

Electronics Today



October 1984

\$2.95

MM70924



Canada's Magazine for Electronics & Computing Enthusiasts

A Look at Video Cameras and VCRs

Project Bonanza
Ten short ones



Video Distribution
Amp

Replace boxes
with a
video amp

The Best From
Your Scope
Operating tips



Computer
Review:
Power 3000

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Systems

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Apple Macintosh from	\$3195

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Floppy Controller Card With serial port built-in and provision for real time clock.	\$189
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Peripheral Board With 2 serial ports, 1 parallel port, 1 game port (provision for optional real time clock) \$169 . With all above options including the real time clock	\$199
Colour Video Board 512 Memory Board with 64K of RAM	\$250
512 Memory with 128K	\$179
512 Memory with 256K	\$250
512 Loaded Memory with 512K	\$399
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With 128K	\$289
With 256K	\$359
With 512K	\$499

Brand new from Shugart SA455 D.S.D.D.

Disk Drive slim line, ideal for IBM or compatible computer

6809 Board as described in May '84 Catalogue with 48K

EPROM Programmer + Software (programs 2716, 2732, 2764, 2712B) with ordinary sockets

Extension Board & Cable with two sockets (this card allows you to be able to have the ZIF sockets beside your computer for easy access.

Parallel Card & Game Port

NEW — soon to be released

512 Bubble Memory Card

At a knockout low price! 300/1200 baud auto dial/ answer, direct connect modem, newest technology, price so low that you'll be sorry if you don't wait for it.

Multiflex Z80A Starter Kit
As described in May '84 Catalogue pg. 16

Monitors

Zenith 122 Amber 12"	\$139
Zenith 123 Green 12"	\$129

Printers

Gemini 10X - CSA approved with one year warranty	\$379
Panasonic Printers now available at a bargain price.	
TTX (Daisy Wheel) Letter quality	\$599
Epson FX100	\$1069

Diskettes

CDC, S.S.D.D. 10 disks for	\$21.95
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Verbatim S.S.D.D. 10 disks for	\$32.95
Paper 500 sheets	\$9.95

We have a huge selection of parts, check out our May '84 catalogue. Here are a few examples:

Memories

4116 150 ps	\$1.95
4164 150ns	\$7.95
4164 TI 150 NS (ideal for IBM Compatibles) ..	\$7.95
2114	\$2.99
6116 150 NS	\$8.95
6514	\$2.99
2716 350 NS	\$8.50
2716 450 NS	\$6.50
2732 450 NS	\$8.95
2764 300 NS	\$12.95
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Most XTALS	\$4.50
8088	\$32.95
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8253A-5 NEC	\$11.95
8259A Intel	\$12.95
8259A NEC	\$11.50
8237A-5	\$43.95

8250	\$14.95
8255A-5 Intel	\$14.95
8255A-5 Other brand	\$7.95
8284 Intel	\$14.30
8284 Siemens	\$7.95
8288	\$27.95
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6502 CPU	\$6.50
6845	\$11.95

Zenith 133 monitor RGB colour	\$749.00
Gemini 15X Printer	\$599.00
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DON'T MISS IT

Due to the popular demand of our customers, we will now give you a choice between buying goods with a 120-day warranty, or you can buy the same quality goods without warranties as final sale, and **SAVE MONEY!** If any of the goods without warranty fail, we will be glad to fix them for you, but at your cost.

NOTE

All goods listed on this page are manufactured using only prime, high quality components and PC Boards, all PC Board products are wave soldered, ultrasonically cleaned, and finished goods are thoroughly tested.

ALL PRICES ON THIS PAGE ARE FINAL SALE PRICES! NO WARRANTY

Should you wish to have a 120 day warranty, all you have to do is ask, and pay a bit more; it is available for almost everything we advertise here.

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16K RAM card	\$49.95	touch tone or pulse dial • com-
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80 x 24 card (with built-in soft		competitors for over \$220.
switch)	\$73.95	
Parallel printer card	\$49.95	OUR PRICE \$169.00
128K card with 64K RAM	\$109.00	If someone can sell it cheaper to
128K card with 128K RAM	\$169.00	you, buy it!
EPROM Programmer		
(with software)	\$65.95	Apple Compatible disk drives (bas-
Serial card	\$59.00	ed on the Shugart SA390 disk drive
Floppy controller (controls 2-5 1/4"		mechanism \$229.
SS/SD floppies	\$44.95	Case & Numeric
8" Floppy controller	\$109.00	keyboard \$129.
6 MHz Z80 with 64K RAM		Power Supply (6502)
on board	\$139.95	(Hydro approved) \$69.
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Apple II & IIe compatible • Full/half duplex autodial/answer •

SYSTEMS:

FAMOUS KEYBOARD WITH 6502 SYSTEM \$499.00

Keyboard with numeric keypad includes ABS case, great power supply, 64K of RAM, floppy controller, 80 x 24 video board with a built-in softswitch (comes with blank EPROMS and no proprietary software). Fully tested and professionally assembled

6502 Board

Packaged in 8088 case with provision for two SA390 disk drives. Includes: 64K RAM, 80 x 24 video with softswitch, floppy controller, powerful (90 W mx) power supply (enough power to handle up to four drives), along with a built-in fan for ventilation of system, serial to parallel keyboard adaptor, and Maxiswitch keyboard.

DON'T MISS IT

ALL THIS FOR ONLY \$699.00
Above system with one drive \$899.00

8088 Systems

Attractive case, power supply, fan and provision for 256K 8088 Board with 64K (fully tested). One blank 2764 (No proprietary software included). Maxiswitch or Cherry keyboard.

All this for an Unthinkable Price of \$949.00

Panasonic Printers SPECIAL \$379.00

After 7 days no refund, no exchange! *Price subject to change

Peripherals for IBM™ or compatibles Assembled & fully tested FINAL SALE!

Note: Read the above definition of final sale. Optional real time clock and software **\$29.00**

Colour Video board
Compositor RGB **\$179.00**

Floppy controller
(Handles up to 4-5 1/4" DS/DD IBM compatible disk drives)
Provision for clock & serial port (not included) **\$139.95**

Floppy controller as described above with RS232 Interface **\$159.95**

Floppy controller (as described above) with RS232 & real time clock **\$189.95**

EPROM programmer
Normal sockets **\$79.95**
2 ZIF sockets **\$99.95**
(Programs EPROMS from 2716 thru to 27128 software included.)

Parallel port & game port card **\$69.95**
Peripheral card **\$149.00**
Includes 2 serial ports, 1 parallel port, game port (optional real time clock).

Loaded peripheral card with all (serial ports, parallel port, game port) on-board & real time clock software **\$176.00**

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512K RAM on board **\$599.00**

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Programming language

FORTH is an inter-active compiled language with the simplicity of BASIC at ten times the speed. ZX FORTH is a full implementation, with 250 commands. It works on 16-bit numbers, has some 32 bit routines, includes a 60-page user/programmer manual.

Regular \$39.95

\$14.95

Due to the fantastic response to our recent offer for support products for the ZX81 and TS1000, ETI is once again offering to its readers the chance to cash in on some great savings. We've added some exciting hardware and software packages to this offer and we're sure that ETI readers will not want to miss this chance to load up their ZX81's and TS1000's at LOW, LOW prices.

If you want to take advantage of these great prices, and we're sure you do, we must receive your order by Nov. 9th, 1984.

BONUS! WITH EVERY ORDER OF \$100 OR MORE, WE'LL THROW IN THREE CASSETTES OF OUR CHOICE!

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\$14.95

3. 128K Expansion System

This is your chance to really make it big with your ZX81/TS1000. Expand your system up to 128K with this package which includes the following four modules:

- Persona interface device
- Minimap memory mapping module
- Two (2) 64K RAM packs

The suggested retail price of this amazing package is \$560.00, but we're letting it go at this Special Offer Price of \$249.00. Wait, that's not all! Additional memory can be added up to a maximum of 1 MEGABYTE — in increments of 64K for \$99.95 or 16K for \$39.95. Remember, this is a limited time offer that will not be repeated again. If you would like more information on this particular package, please send a stamped/self-addressed envelope to the address below.

4. BASIC LEARNING COURSE

with 2 software cassettes. Complete comprehensive learning guide and reference text. Covers every command and function. Actual programme samples are provided in text and on accompanying tapes. Supplied in a 3-ring vinyl binder.

Regular \$39.95

\$19.95

5. PROFESSIONAL KEYBOARD & CASE

Adds full space bar and touch typing convenience for word-processing and other applications. ZX81 fits inside case. Keys rated 20 million cycles.

Regular \$144.95

\$69.95

6. Top 2 Software Games for the ZX81

Published by Sinclair, these bestsellers have a suggested retail price of \$19.95 each. The Special Offer Price? Both for an incredibly low price of **\$9.95!** Don't wait 'till it's too late, order Now!

7. 64K RAM

The ICs alone are worth more than the cost of this complete cased 64K memory expansion (8 x MK 4564). Plugs in directly to ZX81 or TS1000. Expands the Z80A CPU to its addressable maximum.

Regular \$159.95

\$69.95

8. Programs for the ZX81

Here's your last chance to pick up a great book containing 30 programs for the ZX81. This book usually sells for \$16.95, but a 50% saving gets it to you for a LOW \$8.95.

9. Software Surprise Assortment

Big Savings!!! You'll get a minimum of 5 software programs, our choice. We guarantee a selection of excellent quality games, applications, and utility software, plus a vinyl cassette holder for 2 tapes. The retail value of this surprise package will be at least \$80.00 — it's yours at an 80% savings at **\$14.95!**

Send to: ZX81/TS1000 Offer, Moorshead Publications, 25 Overlea Boulevard, Suite 601 Toronto, Ontario, M4H 1B1

Please send me the following. I enclose payment (cheque or money order) made out to Moorshead Publications.

- # 1 ZX Forth at \$14.95
- # 2 Home and Business Management Software at \$14.95
- # 3 128K Expansion System at \$249.00
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Electronics Today



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Features

8

Electronics in Action
More hi-tech from Roger Allan

10

Getting the Best From Your Scope
Operating tips and hints.

12

Fusion Reaction
Free power forever? We've heard that one before, as Roger Allan explains.

26

Designer's Notebook
A sampling of sample and hold circuits.

38

A Look at Video
Cameras, VCRs, and a Sound Converter.

40

Computer Review
John Rudzinski looks at the Power 3000.

42

Machine Code Programming, Part 5
The series continues with a look at moving programs in memory.

44

Computing Today: EPROMs
Yin Pun compares programmable memory chips

Projects

20

Project Bonanza
Ten short projects to keep you busy.

32

Video Distribution Amplifier
If splitter boxes just don't make it, build this project and isolate up to five video machines.

Columns, News and Information

For Your Information	6
Binders	18
ET Bookshelf	46
Order Form	49
Book of the Month	50
Next Month	50
Subscriptions	50
Product Mart	55

Our Cover

John Rudzinski demonstrates the portability of the JVC VideoMovie camera; composite by Ed Zapletal and Bill Markwick. The Power 3000 is reviewed by the cyclist himself.

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Editor:
Editorial Assistant:
Director of Production:
Creative Manager:
Production:

William Markwick
Edward Zapletal
Erik Blomkwist
Ann Rodrigues
Douglas Goddard
Neville Williams
Naznin Sunderji
Lisa Salvatori
Omar Vogt
John McGowan & Associates
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Circuitronics	29
Computel Publishing Society	62
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Daetron	29
Dana's Computer Discounts	6
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Electronic Control Systems	59
Exceltronix	2
Gladstone	4
Griffco Marketing Inc.	35
Heathkit	27
Hitachi Denshi Ltd. (Canada)	7
H. Rogers Electronic Instruments Ltd.	57
Infinite Canada Inc.	57
Kaientai Electronics Merchants Ltd.	29
Kitstronic International Ltd.	59
Komputech	31
McGraw-Hill	25
MCS Microtronics Inc.	62
Orion Electronics Supplies Inc.	61
Peach Microsystems Inc.	57
R. A. Hubbell and Associates	63
Smith Corona	33
Surplustronics	3
Tektronix	64

for your information

Digital DC Clamp-on Ammeter

Pacer Industries, manufacturer of electronic test and measuring instruments, announces a new addition to its line of clamp-on ammeters - the Model DC801.

The instrument features a 100 amp range with 0.1 amp resolution and a 400 and 800 amp range with 1 amp resolution. It is overrange protected to 5000 amps DC and has larger, easier to read LED's. Accuracy is 1-1/2% of reading \pm 1/2 amp. There is no need to break the circuit. The unit is battery operated and is available with an optional Ni-cad rechargeable battery package. For further information contact: Customer Service, Pacer Industries, Inc., 1450 First Avenue, Chippewa Falls, WI 54729, 715/723-1141, Telex 260391.

Circle No. 46 on Reader Service Card.

Tired of fiddling and fooling to set record levels on your cassette deck? Sony now has a computerized cassette, the TC-FX705 (what ever happened to names?). Audio levels are set and displayed in 1 dB steps; a memory permits the user to set five different parameters; suggested retail is \$549.95.



