Electronics Today

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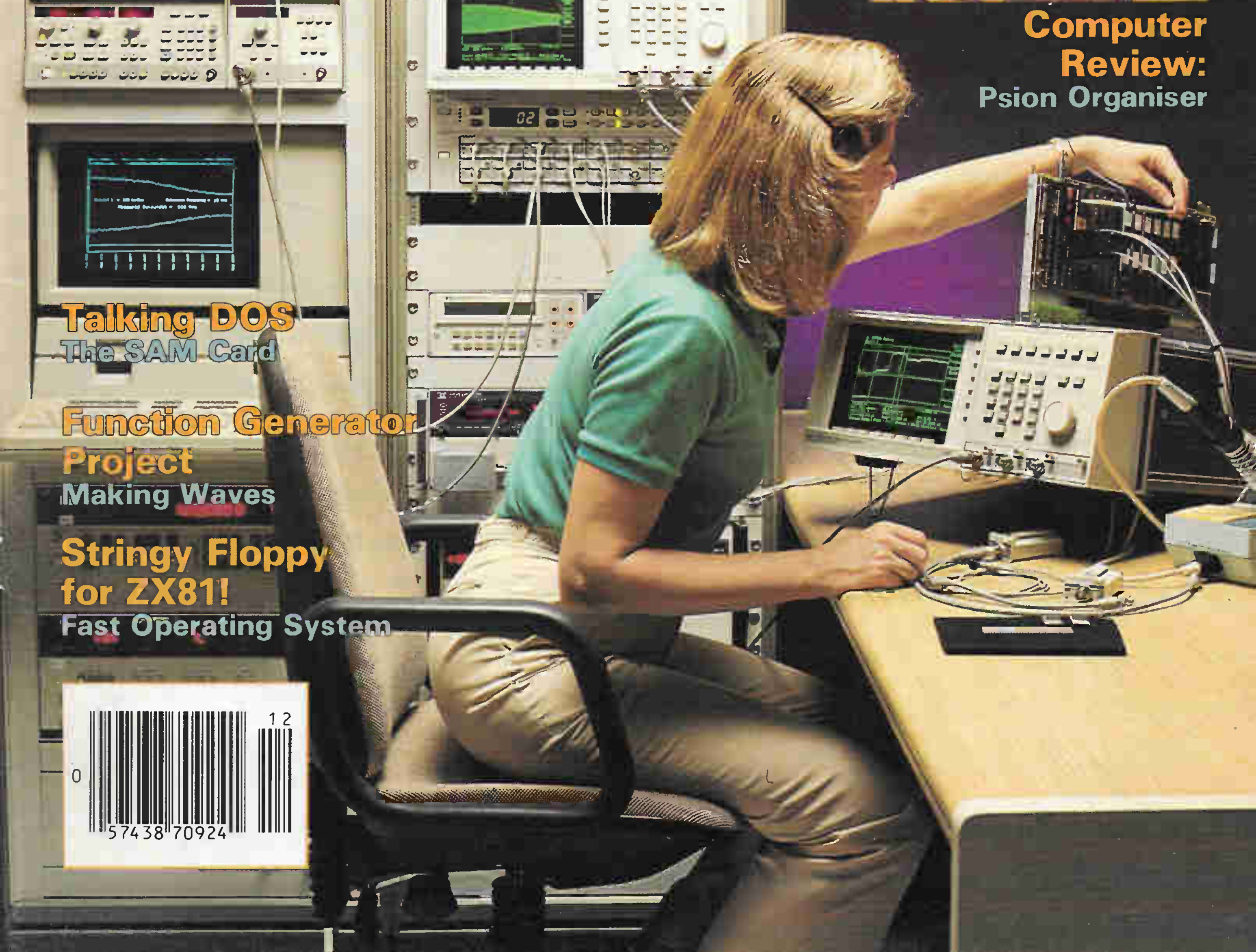
MM70924

December 1984

Canada's Magazine for Electronics & Computing Enthusiasts

Test Equipment
More on What's Available

Computer Review:
Psion Organiser



Talking DOS
The SAM Card

Function Generator Project
Making Waves

Stringy Floppy for ZX81!
Fast Operating System

12
0 57438 70924

The "BEST"
Superb IBM Compatible

XMAS Special
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Not a kit — a complete system

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in March 1984
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- **64K of RAM with presocketed provision for 256K**
- **One disk drive. SA455. Double Sided. Double Density**
- **Colour Video Board**
- **Floppy controller capable of handling up to four DSDD 5¼" disk drives and socketed for optional serial port and real time clock**
- **Monitor not included.**
- **64K RAM upgrade kits for extra memory . . . $57.00**

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This system includes Phoenix Software Bios

OR The Loaded "BEST"
Everything in our $1450 System plus:
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The BEST is a compatible microcomputer featuring the following: 8088 processor running at 4.77 MHz for fast service. (Room for the optional new co-processors, the most popular being the 8087 "number crunching" processor)

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- 5 expansion slots each being identical, so the user can upgrade his machine with IBM compatible hardware.
- D.M.A. controller. Three of the DMA channels are available to the user.
- A timer/counter. This is used by the system for time of day clock; tone generation of the speaker; and a time base.
- An 8 level interrupt controller, 6 of which are bussed to the expansion slots for feature cards. The other two are used for the time of day clock, and the keyboard circuits. (There is also a NMI which is not user accessable since it is used for parity checks)
- Three ROM sockets are available to the user, one generally holds the system BIOS, and the other two can hold any firmware the user wishes to implement.
- A speaker with ½ W of driving power is available to user software which can also control the frequency of oscillation. In fact 3 methods exist to modulate the speakers output: 1) direct control or the output bit stream. 2) output from the programmable timer. 3) the timer clock can be modulated with a program controlled I/O register bit.
- A keyboard interface which is compatible with all IBM compatible keyboards through a 5 pin DIN connector.

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UNHEARD OF PRICE! 8088 Computer $1349

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- Colour Video board
- Floppy controller with provision of (but not including) RS232 and real time clock.
- One SA455 DS,DD Shugart 5¼ inch disk drive
- Motherboard completely socketed with AMP sockets

For the price of $1349 you get a blank 2764 EPROM, but pay extra $55 and get the Phoenix Software Bios!

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Full/half duplex, autoanswer/autodial, touch tone or pulse dial, compatible to systems sold by our competitors for $220.00.

Apple Compatible Disk Drives (SA390)	$229.00
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Colour Video Board **$178.00**
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Test equipment photo courtesy of Hewlett-Packard Canada; the Psion Organiser was photographed by Bill Markwick.

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ZX81 Tape Drive, p 34

Psion Review, p 38

Features

Reviews

Projects

Series

Columns, News, and Information

READER OFFER

THE PSION
THE WORLD'S FIRST PRAC

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Imagine how much more convenient and simple your life could be will a full-feature microcomputer — including screen, keyboard, mass storage and software in your pocket.

That's what THE PSION ORGANISER gives you — a uniquely versatile and innovative computing resource incorporating hybrid microprocessor technoloy more advanced and powerful than that found in micro computers twenty times the price!

A UNIQUE NEW INVENTION

Thanks to a Psion-pioneered breakthrough in solid-state drive technology, the ORGANISER's data program packs offer open-ended, failsafe storage and ultra-fast operation.

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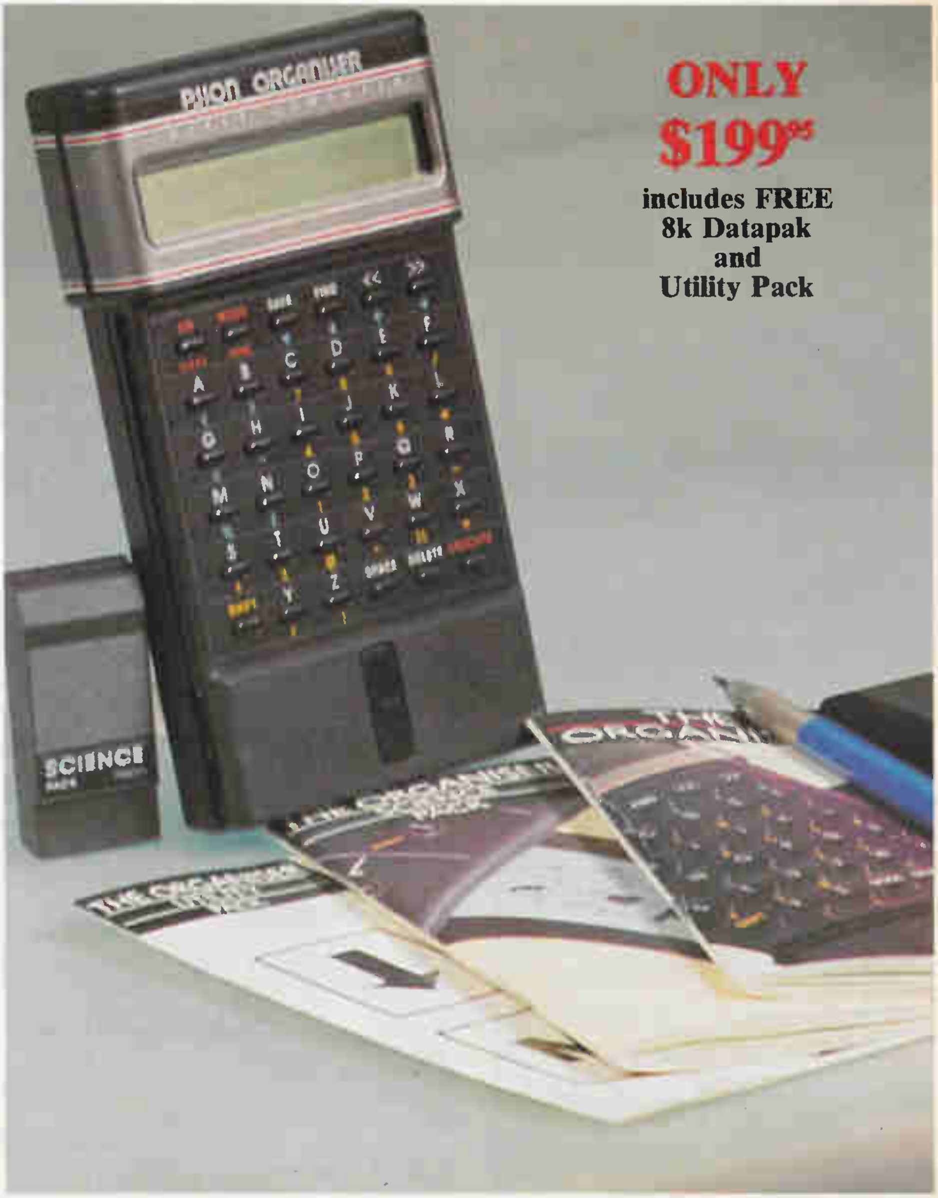
- **The purpose-designed POPL programming language enables you to write and save your own programs.**
- **Communicate with office computers, printers and other peripherals through a standard RS232 interface.**

PACKED WITH EXCLUSIVE FEATURES

- Solid-state drives access information in milliseconds.
- Information stored on datapaks is totally secure. Datapaks may be removed from the Organiser and still retain their information. Datapaks are re-useable through formatting.
- Solid-state drives allow the open-ended use of software and data. There's no limit to the amount of information or variety of programs which can be slotted into the drives.
- Auto-switch off after 5 minutes and low power-consumption CMOS components give six months' life in typical use with standard 9V battery.
- 16 character alpha-umeric display with scrolling over a 200 character record with adjustable contrast.
- Includes an editable calculator. Lets you carry out complex calculations involving up to 200 characters and two levels of brackets. Using the editing facility you can amend your calculation during entry. Moreover, you can go back and edit both data and formulae after a calculation has been carried out allowing you to carry out "what if" analyses.



- The special UTILITY PACK extends the power of the calculator even further with an extensive range of additional mathematical and scientific functions.
- Includes time and date clock function.
- Tough, protective sliding case.
- British designed and built with the highest quality engineering including gold-plated contact points and connectors for rugged, reliable use.

THE PSION ORGANISER: THREE WAYS TO PRACTICAL POCKET-COMPUTING

Use THE PSION ORGANISER in any of three ways:

AS YOUR OWN PRIVATE DATABASE TO STORE PERSONAL INFORMATION AND RETRIEVE IT INSTANTLY

You can use the Organiser to sort all the vital day-to-day information you need —

Names and addresses	**Costomer and supplier records**
Meeting notes	**Survey information**
Schedules	**Statistics**
Important dates	**Exchange rates**
Expense details	**Experimental data**
Restaurants	**Personal Reminders**
Timetables	

ORGANISER
TICAL POCKET COMPUTER

THE PSION ORGANISER: IT'S LIKE HAVING A FILING SYSTEM IN YOUR POCKET

Forget about diaries, notebooks and the backs of old envelopes. THE PSION ORGANISER allows you to type in information as you want and file it away at the touch of a key for instant future reference.

Retrieving information is every bit as simple. Just type in a keyword, a few characters, or even a date or number. THE PSION ORGANISER will search out the appropriate records and display them on the LCD screen. The simple scrolling facility allows you to view an entire entry up to 200 characters long.

Entries can be easily amended and edited and, since all data is permanently stored, there is no danger of it being lost — even if the battery is disconnected. A choice of 8k or 16k datapaks is available for you to build up an infinitely large information base.

WITH READY-TO-RUN SOFTWARE FOR IMMEDIATE PROBLEM SOLVING

A comprehensive range of ready-written software programs is already available for THE PSION ORGANISER and more are on the way.

FINANCE

Mortgage — monthly repayments
Cash Flow — net present value internal rate of return
Investment — bond redemption yield, equity price to earnings ratio estimates
Compound Interest — payments, present value, capital appreciation, savings
Depreciation — straight line, reducing balace, lifetime estimate, depreciation charge schedule, book value schedule

SCIENCE

Physical Constants — Planck, electron mass, electron charge, Rydberg, Gravitation, Avogardro, speed of light, sound. Gas constant, permeability, permittivity, earth radius, Bohr radius, Astronomic unit, etc.
Conversion Factors — UK to MKS etc.
FORMULAE — LC circuit, Lenses, Bohr energy levels, Larmor, plasma, etc.
Integration Under a Curve
Lest Square Fit
Solution of Polynomial Equations

UTILITY

LOG, ALOG, LN, SQRT, EXP, SIN, COS, TAN, ATN, ABS, INT, DEG, RAD, MOD, MIN, MAX, FAC, SGN, ROUND, MEAN, STDEV, PI, RND, RAND, ENG, FIX, POWER FUNCTION AND COPY.

MATHEMATICS

Bessel — functions
Polynomials — solutions of equations
Matrices — solution of matrix equations, Eigenvalues
Integration — under a curve
Curve-fitting — least squares
Statistics — mean, standard deviation, Chi-squared

LINK-UP COMMUNICATIONS

— Industry standard RS232 with ribbon cable plugs into a solid-state drive.
— Configuration module sets the Organiser to transmit and receive programs and data. Options are selected using the cursor keys including:

BAUD RATE : 150-9600
PARITY : ODD, EVEN, MARK, SPACE, NONE
PROTOCOL : NONE, RTS/CTS, XON/XOFF

THE PSION ORGANISER WILL CHANGE THE WAY YOU WORK

THE PSION ORGANISER has its own programming language — POPL — contained in the Finance, Maths and Science packs.

POPL is built around a set of straightforward commands such as IN, OUT and GOTO. It enables you to write your own programs which can be as simple or as sophisticated as you choose. By storing and saving programs in a datapak, you can run them whenever you need.

The PSION ORGANISER impressed us so much that we have made special arrangements to supply readers. In early 1985 it will be available in major stores but until then it is exclusively available from Moorshead Publications.

TO: MOORSHEAD PUBLICATIONS
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Please send me by 1st class registered mail:

	Qty.	Price	Total
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Science Program Pack		$ 79.95	
Math Program Pack		$ 79.95	
Finance Program Pack		$ 79.95	
Linkup Communications Pack		$119.95	
16K datapack		$ 49.95	
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If for any reason you are not completely satisfied with your Psion Organiser, return it in good condition within seven days and we will refund your money in full without question (shipping charges excepted).

For Your Information

Liability
While every effort has been made to ensure that all constructional projects referred in this magazine will operate as indicted efficiently and properly and that all necessary components are available, no responsibility whatsoever is accepted in respect of the failure for any reason at all of the project to operate efficiently or at all whether due to any fault in the design or otherwise and no responsibility is accepted for the failure to obtain component parts in respect of any such projects. Further no responsibility is accepted in respect of any injury or damage, caused by any fault in design of any such project as aforesaid.

Editorial Queries
Written queries can only be answered when accompanied by a self-addressed, stamped envelope. These must relate to recent articles and not involve the staff in any research. Mark such letter ETI Query. *We cannot answer telephone queries.*

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Binders made especially for ETI are available for $9.25 including postage and handling. Ontario residents please add provincial sales tax.

Back Issues and Photocopies
Previous issues of ETI Canada are available direct from our office for $4.00 each; please specify by month, not by feature you require. See order card for issue 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 0.1 uF is 100nF, 5600pF is 5n6. Other examples are 5.6F = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56k ohms 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 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 6326, Stn. F, 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, 14 Knightswood Crescent, Brantford, Ontario N3R 7E6.

Ultra-Safe Bench-Top CNC Lathe For Training

The Colne 5 lathe will operate from most leading parallel-port 8-bit microcomputers. Designed to stand on a bench, it measures only 680 mm x 445 mm x 240 mm and weighs 40 kg. Centre height is 70mm. The lathe bed is tray-mounted and supports the hadstock, tallstock, saddle and cross-slide. The chuck is driven by a DC motor, and feedback is used to stabilise speed under load. The 200-step high-torque stepper motors drive recirculating ball leadscrews for X and Z movements with an accuracy that is better than 0.025 mm.

Special attention has been paid to safety, with a lockable DC motor cut-out button positioned prominently on the front panel, a transparent guard covering all moving parts while the motors are running, and a cut-out switch which operates if the guard is raised. A similar Interlock protects and end cover plate, and microswitches prevent the saddle overrunning the bed. Provided with the machine is a sophisticated software package, on either disk or cassette. Currently available for Acorn, programs for Commodore and Apple micros will follow shortly.

Please send enquiries to: Electrolab Ltd., P.O. Box 320, Belleville, Ontario K8N 5A5. Contact: Mr. Norman C. Wilson, President, telephone: (613) 962-9577.

Circle No.54 on Reader Service Card

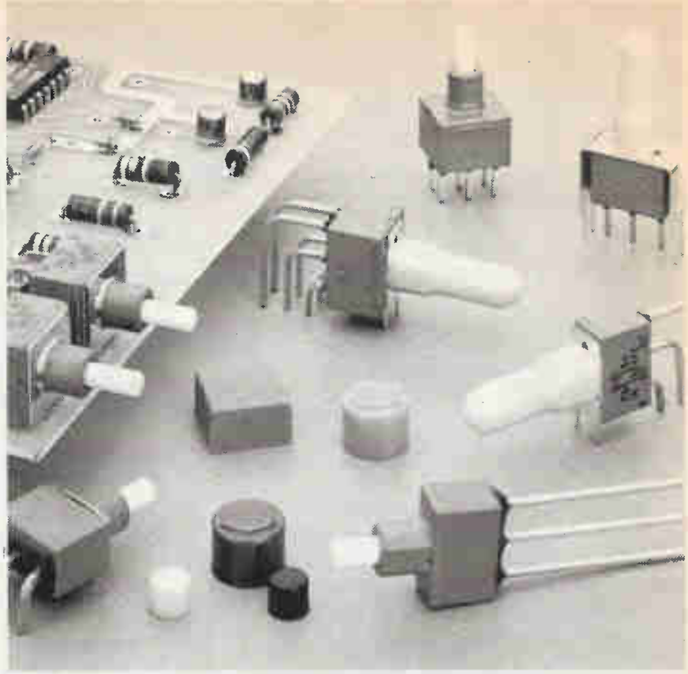
A new catalogue featuring thousands of new, sophisticated electronic products available on a short-term rental basis has been published by Genstar Rental Electronics, Inc. Genstar rents state-of-the-art instrumentation from three Canadian Inventory Centres for time periods ranging from 30 days to three years and np.

The catalogue's selection of products included: Amplifier; Analyzers; Attenuators; Calibrators; Camera; Counters; Couplers; Desktop Computers; Filters; Generators; Meters; Microprocessor Development and Analysis INstrumentation; PROM Programmers; Oscillators; Oscilloscopes; Printers; DC Power Supplies; Probes; Plotters; Recorders; Sources; Synthesizers; Telecommunications; Data and Graphic Terminals; and more.

All items in the catalogue are available for immediate rental, off-the-shelf. This new catalogue may be obtained by phoning toll-free to (800) 268-4939 (in Ontario); (800) 361-5547 (in Quebec and the Maritimes); or (800) 663-1879 (in Western Canada). Written inqniries may be directed to Genstar Rental Electronics, Inc., 6650 Finch Avenue West, Unit 11, Rexdale, Ontario, M9W 5Y6, Telephone (416) 675-7513.

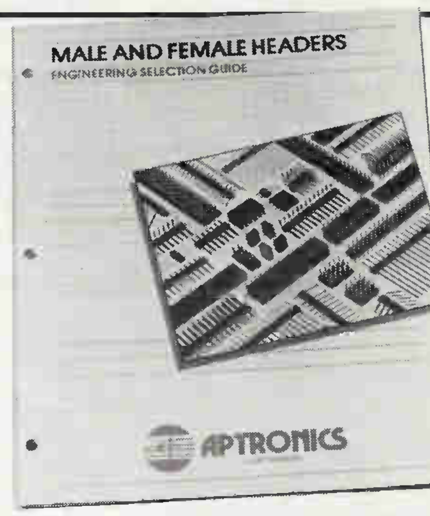
Circle No. 57 on Reader Service Card

Wash Your Switch



Are You Plagued by Dirty Switches? C&K Components, Inc. announces the availability of two new washable momentary pushbutton switch lines. E010 SERIES sealed momentary pushbutton switches feature power capabilities in a miniature package. E020 SERIES sealed snap-acting momentary pushbutton switches feature C&K's long-life snap-acting switching mechanism. Both series are sealed to withstand wave soldering and cleaning processes. Switches can be installed on P.C. boards along with other components. No special handling is required. For further information contact: Mr. John Benson, C&K Components, Inc. 15 Riverdale Avenue, Newton, MA 02158 (617) 964-6400.

Circle No. 58 on Reader Service Card



Aptronics Guide For Male And Female Headers

The 8½" x 11" two-color publication contains two-page spreads on each series header. They detail the headers' straight and right-angle configurations as well as single-row and dual-row options. In addition, the three-holed guide, which can be inserted into a looseleaf binder, features APTRONICS female headers and jumpers.

Line drawings and specifications are given for each product type depicted in the 12-page guide, and there is also an applications page in the back that shows typical system interconnections.

For further information please contact Doug Petter, Lenbrook Electronics, Unit 1, 111 Esna Park Drive, Markham, Ontario. L3R 1H2. (416) 477-7722.

Circle No. 56 on Reader Service Card

continued on page 64

A look at more test equipment, including testbench aids and scopes.

By Bill Markwick

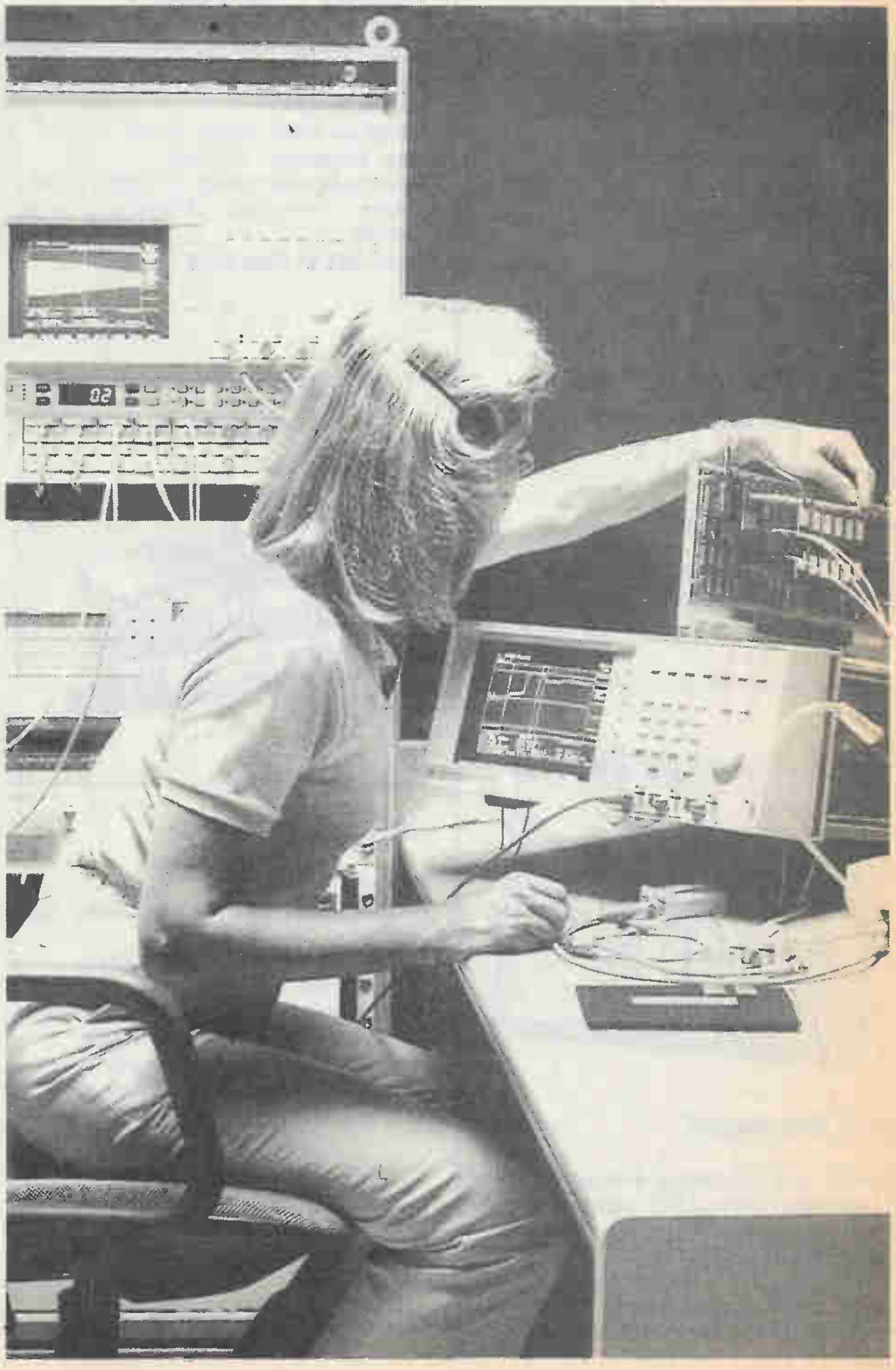
Test Equipment

In our May, 1984 issue we covered some of the new test equipment available for the bench and lab; here's a look at some more of the gadgets that make testing and repairing easier, from small testbench aids to a digital storage scope. We hope to be bringing you coverage of test equipment as an ongoing feature, perhaps every third month.

As we pointed out in May, the microprocessor is a natural for controlling test gear, and more and more of them are turning up. One of the biggest advantages of the microprocessor is the ability to store and recall information, allowing you to make instant comparisons of test readings. Another ability of the micro is compressing two or more instruments into one; the oscilloscope can now function as a multimeter by reading out measurements on the screen along with the waveform.

