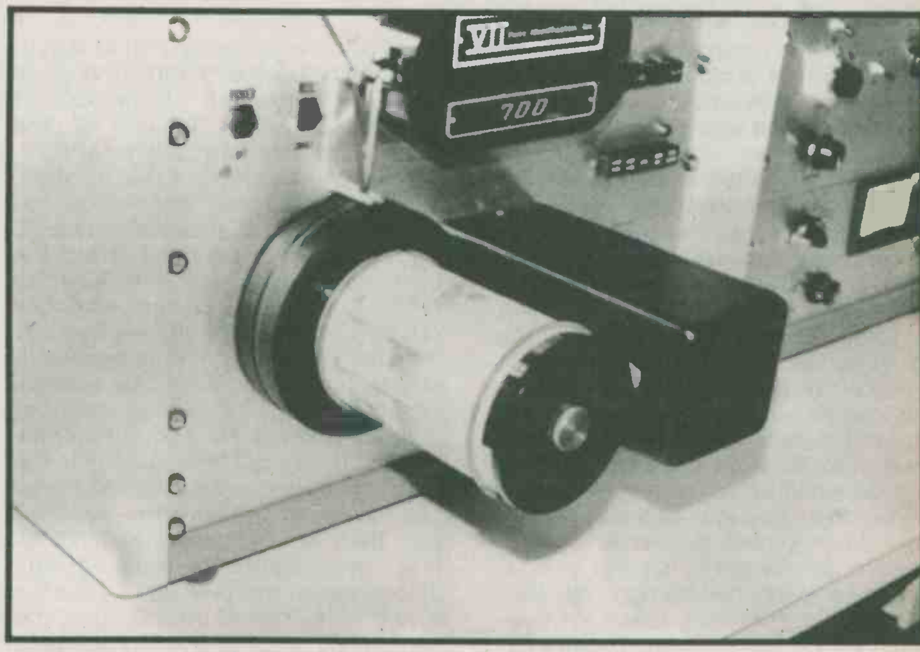
The judge interrupted the defence counsel's questioning of the reliability of spectrograms because *"that has nothing to do with (the sergeant's) expertise in the field."* He told the jury they could accept the evidence as coming from a man who knew what he was talking about. The jury apparently did and they found the accused guilty.

A Court of Appeal upheld the decision, although a dissenting opinion noted, *"Witnesses have come to court to say they were expert in palmistry and fortune-telling, but they have not been allowed to testify, notwithstanding that they knew what they were talking about, since palmistry and fortune-telling are not recognized as scientific."*

Science or fortune-telling?

The comparison may be unfair. Voicegrams do seem to produce pictures of how a person speaks at given moments. And there is a similarity between how a person speaks at different moments — otherwise we wouldn't be able to recognize our friends' voices without seeing their faces.

Rather than discard the sound spectrograph, it would make sense to critically evaluate the theoretical basis for its use and to understand its limitations. Then, if possible, the analysis of voiceprints could be perfected.



Dr. Stevan Pausak of the Ontario Forensic Sciences Centre speaks into the spectrograph's microphone to record a segment of tape which is then wound around a revolving drum. As the drum rotates, a stylus picks up the frequencies used in the loop, one increment at a time, and marks them on a sheet of paper on the drum. When the sheet is unwrapped, the result is one of the voiceprints shown.

Voiceprints

In 1976 the FBI commissioned the US National Academy of Science to carry out a comprehensive study of voiceprint techniques. The investigating committee drew together eight speech, acoustics and electronics experts, including Dr. Tosi, and one lawyer.

The report, published three years later, exposed the lack of scientific backing for the theory of voice uniqueness: *"At present, dependable voice features are not known and the examiner's task remains largely an empirical art."*

The academy found voiceprints were affected by a host of factors including stress, fatigue, illness, alcohol, allergies — and even by such everyday activities as waking up, shouting in a crowded room or whispering.

The acoustics of the recording could be affected by background noise and variables in equipment such as microphones, recorders and telephone links.

In short, the committee called voiceprint evidence "ambiguous." Without taking a stand on admissibility in court cases, it urged "great caution" and an explanation of the method's limitations to be given to a judge or jury along with voiceprint testimony.

At the time of the report's release the courts in only 23 states were still accepting voiceprint evidence.

In Canada voiceprints have not been introduced in court since the 1977 Manitoba decision. The head of the audio analysis unit at the RCMP Ottawa headquarters has recently been quoted as saying there are *"just enough questions"* about the method that identifications should be considered "probable rather than positive." The director of the Ontario Forensic Sciences Centre concurs, saying the centre is not prepared to submit findings from sound spectrography to a court as positive evidence.

Computer cops

In the meantime research is being carried on in another direction — voice recognition by computer.

The process is similar to voiceprint analysis with component frequencies of sound samples broken down electronically. Incoming signals are measured at tiny intervals and the values stored in digital form.

In one experiment the computer stored five sets of 16 monosyllabic words for each speaker. The arrays of sounds are averaged to account for variability within each speaker's voice. The computer later asks a speaker to pronounce four random words from those stored. The words are adjusted for variability, compared with the original sample and the person is accepted or rejected as the original speaker.

The decision process in the program is actually quite a bit more complex than this simplified explanation — so complicated that it is doubtful an examiner, unaided by computer, could carry it out.

Such a system was supplied to the U.S. Air Force for the purposes of access control. Incorrect rejections occurred only one percent of the time and false admittances only two percent. Verification time was 6.2 seconds.

Two University of Victoria linguists have been working on a computer-controlled system that focuses on consonant sounds such as "m," "n," and "sh," on the theory that the frequencies in these sounds are the most characteristic in a person's speech. They hope to improve upon the reliability of voicegrams.

Of course, no self-respecting extortionist or obscene caller is likely to cooperate by storing pre-selected sounds in a computer for later matching. But as the computer method is perfected, it could be adapted to forensic use. It not only performs more thoroughly and quicker than Dr. Tosi's trained listeners, but it has also proven resistant to mimicry.

And computers make impressive court witnesses, as any *Star Trek* fan knows. ETI

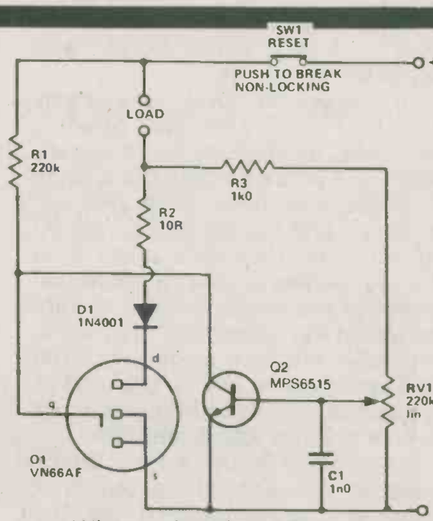
Designer Circuits

Overload Current Trip

Most power supplies incorporate some form of protection circuitry so that an excessive output current cannot flow in the event of an overload. However, these protection circuits are often designed merely to prevent the supply circuitry from sustaining damage, and in the event of an overload permit a level of current flow that is sufficient to damage the circuit being powered. This overload current trip can be used between the powered equipment and the power supply and will cut off the supply almost instantly if a preset threshold current is exceeded. The trip current can be varied from just a few to a few hundred milliamps. The unit will work with supply voltages of 5-40 V.

When power is first applied to the circuit, power FET Q1 will be biased hard into conduction by bias resistor R1. Power is, therefore, supplied to the load via Q1, D1 and R2. There will be a voltage drop across these components, and to some extent this varies with changes in the supply current.

RV1 is adjusted so that at output currents below the required threshold level the proportion of the voltage dropped across Q1, D1 and R2 (and fed to Q2's base terminal) is not sufficient to switch on Q2. If the threshold current is exceeded, the voltage fed to Q2's base is then adequate to switch the device on and it diverts the bias current that formerly went to Q1's gate terminal. Q1 then switches off and cuts the supply to the load. Q2 remains switched on as it receives a strong base bias from the positive supply through the load, current limiting resistor R3 and RV1. Once tripped, the circuit thus latches in the "off" state. It can be returned to the "on" state by clearing the overload and then briefly operating SW1 so that the supply is momentarily disconnected from the unit. When the supply is restored it then starts at the "on" state once again. C1 ensures that the circuit does always initially assume the correct state and it also helps to prevent spurious triggering of the unit.

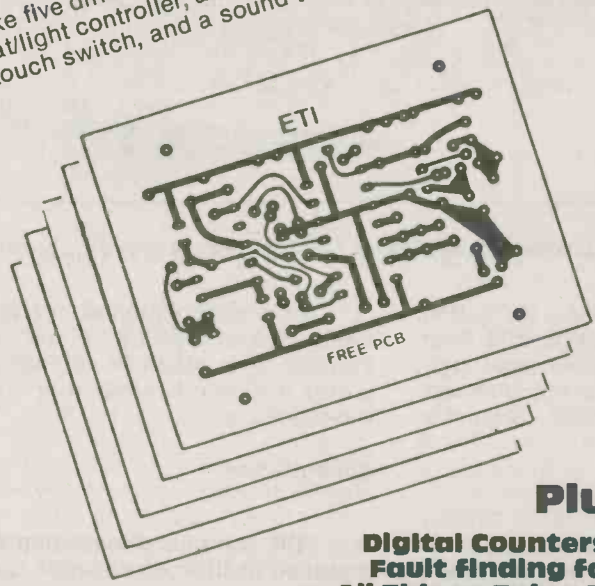


When using the unit it should be kept in mind that about 1V is lost through the device and the output voltage from the supply must be adjusted to compensate for this. The current trip inevitably causes some loss of regulation efficiency, but this is only marginal. If the unit is to have a trip current of about 100 mA or more, R2 can be reduced to about 1R8 in order to maintain the low voltage drop.

ETI next month

Multipurpose PC Board

Make five different projects from one board, including a heat/light controller, an IF tester, an electronic doorbell, a touch switch, and a sound-to-light unit.



Radar

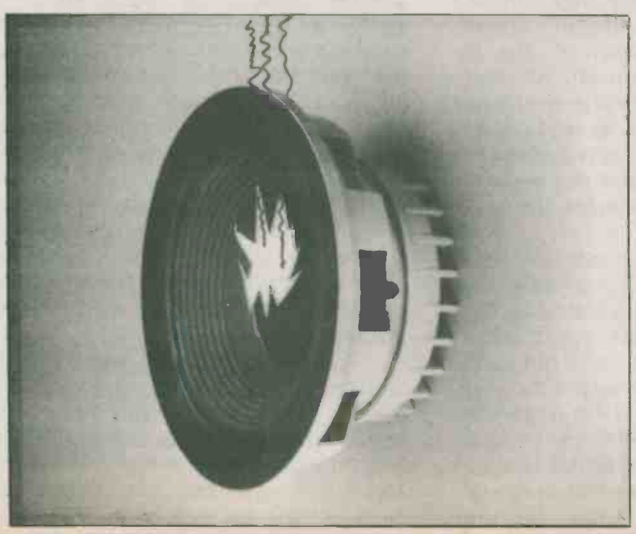
Roger Allen investigates the development of radar technology in WWII, including the equipment and strategy used. Also included is a look at German advances in the field; they were further ahead than is usually believed.

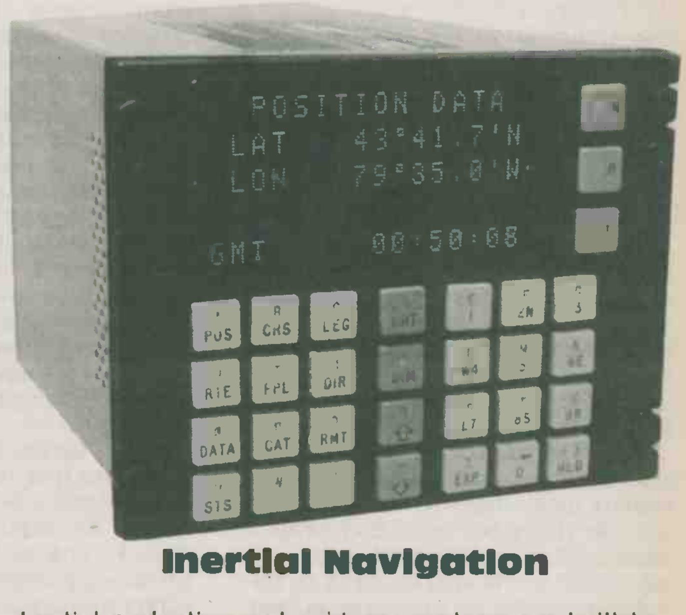
Plus!

Digital Counters and Timers!!!
Fault finding for Beginners!!!
All Things Being Equal — a look at equalisation!!!
ZX81 Interface Board!!!

Loudspeaker Protector

A carefully thought-out unit that disconnects your speakers automatically on overloads and other excessively bad news coming down the leads. Self-powered, self-resetting, and low cost.





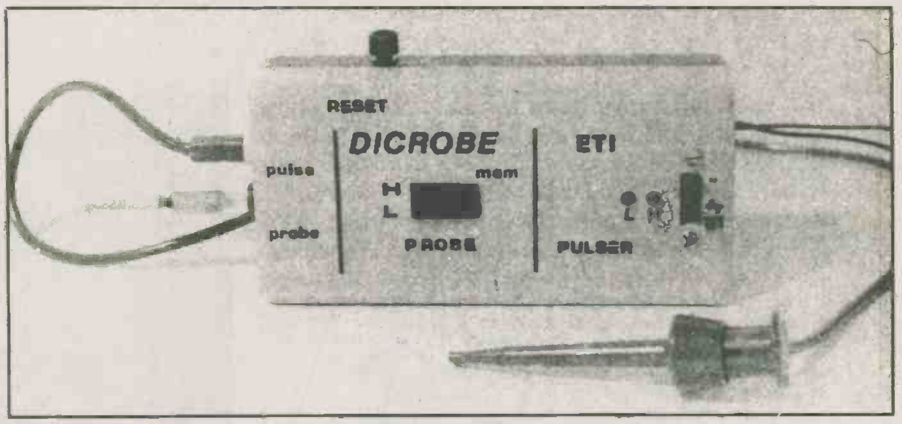
Inertial Navigation

Inertial navigation and guidance systems are built to amazing standards of precision. Commercial aircraft can be guided thousands of miles with almost negligable error. They still manage to lose your luggage, though.

Dual Logic Probe

PROJECT

With all the logic probe designs that have been published, you didn't think we could come up with an original design, did you? Oh ye of little faith ... this one's cheap, compact, and clever. Design and development by Phil Walker.



Using the case and construction techniques specified gives a neat little project.

THIS MONTH'S 'project par excellence' from the ETI workshop is very useful dual purpose logic tester. It is designed with CMOS in mind and uses mostly logic ICs of that family. Our prototype gives results with pulses down to 200 nS wide at frequencies from DC to over 2 MHz.

The ETI Dicrobe is designed as a dual purpose test instrument. One half of it is a reasonably conventional logic probe giving indications for logic high, low, and pulsing states while also having a transition memory to store those events you might otherwise miss. All these conditions are displayed on a seven-segment LED display to give a practical representation of conditions at the probe tip.

Probing For Pulses

The other half of the unit is a logic pulser which automatically senses the logic level of the secondary probe and gives it a short pulse to the opposite state. This can either be a square wave drive at about 5 Hz or 2 uS pulses, again repeated five times per second.

Two LEDs indicate the logic state on this probe but no indication of pulse conditions is given. The two parts of the instrument can be used independently or together. This enables a considerable amount of useful testing to be carried out with this unit alone.

For instance, the pulser could be applied to a clock input while the primary probe looks at the outputs to see if anything happens. Both probes could be applied to a part of the circuit to see if it is shorted to 0V or the positive supply; in this case pulses will be seen if everything is OK (even if there is an output from a gate driving it).

On TTL circuits the probe may not operate so quickly due to the low supply voltage but a useful indication of functions should be possible. Bear in mind, however, that the logic high and low levels for TTL are much lower relative to the supplies than for CMOS.

A Tour Round The Circuit

The primary probe circuit uses a 4049 to sense the input, with the advantage of high speed, high input impedance and CMOS logic thresholds. The output from three sections of this drives the edge detector and two segment drivers. The edge detector drives a set-reset latch (to store the fact that a transition occurred) and a monostable (to give indication of previous conditions).

The secondary probe circuit is a little simpler than the primary probe as it is not designed for high speed. Part of a hex Schmitt trigger senses the input and the result of this is stored on a set-reset latch. Another part of the Schmitt package works as an oscillator at about 5 Hz and drives two other sections via CR networks to provide reset pulses for the set-reset latch and enable pulses for the output circuit.

The output transistors are connected so that they are normally off. When a pulse is to be applied to the output the logic drivers apply base drive to one of the transistors. The particular transistor driven is the one which gives a pulse of the opposite polarity to the normal state of the circuit point to which the probe is connected. After the pulse the state of the circuit is sensed ready for the next pulse.

The three-position switch allows the secondary probe to act as a straight logic probe or an automatic pulser with short duration or square wave pulsing.

Construction

The PCB for this project has been designed to fit inside a small plastic box. There is very little room to spare inside the box so great care must be taken to use small components and make the connecting wires as thin and short as possible.

A fine tipped soldering iron is essential for this project and great care must be taken to avoid solder splashes between tracks. The ICs can be mounted in sockets of the low profile type and the seven-segment display should be mounted in a socket as well. For the display we used some Soldercon connectors; these are taller than the low profile sockets on the other ICs and held it higher above the board to project through the case lid when assembled. Apart from the LEDs and two resistors, all the other components mount normally on the PCB. Take care to get the diodes, transistors, ICs and capacitor the correct way round. The LEDs are mounted so that they will project through the lid.

Two resistors have to be mounted on end so refer to the overlay to see where they should go. Two wire links are needed near IC1 so don't forget these either. The links are close together and should be made with insulated wire. When wiring up, connect lengths of 6" or so to all the connection points indicated except the power supply, which should be 18" or so.

Fit the sockets for the probes into the end of the box where the board mounting pillars are closest together. They must be as near to the bottom of the box as possible. Also fit the reset switch into the side of the box in a similar manner. This switch must be very small to fit in the space provided. If a suitable component cannot be obtained, increase the value of R3 to 10M and use two small bolts as a touch switch. This is suggested only as a last resort!

A small grommet should be inserted in the opposite end of the box to the probe connectors to take the power supply wires. The box lid must have holes cut or drilled in it to clear the display, LEDs and mode switch SW1. SW1 is bolted to the lid and the interpin connections made before wiring to the board.

When fitting the PCB into the box the wires from it must all pass over the ends as there is not enough clearance at the side for them. The probe and switch wires should be short or they will get in the way of the lid. Our prototype used small grommets cut in half as spacers between the PCB and the mounting pillars to get the correct height.

Probing Deeper

The probes themselves were very simple. The main one was a piece of brass threaded rod turned to a point in a drill with a file. This was soldered into a metal tube taken from a piece of plastic connector block. A small piece of thick wire was soldered into the 2 mm plug and then this was soldered into the other end of the metal tube. You may care to experiment with a sewing machine needle instead of the brass rod as these form very durable probe tips.

The other one was simply a piece of wire with a spring probe on the end terminated in another 1 mm plug.

The two probes are interchangeable as required. Power supply wires can be terminated in crocodile clips or anything convenient.

What's The Diagnosis?

The probe is intended for diagnostic work on CMOS circuits where the main part is used to look for the effects caused by the pulser probe being applied to an earlier part of the circuit. This lets us find faults in com-

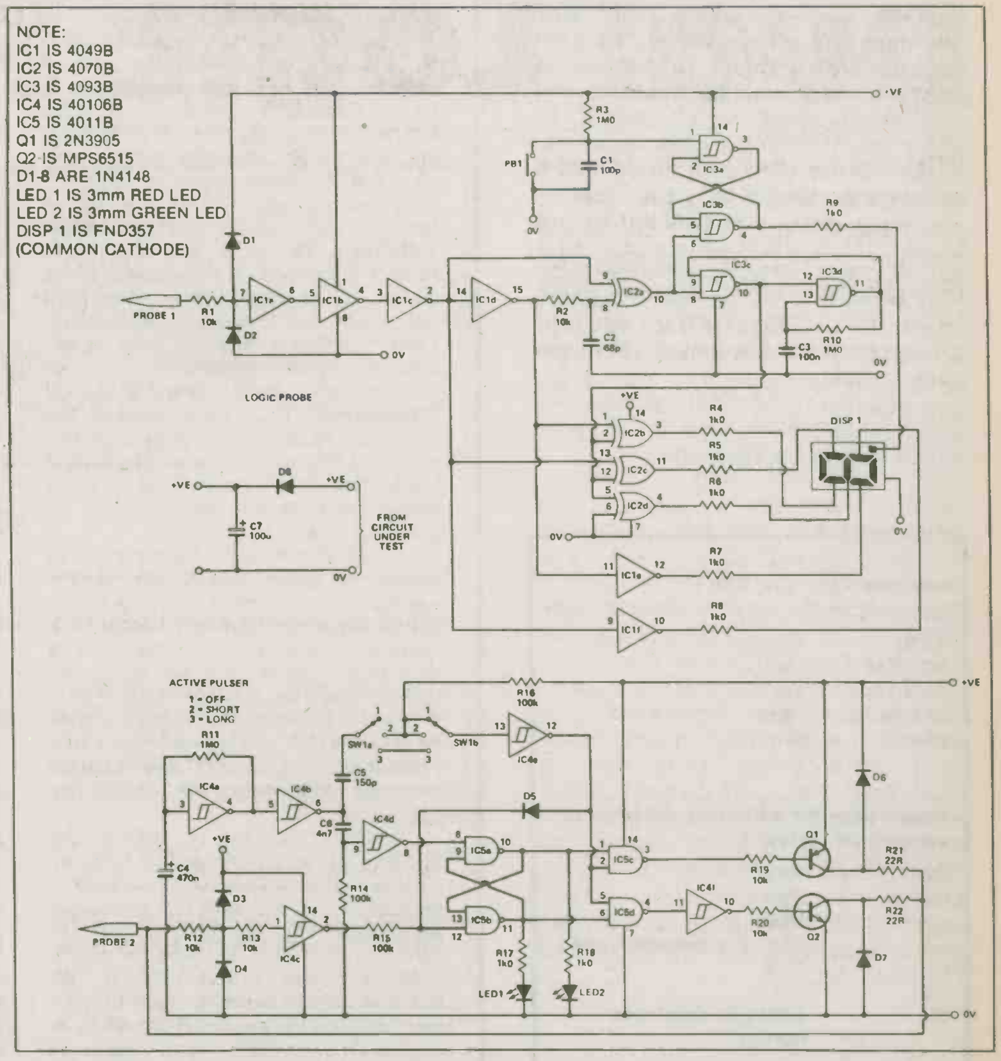


Fig. 1 Complete circuit diagram of the logic probe.

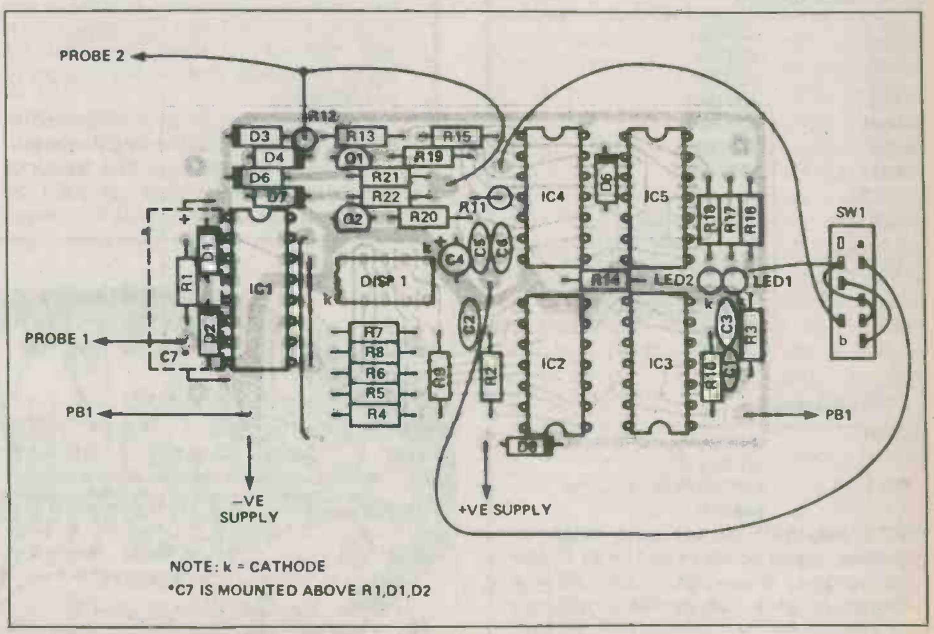


Fig. 2 Component overlay. Note that one end of R12 is soldered to two flying leads, not the board.

Dual Logic Probe

ponents such as gates and many counters and other devices. By connecting both probes to the same point, a check can be made to see whether a short circuit exists to either power rail (no pulses detected). It can also be used as a crude signal source if nothing else is available.

The pulser works best if the point to which it is attached is static, as it has a fairly slow response time. Note that when it is in the active pulsing mode, the LED display does not give a true picture of the logic level at the pulse probe.

The main probe will catch pulses down to 200 nS with a 9 V supply which should be adequate.

PARTS LIST

Resistors (all ¼ W, 5%)

R1,2,12,13, 19,20	10k
R3,10,11	1M0
R4-9,17,18	1k0
R14-16	100k
R21,22	22R

Capacitors (all miniature ceramic except where stated)

C1	100p
C2	68p
C3	100n
C4	470n 35V tantalum bead
C5	150p
C6	4n7
C7	100u 25V axial electrolytic

Semiconductors

IC1	4049B
IC2	4070B
IC3	4093B
IC4	40106B
IC5	4011B
Q1	2N3905
Q2	MPS6515
D1-8	1N4148
LED1	3mm red LED
LED2	3mm green LED
DISP1	0.4" seven-segment common cathode display (FND357 or similar)

Miscellaneous

SW1	3-position miniature slide switch
PB1	subminiature push-button

PCB; two 2mm sockets and plugs for probes; piece of brass rod or studding for probe; crocodile clips; 10-way Soldercon strip; low profile IC sockets (if used); small grommets, wire, screws etc; case.

HOW IT WORKS

MAIN LOGIC PROBE

This part of the circuit is based around IC1,2 and 3. The input from the probe tip passes via a simple protection network R, D1 and D2 to IC1a. This device senses the logic level at the probe tip while also presenting a very high impedance to the circuit under test. Two more sections of the device, IC1b and IC1c, are used to speed up the transition time when the logic state changes at the input. The output from IC1c is used by IC1f to drive one of the segments of the display. IC1c's output is inverted by IC1d and used by IC1e to drive another segment. These two display segments form the immediate logic state indicator.

The outputs from IC1c and IC1d go to IC2b and IC2c. IC2 is a quad exclusive-OR gate which in this case is being used as a controlled inverter. The outputs from these two sections drive two more segments of the display but these are the ones which indicate the previous logic state.

To detect a transition from one state to another, the output from IC1c is applied to one input of IC2a while the output from IC1d is applied to the other via R2 and C2. These components cause the inputs to IC2a to be slightly out of phase with each other. In their normal rest state the inputs to IC2a would be at opposite logic levels causing the output to be high, but for a short time after a transition the inputs to IC2a will be at the same level and the output will be low during this period.

This low pulse has two effects. The first is to set the latch formed by IC3a and IC3b such that the decimal point LED in the display is lit, indicating that a transition has occurred. The second is to force the output of IC3c high, enabling the astable oscillator formed around IC3d. In fact IC3c and IC3d form a monostable to effectively stretch input pulses and transitions so that they can be seen. The low pulse on IC3c input puts a high on IC3d input which, since C3 has been resting at a high level, will make the output of IC3d go low immediately. This forces IC3c output to remain high via its second input until C3 discharges enough to allow IC3d output to go high again.

The output of IC3c is connected to IC2d which acts as a buffer to drive the centre segment of the display. This flashes to indicate that a transition has occurred. IC3c output also drives IC2b and IC2c, causing them to invert the signal on their other input while the monostable is active. The effect of this controlled inversion is that the last transition is mimicked on the display.

The transition memory, IC3a,b, can be reset at will by pressing PB1. The decimal point on the display will go dark until another transition occurs at the input.

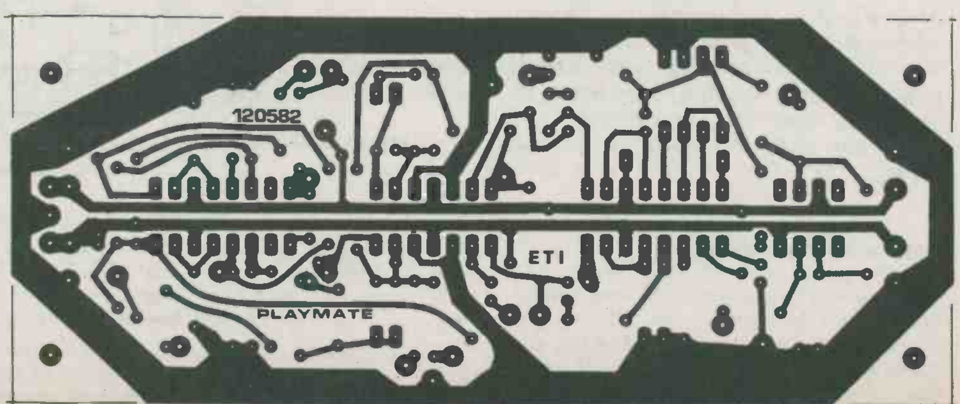
PULSER PROBE

The input from the probe tip is sensed by IC4c, part of a hex Schmitt trigger. Some protection is provided by R12, R13, D3 and D4 against excess input voltage. The output from IC4c goes to the latch formed by IC5a and IC5b via R15. A low on IC4-c output will set the latch such the LED1 is alight and LED2 is off.

IC4a, R11 and C4 form a slow speed oscillator which, via a buffer IC4b, drives the pulse generation circuits. On the rising edge of the output from IC4b, IC4d is driven by C6 and R14 to produce a low pulse of short duration. This pulse tries to reset the IC5a,b latch but will only succeed if IC4c output is high. This updates the latch every cycle of the slow clock.

On the falling edge of the slow clock a signal may be passed to IC4e via C5 and Sw1. Position 1 of the switch does not allow the pulse to pass and the circuit acts as a slow logic probe only. Position 2 of the switch allows the signal through but connects R16 into the circuit such that it forms a differentiator with C5 and makes the output from IC4e appear as short pulses. In position 3 the output of IC4b is coupled to IC4e via C5 virtually without change. This means that the pulses will be approximately 50% duty cycle.

The output from IC4e (consisting of a low logic level with or without positive-going pulses) passes to IC5c and IC5d. The other inputs to these gates are taken from the output of the input sense latch, IC5a and IC5b. If the output of IC4e goes high, then one or other of the outputs of IC5c or IC5d will go low. A low level on IC5c will turn Q1 on via R19 and pull the probe to a high level via R21. If IC5d goes low instead, IC4f output will go high and turn Q2 on via R20. This will pull the pulser probe to the negative supply via R22. D6 and D7 provide a small amount of protection for this part of the circuit while D8 provides overall polarity protection for the probe supply.