The Radio Shack Model 100 portable computer has been very popular because of its large number of features, but it has a small LCD screen and cassette-only data storage. To solve the problem, Radio Shack has a disk/video interface, model 26-3806. It adds a 40/80 column video output and a single 184K floppy disk; a second drive can be added. The required disk control software is internal to the interface. At Radio Shack computer dealers.

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If you're looking for sealed switches, limit switches, or low-profile miniature switches, the Burgess Switch Company has a wide range available, and free copies of data sheets are available. Contact them at 4800 Sheppard Avenue East, Scarborough, Ont. M1S 4N5 (416) 299-0852.

In answer to inquiries about the C&K line of switches, the Canadian representatives are Avotronics Inc., 230 Don Parker Road, Unit #2, Markham, Ont. L3R 2P7, (416) 475-2024, and also Line Electronics, 1503 Dover Court Road, Vancouver, BC., V7K 1K6, (604) 922-5315.

Circle No. 52 on Reader Service Card.

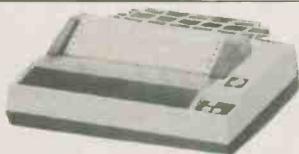
continued on page 58

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Apple Peripherals

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Call for prices on other cards!

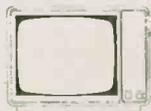
Shugart SA-390 for Apple and Apple compatibles. 40 Tracks 163 KBytes
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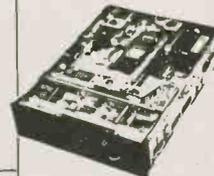
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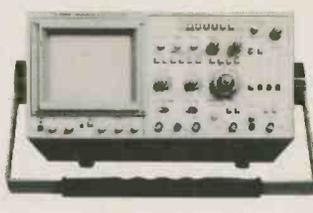
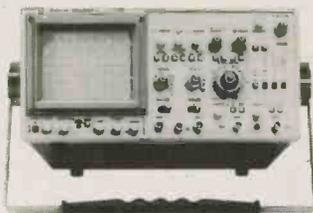
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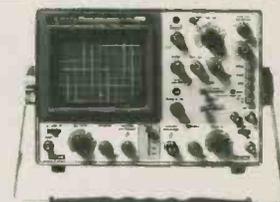
V-099 \$1,478
Waveform Monitor



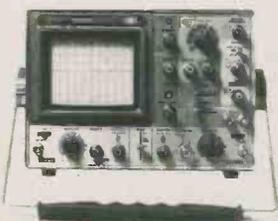
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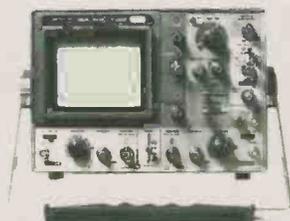
V-509 \$1,995
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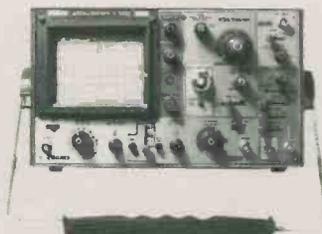
V-134 \$2,437
10 MHz Dual Trace
Storage Scope



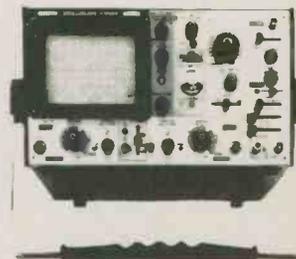
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35 MHz Dual Trace
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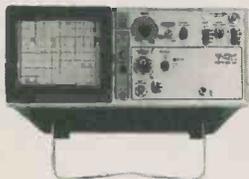


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Electronics In Action

An intelligent telephone answerer, a stereo remote control, and a new computer light pen.

by Roger Allan

THE advent of the telephone answering machine has progressed through three distinct stages. Initially some twenty years ago, devices were built which answered the phone and played a pre-recorded message. The second stage was passed when these machines automatically recorded a telephone call, with the third evolutionary stage being the ability to dial up one's own answering machine and via a beeper retrieve messages that had been recorded.

Most recently, the Command Communications Inc. company in Denver, Colorado, has taken the process the final logical step, whereby not only can one dial up one's own machine to retrieve messages, but via their ASAP Locator, the machine will hunt you down and let you know that a message has been received. This can be done either through dial-

ing a telephone number where you can be reached, or by dialling into a paging device which will locate you via radio.

The ASAP can be programmed with up to four telephone numbers totalling a maximum of 50 digits, including one or two specialized entries which tell the machine what to do. Upon receipt of a message by one's answering machine, the ASAP will then automatically telephone the first of the pre-programmed numbers. If the device succeeds in reaching you, it will sound a distinctive beeping noise; a response from your own beeper will then retrieve the message from the answering machine. Should the ASAP fail to reach you at the first of the pre-recorded numbers, it will wait for four minutes and then try the second number, and so on. Should it fail to reach you at any of the numbers, it will go back to the first, and

start all over.

One of the novel features of this device is its ability to tap into commercial paging systems whether tone, voice or digitally operated. Customarily, to utilize a commercial paging system one first dials their number, waits for a beep, and then dials more numbers specific to your individual pager. The ASAP is capable of undertaking such a process using the asterisk key; this commands it to wait for the paging company's beep before proceeding with the second portion of the telephone address.

A second novel feature is its ability to dial out from behind a switchboard. Customarily, if there are large numbers of telephone extensions connected to a single telephone address, such as is found at most companies, one must dial an 8 or a 9 to reach an outside line. The ASAP has a control function which permits it to dial the 8 or 9 and then commence to dial out the remainder of the number.

And as for the future, fifth generation answering machines? Well, I suppose one could design a system that would receive the message, make a hard copy of it, pass it on to a robot and have it physically chase you down the street carrying the message in a forked stick. But that lies in the future.



AR Stereo Remote Control

Similarly to the ASAP, control of television devices has passed through a number of stages. There was the standard get-up-and-twiddle-the-dials, followed by remote control via a cable, and more recently remote infra-red devices. Teledyne Acoustic Research has carried



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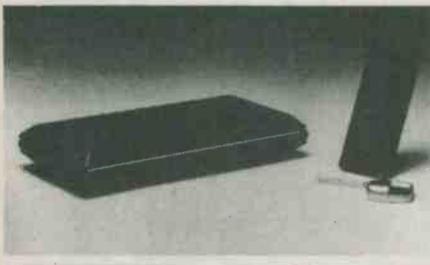
this process another logical step: infra-red control of one's stereo system.

Known as the AR SRC, this device controls some 15 functions from anywhere in a normal sized room via a wireless remote infra-red handset. Containing a 8-bit custom programmed microprocessor, the functions include system on/off, volume control, balance control, -20 dB mute, source switching via remote tape monitor, left vs right speaker comparisons and sleep timer.

Based on increasingly commonplace digital technology, this device also contains an External Processor Loop which can be used for any line level accessory. For example, the EPL circuit can be used to remotely switch devices such as an equalizer, video disc player, compressor/expander, electronic subwoofer, tape deck or some variety of noise reduction device.

The device features ease of use: you don't have to get out of your chair to turn down the stereo when the phone rings, for instance, and correct placement of one's stereo elements is easier, particularly the placement of the speakers. In other words, as the signal processors may be switched in and out of the audio circuit, one is able to obtain instant comparisons for adjusting equalizers, time delays, and dynamic range expanders all from the listening position. No more having to bob back and forth to the equipment adjusting here and fiddling there.

The Sleep Timer function is fairly straightforward, albeit operated via infra-red. Its activation will turn off the stereo after 30 minutes, which is nice if



you like a little music while dropping off to sleep, and prefer good quality sound from your stereo system rather than the 'tinny' noise from clock radios, customarily the only means of sleep timing available.

Gibson Light Pen

Military radar in the 1950s required the development of light pens for the accurate plotting of aircraft. Since then the light pen has been used in industrial applications such as videotape editing where the pen is used to mark on film areas to be cropped or cut out.

More recently, graphics, particularly

computer graphics, have become increasingly important in many areas of business, industry, education and entertainment. The melding of the light pen technologies with these areas of use has produced something of a dichotomy: one can either move to high priced systems or to low grade systems such as Syntec's, Magellan's or TechSketch's. These, while accurate enough in themselves, have shortcomings in their software programs, leading to a finished product that performs sketching and little else.

Koala Technologies Corporation has attempted to overcome this problem with the Gibson Light Pen System. The pen, designed by the same man who developed the first Apple-compatible light pen in 1980, as well as that used by Atari, utilizes a hand-held pointing device connected to a computer via a cable. The user can manipulate and move objects on the computer screen by touching the tip of the light pen to the screen, thus bypassing the keyboard for most functions (eg. everything other than on/off, yes/no, or entering file names). It is compatible with any micro from the Apple II family, and soon will be usable on Commodore and IBM machines. It requires 64K RAM, Applesoft, one disk drive and a TV or monitor.

The system has a number of strengths when compared with other seemingly similar devices. For example, the amount of software support is large and increasing, currently consisting of a PenPainter (a colour graphic system program featuring freehand drawing, elastic geometric shapes and colour-fill patterns), the PenAnimator (in which the user can create up to 20 frames of animation that can run rapidly on a monitor and requires about one floppy's total capacity), Pen-Musician, which is an introduction to music composition consisting of the display of staff lines whereby the user can move notes with the light pen to create a melody, and PenDesigner, a black and white line-art program for technical or business oriented graphics such as floorplans or landscape architecture. The software includes templates such as furniture, bushes and trees, and engineering symbols which can be moved from 'index cards' on the screen.

The light pen makes movements easier to judge and control since it makes direct contact with the screen and operates on an icon-based rather than text-based command system. This is of advantage to small children who reputedly find it difficult to mentally connect the actions of a 'mouse' pointing device or joystick to the reactions on the screen.

Colouring is like adding ink to the pen: the line or symbol drawn appears in the colour chosen and may be changed as often as desired. In addition to coloured

lines, the user can choose presupplied colour and texture patterns and 'fill' them into areas of outlined art. Changing the pen's ink colour to match that of the background can also turn the pen into an eraser. Retracing the lines in this manner acts like 'white out' for a typist. Further, 'blocks of black space can be placed over



large areas to be erased, and the software routines permit the user to print out any picture on Apple dot-matrix printers (and others) in six of sixteen colours and 16 shades of grey.

Essentially, then, something that has been considered a high priced option for computers, or a low priced option with technical drawbacks, is now in the high quality/low price consumer market. ET

*Cardinal Communications, Ltd.,
151819 Stony Plain Road,
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95052*

Getting the Best from Your Scope

Often called the workhorse of the testbench, there is nothing more useful to the professional or the tinkerer than the oscilloscope. Herewith, some operating tips.

By Bill Markwick

WHEN you started into electronics, your first piece of test gear was probably the multimeter, that ubiquitous bit of all-purpose equipment. No doubt the best thing you learned from using one was the importance of being able to measure what was going on inside the circuit, instead of having to guess by just observing the performance.

The next purchase was probably an oscilloscope, and this is where you really get to find out the circuit's secrets. Being able to see the waveforms reveals vast amounts of information that you couldn't get before: that mysterious quivering of the voltmeter's needle is now seen to be an interfering signal, and you can then move the probe to trace its origin. If you've traced circuits using a signal injector and an earphone, using an oscilloscope is infinitely easier, and will show you all sorts of characteristics of the circuit that were hidden before.

But First. . .

Just in case you don't own a scope yet, and are pondering a purchase, here's a quick primer.

The basic scope consists of three parts: the cathode ray tube (CRT), a horizontal amplifier, and a vertical amplifier.

The CRT is similar to a TV picture tube, but the beam is guided by voltages rather than a magnetic coil; this gives it much better linearity. It also has shorter persistence; the trace fades away faster to improve its operating speed.

The horizontal amplifier, as you'd expect, guides the dot of light from left to right across the display. It generates a sawtooth voltage, i.e., voltage which rises smoothly and linearly and then falls quickly to zero again. This voltage, when impressed on the control plates of the

tube, causes the dot of light to travel at a smooth pace from one side to the other and then snap back from the next go. During the return, or retrace, the brightness of the display is suppressed to prevent the retrace from showing on the screen. The rising part of the sawtooth voltage, the part that moves the dot across the display, is precisely timed and can be changed with a rotary switch (sweep time); generally, the time can be set in seconds, milliseconds, or microseconds per division.

The vertical amplifier is the one that impresses the desired signal on the vertical deflection plates. As the voltage rises or falls, the dot follows; the gain of the amplifier is usually set by a rotary switch in volts or millivolts per division. As the dot rises or falls in agreement with the input signal, it's swept along by the horizontal amplifier at a selected rate which displays as much or as little of the signal as you want.