Still, there's lots of room for the standard analog approach for most test benches. It's still cheaper for basic test equipment such as simple scopes, power supplies, generators and so on. There's also a tendency on the part of microprocessor designers to use menus and function keys; while these have their uses in selecting from many complex possibilities; it's hard to beat good old mechanical switches and their positive feel.

Please note that the prices shown are the manufacturer's or distributor's list and may differ from retail prices; the addresses for sources are listed at the end of the article.



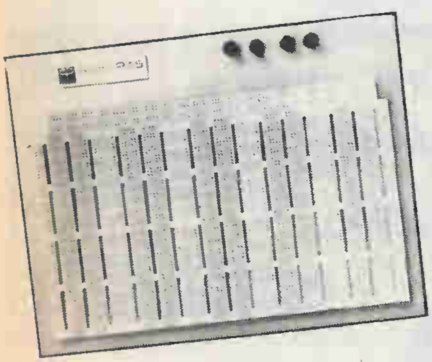
The new Hewlett-Packard 54100A digitizing oscilloscope shown will be reviewed in a future article on logic analyzers.

Testbench Aids

This section covers a few of the breadboards, logic probes and handheld meters that make project building and debugging easier. Breadboards, for instance, eliminate tedious wiring on pegboard, and logic probes are the best way to troubleshoot digital circuits if you can't spring for a logic analyzer.

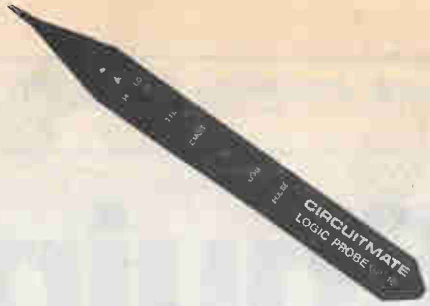
Radio Shack Breadboard

Model: Archer 276-169
Size: 7 by 4 inches
Connection Points: 640
Point Spacing: .1'', accepts DIPs
Other: 3 binding posts, accepts 22 ga. wire
Price: $29.95 from Radio Shack stores



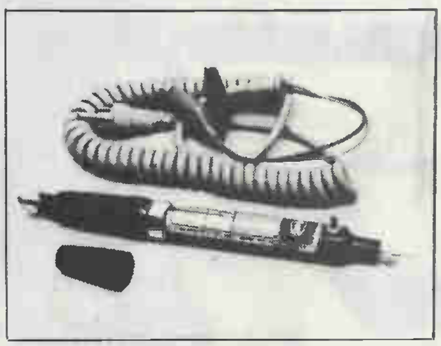
ACE Breadboard

Model: ACE 245 Circuit Evaluator
Connection Points: 6640 in groups of 5
Distribution buses: 40 vertical, 4 horizontal
Point Spacing: .1'', accepts DIPs
Other: 5 binding posts, accepts 22 ga. wire
Price: $209.30 (taxes out) from AP Products



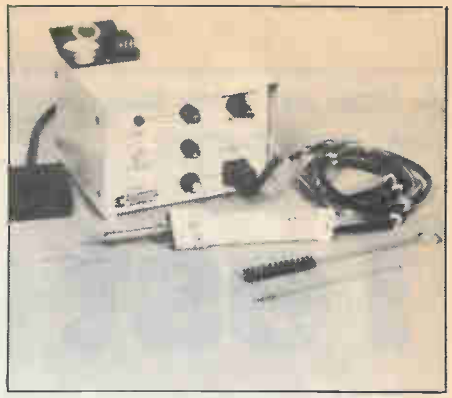
Beckman Logic Probe

Model: LP10
Thresholds: switchable TTL (5V) or CMOS (to 15V)
Minimum Pulse Width: 50 nS
Max. Frequency: 10 MHz
Pulse Indication: steady or flashing LED
Other: overvoltage protection, pulse memory
Price: $29.43 from BCS



OK Logic Pulser

Model: OK PLS-1
Output Level: auto adjusts to any logic family
Output Frequency: single or 20 pps
Pulse Width: 2 uS
Output Polarity: auto adjusts; will toggle any line even if clamped by output
Other: complete overvoltage protection
Price: $127.50 from Len Finkler and Co

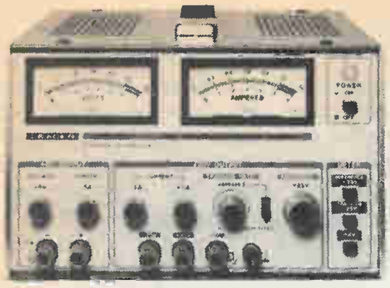


Solder Extractor

Model: EX 550
Method: controlled heat and vacuum through tip
Controls: vacuum footswitch, temp control, vacuum flow
Tip Power Range: 15 to 65 W
Desolder Time: under 2 sec for double-sided PCB
Other: air blast for rapid component cooling (requires air at 75-150 PSI)
Price: $289 US from Automated Production Equipment

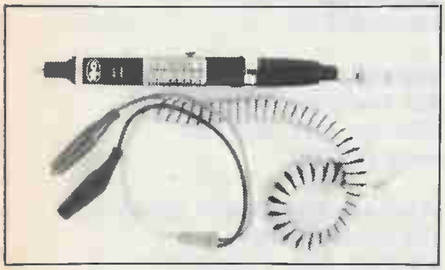
Capacitance Meter

Model: Daetron MC100A
Display: 4 digit LED
Range: 3 ranges, 1 pF to 9,999 uF
Accuracy: 1 for pF, nF; 3 **for uF**
Conversion Time: less than 6 sec for 9,999 uF; less for smaller values
Power: 9 V battery, 16 mA in standby
Price: $89.95 from Daetron



Leader Power Supply

Model: LPS-152
Outputs: to +6, to +25, to -25
Max. current: 5 amps, adjustable limiting
Noise: less than 3 mV
Other: Adjustable tracking on 25 V supplies
Price: $1090 from Omnitronix



OK High Speed Probe

Model: OK PRB-1
Frequency: to 50 MHz
Minimum Pulse Width: 10 nS
Pulse stretching: 50 mS
Input Resistance: 120K
Logic types: any, auto adjusts
Other: overvoltage protected.
Price: $95.95 from Len Finkler and Co.

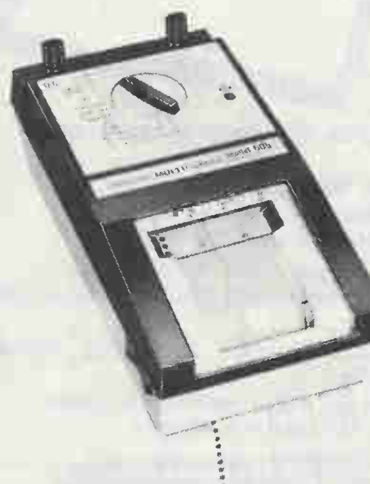
Chart Recorders

While not used that frequently in many labs or home testbenches, there's no questioning the usefulness of having a graph of circuit performance, especially if you're trying to monitor something that happens intermittently; there's also nothing like them for testing frequency response.

Two recorders are shown here as examples: the Simpson includes a built-in multimeter for the recording of voltage or current, and the J.J. Lloyd accepts various plug-in preamplifiers; a logarithmic amplifier, for instance, converts an AC input to decibels for frequency response measurements.

J.J. Lloyd Recorder

Model: PL3
Writing Area: 250 by 380 mm
Pen type: disposable fiber tip
250 mm Sweep Time: 1 sec to 50 minutes
Paper Holding: magnetic strip
Plug-ins Available: DC and AC voltage and current, lin/log RMS, frequency, temperature, etc.
Other: Chart roll drive available
Price: $1596 for mainframe, from Omnitronix

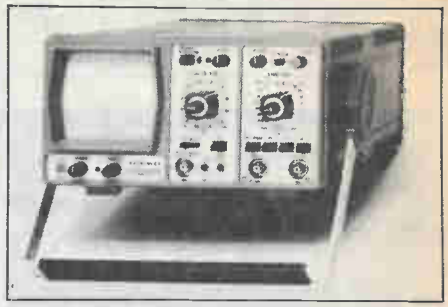


Simpson Multicorder

Model: 605 Series 2
Ranges: 24 ranges, VDC or VAC from 3 to 600, mVDC from 12 to 60, DC uA from 0 to 600, mA AC or DC, amps AC or DC to 6.
Paper Width: 2.6 inches
Paper Speed: 1,3, or 12 in/hr
Power: 120 VAC (battery model available)
Other: wide range of probes and pickups
Price: $809.55 from Simpson

Oscilloscopes

Analog scopes abound, though digital storage techniques are becoming more and more affordable. In the digital method, the signal is sampled and converted to a bitstream which can be stored in RAM; the signal can then be held steady on the screen for examination. There's nothing like them for working with intermittent signals, especially very high or very low frequency waveforms. Some scopes have a secondary memory for recalling a second waveform and comparing it to the signal.

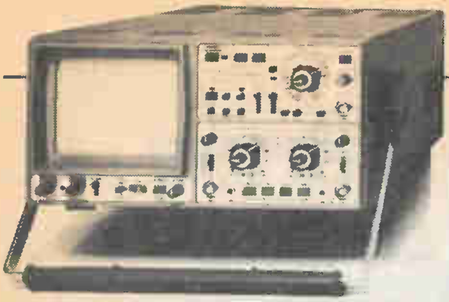


Hameg Compact

Model: HM103
Bandwidth: 10 MHz
Vertical Sensitivity: 2 mV/cm at 10 MHz
Horizontal Sensitivity: .65 V/cm
Trigger bandwidth: 30 MHz
Other: Includes component tester
Price: $550 from BCS

Hameg Dual Storage

Model: Hameg HM208
Bandwidth: 20 MHz
Digital Resolution: 256 vert by 1024 horiz for 10 cm
Digitizing Rate: 20 MHz
Secondary Memory: yes
Vertical Sensitivity: 5 mV to 20 V/div
Horizontal Sensitivity: .2 uS to .1 sec/div
Other: all features available in storage mode
Price: $3350 from BCS

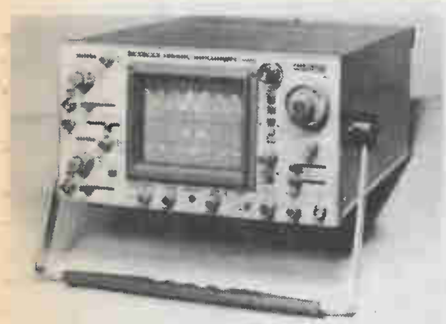


Sony/Tek Dual Storage

Model: 336 Portable
Bandwidth: 50 MHz
Digital Resolution: 256 by 1024
Digitizing Rate: 1 MHz
Secondary Memory: Yes
Vertical Sensitivity: 5 mv to 10 V/div
Horizontal Sensitivity: automatic scaling
Other: onscreen menus and function keys for quick selection
Price: $7538 from Tektronix

Hitachi Readout Scope

Model: V-1100
Bandwidth: 100 MHz
Storage: no
Vertical Sensitivity: 5 mV to 5 V/div
Horizontal Sensitivity: 20 nS to .5 sec/div
Other: voltage and frequency displayed on screen, cursor function allows measuring and display of many parameters
Price: $3600 from Hitachi Denshi



Leader Dual

Model: LBO 525L
Bandwidth: 50 Mhz
Storage: no
Vertical Sensitivity: .5 mV to 5 V/div
Horizontal Sensitivity: .2 uS to .2 sec/div
Other: delay line for fast risetime measure, easy sync of two different frequencies
Price: $1895 from Omnitronix

Miscellaneous

Simpson Frequency Counter

Model: Simpson 710
Range: 10 Hz to 60 MHz
Display: 6-digit .35 in. LED
Sensitivity: 50 mV for sinewave
Filter Type: 1 MHz lowpass
Accuracy: 10 ppm
Price: $294 from Simpson

Simpson Function Generator

Model: Simpson 420
Functions: sine, square, triangle
Outputs: 600 ohm and TTL
Freq. Range: .1 Hz to 1 MHz
Sine Distortion: less than 1 percent to 100 KHz
Power: 120 VAC, AC/battery model available
Other: DC offset control, attenuator
Price: $286.65 from Simpson

Brunelle Function Generator

Model: 3020/3030
Output: Sine, square, triangle, pulse, ramp
Frequency: .2 Hz to 2 MHz, 7 ranges
External control: 0-10 V for 3 decades
Other: Model 3030 includes 6 digit frequency counter
Price: N/A, Brunelle Instruments

Sources

Obviously we can only show a tiny fraction of the models available from many manufacturers. Each manufacturer shown has many others available, and most of them can supply comprehensive catalogues of testbench equipment. It's well worth contacting them if you're upgrading your equipment.

AP Products: national dealership, or contact:
Lenbrook Electronics,
111 Esna Park Dr.,
Markham, Ont. L3R 1H2
(416) 477-7722

BCS Electronics Ltd.,
980 Alness Dr.,
Downsview, Ont. M3J 2S2
(416) 661-5585

Len Finkler and Co.,
80 Alexdon Rd.,
Downsview, Ont. M3J 2B4
(416) 630-9103

Daetron,
935 The Queensway, Box 641
Toronto, Ont. M8Z 5Y9
(416) 255-9701

Automated Production Equipment,
142 Peconic Avenue,
Medford, New York 11763
(516) 654-1197

Bach-Simpson Ltd.,
1255 Brydges St.,
London, Ont. N5W 2C2
(519) 452-3200

Omnitronix Ltd.,
2410 Dunwin Dr., Unit 4,
Mississauga, Ont. L5L 1J9
(416) 828-6221

Tektronix Canada Inc.,
Box 6500,
Barrie, Ont. L4M 4V3
(705) 737-2700

Hitachi Denshi (Canada) Ltd.,
65 Melford Drive,
Scarborough, Ont. M1B 2G6
(416) 299-5900

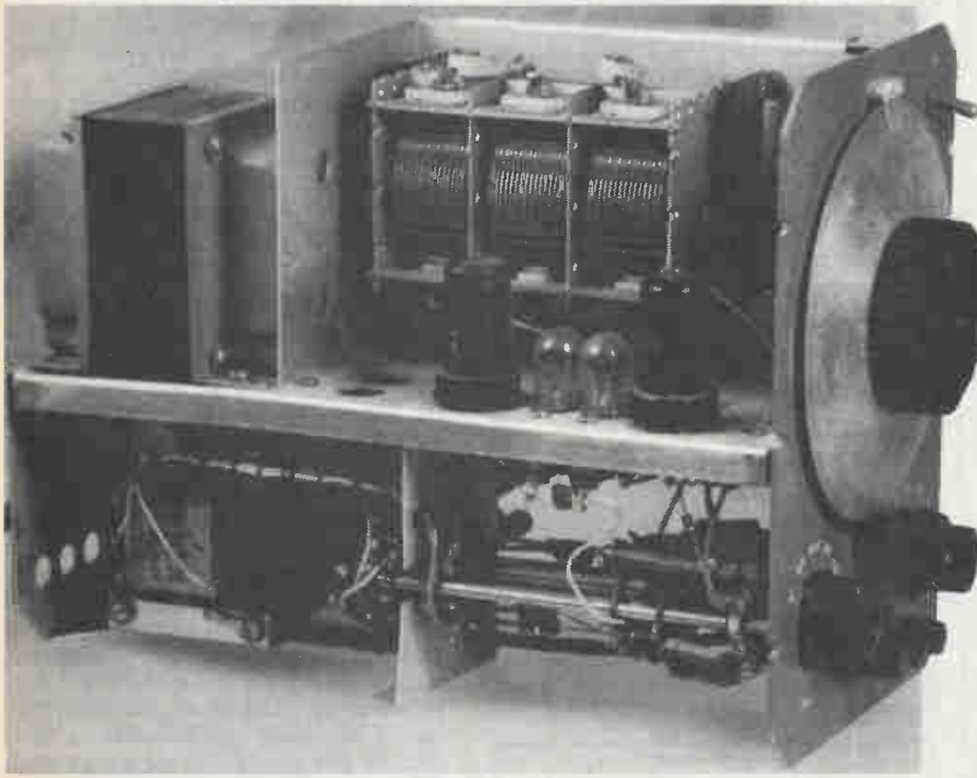
Brunelle Instruments
826 Belvedere St.,
Sherbrooke, Quebec J1H 4B8
(819) 569-1408

■

Getting the Best From Your Signal Generator

Some basic theory and some operating hints for improving your audio oscillator.

By Bill Markwick



The author's venerable Hewlett-Packard HP200 signal generator, showing the variable capacitor, the resistors on the range switch, and the twin stabilizer bulbs (between the metal vacuum tubes).

THE three most important units for any testbench are the oscilloscope, the multimeter, and the signal generator. Since most people start electronics with a multimeter, and we covered scopes in the October issue, we'll have a look at signal generators and what you can do with them.

The great majority of testbench generators will be in one of two classes: the feedback type or the function generator.

Feedback Types

All common sine-wave-only generators are in this category. They all consist of an amplifier enclosed by a feedback loop; that is, the output is connected to the input through a frequency-sensitive network, commonly a resistive-capacitive type. By far the most popular of these is the Wien bridge shown in **Figure 1**. It has only a pair of equal resistors and a pair of equal capacitors; they form a bridge with one series arm and one shunt arm. This makes it easy to change frequencies over a wide range by changing either resistance or capacitance.

The Wien bridge has the characteristic that the phase shift from its input to its output will be zero at one specific frequency; this is the frequency at which the reactance of one of the capacitors equals its associated resistance, or Xc = R. Now we connect the Wien bridge across a non-inverting amplifier to produce positive feedback; that is, a positive-going input produces a positive-going output. Since we have zero phase shift at only one frequency, we now have an oscillator at that frequency; the circuit is shown in **Figure 2**. When the amplifier is first powered up, its internal noise will go from the output to the input and be amplified; because the maximum positive feedback will occur at the resonant frequency of the bridge, it builds up very quickly and we have a signal. Unfortunately, we have an out-of-control signal, because the amplifier will happily go on amplifying until it runs out of voltage. Instead of the desired sine wave, a very distorted square wave is produced unless we add a stabilizing circuit.

Stabilizing

If you put a signal through a Wien bridge at the critical frequency where Xc = R and measure what comes out, you'll find that the voltage has decreased to one-third. Thus our amplifier in the above example has to have a gain of exactly three to keep the oscillation going at a constant amplitude. The required gain is set by the two resistors that meet at the inverting input; the negative feedback resistor is twice the resistor to ground (because op amp theory says that the gain is 1 plus the ratio of the resistors).

If we leave the amplifier just as it is, we'd have a theoretically ideal oscillator. However, the slightest, most microscopic deviation in component values will cause the output signal to either rise in amplitude to the point of distortion or fade away entirely. In fact, you can build the circuit as shown using a trim pot for one of the resistors; if you (patiently) set the trim for a stable output voltage, the

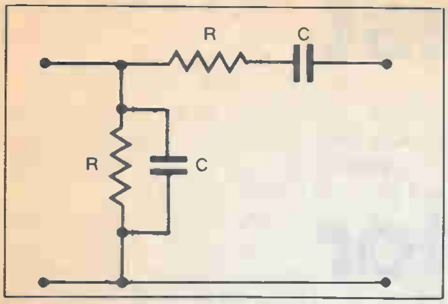


Fig. 1. The standard Wien bridge, popular in signal generators because of the ease of frequency changing; either the Rs or Cs are variable dual units.

mere warmth from your hand will cause enough drift to ruin things.

Light bulbs to the rescue. For our purpose, the most useful characteristic of a tungsten filament is that its resistance vs. temperature relationship is positive the resistance goes up tremendously with temperature. A hot/cold ratio of 10:1 is not unusual for a household lamp. This comes in very handy when the bulb is inserted in the negative feedback loop (between the inverting input and ground). Remember that more negative feedback reduces the voltage gain, and imagine that the output voltage has decided to drift up. This increased output means more current through the bulb, which in turn results in a higher resistance, less reduction of feedback, and the output level restored to normal. Similarly, a falling output causes a reduction in the lamp resistance and more reduction of feedback.

Another non-linear element often used instead of a light bulb is the thermistor. This is a type of semiconductor isolated in a glass bulb; its advantages are better resistance tolerances, lower inductance, and better shock-resistance. Its main disadvantage is very poor availability. The component division of ITT carries a line of thermistors; their model R53 is often used in generators; so far we haven't pinned down a convenient Canadian source.

A higher-tech method using FETs is also popular. The drain-to-source resistance of the FET varies with the gate voltage; in other words, we can use the FET as a voltage-controlled resistor to replace the feedback shunt resistor (the one from the inverting input to ground). The output voltage is rectified by a single diode and charges a capacitor to a negative voltage. This is applied to the FET gate and raises the source-to-drain resistance, increasing the negative feedback to the inverting input and keeping the output constant.

Stabilizer Problems

In the theoretical model, the stabilizer circuit just locks the output level as tight as a drum. In reality, there are two main problems: distortion and amplitude bounce.

The distortion results from the stabilizer's willingness to follow (and change) the output waveform as it cycles up and down. This is usually a negligible problem at frequencies above a few hundred Hertz because the 'inertia' of the bulb, thermistor, or capacitor smooths things out, but at lower frequencies the harmonic distortion will definitely go up as the stabilizer flattens the signal's peaks instead of acting as an automatic volume control.

Manufacturers generally select the light bulb or thermistor or capacitor that has inertia large enough to minimize harmonic distortion while still allowing the fastest possible settling time. Some FET-stabilized generators, such as the Hewlett-Packard 209 series, have an extra capacitor that you can switch in to lower the distortion to a minimum. Now it becomes necessary to change frequency rather slowly, or the amplitude begins to rise and fall until the capacitor settles. This brings us to the next point:

Amplitude bounce is probably one of the most prevalent annoyances that plague operators. As the range switch or frequency knob is turned, the resulting glitches naturally make the amplifier want to change level, and the stabilizer does its level best to smooth things over. Usually things calm down after a second or two, but some generators continue their level swings for some time. Here's a tip if you have a light bulb stabilizer: the performance can be greatly improved by 'burning in'. Check the voltage rating on the bulb (sometimes a pair in series). If there is one, try using a variable power supply or lamp dimmer to slowly bring them up to a dull yellow brightness. Leave them there for a few minutes, and then slowly lower the voltage to zero again. This thermal shocking often makes mischievous bulbs behave. If it doesn't work, you can try changing bulbs; the slightest variation in mechanical construction can affect performance.

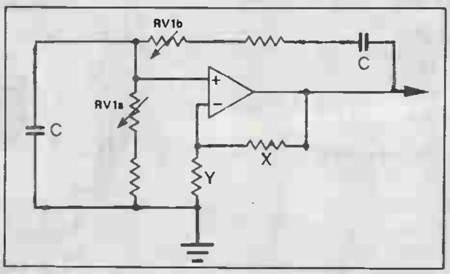
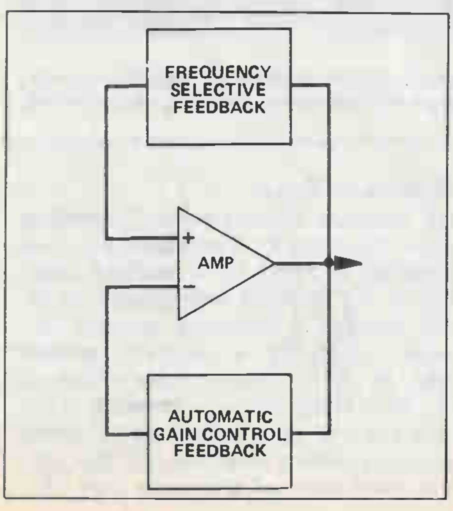


Fig. 2. (a) A typical sine oscillator using the Wien bridge. The pots are ganged together; the stabilizer circuit would be either resistor X or Y depending on type; (b) below, the block diagram.



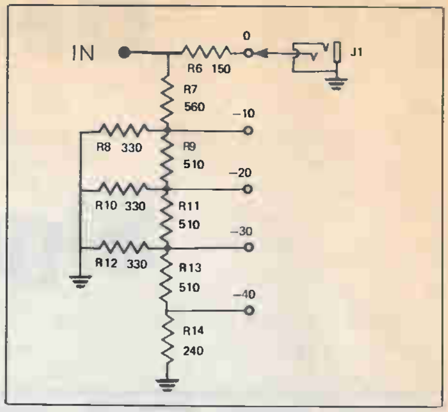


Fig. 3. A 150 ohm attenuator suitable for adding to any generator; see text for further details.

Changing Frequency

The most common method of changing frequency is to gang the two capacitors of the Wien bridge on one rotary shaft: the well-known 'egg-slicer' variable capacitor. Though it's rather large, and its relatively low capacitance calls for high circuit impedances, its mechanical construction can be easily tailored for very smooth tracking of the two sections; this makes for smooth frequency changing. The range switch then consists of pairs of precision resistors to allow different ranges; while the panel is marked 'times 10, times 100' and so on, the main frequency knob will probably have a 12:1 ratio to give overlap for scanning across the frequency spectrum.

In recent years, the advent of laser-trimmed conductive plastic potentiometers has resulted in very good tracking between sections. In this case, the capacitor is replaced with a dual resistor and the range switch has pairs of precision capacitors. Neither laser-trimmed pots nor precision capacitors are particularly cheap, so we haven't seen the death of the old egg-slicer yet.

Function Generators

Because one of our projects this month is a function generator, and fairly well explained, I'll limit the discussion. In general, the Voltage Controlled

Oscillator, which is the heart of the IC, charges a capacitor through a constant current source. This produces a linear ramp voltage, and at some predetermined voltage an electronic switch reverses things and discharges the capacitor, producing a triangle waveform. Each time the triangle passes through zero volts, it trips another electronic switch with very fast risetimes; this produces a square wave. The triangle wave is also applied to a sine-shaper, producing a sine wave of reasonably low distortion. If you have a distortion analyzer available, you may be able to trim the sine way to less than 1% total harmonic distortion.

There are various methods of faking a sine wave, and all of them are best implemented in IC form because they depend on precision matching and very good temperature tracking. In general, generator chips tend to use the non-linearity of a transistor base-emitter junction to curve the triangle into a sine wave.

Aside from the three waveforms available, the function generator has the great advantage of having a very wide range; our project can be swept over a 100:1 range with one pot. The disadvantage is the rather high sine wave distortion should you require a precision signal.

Controlling Output Impedance

The majority of generators have 600 ohm output impedances. This means that any load 'sees' the signal as if it originated from a 600 ohm resistor. To verify the impedance of your generator, set the output (without a load) to a convenient level, say, 2 volts, and then attach a 600 ohm resistance across the terminals. The output level should fall to about half. If it doesn't, try various resistors until the output voltage does fall to half; this is your output resistance. This resistance must always be allowed for in circuit testing; naturally, 600 ohms will not be loaded much if you're driving a 1 megohm load, but if you're working with low source impedances, or unknown ones, it's a good idea to doublecheck the generator's output voltage whenever you change anything else. This particularly applies if you're changing frequency; some circuits change their input impedance, and if you haven't checked the generator level to see that it's the same, you may be misled into thinking that your circuit has odd frequency response.

If you have to have a lower source impedance than 600, you can always use a buffer amp. If there isn't one handy, and you don't mind losing a bit of level, just put a resistor across the output to achieve the desired reduction. Suppose you need a 50 ohm output. A 56 ohm, plus your 600, reduces to 51.2 ohms, which is close enough. The level reduction will be 56/656, .085 times. If your generator can do 5 volts open circuit, the maximum out will be 5 times .085, or 427 mV.

Another problem frequently encountered is poor quality output level potentiometers. Even the top-dog milspec variety tend to get jittery with age, particularly if you're trying to adjust to the last millivolt. A cure is to add a stepped attenuator between the output and the circuit under test. The attenuator can be used as a coarse control to approximate the level you want, and the generator's pot used as a fine control.