Designer's notebook: Unusual Technology

Piezo-electric 'buzzers' such as the PB-2720 are super-efficient and inexpensive sound generators, easily driven by simple CMOS circuitry. In this month's Notebook, Ray Marston shows how to use them.

THERE IS A frequent requirement in instrumentation designs, for example, for some form of alarm or 'fault condition' indicator, perhaps to warn of a short-circuit or overload condition in a power supply or an overspeed condition, loss of oil pressure and so on in a car or truck. If you ever need to design such an alarm, you have the options of using either a visual (lamp or LED) or an acoustic type of output indicator.

The major snag with purely visual indicators is that they are only effective if you happen to be looking at them when they activate. Clearly, acoustic indicators are the most effective types of 'attention grabbers', but in the past they tended to be rather expensive to implement both in terms of money and in power consumption and physical bulk.

The recent introduction of small, inexpensive and highly efficient piezo-electric acoustic transducers such as the Toko PB-2720 has totally changed this situation, however, and it is now possible to build effective acoustic indicators at costs that are very low.

PB-2720 Basics

The PB-2720 piezo-electric transducer is a super-efficient electric-to-acoustic power converter. It consists of a metal plate bonded to a thin slice of piezo-electric ceramic and is housed in a small plastic-moulded resonant chamber.

If you apply an AC signal across the two input terminals of the PB-2720, you get a corresponding audible output. Figure 1 shows the frequency characteristics of the device when it is fed with a 1V5 RMS input and the output level is measured at a range of 10 cm. Note that a good output level is available across a wide frequency band but this peaks at about 4.5 kHz, at which point an output sound level of roughly 85 dB is obtained at a range of 10 cm from a 1V5 RMS input. If you are not familiar with acoustic terminology, 85 dB is typical of the subjective sound level of a noisy office or busy street.

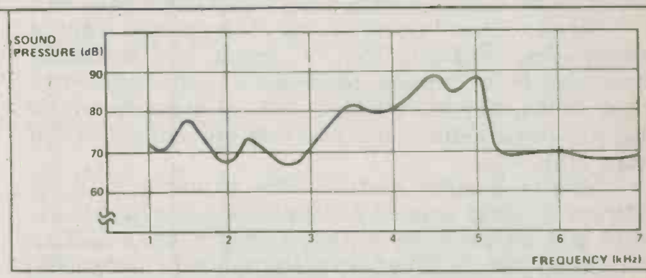


Fig. 1 Frequency characteristics of the PB-2720 'buzzer' with an input of 1.5 V RMS. The sound pressure is measured at 10 cm.

The really impressive feature of the PB-2720 is its high level of power conversion efficiency and consequent low power input requirement for a given power output. Figure 2 shows the input voltage characteristics of the device in terms of current consumption and

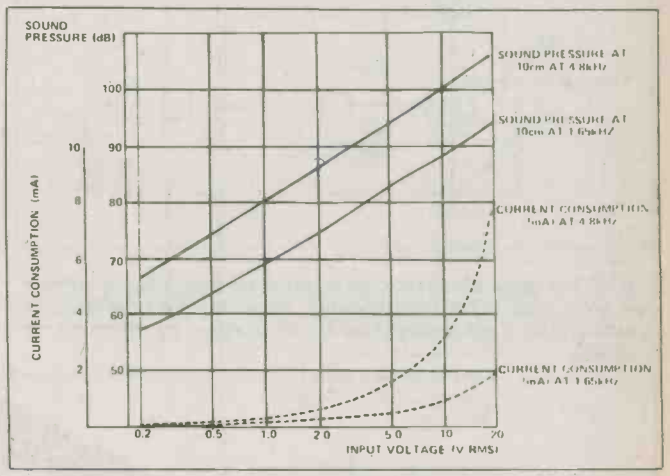


Fig. 2 Input voltage characteristics of the PB-2720 in terms of current consumption and generated sound pressure.

generated sound pressure. Note here, for example, that a 10 V RMS input at 4.8 kHz causes a current consumption of only 3 mA but results in 100 dB of output, while at 1.65 kHz the input consumes only 1 mA (10 mW) for 87 dB of output. Very impressive.

The explanation for these apparently miraculously low levels of power consumption is very simple. Conventional electromagnetic speaker-type transducers have incredibly low conversion efficiency levels, ranging from a mere 0.1% for hi-fi speakers to 2% for 'cheapo' types. The PB 2720, by contrast, is a piezo-electric device and has an efficiency level of about 50%. Thus, for a given output level it needs an input power of only 1/500th to 1/25th of conventional sound generators.

Driving The PB-2720

The PB-2720 is a very easy device to drive. Being ceramic, its input terminals appear to the outside world as a simple capacitor with a static value of about 20nF and a DC resistance of near-infinity: if you drive it with a pure sine wave, you simply find that its impedance decreases as frequency increases.

The most effective and cheapest way to drive the device is to feed it with square waves, but in this case the driver must be able to source and sink currents with equal ease and must have a current-limited (short-circuit proof) output. CMOS drivers fit this bill perfectly.

Figures 3 and 4 show two very inexpensive ways of driving the PB-2720 from a gated 4011B CMOS oscillator; both circuits generate a continuous-tone signal when they are enabled, are gated on by a high (logic 1) input signal, and can use any supply in the range 3 to 18V.

The Fig. 3 circuit calls for little explanation. IC1a-IC1b are wired as a gated 2 kHz astable, and IC1c is used to give single-ended buffered drive to the PB-2720. The circuit can be gated on electronically, or by PB1. The signal reaching the PB-2720 is thus an approximate square wave with a peak-to-peak amplitude roughly equal to the supply voltage: consequently, the RMS voltage across the load is roughly equal to 50% of the supply voltage.

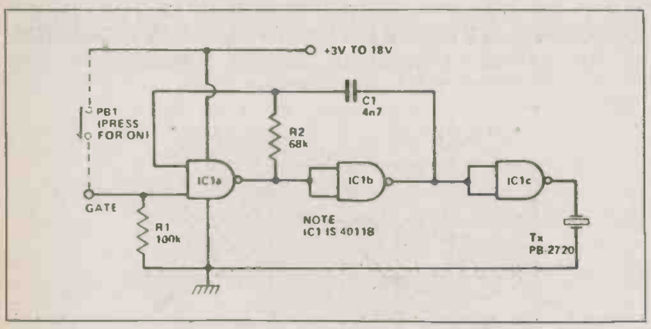


Fig. 3 This basic buzzer circuit is gated by a high (logic 1) input and generates a 2 kHz continuous tone. The PB-2720 drive is single-ended. Sound output (at 10 cm) is about 82 dB from a 10 V supply.

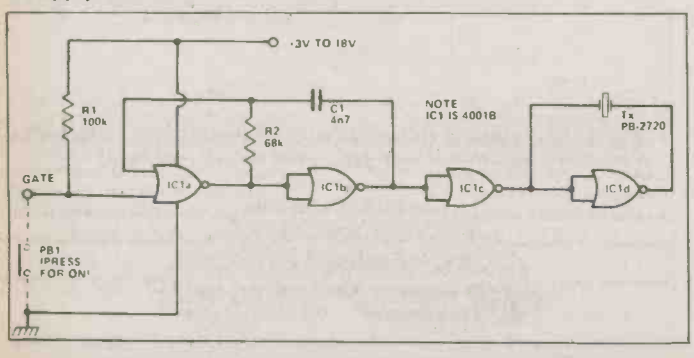


Fig. 4 This version of the basic buzzer circuit uses bridge drive to the PB-2720 and produces an output that is four times louder than the Fig. 3 circuit.

The Fig. 4 circuit is rather more difficult to understand. IC1c and IC1d are series-connected and used to give a 'bridge' drive to the transducer, in which antiphase signals are fed to the two sides of the PB-2720. The consequence of this cunning drive technique is that the load (the PB-2720) actually sees a square wave drive voltage that has a peak-to-peak value equal to twice the supply voltage and thus gives four times more acoustic power than the Fig. 3 circuit. The effective RMS voltage across the load of the Fig. 4 circuit is equal to the supply voltage. Mystified?

Points Of View

The solution to the action of the bridge-driven circuit of Fig. 4 can be understood with the aid of Fig. 5, which shows the waveforms applied to the load from a bridge circuit when it is fed with a 10V peak-to-peak square wave input signal. The important thing to grasp when

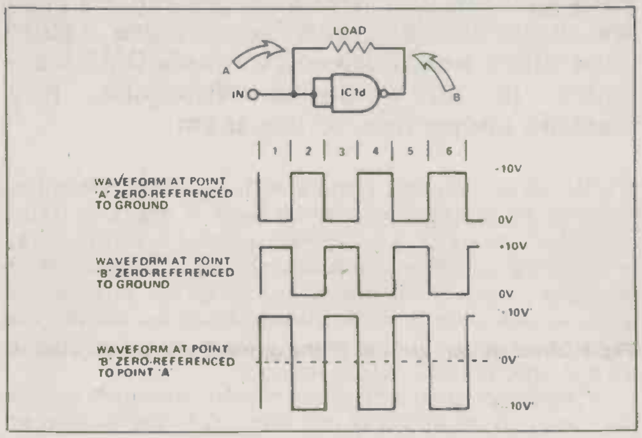


Fig. 5 Waveforms applied to the load from a bridge circuit when it is fed with a 10 V peak-to-peak square wave input signal. Note that the first two waveforms are zero-referenced to ground, but the third waveform is zero-referenced to point A.

looking at this diagram is the basic concept of reference points. You and I are accustomed to thinking in terms of the common or ground line as being the 'zero voltage' reference point. Thus, when we look at point A in Fig. 6 we see a square wave signal that alternates between 0 V and +10 V. Similarly, when we look at point B we again see a 10 V peak-to-peak signal, but in this case it is in antiphase to the A signal (shifted by 180°).

Now the load in the Fig. 5 circuit (irrespective of whether it is a simple resistor or a PB-2720) sees drive voltages purely with reference to one arbitary side of itself. With this concept in mind, let's look at the drive voltage as seen by the load (the third waveform, the true voltage across the load), which assumes that the load is always seeing point A as its 'zero reference' point.

In this case, during period '1' of the drive signal, point B is 10 V positive to point A and is thus seen as being at '+10V'. In period '2', point B is 10V negative to point A, and is thus seen as being at '−10V'. Similarly, through periods '3' to '6' point B is seen as alternating through +10V, −10V, +10V and −10V.

Thus the load in a 10V bridge-driven circuit sees a voltage of 20 V peak-to-peak, or twice the single-ended input voltage. Since doubling the drive voltage results in a doubling of the drive current, and power is equal to the V.I product, the bridge-driven circuit will produce four times more power than the single-ended circuit. If you don't believe it, check it with a 'scope, but don't forget to reference your 'common' terminal to one side of the load.

Sound Practice

Gated CMOS oscillators/drivers can be used in a variety of ways to produce useful alarm sounds from the PB-2720. A few variations are shown in Figs. 6 to 9. If you are not bothered about wave form degradation and need to use the minimum possible number of gates, you can, for example, drive the PB-2720 directly from the output of the CMOS astable, as shown in Fig. 6. Alternatively, if you want the alarm to be gated on by a low (logic 0) input, simply substitute a 4001B for the 4011B, as shown in the bridge-driven circuit of Fig. 7.

Figure 8 shows how you can use a single 4011B to make a pulsed-tone (bleep-bleep) alarm circuit with direct drive to the PB-2720. Here, IC1a-IC1b are wired as a gated 6 Hz astable which is used to gate the IC1c-IC1d 2 kHz astable on and off. The circuit is gated on by a high input; if you want low-input gating, simply swap the 4011B for a 4001B and transpose the positions of PB1 and R1.

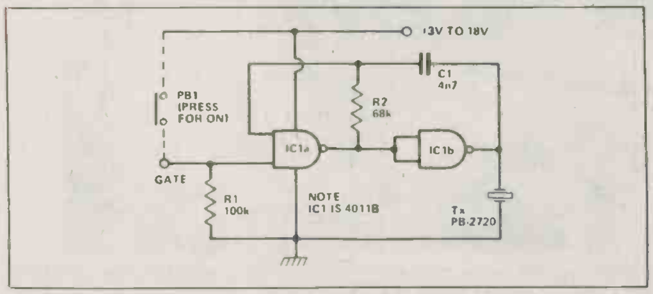


Fig. 6 Direct-output version of the gated 2 kHz buzzer circuit.

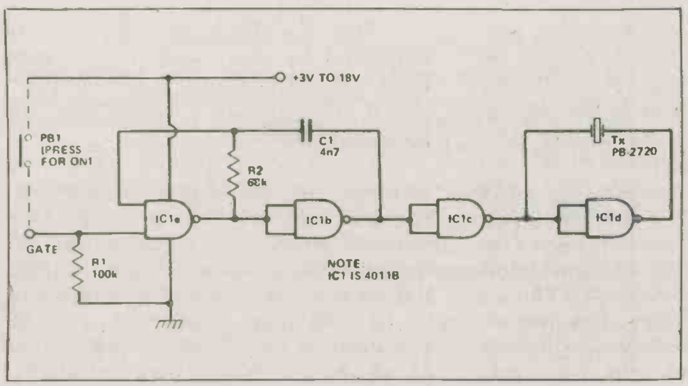


Fig. 7 A continuous-tone 2 kHz buzzer with bridge drive, gated on by a low (logic 0) input.

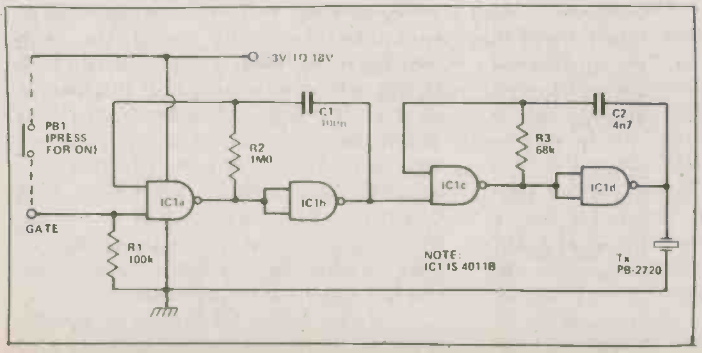


Fig. 8 A gated pulsed-tone alarm, gated by a high input, with direct-drive output.

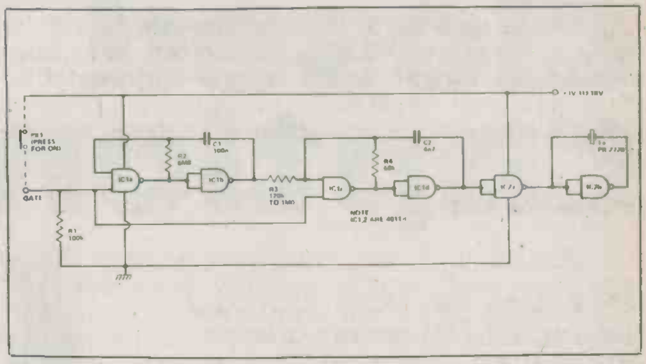


Fig. 9 This gated warble-tone alarm sounds like a police car siren (dee-dah) and has a bridge-driven output.

Figure 9 shows a warble-tone version of the gated alarm. Here, low-frequency astable IC1a-IC1b is used to modulate the frequency of the IC1c-IC1d astable; the depth of frequency modulation depends on the value used for R3.

There are plenty of other gated CMOS generator circuits that can be used to drive the PB-2720. The generators can be gated by a wide variety of sensor circuits, so that the alarms are automatically activated by excesses of light, temperature, voltage or current, and so on; lots of suitable circuits can be found in past issues of ETI.

ETI

Closed Captioning

How does the close captioning facility that we see offered at the start of several TV programmes work? Roger Allan explains.

The heart of real-time closed-captioning is a stenocaptioner who transcribes what he hears into a machine. Here Marty Block of NCI prepares captions for ABC's World News Tonight. Photo B. What you see if you have a converter; they are available from Sears for $369.00.

CLOSED CAPTIONING for the hearing impaired reached the operational phase after more than seven years of development at the PBS in the US, inaugurated as a regular service in the US in March 1980 and on the CBC here in Canada in January 1981.

Closed captioning refers to captions that are encoded in the video signal and cannot be seen on a home receiver unless a decoder is used. The purpose of the 'closed' captioning system is primarily to provide a service for the hearing impaired without distracting the majority of viewers who have normal hearing. The captioning data signal is encoded in the television signal vertical interval of TV Line 21, Field 1. At present, all captioning in English is done by the National Captioning Institute (N.C.I.) either at their Falls Church, Virginia, facility or in Hollywood, California. A French language facility in Montreal (the Canadian Captioning Development Agency) provides the CBC with a few hours of captioned programming each week. An English language captioning centre is expected to be built in Toronto sometime in the spring of 1983.

The process of captioning is relatively straight-forward. At N.C.I., an editor is supplied with a 3/4" video cassette complete with S.M.P.T.E. time code dubbed from the original 2" video master tape of the television program. The captioning editor makes the decision about wording of captions, the timing of when each caption appears and disappears, and also the placement of the captions on the screen. This process is carried out on an editing console in which there is a Sony 3/4" tape machine, disc drives, colour monitor and microprocessor with a "light pen" attachment which is used to arrange the captions on the screen so as to present them in the most readable form and not obscure important picture detail.

The decisions in the editing process are related to the time code on the cassette and stored on floppy discs. The floppy disk is the actual product of the caption editing process. To put the captions on air, an encoder capable of reading time code is required to synchronize the floppy disc data and the 2" master tape. The disk output is encoded on Line 21 and the resulting captioned output can be re-recorded or aired 'live'. The system used by the PBS Closed Captioning System is capable of 'time multiplexing' 4 different signals on Line 21. These are caption Channels #1 and #2 and "text" channels 1 and 2. The caption channels carry the captions for the program being seen, with channel #2 being available for a second language. The text channels are used to provide a full page of information not necessarily related to the television program. The CBC uses the text channel as a "TV Guide" where present and future captioned programs are listed. The home and broadcast plant decoders, known as TeleCaption Adapters and sitting on top of the television set, are capable of decoding any of the 4 modes as well as being able to be switched to bypass for normal viewing.

The TeleCaption decoder is marketed by Sears, as a non-profit item, currently retailing (upon presentation of a doctor's certificate) for $369.00 (Canadian).

The N.C.I. presently caption a total of 40 hours of popular commercial and public television programming each week, in addition to commercials for over 170 advertisers. Further, the service has attempted to expand to include 'live' programs. All US Presidential speeches are captioned as is ABC's *World News Tonight.* More recently, Metrosports, North America's largest independent sports syndicator for television, entered into an agreement with N.C.I. to close caption sports events such as NFL games. Originally, sports captioning began with the 1981 Sugar and Super Bowls. The original service provided basic game statistics, such as down and yards to go, time outs remaining, scoring summaries, penalties and change of possessions. The Metrosports agreement provides for play-by-play descriptions as well as the background information.

At the CBC, Canadian programming such as the *Beachcombers* and *Hangin' In* are sent to the NCI Center in Falls Church where the captioning

Continued on page 78

Kitchen Scales

We now turn our attention to weighty matters. Surely it's time, in these days of digits with everything, that we got rid of the analogue scales readout? You bet it is. Design and development by Rory Holmes.

AT LAST, the electronics enthusiast can make amends for the state of the kitchen table, sinking beneath an ever-growing pile of constructional debris. The ETI Digital Kitchen Scales offer a means of adding a digital readout to an ordinary mechanical pointer type of instrument.

The mechanics of weighing scales are particularly difficult for the DIY approach, requiring a frictionless movement with only one degree of freedom — vertical displacement. We decided to use the ready-built mechanics of a low cost spring movement scale and concentrated on the electronic problem of measuring displacement with high linearity, high resolution, and zero friction!

The resulting design consists of an easily wound inductive displacement transducer and the associated drive electronics on a small PCB, all supplied from a 9 V battery. An analogue voltage proportional to weight is obtained, which is then displayed on a 3½ digit LCD panel meter module. Up to 2 kg can be displayed on the scales, but a zero-offset control allows a given weight to be re-zeroed. This provides the useful facility of weighing and mixing ingredients simultaneously — when preparing cake mixture, for example.

The accuracy and resolution obviously depends a great deal on the initial accuracy of the spring and pivot system used in the scales, but ¼% (5 grams in 2 kilograms) should be easily obtainable.

The inductive transformer we are using is known as a Linear Variable Differential Transformer, or LVDT for short. These are used extensively in industry for just such applications as this project — weighing machines, load cells, machine positioning and so on. The circuit features some

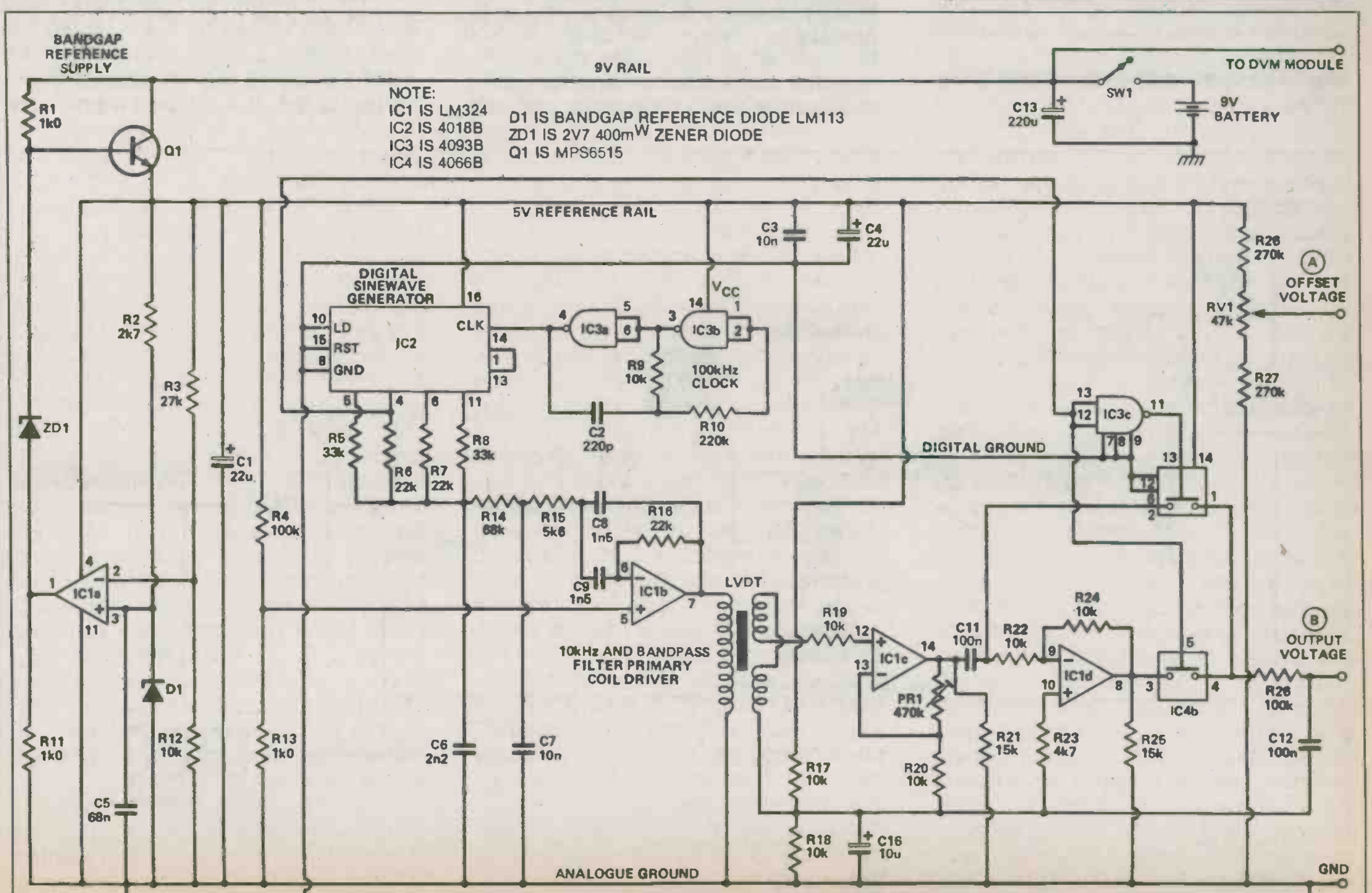


Fig. 1 Circuit diagram of the LVDT and associated circuitry.

novel techniques for allowing an LVDT of few turns to be used; specifically, a phase-lock detection system based on a digital sine wave generator, and a self-stabilising bandgap power supply for precision voltage levels. The block diagrams and boxed-off text give an explanation of the circuit operation and explain how the displacement measurement works.

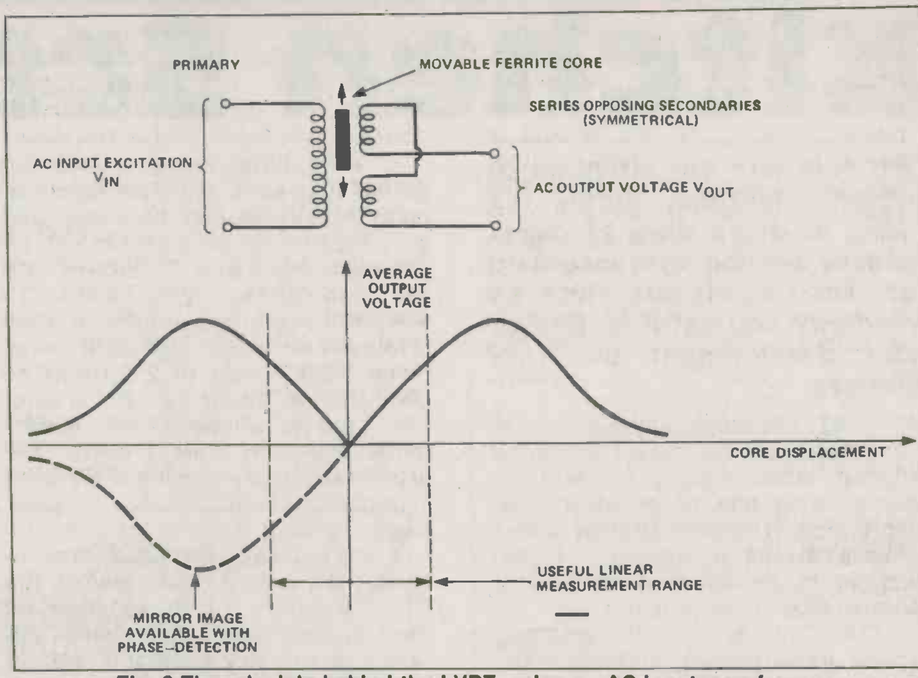


Fig. 2 The principle behind the LVDT, using an AC input waveform.

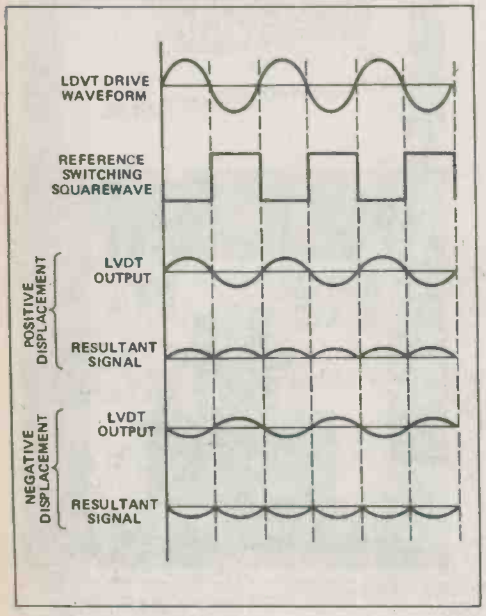


Fig. 3 The output signals generated by the circuit.

Construction

Assemble the PCB in the usual fashion, noting the IC orientation, and the polarity of ZD1 and the tantalum capacitors. Also check the MPS6515 pinouts; these often cause confusion. Twelve Veropins should be inserted at the points marked for external connections. Another point to watch is the hole marked beneath preset PR1; this should be drilled out to 3 mm diameter before mounting the preset, thus allowing its adjustment from either side of the board. Likewise, a 3 mm hole drilled on the other centre allows a secure 4-40 or 6-32 mounting bolt for the board.

When complete, the board may be initially tested by inserting all the ICs into their sockets and connecting a 9V battery to the supply terminals as indicated. If a scope is available,

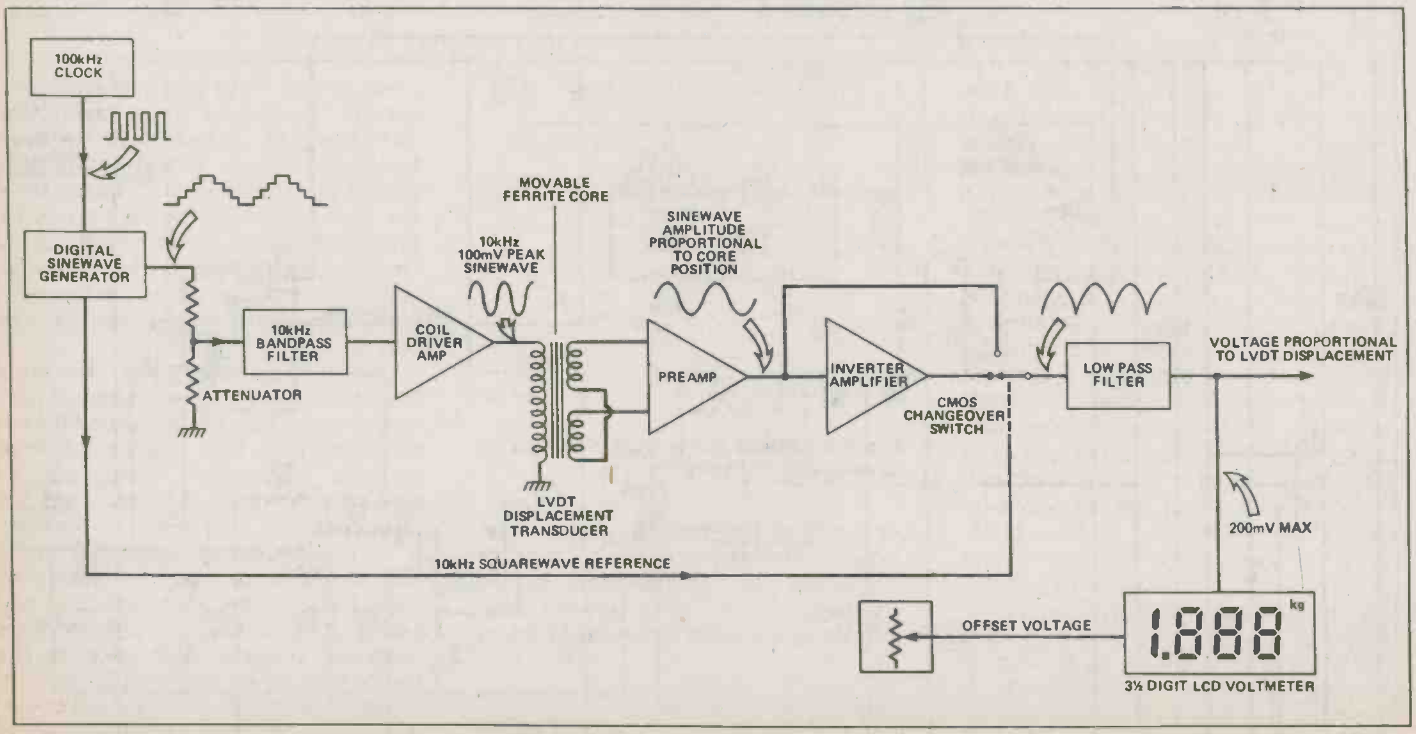


Fig. 4 Block diagram of the Digital Kitchen Scales.

the digital sine wave approximation should be observed at the junction of R14 and C6; it could also be checked with a crystal earpiece, when a high pitched tone of 10 kHz should be heard. The reference supply voltage can be measured with a multi-meter across the wire link and a 0 V terminal. It should be in the region of 5 V if all is well, the exact value being unimportant. At this stage the transducer should be built and wired up before further testing of the PCB.