This is really all you need to change the voltage variations of your signal into a

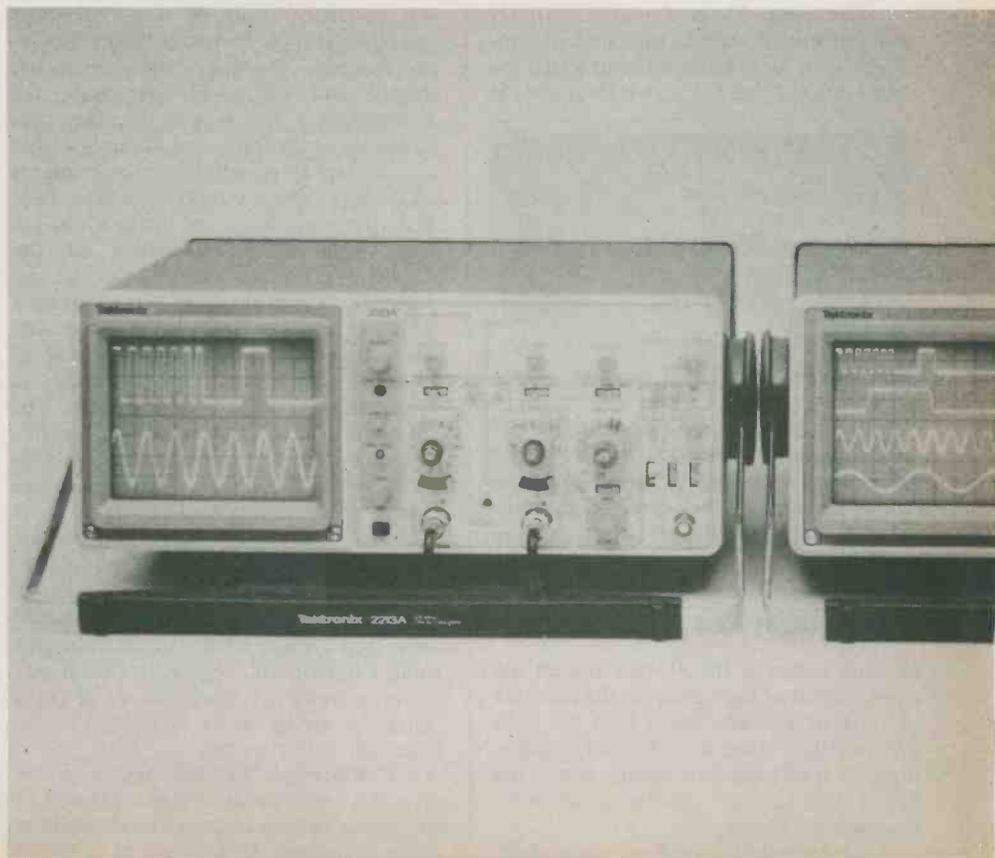
visual representation. However, there are refinements which will make life easier.

Refinements

If you had a scope with nothing more in it than the parts described above, you'd probably find it very awkward to use. In fact, there are still a lot of bottom-of-the-line hobby scopes available in surplus stores; these generally have nothing more than a few potentiometers for control, and strain both your eyes and your temper as you try desperately to stop the display from rolling. Here are some of the things to look for in a scope that you'll get along with:

Calibrations: rotary switches calibrated in known divisions let you use the scope as a measuring instrument for voltage and frequency, and in general simplify resetting the scope to previous conditions. Uncalibrated pots will drive you crazy.

Triggered Sweep: if the horizontal sweep on a non-triggered scope is set just slightly off optimum, the scope begins to display multiple images of your signal, or else the display just rolls lazily off the



screen. The triggering amplifier waits until the input signal starts rising from zero volts, and then it starts the horizontal sawtooth. This locks the sweep to the signal and gives you a beautifully steady trace (most of the time).

DC Coupling: both vertical and horizontal amplifiers should have an AC/DC switch; the centre line of the display will represent zero volts, with positive-going voltages going upward and negative-going ones displaying downward. There are few features so handy in troubleshooting; a flick of the DC switch will tell you the circuit's operating voltages with and without a signal.

Horizontal Input: this lets you disconnect the sawtooth voltage from the horizontal amplifier and insert an external signal; very handy for special-purpose applications such as phase checking or component testing.

Those are the things to look for in a starter scope, unless, of course, you're still paying off that last bank loan and have to settle for one of those surplus horrors.

Operating

It's possible to get all sorts of improved performance out of any scope without spending a small fortune. Let's start with the sort of thing you'd find in the scope's instruction manual:

Set the Baseline: many people don't bother setting the trace to the middle line



A Hameg HM 203 dual trace general-purpose oscilloscope.

(zero volts); this is often because a lot of scopes suffer from drifting of the position controls as they warm up. In any case, it's something well worth doing; at any time you can rest assured that your signal doesn't have an unwanted DC offset.

Set the Timebase: display about two complete cycles; this gives you a good look at the waveform. If you display 10 or 20 cycles, you may miss any unwanted distortion because the waves are squeezed together. Get familiar with the time per division settings and how they relate to frequency; you'll then know if you're looking at 100 Hz instead of 1000. More than once I've been mystified by a circuit's odd frequency response when I had actually set the generator a decade high or low.

Learn the Trigger Amp: don't despair if your signal goes by on the screen like a herd of hula-hoops. Trigger amps are only human, you know. Investigate the little knobs in the trigger section: you can set the trigger to work on either positive or negative signals (a signal that's negative-only may produce poor displays if the trigger likes positive signals), you can set the source to the 60 Hz line (looking at 60 Hz power waveforms often fools the trigger, especially if the signal is noisy), and on some scopes you can set the trigger to work on the sync information contained in TV signals. Our Hameg 204 has high and low frequency filters in the trigger amp to get rid of unwanted noise that would otherwise confuse it.

Caution: if you should decide to look at the 120 V power line, use an isolating transformer of some sort between the line and the scope inputs! You could use a small filament transformer, or if you need better bandwidth to observe glitches, there are proper isolating transformers available. Otherwise, if your scope's power cord is the 3-pin type, you'll probably blow a fuse. If your testbench isn't grounded, all equipment hooked to the scope can be potentially lethal. Nuff sed.

More on Triggering

Usually, the vertical amplifier feeds an adequate portion of your signal to the trigger amp, but occasionally you'll be

looking at a circuit that might produce noisy, low-level, or intermittent signals that baffle your best attempts to adjust triggering. If the circuit is being driven by a signal generator, you can feed the generator's output straight into the External Trigger connector as well as your circuit. If there's a wide voltage difference between the circuit's needs and the generator's output, a resistive attenuator can be used to keep them both happy; I used to send about one volt to the trigger amp and use a 1K pot to control the signal level going to the projects.

Grounding

Do you find that your testbench is plagued with 60 Hz interference, or even unsolvable oscillations in high-gain circuits? The trouble is often due to the grounded power plugs required by underwriter's standards; if you have several of them, you can create a ground loop in which small but annoying interference currents can circulate. Try removing the ground pins and running a short length of heavy wire from the instruments to a water pipe; stay away from the ground wire in the power lines, because it's just too noisy for lab use. And don't tell the underwriters I said so.

Probes

The probe and cable is not just a way to convey the signal up to the input jack; it's an inherent part of the instrumentation, and can seriously affect circuit performance. Suppose you have a high-gain amp which seems to be working nicely, and you decide to look at its output. All you see on the screen is a burst of oscillation. Whaa? The problem may be the capacitance of the probe cable causing instability in your circuit. The cure, of course, is to improve your circuit's stability, but a quick fix can be had by inserting a 10K resistor in series with the probe tip; this usually isolates the circuit under test. A second way would be to use a probe with a 10:1 divider in it; the internal resistors will minimize capacitive loading.

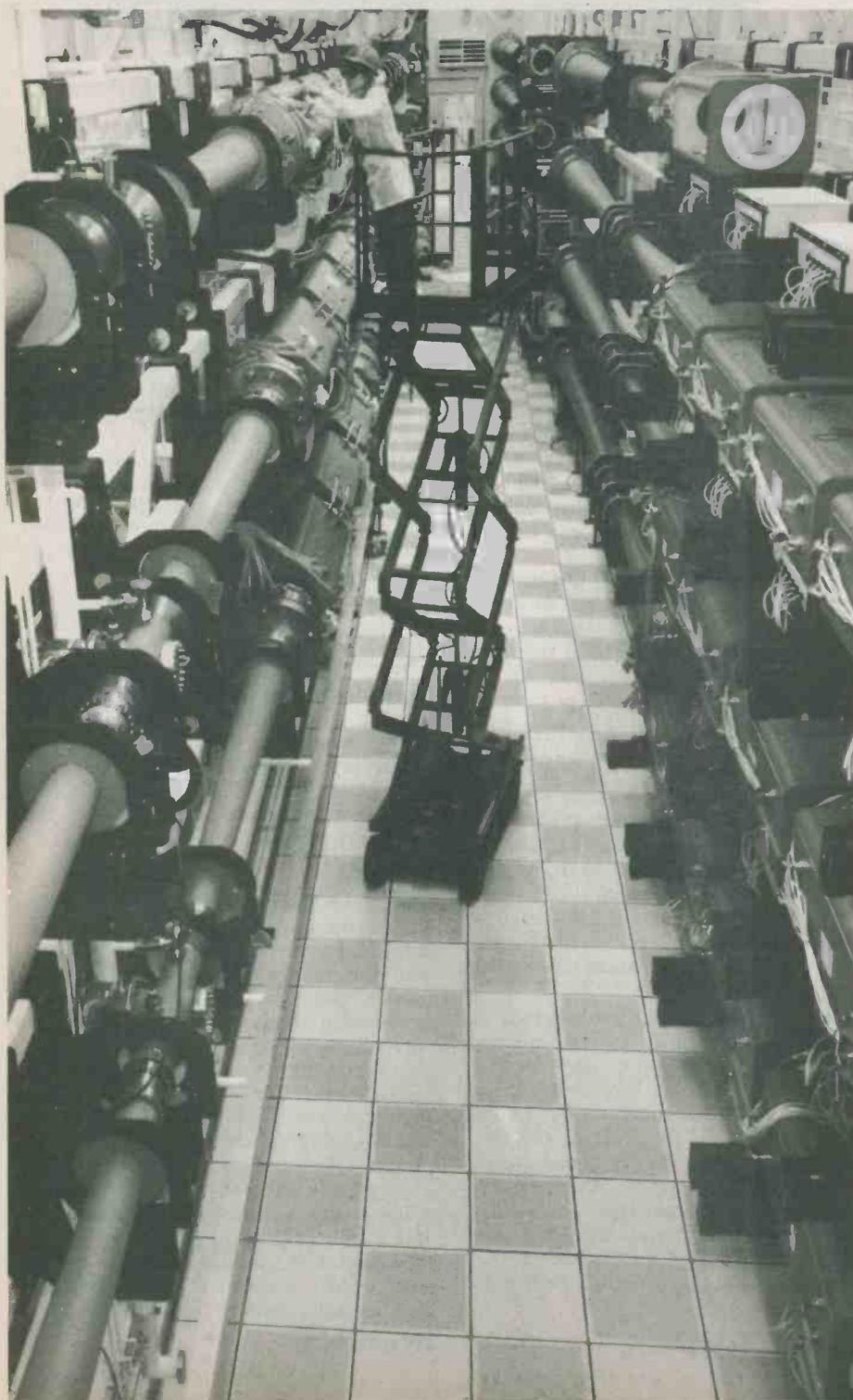
Bandwidth

Let's say that you've concocted a digital circuit using very high speed chips, and you're only running it at about 3 MHz.

continued on page 18



Fusion Research



Perched precariously on a hydraulic lift, a technician working in the NOVA project inspects a portion of the laser bay. Photo courtesy of Lawrence Livermore National Laboratory.

Roger Allan sums up present-day efforts to bottle the sun.

MOST of the energy produced on this planet is converted from its stored form by the combustion reaction: by burning. An important feature of this combustion reaction is that it is exothermic. It releases more energy than is required to start it (energy of activation) or keep it going. Further, to produce energy on a significant, continual scale, the reaction must be self-sustaining. An example is the lighting of a campfire. To light the fire energy is introduced by the match which raises the temperature of small twigs such that they combust, releasing more energy than was required to activate the combustion reaction. The campfire is lit, and its combustion is self-sustaining until it runs out of fuel.

In the past forty years or so, two other forms of combustion for the purposes of producing energy have been investigated, fission and fusion. The fission reaction is well known, but a brief re-statement is perhaps in order. In fission, a heavy element, such as uranium-234 or plutonium-239, both of which are naturally at the point of spontaneously splitting, have a small amount of energy introduced, such as a single nuclear particle. This will cause the atom to split, releasing heat and atomic fragments from the split atom. These atomic fragments then strike other atoms, transferring their energy to them, causing them in turn to split. More heat and atomic fragments are released, striking more atoms and so on. If the rate of fragmentation is fast enough, one produces an atomic explosion; if slowed down and controlled, one has a nuclear power reactor.

Fusion is the opposite process. Instead of splitting atoms, one forces them together, making them coalesce into a single atom. Heat as well as a highly active neutron is released. The heat forces other atoms to coalesce and thus the reaction becomes self-sustaining.

The major fusion reaction known to us, is our sun. Every second it converts 657 million tons of hydrogen into 652.5 million tons of helium, the difference of 4.5 million tons of solar mass becoming energy that pervades our entire solar system, extending five billion miles into space. Fusion occurs in the sun because



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Fusion Research

tremendous gravitational forces squeeze and heat its mass to about 15 million degrees Celsius. The combination of high pressure and high temperature strips atoms of their electrons and drives their nuclei together with tremendous force, causing them to fuse. The mass of the sun is so great that gravitational forces are enough to provide the conditions for producing energy. Not so on the Good Spaceship Earth. And hence the engineering problem.