Figure 3 shows an attenuator that you can put in any small box, or even build it into your generator. It has four steps of reduction of 10 dB each (—10 dB divides by 3.16) plus a zero-attenuation position. The output impedance is constant at about 150 ohms and it loads the generator with about 800 ohms.

If you don't have an oscillator, or would like another, the Audio Oscillator Project appears in *Electronics Today*, July 1983. It features low distortion and switched frequencies. ■

Designer's Notebook:

The Differential Amplifier

A look at basic circuits and how they become the familiar diff amp.

By Ian Sinclair

THE USUAL configuration for a transistor amplifier is the common-emitter one that we have used in each circuit so far. A number of useful and interesting circuits, however, are based on the use of common-collector and common-base configurations, and even more interesting variations can be assembled using two or more transistors in these circuits.

The classic single-transistor common-collector (or emitter follower) circuit is shown in Fig. 1. As shown, this uses two resistors to set the DC base voltage, but these and the input coupling capacitor C1 can usually be dispensed with by using direct coupling (Fig. 2) to the collector of the previous stage when the common collector stage follows another amplifying stage. The design of the circuit is simple; just decide what current, I, that you want to flow in the transistor, and when the value of the emitter resistor R3 (in Fig. 1) is $(V_b - 6.0)/1$. The voltage gain is less than 1 (in other words, there is a loss of signal amplitude in the ciruit) but the input impedance (reistance, if you're using low frequencies only) is very high and the output impedance is very low, which is ideal for a lot of purposes. It's particularly useful, for example, when placed between two common-emitter amplifier states, because the emitter follower acts as a high resistance load for one amplifier stage and as a very low-resistance supply for the second stage. In this way, it's possible to get more gain from two transistors by adding a stage which causes a loss!

Low Gain Is No Loss

Though the voltage gain of the emitter-follower is less than 1, and can be a lot less than 1 if the emitter resistor has a low value, the stage has a current gain which is about the same as the current gain measured for the transistor operating in common-emitter mode. This makes the emitter-follower a useful driver stage where extra current is needed, but some care is required when the circuit is used with pulses or high-frequency signals. There are inevitably stray capacitances across the emitter resistor, and those will be charged by the current flowing through the transistor when the base voltage goes positive. When the base voltage drops, however, the emitter voltage cannot change at a rate faster than that permitted by the time constant of the emitter load resistor and the stray capacitance, so that the trailing edge of a pulse has a slow fall time. This principle can be deliberately used in a demodulator for AM signals, by connecting a capacitor across the emitter resistor so that the time constant is long compared with the carrier wavetime but short compared with the wavetime of the modulation.

Doubling Up

If pulses and high-frequency signals have to be used, a double emitter-follower is a better bet. The basic circuit is illustrated in Fig. 4a — it consists of an NPN emitter follower in series with a PNP one. The bias network uses two resistors R1 and R2, both of high value, and the diodes D1 and D2. The values of R1 and R2 have to be equal and large (100k to 2M2) to set the current through the transistors to a suitable value, usually 1 mA to 10 mA.

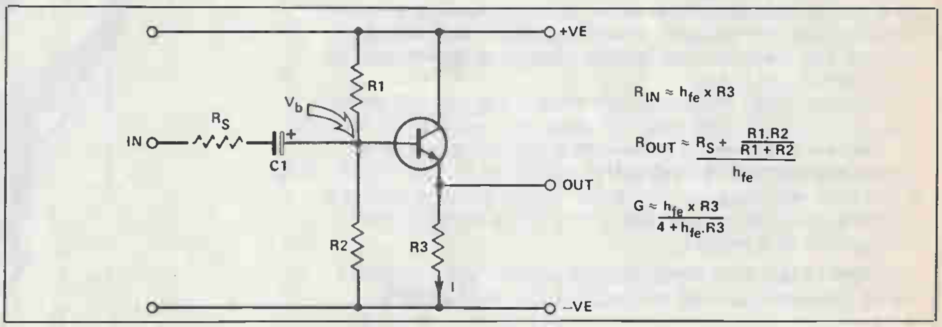


Fig. 1 The straightforward emitter-follower (common-collector) circuit and bias network.

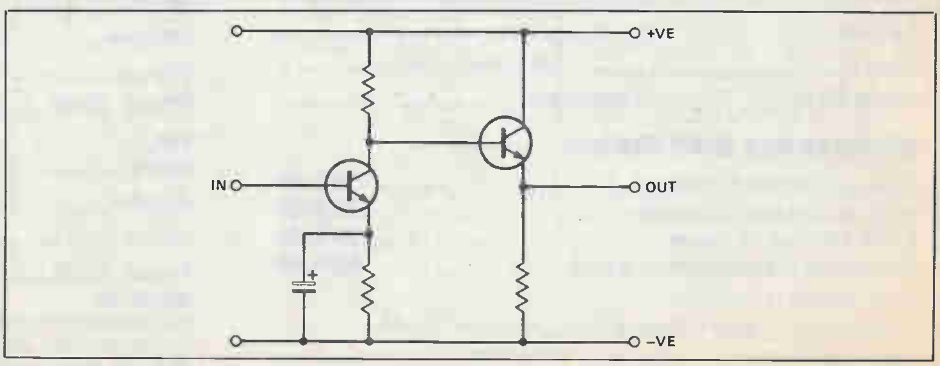


Fig. 2 Using an emitter-follower with direct-coupling.

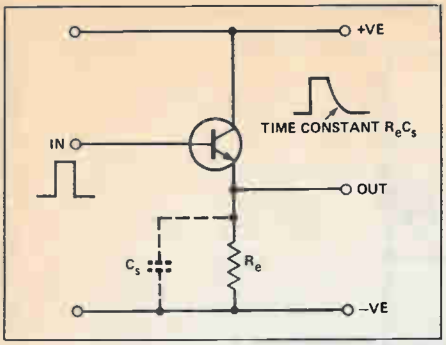


Fig. 3 The effect of stray capacitances on a positive pulse. The emitter-follower cuts off at the negative edge, leaving the stray capacitance to discharge through R_e.

Two parallel coupling capacitors are shown, but an alternative arrangement is a series coupling capacitors arrangement as shown in Fig. 4b. We'll look at this particular configuration in more detail in a later part when we consider power output stages, because it's the basis of most ouput circuits in transistor amplifiers.

Meantime, take a look at the arrangement of Fig. 5, which is a type of double-emitter-follower. This circuit is often referred to as a Darlington Pair, a name I prefer to reserve for the version of the cir-

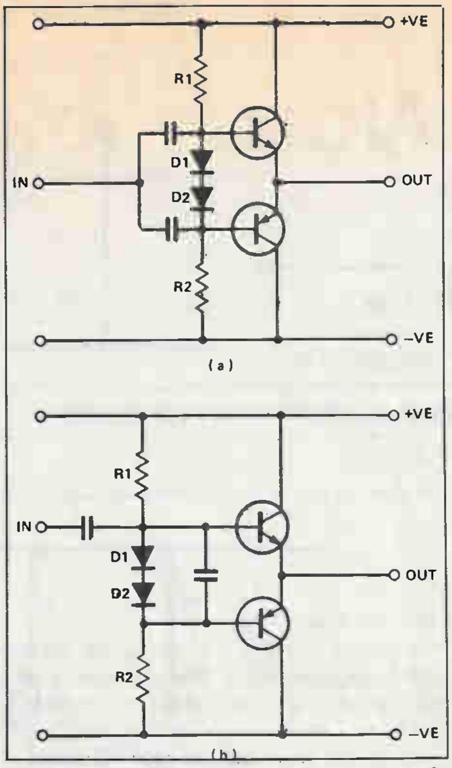


Fig. 4 (a and b) Two different arrangements of a double emitter-follower, using PNP and NPN transistors.

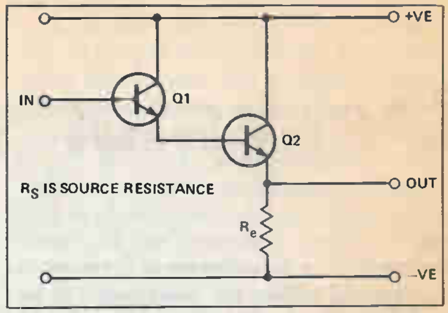


Fig. 5 A Darlington unity-gain emitter follower.

cuit which uses a load resistor in the collector circuit of both transistors. Bias is arranged in the same way as for a single emitter-follower, but the DC voltage drop between the input and the output is around 1V2, since there are two base-emitter jucntions in series. The input resistance is very high about $R_e\ h_{fe1} \times h_{fe2}$, in parallel with the bias components, and the output resistance is very low, about $R_s/(h_{fe1} \times h_{fe2})$. The current gain is $h_{fe1} \times h_{fe2}$, which is also very large. For example, if we use transistors with $h_{fe} = 100$ for both stages, then the compound current gain is 10,000, the input resistance with $R_e = 10k$ is 1M0, and the output resistance when the source resistance is 10k will be 1 ohm! For a lot of applications, Q2 can be a power transistor with a low value of h_{fe}, and the circuit can be used to simulate the action of a power transistor with a high h_{fe} value. The Darlington circuit of Fig. 6 might be expected to have a very high voltage gain, but does not — there is only one amplifying transistor, and the signal feedback from the collector of Q1 back to its base will reduce the overall gain quite noticeably if the circuit is driven (as it usually is) from a high value of source resistance.

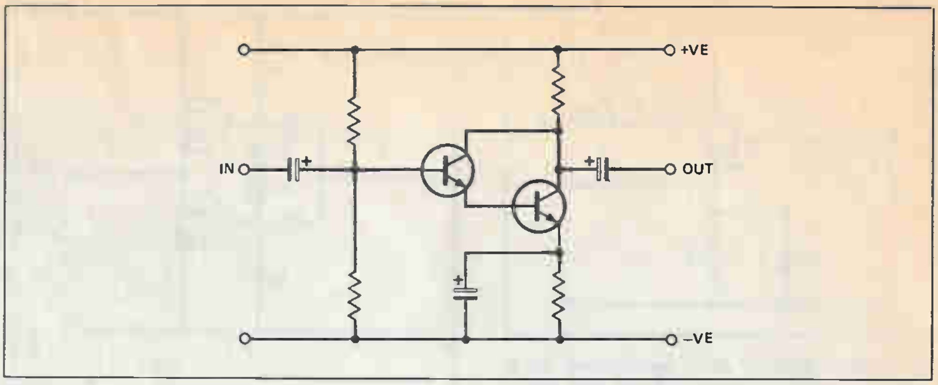


Fig. 6 A Darlington common-emitter amplifier.

Transistor Load? That's Cascode

The cascode circuit was one that was familiar to TV service engineers back in the days of tubes (remember them?), but its transistor equivalent has never been so widely known, which is rather a pity. A cascode circuit consists of a common-emitter amplifier stage directly coupled to a common-base amplifier stage (Fig. 7). The input resistance is fairly low but the output resistance is very high, which makes the circuit particularly suitable for use with tuned-circuit loads or any other type of load which has a very high impedance. The gain is of about the same value as for a single transistor, but the impedance-transforming action (the reverse of the action of the emitter follower) can be very useful.

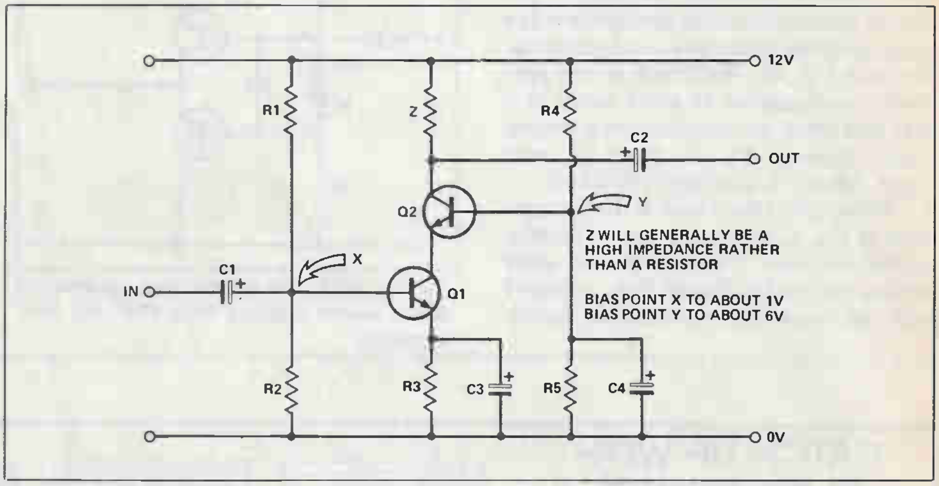


Fig. 7 The cascode circuit, which uses a common-emitter stage driving a common-base stage.

Differential Amplifiers Live On!

Of all the two-transistor amplifier circuits, the most commonly used is the differential amplifier, simply because it features so much in linear ICs. This is an amplifier with two inputs, whose output voltage is proportional to the difference between the signal voltages at the two inputs.

The basic circuit is shown in Fig. 8. The emitters of the transistors are connected, and the bases are biased to about the same DC voltage. The bias is correct when both transistors contribute the same amount of current to the common emitter resistor, and this may need some adjustment unless the transistors are well matched. For ideal action, the value of R4 has to be high, so that large values of R5 and R6 are also needed. A true differential signal at the bases will cause one base voltage to increase as the other decreases, so causing one collector voltage to decrease as the other increases. This creates a large difference signal between the collectors, and ideally the total current through R4 does not change. For a common-mode signal, meaning a signal which applied in the same phase to both bases, the collector signals will also be in phase so that the different signal is, ideally, zero. The voltage

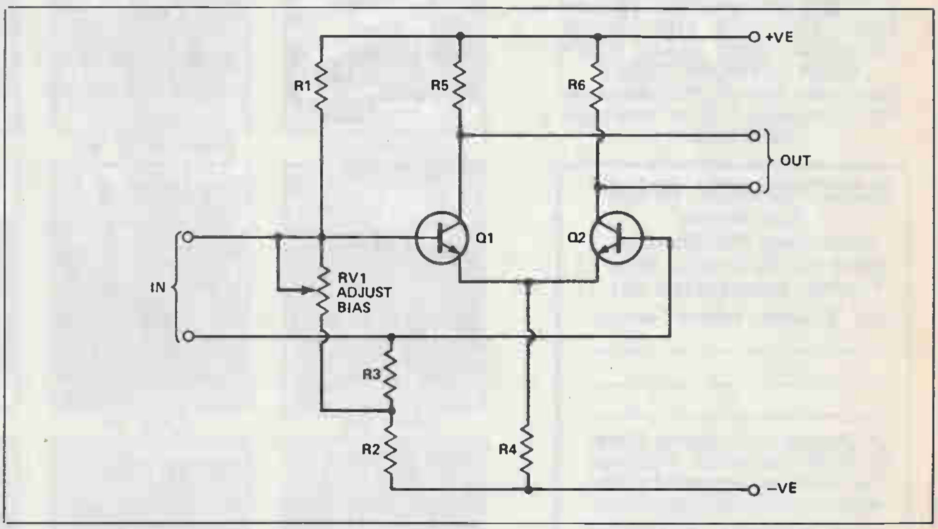
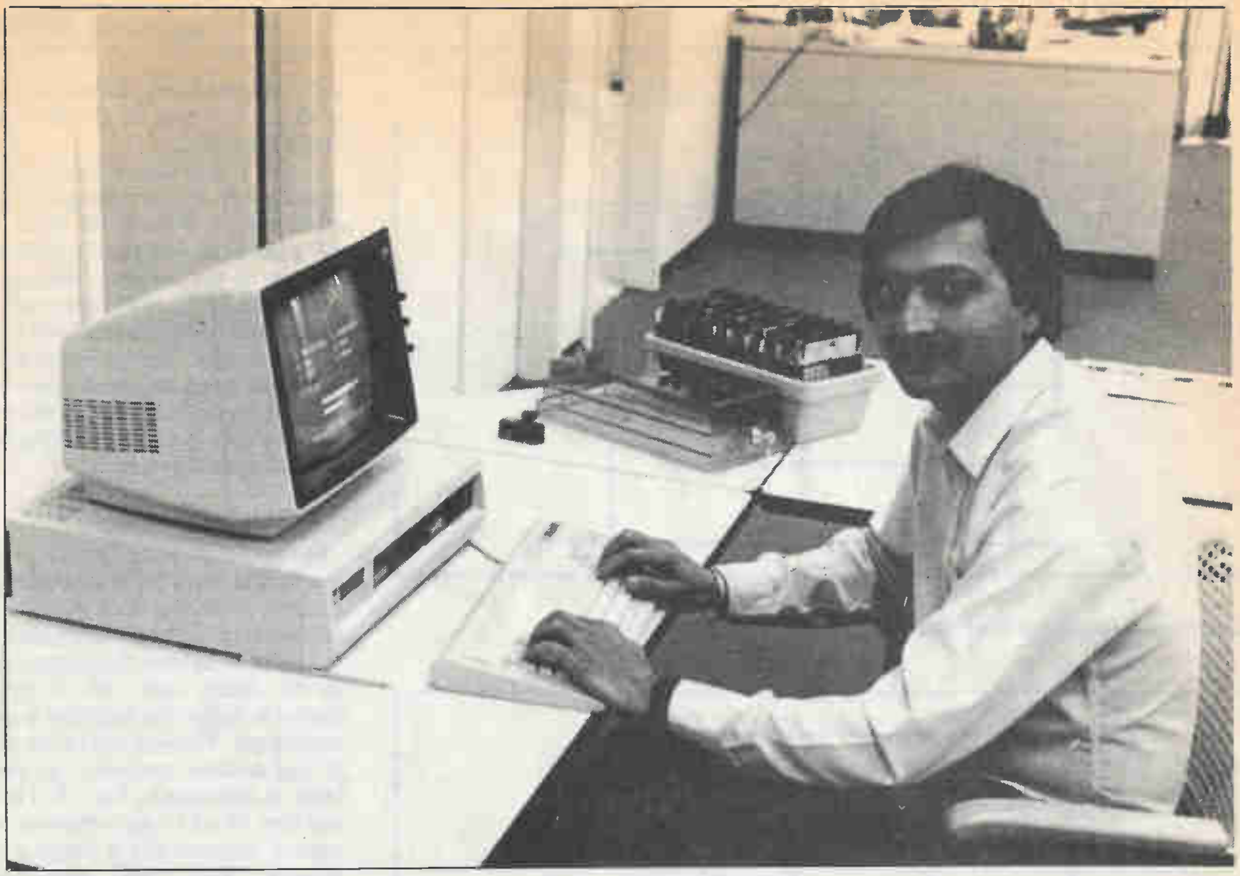


Fig. 8 The differential amplifier circuit. This version is the balanced in, balanced out type.



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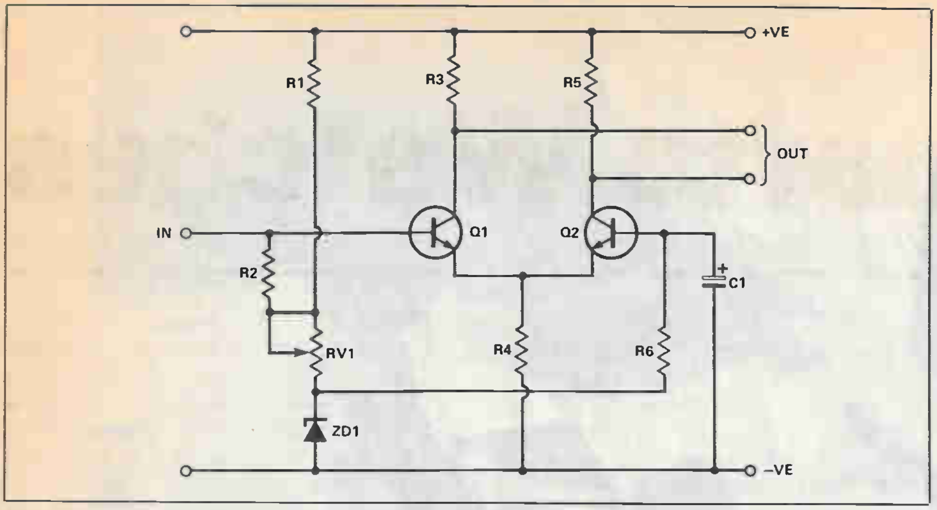


Fig. 9 The differential amplifier used to convert unbalanced signals into balanced.

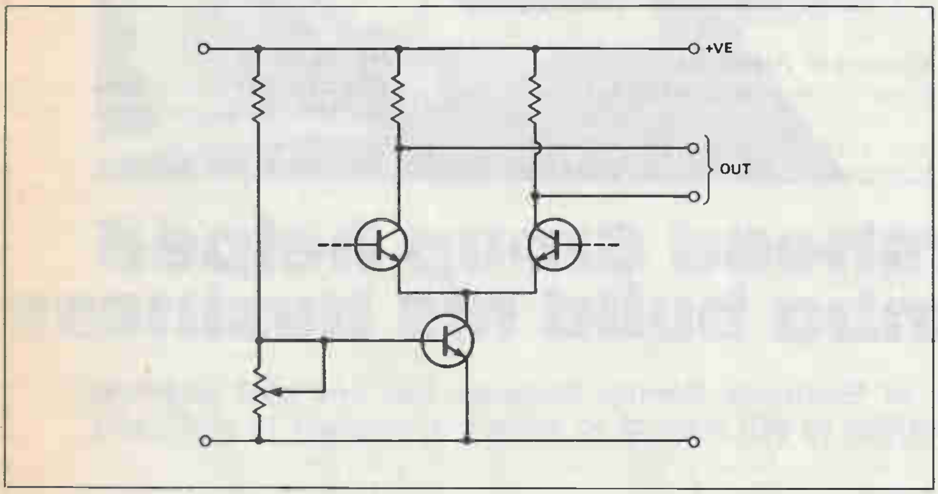


Fig. 10 Using a transistor as the 'tail' of the circuit.

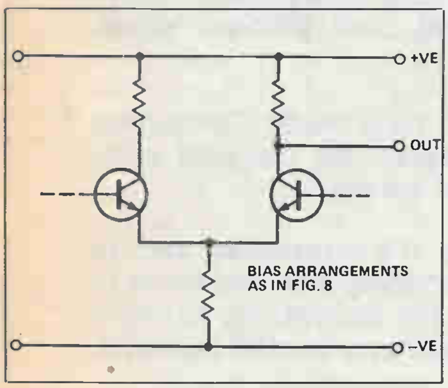


Fig. 11 Obtaining an unbalanced output at one collector.

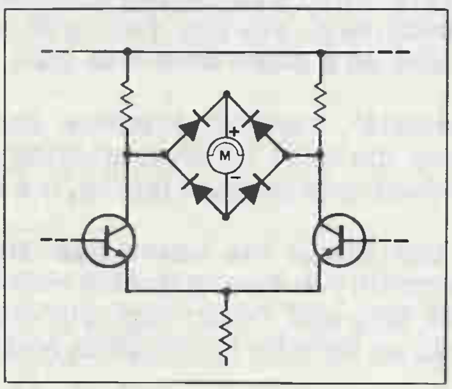


Fig. 12 Driving a bridge rectifier circuit.

gain, operated as a differential amplifier, is about the same as the ideal gain of a single transistor.

The differential amplifier is often used as a way of converting a single-ended input into a differential input for such purposes as driving push-pull circuits. The changes to the circuit to suit this purpose are shown in Fig. 9, illustrating in this case how a zener diode can be used to establish a 'half-supply' voltage level, as an alternative to using balanced power supplies. The voltage gain of the circuit when used in this mode is about the same as that of the differential mode.

Transistor Tails

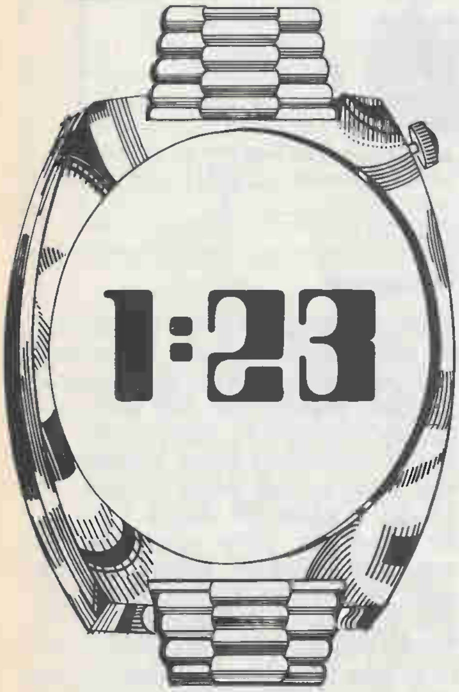
The restriction that affects this type of circuit is the value of the common emitter resistor. Since the value should be high to achieve true differential amplifier action, the currents in both transistors are forced to be small, and this is not always desirable unless the amplifer is used in an early stage. The way out of the problem is to use another transistor as the emitter load, as indicated in Fig. 10. The currents can then be set to suit whatever values are needed, because this is simple a matter of biasing. The 'tail' transistor will, however, act as a high resistance of AC signals, because this resistance is the output resistance of the common-emitter transistor. This is nearer to the type of differential circuitry that is used in linear ICs, and further refinements of the circuit are possible, though the effort is not really worthwhile if a linear IC can be used instead.

The differential amplifier circuit turns up in all sorts of applications, and one of them is the conversion of differential signals to single-ended output as illustrated in Fig. 11. The gain in this type of circuit is only half as much as can be expected in the differential mode. Another frequently used circuit is the metering circuit of Fig. 12 in which the differential signals at the output of the differential amplifier are applied to a bridge rectifier and used to drive a meter. No part of the meter circuit is earthed, and zero setting is carried out by adjusting the biasing of the differential amplifier. This is very useful basis for an AC milliammeter circuit. ■

Quartz Watches

By Roger Allan

The inexpensive quartz watch, either analog or digital, is one of the best examples of elegant miniaturisation.



ONE of the most familiar sights to be found along any street or in any home is quartz watches; their commonality no longer results in any notice, so ubiquitous is their presence. Yet there are in fact two types, and a gradation of qualities of such devices, and further, they are not as perfect as is commonly believed.

Quartz watches' time keeping ability is based on the discovery in 1980 by the French physicists, the Curie brothers, of the piezoelectric effect derived by the passage of an electric current through the crystallized compound of silicon and oxygen known as quartz.

Essentially, when a quartz crystal is cut along a certain axis and a direct current is applied, the crystals begin to oscillate at a temperature-dependent but continuous high and stable frequency. Each oscillation produces a positive and negative charge, charges which are converted into either a mechanical or electrical readout form.

The frequency of the quartz crystal oscillator is dependent on on the shape of the oscillator itself. Customarily, a tuning fork arrangement is used whereby shorter and thicker arms to the fork result in a higher frequency. Higher frequencies do not always result in increased time keeping accuracy; rather, high precision derives from the quality of the crystal and its processing. A carefully trimmed crystal gives a stable and constant oscillation, customarily 32,768 Hz for mass-market watches.

Factors in Precision

There are two generic factors in determining quartz oscillator time keeping precision. High or low temperatures result in decreased oscillation frequency and hence in a time accuracy loss. Customarily, quartz crystals are cut to oscillate at a 'most stable' frequency at around the temperature that is found on the human wrist, approximately 20 to 30 degrees Celsius. Should the temperatures be raised or lowered above that spectrum, the watch will lose time. However, when the operating temperature returns to within the spectrum, the error will decrease back to normal, between 0.02 and 0.7 seconds/day representing an overall accuracy of between 5 and 300 seconds a year for mass-market devices.