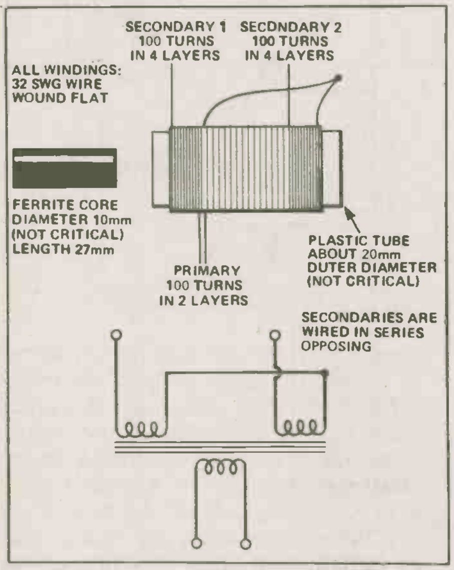


Fig. 5 Coil winding details.

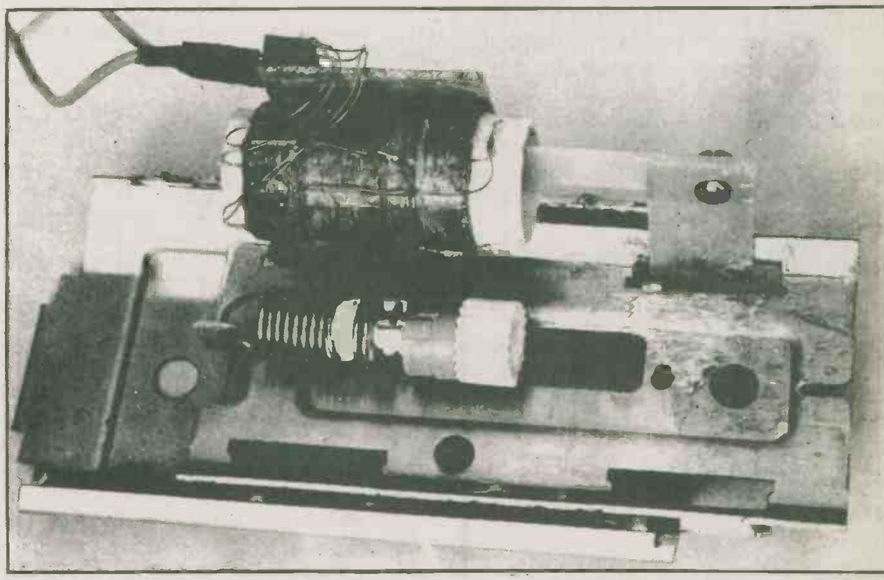
Winding You Up

The LVDT is wound using 32 swg enamelled copper wire on a piece of 20 mm diameter plastic tubing of the type used for electrical conduit, and available from DIY shops. Any similar piece of tubing will suffice since the dimensions are not critical. Figure 6 shows the winding arrangements. Two separate secondaries are wound either side of the central primary winding. All the windings consist of 100 turns wound in the same direction in flat layers; four layers of 25 turns for each secondary, and two layers for the primary. The accuracy and linearity of the LDVT transducer depends upon the two secondaries being as similar as possible and symmetrically positioned about the primary winding. Care should thus be take to ensure the layers are evenly wound and tightly packed. Super-glue may be used to retain each layer as it is wound. After completing the windings and finishing with a liberal coat of glue the two secondaries are then wired in series opposition to form one coil by connecting together the end of each winding.

The LVDT should now be wired up to the PCB using shielded leads as illustrated on the overlay diagram. On our prototype assembly we used a four way 'Molex' PCB plug and socket for this connection since the transducer assembly could then be conveniently plugged in.

Figure 7 shows how the LVDT is mounted to measure displacement. As described last month the mechanics of an ordinary pointer scale are utilised to provide the linear displacement with weight via the inbuilt spring and pivot.

For our prototype we used a small low cost scale which incorporated a ball-race slide mechanism



A typical scale with the LVDT added.

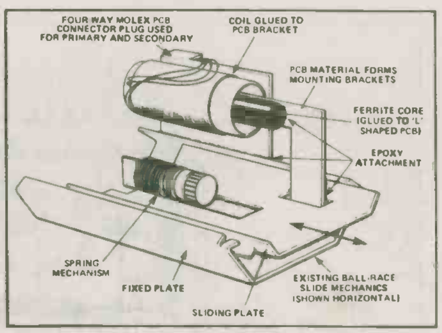


Fig. 6 An artist's impression of the sensor to help with construction.

to support the weighing pan. Practically any type of scales could be converted to a digital readout, provided these is room to mount the LVDT and its associated driver electronics.

Scaling The Heights

Obviously, the more precise the mechanics of the original scale, the greater the degree of accuracy that can finally be achieved with the electronic transducer. The principle is to attach the main coil to a fixed part of the scale while the ferrite core is attached via some rigid element to the weighing pan movement, such that as weight is put on the scale the core moves linearly along its axis into the coil former.

In our prototype the two steel plates of the slide were used to support the transducer as represented in the diagram. Two pieces of PCB material fixed with epoxy act as brackets for the coil former and ferrite core.

The mounting arrangement is not too critical but the following points should be observed. The coil must not be too close to steel or other magnetic material and likewise the ferrite core mounting should be non-magnetic and non-conductive. Remember to allow sufficient leeway on the ferrite mounting for the full displacement (about 1 cm). The ferrite core must be central in the tube, with the axis of both coil and core parallel to the direction of weight displacement. Sufficient rigidity can be achieved using epoxy glue on the transducer, but initially the ferrite core should only be secured to its bracket with tight rubber bands until the calibration procedure.

Having completed the transducer the entire unit can now be tested by wiring up to the LCD meter-module. This module comes as the ICL7106 Evaluation Kit from Intersil distributors, and contains all the components you'll need to make a working DVM with the exception of the PC board and decimal drive circuit. We've included the PCB foil pattern, and the three resistors, capacitor, and transistor for the drive are shown on the schematic of the DVM. Complete the module and connect a flying lead from the drive output to DP1. RV1 is adjusted to give a full-scale reading of 1.999 for a 200 mV input.

PARTS LIST

Resistors (all ¼ W, 5%)

R1,11,13	1k0
R2	2k7
R3	27k
R4,28	100k
R5,8	33k
R6,7,16	22k
R9,12,17,18, 18,20,22,24	10k
R10	220k
R14	68k
R15	5k6
R21,25	1k5
R23	4k7
R26,27	270k

Potentiometers

RV1	47k 10 turn wirewound potentiometer
PR1	470k miniature horizontal preset

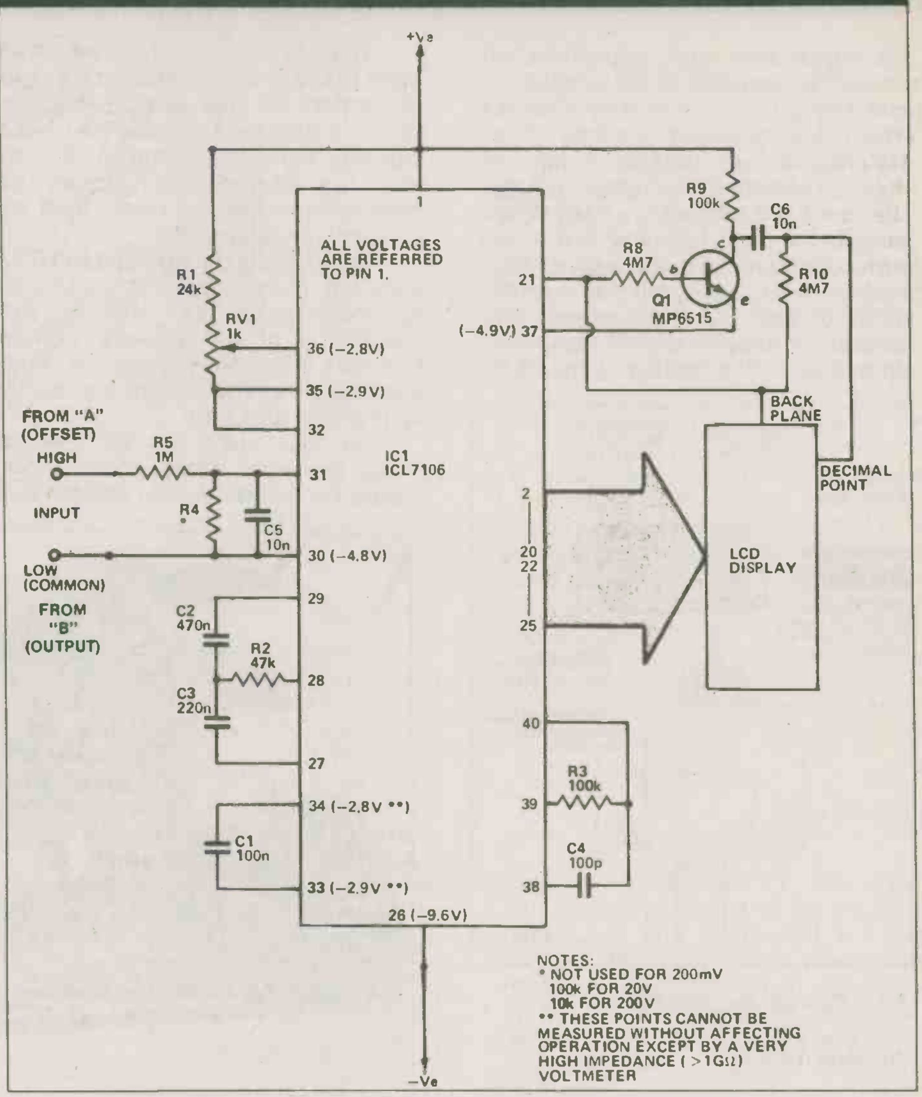
Capacitors

C1,4,10	22u 16V tantalum
C2	220p polystyrene
R3,7	10n ceramic
C5	68n ceramic
C6	2n2 ceramic
C8,9	1n5 polystyrene
C11,12	100n polycarbonate
C13	220u 16V electrolytic

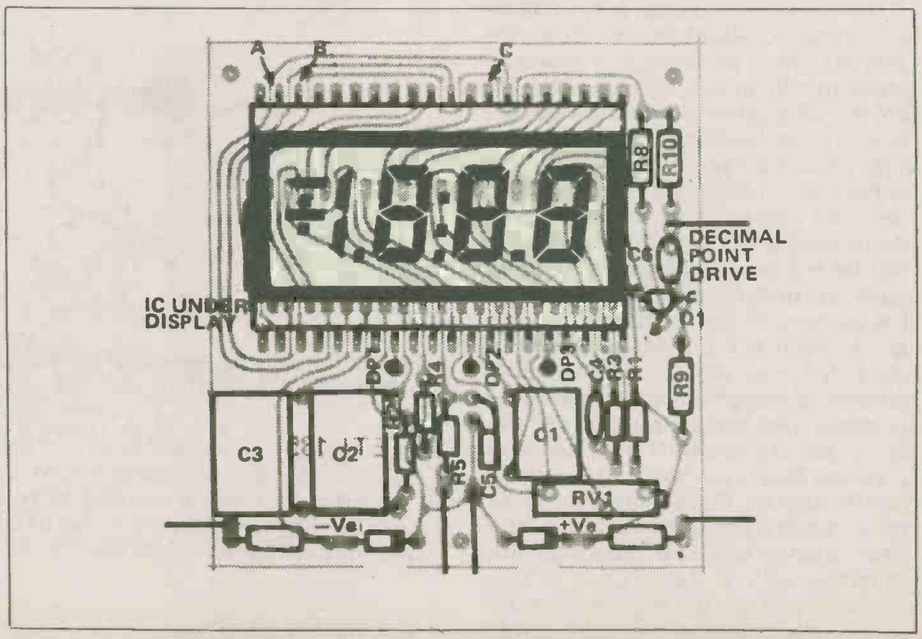
Semiconductors

IC1	LM324
IC2	4018B
IC3	4093B
IC4	4066B
Q1	MPS6515
D1	LM113
ZD1	2V7 400 mW zener diode

3½ digit panel meter evaluation kit, Intersil ICL 7106.



Circuit diagram of the complete panel meter.



Component overlay with the display in place. Points marked A, B, and C are the unused display segments — the vertical part of the +.sign, the arrow, and the semicoln respectively. The IC is under the display with pin 1 at top right.

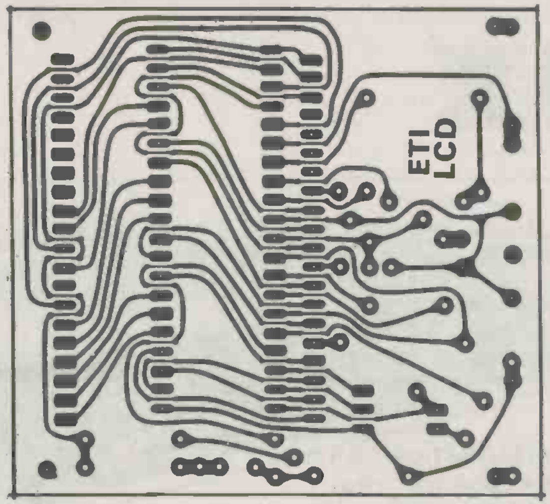
The input voltage at point B should then be connected to the corresponding point on the PCB; point A temporarily connects to the 2V5 reference terminal shown in Fig. 7. After connecting the DVM supply rails to the 9 V terminals on the PCB, power can be switched on. When the ferrite core is near the middle of the coil the meter should be close to 0 V and will indicate + or — readings as the core is moved to either side of the null position. The 100 mV sine wave across the primary coil can be observed on a scope along with the other waveforms illustrated last month. If all is well, the electronics can be assembled inside the scale. Figure 9 shows how we arranged the various components to fit into the existing scale box. The back of the case has now become the front to allow room for the LCD display! The 10 turn potentiometer, RV1, should also be connected up at this stage, along with the on/off switch, so completing the interwiring.

Calibration

Once you are satisfied with your mechanical arrangement for mounting the transducer and associated electronics, the scale should be calibrated using standard or known weights. First, the offset voltage input to the DVM module, marked as 'A' on the wiring diagram, should be temporarily connected to the 2V5 reference terminal shown on the PCB overlay. The preset PR1 should be set at roughly half travel, and the scale loaded up with about 1 kg. After switching on the supply, the ferrite core should be adjusted relative to the coil until it's approximately in the middle at the null output position (this corresponds to half scale deflection). As the null position is approached the DVM will accordingly decrease to zero reading. The ferrite core should now be fixed permanently to its mounting plate using epoxy and allowed to set. When set, the DVM reading must be brought exactly to zero by the addition of small increments of weight, sugar or salt being ideal. The known weight, which can be anywhere between ½ and 1 kg, should be added to the scale pan, and PR1 adjusted until this weight is shown on the LCD display (turning PR1 clockwise increases the reading).

Now remove the weight to check that the reading returns to zero, and adjust PR1 accordingly (a few adjustments to PR1 may be necessary to set the correct reading for the known weight).

Finally, the offset input 'A' can be disconnected from the 2V5 reference and wired to the slider of RV1. Rotating RV1 will alter the reading and the meter can now be easily zeroed for any weight measured, including the empty scale pan. You may now proceed to calibrate the pantry.



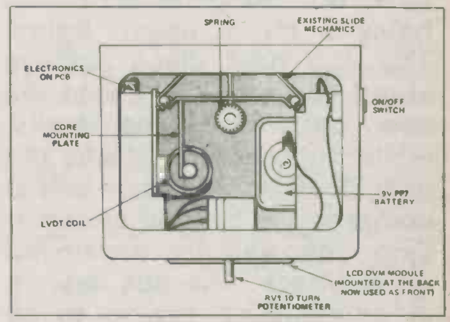


Fig. 8 Artist's impression of the 'view from the top'.

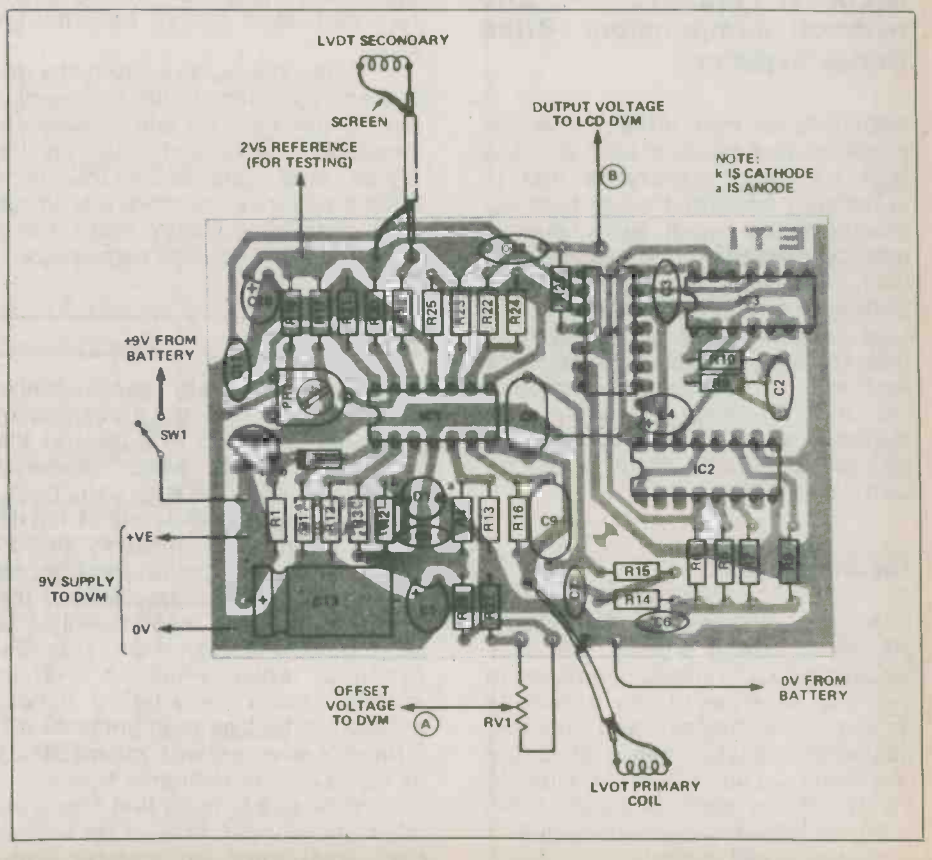


Fig. 7 Component overlay.

Continued on page 76

dbx

Live musical performance can have a dynamic range as great as 90 dB, though 80 dB is probably a more 'usual' figure. The very best discs achieve about 65 to 70 dB, as do the best open reel tape decks, whilst top cassette decks get only 55 dB or so. Hence signal compression is used on recording, followed by expansion on playback. The dbx system of compansion claims to be able to achieve 90 dB, a figure being claimed by digital recorder makers — and without compansion. Brian Dance explains.

PERHAPS the most difficult of all the problems one meets in both disc and tape recording systems is that of preventing unwanted noise from appearing in the output. Such noise is, non-homogeneities in the groove of a disc, while tape hiss arises as each particle of the magnetic material on a tape passes across the replay head gap. the best known noise reduction technique is the Dolby system, but the more recently developed dbx system discussed here operates on different principles. Both have their own advantages.

The dbx system

In equipment using the dbx system, all the incoming signals are compressed by a 2:1 ratio (as measured in dB). For example, if the difference between the loudest and quietest passages to be recorded is 60 dB, the dbx recording circuitry will compress the dynamic range so that there is only 30 dB between the maximum and minimum signal levels.

When the recording is replayed, the circuitry 'restores' the signal to the original 60 dB dynamic range by providing greater amplification for the higher-level signals than for the lower-level signals. Any tape noise will, hopefully, be at a level below that of the smallest signal and will thus be amplified very little. This is illustrated in Figure 1.

In the case of disc recordings, the disc must have been recorded using a dbx compression circuit, in which case it can be replayed with no appreciable playback hiss. Ordinary recorded discs cannot benefit from dbx.

Unlike the Dolby system, the dbx system operates at all frequencies with a compression and subsequent expansion dependent only on the signal level. (Obviously this is a simplification, since there will be certain 'attack' and 'decay' times during which the gain change takes place.)

Dynamic range

A good human ear can perceive sound levels from the threshold of audibility (0 dB) up to a level of the order of 120 dB, which produces severe discomfort or even pain. Occasional transient peak levels of 120 dB occur during live musical performances. However, the background noise level due to movements of the audience, etc, can reach levels of 30 dB (Figure 2) or even more. Thus the dynamic range which a perfect system should be able to handle should not be less than some 80 dB, although some experts regard 90 dB as being a more desirable figure.

When one is recording music on either a magnetic tape or on a disc, the signal must be suitably compressed so that the loudest passages do not overload the equipment and thus cause distortion, yet the quiet passages must be well above the level of the tape hiss or record noise. The maximum dynamic range which can be accommodated on a vinyl recording disc is normally about 55 dB, although 65 dB to 70 dB is said to be obtainable from the very best pressings. Clearly this is well below the desirable dynamic range.

Similarly, the dynamic ranges of professional studio tape recorders are limited to around 60 dB to 70 dB or so for the open reel models, while that of a good cassette recorder may be only about 55 dB (weighted, sans noise reduction figures).

If circuitry is not employed to increase the dynamic range of the recorded signal where necessary, the music as reproduced from the disc or tape sounds uninterestingly flat, and the contrast between the loud and quiet instruments is considerably blurred. Thus the excitement and realism of the performance is largely lost.

The dbx system can compress the signal for the recording process and expand it again so that a dynamic range of the order of 90 dB can be obtained. The noise from the dbx system is claimed to be appreciably below the ambient room noise, as shown in Figure 3.

Comparison with Dolby

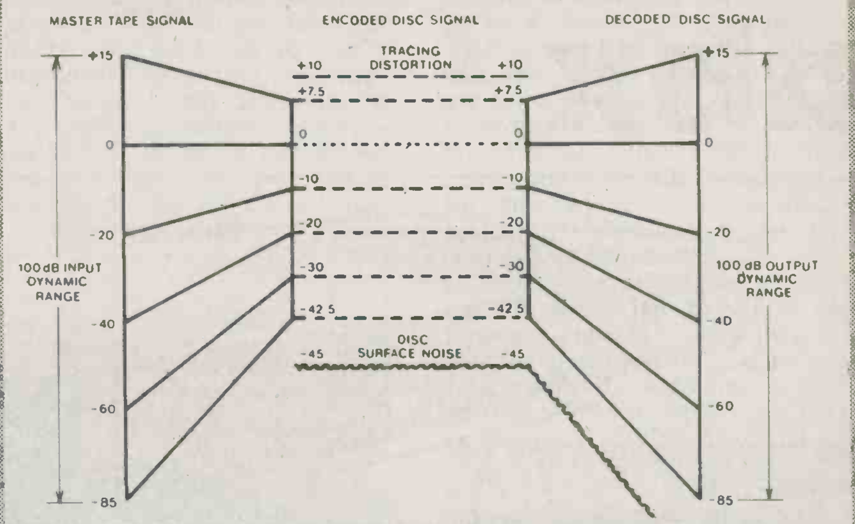
One of the advantages of the dbx system over the various Dolby systems is that the expansion is provided uniformly over the whole frequency range and therefore one does not need to carry out the adjustment procedures which are required for setting up a Dolby circuit. A badly adjusted Dolby circuit can produce an appreciably inferior performance.

Although Dolby does its work well at high frequencies, where the hiss is generally the most obtrusive noise, the dbx equipment will also reduce any low frequency noise such as mains hum or turntable rumble that may be added to the signal by the circuitry.

Figure 3 indicates that the noise reduction obtainable using the dbx tape system is, at least in theory, somewhat better than that provided by a Dolby system. In practice the dynamic range obtainable is greater than that with Dolby B, but it may not be quite so high as the values suggested in the graphs of Figure 3 owing to the need to prevent any possible tape or disc overloading in certain frequency regions.

Any tape recorded for playback through dbx equipment will sound quite peculiar if replayed through a recorder without dbx circuitry; so will any dbx disc. On the other hand a dbx-encoded tape replayed through a Dolby B circuit will provide a reasonable signal if one reduces the treble response somewhat.

Although the number of dbx discs is greatly increasing at the present time, it may be some time before the selection is considered reasonably adequate by most potential users. At present the number of pre-recorded Dolby tapes available is much greater, giving Dolby an advantage there.



Signal compression and expansion during the encoding and decoding stages for dbx discs.

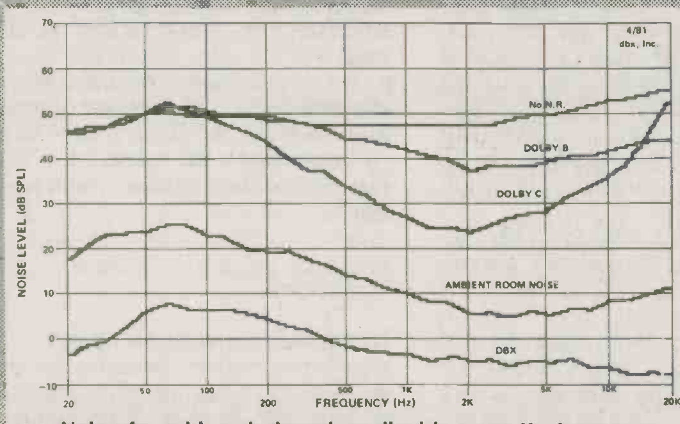
Performance

It is quite uncanny to place the tonearm over a dbx disc and start playing it, since one hears virtually nothing until the first notes of the music are reached! 'Digital' dbx discs provide even quiter backgrounds, since the hiss from the master tape, together with its saturation distortion, wow and flutter, are claimed to be eliminated. However, any digital tape equipment likely to be available in the foreseeable future may be quite expensive, whilst the usual problem of lack of standards in digital equipment is likely to cause considerable difficulties, perhaps for some years to come. Nevertheless, the 90 dB approximate dynamic range of the current dbx discs enables them to achieve a very impressive performance.

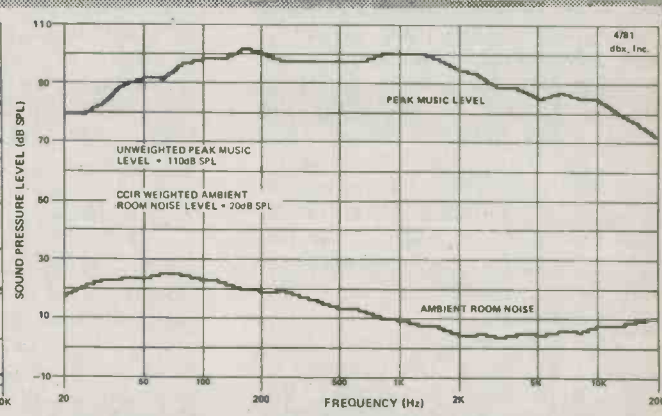
Equipment

For home recording, the series II equipment manufactured by dbx Inc, Chapel St, Newton, Massachusetts 02195, USA, includes a Model 224 (with monitoring facility) and a Model 222 (without a monitoring facility). When used as an addition to one's existing equipment, they claim to provide an 85 dB range on open reel recorders and an 80 dB range even with cassette recorders. This includes a noise reduction of some 30 dB across the entire audio range together with an extra 10 dB 'headroom' at the upper level of the dynamic response.

The peak signal to the weighted background noise ratio is quoted as some 110 dB. The frequency response is quoted flat to within ±0.5 dB over the range 40 Hz to 20 kHz and about −1 dB at 30 Hz. Total harmonic distortion is quoted as being less than 0.5% from 30 Hz to 100 Hz and less that 0.1% from 100 Hz to 20 kHz, while intermodulation distortion is less than 0.2%.



Noise from biased chromium dioxide cassette tape compared with typical ambient room noise. One-third octave analysis. Tape noise level referred to 200 nWb/m = 110 dB SPL.



Peak music and ambient noise levels measured in typical living room environments. One-third octave analysis.

The Model 222 and 224 units incorporate circuitry for the recording and the replaying of tapes and for playback of discs. However, a smaller Model 21 unit is available for the playback of dbx disc. However, a smaller Model 21 unit is available for the playback of dbx discs and of dbx-encoded pre-recorded tapes when the latter become available. The performance of this Model 21 unit, which cannot be used for recording tapes, is fairly similar to that of the 222 and 224 equipment, but the frequency response is quoted as being matched to the decoding curve to within ± 0.5 dB between 30 Hz and 15 kHz, and the total harmonic distortion is given as being less than 0.2% at 1 kHz at up to 4 V RMS output.

The units mentioned are the domestic Series II units, but a Type I series is available for professional use where tape speeds are generally higher; it is not compatible with the Series II units, owing to minor signal processing differences.

When using dbx equipment, one often tends to turn up the volume before the start of the programme simply because one expects to hear some background hiss or noise and may even wonder if the system is working! However, this problem is soon overcome after the equipment has been used for some time. The dbx system can be very demanding on programme material; for example, wideband noise in the presence of high-level programme signals will be considerably amplified, but the programme material will usually mask the noise.

The dbx Model 21 decoder shown with a range of the currently available dbx-encoded discs.

Expanders

The dbx company also produces a range of volume expanding equipment. Most records, tapes and radio programmes have their dynamic range compressed somewhat, and the expanders have been designed with the object of restoring the original wider dynamic range. They can be set to provide any dynamic range expansion from 1:1 (no expansion) up to 1:1.5 measured on the dB scale; the latter is usually far too great and 1:1.2 to 1:1.3 is normally as much as is needed for any programme material.

There are currently three of these expanders available. The simplest is the 1BX, which treats the whole of the audio frequency band together. The next unit in the range is the 2BX, in which the bass and treble are treated separately by splitting the audio frequency band into two parts. The most expensive unit is the 3BX, in which the audio frequencies are divided into three parts, each of which is separately processed. The advantage of splitting the frequencies for separate processing is that a high-level signal in one part of the frequency band will not cause a lower-level signal in another part of the band to be affected.

By making loud passages louder relative to quiet passages, it is claimed that these expanders restore much of the realism of recorded or broadcast music and make it more like what one hears in a live performance. In each unit the frequency response is claimed to be flat to within ± 0.5 dB from 20 Hz to 20 kHz at the 1:1 setting, total harmonic distortion typically 0.1% under the same conditions and intermodulation distortion 0.15% typical.

A further unit, the dbx 118, provides continuously variable expansion from 1:1 to 1:2 and continuously variable compression from 1:1 to infinity. The compression mode is said to be useful when making tapes for playback in moving vehicles, where the ambient noise may be too high for the quieter passages to be heard without volume compression. A peak limiter is also incorporated in the unit.