Problems

Since investigations into the possibility of fusion energy began some 45 years ago, over one hundred possible reactions utilizing different atoms have theoretically been enunciated. All involve light atoms. The four that hold the most promise are the reactions between deuterium (D, also known as heavy water, eg., hydrogen with an extra neutron), tritium (T, hydrogen with two extra neutrons), helium (an isotope, He less a neutron) and ⁴He (common helium).

And hence the engineering nightmare. The sun, due to its high gravitational field, only needs to raise the temperature to 15 million degrees Celsius to produce a sustainable reaction. On earth, due to its relative lack of gravitational pull, and engineers' inability to replicate such a gravitational pull, to start a chain reaction using deuterium and deuterium, a temperature of 500 million degrees Celsius would be required. Of the four most promising reactions, the deuterium and tritium reaction is the most likely obtainable; one only needs to raise the temperature to about 100 million degrees Celsius. Unfortunately, tritium, of all the four elements listed in the equations, is the only one that is radioactive. Most commonly produced as a by-product of fission reactions, such as from the coolant used in Canadian Candu reactors, it has a half-life of 12.4 years. Fortunately, not much of it is required to generate a lot of heat.

But why bother? Quite simply, because of the abundance of the raw materials (deuterium) and the phenomenal amount of heat produced from a small quantity of the raw materials. Deuterium is relatively rare. In a natural sample of water, only one molecule in 6,500 is heavy water. Expressed differently, in 60,000 pounds of water, there is only about 1 pound of deuterium. But water is the most common substance on our planet, after carbon, holding in its seas and lakes about ten trillion tons of deuterium. In a fusion reaction between deuterium nuclei, the total amount of energy released is 340 million BTU's per gram, or about 1.5 quadrillion (1.5×10^{15}) BTU's per ton. In contrast, coal releases about 25 million (25×10^6) BTU's per ton when burned effi-

ciently. Thus each ton of deuterium could produce 60 million times more energy than a ton of coal. The potential energy reserve for the world from deuterium is a little hard to comprehend. The total energy consumption of the world for one year at present could be obtained from 200 tons of deuterium. Even if the world consumed twice the annual amount of energy it now does, the deuterium supply would last about 50 billion years. But to get it started, one needs to raise its temperature to 500 million degrees Celsius (thirty times hotter than the core of our sun). Hence, the research into the deuterium/tritium reaction. Lithium, from which tritium can be made, is less abundant than deuterium (though there has been little exploration for lithium). However, from the known supply one can fuel the world at twice its current energy requirements for almost 50,000 years. And to get it started, one only needs a temperature six times hotter than the centre of our sun.

Raising The Heat

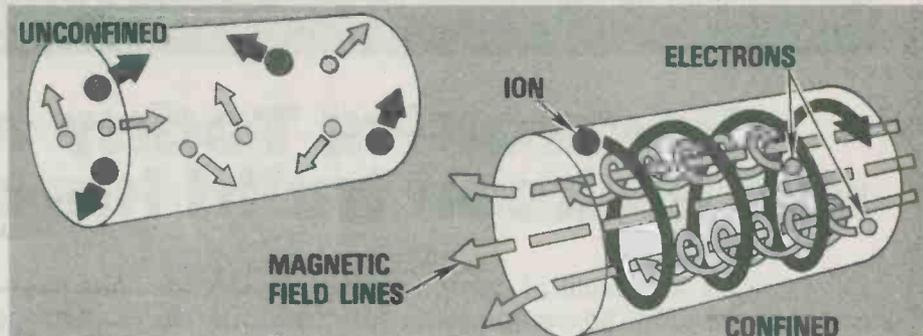
It is this reality, coupled with the relatively benign radioactivity involved, that has

can break loose — meltdowns, releases of radioactive products into the atmosphere, and so on.

The major technical problem currently being addressed is the creation of the tremendous heat required to get the reaction started on a continuing basis. At these enormous temperatures, the fuels (deuterium and tritium) are no longer considered gases. The electrons that normally surround the nuclei are torn away and have a separate existence. This kind of gas, where the electrons and nuclei go their separate ways, is known as plasma. Frequently termed the 'fourth state of matter', after solids, liquids and gases, plasmas are the most abundant materials in the universe. The household varieties include fluorescent light bulbs and neon tubes where plasmas are used at relatively low temperatures to provide illumination. In nature they are found as the aurora borealis (Northern Lights) and their southern counterpart, the aurora australis.

Confining Plasmas

The first engineering problem to be faced is how to confine the plasmas in a vacuum



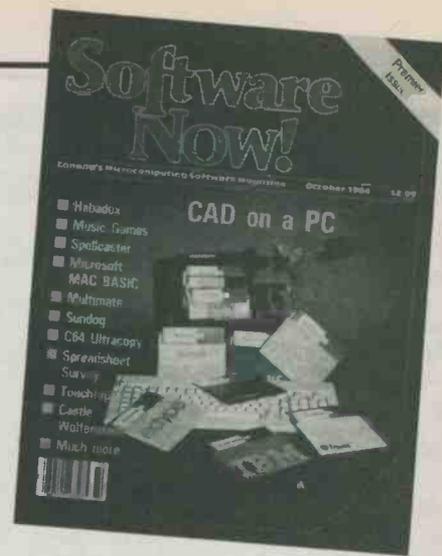
resulted in an increasing amount of research into the construction of a fusion reactor over the past fifteen years. While there are a number of countries involved (Japan, Canada (in tritium handling), a European conglomerate and the Soviet Union) most of the work is being done in the United States at an annual cost of about 1.5 billion dollars. While there are a number of centres of study (including private enterprise via General Atomic in San Diego), the three prime centres are at the Massachusetts Institute of Technology, Princeton University and the Lawrence Livermore National Laboratory in California.

Fusion reactors are several orders of magnitude more complicated to build than fission reactors, require closer tolerances in the workmanship, would probably be a bit larger than fission reactors of comparable power output, and would be more prone to breakdowns. Fortunately, if anything goes wrong, the reaction just stops, unlike a fission reaction (to wit: Three Mile Island) when all hell

(if it weren't a vacuum, adulterants would slow or stop the reaction). There are essentially two ways that this can be done. The first is via inertial confinement. Here the fuel is contained in a tiny glass pellet with a hollow core, less than a millimetre in diameter. The pellet is positioned inside a fusion device and heated by a very powerful laser or charged particle beam to millions of degrees in a fraction of a second (see *Particle Weapons*, ETI, March/84). The rapid heating causes the pellet to implode (the opposite of explode) causing a fusion reaction. To produce significant energy by this method, the pellets must be imploded one at a time in rapid succession, about 40 times a minute. Unfortunately, while seemingly simple, the pellet must initially be at a temperature of near absolute zero (0°K or -273°C). The engineering problem is how to lower the temperature for each pellet, while alternating with the massively high temperatures (six times more than is found in the centre of the sun) some 40 times a minute. Research is being done on

Software Now!

First Issue October 1984



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The difference between we humans and the other inhabitants of the planet is our capacity for making tools. Civilization is often measured by its grasp of technology . . . it's through his use of tools that man has come to be able to manipulate his environment.

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We've reached a level of development in micro computer software wherein one needn't be a computer genius to apply a computer. In fact, one can operate a computer with only a bit more expertise than one needs to successfully make toast. The key that will unlock the power of your computer is the software you plug into it.

The key to that software is understanding.

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Features In The Queue

Here is some of the editorial lined up for the next few issues of Software Now! You can expect it to change a bit . . . new software springs up almost daily and Software Now! always features the most important developments in this dynamic field.

Computer Aided Drafting On a Micro • Techniques in MacPaint • How to choose a Spreadsheet • Apple Software Crate • Getting to the Root of UNIX • The Digital Research Pantry • A Thousand and One Word Processors • IBM's Productivity Family • Can Mac Write? • Professional Software Roundup • Power Programs for the 64 • Approaching the C • Word Processing Support Programs • dBase II Enhancements • Will it Run Multiuser? • Concurrent CP/M •

Reviews (typically 10 each issue): 10 Base • Mighty Mail • WORDEASE • Easy Script • Computer Chef • Electronic Circuit Analysis Program • Supertex Retailer • MAI Basic Four • The Print Shop • TK! Solver • Microsoft BASIC for the Macintosh • Sundog • Turbo PASCAL for the IBM • AutoCAD • MultiMate • Lexicheck and Word Juggler • Dataflex • Symphony • Omniterm 2 • DB Master • Paint Magic.

In addition to this look for these regular features:

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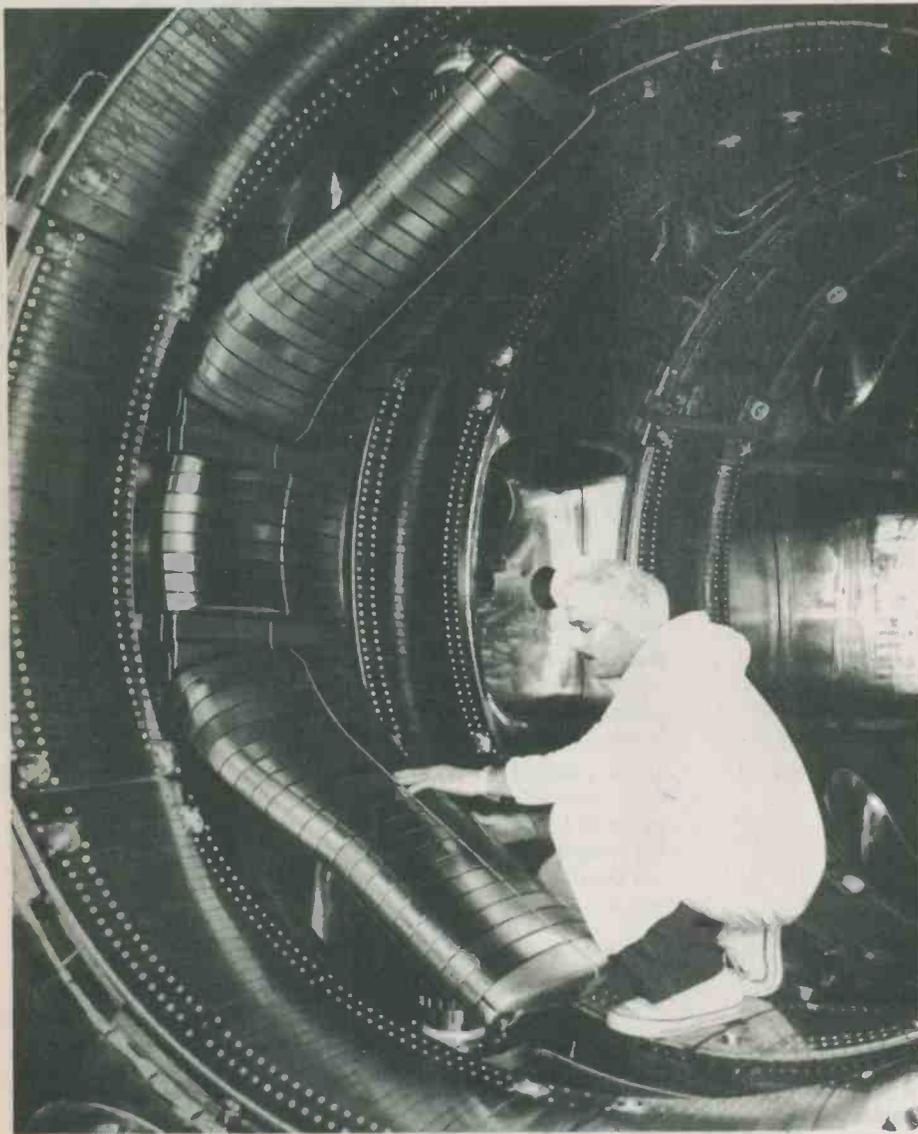
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ETI-3-10-84

Fusion Research



A technician examining the surface of the moveable limiter installed in the interior of the TFTR vacuum vessel. Photo courtesy of Princeton University Plasma Physics Laboratory.

this problem at the Lawrence Livermore National Laboratory in their NOVA Reactor.

The second and more possible method involves magnetic confinement. Plasmas are charged particles. They move at random in a container. But when a magnetic field is applied, particles gyrate in a helical manner along the direction of the field as though confined to a spiral about an imaginary line. Because particles follow the field, they can be insulated from the material walls in a 'bottle' formed by a properly shaped magnetic field.

The most successful method of closed-configuration confinement to date, is the Tokamak (a Russian acronym for "toroidal chamber with magnetic coils"), a circular doughnut shaped device with two sets of gigantic magnets arranged around it. Magnetic fields are produced by electric currents through the wires of the magnets. Of the two sets, the first pro-

duces a toroidal field, that is, it is circular around the doughnut shape. In the Tokamak Fusion Test Reactor (TFTR) at Princeton University, each of the 20 toroidal field magnets contains some 1,500 feet of water-cooled copper conductor wound around a 44-turn coil. Each of the coils weighs 25 tons, operates in a pulsed mode with a peak design current of 73,000 amps, producing a field of 52 kG (kilo gravities) sustainable for about 3 seconds and repeatable every five minutes.