The second factor in quartz crystal accuracy is age, both of the young and old variety. Freshly cut crystals do not keep an accurate oscillation rate. While it may initially seem a little odd to 'age' a rock, that it precisely what is done by up-market manufacturers of such devices (about four months). Supplementary to this, when a quartz crystal has been subjected to a direct current for a sufficiently long period of time (between 7 and 10 years) the bonds between the crystal's molecules weaken (reminiscent of constantly expanding and contracting a rubber band), resulting in a steady decrease in the oscillation rate, and hence a time loss. As such, a quartz crystal's age (after being cut) is somewhat reminiscent of judging wine: too young and it will be 'fresh' or 'pert', while too old and it will be vinegar.

Frequency/time Conversion

Having derived a stable form of oscillation, the next step in such watch making is the derivation of a time constant. It is here that the two types of quartz watches, analog and digital, begin to separate. Both take the oscillations and pass them into an IC. In an analog watch the IC is a CMOS type which contains an oscillating circuit, a frequency dividing circuit and a driving circuit. The oscillating circuit reads the piezoelectric oscillations from the crystal, the frequency dividing circuit takes the rate of oscillations and successively divides them by two until a rate of one oscillation a second is reached, while the driving circuit passes the one oscillation a second rate from the IC to the stepping motor.

In a digital watch configuration, the CMOS LSI reads the oscillations, passes the reading into a frequency dividing circuit as above, and sends it into a counter-decoder driver. The signal is then sent from the IC into the liquid crystal display block. Both forms of IC have an externally connected oscillation regulating device, either a pre-set capacitor or a trimmer capacitor switch.

Analog Stepping

There are two types of analog quartz watches: those with second hand sweep movements and those with second hand step movements. In either form, the signal is converted into mechanical movement via a stepping motor. The step motor consists of a coil block, rotor stators and a step rotor. The step rotor is a permanent magnet with either two or six alternating north and south poles. The current flowing from the IC changes direction once every second. As the current flows to the coil block, the rotor stators become magnets with their tips serving as north and south poles. The north-south tips of the rotor stators and the two north-south poles of the step rotor react to the alternating current and the step rotor turns 180 degrees (60 degrees in the case of a 6 pole version) per second in a specific direction. The turning of the step rotor is transferred by a gear train which in turn moves the hands on the dial face.

Digital Readouts

In a digital version of a quartz watch the end product of the CMOS LSI IC passes into a solid-state panel for readout. There are a variety of such display systems: the liquid crystal version, an LED version, a field effect type and the dynamic Scattering Mode System. In most up-market watches, the field effect type is used.

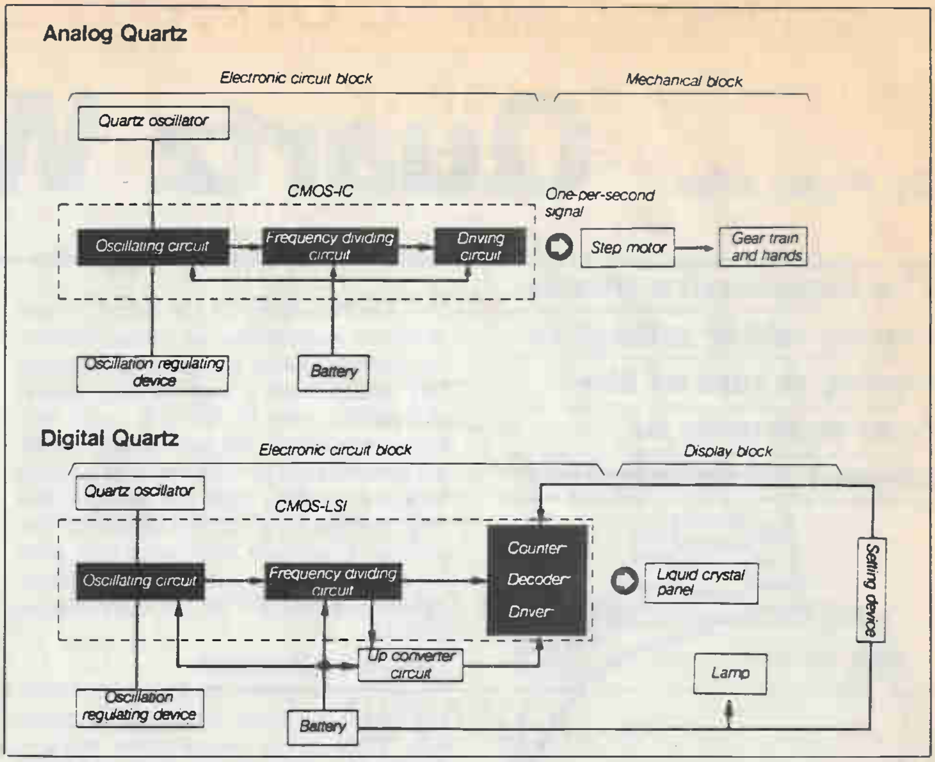


Fig. 1. Block diagrams of analog and digital quartz watch functions.

All materials change in form from solid to liquid to gas as the temperature rises. There are, however, some organic compounds that can change in four ways: from solid to liquid crystal to liquid and thence to gas. The liquid crystals, customarily a nematic type which ensures high optical quality, sharp contrast and low power consumption, have the property of changing color or becoming opaque when subjected to extreme changes in temperature, electrical charges or pressures.

Field-effect LCDs

In the field effect type, the liquid crystal is sandwiched between two glass sheets having molecules twisted 90 degrees between the top and the bottom. This is accomplished by applying a special alignment treatment to the glass sheets. The two polarization sheets are also arranged so that they are staggered by 90 degrees from each other with reference to their polarization axis. When no power is applied to the display component, the polarizing axis of the lower polarization sheet is at right angles to that of the upper polarization sheet. The light waves thus twisted by 90 degrees can also pass through the lower polarization sheet. After passing it, they reach the reflecting mirror, where they are reflected through the same route that them came in from. Accordingly, the liquid crystal panel appears bright.

However, when a voltage is applied between a segment electrode and the common electrode, the resulting electric field acts to orient the liquid crystal molecules vertically. Thus, the admitted waves directly pass through them without twisting and are checked by the lower polarization sheet from reaching the reflecting mirror.

The voltage of the field-affected segment part is blacked out. That is, the segment is displayed in contrast with the surrounding non-affected parts becoming visible. In practice, the seven segments (customarily denoted 'a' through 'g') on the upper plate glass are applied with a voltage selectively to form any desired numeral pattern.

LCDs and Temperature

Since liquid crystal is a chemical substance, it is subject to change when affected by environmental conditions like temperature, moisture and light. Up-market watches have digital displays which last 7 to 8 years, slightly less than the life expectancy of the quartz crystal oscillator. Similar to the effect of temperature on the rate of oscillations, high temperatures (above 60 degrees Celsius) results in the crystal's turning into liquids such that the digits become invisible. This does not effect the accuracy of the watch, and the digits will become visible again when the temperature returns to within the spectrum. Likewise, when the temperature is too low (below -10 degrees Celsius) the speed at which the digits change slows down. As with the higher temperature produced abnormalities, this does not effect the accuracy of the watch, and the speed at which the digits change will return to normal when the temperature returns to within the operating spectrum.

Batteries

There are two sources of electrical supply for such watches: silver oxide batteries or mercury batteries. Dry cells are not used, for while they can produce higher initial voltages, their output voltage almost immediately begins to fall. The silver oxide and mercury versions, while initially producing fractionally lower voltages, are very stable in their electrical supply, the voltage dropping off sharply when they are used up. Silver oxide batteries customarily produce about 1.5 volts, while mercury batteries customarily produce 1.3 volts. The other significant difference between them is that mercury batteries have a longer storage capacity than silver oxide, approximately 20% for the types used in mass-market watches. ■

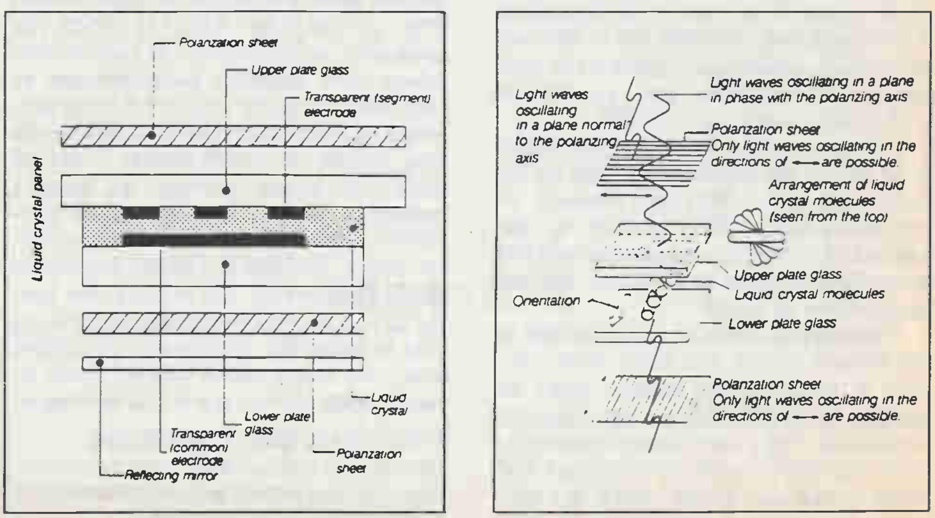
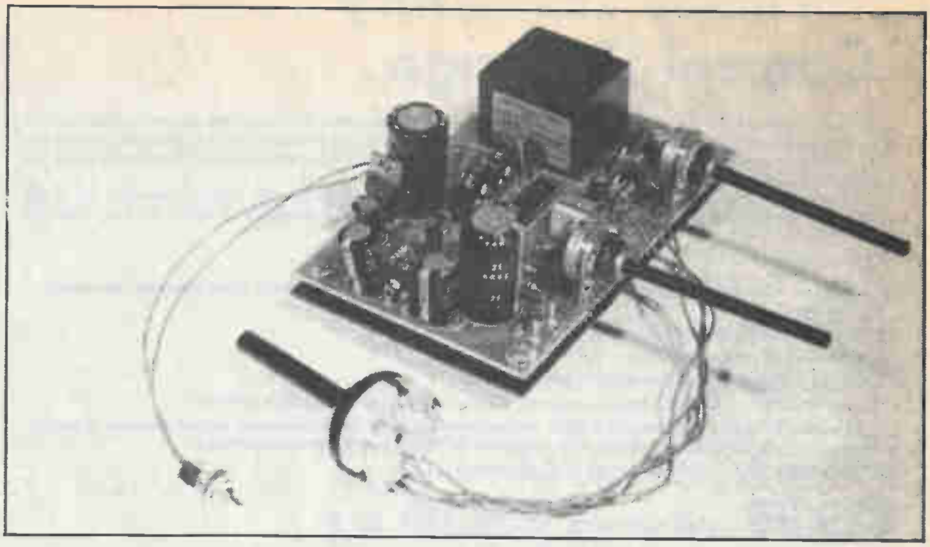


Fig. 2. Cross-sections illustrating the operation of a liquid crystal display.

All the components of the versatile three function signal generator fit onto one PCB, so that it can be cased by itself or with other equipment.

By J.C. Burchell



Function Generator

THIS versatile signal generator produces sine, triangle and square waves over the range 1Hz to 1MHz making it invaluable in the workshop for setting up and testing a wide range of equipment both analogue and digital.

Circuit

The audio signal generator, Figure 1 is based around the XR2206 monolithic function generator, an internal block diagram of which is shown in Figure 2.

The 2206 contains four building blocks for a function generator, most importantly is the Voltage Controlled Oscillator, whose frequency is set by the combination of a capacitor across pins five and six and the timing resistor connected to pins seven and eight. The VCO provides two outputs, the first used as a sync or square wave output, while the second is taken to a waveform generator and shaper block. By altering the resistance between pins fourteen and thirteen it is possible to select either a triangle or sine wave output.

The waveform from the multiplier and shaper block is then further buffered so as to offer a low impedance to any following circuit.

Thus the single integrated circuit is capable of simultaneously producing square waves, and either sine or triangle wave outputs.

The sine/triangle wave output can be both frequency and amplitude modulated if desired.

Range selection is made via a three way switch which alters the value of the timing capacitor connected between pins five and six. The frequency of the output is then varied by RV3, which alters the value of the timing resistance connected to pin seven.

Potentiometer RV2 adjusts the gain of the multiplier, and RV1 is set up so that with RV2 fully clockwise a standard output of one volt RMS is obtained.

Preset RV5 allows adjustment of the waveform symmetry, whilst the selection of sine or triangle is effected by the combination of SW1 and preset RV4.

The sine/triangle output is passed through a simple buffer amplifier consisting of Q1 and Q2, before being finally decoupled to the output by C9. The square wave output is buffered by Q3, note that this signal is approximately 12 volts peak to peak and so cannot be directly coupled standard five volt logic circuits, without further voltage conversion. A simple buffer circuit is shown in Figure 3.

A simple power supply consisting of IC1 and associated components provide the required 12 volts for the circuit.

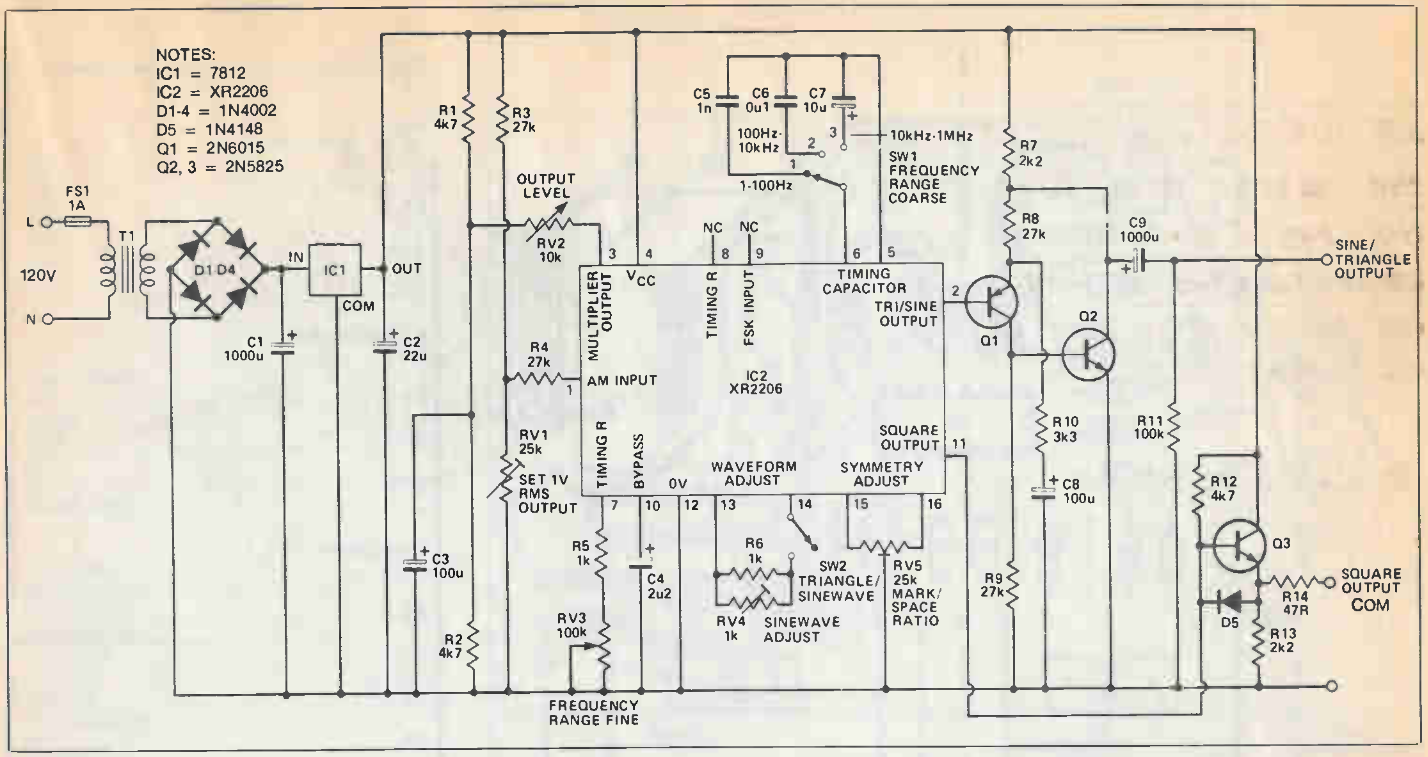


Fig. 1 The Circuit. The single XR2206 function generator chip produces square and sine or triangle waves.

Construction

A circuit of this complexity is best constructed on a PCB, and a suitable layout together with a component overlay is detailed in Figure 4.

When constructing the circuit take care to fit all the active components with the correct orientation as it is possible to destroy them if they are incorrectly placed. Whether or not the power transformer is mounted directly onto the PCB it is important to take additional care in the construction, also note that on the topside of the PCB the fuse is live, and extra care should be taken around this area.

It is a good idea to mount underneath the PCB on spacers, an additional plastic cover, thus helping to prevent accidental bridging of the PCB tracks.

The choice of housing depends on the preference of the constructor, but a metal case should be employed for reasons of safety. The choice of output sockets also depends on how the unit is to be used, but 4mm terminals seem to be the more versatile types to use.

Finally, remember to use a socket for IC2 as this is an expensive device.

Adjustment

Remember that the area around T1 is potentially dangerous from the 120V supply and great care should be taken when adjusting the various presets.

Set SW1 to position two, 100Hz-10kHz, and RV3 to about mid-position. If an oscilloscope is available connect it to the positive end of C9. Switch SW2 should be closed, ie in the sinewave position. Set RV5 to mid-position and ajust RV4 for the best possible waveform. Next adjust RV5 for the best waveform without clipping occuring. Repeat the above procedure until no further improvement can be obtained.

Finally, set RV2 fully clockwise and adjust RV1 to give a one volt RMS output. If no oscilloscope is available then the presets can be left at about mid-position as this setting seems to give a reasonable waveform.

In Use

The use of the signal generator is fairly self explanatory. Because of the extended frequency range, up to 1MHz it is possible to use the generator in both digital and analogue circuits. A typical use here would be in the testing of long wave and medium wave radios, and in particular testing of IF amplifiers and the like.

The square wave output could equally well be used to provide the "external clock" signal to digital circuits, but remember that the output is at 12V and thus the buffer of Figure 3 must be used to interface to TTL circuits.

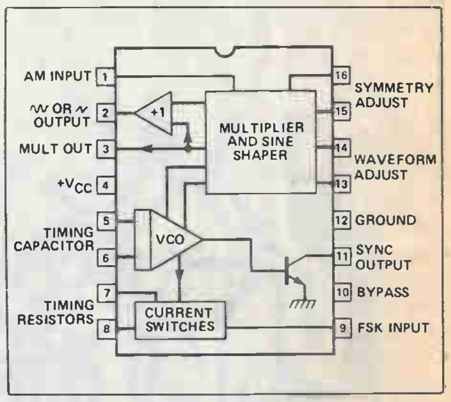


Fig. 2. An internal block diagram of the XR2206 function generator chip.

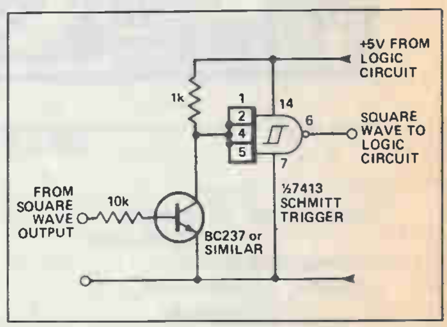
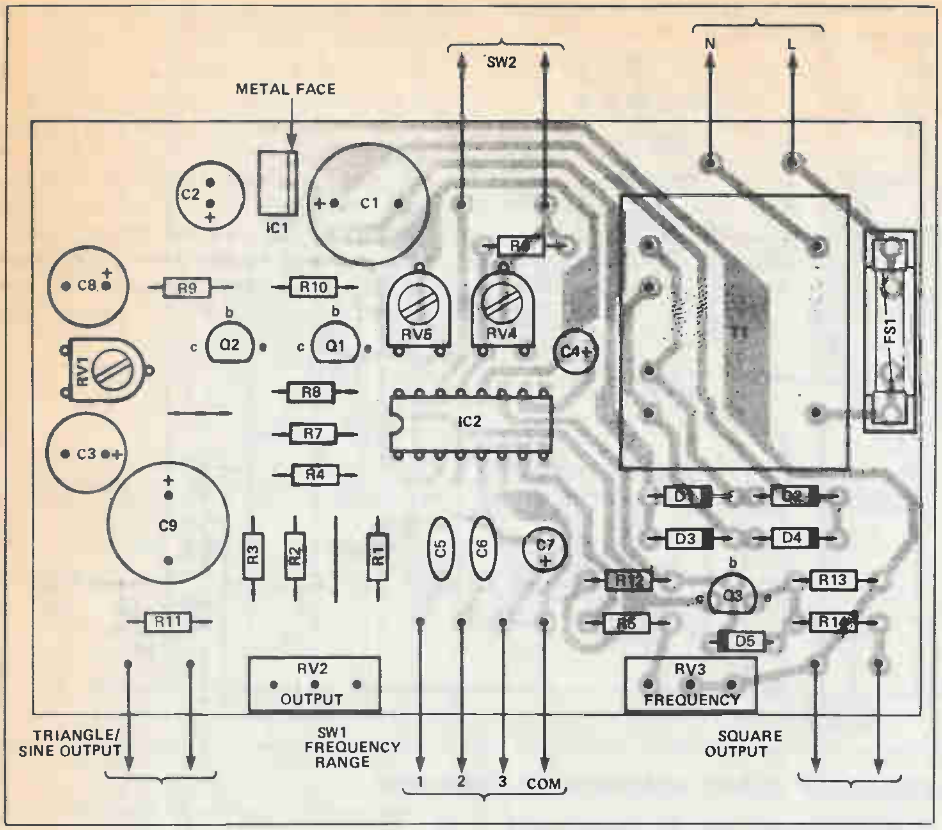
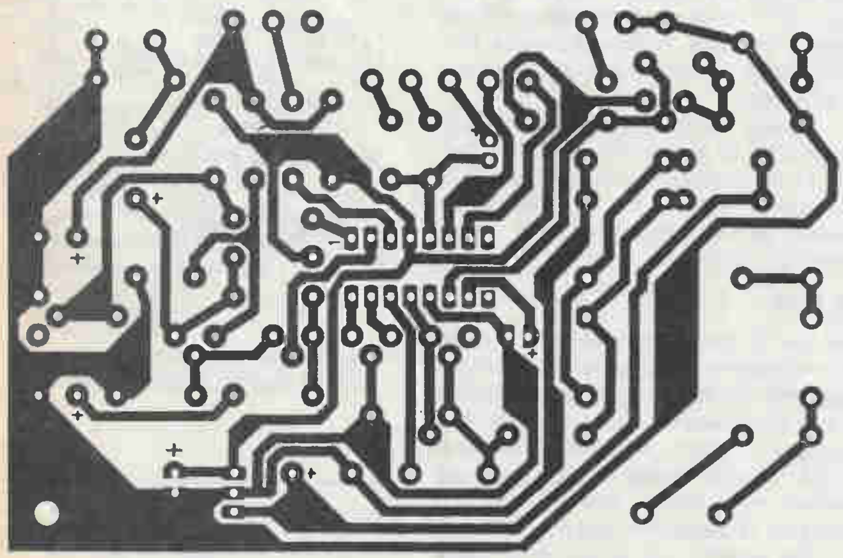


Figure 3. A simple buffer for connecting 12V square wave to a standard 5V logic circuit.





PARTS LIST

Resistors
All ¼ carbon 5%
R1, 2, 12 .... 4k7
R3, 4, 8, 9 .... 27k
R5, 6 .... 1k
R7, 13 .... 2k2
R10 .... 3k3
R11 .... 100k
R14 .... 47R

Potentiometers
RV1, 5 .... 25k horiz preset
RV2 .... 10k linear
RV3 .... 100k log
RV4 .... 1k horiz preset

Capacitors
C1, 9 .... 1000u 25V radial electro
C2 .... 22u 25V radial electro
C3, 8 .... 100u 25V radial electro
C4 .... 2u2 25V radial electro
C5 .... 1n carbonate
C6 .... O.1u carbonate
C7 .... 10u 25V radial electro

Semiconductors
IC1 .... 7812 12V 1A regulator
IC2 .... XR2206 waveform generator
Q1 .... 2N6015 PNP silicon
Q2, 3 .... 2N5825 NPN silicon
D1-4 .... 1N4002 silicon rectifier
D5 .... 1N4148 silicon diode

Miscellaneous
T1 .... 12.6V 300mA power transformer such as Radio Shack 273-1385
FS1 .... 1A PCB mounting
SW1 .... 1 pole 3 way rotary
SW2 .... SPST min toggle

Printed circuit board; plastic insulating base; connecting wire; solder etc..

For the XR2206, try Active Components, see advertiser's Index.

SPECIFICATION

Frequency range	1Hz to 1MHz
Output level: Sinewave	one volt RMS
: Squarewave	12 volts peak to peak
Sinewave distortion	0.5 percent typical
Outputs: Squarewave	12V fixed P-P
: Sinewave	
: Triangle	variable upto one volt RMS
External controls	range
	fine frequency
	output level
	sine/triangle select
Supply	self contained, 120V input

Loudspeaker Tester

IF YOU ever find yourself setting up loudspeaker systems for discos, groups or public address etc., sooner or later you will need to check various parts of the equipment. This tiny piece of test gear should make life a lot easier.

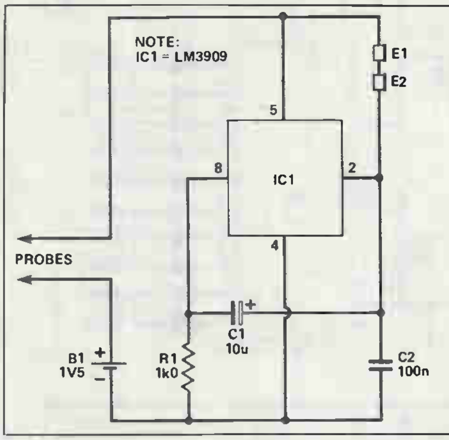
One way to test continuity is to use a multimeter on the ohms range but this has at least two disadvantages in that you have to look at the scale (often in poor light) to see what is happening and it does not prove that a loudspeaker is working even if the resistance reads correctly. This project has the advantage that it gives an audible indication of continuity from its built in sounders and will also drive a loudspeaker connected to its terminals.

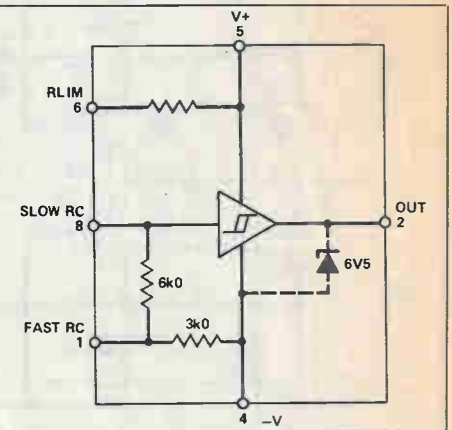
The Circuit

This was originally designed as a low power LED flasher but will function quite well as an audio oscillator under the right conditions. The heart of this gadget is the LM3909 IC. A notable feature of the device is that it will operate from a single 1.5 volt dry cell. This enables us to build a very simple and compact unit.