Equaliser

The dbx 20/20 unit combines a microprocessor-controlled ten-band graphic equaliser, real-time analyser, pink noise generator, sound pressure level meter, and includes a calibrated microphone; it is designed to automatically adjust for the effects of furniture, drapings and other factors which alter the acoustics of the listening room. When the microphone is placed in the desired position of listening, the precise equalisation characteristic is computed within 15 seconds. This characteristic can then be stored for later use at the touch of a memory button. The best average characteristic can also be computer for a number of listening positions.

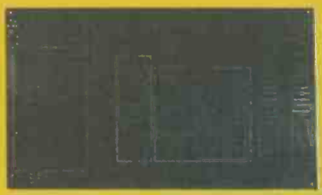
Bargraph LED readouts are provided on all ten bands in this instrument.

Conclusion

The dbx eqipment can certainly provide some rather amazing dynamic range expansion and noise reducing effects, but like all such equipment, it must be used intelligently.

ETI

6502 MOTHER BOARD(BARE)



This beautifully made G-10 epoxy PCB runs the ever popular 6502 CPU. Fully and clearly screened to give the precise identification and location of all parts from resistors to the CPU This board will operate with software in these formats
(a) 6-2716's (b) 3-2732's
(c) 6-Masked ROM's (d) 3-2532's
giving you the maximum latitude possible. Upper and lower case character set is available and 3 separate prototype areas are on the board. Each board is pretested for shorts and opens and it has both color trim and crystal trim variable capacitors. (never buy a board without both of these) This board will run all 6502 software, fully compatible with Apple™ products and other peripheral boards.
6502 BOARD $60.00

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(a) Tin IC sockets, 8,14,16,20,24,40 ... $13.00
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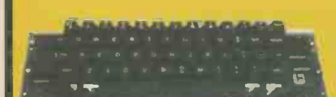
(c) ½-½ IC Skts, gold, 40,24 rest tin .. $18.00
(d) Edge connectors, set of 8 .... $25.00
(e) Resistors, all the ¼W resistors $1.00
(f) SIP resistors, 3-0.1w 1Kx9 .... $2.00
(g) Capacitors all the .1 + others $7.00
(h) Transistors & diodes $2.00
(i) Crystal, trimcaps, trimpot, RCA jack audio jacks, header pins, coil $6.00
(j) All TTL parts $34.95
(k) All linear parts $4.00
(l) 6502 CPU $7.00
(m) RAMS 24 4116's $36.00
(n) 2716's 6 pcs $27.00
(o) 2716 character gen programmed .. $8.00
(p) 2732's 3 pcs $25.00
(q) Complete kit, no IC's $57.00
(r) Complete kit, all IC's $160.00
(s) Complete kit, all IC's, gold $170.00
(t) Wired and tested motherboard with all parts, including blank 2732's .. $395.00
(u) Wired motherboard, with all IC's packed separately ready to stuff . $300.00
(v) Wired motherboard, no IC's $189.95

MODULATOR
Those of you who have no monitor can use the following modulator to interface to a std TV set. High quality unit good for all uses, has integral filter for top grade colour reception $29.95

ASCII KEYBOARDS



Some of you will get your PC boards running with surplus keyboards but some will not and if you want the 'original' look try one of these two keyboards. Both are ASCII and can implement all the 'original' keyboard functions.
(a) Light brown, suitable for our beige enclosure. With header cable ... $130.00
(b) Light grey, suitable for our ivory enclosure. With header cable ... $130.00

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16 Pin header $2.00	14.318Mhz xtal $3.00
50Pf trimcap $0.75	17.430Mhz xtal $5.00
250-ohm trimpot $0.50	27Uh coil $0.75
RCA Jack $0.75	Audio jack $0.75
Header pins (10)..... $0.35	Header (5 pin)...... $0.50
1K by 8 SIP $0.75	Power, male $0.75
1K by 9 SIP $0.75	Power, female $0.75
1K by 7 SIP $0.75	Speaker, 3", 8ohm ... $1.50
10K by 9 SIP $0.75	Ribbon cable 8' $3.00

DISC DRIVES

(a) Siemens full height 5¼" drive, fully enclosed with cable ready to plug in to your Apple™ or similar computer. Fully software compatible, Apple is now using Siemens drives instead of Shugart for that good old German precision. 6 month warranty
.... $369.00
with controller $468.00
(b) SA-200 style ½" height low profile 5¼" disc drive fully enclosed with cable ready to plug in, etc. 6 month warranty. Saves a lot of space $369.00
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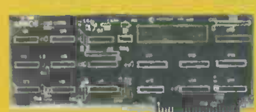
(c) Bare SA400L DISK DRIVE all set for you to modify with an analog board to make into your own system $259.00
Analog card, bare $12.00
Analog card, stuffed $35.00
Case for SA400L $16.00
Cable for SA400L $9.00
(d) Bare SA390L DISK DRIVE. Mechanism only, no PCB on back a lot easier to modify. Comes with speed controller on board.
.... $219.00
Analog Card bare $20.00
Analog Card Stuffed $70.00

PERIPHERAL BOARDS



A variety of printed circuit boards that allow you to add various capabilities to your 6502 board. All the bare boards are $15.00 each, alone or in quantity. The wired and tested peripheral boards vary in price with their capability.
(a) Z-80 A very popular board that allows for the use of CPM™ and Z-80 programs on the 6502 PCB. Wired and tested $129.00
(b) 80 Character. Another popular board that displays 80 characters of text on a normal screen. Wired and tested $139.00
(c) 16K, or language, allows an extra 16K of memory to be used and avoids the need for a ROM card on disc based systems, one of the most popular. Wired and tested ... $79.00
(d) Floppy disc controller. A must if you want a disc drive. You must buy a DOS to run with the card. Wired & tested $99.00
(e) ROM card, when populated with a few 2716's can hold another language. Does not come with a language. Useful until you get a disc. Wired & tested $69.00
(f) RS-232 Another very useful card that lets you communicate with printers ect using serial data flow. Has RS-232 serial capability. Wired & tested $99.00
(g) Printer card allows you to talk to parallel printers, such as the very popular EPSON. Wired & tested $99.00
(h) Prototype. A card that does nothing but lets you wire wrap any kind of circuit you can imagine. All holes no annoying power busses to eat up all the space. Bare Board only $15.00

REMEMBER ANY BARE BOARD IS ONLY $15.00

ABS CASES

$79.00

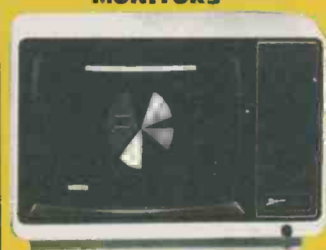
For those who wish to copy the 'original' as closely as possible we have the following enclosures, both fit the PCB's, power supplies, and keyboards exactly.
(a) Beige case, ABS, all hardware, close colour match to the real thing .
(b) Ivory case, ABS, all hardware, to many a nicer colour for the home .

GREAT DEAL

Want a great deal? Want a winner? Well here's one for you. We made a big buy on the power supplies (Black Beauty), ABS cases, ASCII keyboards and the famous Parts Galore 6502 bare board and we now offer this special deal. All four of the above for only $299.00

This special price is only for purchasers of all four items at one time. We have lots of stock and can ship right away.

MONITORS



(a) Zenith 12" green phosphor, with 40/80 column switch, ideal for the Apple™ or similar video output systems $165.00
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0.2, 2.0, 20.0, 200.0, 1000.0
Voltage, AC
0.2, 2.0, 20.0, 200.0, 750.0
Current, DC
200ua, 2ma, 20ma, 200ma, 2000ma, 10A
Current AC
200ua, 2ma, 20ma, 200ma, 2000ma, 10A
RESISTANCE
200, 2K, 20K, 200K, 2000K, 20M Ohms
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EXTRA FEATURES

● Diode test circuit ● Lo voltage ohms, 0.5v ● Lo battery indicator ● Auto-Zero ● Auto polarity ● Overload protection, all ranges ● ABS case (will not crack) ● One hand push buttons.

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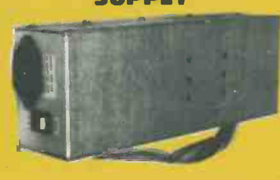

We only stock one power supply, the best and highest power of all. We found out that almost everyone wanted high power and not the weak effort that the original company puts out. So we found the one that had the best construction internally as well as the best output. Our "Black Beauty" puts out 5 amps at 5V, 2½ amps at 12V and ½ an amp at −5 and −12. We went one step further and obtained Ontario Hydro inspection for them so that you know they are OK.
"BLACK BEAUTY POWER SUPPLY" $115.00

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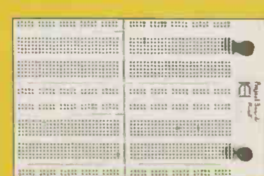

KH-408 (as pictured) $38.00
KH-204 ½ the size of KH-408 .... $20.00

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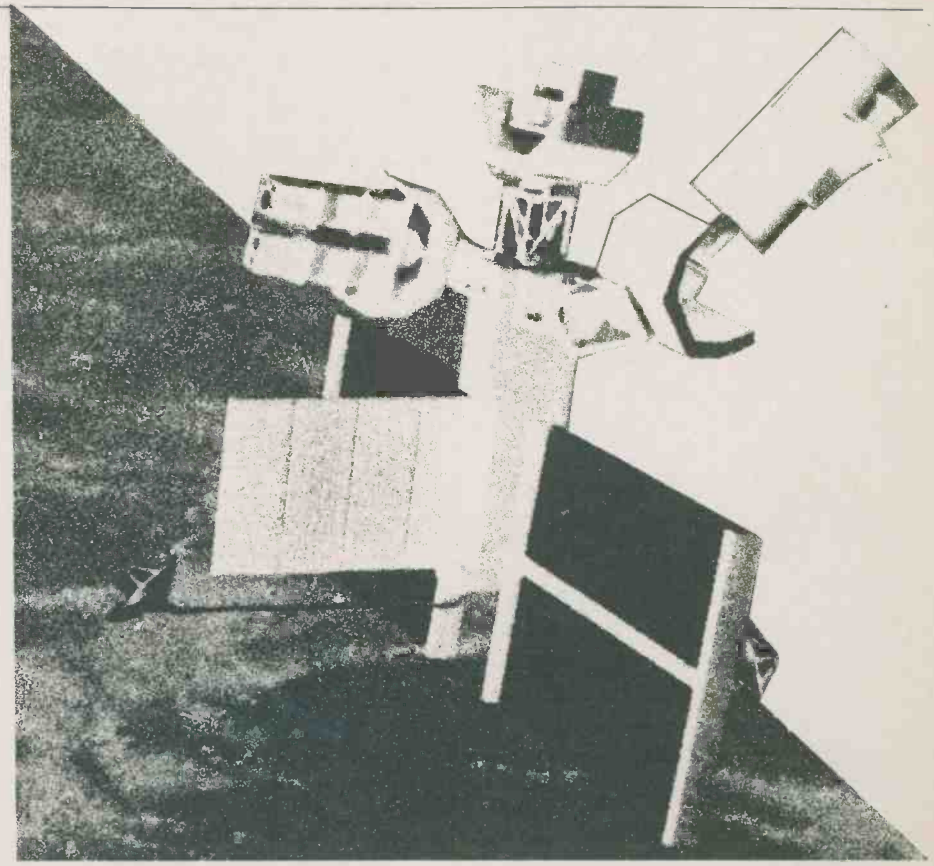
Starlab

The Starlab project is likely to be the most exciting thing to happen to space science until well into the next century. It promises to revolutionise our knowledge of the universe, while at the same time assuring Canadian astronomers a place in the front rank of world astronomy — providing the funds are made available.



ASTRONOMERS have been dreaming about telescopes above the atmosphere since the dawn of the space age. Free of weather and turbulence, space telescopes promise to allow observations of phenomenal accuracy and clarity. They open up the possibility of observing objects far too faint to be seen from the ground, and of observing those objects that broadcast most of their energy in the ultraviolet and X-ray portions of the electromagnetic spectrum. This part of the spectrum is invisible to us at the surface of the Earth because the atmosphere is opaque to the entire electromagnetic spectrum, except for 'windows' in the optical, infrared and radio portions of it.

The invisibility of ultraviolet sources has only recently become a problem in astronomy. The vast majority of stars broadcast at wavelengths near that of the Sun, and astronomers have had enough to do understanding these 'normal' stars. Increasingly, however, it is the atypical stars — stars of incredible densities, temperatures and turbulence, that interest astronomers. This is the realm of quasars, pulsars, neutron stars, and all the other exotica of modern astronomy. Substantially, this is an ultraviolet universe, since fundamental physical laws dictate that as temperature increases, so wavelength shortens.

Tantalising glimpses

To date, astronomers have had tantalisingly brief glimpses of this high-energy universe. The British and Americans have fitted small ultraviolet telescopes to a number of satellites, and for several years sounding rockets have been carrying experiments above the atmosphere for brief exposure to the space environment. But the equipment available has been miserable compared to that available at a proper ground observatory.

With the advent of the Space Shuttle, the constraints that have hampered space astronomy have disappeared, or at least been alleviated. NASA's space telescope is due to fly in the shuttle next year, and it will revolutionise astronomy. It is designed to take full advantage of the space environment: no clouds, no atmospheric distortion and no scattered light.

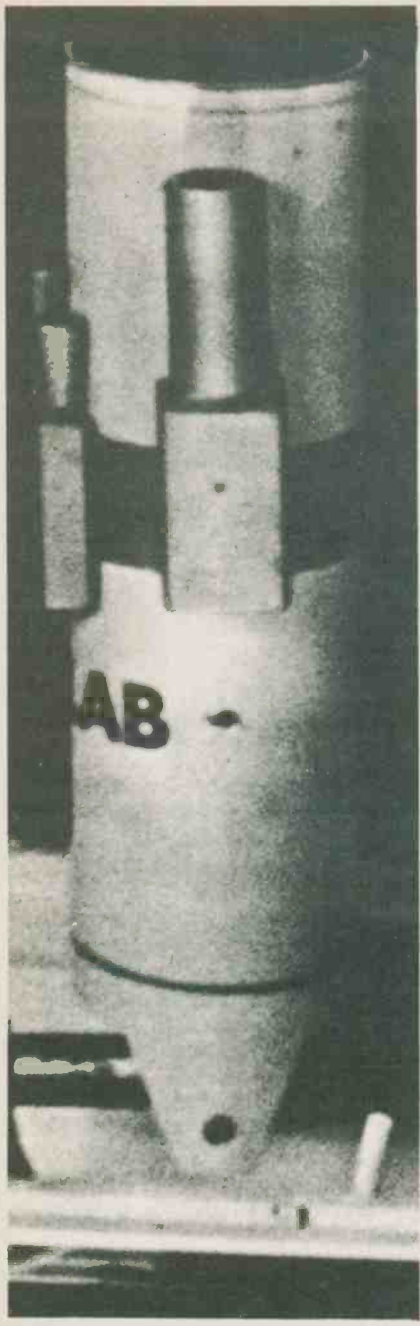
The problem with the space telescope is that it will have no power at ultraviolet wavelengths. Since ultraviolet photography requires its own special techniques, NASA had proposed to supplement the space telescope with a purpose-built UV telescope. That was in the good old days when the agency was awash with funds; when the money dried up, the UV telescope died, along with many other imaginative projects.

A golden opportunity

In 1979, Australian astronomers realised that a golden opportunity was lying around NASA's back door. The proposition was simple: if NASA could provide space in the shuttle, Australia would build the telescope.

By 1980 the specifications for the basic design were completed. The project had grown to include Canada, a highly sophisticated one-metre telescope and a very state-of-the-art device called a Photon Counting Array (PCA).

During 1981, NASA and the Canadians managed to obtain funds for their parts in the project. Astronomers at the Australian National University, however, were still trying to convince the Federal government that funds should be set aside for the construction of the Australian part of the project, the PCA. Plans at the moment call for all the research and development work to be completed by 1984. Building should commence soon afterwards and, if all goes well, the world's first large



Model mock-up of the Starlab telescope.

ultraviolet satellite will lift off from Cape Canaveral some time in 1989.

Although the physics of Starlab is well understood, building it will still be a complex operation. Much of the design will stretch the state of the art to the limits.

Design

Ultraviolet light imposes special constraints on the design of a telescope. Because of the very short wavelength it is difficult to reflect ultraviolet waves, and impossible to refract them using conventional quartz lenses. As a result, the optics of Starlab will consist entirely of mirrors made of lithium or magnesium fluoride. These materials can be made extremely smooth, far more so than the surfaces of conventional mirrors. This smoothness is neccessary, since reflecting surfaces must be machined and positioned with tolerances that are small compared to the wavelength of the incident radiation. Since Starlab is designed to operate with wavelengths just 900nm long, its mirrors will have to be smooth indeed!

This requirement of miniscule dimensional errors in the optics affects every facet of the telescope's construction. It must be light enough from space use, yet rigid enough to withstand the rigours of launch. It must not expand or contract with changes in temperature as it moves from unshielded sunlight to frozen darkness, as it will do on every orbit. Finally, it must be insensitive to the layer of micrometeoroid dust that covers all exposed surfaces in space.

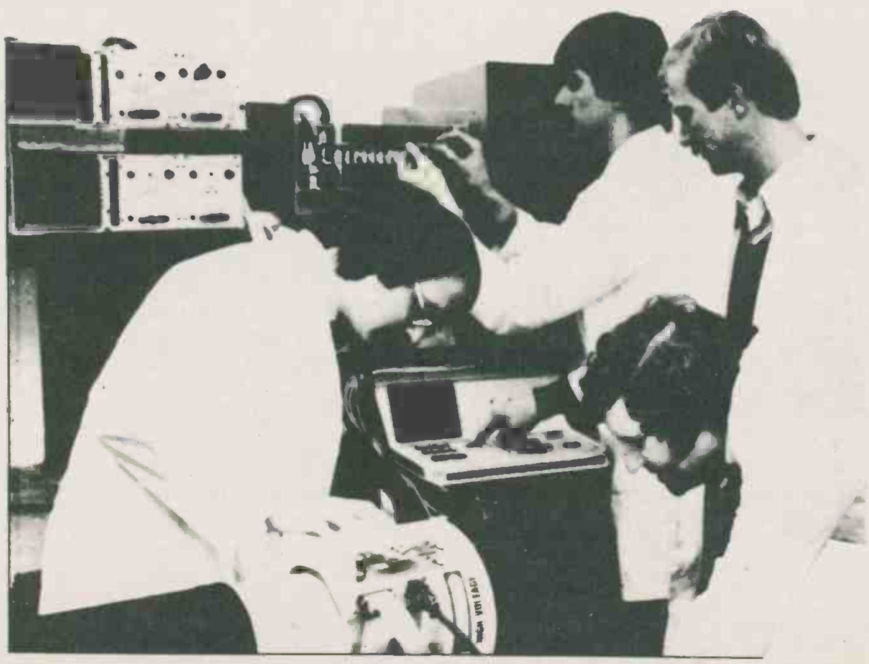
To be of any practical benefit, when a ray of light has passed through the telescope's optics, the information it contains must be presented to the waiting astronomer. Conventionally, this is done by an eyepiece or a photographic plate. On Starlab, the job is performed by the photon counting array (PCA). It turns an incoming ray of light into an electronic event that can be communicated to Earth.

The first step in this process is to amplify the light. This is done in an image intensifier, which essentially consists of a plate covered with myriad holes 10 um across. Single photons of untraviolet wavelength are admitted by these holes. A potential difference applied across the plate accelerates the photo onto a phosphor screen, causing a cascade of photons to fly off the other side. The process is effective enough to ensure that every incoming photon causes a million to be ejected from the screen.

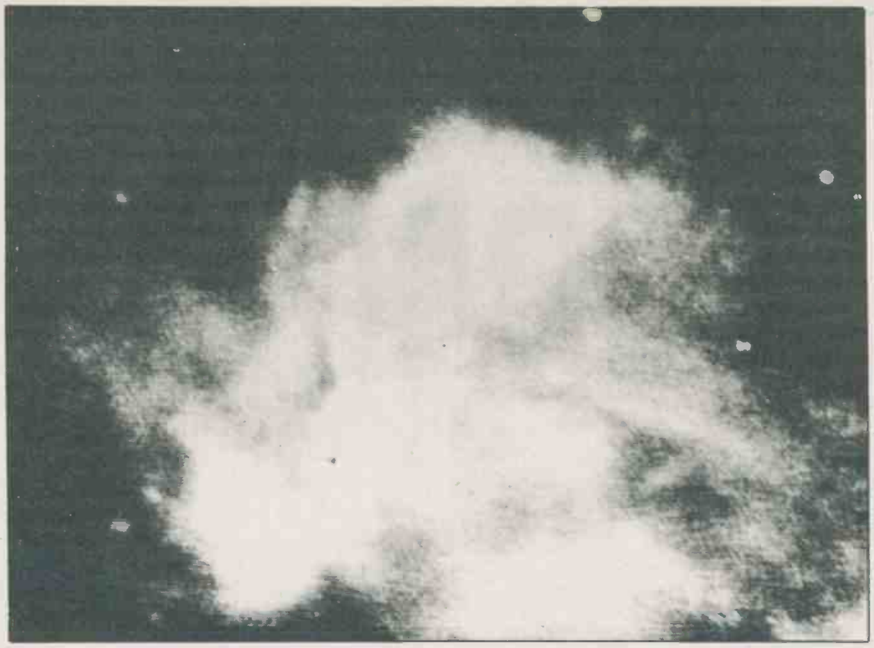
This photon cascade is now ducted down fibre optics to an array of charged couple devices (CCD). A CCD is a device that will emit electrons when struck by photons. The current from the CCDs activates an on-board memory, which stores the information until directed to transmit it by a groundstation.

As with an audio amplifier, the main criterion by which a light amplifier is judged is its level of distortion. In the case of a light amp, however, what is at stake is not the shape of an input curve, but the position of input photons. The correct term for this is 'resolution'. It is defined in angular measure as the ability of an imaging system (telescope, PCA) to differentiate between two point sources (stars) very close together.

In Starlab's PCA, the stage of maximum distortion is the phosphor screen. We may expect that a single highly energetic photon will hit the screen in precisely the same relative position as it entered the system. However, the cascade that this impact causes will be widespread, and



Electronics engineers at the Mount Stromlo Observatory (Canberra, ACT) testing the prototype of the large-format photon-counting array.



N66, a nebulosity in the Small Magellanic Cloud, taken with the photon-counting array on the 1 m telescope at Siding Spring Observatory (near Coonabarabran, NSW).

may be expected to illuminate a number of CCDs.

The solution is to statistically examine the distribution of the photon cascade across the CCDs. This has proved extremely effective experimentally, since the cascade is distributed symmetrically about the point of impact of the original photon. Using a statistical system like this, it is possible to make extremely fine distinctions in the visual field with only 43 CCDs.

The engineers and astronomers who are now designing the PCA for Starlab believe they will be able to achieve greater resolution with their device than will be achieved in the telescope optics. They already have a two-dimensional PCA working at Siding Springs Observatory so their optimism has some foundation, but the space environment places special strains on any electronic system.

For a start, Starlab's orbit will take it through the Van Allen radiation belts, where ionised particles in the Earth's magnetic field provide a constant radiation background to all the electronic events on board Starlab. Even when not in the Van Allen belts themselves, Starlab must still be immune to the output of the Sun and other cosmic ray sources.

Another problem will be heating. In a vacuum, with no convection to remove waste heat, all the components have to either radiate or conduct. Thus a great deal of attention has to be paid to the adequate heatsinking of every component on board.

Perhaps the most serious problem of all is that the space platform will only have 12 kW of power available to drive all Starlab's instruments. Since this includes a 50 megabyte memory, it is very possible that Starlab will demand large-scale integration of much of its circuitry. this would reduce both power and heating problems.

What to look at?

So, what will Starlab see? Plans at the moment call for an extensive study of Cepheid variables — a type of star that varies in size and brightness in a well-understood manner. They can be used as distance markers, and because they can be resolved as discrete stars in galaxies some considerable distance away, a study of Cepheids will give astronomers a valuable new aid to measuring the distances of galaxies.

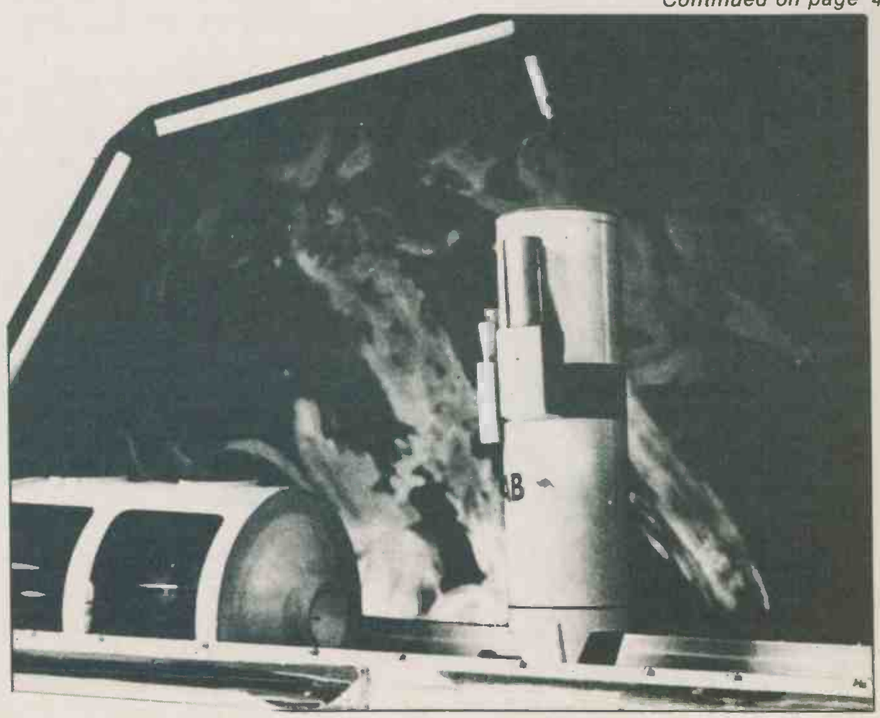
Supernovae, exploding stars, will be another target. It seems to be one possible fate of very massive stars that at a certain time in their lives, when all their atomic fuel has been used up, they undergo a massive explosion. Such is the violence of this event that fully 90% of the mass of the star may be blown away. At maximum intensity, it is not unusual for a supernova to outshine the rest of its galaxy, i.e: for one star to outshine 10^{11} stars, albeit for only a few days.

But not only the drama of a supernova explosion appeals to astronomers. They believe the cores of supernovae are the birthplace of all the metals heavier than iron. In this maelstrom of heat and energy atoms of successively greater atomic mass undergo atomic fusion, building elements all the way to uranium and beyond. Studying this process in the ultraviolet may be very instructive.

Black holes

Closely allied to the supernovae are black holes. Some researchers hold that a very massive star, for reasons

Continued on page 40



Mock-up model of Starlab being lifted out of the instrument bay of the Space Shuttle.

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- The Apple 'clone' industry update
- Introduction to word processing
- A play with Prestel
- Survey of printers
- Peripherals for CBM micros
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- Micro BBS for the Vic-20
- Z80 assembler programming
- Spread-sheet programs (such as VisiCalc)
- Computers in medicine
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- The true capacities of systems
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- Disk hardware
- Advanced capacities of BASIC
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(The features mentioned here are planned for the first few issues; circumstances may result in changes).

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Continued from page 37
not clearly understood, may either blow itself up in a supernova or collapse into a black hole. Others hold that it does both, that the outer parts of the star explode, while its core implodes until it reaches so small a size and so high a density that light cannot escape. Whatever, for a long time part of the mystery of these singular objects was that they were, by definition, impossible to see. More recent work, however, has shown that black holes might be quite bright in the ultraviolet.

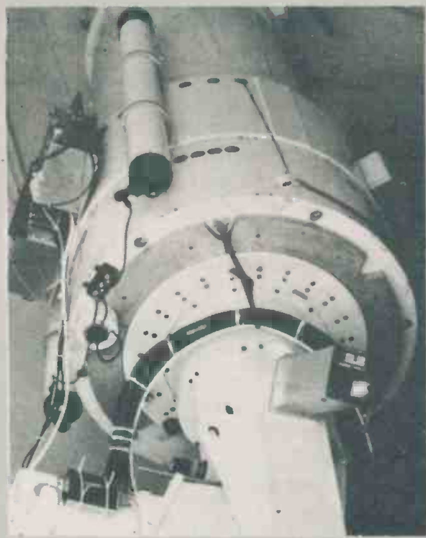
It is argued that if any gas or dust was in the vicinity of a black hole it would be sucked into the hole. In doing so it would be accelerated to near the speed of light, which would cause the dust to radiate strongly in the ultraviolet. Early X-ray and ultraviolet satellites have already picked up one likely candidate: the source Cygnus X-I consists of a bright, massive star, and a dark, equally massive companion.

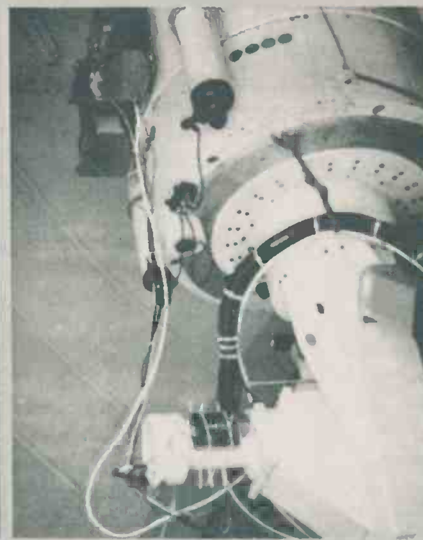
The idea that black holes are not quite so black is fuelled by current models of those enigmatic markers of deep space, the quasars. These hold that a quasar is simply a galaxy too big or too dense for its own good! The galaxy has formed a black hole at its centre and is now swallowing entire stars, releasing prodigious amounts of energy as it does so. Once again, Starlab should be able to test these theories by viewing the UV liberated close to the black hole.

Other work

Although not as dramatic, other aspects of the work planned for Starlab are potentially as rewarding. Starlab will make sky surveys down to very faint magnitudes with unparalleled accuracy. It will study clouds of interstellar dust and gas that flow brightly in the UV, but are invisible visually. It will be used to study the planets, and astronomers hope that the new view of these familiar objects will answer some of the oldest questions.