The second set of magnets produces a poloidal field (PF), that is a spiral around the doughnut shape. In the TFTR configuration, each of the four PF magnets contains 860 turns of water-cooled copper conductor weighing in at 80 tons each.

Having constructed the system for stabilizing the plasma once it is in the Tokamak, the next engineering problem is how to get the plasma into it. That is, the

injection of tritium and deuterium. Fortunately, this part of the structure is relatively easy to build; it is essentially a big pump.

Next is the process by which the plasma has its temperature raised to the level of 100 million degrees Celsius. It is currently the major stumbling block in the design and construction of a working fusion reactor, and some 60% of the \$1.5 billion per year that the U.S. is spending on fusion is directly or indirectly concerned with solving it.

There are four processes which when used in conjunction will, it is believed, provide the necessary temperature. To date, only three have been used concurrently, with the fourth expected to be operational by the end of the decade.

Heating The Plasma

The first is called Ohmic heating (OH). It is a by-product of the poloidal field. Essentially, since plasma is an electrical conductor, it can be heated by an electric current passing through it. It is the same idea that occurs in an electric light bulb or an electric heater. The heat generated depends on the resistance of the plasma and the current applied. However, as the temperature of the heated plasma rises, its resistance decreases and the Ohmic heating becomes less effective. It appears that the maximum plasma temperature attainable by Ohmic heating in a Tokamak is 20-30 million degrees Celsius.

The second method of inducing heat into the plasma is via a neutral beam injection system. This involves the introduction of high-energy (neutral) atoms into the ohmically heated, magnetically confined plasma. The atoms are immediately ionized and are trapped by the magnetic field. The high-energy ions then transfer part of their energy to the plasma particles in repeated collisions, thus increasing the plasma temperature. The current idea is to use four beams, three travelling in the direction of the plasma, and one travelling in counter current.

The third method is via magnetic compression. A gas can be heated by sudden compression. In the same way, the temperature of a plasma is increased if it is compressed rapidly by increasing the confining magnetic field. In a Tokamak, this compression is achieved simply by moving the plasma radially inward into a region of higher magnetic field. Since plasma compression brings the ions closer together, the process also makes it easier to attain the required density for a fusion reactor. The design of the TFTR vacuum vessel and the PF system provide for this sort of magnetic compression. In the PF system, a 12 MJ capacitor bank is discharged into the coils. The increased magnetic field moves the plasma radially inward from an initial location of 310 cm from the

machine's centre to a final position of 209 cm. If this movement is sufficiently rapid, the plasma density will increase by 120%, the plasma temperature will increase by 70%, and the plasma current will increase by 50%.

These three systems have, since last November, produced a temperature of 75 million degrees Celsius, three-quarters of the way to the 100 million degrees Celsius needed.

The fourth method of heating has not yet been utilized, but will be in the next few years. An as yet untested method, it involves utilizing radio waves. In this method, plasma is to be heated by radio-frequency waves generated by oscillators of the same type used in radio stations, microwave ovens and radars (see *The Potent Helix*, ETI, February/84). Waves

The fusion reactor may join the ranks of the zeppelin and supersonic transport because of massive funding requirements

with a specific frequency transfer, part of their energy to the ions or electrons in the plasma. These particles collide with other particles, thereby increasing the plasma temperature. There are three types: ion cyclotron resonance heating (ICRH), electron cyclotron resonance heating (ECRH), and lower hybrid heating (LHH).

In ICRH, a wave of between 10 MHz and 200 MHz is generated and pulses into the Tokamak's plasma. The oscillating magnetic field causes a magnetosonic wave to be formed in the plasma. When the frequency, or a multiple of that frequency, matches the ion cyclotron frequency, the wave will be dampened by the plasma particles. The wave then transfers its energy to the ions, causing them to spiral faster in a helical path of greater radius. Through collisions with other plasma particles, these more energetic ions will transfer their energy to the other particles, thus heating the plasma.

In ECRH, the frequency of the transmitted waves (between 60 and 200 GHz) is matched to the frequency at which the electrons circle the magnetic field lines (the electron cyclotron frequency). By absorption of the waves, energy is transferred to the electrons and, in turn, to the rest of the plasma by collisions.

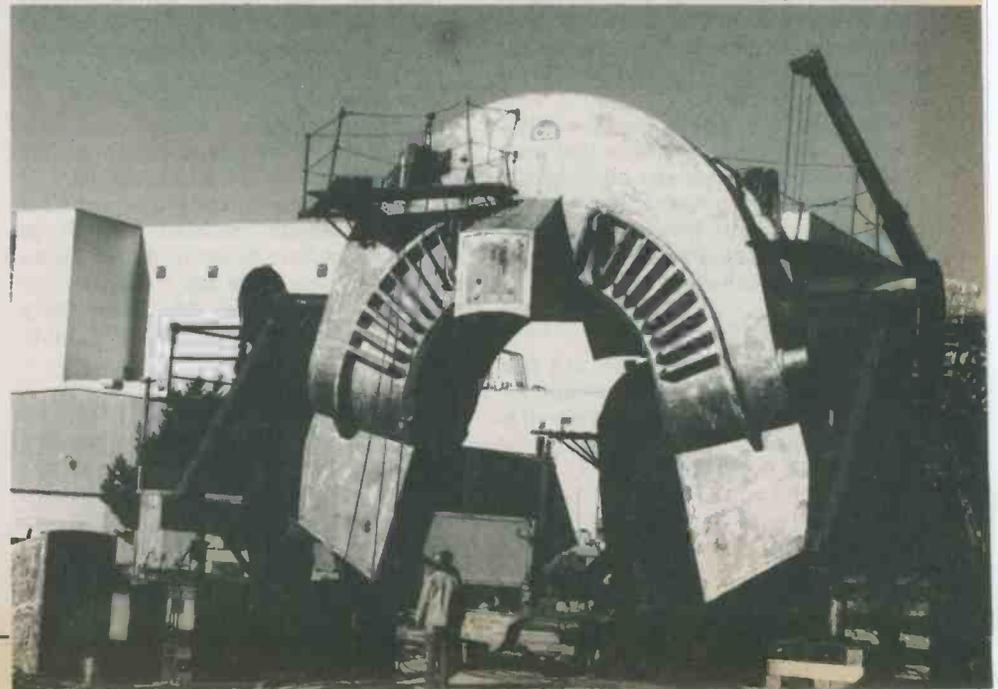
LHH runs at about 0.5 to 5 GHz. Instead of matching the frequency at which

plasma particles spiral around the field lines, as in ICRH or ECRH, the lower hybrid heating works by matching the speed of the wave to the speed at which ions or electrons move. After it is introduced into the outside of the plasma, the lower hybrid wave follows the magnetic field as it travels around the torus (the hole in the doughnut). At the same time, it slowly moves radially inward toward the centre of the plasma, due to the refractive properties of the plasma. The velocity of the lower hybrid wave can then be said to have two components: one component perpendicular to the magnetic field lines, and a second much faster component parallel to the field lines. Plasma electrons travel around the torus about 20 times faster than the ions. When the faster, parallel velocity component matches the thermal speed of the electrons moving parallel to the magnetic field, energy is transferred from the electric field of the wave to the electrons, thereby heating them. Further, toward the plasma's centre, the wave is sufficiently slowed by the higher plasma density that the perpendicular wave component is slow enough to match the ion velocity. Energy is then transferred from the wave's electric field to the ions. With these two transfers of energy, the plasma's temperature is raised in combination with the other three methods, to above 100 million degrees Celsius.

Alternate Designs

There are two other alternate designs for a fusion reactor chamber currently under development and investigation. The first is called a 'Spheromak'. Essentially, it is a large hollow sphere, with the plasma maintained as a sphere within the sphere

The massive Yin-Yang magnets used in the Spheromak project are shown being lowered into their final resting places. Photo courtesy of the Lawrence Livermore National Laboratory.



via magnets. One is under construction at Princeton University Plasma Physics Laboratory. A second more powerful one, the NOVA, is under construction at Lawrence Livermore National Laboratory and is expected to go on-stream later this year.

The second alternate is the Tandem Mirror Fusion Test Facility (MFTF-B) under construction at the Lawrence Livermore National Laboratory. In this design, the phenomenon or mirror plasma confinement (the automatic appearance of a high, positive, ambipolar electric potential) is utilized. Constructionally, the device looks like a long sausage with enormous, cryogenically cooled superconducting magnets of a yin/yang shape (S-shaped) located at either end. High temperature mirror-confinement plasmas are built up and maintained in the end cells by the same neutral-beam injection technique mentioned above. These confined plasmas serve as electrostatic 'plugs' that then confine the central plasma.

The Reaction

Having achieved a plasma of sufficient density and heat, the fusion reaction takes place. Four-fifths of the energy from the D-T reaction is released in the form of fast moving neutrons. These neutrons are 15 to 30 times more energetic than those released in fission reactions. (See *Electronics in Fine Art*, ETI, July/83). The first wall surrounding the plasma and vacuum region takes the brunt of both the neutron bombardment and the electromagnetic radiation from the hot plasma. In colliding with this wall, the neutrons give up some of their energy as heat. This heat must be removed by rapidly circulating coolant to prevent the wall from melting. After being piped out of the

Fusion Research

reactor, the heated coolant is used to produce steam and generate electricity.

A few of the neutrons colliding with the atoms of the first wall have the beneficial effect of dislodging some neutrons from the atomic nuclei. These dislodged neutrons, plus the original ones generated by the fusion reaction, pass through the wall and into a blanket composed of lithium, either in a liquid or solid state. Here the bulk of their energy is to be used to produce heat, which also is used to create steam for generating electricity, and eventually the neutrons are absorbed by the lithium to 'breed' more tritium.

As such, structurally a fusion reactor is an engineering nightmare. The plasma has to be hotter than six times the interior of the sun, yet mere feet away, the magnets keeping the plasma in place have to be superconductors, i.e., cooled to within a few degrees of absolute zero. Lithium in the blanket is extremely combustible when it comes into contact with air or water — even the water contained in solid concrete. The tolerances are so tight that even a minor change will stop the reaction dead in its tracks.

Environmentally however, a fusion reactor is all but a dream come true, with one exception. The major possibility for the release of radioactivity during routine plant operations would be from a leakage

of tritium. Complete control of tritium is well within current technological capabilities, and the quantities involved are minute. Canada's contribution to the international effort (via the National Research Council and Ontario Hydro's Fusion Technology Project) is in this area. Further, a runaway reaction is not possible because of the nature of the plasma and because of the low fuel inventory that would be present in the vacuum vessel during operation. The components and waste products from a fusion reactor are not suitable for diversion to the production of nuclear weapons, sort of. The 'sort of' comes from the lithium blanket being bombarded by the neutrons. Take any piece of uranium straight out of the ground and imbed it into this blanket, leave it for a month to be irradiated by the neutrons, and you have a chunk of weapons-grade material.

More Ifs

Commercially, fusion reactors are 'iffy' at best. While the fuel supply is secure, abundant and cheap, there are two problems. The first is the construction cost. Being far more expensive than fission reactors (already running at 6 to 8 billion dollars each), utility managers are wary of investing so much in a new technology, even if it could be demonstrated to be

practical. Secondly, due to the close tolerances, breakdown will be more frequent than in fission reactors, and when it's not working, no electricity is generated, hence no company income. Commercially, it appears that managers are more prepared to spend smaller sums (hundreds of millions rather than billions) for tried-and-true technologies such as coal burners with first-rate scrubbers, than risk billions in cost overruns for a fusion reactor. As Lawrence M. Lidsky, professor of nuclear engineering at MIT, a foremost authority and researcher in the field for the past 20 years, Associate Director of the *Journal of Fusion Energy* has written about fusion project's future:

"Our knowledge of the related physics has grown enormously in the effort. Now the solution of the scientific problem appears to be almost within our grasp, and many assume that with it will come that technological Holy Grail: virtually unlimited, environmentally safe energy. But that outcome is unlikely. Instead, the costly fusion reactor is in danger of joining the ranks of other technical 'triumphs' such as the zeppelin, the supersonic transport and the fission breeder reactor that turned out to be unwanted and unused."

ET

Getting the Best of your Scope

continued from page 11

You connect your scope to the output, expecting to see a reasonably good square wave, but you're presented with a sort of skewed sine wave. Huh?

The answer lies in the rise and fall times of both the probe and the scope itself. For a complete explanation, see "Accurate Rise-Time Measurements" in the January, 1984 *Electronics Today*. In short, the problem is caused by the fact that various parts of the scope's circuitry look like a series of R-C filters. Each bit of capacitance takes time to charge; the result is a serious degradation of the squarewave steepness.

This may not be a problem if you have a 50 MHz scope, but you'll find that most general-purpose scopes are a bit lacking in the rise-time department; the claimed bandwidth is usually specified by the frequency at which the amplitude declines by some amount, probably 3 dB.

Measuring Frequency

There are three ways to do this. The first is simply to read the time of one complete cycle from the horizontal scale; the frequency is the reciprocal of the time: $F = 1/T$. A calculator simplifies this.

If you don't trust your horizontal amp's accuracy, but you have a dual trace scope and a trusted generator, you can put the signal on one trace and the oscillator on the other. Set the trigger amp to work

on the signal, and adjust the generator until the traces look identical. The frequency can be read from the generator.