Most of the circuit is completely standard except that we have used a pair of low impedance earphones instead of a loudspeaker. This was done so that the complete unit would fit into a small plastic box. If you can find a small loudspeaker with a coil impedance of 16 ohms or more this would do instead or alternately an eight ohm speaker in series with a coil (50 turns of 22 swg enammelled wire wound on a 2BA steel bolt) may be worth a try.

In operation the battery supply is completed via the test probes and the external circuit. If the resistance of the external circuit is low enough the LM3909 will oscillate and produce a tone from the two earpieces. The frequency and loudness of this tone will depend on the resistance and reactance of the external circuit and the characteristics of E1 and E2. Shown below right is an internal view of IC1.





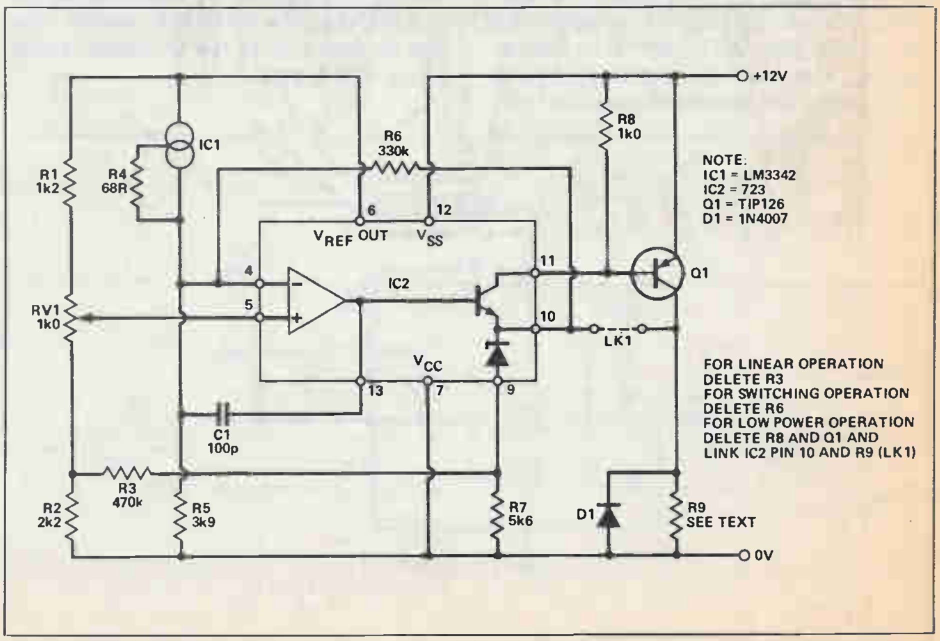
Temperature Controller

THE temperature sensing element in this circuit is the LM3342 current source IC. This is programmed by means of a resistor to pass a current of about 1 mA. Due to the nature of the device the current is not greatly affected by the voltage across it but is affected by the temperature. In fact the current increases linearly as the temperature rises and this is used to generate a voltage proportional to the absolute temperature. In order to make use of this effect we have employed a well-known voltage regulator IC, the 723. This gives us several functions in one device which would otherwise have to be provided separately. First it contains a temperature stable voltage reference which is used to supply the temperature sensor and the reference adjusting potentiometer. Second it contains an operational amplifier with a moderately high gain and lastly it has an output transistor capable of passing up to 150 mA.

The circuit is configured such that increasing temperature tends to reduce the power in the load. To use this in a linear mode feedback can be provided from the output to the inverting input to the op-amp section. The resistor value chosen for this gives about 1 volt per degree Centigrade. For switching mode operation the necessary feed back is provided to the non-inverting input of the op-amp which gives a sharp on-off action. The rate of switching will depend on external factors such as the thermal inertia and sensor position, etc.

For low power operation it may be possible to omit the ouput transistor from the circuit and use the 723 output device only. This is made possible by shorting IC2 pin 10 to R9 using LK1 and replacing R8 with another link.

For wide range operation you may find it necessary to put a resistor of 1k or so across link LK1. The diode D1 is only necessary when inductive loads such as relays or fans are used instead of resistors.



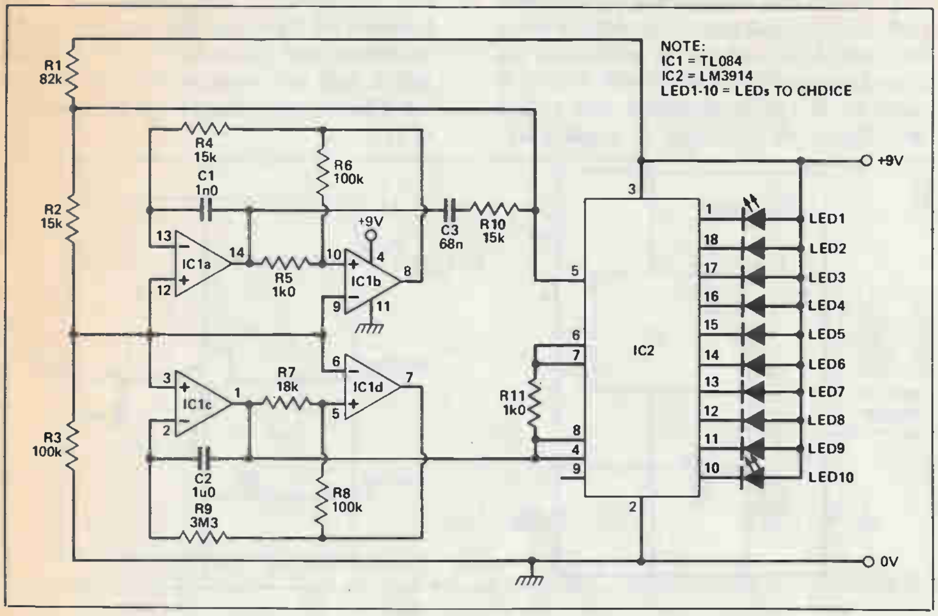
Light Chaser

THE DISPLAY consists of ten red LEDs driven by an LM3914 linear bar-graph IC. This IC also contains a voltage reference source and all the necessary comparators to control the display.

In order to produce the smooth to-and-fro sweep two sections of a quad operational amplifier have been configured as a triangle wave generator. The output from this is applied to the lower end of the voltage reference and comparator chain while the other end of the comparator chain is connected to the upper end of the voltage reference.

This means that reference voltage is sitting on top of the triangle wave generator and is being swept up and down past a reference applied to what is normally the signal input pin. This produces the basic back and forth sweep on the display.

As it stands so far the display would be jerkey so some method of smoothing out the transition between adjacent LEDs is necessary. This is done by connecting up the remaining two sections of the quad op-amp to form another triangle wave generator operating at a much higher frequency. The output from this is mixed with the reference voltage to smear the display over two or three LEDs at a time. This makes the display much smoother and more realistic.



Designs By Phil Walker.

Envelope Generator

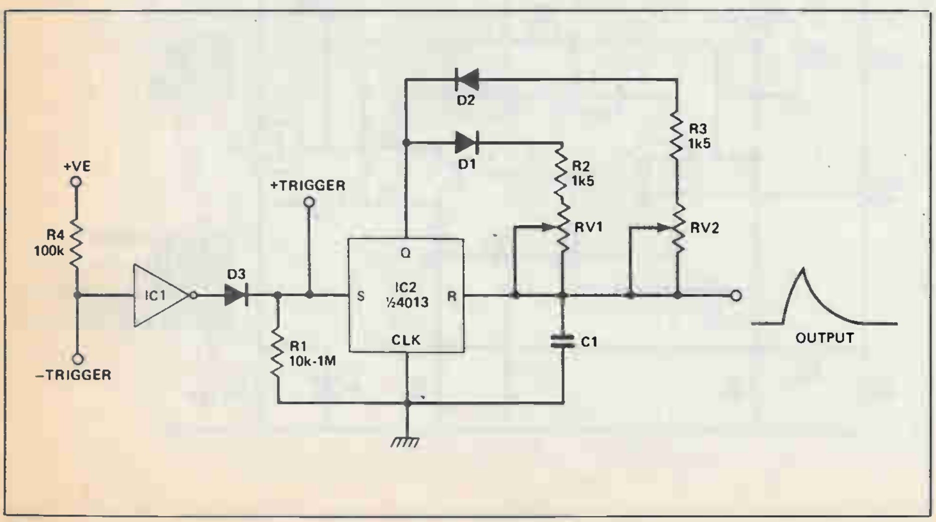
By Jeff Macanley

ALTHOUGH the ADSR envelope generator has become standard there are occasions when a simpler and cheaper alternative is desirable.

The accompanying circuit shows such a device. The basis is the humble flip flop, IC2, half a 4013B. When a positive going pulse is applied to the set input the Q output goes high allowing C1 to charge via the attack pot, RV1, and D1. Notice, though, that the reset pin is connected back across C1: in consequence, as soon as the voltage across this component exceeds about 50% of the supply voltage, the flop flop resets, reverse-biasing D1.

C1 now discharges through the decay pot and D2. With the values shown both attack and decay are variable from a few milliseconds to several seconds. The two current limiting resistors should not be left out because the maximum current that can be drawn from the Q output is only about 10mA peak.

If negative triggering is required the inverter circuit shown can be employed. This has the advantage of allowing the device to be triggered from open collector devices. IC1 can be any inverting CMOS gate, NAND or NOR, with unused inputs wired to +ve (NAND) or 0V (NOR); it can even be an inverter gate! Note that supply connections to IC1 and 2 will need to be added. ■



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By Roger Allan

Haws Weather Station

Electronics in Action

A computer weather station, a radar detector, a TV system translator, and a smart credit card.

HAWS Weather Station

It is perhaps a trite point to say that with the rise of the microcomputer industry there has been a concomitant plethora of software packages to accompany the machines, along with a very large number of computer hardware peripherals. But if one thinks for a moment, one recognizes that virtually all of the peripherals within the financial range of the home computer owner involve telecommunications, e.g., modems and the like. There are virtually no devices designed (at least, within the monetary range of an Apple owner) that provide some sort of automatic input of data for use other than just talking to someone else. Matters, almost of necessity, are beginning to change.

One of the more interesting areas that could possibly be connected to a computer is information concerning the atmosphere.

Whether one is a home gardener wanting to know when to plant the family tomatoes, a farmer with somewhat larger horticultural ambitions, a student learning about the natural world, or small business wishing to know whether to have an outdoor sale, all have a vested interest in what, if anything, is going to descend from the heavens, and at what temperature. Environment Canada, with their reports over the radio, do their best, but it hardly aids in small localized areas.

To that end Vaisala Inc, a Finnish company with several overseas branches who have been involved in the design and manufacture of government meteorological quality devices for almost half a century, are now marketing what they call the HAWS (Home Automatic Weather Station). Currently, it can only be run on Commodore machines, but according to Bennet Lavine, their North American Product Manager, the next two to three months will see the marketing of a universal linkage operable on any of the standard micros.

The device is quite straightforward. There is an external component which one mounts on the roof or an outside wall, an connecting cable to the Commodore, and a software program.

The external element contains three sensors of government meteorological quality for temperature, barometric pressure and humidity. The readings from the sensors are converted by a built-in transducer to the appropriate electronic form and fed to the computer. There all sorts of interesting things are done. There are nine built-in programs that run, with the option (for educational purposes), of having a student enter numbers and variables to enhance their understanding of weather preparatory to their next geography exam. DISPLAY provides a continuous readout on the TV screen of temperature, humidity, dewpoint and atmospheric pressure, updated every 15 seconds. COMFACTOR, which is based on temperature readings from the HAWS and a visual observation inputted by the operator (since the HAWS is totally electronic, there is no wind velocity device, which are always mechanical in design), provides a computation of the wind chill factor.

CLOUDALT, using temperature and relative humidity readings, determines cloud altitude (as an aside, the temperature decreases about 3 degrees F for every 1,000 feet of rising altitude, known as the 'lapse rate'. This, in combination with the humidity reading, provides the raw data for determining cloud altitude). TREND allows the operator to collect and store weather data automatically for up to 36 hours. GRAPH provides a graphic display of TREND, e.g., individual curves for pressure, temperature, relative humidity, and dewpoint, along with statistical data such as high, low, average and mean values for the above.

CALC allows the operator to determine meteorological parameters and equations such as calculating dewpoint from relative humidity and temperature readings, temperature conversions and conversions from millibars to inches and vice versa. PRINT sends everything to a printer, and FORECAST, predicated on the information sensed and processed, provides the next day's forecast for the operators individual location.

Having mastered the above, and it is really rather simple to use, one can then customize parts of the program for one's own usage, such as frost forecasting (home gardeners) and the determination of heating and cooling days to coincide with heating and air conditioning controls, thereby maximizing energy efficiency in the home, school or office.

Vaisala Inc.,
2 Tower Office Park
Woburn, MA.,
01801

Radar Detector

One of life's little irritations is being pulled over by a member of the local gendarmerie for the alleged offence of break-ing the appropriate section of the Traffic Act by proceeding at a velocity somewhat in excess of that considered safe by The Powers That Be. As the Presidential campaign slogan for Senator Goldwater stated, 'In your heart, you know he's right', but it doesn't help matters when one is forking over the fine (not to say losing points).

Since a certain amount of legal controversy some ten years ago, after which it was finally determined that the possession and use of equipment solely designed to foil police radar was legal, a veritable cottage industry involving the design and manufacture of such devices developed. They are many in number, customarily bulky in substance, and usually require Harry Houdini-like contortions to retro-fit them under the car's hood. At least until recently.

The B.E.L.-Tronics company recently expanded their line of high-tech radar receivers with the introduction of what they call their Detection/Mirror. Quite simply, it is a largish mirror which, via expanding spring-loaded clips, may be retro-fitted over one's car's mirror. Here any similarity between their device and other car radar detectors ends.

Located on the right-hand side of the mirror is a microstrip antenna. This is connected internally to what B.E.L.-Tronics call their Compuheterodyne microprocessor. Essentially, the superheterodyne picks up in-coming radar signals on the X and K bands, mixes them with another locally generated frequency, producing a signal with a sufficiently low frequency as to be easily usable by the microprocessor.

This microprocessor is set at either an LR (long range) or LO (short range, e.g., city) position (more properly known as the Radar Signal Discrimination Mode, or RSD). The purpose of the LO position is to reduce X band sensitivity to an optimal level, that is, one which results in elimination of signals from microwave intrusion alarms, microwave door openers, etc, which operate on the band. K band sensitivity remains at full strength.

There is also a Filter Mode. This is designed as a monitoring device for in-coming weak signals. Like the RSD, the Filter Mode is only activated in the LO position.

As one approaches and passes a signal source, the signal will slowly increase and then slowly decrease. The weak signal may be a police radar detected at a long distance. As soon as the weak signal is picked up in the Filter Mode, the unit will sound one audio alert beep. This will be followed by a seven second delay as the microprocessor analyses the signal strength. If the signal is still present at the end of this time, the unit will sound another alert pulse.

The signal is then monitored for 20 seconds, during which the device emits a soft clicking noise. This process will continue until either the signal disappears, or, if the signal becomes progressively stronger, the clicking and audio alert

Circle No. 23 on Reader Service Card

Circle No. 6 on Reader Service Card

pulses will accelerate. At the same time, a built-in Visual Signal Strength Meter will indicate approach to the signal source by the illumination of the red LEDs.

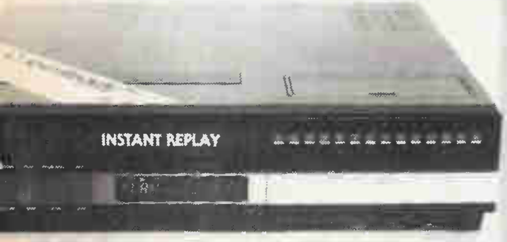
Anyone who spends long hours travelling is subject to speeding tickets through occasional lapses of concentration or by falling prey to revenue-located speed traps. With this device, powered from the cigarette lighter, perhaps both the safety of the highways and the financial well-being of the driver may remain better intact.

B.E.L.-Tronics Ltd.,
2422 Dunwin Drive.,
Mississauga, Ont.

The Image Translator

With the rise of national television networks, there has developed an (inevitable) bailiwick protection mentality. Every tin-pot Power That Be believes that their system of transmission is better than the next country's. World-wide, therefore, a number of mutually incompatible systems have developed. There is the National Television System Committee (NTSC) standard used in the United States, Canada, Mexico, Japan and parts of South America; the Phase-Alternate-Line system (PAL) used in Western Europe, Britain, Australia and parts of Africa and South America; and the Sequential-and-Memory system (SECAM) used in France, the USSR, Eastern Europe and some Arab and African nations. Without going to the lengths of examining the entrails of the various systems, essentially they differ in the number of lines per image,the number of pixels per line, bandwidth and tape speeds.

The difference in transmission modes has never been of major import to the home consumer, at least not until recent years with the rise of the video tape industry. Now it's becoming a bit of a problem. Schools, particularly at the university level, who have ties with foreign institutions are increasingly finding that they cannot exchange educational video material without the purchase of foreign equipment. Countries that have cultural ties with others that are on different transmission standards, such as Britain and Canada or Spain and Mexico, for example, are finding that the conversion costs of video tapes add unnecessary and surprisingly high costs to their links. Businesses who are attempting to crack the international market have the additional transmission translation costs to bear.



There are ways around the problem, utilizing multi-standard units. Unfortunately, these units, which require modification not only to the receiver but to the monitor, have the detrimental side effect of not being able to record well in either standard, and suffer a generalized degradation of video quality overall.

In an attempt to overcome this problem a company known as Instant Replay has developed an Image Translator device soon to be included in General Electric's VCRs. It may be connected to any other NTSC standard VCR providing that it has a vertical hold control.

The system does not modify the record characteristics of the signal, regardless of which system is being utilized. Their device modifies the playback characteristics of the signal, but only to the point of making the monitor believe that it is receiving a signal of its original standard. This does result in a 5% degradation in color, but only in the playback of the foreign standard. It does not effect the original NTSC standard.

More specifically, the Image Translator plays all PAL video tapes in colour, including PAL B (Western Europe, India, Africa, the Far East, Australia and Scandinavia), PAL N (Argentina, Peru, and Paraguay), PAL I (Britain, South Africa and Ireland) and PAL M (Brazil). It also, in monochrome, plays SECAM B,G and V (found in Eastern Europe), SECAM D (USSR), SECAM H (the Middle East) and SECAM L (France). It plays on any regular television set or monitor, has a cable ready 107 channel tuner, 2 event, 14 day programmable timer, 5 function remote control, electronic digital watch, and other examples of the bits and pieces one has come to expect on any up-market VCR.

One final point. For those who wish to send tapes of the new grandchildren back to the 'old country', it can now be done without their having to purchase a brand new television.

Instant Replay,
The Mutiny at Sailboat Bay,
2951 South Bayshore Dr., 8th Flr.,
Coconut Grove, Florida 33133

Phonocard

The next logical evolutionary stage that credit cards will pass through consists of cards which in themselves have monetary value. When one inserts such a card in the appropriate device, it will automatically debit one's prepaid account. The difficulty with such cards is how to make them counterfeit-proof.

The industry leader in such debiting cards is Landis and Gyr, a Swiss company with a number of research installations in North America. They have been very successful in introducing such a a debit card in fourteen European countries, particularly the UK, where British Telecom has about 10,000 card phones with the public utilizing over a million cards a month.

Basically, their card system is dependent on optical technology they call 'monetics'. The card is coded using laser interference patterns, with the monetary units micro-embossed on its surface. Upon inserting the card into the telephone machine, an LED creates a non-coherent light beam which strikes the card at a particular angle. The angle is determined to provide the maximum amplitude at the angle of refraction and the minimum amount of light at the angle of reflection. Electronically, the device then compares the two signals to determine firstly if the card is forged, and secondly the number of monetary units left on the card. The result is displayed on a liquid crystal output.

As the telephone call progresses, the unit shows the number of monetary units remaining, and decreases them at the appropriate rate. When the call is ended, the amplitude of the signal light is increased, burning away the number of monetary units that have been expended by the caller. A double check is performed to make sure that the micro-embossments have in fact been incinerated. The card is then returned to the user.

Should the device determine that the card user is running out of monetary units on a particular card, an audible signal is generated. The user may then either conclude the telephone call or press a button.

Landis and Gyr, Inc.,
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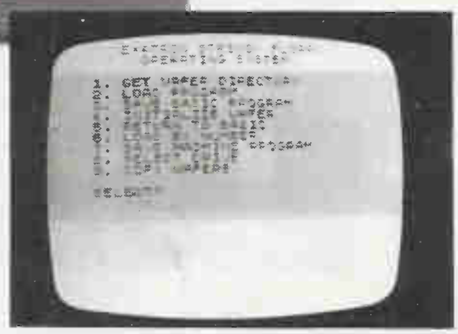

High-speed loading and saving for the ZX-81, including a menu-driven operating system for easy file handling.

By Bill Markwick

Exatron ZX81 Tape Drive

IF YOU'RE annoyed with the slowness and unreliability of audio cassette tapes for ZX-81/Timex 1000 data storage, a company called A & J Microdrive of California are distributing the Exatron Stringy-Floppy Microdrive that will cure some of the problems. Sitting in a case that isn't much bigger than the ZX-81, it accepts tiny cassettes ('wafers') that move the tape in an endless loop like an 8-track cartridge, and are available in lengths from five feet (7K bytes) to 50 feet (70K). It includes its own power supply, and an interface which fits onto the back of the computer (there are no connections to the Ear/Mic jacks) and still allows the connection of other peripherals. Two drives can be connected for up to 140K of storage. A single-drive system costs $319.95.

Unpacking

The first thing you'll find out is that the system must have 16K to 32K of RAM available. Connection without a memory pack resulted in a 'too little memory' message, and connection with the Gladstone 64K resulted in nothing at all.

The interface goes onto the computer first, followed by a RAM pack; the system's AC plugpack connects to the main case via a phono cable. The ribbon cable between the case and the interface has a second connector for Drive Two.

When all this is connected, the computer functions as usual; the system must be called with 'PRINT USR 12345', a fair amount of typing if you're going back and forth between the system and BASIC, even allowing for keywords. However, once this is typed in, you'll see a menu, which is approximately:

DIRECTORY
LOAD
SAVE
INITIALIZE
RETURN TO BASIC
LOAD BY NUMBER
SAVE MACHINE PROGRAM
SELECT DRIVE
COPY WAFERS.

Initializing

The file directory, capable of holding up to 127 files, is considered the first program and must be written onto the tape before anything else is attempted. If you request the file directory from a blank disk, the system will just run forever. A five-foot tape took about 15 seconds to initialize, and a 50-footer about 2.5 minutes. During this time, the tape is verified for quality; the 50-footer evidently didn't make it, although there was no error message. It just returned the menu with the message that 3000 bytes were available. I tried a 35-footer with better results: 47000 bytes available.

Tryout

I typed in several short programs. They were saved and re-loaded with a speed that depended on the tape size; the shorter tapes took only 15 seconds or so; the longer ones whirred for up to several minutes. There were two unlabelled LEDs on the front panel, and the one I presumed was the 'Read' indicator stayed on much longer than 'Write' during saves. This was no doubt caused by a tape/memory comparison for error checking. It resulted in very good reliability during the testing; there was never a problem in this regard. However, it also resulted in very long load and save times with the larger tapes; presumably the tape has to go all the way around again for playback and comparison. The transfer rate is 10.4K baud.

The first problem to crop up, as you may have already noticed from the menu, is the lack of a Delete feature. If there is one, it didn't present itself in the manual or during operation. I thought that initializing the tape again would erase it, but it seemed to affect the bytes-free count. Perhaps the 50-foot tape wasn't defective, but full of hidden files.

There were a few other glitches, none of them serious: if you pressed 'Return' instead of 'Break' to cancel a command, for instance, the system would hang until the power was turned off and on. The 'Copy' function works only with two drives.

Summary

The system loaded and saved reliably with a far better speed than cassette decks; it also features a good operating system for file handling, and will also chain programs together for sequential running. There is also an 'Economy' mode which disables all the file-handling features and buys you 1K more of memory space; you're now limited to basic loading and saving without the file directory.

The lack of a Delete feature means that you'll have to keep everything you save, no matter how obsolete it is, unless the designers have come up with an undocumented program that will do the job. The cost is also rather high: over six times the cost of the computer itself, assuming that you already have a RAM pack. If you have a 64K RAM pack, you'll have to go hunting for some hardware or software method that will make it compatible with the system.

In general, the system is well made and will simplify file handling for any ZX-81/Timex 1000 owner. Whether it's worth the purchase price depends on whether or not you want to stay with the Sinclair system or upgrade to a more modern computer.

The Exatron Microdrive is available from Gladstone Electronics, 1736 Avenue Road, Toronto M5M 3Y7, (416) 787-1448.

■

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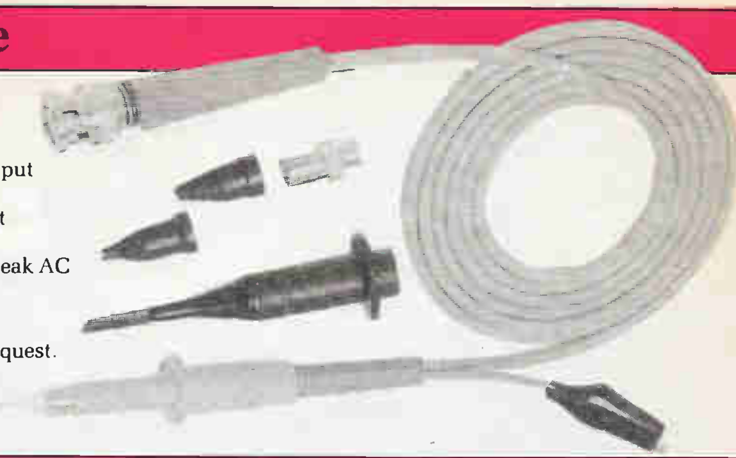

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Working Temperature Range	−25 to +70°C
Cable Length	1.5 Metres

REF POSITION — Probe tip grounded via 9 MΩ resistor, oscilloscope input grounded

×10 POSITION

Attenuation Ratio	10:1
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Specification

Attenuation Ratio	10:1
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Compensating Range	10–60 p.F.
Input Resistance	10 MΩ When used with oscilloscopes which have 1 MΩ Input. (Probe resistance 9 MΩ ±1%)
Maximum Input Voltage	600 Volts DC Including peak AC, derating with frequency
Working Temperature Range	−25 to +70°C
Cable Length	1.5 Metres

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The technology of larger computers meets the pocket calculator in this remarkable model from the U.K.

By Bill Markwick

Psion Organiser

THE microprocessor and micromemories have made Buck Rogers technology ho-hum; the elves are putting them in everything from kid's toys to intelligent doorbells and making each new unveiling of the latest miracle about as exciting as the daily weather report.

Still, it's hard not to be impressed with the Psion Organiser from the UK, a pocket computer-calculator that really *does* fit in your pocket because you don't have to add interfaces or cassette recorders. The size in mm with the case closed is 142 x 78 x 29.3, and the weight is 225 grams. For those who regard metric as some sort of subversive secret code, it's narrower than a large pack of cigarettes and slightly longer and thicker. It presently lists for $199.95 in Canada, and includes one datapack and one Utility pack.

The Main Features

Here's a quick look at what it can do before we start tinkering: it comes with 10K of non-volatile character storage in cartridges, two cartridge slots, a database with a search function, a utility pack with math functions, a 16-character LCD display, a clock/calendar, BASIC-like programming with the optional Science pack, and a calculator that you can edit. There are also lots of optional goodies.