But perhaps the most interesting work will be the testing of various cosmological models. Modern cosmology takes Einstein's theories as its starting point, and fortunately it can be demonstrated that there are only a few alternative models of the universe that fit the master's theorems. Broadly speaking, the universe must either have started in a big bang and be expanding into eternity, or it must be oscillating from extreme density to extreme rarity, and back again. Continued on page 78

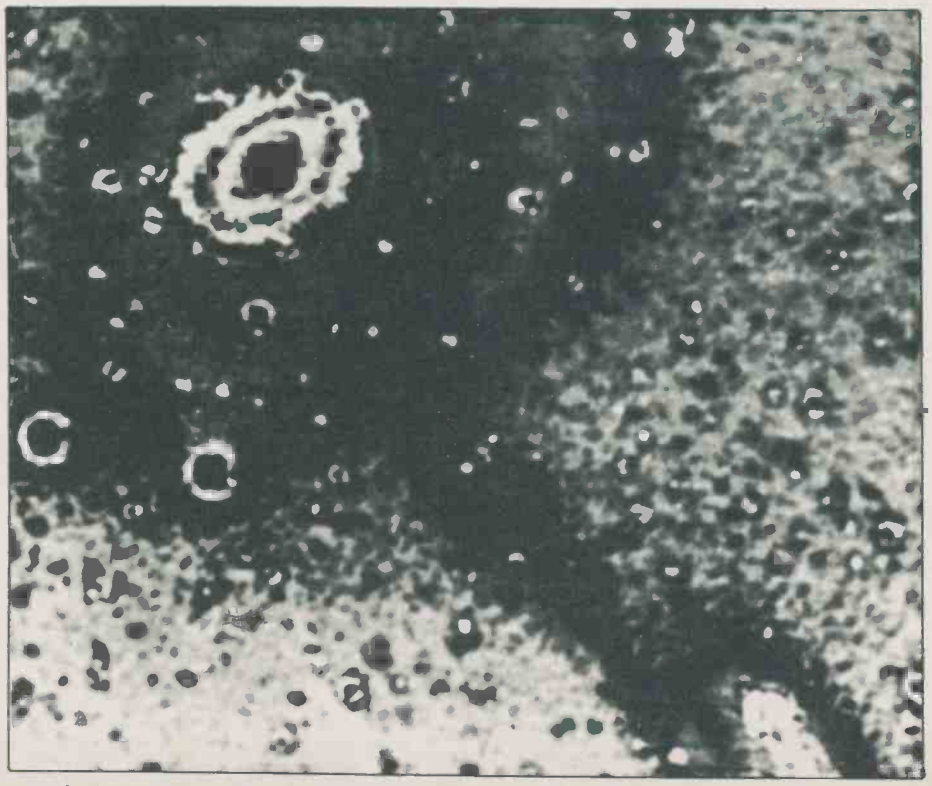




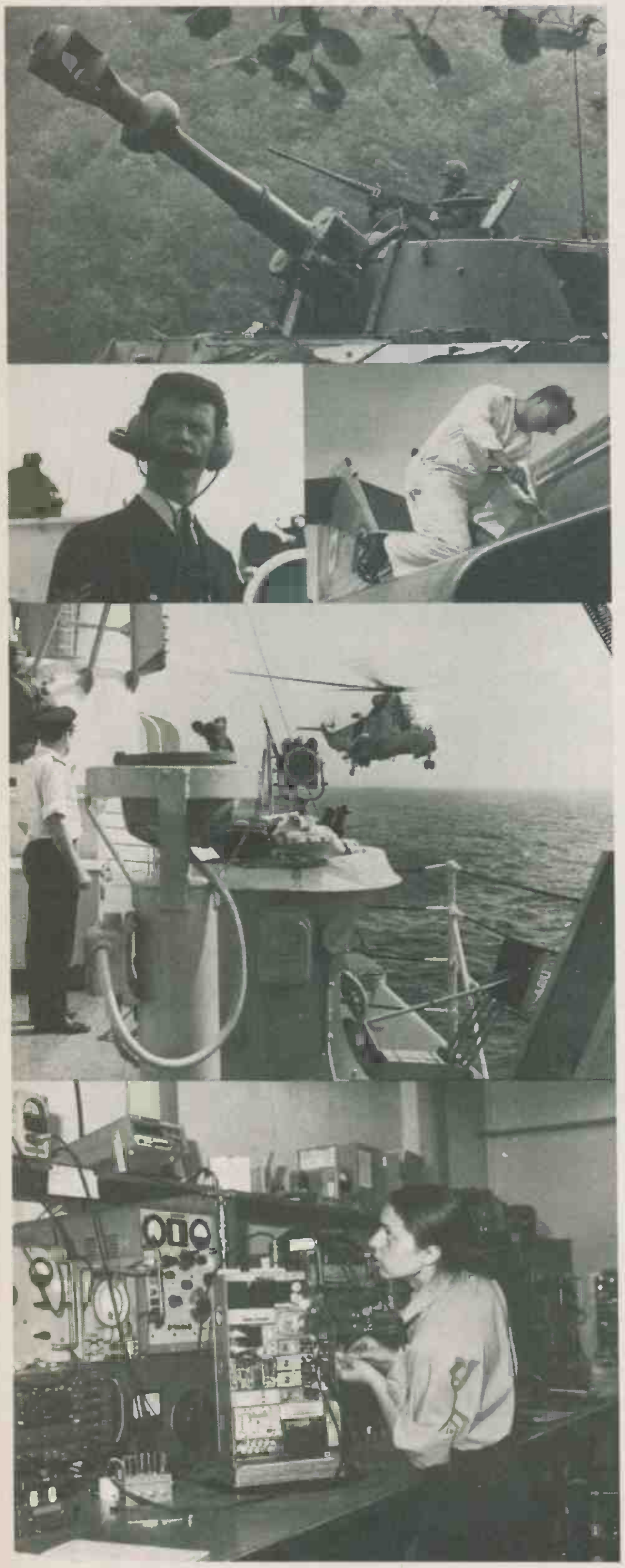
The Cassegrain Echelle Spectrograph and the 2D PCA on the 40-Inch telescope at Siding Spring Observatory.

The Cassegrain Echelle Spectrograph, funded by the ANU Large Equipment Fund and built by Boller and Chivens, is now installed on the 40-inch telescope at Siding Spring. The spectrograph, which was designed to be compatible with the AAT, has a 4-inch beam: with the 79 groove mm^{-1} echelle, it gives a dispersion of λ(Å)/1000 Å/mm. Narrow emission lines have a FWHM of nine microns, and the instrument is stable to three microns over six hours of hour angle. At the detector (2D PCA — see right), 25 microns projects back to 2.5 arcsec at the slit, on the 40-inch telescope.

Development of the 2D photon counting array (PCA) progressed well in 1980, and the detector is now in use on the echelle spectrograph. At present, the front end is a 25 mm proximity focus, dual stage, chevron microchannel plate intensifier with an S-20 cathode on a quartz substrate. This is imaged on to a Fairchild CCD with enough gain to photon count an event centre to half a diode in the direction of dispersion. Currently the memory works at 10 MHz, with a 760 x 240 format. The pixel size is 15 x 36 microns, and the resolution in the direction of dispersion is 20% modulation at 20 line pairs mm^{-1}.



A picture (reverse) of Cygnus X-1, a likely candidate for study using Starlab.



Zenith Z-100

Steve Rimmer puts the Z-100 and its operating systems to the test. If only they'd let us keep the review models . . .

IT REMAINS UNCLEAR to me why, in the general metaphysical order of the universe, I should not have been born into some sort of situation where I could have a few computers like this one. I don't mean vast wealth, of course; a few tawdry millions would be fine. After all, I like the computer. It's fairly heavy and substantial and we get along well. I know how to use it. I can't understand why I should be denied one just because I'm about seven thousand dollars shy of the purchase price.

I know, the Earth says not why she spins.

The Zenith Z-100 is a very nice computer. Not without its flaws, it is both powerful and friendly nonetheless and a perfect trip of a system in the high end of the market. It has two processors, an eight bit 8085 and a sixteen bit 8088 with up to 192 kilobytes of RAM on board. There is a full colour, very high resolution graphics screen with 640 by 225 pixels to mess with, plus vast reams of options, bells, whistles and infernal doo-dads to amuse the mind and abscond with the senses. All of this is wrapped up in either of two packages, one with a built in monitor and one with a flat space on top to use the tube of your choice. We got the latter version to have a play with.

Diskredited

The Z-100 comes with quite a bewildering array of options and choices. Primary among these is the choice of disk operating systems. You could take both, of course . . . the configurations are all in software, and which DOS you are running at any given time is purely a function of which disk is in the drive when you boot the system. However, the two are incompatible, and there does not seem to be any easy way to switch files from one to the other. As is to be expected, neither is clearly superior.

In the left corner we find CP/M 85. It is a pretty standard implementation of CP/M for the processor. The 8085 will run 8080 Z-100. The disks we got had things like Wordstar and Supercalc on them, and their operations were just like we've all come to know and love. There were also the usual CP/M utilities. The merits and features of CP/M have probably been bandied about enough by now . . . suffice it to say that there is a whole zoo of the all time best software available for CP/M based beasties, much of it free, and a large number of good things like languages and other programming friendlies, including Digital Research's own Z-80 mnemonic assemblers, are available for this system.

On the other hand, Zenith have not gone to a great deal of trouble over the Z-100 implementation of CP/M . . . clearly, they'd rather sell you their own DOS. As such, the CP/M based BASIC is just regular old MBASIC, without any kind of fancy colour drivers or whatever. There are no CP/M programs to read the clock or use any of the other fancy bits that make this system more than just another box with drives. Using the Z-100 under CP/M is a bit like using a TRS-80 Model II. It's not nearly as much fun as it could be.

There is also CP/M 86 available for the Z-100, taking advantage of the faster sixteen bit processor also available in the system.

Zenith's own disk operating system is called ZDOS. Now, it is tempting to suggest that the Z actually stands for Zenith, although nothing could be farther from the truth. It is actually the first initial of Zoltan DiRevulso, a three eyed nether troll software engineer from Oil Sludge, Alberta who offered to write the package in exchange for three sheep and a pack of Maxell gold labels because he was poor. Being a troll, he was actually pretty stupid too and . . . well, it sounds like a believable tale if you read it fast.

ZDOS is actually a bit of a drag. Not that it isn't a good disk operating system . . . old Zoltan was a turkey at horse trading but he could write code . . . but it is so CP/M-like that it is clearly around just to feed Zoltan and muddy the waters in terms of systems. It has no inherent superiorities in its architecture . . . it is better for some things only because it comes with programs and utilities that nobody has bothered to develop for CP/M. However, CP/M software is not directly compatible with ZDOS. Choosing CP/M will make many of the system's features inaccessable to you unless you write the required dedicated code (as, ahem, the manufacturers should have). Choosing ZDOS will put all those neat programs available for CP/M based systems into the fourth dimension. Choosing both will prove confusing for the beginner, as ZDOS has been set up using different keywords. Not the CP/M's keywords are particularly intelligent ... they are however, convenient and fairly widespread.

The common functions in ZDOS are as follows.

—COPY Moves files around on the disks. The COPY routine is part of the CCP (or whatever ZDOS calls it), rather than being a transient.

—CREF Creates a cross reference for the assembler.

—DATE Reads the internal calendar and prints the results on the screen.

—DEBUG is a run time environment for debugging code, similar to the CP/M DDT. It's almost identical.

—DIR is the directory command. Some things never change. However, this DIR gives a single column directory which cheerfully scrolls quickly off the screen ... a royal turkey, actually.

—DSKCOMP compares two disks.

—EDLIN is the contextual editor, and is just as much of a drag as is CP/M's ED.

—DEL and ERASE kill off files.

—FORMAT wipes a disk clear and gets it ready for new data.

—LINK patches together isolated modules of code.

—MAKE does batch processing with ambiguous parameters.

—MAP assigns the virtual peripherals to the real ports.

—MASM is the assembler.

—SYS puts the system onto a disk.

—TIME prints up the contents of the clock.

—TYPE prints a file to the screen.

It lacks a few of the useful bits of CP/M, such as CONFIG, which is a convenient way to handle I/O, and SAVE, which makes files out of blocks of RAM and has been known to save many a program that has been impaled upon the foaming jaws of a disk error.

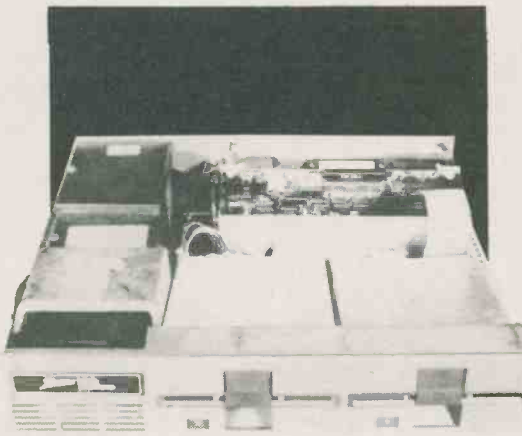
One curious thing about ZDOS is that it appears to be compatable with the non-CP/M DOS available with the IBM Personal Computer. The command structure is the same, and playing with some left over disks from our IBM PC review revealed that, while the BIOS's are quite different, the rest of the system seems happy. This may indicate that some or all IBM PC software will run on the Z-100, although we haven't tried enough of it out to be able to say for sure.

All told, I was not impressed with ZDOS. It seems like more of a marketing thing than any kind of legitimate software creation, and it seems destined to cause no end of hassles for users of this largely beneficent system.

Tongue of the Rabble

As mentioned previously, MBASIC is nothing special, and as we've dealt with the low life Microsoft full house package previously, nothing more probably needs be said over it. It's powerful, but not terribly exciting.

The ZBASIC that runs under ZDOS is rather more lively. Also a work of the high lord Microsoft, it is intensely similar to the BASIC of the if 800 we looked at a while ago. In fact, the only substantial difference we found is that, in the CIRCLE function, circles larger than the screen simply fall off the edge of the Z-100's screen while forming into a square boarder on the if. Earth shattering, this.



ZBASIC has a full house of graphics commands. There are eight colours, and none are intensively unpleasant to look at if you don't mind everything being super saturated. There are three parameters to play with at any given time, these being the border, background and foreground colours. There are a number of commands that will change these things, simplest of which is COLOR (in Yank, of course), which will do an initial set up. One useful aspect of this statement is that, if you choose not to specify one or more of its three parameters it simply leaves those functions unchanged rather than flipping them back to the initial defaults.

There are two ways to draw pictures on the screen. The first is fairly fast in operation, using the draw command. It is also unspeakably tedious to set up, requiring the compilation of long strings of command primitives which, once gotten together, are really meaningless to the naked orbs. Furthermore, this sublanguage features virtually no error messages of its own, meaning that you have to spot any glitches in the string by pure stealth and cunning.

The other way to draw is using the standard high resolution graphics commands ... LINE for straight bits and CIRCLE for the curvies. These, while not so fast as DRAW, are brilliantly simple to use. As is typical of most of the BASIC, they have many options for getting fancy with but it is possible to ignore the ones that aren't applicable without gorfing up the syntax.

LINE specifies lines between any two points, or between the last plotted point and a new point, in any colour. Circle, predictably, does circles. However, the aspect ratio of the circle is adjustable ... it's set arbitrarily to look round on a Zenith monitor ... and you can, as such, create ellipses. You also need not do a full circle; arcs are cool, and you can specify starting and stopping points for the plot. The number jumbling required to use the CIRCLE command is, in fact, a bit complex, but it can be mastered with a bit of effort.

There is also a PAINT command available, which makes doing solid blocks of colour pretty painless. To fill in a shape on the screen, one simply picks a point within it as a starting point for the painting, gives the little beast a colour to paint with and the colour of the border of the shape and lets it get on with its existence. PAINT is reasonably fast and amusing to watch while it's working. However, it creates a fairly huge pseudo-stack for itself when it works to store delineation co-ordinates and programs that call for PAINTing complex figures may find that PAINT wants more than the available amount of RAM.

The BASIC also has a large number of other exotic, if less exciting, features available. These include all manner of disk handling functions ... if you con't like the several file techniques provided you could probably devise your own. There are also time and date routines, lots of boring math stuff and while-wend loops.

The Z-100's keyboard has twelve programmable keys on it which the

Continued on page 72

ZX81 Printer

Sooner or later, every computer owner wants hard copy from his or her machine. If you have a low-cost machine, printout need not be high-cost — thought Clive Sinclair. So he produced the ZX printer, and at a price to suit the ZX owner.

THE ZX PRINTER, as befits the machine it is designed to team with, is compact, functional and simple to operate. It plugs directly into the ZX81 or the ZX80 with 8K BASIC ROM. It provides metallised paper, obtainable from the suppliers at $16.95 for a three-roll pack. You can print nine lines to the vertical inch (25.4 mm) at a speed quoted as 50 characters per second. The 20 m roll allows you to print over 250 screens-worth of text (about 6500 lines)!

Putting it to use

The ZX printer is extremely simple and quick to put into operation. It takes longer to put a mains plug on the power supply lead than it takes to plug in the printer and learn the use of the one control available — the paper feed. The plug on the printer lead has an integral socket to accept the add-on 16K RAM pack. The 17-page instruction book gives a clear description of how to load a fresh roll of paper, use the feed button, tear the paper neatly off the roll (!), clean the printer and, of course, the general principle of operation. There is also a selection of programs aimed at giving you the pleasure of seeing your new acquisition work, while at the same time showing the use of those BASIC statements associated with the ZX printer. Strange as it may seem, these BASIC statements are neither explained nor described in the text; instead we are directed to read chapter 20 of the ZX81 instruction book.

It would amuse me to report that the ZX81 instruction book then referred you to the ZX printer instructions; however, although it does tell you that the printer will have instructions with it, it has a short chapter to quite clearly explain the function of the three relevant BASIC statements. These are LLIST, LPRINT and COPY. The first two are just like LIST and PRINT except that they direct the display to the printer instead of to the television screen or monitor. The third statement, COPY, enables you to print out a copy of whatever is displayed on the screen at the time.

General theory of operation

Normally when reviewing equipment or books it is not the 'done thing' to quote more than a sentence or two from any supplied text, but in this instance the ZX printer instruction book gives us a very simple and concise description of the basic workings of the printer:

> 'the printer functions in rather the same way as a TV picture, i.e: by scanning from left to right. A conductive stylus is pulled across the paper at high speed, and where a black dot is wanted a pulse of current is passed through the stylus. This evaporates the aluminum coating on the paper, and allows the black backing to show through. To avoid the need to return the stylus quickly to the left-hand edge of the paper, there are in fact two styli, mounted on a moving belt, which follow each other in quick succession. The belt and the paper feed roller are both driven continuously whilst printing, so that when the next stylus comes round, the paper has been moved up ready for the next line.'

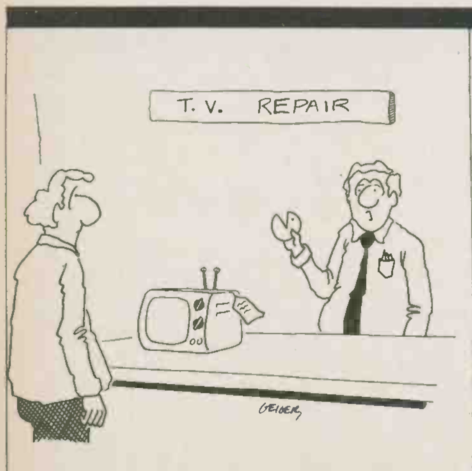
Having only three major print statements to consider, the ZX printer is very easy to use. Formatting the display to the printer can be carried out using the TAB and AT @ statements, albeit when using the AT statement line commands are ignored and only column commands in

Continued on page 74

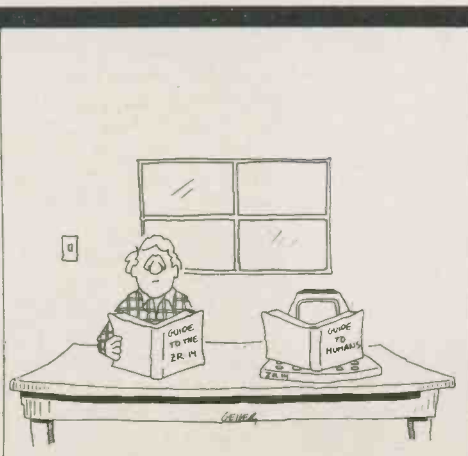
Circle No. 21 on Reader Service Card.

Circle No. 8 on Reader Service Card.

Circle No. 5 on Reader Service Card.



You've gotta stop using your video game so much . . . we found one of these munching on the picture tube.



You must be using the garage door opener.

Chess Robot

The Novag Chess Robot pondering its next move.

It's almost as good as Bobby Fischer, and it has a personality to boot. An amazing servo-computer chess player. Bill Markwick reports.

I MUST ADMIT that I started out to try the Novag Chess Robot with a somewhat jaded view; it might have turned out to be just another glorified calculator. I couldn't have been more wrong!

Evan Efston, of Eftonscience, 3350 Dufferin St., Toronto, sat me down in front of the chess set with the robot arm. *"There are an estimated four million chess players in Canada,"* he said, *"and this robot solves the problem of having to learn the complexities of computer programming."* He pressed the "demonstration" button on the front panel, and the robot arm extended with a gentle whir. It began to pick up the pieces and set them down again quickly and accurately, moving them from a storage area at the side of the chessboard to a regulation chess setup, and then began to play both sides, all without hunting or noticeable overshoot.

We cancelled the demonstration mode, and pressed "new game". The arm reset the pieces, and pointed to Level 0, the easiest of 10. Mr. Efston pressed an intriguing button marked "Emotions". The robot suddenly changed from a well-behaved servo-motor to a *chess player.* It scanned back and forth in front of my pieces, reaching for one or another and then retreating before making a choice. Mr. Efston pressed "Sound", and it started *humming* a tuneless melody. It set down its piece, and as I pondered my move, it began to emit a raucous series of squawks and tootles. "It'll try to distract you unless you cancel the emotions," said Mr. Efston with a grin.

With my limited knowlege of chess, I had no trouble sacrificing the game and, when the robot won, it squealed with electronic joy, loudly clicking its little fingers together and swinging the arm back and forth. It isn't just user-friendly - it's absolutely endearing! It also goes berserk if it loses; wouldn't you like to be able to switch off a friend's tantrum at the touch of a button?

Besides playing chess from beginner's level to tournament, the robot has 5500 opening moves, a TRACE mode which allows you to review your entire game, a HINT mode which suggests moves, and an optional printer (at $165.50) which prints all moves in standard chess notation. There's also a quartz Chess Clock ($129.50) for tournament-style timing. If that isn't enough, it has a memory that will store your game for up to three months with the power off, a black/white interchange which lets the robot play your side and extricate you from a mess, and 16 of the world's classic chess games which the arm will replay. Another 64 games are available with an optional memory module. Two people can also play while the robot keeps a watchful CPU on illegal moves.

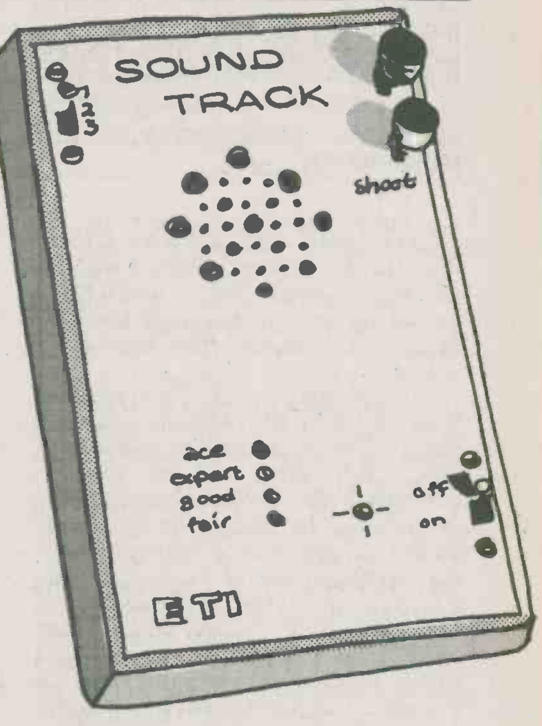
The robot follows moves by scanning reed switches under the board which are activated by magnets in the chess pieces. If the piece can operate the switch, it's close enough for the mechanical fingers to grasp it easily and accurately. The computer identifies each piece by following its route from the starting lineup. You could fool it by using a non-standard lineup, but it gets a bit pointless.

The innards use a Z80B running at 3 MHz; it obtains game instructions from 32K of ROM and mechanical steering from another 8K. A further 2K integrates the two functions.

The unit is very well made and didn't exhibit any of the idiosyncrasies you might expect from a servo-computer of this complexity. The one drawback is the price: $1995.00. This puts it out of reach of the average chess fan, but it's reasonable to assume that chess clubs will be lining up for it once they check out its performance. (There are more computerised but non-robotic chess boards at Efstonscience from $94.50.) ETI

Sound Track

Play it again (and again, and again), SAM! When you feel like working off your aggressions, try to zap the nasties as they fly past. Design and development by Phil Walker.



THE ETI Sound Track is an 'arcade' game you can carry in your pocket. It requires no special displays as all the cues are sounds. The object of the game is to intercept all 15 of the attackers with your own armament. In order to do this you have to judge the best moment to fire from the simulated sound of the attacker. It is made more realistic by the fact that both volume and frequency changes due to Doppler shift are included. As the game progresses the speed of the attack increases to prevent you getting too used to one pace. Also there are three levels of skill which determine how difficult it is to hit the attackers at all.

At the end of the game, if enough of the attackers have been intercepted, an LED will light up to give an assessment of your performance. As an option, an aiming control can be fitted, if space permits, which will allow multiple shots if you are quick enough. To start the game, press the reset button and wait for the first attack. Now it's up to you. Bear in mind that your shots are effective only at the end of the shooting noise and while the target light is on.

The Circuit

The circuit for this project uses standard op-amps, CMOS counters and gates and a special sound effects IC. This allows us to make fairly realistic sounds to simulate an object flying past, some sort of weapon being fired and an explosion if a successful interception has been made. In order to make the completed project hand-held, the PCB is fairly crowded but quite a lot has been put onto it.

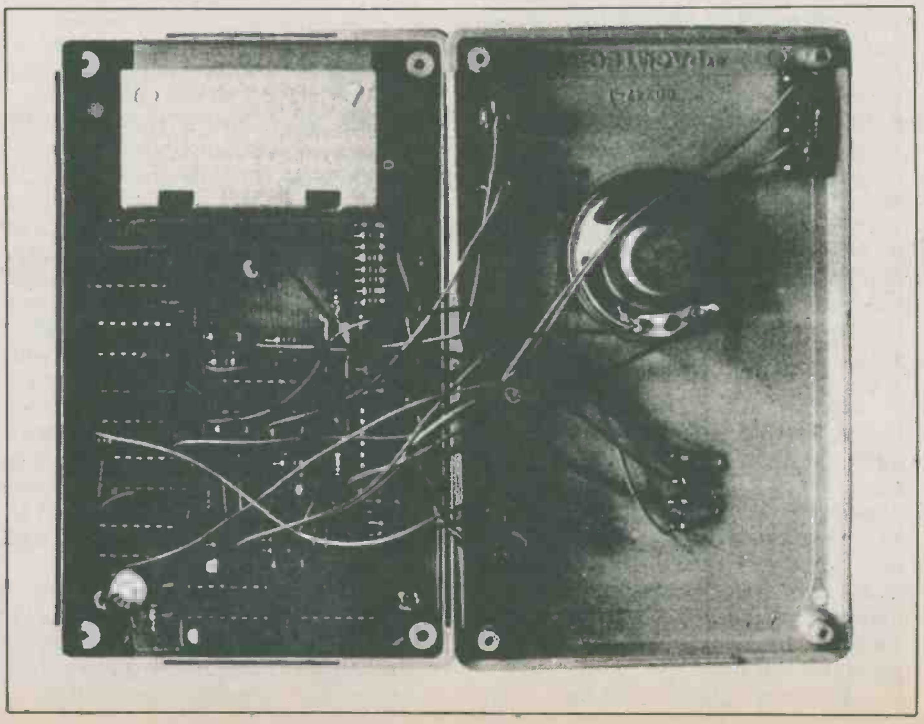
The heart of the system is a voltage controlled oscillator operating at a frequency of less than 0.2 Hz. This provides two outputs; one is an asymmetrical triangle wave which controls the attack sound effect and simulates the position of the target while the other output is a logic signal to drive the score counters. The VCO frequency is modified by the attack counter such that the attacks proceed more rapidly as the game progresses.

The fire control section of the circuit produces two signals. The first of these is a long pulse which causes the shooting sound to be made by the sound generator. The second, immediately after, is a short pulse which enables the hit detector. If at the same time the ramp from the VCO is within the limits of the window discriminator in the hit detector, then a HIT will be registered and the HIT counter updated. At the same time the sound generator will be switched to provide an explosion effect.

The sound select logic and analogue control switching (in the absence of any other demand) will assume an attack sequence and configure the sound generator to give a mixture of white noise and a tone. As the ramp voltage from the VCO falls, simulating an attack, the volume will increase to a maximum and then decrease again. Simultaneously, as the volume reaches its peak, the pitch of the tone will decrease rapidly and stabilise at a lower level to simulate Doppler shift. While the ramp voltage returns to its starting level the sound generator is inhibited.

If either shooting or explosion effects are demanded, these will take precedence over the attack sound. The explosion is produced by envelope-shaping the white noise source in the chip while the shooting sound is given by an audio frequency VCO, frequency-modulated by a much lower frequency triangle wave.

The display given by the LEDs is to give some indication of the number



of successful interceptions made in a game. The first LED will light when eight out of the 15 attacks have been stopped. The next will light at 12, then 14, and finally 15. There is one other LED which flashes each time a HIT is possible, but note that the shoot button usually has to be pressed before it lights.

Construction

No major problems should be encountered in making this project; care must be taken when soldering the board as there are many places where tracks run between IC pins. Make sure that all the links are in place and that diodes, ICs and polarised capacitors are the right way round. Low profile IC sockets may be used but the case we used may then be a little tight.

SW1, R6 and R7 were mounted so that they fitted beside the battery compartment on one side while PB1 and PB2 went the other side. The LEDs are mounted on the front of the box so that they poke through the panel; use a little glue to hold them in place. Some interconnection work and components have to be put on to these (D7-10) and this should be kept as close to the panel as possible. If there is room, fit RV1 and R7 but this will only be possible if a very small potentiometer is available or a different box is used.

All interwiring should be carried out using thin flexible wire and kept as short as practicable. When fixing the loudspeaker check first that it will fit in the desired position and adjust fixing pillars etc. to ensure this. It is intended that it fits with part of the cone overlapping the battery compartment so a little shaving with a sharp knife may be required. When the speaker position is known, drill a series of holes in the panel and glue it into position.

The wiring may now be completed and the box assembled to finish the project. Fit a 9V battery to the connectors and it should be ready.

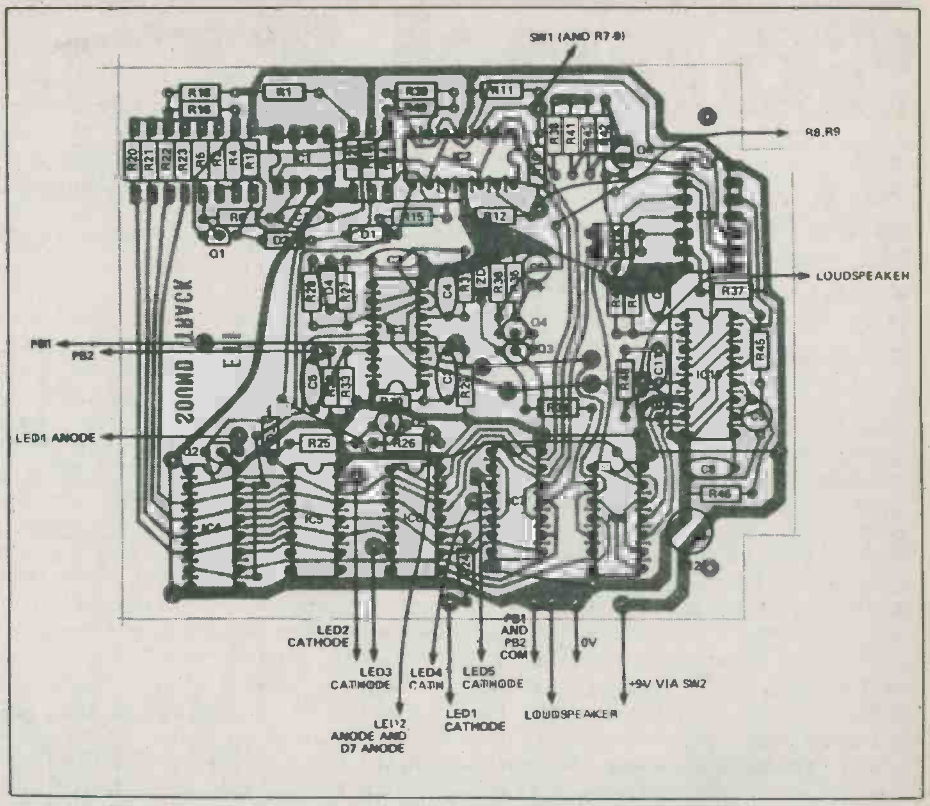


Fig. 1 Component overlay for the Sound track hand-held 'arcade' game. Note that some components are mounted off-board; see the photographs.