If you don't trust either your scope or your generator, and you're working with fairly low frequencies, you can use the accuracy of the 60 Hz power line to find a frequency (or check the accuracy of your generator - the power line is much better than 1%, short-term). Connect the unknown signal to the vertical amp as usual, and connect the output of a small filament transformer to the horizontal input; the voltage isn't critical, especially if your scope has an attenuator function on the horizontal input - about 3 to 6 volts AC is good. If the two signals are exactly in phase, you'll see a straight line. If they're 90 degrees out of phase, you'll see a circle, the noted Lissajous figure. If the unknown is three times the 60 Hz signal, you'll see three circles and so on. This obviously has its limits; the signal really should be a multiple of 60 to simplify counting.

Common Mode

Most signals are measured by connecting the scope between the source and ground, but there are times when you'd like to observe a component in a location that just won't play fair. Picture, if you can, a power amp transistor with its emitter connected to the negative power rail. If you'd

like to look at the signal on the base, for instance, and you connect between base and ground, all you'll see is the ripple from the power supply.

Some scopes have common-mode (balanced) inputs; since the supply ripple is common to both input leads, it gets subtracted and you're left with the desired signal. However, you can fake this function by making sure that the scope is isolated and floating (no ground pin, no other metallic connection anywhere). Connect the ground lead to the negative power rail, and the probe tip to the transistor base. You should be able to see the base signal reasonably well, depending on how well balanced your setup is. Don't forget that your scope frame is now energized to the potential of the negative rail.

And...

In researching this article, we came up with more scope goodies than you can shake a stick at. What we'll do is continue on in a future issue with lots more, including useful peripheral equipment for your scope, storage scopes, photographing the scope trace, and more operating hints. In the meantime, do you have an interesting scope story to tell? Send your hints to The Editor, *Electronics Today*, Unit 6, 25 Overlea Blvd., Toronto M4H 1B1, and we'll try to include your ideas in the upcoming article.

ET

Moorshead Publications Software Services

Stockboy Inventory Control Package

When we first advertised this program, we would have been pleased with a fraction of the orders we received. On reflection we should have appreciated what a bargain it is. Inventory programs are generally pretty expensive and some of them are inflexible and some even badly engineered. You may find that even small inventories generate enormous files.

Stockboy is a good, powerful, flexible bargain-priced package which will handle inventory for small businesses. We use Stockboy within Moorshead Publications for our own inventory control and it has stood the test of time.

Stockboy can:

- Maintain an inventory database with current, maximum and minimum stock reporting when an item needs re-ordering.
- Be a point of sale terminal, adjusting the stock data base on line.
- Produce individual packing lists.
- Generate a customer list to be used in mass mailings.
- Run on any CP/M or MS-DOS based computer, even an Apple II running with a softcard.

Stockboy is written in Microsoft BASIC, and is designed to be easily altered to suit your needs. It can be compiled using BASCOM if you desire. It is designed for use by non-technical operators.

Available for: CP/M and PC formats

\$29.95 most systems **\$34.95** for 8"

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MDM730

MDM730 is one of the most powerful MODEM7 programs available... and the Computing Now! version of MDM730 incorporates features not available in the public domain editions. If you are into telecommunications, bulletin boards and downloading software your life will be full and meaningful with this code. For background on MDM730, see July 1984 Computing Now!. Consider the facilities.

- Terminal program which works at any baud rate.
- Ten programmable macro function keys.
- Thirty six number phone library.
- Christensen software transfer protocol.
- User settable toggles for line feeds, ON-XOFF and so on.
- Extensive help menus.
- Baud rate selection on the fly (or the spider).
- ASCII dump and capture.
- Status menu
- Many more features.

In addition to all this splendor, however, we've added dialing support for the Apple version. While the standard MDM730 cannot dial unless it's hooked to a Hayes Smartmodem, we've added patches to it to allow it to do pin twenty five pulse dialling and to dial through the Hayes Micromodem II and the SSM card. The Computing Now! MDM730 will also

- Select a number from the library and dial it
- Accept a hand entered number and dial it
- Wait for carrier
- Log you onto the remote system if it's free
- Optionally autodial if the remote board is busy.
- Count the number of attempts at dialling the remote BBS.

The Computing Now! MDM730 package is available for

- The Hayes Micromodem II.
- The SSM 300 Baud modem card.
- The PDA 232C serial card with external modem.

The PDA 232C package includes versions supporting both the Smartmodem and a dumb modem with pin twenty five line control, such as the Novation AutoCat. Also included with each package are utilities to permit easy alteration of the phone number library and the function key macro strings plus an extensive documentation file.

The source code file for this program is over a hundred and fifty kilobytes long. It cannot be hacked on a standard Apple. We patched it on a larger machine and downloaded it. As such, we're pretty sure that MDM730 with these features is unavailable elsewhere.

Available for: Apple II + CP/M 2.2. systems

TRS-80 Model II (complete with the above applicable features)

Please specify modem version from above list. **\$29.95**

Ontario residents add 7% PST.

Fine Print:

The original MDM730 code is in the public domain. We are offering this part of the program without cost. The charges for this package are for the patches created by Computing Now! and to defer the cost of handling and postage.

This software is guaranteed to work correctly if properly applied. The serial cards on Apple and compatible systems must be installed in slot two with at least 48K of RAM running Microsoft CP/M 2.2. The PDA 232C version will require the availability of either a Hayes Smartmodem or a modem with pin twenty five line control to dial. Users of the SSM card version may experience some difficulty in detecting extremely faint carriers on older versions of this card.

Formats

Where CP/M is shown, the following formats are available:

Apple II + CP/M (see below)
 Access Matrix, Morrow Micro Decision, Superbrain, Xerox/Cromenco*, Epson QX-10VD, Sanyo MBC1000, Nelma Persona, Kaypro II, Osborne Single Density*, Osborne Double Density, Systel/Olympia, 3R Avatar, Attache, Televideo, Lobo Max-80*, DEC VT-180, Casio FP-1000, Micromate, Zorba, 8 inch SSSD*

*Software marked with an asterisk is the higher price quoted.

MDM730 for the Apple II + CP/M requires two disks and is at the higher price.

PC

Available for the IBM PC and genuine compatibles.

AppleDOS

For Apple II + and genuine compatible systems.

TRS-80 Model II CP/M

Will operate under either Lifeboat or Pickles and Trout CP/M.

Apple Wordstar Fixer

Apples and Wordstar are not entirely friendly. Apple compatible systems equipped with Vindex type eighty-column cards do a number of unpleasant things to this popular word processor. While there are simple cures for this... they all involve some delicate code hacking.

The Fixer solves this problem. Place it on the same disk as your copy of WS.COM, type FIXER and after a suitable amount of disk noise, you will have APWS.COM on there too. This version of Wordstar includes special patching and unhooking code which runs each time you boot Wordstar, and makes your fruit behave as it should. It releases the control K's, translates the left arrow key to a delete character, and patches Unltron keyboards.

In addition, the fixer allows you to set some of the defaults of Wordstar which the MicroPro INSTALL package doesn't really get to. All of these features are menu driven in English for absolute non-technical operation.

Will run in either 44K or 56K CP/M.

Available for:

Apple II + CP/M only.

\$19.95

Ontario Residents add 7% P.S.T.

DOSDIAL

The Apple Terminal Package

There are plenty of terminal programs for the Apple II and its emulators. Some dial, some download. However, only DOSDIAL is this splendidly cheap.

DOSDIAL is a hybrid Applesoft and machine code package for fast operation and easy modification. It features a phone number library and automatic dialling. It operates on any fruit with a PDA 232C serial card and an autodial modem. A complete source file of the assembler code is included to allow it to be quickly patched for other serial cards.

Will work on any Apple + or compatible system with a PDA 232C serial card and an autodial modem.

Available for:

Apple II +

\$16.95

Ontario residents add 7% PST

A Teacher for the Apple

Specifically developed for the educational market, this 5-1/4" disk introduces both teachers and students to the Apple +, IIe and compatible systems.

It is designed to show you how to make the computer work for you.

After introducing you to the computer, it goes on to explain the BASIC programming language and step-by-step instructions show you the ins-and-outs of programming this system and using its many features including disk operating systems and high resolution graphics.

This program is designed for the total novice and it is designed to work accordingly. All you do is turn the computer on, slide in the disk and it takes over!

Requires Applesoft BASIC, 48K RAM and one disk drive.

Available for:

AppleDOS only

\$35.00

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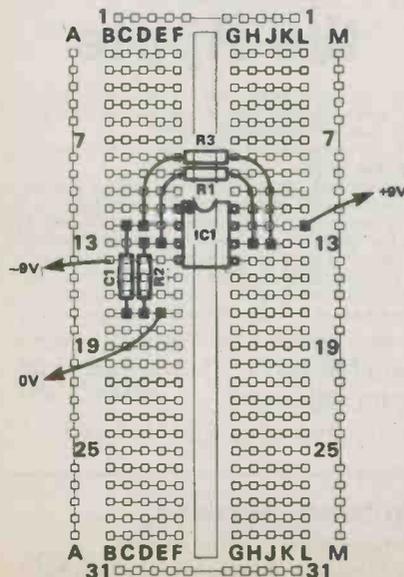
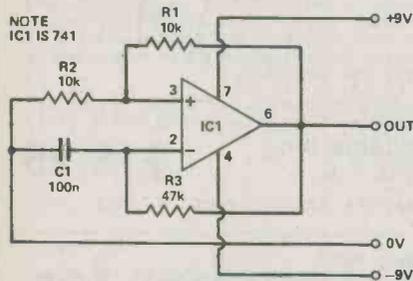
10 Short Projects

Square Wave Oscillator

by G. Boyce

IF you thought that the only way of producing a square wave was to use a 555 timer IC, then here's a circuit to change your mind. It's a square wave generator requiring only five components, including the IC — a 741 op-amp. The circuit consists of a Schmitt Trigger with positive feedback provided by the 10k resistors. The timing components, C1 and R3, control the frequency of oscillation and this can be varied over quite a large range (50 Hz to about 7 kHz) before the shape of the wave is no longer square.

If you monitor the voltage at pin 2, it can be seen to follow an exponential charge/discharge pattern, determined by the RC constant of R3 and C1. The mark-to-space ratio can be altered by placing a 10k resistor and a series signal diode in parallel with R3. This makes C1 discharge 11 times faster than it charges up. Current consumption is about 1.5 mA per rail.



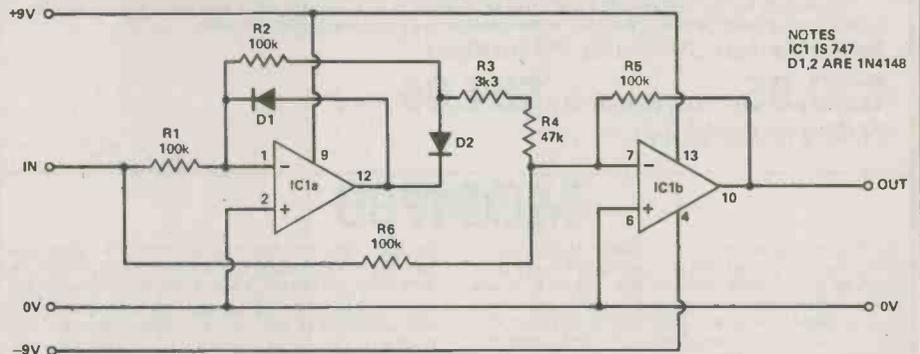
Circuit of the square wave oscillator.

Full Wave Rectifier/Frequency Doubler

by M. Fulton

THE easiest way of converting AC into something resembling DC is to use a bridge rectifier followed by a large smoothing capacitor. Without the capacitor, the resulting waveform consists of positive half waves, at twice the original AC frequency. This is fine for typical power supply voltage; but at lower levels a problem arises. The voltage drop

the input is positive, D1 maintains the virtual ground (D2 is reverse biased) by conducting and leaving the output 'looking at' 100k to the 0 V rail. When the input goes negative, D2 is turned on and D1 turned off. The output is then the exact inverse of the input — positive going half sinewaves. We now have half wave rectification from a low-level AC input. By adding the original waveform to the output in the right amount, the result is full wave rectification (with some distortion).

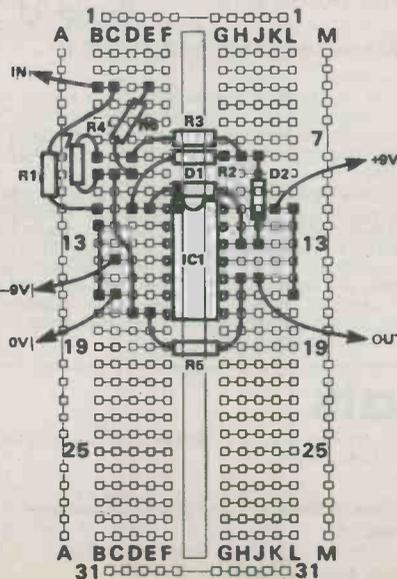


Circuit of the full wave rectifier/doubler.

across the diodes (about 600 mV for silicon) becomes significant and the usual bridge circuit is unsuitable. A simple way to overcome this problem is to use an op-amp, like IC1a, in the circuit shown. This consists of an inverting amplifier with negative feedback (pin 12 to pin 1), so there is a 'virtual ground' at pin 1. When

This mixing is carried out by the summing amplifier IC1b.