Powering Up

Slide off the protective cover, or leave it latched down to expose the keyboard, and you'll see the alphabetic keyboard with its 36 tiny keys on 7/16 inch spacing. Oops, 11 mm. Push the On button and you'll see the display giving the hour, minute, second, month and day in characters 1/4 inch high. Oops, 6.4 mm.

The keys are spaced widely enough that they'll be no bother to people with large fingers, but they aren't very high and fingernails get in the way occasionally. If you play the guitar you can run your Organiser with your left hand.

Before going into the available menu, turn the unit over and you'll see two data packs facing one edge; they're about the size of a medium-sized postage stamp, and slide out from their pin connections for interchanging. They're called "solid-state drives" in the manual, and do indeed function just like a disk. The Organiser comes with one datapack marked with "8K"; in fact, data compression is used to store 10,000 characters into this 8K. No technical information was available to explain how they did this; we'll have to assume that they strip off unnecessary bits from each byte. Two data packs can be inserted, and if you buy the 16K versions, you end up with the equivalent of 40K of character storage.

One of the datapacks can be removed and replaced with software packs. These are Science, Math, Finance, and a Communications package (others will soon be available, according to the manufacturer).

The Organiser comes with the Utility software pack and one 8K datapack. Pressing the **Mode** switch will scroll you through the menu of features available with these two: **Enter**, **Off**, **Calc**, and **Copy**.

Enter is the database, and the prompt is waiting for you to enter anything you like: names, numbers, jokes, whatever. You can type in up to 200 characters, and scroll back and forth, insert, or delete. Numbers are obtained by using a Shift key; the shifting and the alphabetic layout were awkward to use, particularly if you're used to a typewriter keyboard, but this was personal preference. I think if I

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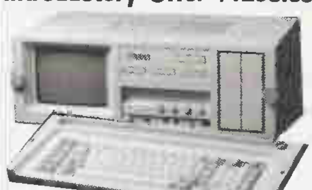

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could change any one thing on the Organiser, it would be the keyboard.

However, once you get your text string to your liking, pressing the **Save** button will call up the word **Save1**, indicating that the string will be saved to data pack 1. If you press the **Save** button again, you'll see **Save2** if a second datapack is fitted. Characters are saved at the rate of four to eight per second, depending on the battery freshness.

Now press **Clear** to delete your string from the screen, press **Find**, and it will prompt you for any word or part of a word in the string. Almost anything will do for a search clue; if you can't remember anything at all, just pressing **Execute** (the same function as **Enter** or Return) will display the first 16 characters of each data entry. If you know any unique word from the string, it will find your entry almost instantaneously if the datapack is almost empty or in about 5 seconds if it's full.

Incidentally, if you're called away to the phone without saving your string, the unit powers down automatically unless a key is pressed within five minutes, eliminating your text. Better to press **Save**, even if the string isn't correct yet. You can always fix it later.

Now we come to the only serious drawback I could find in the system: you can't delete obsolete files. While the menu shows an **Erase** function, and indeed it does erase all traces of your entry, it doesn't actually remove it from the RAM; it's there taking up space forever, even if you can't see it. The reason is no doubt due to design problems in implementing an electrically-erasable PROM for such a small computer.

There is a way around this, however. You can copy usable files to a second pack with the Copy function, and then erase the first one with an ultraviolet EPROM eraser; a port in the datapack is provided for this. If you don't have access to an eraser, Psion makes one, available in Canada for about $120. You could always use it for erasing other EPROMs as well.

Calc

Even without the Utility pack fitted, the Organiser has a remarkably convenient calculator. It has the usual four functions, plus two levels of parentheses, plus scientific notation. The entire line of calculations can be edited; that is, after calculating you can scroll into the string, change something, and recalculate. You can also **Save** any calculation into the database and recall it into the calculator function at any time. Finding it again requires you to remember at least one number in the calculation, or you'll have to trek through the entire database listing.

The Utility pack increases the flexibility to the level of a any comprehensive scientific calculator. Functions available are the usual logs, exponents, trig, minimums, maximums, mean, standard deviation, and so forth. A random number generator can be set for automatic random seeding, or re-seeding which results in the same string of random numbers each time. The Fix command will set the number of decimal places from zero to six. Again, all calculations are editable (their word).

The real whizbang calculator functions happen when you plug in the Science pack, however.

The Science Pack

This pack turns the Psion into a genuine computer; it can run resident scientific programs or let you write your own in a compact language very similar to BASIC.

The Organiser behaves much the same way as before when you power up, but adds the functions **Prog**, **Run**, and **Cat**. **Prog**, as you might have guessed, is for writing or editing programs, and **Cat** is the catalogue of available functions and programs (yours and its). The catalogue is a bit difficult to use on a 16-character display, as you'd expect, especially since cryptic abbreviations are used for resident functions. However, **Cat** does have the search function if you can remember anything at all about the filename.

There are 23 scientific constants available, and they or their abbreviations can be plugged into your equations. Some of them are the speed of light, the charge on an electron, Boltzmann's constant, the speed of sound, Avogadro's number, and the gravitational constant.

13 conversions are available; like the constants, they can be used in either the calculator or program modes. Examples of the conversions are metres to feet, horsepower to watts, calories to joules, rags to riches, and so on.

There are eight programs stored in the pack; they'll only be of use to a few people, and are really included as demonstrators of programming capability. You can take them apart and see how it's done using the **Edit** mode. There's an Image program, for instance, which asks you for the focal length of a lens and the image distance; it returns the distance of the image from the lens. Another is LC, the period of a resonant LC circuit; Bohr tells you the energy levels of an atom for various quantum. The Bragg formula, which is one I use every day, calculates the separation of atoms or scattering centres in a lattice for successive orders of diffraction. I usually work it out on an abacus, though.

The roots of either quadratics or polynomials of up to the sixth degree are almost instantly calculated. When typing **Quad**, for instance, it assumes that you're working with the standard form of the general quadratic equation and asks you for the values of the coefficients; it then displays the possible values of X. If you enter gibberish, as I am wont to do, it will make a valiant try and return the values of the imaginary roots.

The **Line** function accepts data points of the form (X,Y) and does a best-fit to a straight line of the form Y = AX + B. After entering the data, you're presented with the slope and the Y intercept of the line. The **Integr** function can be used to calculate the integral under a curve; up to twenty points on the curve may be entered.

Programming

With the Scientific pack in place, you can begin writing your own programs in a remarkably compact, convenient language called POPL, the Psion Organiser Programming Language. It will be very familiar if you know BASIC, but contains some very powerful features borrowed from other languages.

To write a program, execute **Prog** from the menu and enter the program name when prompted. There are no line numbers used; the vertical cursor keys let the computer know when you've finished with a statement.

Here's a BASIC program to do a simple conditional:

```
10 INPUT “NUMBER”;N
20 IF N<10 GOTO 40
30 IF N>11 GOTO 60
40 PRINT “SMALLER”
50 END
60 PRINT “LARGER”
```

And here's the same thing on the Psion:

```
IN “NUMBER” N
IF N<10 GOTO HERE
IF N>11 GOTO THERE
HERE: OUT “SMALLER”
THERE: OUT “LARGER”
```

One of the nicest features of the PSION's language is the ability to call other programs from within yours.

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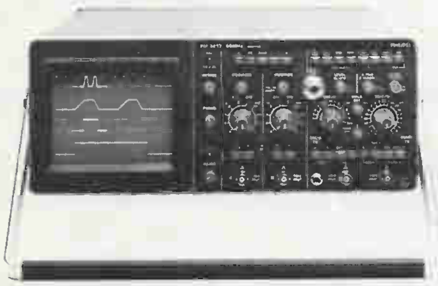

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Other Programming

Aside from all the usual conditionals, such as IF, AND, OR, etc., there are 20 storage locations numbered 1 to 20 in addition to the 26 alphabetic variables. These are used to create arrays by storing and recalling via a loop.

Incidentally, there is no FOR-NEXT loop; it has to be created using an incremental counter and GOTO statements. It takes about the same amount of typing as the BASIC statement.

One of the nicest features of the language, borrowed from languages like Logo and Pascal, is the ability to call other programs from within yours. For instance, the program above could be stored as COND, for conditional, and this filename is simply inserted on its own program line; when the main program comes to it, it will retrieve COND from memory and execute it before continuing. If, for some reason, you want a program to run over and over, you simply put the program name on the last line and it will call itself until **Clear** is pressed.

Other

The Organiser (and each software pack) comes with a reasonably good instruction book. Like a lot of computer doc authors, they've dispensed with the index, and important points are often buried in the text instead of being in bold type. However, most of the features can be figured out very quickly due to the general excellence of design; I was doodling away with almost every available feature in one afternoon.

There is also a communications pack available, but one wasn't available in time for the review. In short, it's an RS–232 connector that fit in place of one of the datapacks; the communications parameters such as baud rate, parity, etc. can then be set. The computer can now be attached to a modem or printer.

It's difficult to compare the Psion to anything else. It seems to be unique. However, since you need a $79 Science pack before you can program, it's in the same price range as the Radio Shack PC–2, another pocket machine that runs BASIC. The great advantage held by the Psion is that it's truly self–contained; the PC–2 requires a large, expensive interface and a cassette recorder before you can save or load. Also, the PC–2 has only 2640 bytes of memory against the equivalent of 10K in the standard Psion, which is also expandable to the equivalent of 20K (or 40K if you don't fit a software pack).

In short, it's a superbly designed machine. The only drawback is the lack of proper file deletion; reaction to the keyboard depends on personal opinion. Its power makes it a useful timesaver for almost everyone who'd like a database, scientific calculator, financial calculator, and computer; more application packs are said to be on the way.

Quick Reference

Price:	$199.95
CPU:	HD6301X, .92 MHz
RAM:	2K internal, 2 slots for 8K or 16K pack
ROM:	4K excluding datapacks
Software:	BASIC–like, requires Science pack, $79
Power:	9 V radio battery; no adapter available
Display:	16–character LCD
Other:	36 keys, contrast control

■

Circle No. 41 on Reader Service Card

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Circle No. 25 on Reader Service Card

By Yin H. Pun

Computing Today

The SAM and a Talking DOS

An inexpensive voice synthesizer and ways to use it.

SAM, short for Software Automatic Mouth by Don't Ask Software, is a speech synthesizer for the Apple II created entirely in software. It includes a simple, general purpose Digital to Analog converter, a manual and a disk. "Recorded" speech synthesizers (such as "The Voice" from Muse) are popular software synthesizers but are a little bit difficult to understand fully. These speech synthesizers employ a method of recording an audio signal from the tape input port into the memory and playing it back through the Apple's speaker. However, with the addition of a Digital to Analog converter and preprogrammed voice phoneme "spectra" and timing, SAM's voice is much clearer and intelligible. It has a fair amount of inflection and intonation. It is almost as good as a completely hardware synthesizer such as the "Echo" card using the "Votrax" chip.

The disk has four demonstration programs, including Hamlet's "To be or not to be" soliloquy and a short story about the history of speech synthesizers. The excitement wears off in a matter of hours and you become bored with hearing the same speeches being said over and over again to the point where you could even recite them yourself. Therefore, I have written a couple of application programs using the SAM card and accompanying software.

Two main programs operate the speech synthesizer: SAM, the phoneme translator and the RECITE English translator. I will not deal with the workings of SAM; it is all explained in the manual.

Using the Reciter From Applesoft

The RECITER is a direct English to Speech translator program which reads aloud any English text, given by the variable SA$. It requires SAM as it uses it as a subroutine. Give the English text in SA$ and CALL 38131.

```
SA$= "I AM A COMPUTER"
CALL 38131
```

Periods will give a pause and a lowering of tone. Also, the English must be uppercase-only or RECITER will not accept it.

Using The Reciter From Machine Language

Calling the RECITER from machine language is similar to calling it from Applesoft. The English string is poked into locations $9500-95FF and is ended by $8D, a carriage return. The ASCII values must have their bit 7 set, that is, they must be greater than $80. Once this is set up, simply do a JSR $94F9. Keeping this in mind, I wrote a program to make Applesoft BASIC and DOS 3.3 say anything that is printed to alleviate the need for setting the SA$, etc.

Using The Talking DOS 3.3 Program

Type in the object code from the listing of program 1 and then type:

```
BSAVE TEXT TO SP.300,A$300,L$96
```

then insert your SAM software disk and

```
BLOAD SAM
BLOAD RECITER
```

To start the talking program type:

CALL 768 from Applesoft
300G from the monitor

continued on page 67

Electronics Today Bookshelf

ELECTRONIC THEORY

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Mr. Richard Torrens is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book. The projects themselves can be split down into simpler building blocks, which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

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2 **BP90: AUDIO PROJECTS** $7.60
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

3 **The GIANT HANDBOOK OF ELECTRONIC CIRCUITS**
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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

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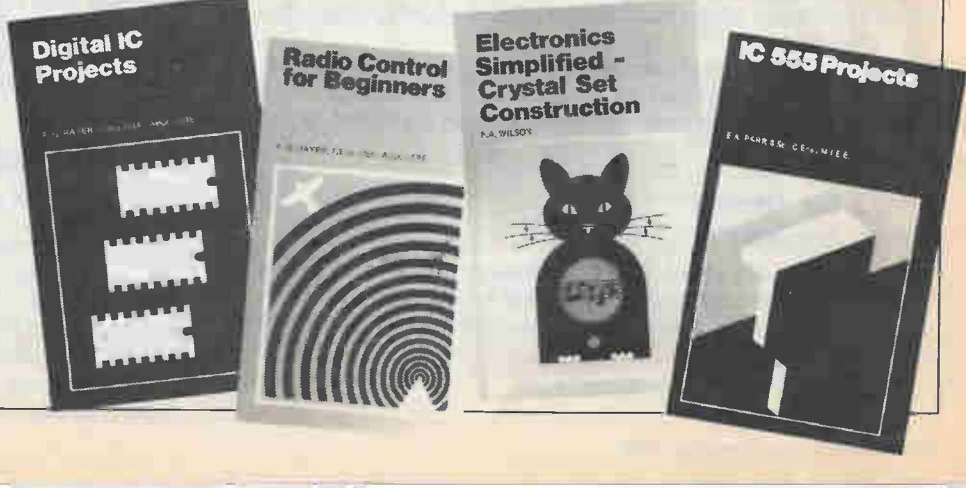
There are other types of power supply and a number of these are dealt with in the final chapter, including a cassette power supply, Ni-Cad battery charger, voltage step up circuit and a simple inverter



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Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS
R.A. PENFOLD $7.60
Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

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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.

BP113: 30 Solderless Breadboard Projects-Book 2
R.A. Penfold $8.85
A companion to BP107. Describes a variety of projects that can be built on plug-in breadboards using CMOS logic IC's. Each project contains a schematic, parts list and operational notes.

BP104: Electronic Science Projects
Owen Bishop $8.85
Contains 12 electronic projects with a strong scientific flavour. Includes Simple Colour Temperature Meter, Infra-Red Laser, Electronic clock regulated by a resonating spring, a 'Scope with a solid state display, pH meter and electrocardiograph.

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING $7.60
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.

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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.

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Electronics Today Bookshelf

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RS232 Explained

A serial interface should be the simplest way to connect two pieces of computer gear together. Unfortunately RS232 complicates matters.

By Graham Wideman

ONLY TWO pieces of wire are needed to allow one computer device to talk to another, and three if you want a two-way conversation. So you would think that hooking together computer equipment with serial interfaces would be easy — provided, of course, that the various equipment manufacturers had adopted a standard for their interfaces. And herein lies a problem.

The 'standard' which was adopted for serial interface was one known as 'RS232'. RS232 is a standard of the American Electronics Industries Association, and was originally intended for the interface between 'Data Terminal Equipment' (DTE — in other words a computer 'dumb' terminal) and 'Data Communications Equipment' (DCE — equipment which facilitates communication to a remote computer, like a modem).

The standard specifies the electrical characteristics of the interface signals, along with the shape and pin assignments of the connectors to be used. In addition there are certain other conventions which go along with the standard, like the commonly used data rates and formats.

The standard specifies the electrical characteristics of the interface signals, along with the shape and pin assignments of the connectors to be used. In addition there are certain other conventions which go along with the standard, like the commonly used data rates and formats.

Now, although it's possible to borrow the electrical and timing conventions from this standard, many aspects are ambiguous. As mentioned above, RS232 specified two different 'sexes' of equipment, terminal equipment and communications equipment, each with their own sex of connector, and their own connector pin assignments. But the standard is now being applied also to computers, printers, plotters, digitising tables, speech synthesisers and so on, which don't fall conveniently into the category of either sex. Consequently any particular piece of equipment has a more or less arbitrary sex assingment.

Furthermore, RS232 contains specifications for using its connectors and signals for a large number of different applications. Since today's equipment needs only the simplest of such arrangements, most of RS232's features are not used, and in fact merely add to the confusion as manufacturers arbitarily select the few features they need for their interface.

OK, the fact that the interface is somewhat arbitary on any particular piece of equipment would be compensated if the equipment manual told you how it worked. Not the case. In fact the description of how the RS232 interface works is *almost universally the worst described part of the manual*, ranging from extremely ambiguous to downright wrong.

The basics of a serial interface

There are many possible ways to make a serial communications 'channel'; RS232 is just one method. Let us examine serial interfaces in general, and see how RS232 implements the various features involved.

I should point out here that many of these features are not strictly a part of RS232, but are conventions which are used with it. The best way to declare something as a 'convention' is by referring to data on the ICs used to implement RS232 serial interfaces, namely the 'UART' which formats the data (such as the National 5303 and similar), and the 'line driver' and 'reciver' which actually send and receive the electrical signals on the serial cable (National LM1488 and 1489 respectively).

Suppose we are dealing with the simplest type of interface, one in which there is a 'sender' and a 'receiver', such as may be the case where a computer sends data to a line printer. Two wires connect the two devices, one wire being 'Ground' or zero volts, the other wire carrying the data.

Ones and zeros

The first task is to decide how to represent the binary 'one' and 'zero' as voltages. A TTL logic IC regards a voltage less than 0.4 V as a logic zero, and a voltage greater than 2.8 V as a logic one. A TTL output is not, for various reasons, suited to sending data down a long wire, so RS232 does things differently. A 'zero' is represented by a 'high' voltage between +3 V and +12 V for some reason also called 'space'), while a 'one' is represented by a 'low' voltage between -3 V and -12 V (also called 'mark'). The range between -3 V and +3 V is undefined.

Next we must decide in what order and with what timing the bits are to be sent down the wire. RS232 calls the unit of data transmission a 'character', even though the data sent may not actually represent a character. A particular device may be set to transmit or receive 5, 6, 7 or 8-bit characters, with seven being the most common (because seven bits will represent the entire ASCII set of 128 characters), and eight the next most popular. These characters are sent *least significant bit first*. Using the scheme as I have so far described it, the letter 'B', which is ASCII 42 hexadecimal, or 66 decimal, would appear on the line as (see also Figure 1):

High low high high high high low
(7-bit code)

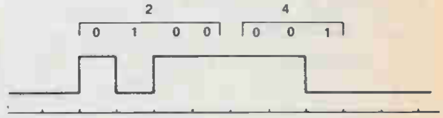

Fig. 1. The letter 'B' (hex 42) represented as a sequence of voltage levels, as used by RS232 devices.

How does the receiver know when a particular character starts? We could use a third wire to signal that a character is starting on the second wire. This is a form of 'synchronous' communication, and is not used with any personal computer equipment. Instead RS232 has a way of telling the receiver that a character is starting. It works as follows.

Start bit

Suppose the receiver receives the above letter 'B'. Normally the communications line sits at 'mark' or low. Along comes bit one, which is a high, and immediately the receiver knows a character is coming in. Now, assuming that the receiver and sender are set so that they agree as to how long each bit is, the receiver will be able to recognise a high, then a low, then another low and so on, until the whole 'B' has been received.

However, suppose that instead the letter 'A' was sent, which is 41 hex, and therefore is represented (also see Figure 2) as: Low high high high high high low

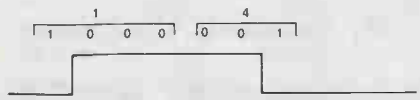

Fig. 2. The letter 'A' (hex 41) represented in RS232 voltage levels.

This time, by the time the receiver finds out something is happening, it's already on the second bit! And what if you had a character composed entirely of lows?

The way around this problem is to prefix every character with a 'start' bit, which is invariably high.

Stop bit

This still leaves one problem. Suppose we send several hundred characters in a row. It would be unreasonable to expect that the sender and receiver agree as to the time-per-bit to such great accuracy that they would still be in step after so many bits. To overcome this each character is suffixed with one or two (according to how the devices are set) 'stop' bits, which are always low. After each character we always have a low-to-high transition which can be relied upon to keep the two devices in step.

Notice that there is nothing particularly special about the start and stop bits. They look like any other bits, except that there is always a low-to-high transition at least once per character, and it's between these two bits. I point this out because it means, for example, that if you are sending serial data to a printer, if the signal is momentarily disconnected (transmission continuing but receiption interrupted) then upon reconnection the printer will probably not be able to interpret the incoming stream of highs and lows. The printer will be confused until the next pause in transmission, unless the combination of received characters enables the printer to determine where the stop-start location is.

Transmission Speed: 'Baud Rate'

Naturally, both sender and receiver must be set to the same nominal communications speed. This speed is measured in bits-per-second, a unit also known as the baud. (One bit per second is one baud.) Commonly used rates are: 110 and 133 (for Selectric terminals, for example), 300 baud (modems communicating via telephone), 600, 1200, 2400, 4800 and 9600 baud. Some devices also communicate at 19 200, 38 400 and even 76 800 baud, but such are rare.

Parity

An embellishment which is occasionally seen is the use of 'parity' as an error checking method. In a seven-bit code, for example, an extra bit may be added after the last bit (but before the stop bit). The sender counts the number of 'one' bits in the character, and if the answer is even it sets the parity bit to 'one', if not it is made 'zero'. (This is the even parity convention. There's an equally little-used odd parity convention which makes the parity bit 'one' for an odd total.)

When the receiver gets the character it does the same arithmetic and compares its answers to the parity bit received with the character. If it has the same answer it knows all is well; if the answer is wrong an error has occurred somewhere. For example, suppose an 'A' is transmitted (seven-bit, even parity). This would be represented as in Figure 3.

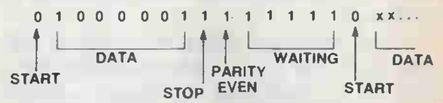

Fig. 3. Representation of the letter 'A' in seven-bit even parity code. Note that a '1' is a low voltage and a '0' is a high. The line normally sits at low or '1'.

Now if one of those bits were accidentally changed somewhere along the way, there would be either one or three '1's, which is an odd number and does not agree with the parity bit. (And of course if the parity bit was accidentally changed, it wouldn't agree properly either.) You can probably see that this scheme cannot show where the error occurred or how to fix it, nor does it signal double errors. It is basically a low-overhead warning device.

In fact parity is generally ignored, since most personal computer equipment is not operated in electrically noisy environments where such errors are likely to occur, and in any case such equipment has no convention for requesting that the sender resend the faultily received data. (Often the receiving device may be set to expect the parity bit but not use it.) However, I have included this description so that you know what parity is when the equipment has a switch to select or deselect its use.

Lots of options!

As you can see, even thus far there are plenty of options to choose from. In a typical device many of these options may be swtich selectable, usually miniature DIP switches inside the box, or perhaps soldered jumpers. In some cases, such as terminals and computers, some of these features may be programmed from the keyboard or from software.

How many duplexes?

Although not strictly of direct concern in the RS232 interface, some equipment, particularly terminals and modems, provide a 'Full/Half Duplex' switch.

'Full Duplex' means that when the terminal transmits a character to the remote computer the computer immediately echoes the character back to the terminal, whereupon it appears on the terminal's screen (or paper, if a teletype). If there is no echo then the character you typed will not appear on the terminal's screen. This is a kind of insurance method to let you know that the computer is listening.

In 'Half Duplex' set-ups it is assumed that the computer will not echo the characters from the terminal, and thus the terminal puts the typed characters on the screen whether or not the computer is awake.

The surprise comes if you have your terminal (or modem) set to Half Duplex, and the computer you are talking to echoes the characters. Then if you type 'FRED' you'll see 'FFRREEDD'.

Not so fast!

A commonly needed feature is the ability to tell the sending device to slow down. I don't mean to send at a lower baud rate, but rather to pause for a moment. A typical situation where this occurs is in slow printers. When the carriage reaches the end of the line the printer must tell the sender to wait until the carriage returns before sending more characters.

Such a signalling system is known as 'handshaking'. Typically this is implemented by adding the extra wire to the interface cable. The receiver maintains this wire at a 'high' signal level while it's OK for the sender to send, pulling it 'low' to tell the sender to halt the flow of data. Sometimes an interface will have handshaking lines both ways, so that either device can halt the other.

A complete two-way interface would consist of two data wires, two handshaking wires and ground — a total of five wires. Most RS232 hook-up problems occur because one piece of equipment needs some of these signals which the other does not provide, or because the wires in each piece of equipment are not connected to the corresponding pins in the interfacing connects.

Not so fast type two

A quick note here that on some intelligent printers handshaking is carried out using a method called 'X-on, X-off'. Instead of a separate handshaking wire, the printer has a data output wire (normally printers only receive data). If the printer wishes to halt the sender the printer sends a control character to the sender (usually control-S, hex 13, which is also known as 'Direct Control 3'). Subsequently sending the same character will restart the data. Note that this is the same character which you use in CP/M (and Apple) to stop and start a continuous display to the screen from the keyboard.

Handshaking and buffers, etc.

How necessary is handshaking in practice? A major sore point in the small computer industry has been the need for handshaking in printers. The Epson MX-80, for example, was available at one time with a serial interface known as 8141. The interface could only remember a maximum of two characters as they arrived from the computer. Since the 'line-feed' time exceeds the time of two characters, even at the slowest baud rates it was necessary for the interface to signal a halt after each line. The Exidy Sorcerer and the standard Apple printer interface board do not have any handshaking inputs, and consequently it would be impossible to make this combination of equipment work serially. (This particular problem rarely comes up since the MX-80 has a parallel input which is usually used. The Sorcerer has a parallel output, and the Apple has available for it a parallel printer board. I am simply showing how close to the surface such problems are swimming.)

A major sore point in the small computer industry has been the need for handshaking in printers; without it a halt after each line was necessary.

A solution to this dilemma which is finding widespread adoption is to incorporate a 'buffer' into the serial interface. Such is the Epson 8145 interface, which as a 2000-character (approx.) buffer. Since the MX-80 chugs along at 80 characters-per-second (cps), if the computer transmits at 300 baud (30 cps) the buffer is normally virtually empty. At line-feed time the buffer fills up a little as the computer continues to transmit. But the MX-80 catches up on the next line. There is thus no need for handshaking. You can, however, get into trouble if the computer sends a large number of form-feeds, which take a long time.

Wires and connectors and stuff

The connector used with RS232 is known as a 'DB25', which has 25 pins in the male, and 25 receptacles in the female. Figure 4 shows the ribbon cable style of connector, with pin numbering shown in Figure 5. But why 25 pins?

RS232 was endowed with a pile of features not now used, and these were implemented using most of the 25 pins. Now very few of the pins are used. The extra pins provide two opportunities for confusion and problems, however. One problem is that with such a profusion of pins it can be difficult to figure out which ones you are supposed to use for your application.

'Business end' of male, or solder side of female.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	

'Business end' of female, solder side of male.

13	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
	25	**24**	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**	**15**	**14**

IMPORTANT NOTE: This numbering scheme means that with the IDC connectors the pin numbers do *not* correspond to the ribbon conductor numbers; 1 will be 1, but pin 14 will be ribbon conductor 2, etc.