PARTS LIST

Resistors (all ¼W, 5%)

R1,2,4,12,39	100k
R3,5,6,22,29, 30,31,32,33, 35	1M0
R7,15	220k
R8,46	6k8
R8,10,42	15k
R11,41	82k
R21,27	2M2
R14,23	470k
R16	180k
R17,19,37	27k
R18	150k
R20	4M7
R25	47k
R24,26,38	1k0
R28,48	10k
R34,36	22k
R40	3k3
R43	4k7
R44	1k5
R45	68k
R47	12k

R13 is not used

Potentiometer

RV1	100k linear

Capacitors

C1,8	100n polycarbonate
C2	220n polycarbonate
C3,5	4n7 ceramic
C4,11	1n0 ceramic
C6	2u2 16V tantalum
C7	10n ceramic
C8	68n polycarbonate
C9,10	10u 10V PCB electrolytic
C12	100u 10V PCB electrolytic

Semiconductors

IC1	TL082
IC2	TL084
IC3	4093B
IC4	4520B
IC5	4012B
IC6	4023B
IC7,8	4011B
IC9	4066B
IC10	SN76495 (T.I.)
Q1,2,3,4,6	2N2926
Q5	2N3905
D1-10	1N4148
ZD1	5V6 400mW zener
LED1,3,4,5	Green miniature LED
LED2	Red miniature LED

Miscellaneous

SW1	miniature 3-position slide switch
PB1,2	miniature push-to-make push-button
SW2	miniature slide switch (on/off)

Case 9V battery and connector; knob for pot; loudspeaker.

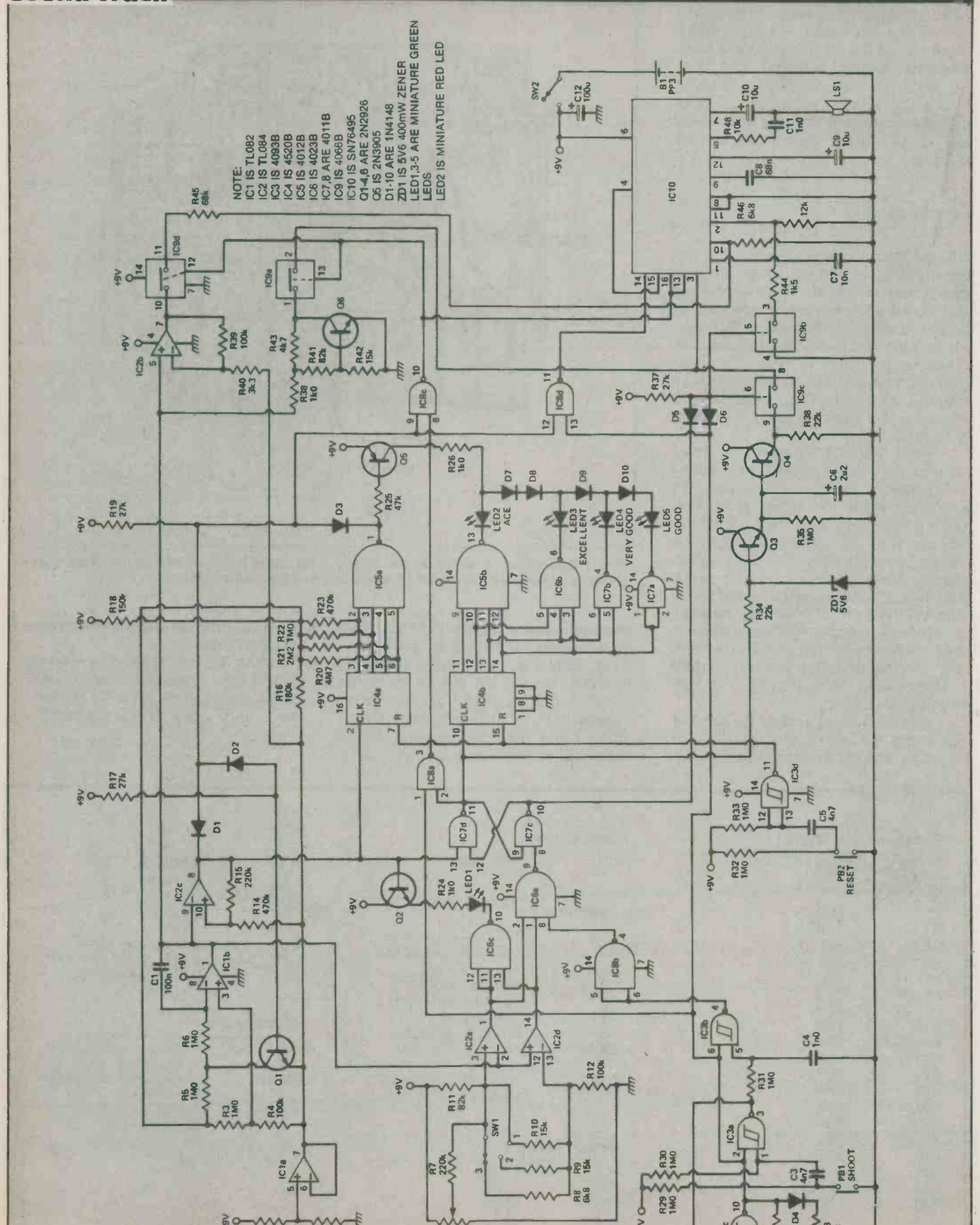
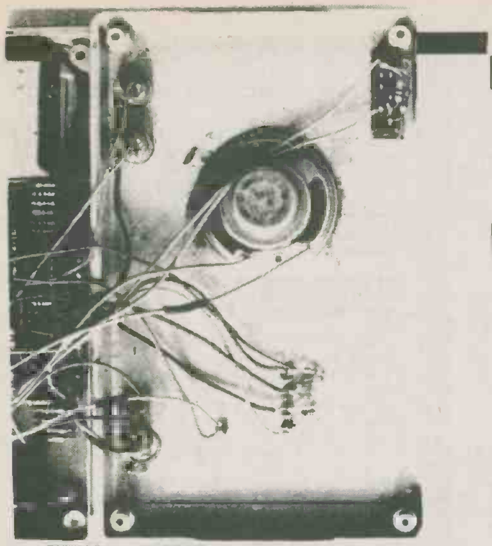


Fig. 2 Circuit diagram for the Sound Track.



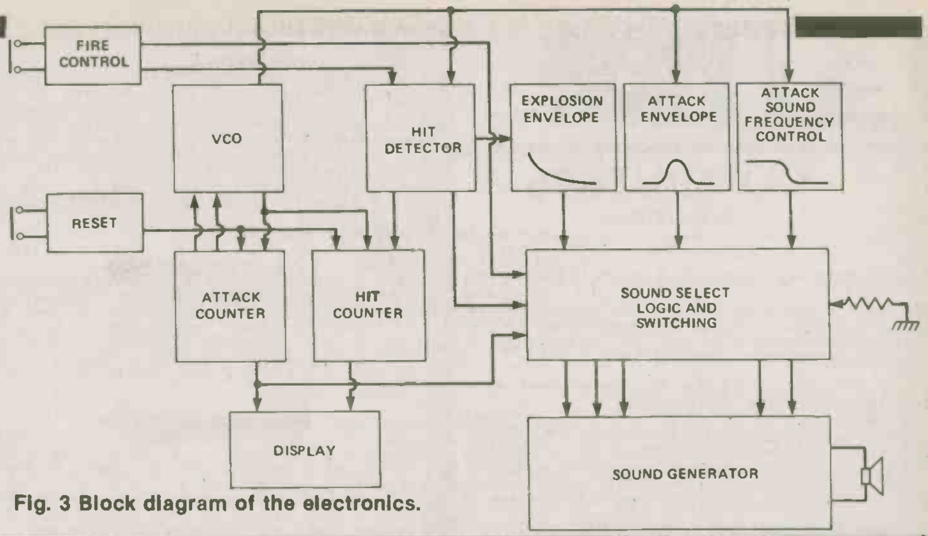


Fig. 3 Block diagram of the electronics.

IC1a buffers the voltage at the junction of R1 and R2 to give a reference at half the supply. IC1b and IC2c form a very low frequency voltage controlled oscillator. R20-23 make a simple D-to-A converter which varies the VCO frequency by a small amount as the game progresses. The timing for the whole game is derived from the VCO and provision is made by D1-3 to stop the circuit oscillating when the required 15 attacks have been counted by IC5a.

IC2a and IC2d form a window comparator whose position and width can be varied by RV1 and SW1. IC3a and IC3c are connected as a monostable and are triggered by PB1 being closed. C3 ensures that the period of the monostable is not affected by further closures of PB1. When the monostable time ends, IC3b is enabled for a short time determined by R31 and C4. This signal is inverted by IC8b and is applied with the outputs from the window comparator circuit to IC6a. If all the inputs to this IC are high at the same time this signifies a "HIT" and the output of IC6a will go low. This action causes the latch formed by IC7c and IC7d to be set with IC7c output high. The resulting low on IC4b clock input increments that counter, increasing the score, while further counting on the same attack run is prevented by the latch action in IC7c/d. IC5b,6b,7b and 7d decode the outputs from IC4b to give a suitable display on the LEDs when Q5 is enabled by IC5a at the end of the game. IC3d is used to debounce the reset switch PB2 and the circuit at its input ensures that only a short pulse is available at its output.

The analogue control signals for the sound generator chip IC10 are produced in three parts and switched into circuit when required by IC9. The control signals for IC9 and IC10 are derived by IC8a, 8c, 8d and an AND gate made up of D6, D5, and R37.

The analogue control signals are produced individually. The Doppler style fall in frequency as each attack progresses is produced by IC2b. This device has a fairly high gain and at the start of the attack its output is driven to the positive rail by the ramp output from the VCO. As the ramp voltage falls past the reference voltage the output of IC2b will change from positive to negative quickly (but not instantanously). If there is no other sound required at the time this output will modulate the oscillator in IC10 via R45.

Another effect required to simulate an object passing is that the noise produced by it will first increase and then decrease. This is accomplished by the circuit around Q6. At high voltages Q6 will be fully on and the output is low. At low voltages Q6 will be off but the output will again be low. As the voltage applied to the circuit increases, (until the voltage on the base of Q6 is sufficient to make it conduct) the output voltage will be the same as the input. When, however, Q6 starts to conduct, the junction of R38, R41, and R43 will stay at a constant potential. The reason for this is that as the input voltage rises, more current will flow into the circuit via R38. A small amount of this will go through R41 to drive Q6 further into conduction, drawing the rest out via R43. This action will continue until the voltage across Q6 is virtually zero again. The output from Q6 drives the volume control pin of IC10 via IC9a.

The last effect is of a decaying explosion. While IC10 will produce the noise of the explosion, the decay envelope has to be generated by Q3 and Q4. Most of the time the base of Q3 is held at 5V6 by the output of IC7d (part of the "HIT" latch). In the event of a "HIT" being registered, the base of Q3 will now be driven low. C6, which previously was held at about 5V by Q3, will start to discharge via R35. The voltage on C6 is buffered by Q4 and fed to IC10 by IC9c. Also for the explosion effect, R44 is connected into circuit by IC9b. This changes the noise slightly to give a more realistic sound. C11 and R48 are included in the amplifier circuit feedback to give more prominence to the mid-frequencies and cut down on the hiss effect of the digital generation of the various noises.

ETI

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A newcomer to electronics tends to be overwhelmed when first confronted with articles or books on microprocessors. In an attempt to give a painless approach to computing, this small book will start by designing a simple computer and because of its simplicity and logical structure, the language is hopefully easy to learn and understand. In this way, such ideas as Relative Addressing, Index Registers etc. will be developed and it is hoped that these will be seen as logical progressions rather than arbitrary things to be accepted but not understood.

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BP78: PRACTICAL COMPUTER EXPERIMENTS $7.30
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Curiously most published material on the microprocessor tends to be of two sorts, the first treats the microprocessor as a black box and deals at length with programming and using the "beast". The second type of book deals with the social impact. None of these books deal with the background to the chip, and this is a shame as the basic ideas are both interesting and simple.
This book aims to fill in the background to the microprocessor by constructing typical computer circuits in discrete logic and it is hoped that this will form a useful introduction to devices such as adders, memories, etc. as well as a general source book of logic circuits.

HANDBOOK OF MICROPROCESSOR APPLICATIONS
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Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.

Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

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BP93: ELECTRONIC TIMER PROJECTS **$8.10**
F.G. RAYER
Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

110 OP-AMP PROJECTS
MARSTON
HB24 **$11.75**
This handbook outlines the characteristics of the op-amp and present 110 highly useful projects—ranging from simple amplifiers to sophisticated instrumentation circuits.

110 IC TIMER PROJECTS
GILDER
HB25 **$10.25**
This sourcebook maps out applications for the 555 timer IC. It covers the operation of the IC itself to aid you in learning how to design your own circuits with the IC. There are application chapters for timer-based instruments, automotive applications, alarm and control circuits, and power supply and converter applications.

110 THYRISTOR PROJECTS USING SCRs AND TRIACS
MARSTON
HB22 **$12.05**
A grab bag of challenging and useful semiconductor projects for the hobbyist, experimenter, and student. The projects range from simple burglar, fire, and water level alarms to sophisticated power control devices for electric tools and trains. Integrated circuits are incorporated wherever their use reduces project costs.

110 CMOS DIGITAL IC PROJECTS
MARSTON
HB23 **$11.75**
Outlines the operating characteristics of CMOS digital ICs and then presents and discusses 110 CMOS digital IC circuits ranging from inverter gate and logic circuits to electronic alarm circuits. Ideal for amateurs, students and professional engineers.

BP76: POWER SUPPLY PROJECTS **$7.30**
R.A. PENFOLD
Line power supplies are an essential part of many electronics projects. The purpose of this book is to give a number of power supply designs, including simple unstabilised types, fixed voltage regulated types, and variable voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low voltage types for semiconductor circuits.

There are other types of power supply and a number of these are dealt with in the final chapter, including a cassette power supply, Ni-Cad battery charger, voltage step up circuit and a simple inverter.

BP84: DIGITAL IC PROJECTS **$8.10**
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS **$7.55**
F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Numeral indicating devices have come very much to the forefront in recent years and will, undoubtedly, find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.

In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

BP73: REMOTE CONTROL PROJECTS **$8.60**
OWEN BISHOP
This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are radio control systems considered but also infra-red, visible light and ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

BP99: MINI—MATRIX BOARD PROJECTS **$8.10**
R.A. PENFOLD
Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

BP103: MULTI-CIRCUIT BOARD PROJECTS **$8.10**
R.A. PENFOLD
This book allows the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREADBOARD PROJECTS — BOOK 1 **$9.35**
R.A. PENFOLD
A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

See order form in this issue. All prices include shipping. No sales tax applies.

ETI bookshelf

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING **$8.10**
R.A. PENFOLD
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

CIRCUITS

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 **$8.25**
R.A. PENFOLD
Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings; Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 **$9.35**
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

The GIANT HANDBOOK OF ELECTRONIC CIRCUITS
TAB No.1300 **$24.45**
About as twice as thick as the Webster's dictionary, and having many more circuit diagrams, this book is ideal for any experimenter who wants to keep amused for several centuries. If there isn't a circuit for it in here, you should have no difficulty convincing yourself you don't really want to build it.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS **$5.50**
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.

This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

BP87: SIMPLE L.E.D. CIRCUITS **$5.90**
R.N. SOAR
Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

BP42: 50 SIMPLE L.E.D. CIRCUITS **$3.55**
R.N. SOAR
The author of this book, Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.). A useful book for the library of both beginner and more advanced enthusiast alike.

BP82: ELECTRONIC PROJECTS USING SOLAR CELLS **$8.10**
OWEN BISHOP
The book contains simple circuits, almost all of which operate at low voltage and low currents, making them suitable for being powered by a small array of silicon cells. The projects cover a wide range from a bicyle speedometer to a novelty 'Duck Shoot'; a number of power supply circuits are included.

BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS **$5.50**
F.G.RAYER, T.Eng.(CEI),Assoc.IERE
Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

BP44: IC 555 PROJECTS **$7.55**
E.A. PARR, B.Sc.,C.Eng., M.I.E.E.
Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

BP24: 50 PROJECTS USING IC741 **$4.25**
RUDI & UWE REDMER
This book, originally published in Germany by TOPP, has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, a "must" for everyone whatever their interest in electronics.

BP83: VMOS PROJECTS **$8.20**
R.A. PENFOLD
Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

BP65: SINGLE IC PROJECTS **$6.55**
R.A.PENFOLD
There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

BP97: IC PROJECTS FOR BEGINNERS **$8.10**
F.G. RAYER
Covers power supplies, radio, audio, oscillators, timers and switches. Aimed at the less experienced reader, the components used are popular and inexpensive.

BP88: HOW TO USE OP AMPS **$9.35**
E.A. PARR
A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

IC ARRAY COOKBOOK
JUNG
HB26 **$14.25**
A practical handbook aimed at solving electronic circuit application problems by using IC arrays. An IC array, unlike specific-purpose ICs, is made up of uncommitted IC active devices, such as transistors, resistors, etc. This book covers the basic types of such ICs and illustrates with examples how to design with them. Circuit examples are included, as well as general design information useful in applying arrays.

BP50: IC LM3900 PROJECTS **$5.90**
H.KYBETT,B.Sc., C.Eng.
The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and the Hobbyist. It provides the groundwork for both simple and more advanced uses, and is more than just a collection of simple circuits or projects.

Simple basic working circuits are used to introduce this IC. The LM3900 can do much more than is shown here, this is just an introduction. Imagination is the only limitation with this useful and versatile device. But first the reader must know the basics and that is what this book is all about.

223: 50 PROJECTS USING IC CA3130 **$5.50**
R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R.F. Projects III — Test Equipment IV — Household Projects V — Miscellaneous Projects.

224: 50 CMOS IC PROJECTS **$4.25**
R.A. PENFOLD
CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.

Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories: I — Multivibrators II — Amplifiers and Oscillators III — Trigger Devices IV — Special Devices.

THE ACTIVE FILTER HANDBOOK
TAB No.1133 **$11.45**
Whatever your field — computing, communications, audio, electronic music or whatever — you will find this book the ideal reference for active filter design.

The book introduces filters and their uses. The basic math is discussed so that the reader can tell where all design equations come from. The book also presents many practical circuits including a graphic equalizer, computer tape interface and more.

DIGITAL ICS — HOW THEY WORK AND HOW TO USE THEM
AB004 **$11.45**
An excellent primer on the fundamentals of digital electronics. This book discusses the nature of gates and related concepts and also deals with the problems inherent to practical digital circuits.

MASTER HANDBOOK OF 1001 PRACTICAL CIRCUITS
TAB No.800 **$20.45**
MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS
TAB No.804 **$19.45**
Here are transistor and IC circuits for just about any application you might have. An ideal source book for the engineer, technician or hobbyist. Circuits are classified according to function, and all sections appear in alphabetical order.

THE MASTER IC COOKBOOK
TAB No.1199 **$16.45**
If you've ever tried to find specs for a so called 'standard' chip, then you'll appreciate this book. C.L. Hallmark has compiled specs and pinout for most types of ICs that you'd ever want to use.

ELECTRONIC DESIGN WITH OFF THE SHELF INTEGRATED CIRCUITS
AB016 **$13.45**
This practical handbook enables you to take advantage of the vast range of applications made possible by integrated circuits. The book tells how, in step by step fashion, to select components and how to combine them into functional electronic systems. If you want to stop being a "cookbook hobbyist", then this is the book for you.

AUDIO

BP90: AUDIO PROJECTS **$8.10**
F.G. RAYER
Covers in detail the construction of a wide range of audio projects. The text has been divided into preamplifiers and mixers, power amplifiers, tone controls and matching and miscellaneous projects.

HOW TO DESIGN, BUILD ... KER SYSTEMS
OUT OF PRINT ...45
E... can b... speakers. This book contains ... a variety of speakers as well as inst... on how to design your own.

205: FIRST BOOK OF HI-FI LOUDSPEAKER ENCLOSURES **$3.55**
B.B. BABANI
This book gives data for building most types of loudspeaker enclosure. Includes corner reflex, bass reflex, exponential horn, folded horn, tuned port, klipschorn labyrinth, tuned column, loaded port and multi speaker panoramic. Many clear diagrams for every construction showing the dimensions necessary.

BP35: HANDBOOK OF IC AUDIO PRE-AMPLIFIER AND POWER AMPLIFIER CONSTRUCTION ...50
F.G.RAYER, T.Eng.(CEI) A...
This book ... g a... controls, Pa... includes practical co... IC and Hybrid IC and Transist... about 250mW to 100W output.
OUT OF PRINT
Out of stock until December 1982.

BP47: MOBILE DISCOTHEQUE HANDBOOK **$5.90**
COLIN CARSON
The vast majority of people who start up "Mobile Discos" know very little about their equipment or even what to buy. Many people have wasted a "small fortune" on poor, unnecessary or badly matched apparatus.

The aim of this book is to give you enough information to enable you to have a better understanding of many aspects of "disco" gear.

HOW TO BUILD A SMALL BUDGET RECORDING STUDIO FROM SCRATCH. . .
TAB No.1166 **$16.45**
The author, F. Alton Everest, has gotten studios together several times, and presents twelve complete, tested designs for a wide variety of applications. If all you own is a mono cassette recorder, you don't need this book. If you don't want your new four track to wind up sounding like one, though, you shouldn't be without it.

BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING **$5.50**
M.K. BERRY
Electronic music is the new music of the Twentieth Century. It plays a large part in "pop" and "rock" music and, in fact, there is scarcely a group without some sort of synthesiser or other effects generator.

This book sets out to show how electronic music can be made at home with the simplest and most inexpensive of equipment. It then describes how the sounds are generated and how these may be recorded to build up the final composition.

BP74: ELECTRONIC MUSIC PROJECTS **$7.70**
R.A. PENFOLD
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

BP81: ELECTRONIC SYNTHESISER PROJECTS **$7.30**
M.K. BERRY
One of the most fascinating and rewarding applications of electronics is in electronic music and there is hardly a group today without some sort of synthesiser or effects generator. Although an electronic synthesiser is quite a complex piece of electronic equipment, it can be broken down into much simpler units which may be built individually and these can then be used or assembled together to make a complete instrument.

ELECTRONIC MUSIC SYNTHESIZERS
TAB No.1167 **$10.45**
If you're fascinated by the potential of electronics in the field of music, then this is the book for you. Included is data on synthesizers in general as well as particular models. There is also a chapter on the various accessories that are available.

See order form in this issue. All prices include shipping. No sales tax applies.

TEST EQUIPMENT

BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION — **$7.30**
F.G. RAYER, T.Eng. (CEI), Assoc. IERE
This book covers in detail the construction of a wide range of test equipment for both the Electronics Hobbyists and Radio Amateur. Included are projects ranging from an FET Amplified Voltmeter and Resistance Bridge to a Field Strength Indicator and Heterodyne Frequency Meter. Not only can the home constructor enjoy building the equipment but the finished projects can also be usefully utilised in the furtherance of his hobby.

99 TEST EQUIPMENT PROJECTS YOU CAN BUILD
TAB No.805 — **$14.45**
An excellent source book for the hobbyist who wants to build up his work bench inexpensively. Projects range from a simple signal tracer to a 50MHz frequency counter. There are circuits to measure just about any electrical quantity: voltage, current, capacitance, impedance and more. The variety is endless and includes just about anything you could wish for!

HOW TO GET THE MOST OUT OF LOW COST TEST EQUIPMENT
AB017 — **$9.45**
Whether you want to get your vintage 1960 'TestRite'signal generator working, or you've got something to measure with nothing to measure it with, this is the book for you. The author discusses how to maximize the usefulness of cheap test gear, how to upgrade old equipment, and effective test set ups.

THE POWER SUPPLY HANDBOOK
TAB No.806 — **$16.45**
A complete one stop reference for hobbyists and engineers. Contains high and low voltage power supplies of every conceivable type as well mobile and portable units.

BP70: TRANSISTOR RADIO FAULT-FINDING CHART — **$2.40**
CHAS. E. MILLER
Across the top of the chart will be found four rectangles containing brief descriptions of various faults; vis: — sound weak but undistorted; set dead; sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

ELECTRONIC TROUBLESHOOTING HANDBOOK
AB019 — **$12.45**
This workbench guide can show you how to pinpoint circuit troubles in minutes, how to test anything electronic, and how to get the most out of low cost test equipment. You can use any and all of the time-saving shortcuts to rapidly locate and repair all types of electronic equipment malfunctions.

COMPLETE GUIDE TO READING SCHEMATIC DIAGRAMS
AB018 — **$10.45**
A complete guide on how to read and understand schematic diagrams. The book teaches how to recognize basic circuits and identify component functions. Useful for technicians and hobbyists who want to avoid a lot of headscratching.

RADIO AND COMMUNICATIONS

BP79: RADIO CONTROL FOR BEGINNERS — **$7.30**
F.G. RAYER, T.Eng.(CEI),Assoc.IERE.
The aim of this book is to act as an introduction to Radio Control for beginners to the hobby. The book will commence by dealing with the conditions that are allowable for such things as frequency and power of transmission. This is followed by a "block" explanation of how control-device and transmitter operate and receiver and actuator(s) produce motion in a model.

Details are then given of actual solid state transmitting equipment which the reader can build. Plain and loaded aerials are then discussed and so is the field-strength meter to help with proper setting up.

The radio receiving equipment is then dealt with which includes a simple receiver and also a crystal controlled superhet. The book ends with the electro-mechanical means of obtaining movement of the controls of the model.

BP96: CB PROJECTS — **$8.10**
R.A. PENFOLD
Projects include speech processor, aerial booster, cordless mike, aerial and harmonic filters, field strength meter, power supply, CB receiver and more.

222: SOLID STATE SHORT WAVE RECEIVERS FOR BEGINNERS — **$5.20**
R.A. PENFOLD
In this book, R.A. Penfold has designed and developed several modern solid state short wave receiver circuits that will give a fairly high level of performance, despite the fact that they use only relatively few and inexpensive components.

BP91: AN INTRODUCTION TO RADIO DXing — **$8.10**
This book is divided into two main sections one to amateur band reception, the other to broadcast bands. Advice is given to suitable equipment and techniques. A number of related constructional projects are described.

BP105: AERIAL PROJECTS — **$8.10**
R.A. PENFOLD
The subject of aerials is vast but in this book the author has considered practical designs including active, loop and ferrite aerials, which give good performances and are reasonably simple and inexpensive to build. The complex theory and math of aerial design are avoided.

BP46: RADIO CIRCUITS USING IC's — **$5.90**
J.B. DANCE, M.Sc.
This book describes integrated circuits and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. The chapter on amplitude modulated (a.m.) receivers will be of most interest to those who wish to receive distant stations at only moderate audio quality, while the chapter on frequency modulation (f.m.) receivers will appeal to those who desire high fidelity reception.

BP92: ELECTRONICS SIMPLIFIED—CRYSTAL SET CONSTRUCTION — **$7.30**
F.A. WILSON
Aimed at those who want to get into construction without much theoretical study. Homewound coils are used and all projects are very inexpensive to build.

REFERENCE

THE BEGINNER'S HANDBOOK OF ELECTRONICS
AB003 — **$10.45**
An excellent textbook for those interested in the fundamentals of Electronics. This book covers all major aspects of power supplies, amplifiers, oscillators, radio, television and more.

ELEMENTS OF ELECTRONICS — AN ON-GOING SERIES
F.A. WILSON, C.G.I.A., C.Eng.,

BP62: BOOK 1. The Simple Electronic Circuit and Components	**$8.95**
BP63: BOOK 2. Alternating Current Theory	**$8.95**
BP64: BOOK 3. Semiconductor Technology	**$8.95**
BP77: BOOK 4. Microprocessing Systems And Circuits	**$12.30**
BP89: BOOK 5. Communication	**$12.30**

The aim of this series of books can be stated quite simply — it is to provide an inexpensive introduction to modern electronics so that the reader will start on the right road by thoroughly understanding the fundamental principles involved.

Although written especially for readers with no more than ordinary arithmetical skills, the use of mathematics is not avoided, and all the mathematics required is taught as the reader progresses.

Each book is a complete treatise of a particular branch of the subject and, therefore, can be used on its own with one proviso, that the later books do not duplicate material from their predecessors, thus a working knowledge of the subjects covered by the earlier books is assumed.

BOOK 1: This book contains all the fundamental theory necessary to lead to a full understanding of the simple electronic circuit and its main components.

BOOK 2: This book continues with alternating current theory without which there can be no comprehension of speech, music, radio, television or even the electricity utilities.

BOOK 3: Follows on semiconductor technology, leading up to transistors and integrated circuits.

BOOK 4: A complete description of the internal workings of microprocessor.

BOOK 5: A book covering the whole communication scene.

BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE — **$12.25**
ADRIAN MICHAELS
This book will help the reader to find possible substitutes for a popular user-orientated selection of modern transistors. Also shown are the material type, polarity, manufacturer selection of modern transistors. Also shown are the material type, polarity, manufacturer and use. The Equivalents are sub-divided into European, American and Japanese. The products of over 100 manufacturers are included. An essential addition to the library of all those interested in electronics, be they technicians, designers, engineers or hobbyists. Fantastic value for the amount of information it contains.

BP108: INTERNATIONAL DIODE EQUIVALENTS GUIDE — **$8.35**
ADRIAN MICHAELS
This book is designed to help the user in finding possible substitutes for a large user orientated selection of the many different types of semiconductor diodes that are available today. Besides simple rectifier diodes also included are Zener diodes, LEDs, Diacs Triacs, Thyristors, Photo diodes and Display diodes.

BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES — **$2.80**
B.B. BABANI
This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Great Britain, USA, Japan, Germany, France, Europe, Hong Kong, and includes types produced by more than 120 different manufacturers.

BP14: SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES — **$4.80**
B.B. BABANI
The "First Book of Transistor Equivalents" has had to be reprinted 15 times. The "Second Book" produced in the same style as the first book, in no way duplicates any of the data presented in it. The "Second Book" contains only additional material and the two books complement each other and make available some of the most complete and extensive information in this field. The interchangeability data covers semiconductors manufactured in Great Britain, USA, Germany, France, Poland, Italy, East Germany, Belgium, Austria, Netherlands and many other countries.

TOWER'S INTERNATIONAL OP-AMP LINEAR IC SELECTOR
TAB No.1216 — **$13.45**
This book contains a wealth of useful data on over 5,000 Op-amps and linear ICs — both pinouts and essential characteristics. A comprehensive series of appendices contain information on specs, manufacturers, case outlines and so on.