If R3 and R4 are replaced by a 100k pot, the output is fully adjustable from half wave rectified, through full wave to a sloping edge square wave — dependent on the input level. Current consumption is around 2 mA per rail.



Rectifier/doubler layout.

Signal Tracer

by H. Jackson

THE circuit is divided into two stages. The first stage uses Q1 as a source follower, providing no voltage gain but a high input impedance (about 1 Megohm) to prevent loading of the circuit being tested. The second stage supplies all the voltage gain (more than 40 dB) by using Q2 in a common emitter configuration. Q2 is biased near to cut-off by R5 and R6, so that it provides a crude form of rectification, as well as gain. Capacitor C3 acts as an RF filter and, in conjunction with the distortion from Q2, produces AM demodulation.

The input signal to Q2 normally comes directly from Q1 via C2, but when a high level input is present, SW1 can be set to the 'low' position; this avoids overloading by sending the signal through

10 Short Projects

an attenuator network R3, R4.

Figure 2 shows the component layout on a piece of Veroboard (24 x 10). The device is housed in a small plastic case, so that it can be hand-held, and is connected to the circuit under test via a long M3 bolt (file the tip to a point) with a crocodile clip (on the end of a wire) used for the ground.

The best technique for tracing a signal through a radio is to start at a point, in the signal path, near the first gain stage and work along the signal path towards the output. When you reach a point where the signal 'vanishes' you have roughly located the fault. For example, if there is a signal present at the base of a transistor, but not at its collector (or emitter, if it's an emitter follower), then the fault is probably in the transistor or the components around it.

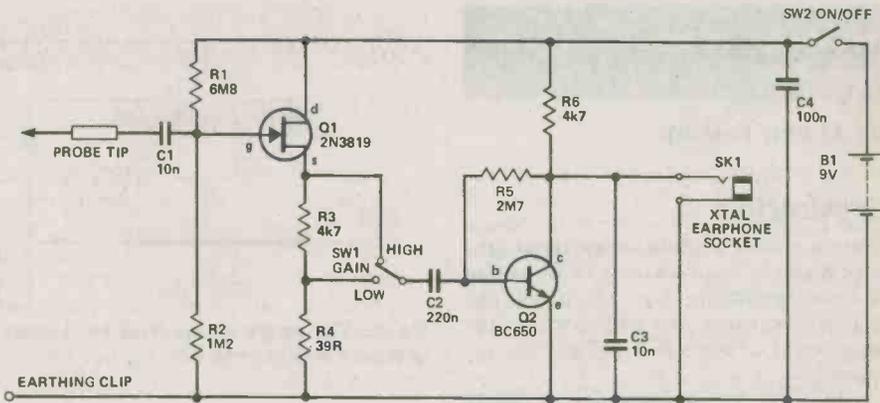


Fig. 1. Circuit diagram of the Signal Tracer

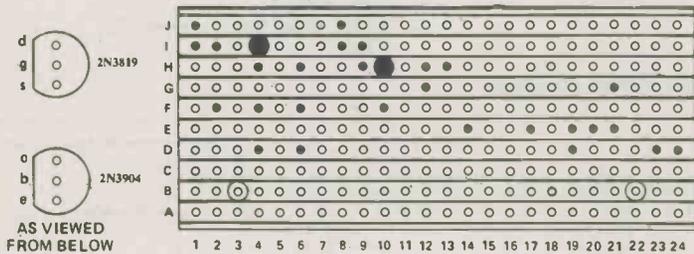
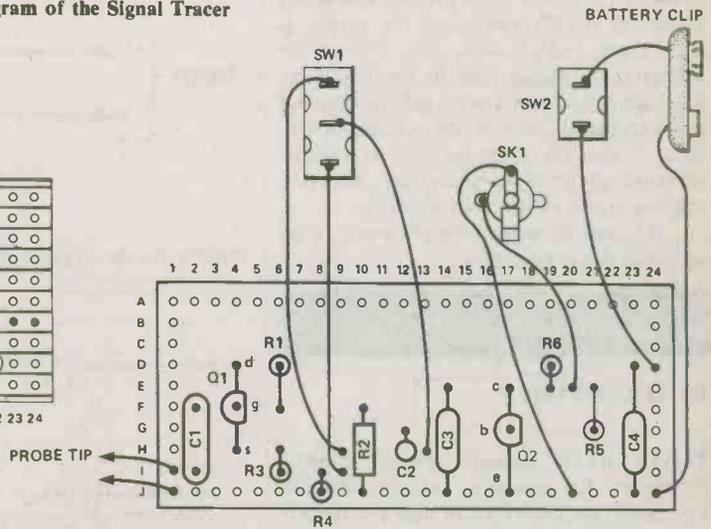


Fig. 2. Veroboard layout



Voltage follow-and-hold circuit

by Owen Bishop

THIS circuit gives your eye and the needle a breathing-space in which to catch up with a changing voltage. Pressing the button, it takes a sample of the input voltage at any instant; the circuit then holds the sampled voltage while the needle of the meter comes to rest, and your eye has time to take the scale reading with all the accuracy you need.

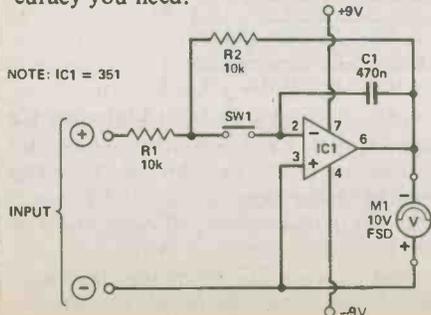


Fig. 1. the Follow-and-Hold circuit.

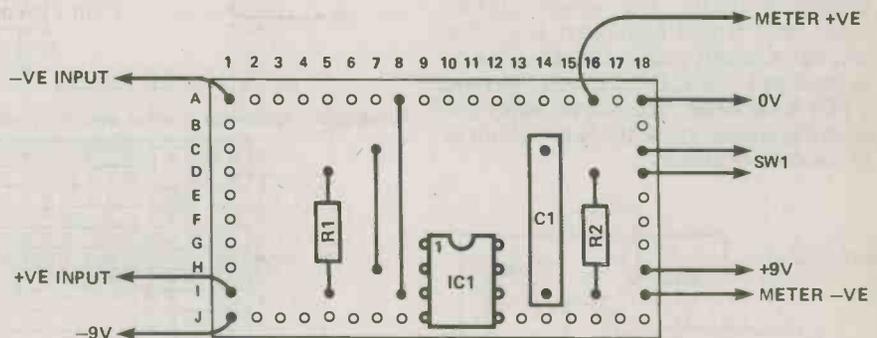
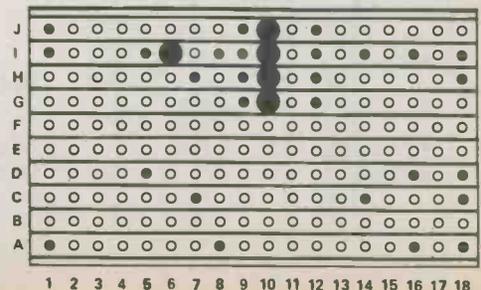


Fig. 2. The Veroboard component overlay (top) and the track-side view (bottom), showing the positions where the strips are cut.



10 Short Projects

Negative Voltage Generator

by Owen Bishop

Construction

There is almost nothing to say about this, since it can be built up on a PCB the size of a postage stamp. Also, the circuit can be incorporated in any odd space on the main board of any other project that requires it.

It works for a wide range of supply voltages (+1V5 to +10V). Pin 6 must be joined to the 0V rail when the supply is less than +3V5 and for these low voltages, the diode may be omitted. The PCB design allows a wire link to connect pin 6 to the 0V rail for low voltage operation. If the unit is to be used at various voltages, some high, some low, a switch can be wired in place of the link.

The circuit works straight away — no adjustments are needed.

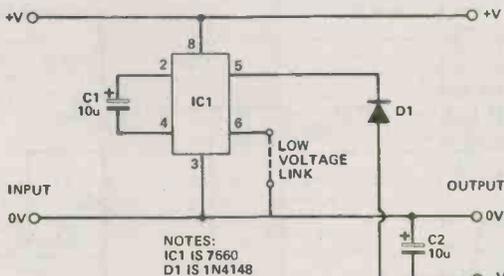
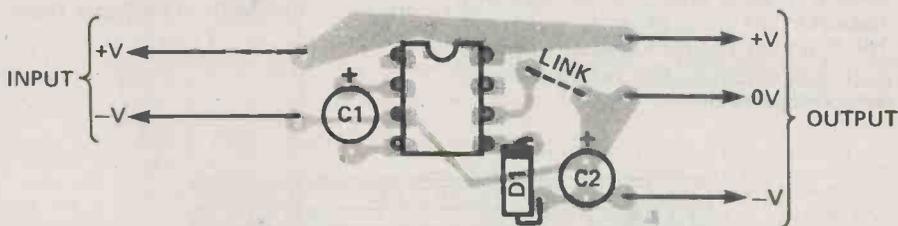
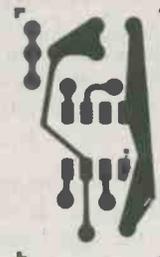


Fig. 1. The circuit of the Negative Voltage Generator uses just one IC.



Overlay for the Negative Voltage Generator.

Microammeter

by Owen Bishop

THIS circuit adapts any ordinary voltmeter to measure currents in the microamp range. You can also use it with a multimeter, switched to a voltage-measuring range. The lowest current range on a typical multimeter is 0 - 250 μ A, but with this circuit, the range can be as small as 0 - 1 μ A. Of course, if you have a FET multimeter, you will probably not need this circuit, as it is likely to be built into your meter already.

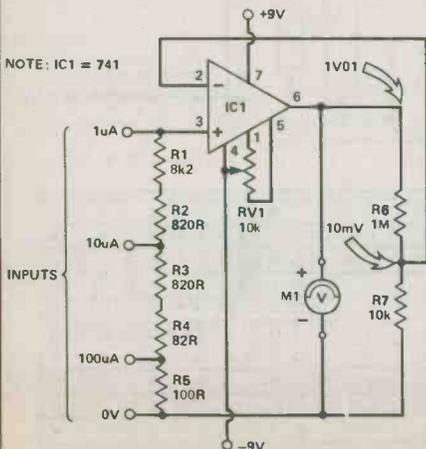
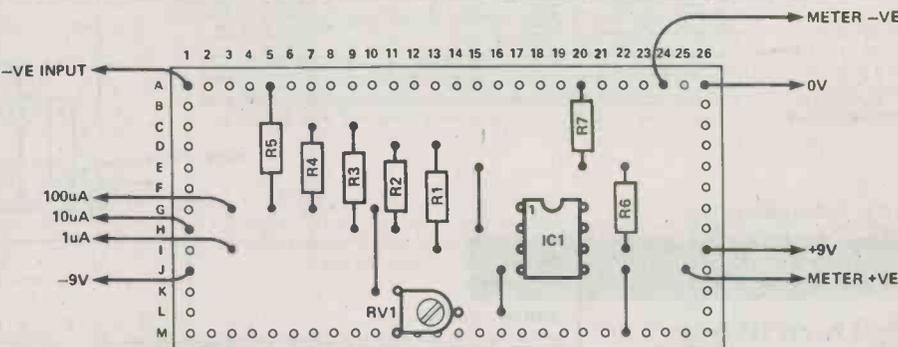
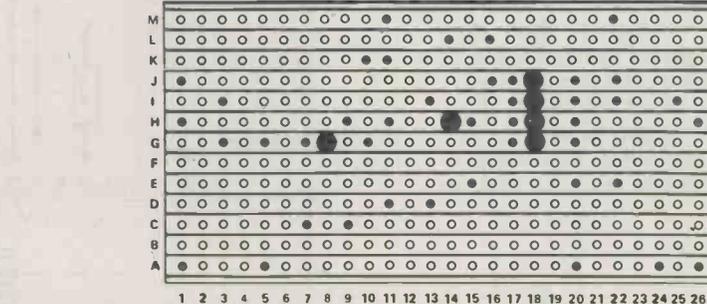


Fig. 1. The Microammeter circuit.



Veroboard component overlay and track-side view.



Setting up

To set up the circuit, connect the voltmeter as shown in Figure 2. This should, preferably be a 1 V FSD panel meter or a multimeter switched to the 1V DC range, but a 2 V or 3 V meter will do almost as well.

Now switch on the power; the meter will show a reading of some kind. Join the

1 μ A input socket to the junction of R6 and R7, using a test-lead; this connects the two inputs of the op-amp together. The reading on the meter should be 0 V, but if not, adjust the offset null potentiometer (RV1) until the needle of the meter comes to rest at zero. The temporary lead may now be removed, and the circuit is ready for use.

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* single density formats require two disks. The package cost for these formats is \$19.95

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Modem7. Allows you to communicate with any CP/M based system and download files. Complete details were in Computing Now! November 1983.

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FORTH. A complete up-to-date version of FIG FORTH, complete with its own internal DOS.