Fig. 5. DB25 contact numbering.

The second problem area is that with all those extra tantalising pins available and otherwise doing nothing, many manufacturers use the 'spare' pins for other purposes. Exidy used them for the cassette interface. IDS, in their Paper Tiger printers, use the same DB25 for both serial and parallel interfaces. That's fine except that if ing convention can result in a variety of confusions. If the equipment is masquerading as a DCE the manual may tell you that, for example, pin 2 is 'Transmitted Data', which strictly speaking is an *input*. However, the manual writer may not know this and instead call it 'Received Data', intending 'Received' in a looser sense.

Fighting back

The first thing to do before connecting *anything* is to make yourself a pin chart for each piece of equipment you may have to connect together. This is *especially* important if you are involved with many different units. I have a whole binder full of such charts on the equipment I work with. Using this binder I can almost instantly connect any two units with few problems.

The point to this chart is that for each of your pieces of equipment (and I assume you're working with at least two!) it serves to collect the tidbits of information you will glean from the manuals, the schematic and so on. You end up with the info in the same format for each unit, where it can be simply compared to give you the best idea of how to wire things up *before* you blow

'Official' Signal Name	Abbrev[1]	Pin No.	DTE 'Terminal'	DCE 'Modem'	Comments
Protective ground	PG	1	—	—	Optional
Signal ground	SG	7	—	—	Necessary
Data:					
Transmitted data	TxD	2	Out	In	
Received data	RxD	3	In	Out	
Handshaking:					
Request to send	RTS	4	Out	In)	Basically
Data terminal ready	DTR	20	Out	In)	same use
Clear to send	CTS	5	In	Out)	Basically
Data set ready	DSR	6	In	Out)	same use
Connector Sex:			Male[2]	Female	

(1) Note that the handshaking lines are sometimes indicated as inverted signals (e.g: $\overline{DTR}$). The idea is that if for the data a low is a '1', then if the data terminal is ready it should send out a '1'. In fact it sends out a high, which corresponds to a zero, hence the desire to use inverted signal notation. This refers, however, to the identical signal. In contrast there is the rare occasion when the equipment actually does put out an inverted signal, i.e: low means ready, high means not ready. Yeah, I know, but don't complain to me!

(2) In fact almost all terminals use female chassis-mount connectors. (A notable exception is the Heathkit H19.) It seems that it is almost standard practice to use females on equipment chassis, and male on cables (except for much DEC equipment, which uses male chassis mounts on equipment, and female connectors on cables). Note that this means you can't tell the DTE/DCE gender from the sex of the connectors.

Fig. 6. Table of signals, what they do, and connector pin assignments.

between such units you use a cable with too *many* wires implemented (and this can easily be the case if you use a standard RS232 cable in a set-up which does not use handshaking) then you are likely to blow something at one or both ends!

The pins which *are* commonly used are shown in Figure 6. Note that the nam-anything, and before you have the frustrating experience of having the system not work.

If handshaking lines are provided, try to find out if they actually do anything, or if they are dummies. For example, one printer may have an output which signals the sending computer to halt. Another printer may claim to have the same handshaking output, but is actually internally wired permanently high, and is provided merely for supposed compatibility to a computer which may need such an input so as not to halt. got that?!

Wiring up the cable

You will notice that if one of your unit is a true DTE and the other a true DCE then a standard cable (pin 1 goes to pin 1, 2 to 2 and so forth, which is called a 'straight-through') will work. You are unlikely to see this situation very often, which is something you should know before you buy such a cable made up (they're likely to be expensive readymade), or before you get convinced by the salesman that the printer hook-up is trival.

So you decide to wire your own cable. First, of course, you must obtain the appropriate sexes of connectors to mate with what you have on the equipment and a cable with a sufficient number of conductors. If it's over 20 feet you may wish to use shielded cable, but I've used unshielded up to several hundred feet. Next, no matter what the equipment involved wire pin 7 to

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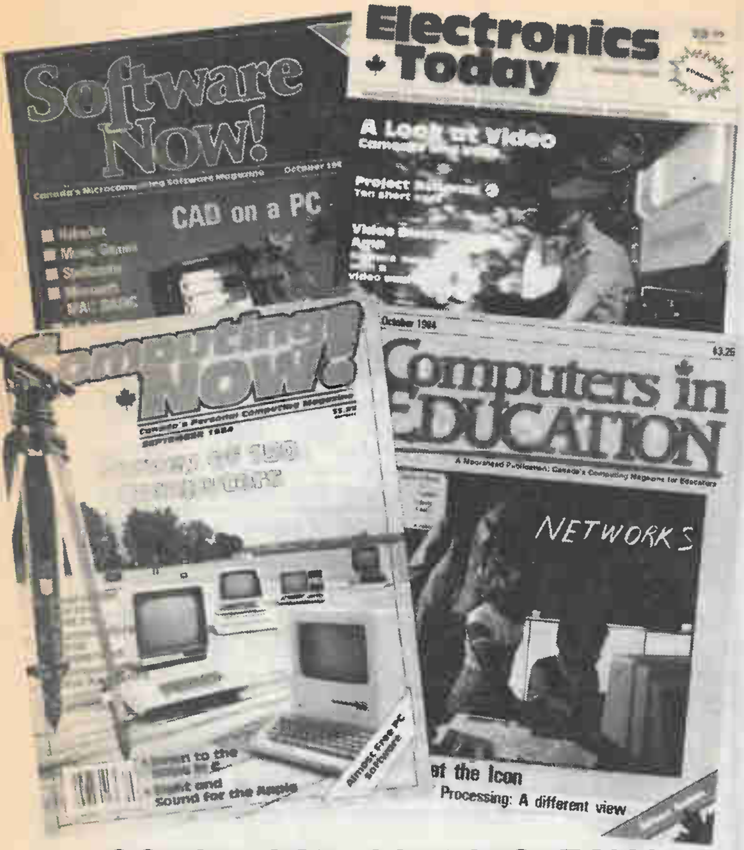

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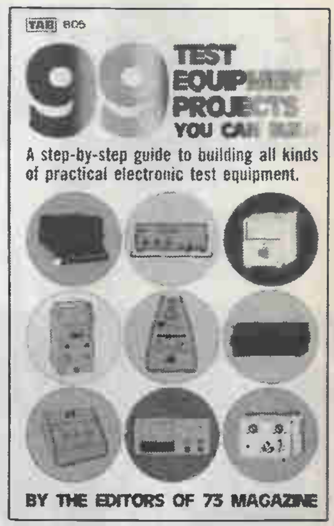

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ZX81 Tape Controller

This twin relay output port for the ZX81 gives the computer more control over a cassette recorder via the cassette interface, and avoids feedback problems in loading and saving data. It has other uses, too.

By R.A. Penfold

ALTHOUGH the ZX81's cassette interface has received at least its fair share of criticism, if used correctly with a cassette recorder and tape of reasonable quality it provides fairly reliable saving and loading. However, in some respects this interface is quite crude, and it does not provide any form of tape motor control.

Controller Operation

This project is basically just a twin relay output port for the ZX81, and it is primarily intended as an aid to loading and saving, although it can be used in many other ZX81 applications which require a twin relay port.

If we consider the relay switching first, one of the relays has a single make contact which is used to activate the motor of the cassette recorder. The other relay has double pole changeover contacts, and these are arranged so that normally the earphone socket of the recorder is connected through to the "Ear" socket of the ZX81, but the microphone socket of the recorder is disconnected from the "Mic" socket of the ZX81.

In order to load a program it is just a matter of activating relay 1 so that the motor in the recorder is switched on, and then switching this relay off again once the program has been successfully loaded. In order to save a program both relays must be switched on, and then off again once their program has been saved. No plugging and unplugging of the microphone and earphone leads is needed as this is effectively done by relay 2.

The circuit which drives the relays is fairly conventional ZX81 2-bit output port. An address decoder circuit decodes only line A13 to A15, plus the $\overline{\text{MEMRQ}}$ line so that the port is placed in ZX81's memory map rather than in its input/output map. This is done simply because ZX81 BASIC language does not include IN and OUT instructions, and input/output devices can only be operated from BASIC using PEEK and POKE in conjunction with memory mapping.

The decoded output is used to control two data latches which are fed from lines D0 and D1 of the data bus. The latched outputs drive the relays via conventional single transistor relay drivers. The address decoder is also used to disable the ZX81's ROM which would otherwise interfere with the output port.

The Circuit

Figure 2 shows the full circuit diagram of the ZX81 Tape Controller Unit. The address decoder is based on IC1, which is a 74LS138 three-to-eight line decoder. In this circuit the three address inputs are fed from lines A15, A14, and $\overline{\text{MEMREQ}}$, while the positive enable input of the device is used to decode A13. IC1 also has two negative enable inputs, but these are not needed in this circuit and are simply connected to the negative supply rail so that they are permanently enabled.

Only output 0 at pin 15 of IC1 is utilized in this design, and this output goes low when A14, A15, and $\overline{\text{MEMRQ}}$ are low and A13 is high. In other words, when any address in the range 8192 to 16383 is accessed.

If it is a positive pulse that is required to operate both the data latches and the $\overline{\text{ROMCS}}$ line, and Q1 is used as an inverter to convert the output of IC1 to a signal of the correct polarity.

The output of Q1 is used to directly drive the clock pulse input of the data latches, but it drives the $\overline{\text{ROMCS}}$ line via diode D1. The reason for disabling the ZX81's ROM is that only partial address decoding is used in the ZX81, and apart from its base addresses, the ROM appears at various address blocks throughout the 64K address range. Taking the $\overline{\text{ROMCS}}$ line high disables the ROM, so that an address block occupied by one of these "ROM echoes" can be used for other devices.

However, internal circuits of the ZX81 operate the $\overline{\text{ROMCS}}$ line, and must not be prevented from doing so by external circuits, or the computer will "crash". D1 is therefore included in series with the output of the $\overline{\text{ROMCS}}$ line so that Q1 can pull this line high when a suitable address is accessed, but it does not hold it low at other times.

IC2 is the data latch, a 74LS174 device. It is actually a hex D-type flip flop, but it works well in this applciation, and the four unused flip flops are just ignored. R3 and C1 are used to provide a negative reset pulse to the "master reset" terminal at switch-on. This ensures that intially both relays are in the off state.

The relay driver circuits have Q2 and Q3 as standard common emitter switches, with the usual protection diodes (D2 and D3) in their collector circuits. The main circuit is supplied with power by the stabilised 5 volt output of the ZX81. A 5 volt supply is inadequate for most relays, and the non-stabilised 9 volt (nominal) output of the ZX81 is therefore used to supply the relays and their drivers.

The relay switching circuit is exactly the same as the arrangement outlined in Figure 1 and described earlier. An important point to note is that neither side of the motor control output (SK1) connects to the earth rail. With most cassette recorders neither of the remote control terminals connect to earth, and connecting either terminal to this rail usually prevents the remote control facility from operating (and could even damage the recovery).

The total current consumption of the circuit is under 100 milliamps, even with both relays switched on, and the ZX81 is readily able to supply a current of this modest magnitude.

Construction

The plastic case having approximate outside dimensions of 150 by 80 by 50 millimetres is adequate to comfortably accommodate all the components. The suggested front panel layouts can be seen by referring to the photographs.

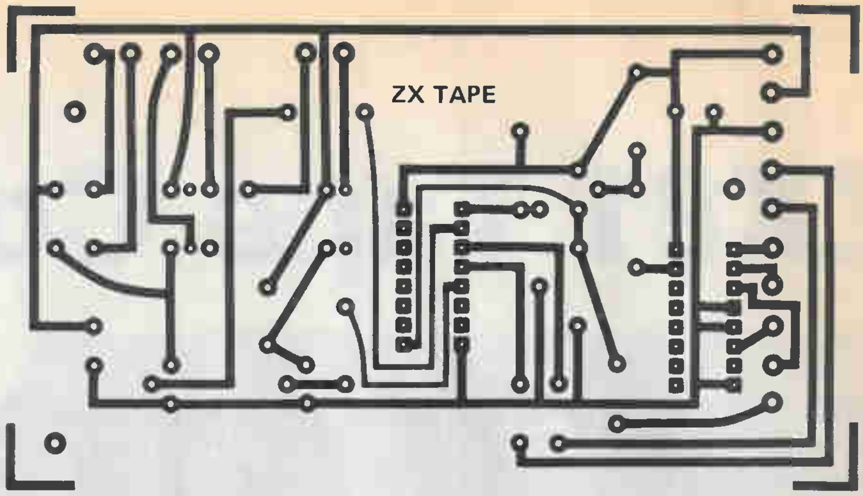

Fig. 1 The PCB for the tape controller.

It is advisable to have the two sockets which connect to the ZX81 well separated from the three which connect to the cassette recorder so that the unit is easily wired into the system without making any errors.

As explained previously, neither side of SK1 must be allowed to come into electrical contact with the ground rail. What this means is that either a metal case must not be ued, or SK1 must be an insulated type (or insulated from the metal case). In practice it is probably best to use a plastic case and avoid any insulation problems with SK1.

Relays

A slight problem has arisen since this project was originally designed: the PCB for the tape controller calls for relays which are no longer manufactured. We apologize for this inconvenience but things like this do happen. To overcome the problem, there are two possible solutions.

The first, although we don't recommend this method unless you're really keen, is to rework the PCB artwork to suit the recommended relays. This could (and does) involve a considerable amount of time and effort.

The solution which we recommend is to wire the two relays off-board. This is a somewhat unorthodox (and untidy) method but a workable solution none the less. A larger case will probably be required to house the completed unit and care must be taken with the off-board wiring to the relays.

A suitable subsitute for RLA1 is the Potter & Brumfield type R50S-E2 Y1 or Radio Shack #275-003. The substitute for RLA2 is a Potter & Brumfield type R5OS-E2 Y2. The P & B relays are available from Electro Sonic Inc., 1100 Gordon Baker Rd., Willowdale Ont., M2H 3B3, (416) 494-1555. As well, any relay that will operate reliably on a supply potential of about 9 volts, with a coil resistance of

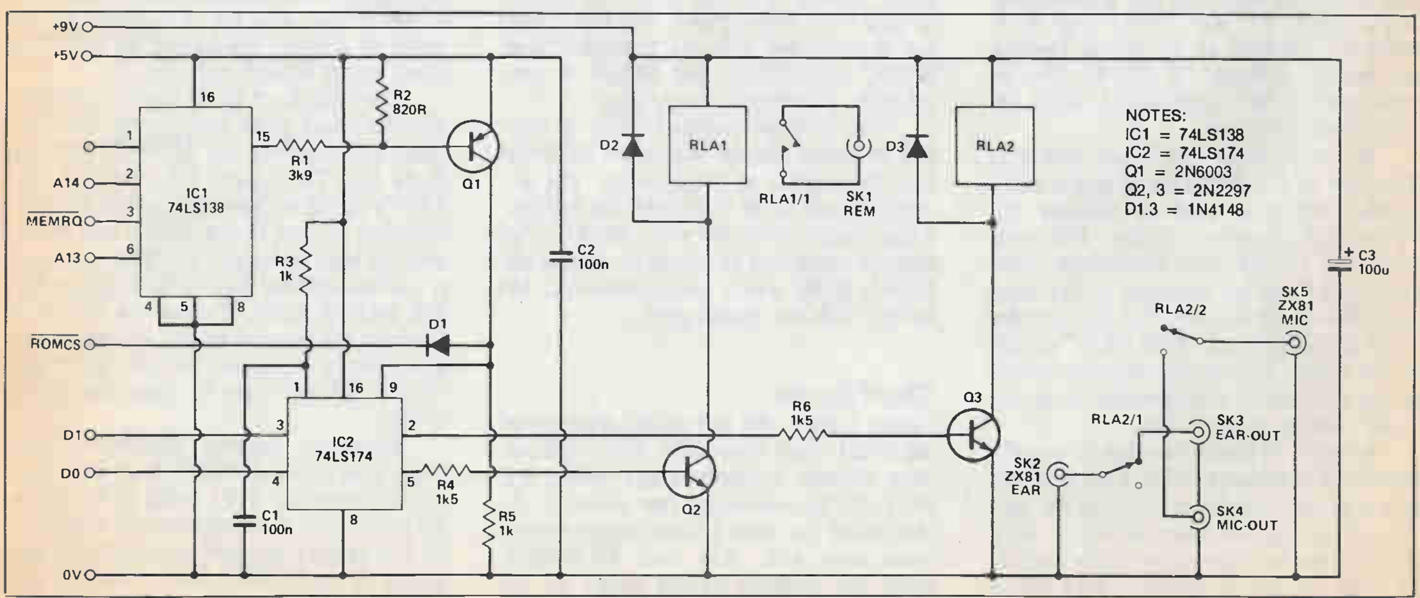

Fig. 2 The Circuit Diagram of the ZX81 Tape Controller. Power is supplied by the computer.

PARTS LIST

Resistors
(All ¼W 5% carbon)

R1	3k9
R2	820R
R3, 5	1k
R4, 6	1k5

Capacitors

C1	100n polyester
C2	100n ceramic
C3, radial	100u 16V electro

Semiconductors

IC1	74LS138 3-to-8 line decoder
IC2	74LS174 hex D-type flip/flop
D1, 2, 3	1N4148 silicon signal diode
Q1	2N6003 silicon PNP
Q2, 3	2N2297 silicon NPN

Miscellaneous

SK1	2.5mm jack socket
SK2, 3, 4, 5	3.5mm jack socket
RLA1	12 volt 300 ohm coil SPDT contacts
RLA2	12 volt 300 ohm coil DPDT contacts

See text for additional information on relays.

Printed circuit board; plastic case, about 150 x 80 x 50mm; ZX81 edge connector and 10-way ribbon cable; two 16-pin DIL IC sockets, Veropins, wire, etc.

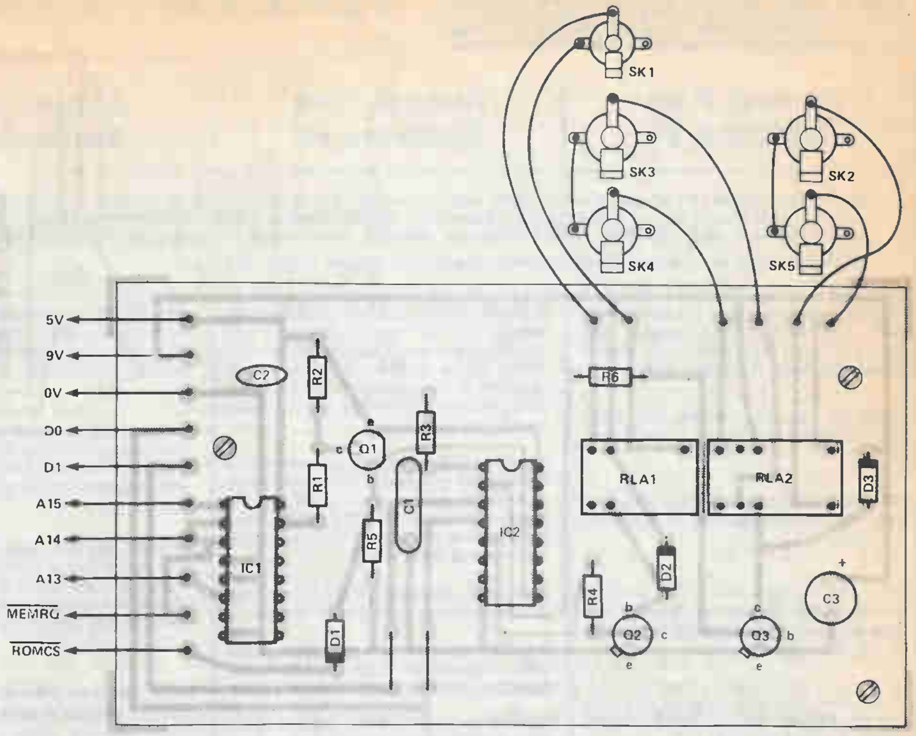

Fig. 3 The component overlay diagram for the ZX81 tape-controllers. See text for relay details.

around 200 ohms or more should do the job.

Fit Veropins to the board at places where connectors to the ZX81's edge connector and the sockets will be made. Do not overlook the two link wires just to one side of D1.

The connections of the ZX81's edge connector are made using a piece of ten-way ribbon cable about 0.5 metres long and terminated in a ZX81 style 2 by 23 way (plus polarising key) edge connector. Be careful to connect the lead to the edge connector correctly — Figure 4 shows the necessary connections. A cutout for the ribbon cable to pass through is filed in the case at any convenient point.

In Use

After giving the completed unit a couple of thorough checks, connect it to the ZX81's edge connector and switch on the computer. It should operate normally, and the relays in the controller should not switch on. Typing POKE 9000,3 into the ZX81, then hitting RETURN should result in both relays switching on. Then typing POKE 9000,0 and hitting RETURN should switch them off again.

In order to connect the control output of the controller to the "Control" or "Remote" input of the recorder a lead fitted with two 2.5mm jack plugs will probably be needed. Some cassette recorders use DIN connectors, and you will then need to refer to the handbook for the recorder to determine what type of plug is needed and the correct method of connection.

As the ZX81 cannot have multiple statements, a short program must be used when saving a program (and there must be a small amount of memory left to accommodate this program). The way this is done is to place the tape control program at higher line numbers than the main program.

For instance, if the main program ends at line 3590, the control program could be placed at any lines from 3591 up to the maximum acceptable line number for the ZX81.

Three program lines are shown below (complete with sample line numbers):

```
3600 POKE 9000,3
3700 SAVE "Program Name"
3800 POKE 9000,0
```

The first line switches on the cassette motor and sets the controller to the "save" mode; the next line saves the program; and the last one switches off the motor and sets the controller back to the "load" mode.

To run the control program simply type GOTO followed by the first line number of the control program (ie GOTO 3600) in the above example, and then hit RETURN. This is not quite as cumbersome as it might seem due to the ZX81 keyword system, and it is quite quick and easy in use.

Of course, when the main program is run the control program (which is also saved) is of no consequence as the program never reaches the three line numbers concerned. Remember to have the cassette in the recorder at the point where the program must commence, and to press both the "record" and "play" keys before starting the control program.

When loading a program it is really just a matter of typing:

POKE 9000,1

to enable the cassette motor to be switched on then:

POKE 9000,0

to switch off the motor once the program has been loaded. A simple control program similar to the one used when saving programs could be used, but the final POKE to switch off the motor would not function, since the loaded program would replace the control one ■

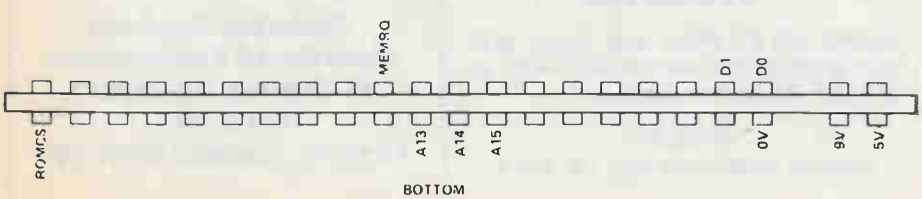

Fig. 4 A close-up of the correct connections from the ten-way ribbon cable to the ZX's edge-connector.

Machine Code Programming Part 7

Machine code can be learned on the unit shown, a Multiflex Z80A from Exceltronix. A similar board using the 6502, the Rockwell AIM-65, is available from Active Components (see ad index).

In this last part, we look at I/O.

By Bob Bennett

EVERY computer, no matter what its pedigree, is just a handful of electronic components connected together. This constitutes the world of that particular computer and anything else belongs to the outside world. And every computer, to justify its existence, has to be able to communicate with the outside world — how else would you get information to a screen, or some other display, or to a printer, or from a keyboard?, not to mention the program going out to, or coming in from your tape recorder.

Although the method of this two-way communication may differ according to which CPU the computer has, the principle is essentially the same for every computer. An I/O port is just another name for an I/O address, and the principle is to use a register as an intermediary between the computer and the peripheral via an address. In some computer systems the method is to reserve a few addresses for I/O ports and, by using load or move instructions, transfer either the contents of the register to the port or vice versa.

In both cases the contents of the register is known as a data byte, and the above method is usually called memory-mapped I/O.

Because the Z80 set has quite a number of I/O instructions, and because the method used is slightly different, I will give examples from the Z80 set, and for the Spectrum in particular. To illustrate input port usage, let's pretend that we have just written a machine code game which places a graphics character on the screen. Whatever the object of this game is doesn't matter, but we do require to move the character about the screen using the keyboard to control the movements up, down, left and right. Page 160 of the Spectrum BASIC handbook gives a list of the eight addresses which are concerned with the keyboard input. These addresses range from 65278 to 32766, which is not surprising, because, in theory, 65,536 addresses could be used as I/O ports in the Z80 system.

The ideal keys to use for movement of our character would be the cursor control keys, but reference to page 160 shows that keys 6, 7, and 8 are input at address 61438 and key 5 is at address 63486. It would make for easier programming if all four keys were accessed at the same address so I'm going to opt for keys Y, U, I and O for up, down, left and right respectively, as these are all at address 57342. There is a misprint in the handbook which gives this address as keys P to 7, but should read P to Y. Figure 1 gives a listing in hex for the program to read the keys from input port address 57342 but I will explain what is happening. I would urge those of you who are fairly new to machine code programming to write the instructions down the side of a large ruled note pad (A4 size), with the addresses, and use appendix A of the Spectrum handbook to convert the hex to the Z80 assembler mnemonic.

The program I have given is only a small portion of our mythical program; it can be at any address, even in the printer buffer, and is called from the first address

CODE	EFFECT
3E	Load A
02	with 2
CD	Call address in ROM
01	to open stream to
16	upper 22 lines of screen
3E	Load A with high byte
DF	of port address
DB	IN A,(nn)
FE	nn = low byte of port address
CB	use instruction after CB
67	Bit 4 A, if reset then Y has been pressed
28	if Y pressed zero flag set so jump
18	forwards to print Y
CB	
5F	Bit 3,A then if Y not pressed
28	if U pressed then jump
10	to print U
CB	
57	Bit 2,A then if U not pressed
28	if I pressed then jump
08	to print I
CB	
4F	Bit 1,A then if I not pressed
20	0 has not been pressed so jump
EC	backwards to load A with high byte again
3E	Load A with code for letter 0
4F	because 0 must have been pressed to get here
D7	Print 0
C9	Return
93E	Load A with code for letter I
49	because I must have pressed to get here
D7	Print it
C9	return
3E	Load A with code for
55	letter U
D7	Print it
C9	Return
3E	Load A with code for
59	letter Y
D7	Print it
C9	
end of program	

A routine to read certain keys.

as RANDOMISE USR address. The object of small routine is to 'capture' one of four keypresses and move the character on the screen in the direction that the key represents. However, all this program will do at present is print onto the screen the character of the key pressed. Earlier I said that the data coming in, or going out, was a data byte, and we are going to test certain bits of the data. There are five keys at this particular port and bits D0 to D4 represent five keys with bit D0 for key P and working inwards on the keyboard to bit D4 for key Y (the D stands for data), so the bits we want are D4 to D1.

The first five bytes of the program open the stream to print to the first 22 lines of the screen; if you want to print to the bottom two lines then load A with 1 instead of 2. Next the high byte of the port address is loaded into register A, then the instruction DBFE — INA, (nn) where nn is the low byte of the port address, which in this case is FEh. Now the computer has the information — the port address is 57342 (keys P to Y) — and the data byte has to come into register A.