CMOS DATABOOK
TAB No.984 — **$14.45**
There are several books around with this title, but most are just collections of manufacturers' data sheets. This one, by Bill Hunter, explains all the intricacies of this useful family of logic devices . . . the missing link in getting your own designs working properly. Highly recommended to anyone working with digital circuits.

MISCELLANEOUS

BP68: CHOOSING AND USING YOUR HI-FI — **$7.25**
MAURICE L. JAY
The main aim of this book is to provide the reader with the fundamental information necessary to enable him to make a satisfactory choice from the extensive range of hi-fi equipment now on the market.

Help is given to the reader in understanding the equipment he is interested in buying and the author also gives his own opinion of the minimum standards and specifications one should look for. The book also offers helpful advice on how to use your hi-fi properly so as to realise its potential. A Glossary of terms is also included.

BP101: HOW TO IDENTIFY UNMARKED IC'S — **$2.70**
K.H. RECORR
Originally published as a feature in 'Radio Electronics', this chart shows how to record the particular signature of an unmarked IC using a test meter, this information can then be used with manufacturer's data to establish the application.

SIMPLIFIED TRANSISTOR THEORY
TRAINING SYSTEMS, INC. AND LEVINE
HB20 — **10.25**
This book is designed to provid... n of the physical theory and ... tran-sistors and transist... no previous knowledge ... understanding of basic...

OUT OF PRINT

...sented in a series of brief, lo... ps, or frames—over 400 in all. A con-cl... section provides both a concise review and a c... nt reference source for future use.

AUDIO AND VIDEO INTERFERENCE CURES
KAHANER
HB21 — **$9.05**
A practical work about interference causes and cures that affect TV, radio, hi-fi, CB, and other devices. Provides all the information needed to stop interference. Schematic wiring diagrams of filters for all types of receivers and transmitters are included. Also, it supplies simple filter diagrams to eliminate radio and TV interference caused by noisy home appliances, neon lights, motors, etc.

BASIC TELEPHONE SWITCHING SYSTEMS
TALLEY
HB27 — **$15.25**
The Revised Second Edition of this book, for trainee and engineer alike, includes updated statistical data on telephone stations, and new and improved signaling methods and switching techniques. It also includes E & M signaling interface for electronic central offices and automatic number identification methods used in step-by-step, panel and crossbar central offices.

INTERRELATED INTEGRATED ELECTRONICS CIRCUITS FOR THE RADIO AMATEUR, TECHNICIAN, HOBBYIST AND CB'ER
MENDELSON
HB29 — **$11.35**
This book provides a variety of appealing projects that can be constructed by anyone from the hobbyist to the engineer. Construction details, layouts, and photographs are provided to simplify duplication. While most of the circuits are shown on printed circuit boards, every one can be duplicated on hand-wired, perforated boards. Each project is related to another projects so that several may be combined into a single package. The projects, divided into five major groups, include CMOS audio modules, passive devices tohelp in benchwork, test instruments, and games.

BASIC CARRIER TELEPHONY, THIRD EDITION
TALLEY
HB28 — **$14.45**
A basic course in the principles and applications of carrier telephony and its place in the overall communications picture. It is abundantly illustrated, with questions and problems throughout, and requires a minimum of mathematics.

ROBOTICS

THE COMPLETE HANDBOOK OF ROBOTICS
TAB No.1071 — **$13.45**
All the information you need to build a walking, talking mechanical friend appears in this book. Your robot can take many forms and various options — light, sound, and proximity sensors — are covered in depth.

HOW TO BUILD YOUR OWN SELF PROGRAMMING ROBOT
TAB No.1241 — **$13.45**
A practical guide on how to build a robot capable of learning how to adapt to a changing enviroment. The creature developed in the book, Rodney, is fully self programming, can develop theories to deal with situations and apply those theories in future circumstances.

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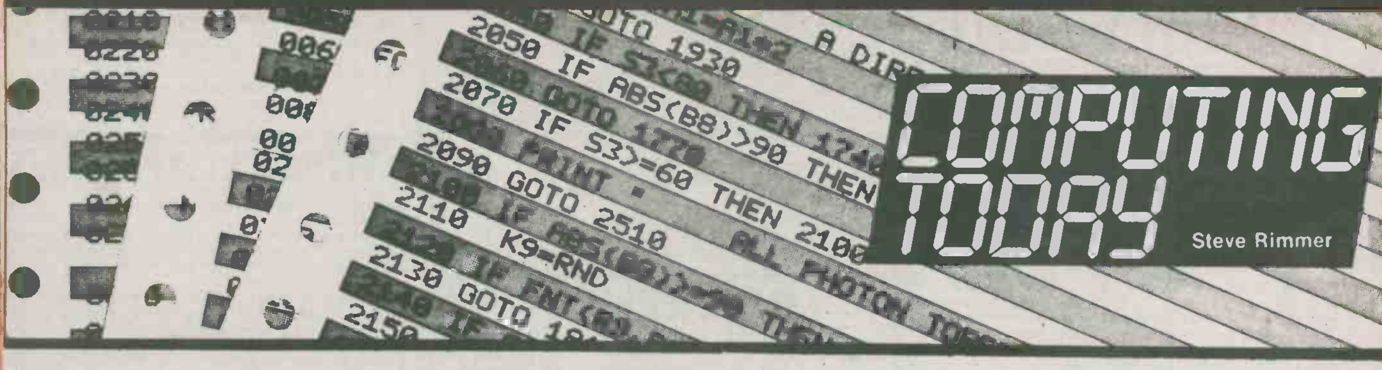


COMPUTING TODAY

Steve Rimmer

THE APPLE II was originally designed in 1976 by two guys (in a garage). It was neat for its time, but technology has long since outsripped it. Among its limitations are an on board RAM space of only 48K . . . a king's ransom in '76 but available for less than thirty dollars at today's prices. Then there's the video display, which is forty columns wide and upper case only. The on-board BASIC is the pits, and, in fact, most of the ensuing architecture leaves a lot to be desired.

However, the main concept behind the hardware design remains sound. The bus structure is fiendishly versatile and it is frequently noted, as a credit to its designers, that it is forever being turned to tasks its designers never even dreamed it could do. There is more third party hardware and software available for the Apple II than for almost any other microcomputer in existence.

Even at present, despite the ravages of time and pirates, the Apple II sells fairly well.

The limitations of the Apple can be corrected. You can plug in a Videx card to provide 80 column lines of characters, and a keyboard enhancer to permit the keyboard to handle lower case. A soft card will allow the Apple to run CP/M and MBASIC. A language card will add another 16K of RAM. Clearly, though, it is still an old system.

This January Apple introduced a revised version of the system, the Apple IIe at a press conference in Toronto. It looks a lot like the Apple II, although its keyboard, with a number of enhancements like shift lock and two programmable keys, more resembles that of the Apple III. As one might expect, the keyboard generates lower case characters now, and the screen can display them. The screen still only has forty characters to a line, although there is a plug in card available that will expand this to eightly.

The Apple IIe still uses a 6502 processor and the same general architecture as the Apple II. However, the board has been depopulated quite a lot, chopping the chip count from 110 small scale deals to 31 complex beasties. This includes two custom LSI chips which, at least for the time being, should keep anyone from pirating this fruit.

It is also possible to add a second 64K of RAM to the system in a bank switched arrangement, which is a good trip for VisiCalc models and other applications that use a lot of storage.

Asking the Apple heavies at the press conference about software compatibility was a bit of an exercise in translation. The system's software and structure is close to, but not identical with the Apple II. As such, most software for the older system will probably run on the Apple IIe. However, it was hard to pry from them the nature of the changes wrought and what could be expected to take exception to them. Some appear to be in the graphics section, which may mean that high resolution games will prove uncool.

Inasmuch as commercial Apple software is very deliberately made difficult to back up and get into, doing patches, even simple ones, on these things is probably all but impossible. As such, owners of Apple IIe's will have to wait for the manufacturers of the software they want to come up with compatable versions in the event of a mismatch.

The Apple IIe still sports what appears to be the oringinal Applesoft BASIC. The uninitiated should be aware that, by 1976 standards, Applesoft was sort of okay. Pity, what.

The beast costs $1995.00 Canadian, slightly less than an Apple II. All told, it's not a bad choice for a computer, although, if you are thinking of using a lot of the existing Apple II compatable stuff it will want a heavy scrutening.

Lisa

And then there's Lisa, the other system that was announced at Apple's press conference. What a trip. Lisa is by far one of the shiniest toys I've ever seen since I got my first 8K PET.

The Lisa, is, first off, a heavily business-oriented system. It goes for about fourteen grand. It is, said the dudes in the suits, a system for knowledge workers, whatever they are. It is supposed to be ultra user-friendly, capable of doing all sorts of amazing things and will communicate with one in quasi-human terms. Aside from that, it's neat.

Lisa stands for Local Integrated Software Architecture. Do they dream up the names first and then come up with words to fill them in, do you think? It looks a bit like a DEC terminal. It has two floppy drives and a very high resolution screen with software allocatable characters and heavy graphics capabilities. It can be communicated with using its keyboard, but its software is highly menu driven, and a lot of the interacting one does with the Lisa is via a small trackball controller called the "Mouse". You roll this thing around on your desk top and a cursor follows suit on the screen.

The system is based on Motorola's 68000 32/16 bit processor ... that's a thirty two bit wide internal bus with a sixteen bit data bus. It has a megabyte of RAM and two 5¼ inch floppies which can take 1.7 megabytes all told. There's also a five meg hard disk drive.

The main tube is black and white only, but supports 720 by 364 pixels or 40 lines of 132 characters. The screen can be dumped, graphics and all, to a dot matrix printer for complete reproduction. There are also communications facilities to be had and many other special purpose peripherals can be associated with the old girl through her several ports.

One may joke about the system being female but there was one Apple executive who referred to it as such quite seriously. I think he was in love.

The main trip of Lisa is unquestionably its software. The idea is for it to represent a desktop. There are little drawings of the things associated with one's desk on the bottom of the screen ... a trash can, a clock, a calculator, a clip board, a file and so on. The several main functions of the system are similarly represented along the right hand side of the screen. Each of these things can be

called up by moving the mouse cursor over its symbol and pushing its button. The software package is integrated, such that all menus are interactive with all other menus and one never has to actually run a program. You just leap from one bit to another as you see fit.

The programs themselves are heavily into menus. The menu pages appear upon command, growing out of the screen in a spray of concentric rectangles ... a tad Star Wars, but attractive. Let the boys down in the software department have their fun. Menu entries are mouse-selectable. Most of the programs work in Lisa's first rate graphics in some way.

The main Lisa package consists of an integrated set of the most used business programs. It is by no means all that can be run on the system ... there are lots of other packages available, such as several higher level languages ... and Apple expects a lot of stuff to come from third party suppliers. (Give me a Lisa and I'll write you a version of Camel Killer, lads.) The primordial Lisa's main menu selects between LisaCalc, which is, predictably, like VisiCalc, but with split pages and field formatting, LisaWrite, a word processor which, because of Lisa's hh resolution screen, can display text in different character fonts, bold, italics, underlines, and so on, LisaGraph, a graphic display program for LisaCalc data, LisaDraw, a complete graphic page craetion system, LisaList, a data base and, lastly, LisaProject. This final entry is actually fairly interesting, although you'll have to judge for yourself whether it's particularly useful. It allows one to construct these expansive spreadsheet-like flowcharts of the stages involved in multiple task projects and then to plan though them, editing the whole works, figuring out costs, timetabling and so on. It's fun to watch, of course ... I feel ill equipped to evaluate such a tool; I only use VisiCalc to figure out how much wood I need to build guitars, and then only 'cause I feel like I should use it for something. Forecasting software threatens my carefully manged chaos.

Sitting With The Girls

I think that Lisa-like systems are a bit of a threat to overall computer literacy. So much work has gone into it to make Lisa accessable to the user with no computer related experience that he or she will never actually have to acquire any. This only becomes an issue the day he or she wants to ascend beyond the limits of the software. Peering over the edge one sees the gaping maw of the untamed machine that has been writhing beneath the well tended landscape all along.

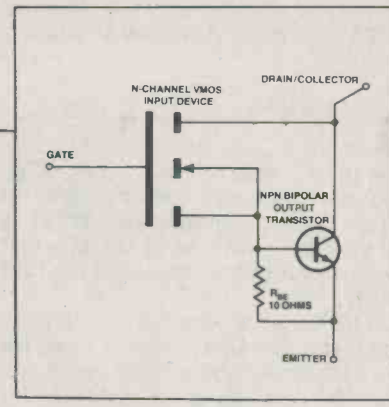
However, this caveat aside, it's definitely a blast, and a nice implementation of the state of the art. While its software is dripping with gimmicks it is unquestionably well thought out and most powerful. One may question whether the gimmicks make it appreciably better than an eight bit disk banger running the generic versions of these program but, hey, that is between you and your accountant. Probably a spiritually greater potential for the Lisa exists in other areas, most notably those of graphics and digital animation.

No home should be without one.

ETI

Superfet

A new monolithic device which allegedly has the advantages of VMOS devices combined with the high current handling capability and low saturation voltage of a bipolar transistor has been developed by Supertex Inc of California, and is claimed to offer considerably better switching performance than existing products. By Brian Dance.



THE INTERNAL circuit of the Superfet, shown here, consists of a VMOS input device — which provides an extremely high input impedance, a current gain of perhaps a hundred million and a very fast switching capability — and a bipolar output transistor specially designed to preserve the fast switching ability.

A 10 ohm resistor is connected between the base and emitter of the bipolar output transistor to prevent the device from being turned on by spurious transient signals. In fact, this resistor consists of 32 separate resistors connected in parallel to preserve the fast switching capability, while the output transistor has many small emitter regions connected to two output pads. The input VMOS transistor occupies about 40% of the area of the 6.5 mm by 6.2 mm chip.

The Supertex XN01 was the first Superfet described in a paper given at the US Powercon Conference recently. It consists of an n-channel enhancement mode DMOS power FET and an npn high current, high voltage power transistor.

It is a really high power device, available with voltage ratings from 350 V to 500 V, and can pass a continuous drain current of 20 A (40 A when pulsed) with a power dissipation that can reach 150 W.

A particular feature of this device is that a drain-emitter voltage of only 6 V can be used to produce the maximum current of 20 A. It is claimed that the saturation voltage of the Superfet is lower than that of any comparable power MOSFET device. Resistive switching speeds are comparable with those of power MOSFET devices and more than twice as fast as those of a comparable 450 V, 20 A power Darlington device.

Incidentally, it is not possible to make a circuit with the performance of a Superfet by connecting a VMOS device to a high-power bipolar transistor. The switching speeds of the available VMOS and bipolar devices are similar to or worse than that of the Superfet, while parasitic lead inductances in the connections to the two devices would drastically limit the operating speed.

Supertex has stated that even if devices with a faster switching capability should become available, it will not be possible to use them to match the performance of the Superfet owing to the lead inductances.

As in the case of all enhancement VMOS devices, the Superfet will be nonconducting at zero gate voltage (maximum current 10 mA at 25°C or 100 mA at 125°C). A positive potential applied to the gate will turn the device to its conducting state.

Applications of the Superfet are expected to lie mainly in fields where fast switching is needed at high power levels (e.g: switch mode power supplies). This device is likely to be much used in switched mode power supply units for higher frequencies than can easily be handled by high-power bipolar discrete transistors. Devices which will operate at 200 kHz or more are required for this purpose. Another application is in the field of ac motor control.

ETI

Device Type	Max. Drain-to-Emitter Voltage BV_{DES}	Drain-to-emitter Voltage V_{DE}	Current when Conducting
XNO135N1	350 V	6 V	20 A
XNO140N1	400 V	6 V	20 A
XNO145N1	450 V	6 V	20 A
XNO150N1	500 V	6 V	20 A

Summary of XNO1 device categories; all are in TO-3 packages.

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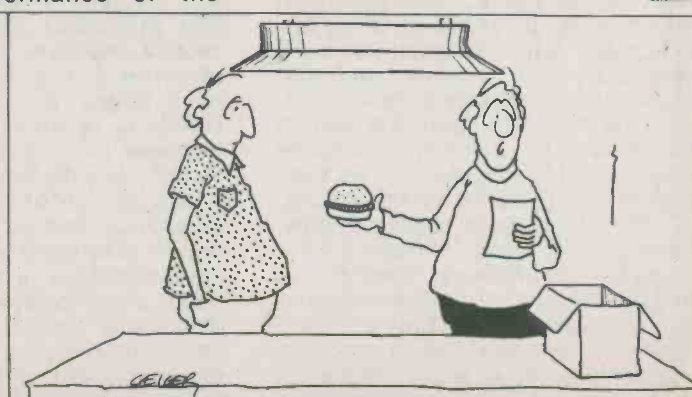

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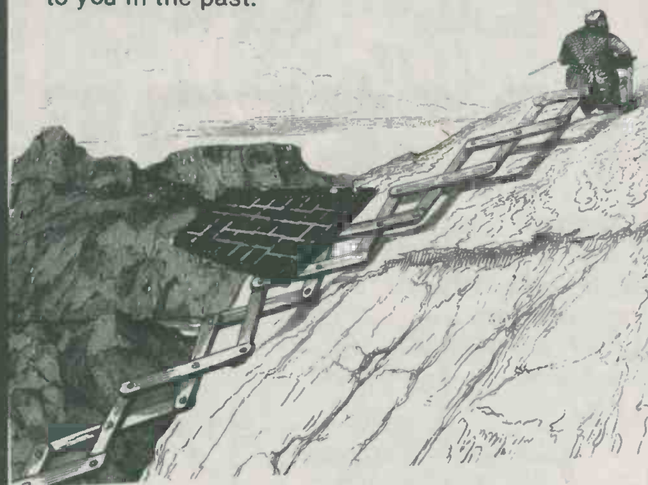

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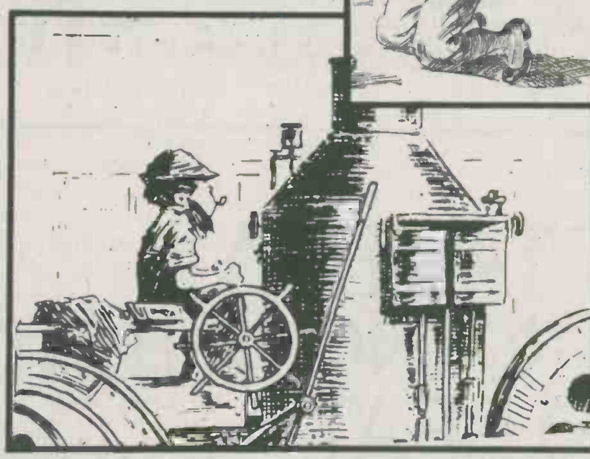

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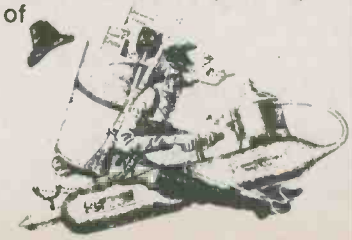

Into Digital Electronics Part 7

We're down to the real nitty-gritty this month as Ian Sinclair describes how simple counting circuits work. As usual there are plenty of practical circuits for you to experiment with.

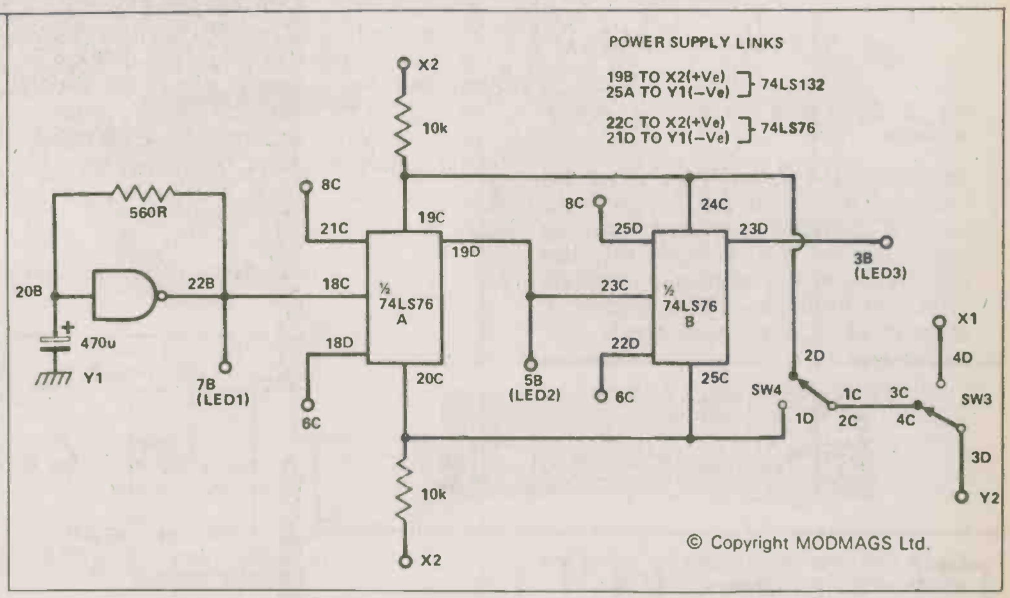

Fig. 1 Two-stage counter using a single 74LS76, with the 74LS132 providing clock pulses.

LAST MONTH, we spent some time making a J — K flip-flop toggle. In case you've forgotten, the J — K toggles when J = 1 and K = 1. This can be done by connecting each of these terminals to the +5V line or, if we're using slow clock speeds, just by ignoring them — unconnected inputs will 'float' to logic 1. As we don't want to encourage sloppy habits, we'll use a wire link to make quite sure that these terminals are at +5V.

The toggling J — K, like any other toggling flip-flop, gives one complete pulse out for two clock pulses in. What about using two such flip-flops, with the Q output of the first flip-flop connected to the clock input of the next? Nothing like trying it, and we can use the board more or less as it was connected before. Figure 1 shows the circuit, including the clock pulse generator and switch arrangements, just in case you've stripped or changed the board since last month. We're now making use of both of the flip-flops in the 74LS76 package.

Now in this circuit, LED1 indicates the clock pulses, LED2 shows the output of the first J — K and LED3 shows the output of the second J — K. The switches are still wired to control J, K, R and S, and so they have to be set with SW1 and 2 high, SW3 low and SW4 low. This resets both flip-flops (because we've connected both the R pins and both of the S pins to their respective control lines). When you're ready, push SW3 high so that the set/reset lines are no longer used, and watch the LEDs. The flashing is not just at random because these LEDs are indicating a two-stage binary count.

Binary Counting

If you haven't made friends with binary counting yet, then help is at hand. Instead of letting the clock pulse do the counting, we'll use a switch, SW1, so that there is a count each time we switch up and down. Now since this is a mechanical switch, its contacts will bounce, so the switch has to be rewired using an R — S flip-flop to get rid of the bouncing. This calls for the 74LS132 to be used, and Fig. 2 shows the complete circuit. You won't need to change the connections to the 74LS76 much, only the J and K pins need to be connected to +5 V instead of to the switches. The new connections around SW1 are shown, SW2 is not used, and SW3 and 4 are unchanged.

Now try again, using a bit of table filling this time. One of life's little confusions is that we show circuit diagrams with inputs coming from the left-hand side and outputs at the right-hand side. The input to a counter, however, goes to the counter unit which changes at each pulse, the units counter. When we write a number, though, we show the lowest value units on the right, J — K A is the units counter, its LED, LED2, is counting units, and its state (0 or 1) goes in column at the right of Table 1. The next J — K, B, is counting 2s and its state (0 or 1) goes in a column which is to the left of the first one.

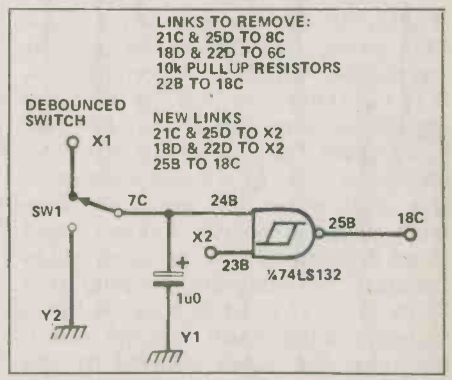

Fig. 2 Debounced switch clock generator for the counter.

BINARY		
TWO'S	UNITS	DENARY
0	0	0
0	1	1
1	0	2
1	1	3

Table 1. Binary outputs from units and twos counters and their denary equivalents.

Did I say units and 2s? Yes, because these counters don't use the familiar scale of ten, in which units up to 9 go into the units column, and each goes in the next column to the left (Fig. 3). Because J — K's count in 2s, the columns don't contain units, tens, hundreds, thousands, etc., but units, twos, fours, eights, etc. We're

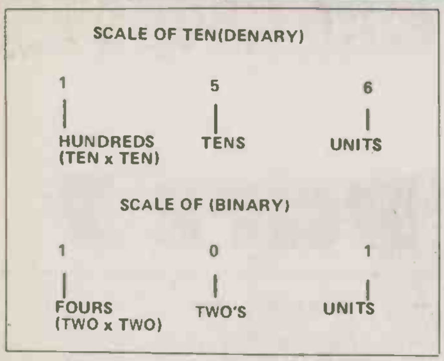

Fig. 3 Comparing binary and denary numbers.

using two J — K sections, so we are counting units with F/F A and two's with F/F B. Table 1 shows a counting sequence for two flip-flops, with the decimal numbers shown alongside. With two flip-flops we can count only up to three ($Q_B = 1$, a two, and $Q_A = 1$, a one, making a total of 3) before the flip-flops go back to $Q_B = 0$, $Q_A = 0$.

REMOVE LINKS:
25B TO 18C
7C TO CAPACITOR (REMOVE CAPACITOR ALSO)
CONNECT LINK:
7C TO 18C

Fig. 4 Connection changes for using the switch without the debounce circuit.

Before we move on, try the small modification which is shown in Fig. 4. This consists of moving the clock input connection of F/F A from the R — S to the switch, so that the debouncing circuit is no longer in use. Reset (SW3 down, then up again, with SW4 down), so that LEDs 2 and 3 are unlit. Use SW1 once, and see what happens. Keep using SW1, and you'll find in all probability that at some stage the count goes haywire, jumping from 01 to 11 or 11 to 01 and so on. What happens is that each time the switch bounces, the pulse created by the bounce is counted as another clock pulse by the flip-flops. It's for this reason that any switch which controls a pulse circuit needs to be debounced. Switches which simply set or reset don't need this treatment.

Now to greater things. Suppose we add another two J — K flip-flops to our circuit, in the form of another 74LS76. We can now have LEDs which indicate a 4s column and an 8s column, and we can count up to the binary number 1111, which is decimal 15. At this point, it's convenient to introduce a method of numbering flip-flops and outputs which is used a lot in digital circuitry. Instead of numbering 1,2,3 .... As usual, there's a perfectly good reason. Numbers such as 2, 4, 8, 16, 32, 64 and so on, which are the values of the quantities in

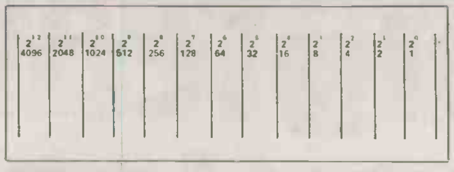

Fig. 5 Denary number columns for binary numbers, showing the powers of two.

binary number columns (Fig. 5) are all powers of 2. A power of 2 is the number of twos which have to be multiplied together to get the column number. For example, 4 is 2 x 2, two multiplied by itself, writeen 2^2. Eight is 2^3, or 2x2x2; sixteen is 2^4, 2x2x2x2. The power or index is written as a

COUNT	D (LED1)	C (LED2)	B (LED3)	A (LED4)
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Fig. 7 Blank truth table for the four-stage counter.

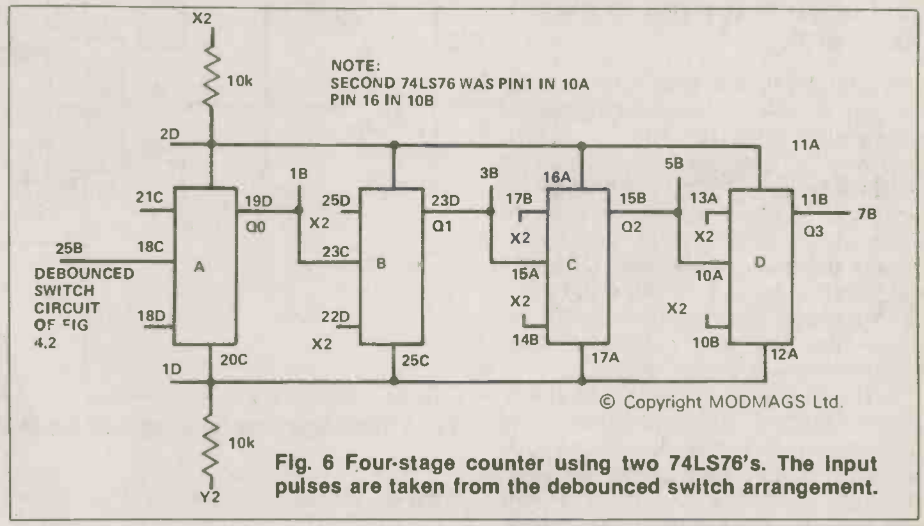

Fig. 6 Four-stage counter using two 74LS76's. The input pulses are taken from the debounced switch arrangement.

small number, raised higher than the 2 and on its right-hand side. A few hundred years ago, mathematicians agreed that the meaning of 2^1 would be simply 2, and 2^0 would mean 1. The columns for a four-digit binary number will be written as 2^3, 2^2, 2^1, 2^0, so we number the flip-flops F/F3, F/F2, F/F1, F/F0. This makes it a lot easier to remember what each flip-flop is counting, the number of the flip-flop is the power of two.

Having swallowed all that, have a go at the circuit of Fig. 6. It's a four-stage binary counter, using two 74LS76 ICs, and with the 74LS132 used for debouncing SW1. As usual, we start by resetting, with switches 3 and 4 both low, then SW3 set high. After that, each complete up-and-down movement of SW1 will cause a single pulse to be counted. Fill in the count table (Fig. 7) for yourself — it's quite a long one with 16 entries.

Once you've satisfied yourself that the count is a regular binary sequence (translation — each binary number is one greater than the one before), switch off and reconnect the 74LS132 as a clock oscillator, and use SW1 in a gating circuit (Fig. 8) with one of the spare NAND gates of

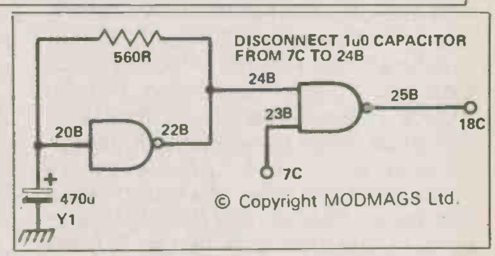

Fig. 8 Gating the clock pulses to the counter so that the clock pulses can be stopped and started. Use this in place of the debounced switch.

the 74LS132. The reset action is as normal, but now counting will take place only if SW1 is at logic 1. You can interrupt the count at any time, and the number of pulses which have entered the counter (at the clock input of F/F0) will have caused LEDs to light. They stay lit when the counting stops. If you don't reset, switch off or start counting again. The number of pulses remains stored in the form of flip-flop outputs for as long as you like. You can use SW1 to count a few more pulses, then stop again just as you wish; this is one more step in the construction of a binary counter. We'll continue next month with the LS76 used in more counters and shift registers. ETI

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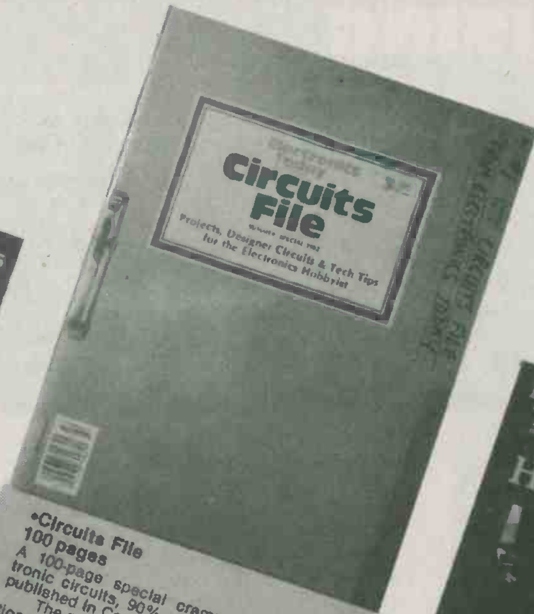

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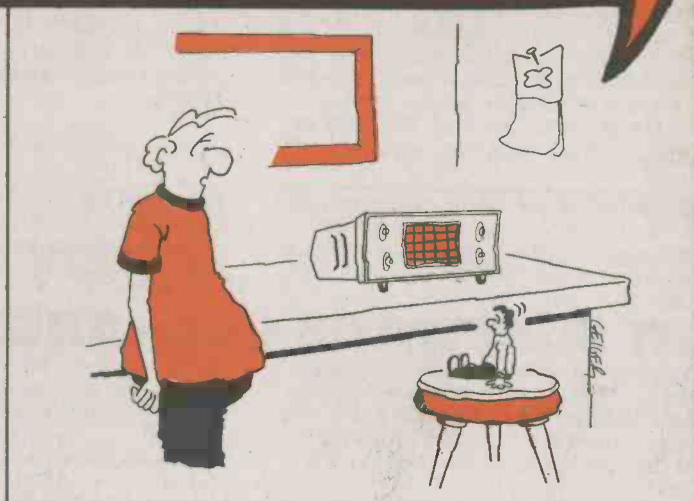
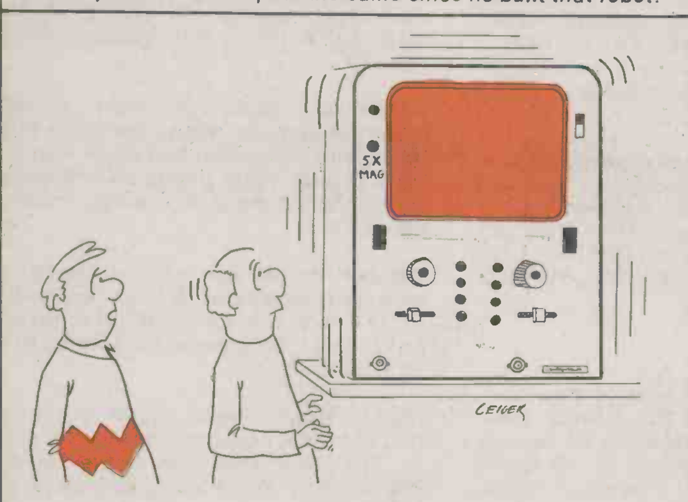


I told you not to touch the attenuator switch.



You must have pushed the 'Magnification' button

It plays disco music at an extremely high frequency — replels all types of insects within a two mile radius.

She became offended when I suggested she might be interested in our new 5-digit digital bathroom scale.

That's just the overload indicator.

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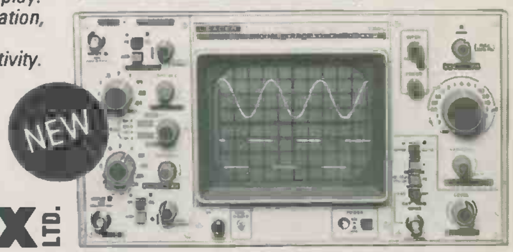

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19 x 4	17 x 3.5 x 12	42.50
19 x 3	17 x 2.5 x 10	37.50
19 x 2.5	17 x 2 x 10	36.50
17 x 6	15.5 x 5.5. x 9	41.50
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12 x 6	11.5 x 5.5 x 7	29.50
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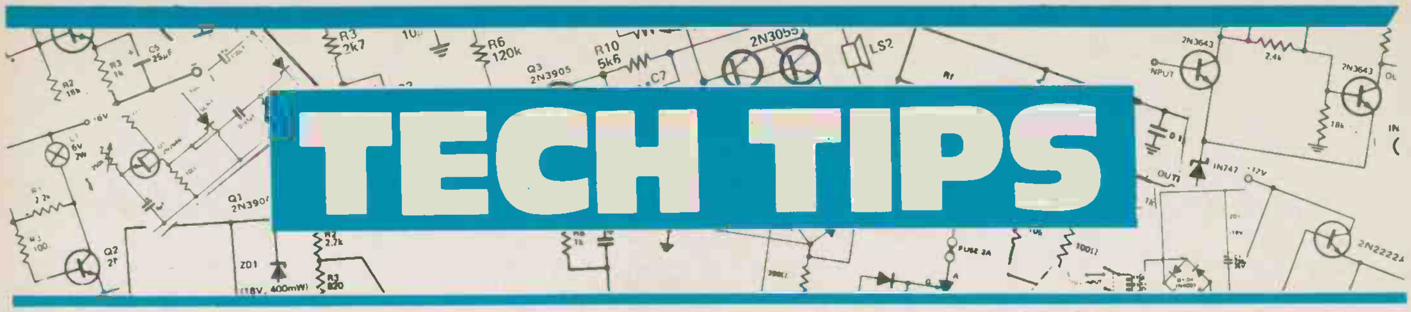
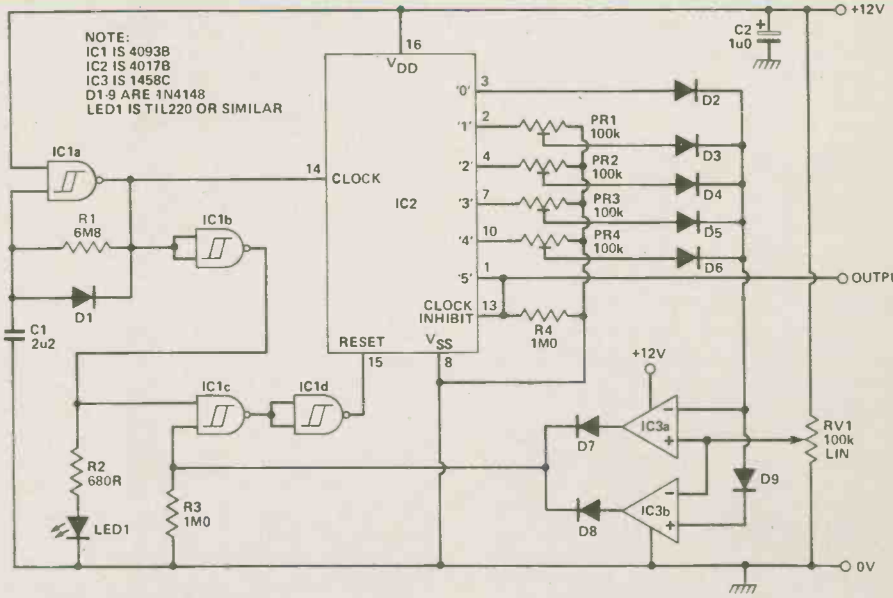


TECH TIPS

Rotary Combination Lock
Chris Pearce



There are many circuits for push-button and rotary switch combination locks, but this circuit uses a potentiometer to enter the four-digit code (easily expanded to eight). LED1 flashes approximately every 2 seconds. To enter the code, the potentiometer must be turned to the first digit for the duration of one flash, then moved to the next digit, ready for the next flash, and so on until the code is entered. If a wrong number is entered at any time the lock will reset and the code must be re-entered.

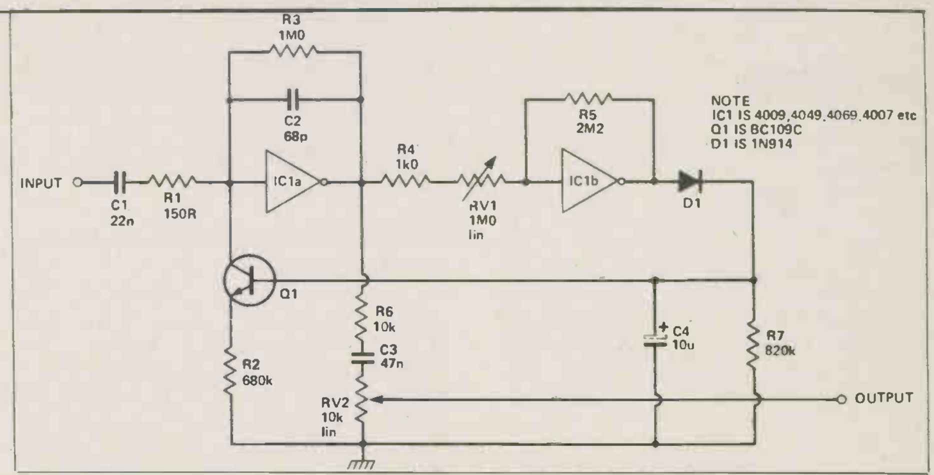
RV1 should be set up so that it can point to a number between 1 and 10. As a 12 V supply was used, '1' corresponds to 2 V, '2 to 3 V, and so on. Circuit operation is as follows: IC1a and C1, R1, D1 form an oscillator which provides clock pulses for the circuit timing. This clock pulse drives IC2 and is also inverted to drive LED1 and the reset logic.

Assuming IC2 is reset and the code is '1234', a high will appear at IC2 pin 3, which corresponds to a count of '0'. On receiving the next clock pulse, the high will move to count '1' (pin 2). This will drive PR1, and thus feed a voltage to the window comparator IC3. D9 sets the window width at 0V6. As the first digit of the code is '1', which corresponds to 2V, PR1 will be set to 2V9, allowing for 0V6 dropped across D3, and thus settig the upper window limit to 2V3 and the lower to 1V7. If, when the LED flashes, the potentiometer is set to within the limits, the comparator output will be low and IC2 cannot be reset. On the next clock pulse IC2 will move to count '2' ready for the next digit and so on.

If the potentiometer is outside the limit ie the wrong number, the comparator output will be high and IC2 will be reset when the LED flashes. If the correct code is entered the clock of IC2 will be inhibited via pin 13 and the output will be high. To set the lock the potentiometer is moved off the last digit.

C1 should not be electrolytic. C2 provides decoupling and should be placed near IC3. The chance of breaking the four digit code in any one attempt is 1 in 10,000, and 1 in 100,000,000 for an eight digit code.

CMOS Sustainer for Electric Guitar
S.P. Giles, Edmonton



I believe this must be one of the simplest and cheapest sustainers for electric guitars around. IC1a and IC1b are both CMOS inverters, wired to act as op-amps. Any inverter will do the trick, such as 4009, 4049, 4069 or 4007.

The gain of IC1a is determined by the collector-emitter resistance of Q1 plus R2. If the output level is to remain constant while the guitar note decays away, the gain of IC1a must be increased by a corresponding amount. This is achieved by rectifying the output of IC1a through IC1b and D1 and passing the resultant DC voltage, which is smoothed by C4 and R7, to the base of Q1. This forces the collector-emitter resistance of Q1 to increase in proportion to the input level from the guitar. RV2 can be set to any desired level and when set high can easily overdrive the input stage of the guitar amplifier giving a tube-type of distortion.

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BASIC can make use of. While running a program, it is possible to have the program accept input from these dudes. However, even more useful is that they can be programmed in quite a different way in the direct mode to assist in program development. Each key can store a string which, when the key is depressed, will be printed up on the screen in the next available cursor location. Thus, if key 1 had the string "LIST" + CHR$(13), hitting it would be all that would be required to list the current program.

The keys actually have default strings in them ... actually uncharacteristically badly chosen for several of them (the LIST lacks a carriage return, for example) but they can be altered by the user. One innovation which would have been a trip would have been the capacity of storing all the key strings in a disk file so that each user could permanently define the keys in a useful way. I think I'd be tempted to patch this with the debugger if I owned a Z-100.

Finally, the BASIC possesses genuine pseudo-PET screen editing. Like the if 800, it makes scant mention of this, but, as with the CBM machines, editing a line of text requires nothing more than cursoring up to it, doing the changes and hitting a line return anywhere in the line to re-enter the modified line into RAM. This is manifestly easier than fighting with EDIT functions.

Huge BASICs like this one are glacially slow and they do tie up an awful lot of RAM. However, this one does do very nice work indeed, and will prove suitable both for playing and for doing special purpose business and scientific programs. If you want the thing to operate in your lifetime be prepared to go for a much lower level language or, gasp, machine code.

More Bitsies

The Z-100 came with quite a lot of other neat stuff, including a business package of some sort called Multiplan. It also had some communication facilities that looked promising, and its rather fast clock speed looked to do rather well on our benchmarks. However, prior to our getting all this together Zenith unexpectedly showed up and scarffled their machine back, so, sadly, we never got to try out all the other fun software toys.

The hardware on which all this software runs is probably worth a mention, as it's pretty nifty. The Z-100 (either version) comes in a fairly brutal high impact plastic case. In the usual position for the keyboard we find ... keys. Yes, lots of 'em. The keyboard was among the best we've tried, being a real trip even for long grueling sessions of typing. It is fully buffered, and some fooling with the interrupts revealed that you can actually get seventeen characters into its buffer before it overflows and freaks. The keys click, but you can shut them up if you want to. There are the twelve aforementioned programmable keys, a numeric keypad, cursor movers and a fast repeat (regular speed repeat happens when you hold down any key). The only minor drag in the keyboard is that there is a vast plethora of deletes and backspaces; it's often hard to know which one is called for in a given situation.

The actual computer within is built on a single motherboard. However, unlike most such systems, it supports the S-100 bus (hence the name of the machine, one might suppose. Zoltan always liked busses because he didn't have to worry about drivers.) There is a card cage with five slots and the like. The CPU, however, not on a bus card, but, rather, on the motherboard. Only the floppy controller is plugged in. While this does not permit one to go switching CPUs at a later date, the bus can accept additional RAM cards and will support any special purpose cards one feels like giving it. Quite nice, actually.

There are two serial ports out back to facilitate communications. They're fully software programmable, dealing with baud rates from 110 to 38,000.

The screen of the Z-100 has twenty five lines of eighty characters. The actual character patterns are read from a RAM buffer and, as such, are redefinable. The characters are effectively plotted on a high resolution screen, meaning that you can have them plus graphics up there at the same time with no concern as to position. The screen can display high resolution pictures with 640 by 225 pixels, with an optional increase in vertical resolution to 500 pixels using a special monitor. RGB and composite video are available.

The machine comes with two 5¼ inch disk drives in your choice of single or double sided configurations. Each drive can hold up to 640K of data formatted. The thing will also support a single external eight inch drive. If you don't like all of these permutations you can rip out one of the floppies and replace it with a little five inch Winchester, holding 5.3 megabytes.

The system's documentation was extensive ... huge three ringed binders full or stuff ... and all right. The BASIC manual was a bit thin on examples and detail in a few places, but there was lots of low level hardware documentation, which is a lot harder to do without. There was not as much low level documentation on the ZDOS as one might like if one were to try writing programs for it, but it could be puzzled out.

Playing 'Til Dawn

As fiendishly expensive, splendidly functional computers go, the Z-100 is right up there. It's loaded with stuff, well constructed and its creators have only done a few things not entirely in the user's best interest, which is really pretty good. It will serve the needs of business applications very well, especially in those situations wherein a computer is called on to perform a number of tasks, such as word processing, presentations, financial planning, and so on. There are few colour tubes which can equal the crispness of a decent black and white monitor, so in situations that call for the machine to be stared at a lot, such as in word processing, a second tube should be hung off the composite video port.

As alluded to before, with exception of its not having a built in printer, the Z-100 is almost identical to the if 800. If you were waiting for an if in a plastic box, here's your chance. On the the other hand, the if, replete with printer, is fractionally cheaper.

As for a home system to play with ... if you can spring the bucks, go for it.

Oh thrills, Billy, let's write a flight simulator and get high ...

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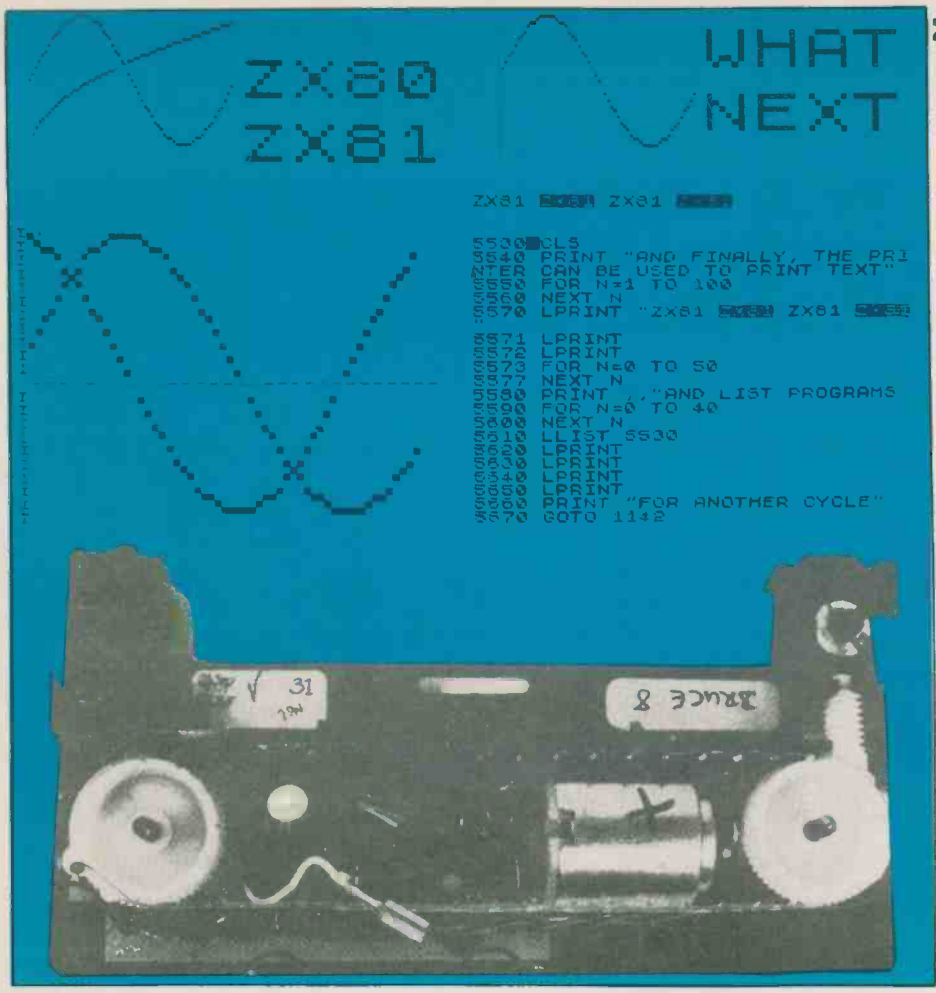
Circle No. 23 on Reader Service Card.

Circle No. 4 on Reader Service Card.



The internal workings of the printer. The belt carrying the two styli runs between the two white pulleys. Some examples of the printout are shown on this page.

ZX81 Printer

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the range ±21 actioned. Although unlikely to cause much confusion, it must be remembered that the output from LPRINT is not printed immediately but stored in a buffer one line long. The computer will only print:

1) when the buffer is full
2) after an LPRINT statement that does not end in comma or semicolon
3) when a comma or TAB item requires a new line
4) at the end of a program if there is anything left unprinted.

In conclusion

The printout presented by the ZX printer was clear and readable with no disturbing fuzziness which occasionally has been seen with other systems. Graphic symbols can 'join up' from line to line, giving a clear, continuous picture. Keeping the printer clean is probably very important, and although the review model has been tested to some extent, long term reliability cannot be commented upon. As with the ZX81 and the ZX80 before it, the ZX printer offers something that, for the initial outlay, is quite remarkable, and can only add to the effectiveness of your ZX system. ETI

Kitchen Scales

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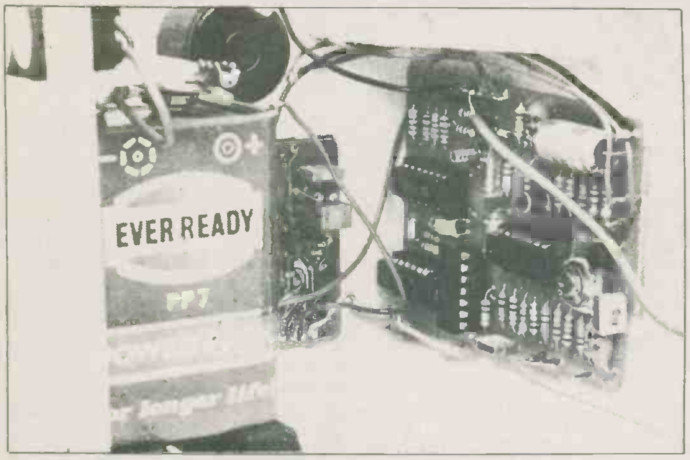
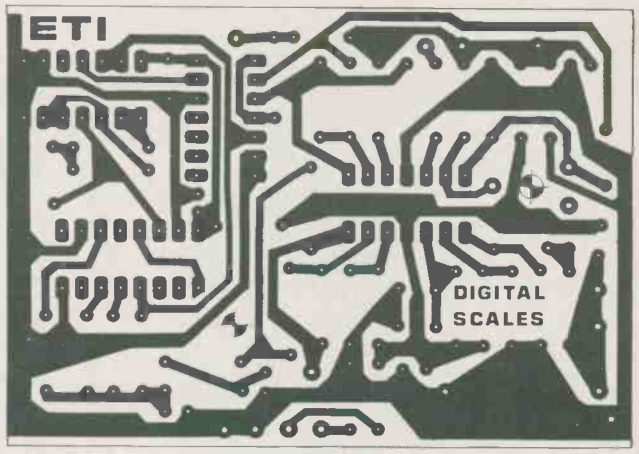


An internal view showing the arrangement of the boards.



HOW IT WORKS

The block diagram of Fig. 5 gives an overview of the circuit operation. essentially, a Linear Variable Differential Transformer (LVDT) is used as a transducer, providing a voltage proportional to the displacement of its moveable core (a spring movement initially provides the linear displacement with weight). The circuitry generates the LVDT drive waveforms and uses a phase-locked detection technique to recover a stable voltage related to position (and thus weight). The voltage measurement obtained is displayed on a 3½ digit LCD DVM module to give a direct readout in kilograms.

Figure 3 illustrates the principle of the LVDT using an AC excitation signal. All the circuitry on the left of the LVDT shown in Fig. 1 is involved in supplying a stable 10 kHz sine wave to drive the primary coil. To achieve the required amplitude and frequency stability the sine wave is generated digitally using an even length walking ring counter based on IC2, the 4018 divide-by-(2 to 10) synchronous counter. IC2 is configured as a five stage divide-by-10 counter by feeding back the Q5 output on pin 13 to the input on pin 1. The Q1-Q4 outputs are summed with selected resistors R5-8, thus approximating the sine wave. The counter is clocked at pin 14 from a 100 kHz astable oscillator formed from IC3a,b. Since the counter divides by 10 the sine wave generated with always be one-tenth of the clock frequency, ie 10 kHz. The coil excitation frequency thus depends only on the C2/R9 astable time constant, and the amplitude only on the CMOS supply voltage.

The stability of the voltage levels is ensured by using a precision 5 V supply based on the bandgap reference diode D1. The op-amp used to regulate this supply (IC1a) actually powers itself from the 5 V output, thus stabilising its own power rails. A bias current of about 1.5 mA (also taken from the 5V rail) is fed to the reference diode through R2, to produce an extremely stable voltage of 1V2 at the non-inverting input of the op-amp. The other (inverting) input of the op-amp is taken from the R3-R12 potential divider, the ratio of which sets the 5 V output due to negative feedback around the op-amp and series pass transistor Q1. ZD1, a 2V7 zener diode, allows the output of the op-amp to keep the base of Q1 at 5V6 while operating well below its own supply rail voltage.

The 5 V rail supplies all the circuitry but a separate digital ground is used for the logic ICs. This prevents digital noise from affecting the analogue signal measurement. C1 provides smoothing for the analogue supply rails, while C3 and C4 provide smoothing and decoupling for the digital circuitry.

Capacitor C6 filters the digital sine wave approximation from IC2, which is then attenuated to about 50 mV by the R14/C7 low-pass filter network. The resulting signal, a much better sine wave, is fed to the bandpass filter and coil driver amplifier based around IC1b. IC1b is configured as a standard 10 kHz active bandpass filter and gives a very pure sine wave on its output at pin 7 for driving the LVDT.

The LVDT primary coil has few turns and a correspondingly low resistance of about 4 ohms. Since IC1b (part of an LM324) can only supply about 25 mA of output current, the peak sine wave amplitude driving the coil should not be more than about 100 mV. Also, the output impedance of the op-amp should be very low. This is because the excitation voltage must remain constant as the primary coil inductance changes due to the core displacement. DC coupling is thus used between the coil and the op-amp output.

The sine wave swings ±50 mV about a reference level set at 50 mV above the analogue ground. This is only possible due to the ground sensing capability of the LM324 op-amp. Potential divider R13/R4 directly divides the precision 5 V supply by 100 to provide this reference level at the non-inverting input on pin 5.

The voltage output from the differential secondary of the LVDT (illustrated in Fig. 3) is amplified by IC1c. This op-amp is configured as a non-inverting DC amplifier with a high input impedance and a gain of around 20, the latter being determined by PR1. The 10 kHz sine wave signal is directly coupled from the coil and will be centred around the 2V5 reference rail provided by the potential divider R17, R18. The secondary is wired 'series opposing' such that there will be no signal when the ferrite core is centred.

The phase-locked detection is performed by multiplying the signal by +1 and −1 on alternate half-cycles of the sine wave to produce a bipolar signal centred about the reference level. IC1d, the last op-amp in the LM324 package, is configured as a straightforward inverter, AC-coupled to the sine wave signal. Two CMOS analogue switches, IC4a, 4b, switch the signal either directly (x 1) or through the inverter (x − 1) on each separate half cycle. They are switched alternately, using logic inverter IC3c, from pin 4 of IC2, a square wave output of the digital sine wave generator. This produces the waveforms shown in Fig. 4 since the square wave edges correspond to the zero-crossing points of the sine wave after detection.

The resulting phase-detected signal is low-pass filtered by R28 and C12 to produce a ±100 mV DC voltage, linearly proportional to the displacement of the LVDT. A further voltage is provided by the 10-turn potentiometer RV1 in conjunction with the potential dividers R26 and R27. A reference of ±300 mV (relative to the 2V5 rail) is available at the slider of RV1. The two voltages are fed to the differential input of the LCD panel meter. This allows the digital scale to be returned to zero readout, allowing further measurements when, say, 1 kg is already being registered. The diagram of Fig. 2 shows how the LCD voltmeter is wired up for our application to give a 200 mV full scale deflection (corresponding to 2 kg).

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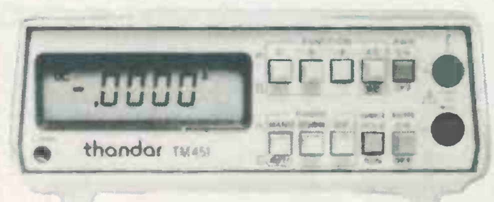

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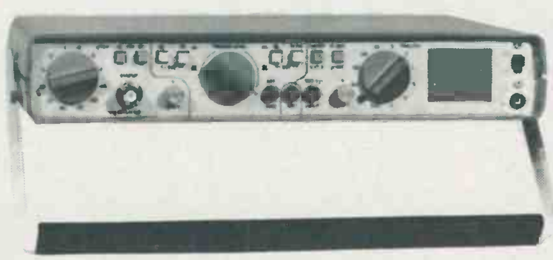

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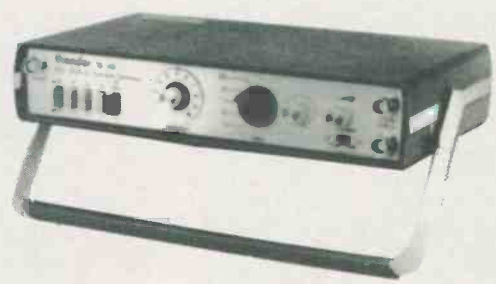

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Starlab

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A faint X-ray SNR is visible in the bottom right hand corner of this picture of a field of the Large Magellanic Cloud, taken with the 2D photon counting array fitted to the 1 m telescope at Siding Spring Observatory through a Hx filter in a 1000 second exposure.

Another view of the mock-up model of Starlab emerging from the instrument bay of the Space Shuttle.

The main observable difference between the two models lies in the density of matter at extreme distances from Earth. Unfortunately, the present generation of Earth-based telescopes is incapable of seeing quite far enough.

Starlab will be able to see objects as faint as magnitude 24, considerably better than the best ground-based observatories. Scientists are guessing that this will enable them to view objects receding from us at a massive 80% of the speed of light. That is most of the way back to the big bang, and should certainly be sufficient to decide the shape of the universe we live in.

If the money is forthcoming, the first mission will be in 1989. Current plans call for the shuttle to retrieve Starlab some six to twelve months later. After servicing and possible reinstrumentation there will be a second and longer flight.

There is no reason why Starlab should not be used until it becomes so obsolete that no more worthwhile astronomy can be done with it. One would think that by then we would certainly have got our money's worth out of it!

Most astronomers would bet that it will have changed the way we look at the universe. ETI

Close Captioning T.V.

Continued from page 24

is arranged and the floppy discs sent by air to Toronto. The French language programming is done in Montreal. While the CBC has not yet quite fulfilled its undertaking to the Parlimentary Committee on the Disabled and Handicapped during the Year of the Disabled (1981) to provide five hours of close captioned material programming per week both in French and English, it has almost met this undertaking, of which only one hour (*Barney Miller* and *Three's Company*) are US imports.

A recent experiment, demonstrating the compatibility of Line 21 TeleCaptioning with the British VideoText and Teletext, involved WJLA-TV, Channel 7, Washington D.C. The purpose of the experiment was to prove the same captions can be seen at the same time on decoders built for either system. The difference between the system is that TeleCaptioning is specifically designed for telecaption programming for the hearing impaired while Teletext is designed as a large volume information system for many different television viewers, of which telecaptioning for the hearing impaired is only one use. The benefits of the compatibility between systems is that it means that a broadcaster can serve any audience easily and economically, without making any financial investment.

In Canada, there are some 200,000 severely hearing impaired persons. While the number of TeleCaption Adapters sold in this country is not known, up until November 1982 some 60,000 had been sold in North America as a whole. The expected cost to the CBC to provide the five hours of programming a week in the two official languages is approximately one million dollars a year, pro-rated at the American experience of $2,000 (US) per hour. ETI