The next two bytes are CB67 — BIT 4,A. These together mean that we are going to test the current status of bit 4 in the A register and put the result into the zero flag bit of the status register. (Z flag = 1 if bit 4 of A register = 0). The following instruction 28 18 — JRZ,e, will cause a jump forward by the displacement 18h if the Z flag is set (ie. if bit 4 of the A register was 0 indicating that the 'Y' key was pressed) and print the letter 'Y'. If, however, the 'Y' key was not pressed, the jump will not take place and the next instruction executed will be CB5F — BIT 3,A and so on until BIT 1,A.

Note well the last conditional jump instruction, 20h — JR NZ,e, which jumps back to 3EDF to start again; this means that if none of the 4 keys are pressed the computer will wait until one is.

This program is not the most elegant of programs, and is certainly not the only way to 'read' the keyboard. The instruction DBh nn — INA,(nn) is the first of 8 simple IN instructions, but the other seven have a slightly different form, and there are also eight simple OUT instructions which follow the same pattern of the IN instructions.

Covering the rest of the IN instructions first, they take the form IN register, (register). This means that the first register will receive the data byte, and the port address is formed from the low byte in the register in brackets, and the high byte in the other register of the register pair. To explain that, the instruction ED78 — INA,(C) could have been used in my program, with C loaded with FE, and B register loaded with DF, and the A register still tested for bits D4 to D1.

The first of the simple OUT instructions is D3 nn — OUT(nn),A; the other seven are of the form OUT (register), register with the register in brackets again holding the low byte, and the other one of the pair holding the high byte, the other register in the instruction being used for the data byte.

There are four fully automatic I/O instructions, two IN and two OUT, and all four are of similar pattern. The instruction ED B2h — INIR means IN (C) from address (HL) with register B holding the number of times the instruction is repeated; the address is then incremented, and B decremented, and repeated until B reaches zero. The second IN automatic instruction ED BAh — INDR which uses the same register format but with (HL) being decremented, which is what the D stands for.

Automatic OUT instructions are the same except that register C holds the data to go out to address (HL). There are two non automatic IN instructions, and two non automatic OUT instructions which follow the same pattern as the automatic instructions but the increment, or decrement (HL) is only done cone, that is, the R, for Repeat, is left off, as in ED A2h — INI.

By the way, for those of you who have never met the instruction D7h — RST 10h used in the example program, it is an instruction to print the contents of the A register to the next PRINT position on the screen. ■

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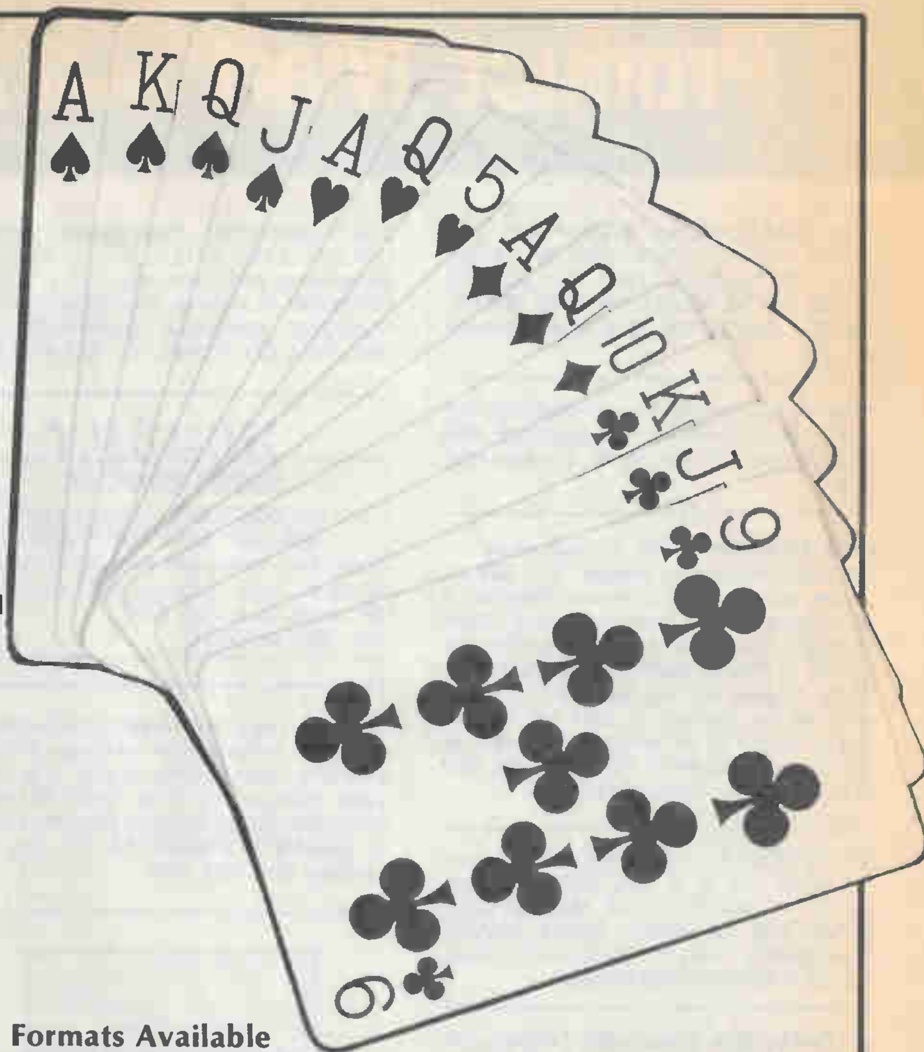

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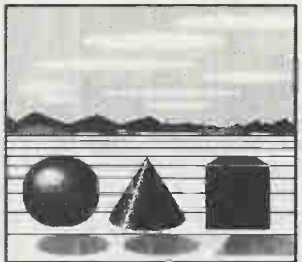

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Job vacancies for accountants, engineers, scientists, executives and other professionals showed no change in both the last three and the last 12 months. It was the second successive quarter in which openings were unchanged, according to the Technical Service Council, an industry-sponsored placement service and personnel consulting firm.

The Council's quarterly survey of positions with 1,700 employers covers manufacturing, mining, construction, consulting and service organizations, but not governments or institutions.

None of the specialties surveyed reported a strong demand. Occupations reporting the most numerous vacancies were computer programmers, systems analysts, electronics engineers, mechanical sales engineers and electronics sales engineers. Openings in some of these fields are one-fifth of 1981 levels.

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With the WSB-10 waveform generator the user can define up to 2048 data points and output them as periodic, single cycle or burst waveforms in either single cycle or continuous mode. A 16-bit software programmable timer is used to set the output rate from 2.4 millihertz to 5 Megahertz. Output resolution is 12-bits, with a range of -5 to +5 volts. Once the board is initialized it operates as a stand-alone unit freeing the PC for other tasks.

The WSB-10 will be available Nov. 1, 1984, for the single unit price of $595. An application software package containing BASIC callable drivers is supplied free with purchase. For more information please contact Qua Tech, Inc., 478 E. Exchange Street, Akron, Ohio 44304, (216) 434-3154.

In our September issue we featured the Offbeat Metronome project which as it turns out, contains an error in the PCB. The positive terminal of C9 should be connected to pin 7 of IC2 instead of pin 6. To rectify this problem, cut the trace from the positive lead of C9 to the base of Q1 and connect a jumper from the positive lead of C9 to the collector of Q1. The circuit diagram is correct.

Some additional improvements for this project are as follows: Replace RV5 with a pot of larger value because tuning to 440Hz may be a little difficult. Substitutes for Q1 and Q2 are 2N2222A and 2N2906A respectively. ET would like to (embarassingly) but graciously thank Stephen Kamichik for these helpful hints.

We recently received a letter from a reader in British Columbia who was having trouble getting a Signetics NE570N compandor chip for the drum machine project in our summer of 1983 50 Top Projects book. These chips are available from component stores across Canada carrying Signetics products. If you still can't find the chip, you might try Zentronics, 8 Tilbury Court, Brampton, Ontario; they carry a full line of Signetics semiconductors. For Zentronics customers with an approved account, the minimum order is $25. The minimum order for those without an account is $50.

Zentronics' Parts Department can be reached at (416) 451-8445.

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What is Ernie?

Ernie is a new and relatively inexpensive small personal robot designed around the powerful new CMOS version of the popular 6502 8-bit microprocessor.

The brain of this robot consists of 2K of static RAM and 2K of ROM. It features such functions as: ultrasonic obstacle detection, on-board beeper and variable speed, and directional controlled drive motors.

Ernie is capable of functioning independantly or via an RS232 link and optional software with either the Apple II, Radio Shack Color Computer, or Commodore 64 and VIC-20 systems. The software, titled "Ernie's Mother", utilises plain english statements and commands, making it ideal for young children to get acquainted with computer programming.

It comes in three forms: assembled and tested @ $389; complete parts kit @ $296; and construction plans for $25.95. The software is available on cassette tape for $15.95 and floppy disc for $19.95. For more information on Ernie contact: David Genge, Microhmega Electronics Ltd., 918-16th Avenue N.W., Calgary, Alberta, T2M 0K3. (403) 289-6264.

Circle No. 46 on Reader Service Card.

In the directory section of our October issue, we listed the address for Toronto Software World incorrectly. The correct mailing address is P.O. Box 84, Agincourt, Ontario M1S 3B4. We apologise for any inconvenience this may have caused.

PREH—COMMANDER for Apple II

This keyboard has been specially designed for the Apple II computer. It provides all 128 ASCII characters.

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For further information please feel free to contact: Bruce Petty, at (416) 789-7761.

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Track Repair Kits

Model SRS 050 Track Repair Kits allow the user to repair damaged printed circuit boards to "like new". The repair to the circuitry is made by utilizing a variety of copper foil etchings which complement the existing board circuitry. Plated through holes are repaired by swaging and eyelet/funnelet into the board.

The kit is available in four models: Standard, Service Technician's, Basic and Deluxe. These kits differ in the tools supplied and all are capable of making high quality repairs. Prices range from $18.00 to $129.00. For information on distributors contact: Automated Production Equipment Corp., 42 Peconic Ave., Medford, New York 11763. (516) 654-1197.

Circle No.50 on Reader Service Card

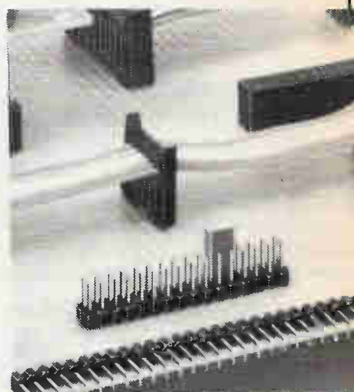
Microtel Limited has entered into a two-year, $6-million agreement with Hughes Aircraft Company of Los Angeles for the supply of electronic components which will be manufactured at the Microtel plant in Brockville, Ontario.

This is an extension to a contract initially won by Microtel a year ago for the supply of "backplanes" used on various Hughes products. Under terms of the new agreement which extends through 1985-86, Microtel's custom-manufacturing organization, Manutronics, will be manufacturing seven different components for Hughes.

Microtel has produced more than $4.5-million worth of the sophisticated "backplanes" for Hughes to date. The complex components are produced on computerized, automated wiring machines.

Microtell is a leading Canadian manufacturer of a broad range of telecommunications equipment, headquartered in Burnaby, B.C. The company has manufacturing facilities in Burnaby, Brockville, Ont. and Saskatoon, Saskatchewan, and serves its customers through a network of sales offices across Canada and in Atlanta, Georgia.

Shunts And Jumpers



Say that ten times, really quick! Seriously though, the "MS" series insulated and non-insulated shunts and "JL" series jumpers allow you to experiment or easily modify your boards.

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Circle No.59 on Reader Service Card

Marantz Company Inc. has announced that distribution of its Marantz line of quality audio products in Canada will be handled by TC Electronics. The appointment is effective immediately. Marantz was formerly distributed by BSR (Canada) Ltd., which recently ceased operation.

TC Electronics' address is 87 Brunswick Boulevard, Dollard Des Ormeaux, Quebec, H9B 2J5. Telephone number is 514-683-7161.

Circle No.60 on Reader Service Card

Readers interested in constructing all or part of a satellite dish antenna system may recall the construction project run in Electronics Today in July and August, 1983. The author of that article, Ron Coles, reports that enough enquiries resulted that he has now started a business, Colesat Systems, selling complete systems and components. Interested readers can contact Colesat at RR #2, Tantallon, Nova Scotia B0J 3J0, (902) 826-2875.

Circle No. 49 on Reader Service Card.

continued on page 68

pin 7. If it's a straight-through you are making, then go right ahead, 2 to 2, 3 to 3, etc.

The next-most-delightful situation is where the two units are of the same sex and need no handshaking lines. For the data lines simple wire 2 to 3 and 3 to 2.

If handshaking lines are needed then determine which handshaking outputs actually mean something (as opposed to the dummies). Then connect these to the handshaking inputs of the opposite units.

You may have a sender which is sending to a receiver which does not need to halt the sending device. If this is the case you need to decide what to do with the sender's handshaking input. In some units it can merely be left open (unconnected), and this is seen as the same as 'high'. On other units open is taken as a 'low' and halts transmission. The handshaking input may be wired permanently high by jumpering it to a handshaking *output* on the *same device*. This is normally done inside the plug on that unit's end of the cable. Figure 7 shows some typical cable configurations.

Fig. 7a. The simplest possible cable, opposite sexes and no handshaking.

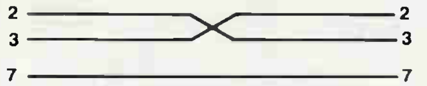

Fig. 7b. The next simplest cable, DCE to DCE or DTE to DTE, and still no handshaking.

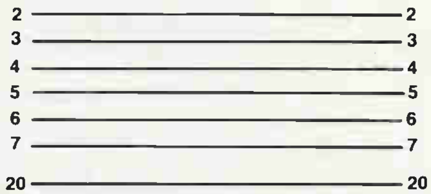

Fig. 7c. Cable to join opposite sexes with handshaking. ('Standard' straight-through cables.)

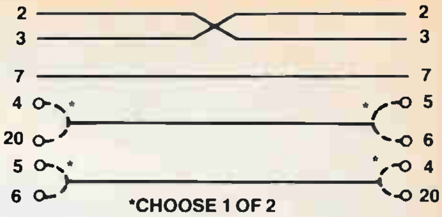

Fig. 7d. Joining same sexes with handshaking (one possibility).

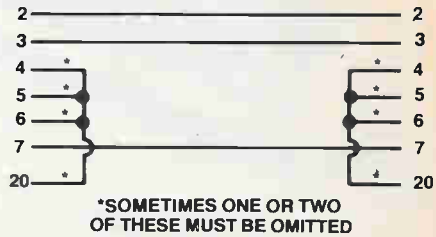

Fig. 7e. Joining opposite sexes, with defeated handshaking at both ends.

Fig. 7. Some typical cable hookups.

The initial hook-up

Armed with the appropriate (we hope) cable, plug it in and see if it works! It probably won't, so refer to the following, summary of all the things to check to make the two pieces of equipment into compatible communicators. ■

1. Number of **bits per character:** 5, 6, 7 or 8.
2. Number of **Stop bits:** 1 or 2.
3. **Baud Rate:** 110, 150, 300, 600, 1200, 1800, 2400, 4800, 9600 or other.
4. What to do with **Parity:**
   On transmission: No Parity, Even Parity, Odd Parity, Parity bit set to 0, or Parity bit set to 1.
   On receiption: No Parity expected, Ignore Parity, Expect Odd, or Expect Even.
5. **Full** or **Half Duplex.**
6. Make sure machines are **One Line** if they have the ability to be off line.

continued from page 45


```
0800          *TEXT TO SPEECH CONVERTOR
0800          *BY YIN H. PUN, COPYRIGHT (C) JULY 1984
0800          *REQUIRES D/A CONVERTOR CARD AND
0800          *S.A.M./RECITER SOFTWARE
0800                   OBJ $300
0300                   ORG $300
FDED          COUT     EQU $FDED
FDF0          COUT1    EQU $FDF0
FE93          SETVID   EQU $FE93
C000          KEYBOARD EQU $C000
C010          KEYSTROB EQU $C010
9500          TEXT     EQU $9500
94F9          RECITER  EQU $94F9
03D0          DOSWARM  EQU $3D0
03EA          HOOKDOS  EQU $3EA
03F5          AMPER    EQU $3F5
03F8          USER     EQU $3F8
0300 A9 4C    INIT     LDA #$4C          :SET AMPERSAND AND
0302 8D F5 03          STA AMPER         :CONTROL-Y CONNECTIONS
0305 8D F8 03          STA USER
0308 A9 18             LDA #START
030A 8D F6 03          STA AMPER+1
030D 8D F9 03          STA USER+1
0310 A9 03             LDA /START
0312 8D F7 03          STA AMPER+2
0315 8D FA 03          STA USER+2
0318 48       START    PHA               :MODIFY OUTPUT CHARACTER HOOK
0319 A9 00             LDA #$0
031B 8D 93 03          STA POINTER
031E A9 2A             LDA #WARM
0320 85 36             STA $36
0322 A9 03             LDA /START
0324 85 37             STA $37
0326 68                PLA
0327 4C EA 03          JMP HOOKDOS       :MAKE IT WORK WITH DOS
032A 8E 94 03 WARM     STX SAVEX
032D 8C 95 03          STY SAVEY
0330 AE 00 C0          LDX KEYBOARD      :GET CHARACTER FROM KEYBOARD
0333 E0 81             CPX #$81          :IS IT A CONTROL-A?
0335 F0 4B             BEQ QUIT          :YES, THEN RESET OUTPUT HOOK
0337 AE 93 03          LDX POINTER
033A 48                PHA
033B 09 80             ORA #$80          :SET BIT 7 ON
033D C9 E0             CMP #$E0          :CHECK FOR LOWERCASE
033F 90 02             BCC WARM1
0341 29 DF             AND #$DF          :SHIFT TO UPPERCASE
0343 9D 00 95 WARM1    STA TEXT,X        :PUT CHARACTER IN INPUT BUFFER
0346 C9 88             CMP #$88          :IS IT A BACKSPACE?
0348 D0 06             BNE WARM2
034A CE 93 03          DEC POINTER       ;DECREMENT THE CHARACTER
034D CE 93 03          DEC POINTER       :POINTER IF IT IS.
0350 EE 93 03 WARM2    INC POINTER
0353 68                PLA
0354 20 F0 FD          JSR COUT1         :OUTPUT CHARACTER TO SCREEN
0357 C9 8D             CMP #$8D          :IS IT A CARRIAGE RETURN?
0359 F0 0C             BEQ TALK          :YES, SPEAK!
035B AE 93 03          LDX POINTER
035E F0 07             BEQ TALK
0360 AE 94 03          LDX SAVEX
0363 AC 95 03          LDY SAVEY
0366 60                RTS
0367 A2 00    TALK     LDX #$0
0369 8E 93 03          STX POINTER
036C 48                PHA
036D 20 F9 94          JSR RECITER       :GO AND SPEAK OUTPUT LINE
0370 A2 00             LDX #$0
0372 A9 8D             LDA #$8D
0374 9D 00 95 TALK2    STA TEXT,X        ;RESET INPUT BUFFER
0377 E8                INX
0378 D0 FA             BNE TALK2
037A 68                PLA
037B AE 94 03          LDX SAVEX
037E AC 95 03          LDY SAVEY
0381 60                RTS
0382 2C 10 C0 QUIT     BIT KEYSTROB      :SET OUTPUT HOOK BACK TO
0385 48                PHA               :NORMAL
0386 20 93 FE          JSR SETVID
0389 68                PLA
038A AE 94 03          LDX SAVEX
038D AC 95 03          LDY SAVEY
0390 4C ED FD          JMP COUT
0393 00       POINTER  HEX 00
0394 00       SAVEX    HEX 00
0395 00       SAVEY    HEX 00
0396                   END
***** END OF ASSEMBLY
```

Listing 1. The source code for the Text-to-Speech converter.

```
10  REM TALKING MW FILES
20  REM BY YIN H. PUN
30  REM MAY 31, 1984
35  D$ = CHR$(4)
40  PRINT D$"BLOAD SAM"
50  PRINT D$"BLOAD RECITER"
55  PRINT D$"BLOAD TEXT TO SP.300"
60  PRINT D$"RUN SAY MW.300"
```

Listing 2. The BASIC program for Talking Magic Window files.

```
10  REM TYPE BINARY TEXT FILES
15  REM BY YIN H. PUN, JULY 1984
20 D$ =  CHR$ (4)
30  HOME : PRINT "MAGIC WINDOW BINARY FILES"
40  PRINT "TO SPEECH CONVERTOR PROGRAM"
50  PRINT : PRINT "BY YIN H. PUN, JULY 1984"
60  PRINT
70  PRINT : PRINT "WHICH FILE TO PRINT? (INCLUDE .MW SUFFIX)": INPUT "OR '1' TO
CATALOG DISK 1 OR '2' TO CATALOG DISK 2 => ";FI$
80  PRINT D$
90  IF FI$ = "" THEN 70
100  IF FI$ = "1" THEN  PRINT D$"CATALOGD1": GOTO 10
110  IF FI$ = "2" THEN  PRINT D$"CATALOGD2": GOTO 10
120 IF  RIGHT$ (FI$,3)       ".MW" THEN  PRINT : PRINT "NOT A .MW FILE!": GOTO 70
130  PRINT : PRINT "LOADING... INTO MEMORY.": PRINT
140  PRINT D$"BLOAD"FI$",A$1800"
150  PRINT : PRINT "TYPE CTRL-C TO ESCAPE TO MENU.": PRINT : PRINT
160 A = 4096 + 2048 :L =  PEEK (43616) +  PEEK (43617) * 256 - 257 + A: REM END
   ADDRESS
170 SAYIT = 38137: REM RECITER
180 P = 38144
190  CALL 768
200  FOR T = A TO L: PRINT  CHR$ ( PEEK (T));: NEXT
210  PR# 0
220  RUN
```

Listing 3. The BASIC program for SAY MW.300

continued from page 65

The largest computer event in Canada, and the third largest in North America, the 15th Annual Canadian Computer Show and Conference, will open its doors November 19 – 22, 1984 at the International Centre, Toronto, Ontario.

A new building has been added to the already existing facility to accommodate the more than 350 exhibitors expected. International and national companies will display the latest in computer products and services including an increased number of firms representing the software area.

The Canadian Computer Show is the number one event business people choose as evidenced by the 1983 audited figures. Out of the 28,000 paid attendees, 95/ were adult atendees with a professional status.

The show is open on Monday, November 19th from 10 a.m. to 6 p.m., Tuesday and Wednesday from 10 a.m. to 8 p.m. and Thursday from 10 a.m. to 6 p.m. Admission is $10 with attendance restricted to adults over the age of 18 years.

The Canadian Computer Show and Conference is managed by Industrial Trade Shows Inc., leaders in computer and office automation shows across Canada. For more information contact James K. Mahon, Group Show Manager, 20 Butterick Road, Toronto, Ontario M8W 3Z8 (416) 252-7791.

Circle No.55 on Reader Service Card

Mouse for Apple IIs

Due to the success of the Apple Macintosh and its mouse, the mouse has now been made available for the perenially-popular Apple II series computers. The "MousePaint" software program, makes it possible to draw hi-resolution graphics on the Apple II, in a manner similar to that which is done on the Macintosh.

Employing easy-to-read menu-driven commands, "Mouse Driver" will support most popular printer interfaces and printers, providing end-uers with crisp printouts of their graphic compositions.

This program will work with an Apple II, Apple II Plus, or an Apple IIe computer provided it has 64K (kilobytes) of RAM (random-access memory) and uses the Apple "ProDOS" operating system. An "AppleMouse II", and a dot matrix printer with interface are also required.

The following printer interfaces are supported: -Grappler Plus and buffered Grappler Plus. -Dumpling GX and Dumpling 64. -Uniprint. -Videx PS10. -Epson Apple Interface, Type II. -and the printers supported by these interfaces.

The "Mouse Driver" program has also been made available for general sale at a price of $39.95.

More information about this product can be obtained by contacting Tony Leung at ARkon Electronics Ltd., 409 Queen St. W., Toronto, Ont. M5V 2A5, 593-6502.

Circle No.52 on Reader Service Card

A new copper etch solution called Circutron® Micro Etch SP that removes various chemical films from printed circuit boards, has been developed by the Harshaw/Filtrol Partnership. Micro Etch™ SP is a free-flowing acid based powder. When it is dissolved in water, the solution removes copper oxide films, resists residues and oxide inhibitor films from laminate copper foil surfaces. In addition, the process produces a uniform matte etch on copper surfaces to promote subsequent electroplate adhesion. The copper etch bath contains no phosphates or chromates of ammonium compounds. It can be regenerated by adding Micro Etch SP and controlled by analyzing the copper content. For more information on Circutron Micro Etch SP, contact Thomas F Hemsath, Harshaw/Filtrol Patnership, 1945 East 97th Street, Cleveland, Ohio 44106 (216) 721]-8300.

Circle No.53 on Reader Service Card

ETI keeps getting letters concerning the availability of the LM1894 from September, 1983's DNR project. We regret to say that the IC is still not available in small quantities.

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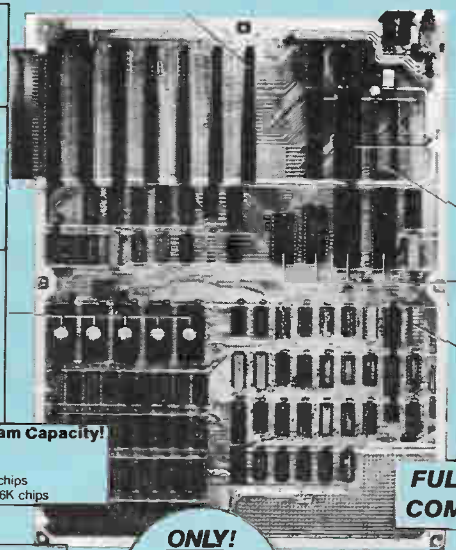

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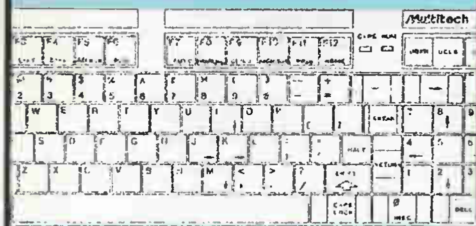

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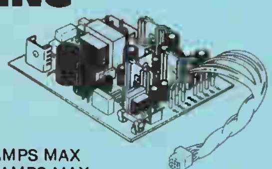

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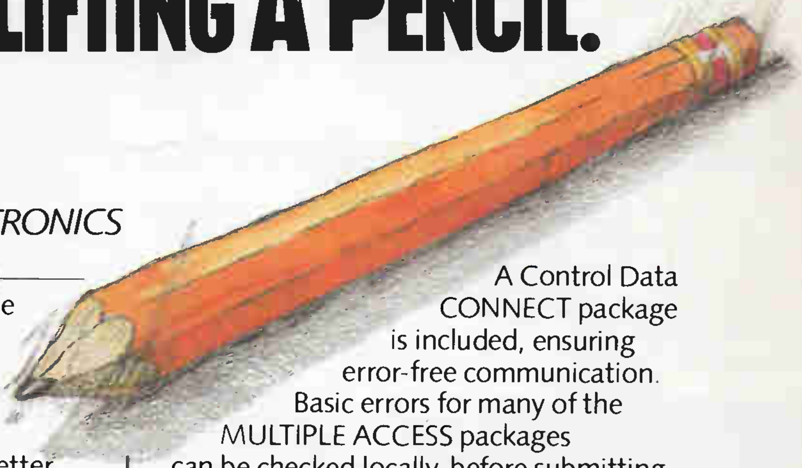

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