DUU. The ultimate disk utility allowing you to recover accidentally erased disk files, fix garbled files, rebuild and modify your system. A real gem.

D. A sorted directory program that tells you how big your files are and how much space is left on the disk.

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Finance. A fairly sophisticated financial package written in easily understandable, modifiable Microsoft BASIC.

BADLIM. Ever had to throw out a disk with a single bad sector? This isolates bad sectors into an invisible file, making the rest of the disk useable.

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QUEST. A "Dungeons and Dragons" type game.

STOCKS. This is a complete stock management program in BASIC.

SEE. Also known as TYPE17, will TYPE any file, squeezed or not allowing you to keep documents in compressed form while still being able to read them.

Order as AFS #1 and specify system

BISHOW. The ultimate file typer, BISHOW version 3.1 will type squeezed or unsqueezed files and allow you to type files which are in libraries (see LU, below). However, it also pages in both directions, so if you miss something, you can back up and see it again.

LU. Every CP/M file takes up unnecessary overhead. If you want to store lots of data in a small space, you'll want LU, the library utility. It permits any number of individual files to be stored in one big file and cracked apart again.

RACQUEL. Everyone should have one printer picture in their disk collection.

MORTGAGE. This is a very fancy mortgage amortization program which will produce a variety of amortization tables.

NSBASIC. Large disk BASIC packages, such as MBASIC, are great... and very expensive. This one, however, is free... and every bit as powerful as many commercial programs. It's compatible with North Star BASIC, so you'll have no problem finding a manual for it.

Z80ASM. This is a complete assembler package which uses true Zilog Z80 mnemonics. It has a rich vocabulary of pseudo-ops and will allow you to use the full power of your Z80 based machine... much of which can't be handled by ASM or MAC.

VFILE. Easily the ultimate disk utility, VFILE shows you a full screen presentation of what's on your disk and allows you to mass move and delete files using a two-dimensional cursor. It has heaps of features, a built-in help file and works extremely fast.

ROMAN. This is a silly little program which figures out Roman numerals for you. However, silly programs are so much fun...

CATCHUM. If you like the fast pace and incredible realism of Pacman, you'll go quietly insane over Catchum... which plays basically the same game using ASCII characters. Watch little "C's" gobble periods while you try to avoid the deadly "A's"... It's a scream.

Order as AFS #2 and specify system

OIL. This is an interesting simulation of the workings of the oil industry. It can be approached as either a game or a fairly sophisticated model.

CHESS. This program really does play a mean game of chess. It has an on-screen display of the board, a choice of colours and selectable levels of look ahead.

DEBUG. The DDT debugger is good but this offers heaps of facilities that DDT can't and does symbolic debugging... it's almost like being able to step, trace and disassemble through your source listing.

DU87. The older DUU program does have some limitations. This version overcomes them all and adds some valuable capacities. It will adapt itself to any system. You can search, map and dump disk sectors or files. It's invaluable in recovering damaged files, too.

ELIZA. This classic program is a micro computer head shrinker... It runs under MBASIC, and, with very little imagination, you will be able to believe that you are conversing with a real psychiatrist.

LADDER. This is... this program is weird. It's Donkey Kong in ASCII. It's fast, bizarre and good for hours of eye strain.

QUICKKEY. Programmable function keys allow you to hit one key to issue a multi-character command. This tiny utility allows you to define as many functions as you want using infrequently used control codes and to change them at any time... even from within another program.

RESOURCE. While a debugger will allow you to disassemble small bits of code easily enough, only a true text based disassembler can take a COM file and make source out of it again. This is one of the best ones available.

Order as AFS #3 and specify system

PCWRITE. While not quite Wordstar for nothing, this package comes extremely close to equalling the power of commercial word processors costing five or six bills. It has full screen editing, cursor movement with the cursor mover keypad, help screens and all the features of the expensive trolls.

SOLFE. This is a small BASIC program that plays baroque music. It's also a fabulous tutorial on how to use BASICA's sound statements.

PC-TALK. A Telecommunications package for the IBM PC which does file transfers in both ASCII dump and MODEM7/X-MODEM protocols and comes with... get this... 119424 bytes of documentation.

SD. This sorted directory program produces displays which are a lot more readable than those spewed out by typing DIR.

FORTH. This is a small FORTH in Microsoft BASIC. You can build on the primitives integral with the language.

LIFE. An implementation of the classic ecology game written in 8088 assembler.

MAGDALEN. This is another BASIC music program.

CASHACC. This is a fairly sophisticated cash acquisition and limited accounting package written in BASIC. It isn't exactly BPI, but it's a lot less expensive.

DATAFILE. This is a simple data base manager written in... yes, trusty Microsoft BASIC.

UNWS. Wordstar has this unusual propensity for setting the high order bits on some of the characters in the files it creates. Here's a utility to strip the bits and "unWordstar" the text. The assembler source for this one is provided.

HOST2. This is a package including the BASIC source and a DOC file to allow users with Smart-Modems to access their PC's remotely. It's a hacker's delight.

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10 Short Projects

Eggtimer

by A. Flind

In the circuit of Fig. 1, IC1a, b, and c form the timer. Pressing S1 discharges C2 and sets the timer running. RV1 sets the oscillator's rate and is used as a calibrator to set the range. When the timer completes its run, IC1c's output goes low. This pulls IC1d's input low via C3, and its output goes high and stays high for about 5 seconds, until R5 manages to charge C3 sufficiently to take it low again. While it is high, the oscillator comprising IC2c and d is able to run, producing an audio tone. This completed the circuit as specified, but left two spare gates available in IC2. It seemed a shame to waste them, so they have been wired to form a second astable, IC2a and b, with a frequency of about 2 Hz, gated on while the timer is running. The outputs of the two astables are fed to the output stage, so the net result is a quiet ticking noise while the circuit is running, culminating in a 5 second bleep when the set time is reached. D3 and D4 cause the output to consist of short pulses rather than a square wave, as this greatly improves battery economy. R14 keeps the volume to a reasonable level.

A large piece of Vero was used to hold all this circuitry, 24 strips of 50 holes. Fig. 2 shows the 48 breaks, and Fig. 3, the component layout, including 23 links. Wire RV1 to decrease resistance when rotated clockwise. RV1 and RV2 then both increase the period for a clockwise rotation. To set the circuit up, turn RV1 fully anti-clockwise (minimum period) and adjust RV2 to provide a time of just under one minute. Then check that RV1's maximum setting gives over 6 minutes. The control can then be calibrated by trial and error for times of 1 to 6 minutes. The current drawn by this circuit is minimal at all times, even when giving the output tone it is no more than 5mA, so a 9V battery should last for a very long time.

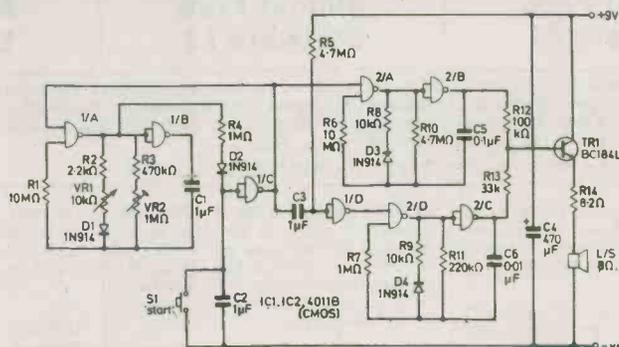


Fig. 1. Eggtimer circuit.

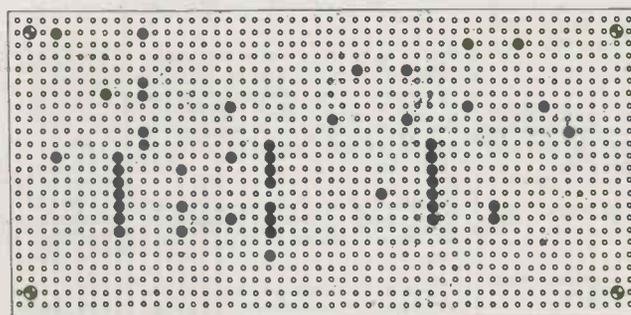
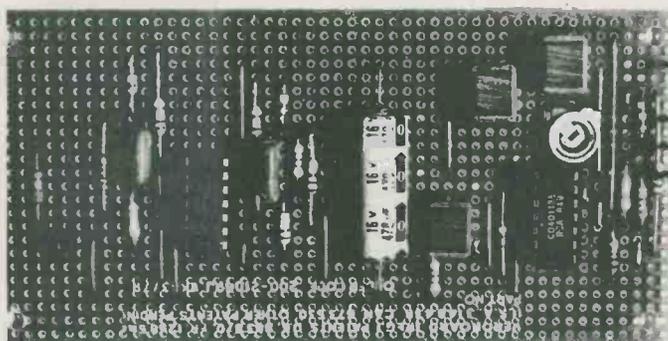


Fig. 2. Eggtimer, copper side.

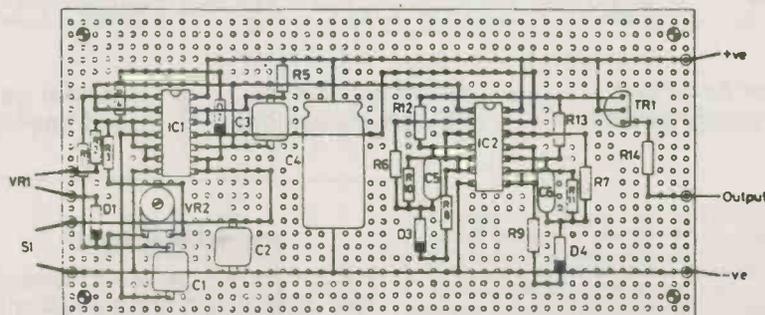
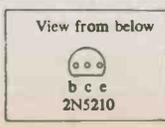


Fig. 3. Eggtimer, component layout.



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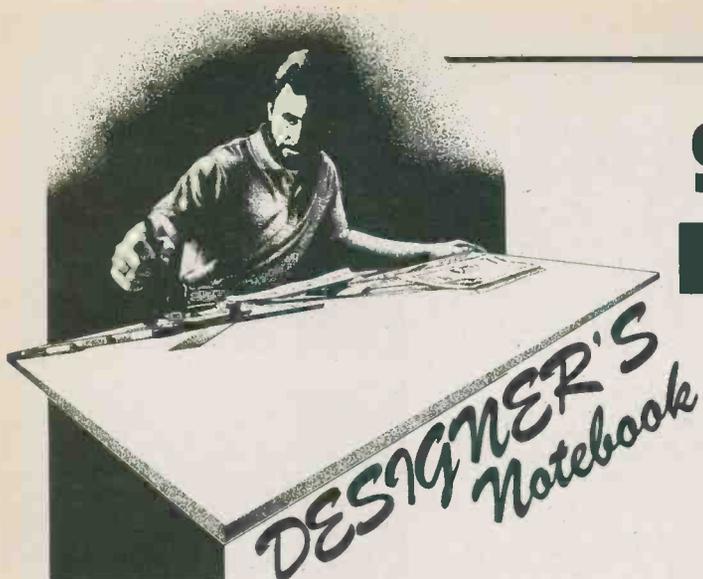
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Sample and Hold Circuits

The sample and hold circuit is the analog equivalent of a memory, as Joe Pritchard explains.

LET US start this article with a definition: a sample and hold circuit is used to obtain a discrete value that represents an analog signal at a particular instant in time. It samples the signal, and then, on a given command, holds the value that the signal possessed at the instant of interest. These circuits have found use in many different areas of electronics where it is necessary to take a "snapshot" of a signal at a particular instant.

We'll first look at these circuits from a theoretical point of view, examining an ideal circuit. At its simplest, a sample and hold circuit consists of some means of holding the voltage, and some means of connecting this storage element to the signal of interest when we want to sample the signal. Figure 1 shows us an ideal sample and hold circuit, in which we have an electronically-controlled switch to connect the capacitor, our storage element, to the input signal when we wish to sample the input. On opening the switch, the capacitor holds the voltage that was present at the input the instant the switch was opened. We shall call the input voltage V_{in} and the impedance of the source R_{out} . The *sample period* is the length of time for which the switch is closed and the *hold period* is the length of time the switch is open.

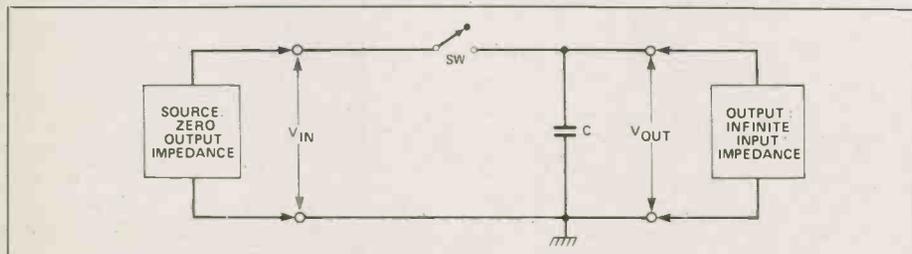


Fig. 1. Ideal sample and hold.

When we initiate a sampling period by closing the switch, the following happens. After the switch is closed, ignoring the on resistance of the switch, the circuit approximates to that in Fig. 2. As you can

see, we now have a simple RC circuit in which the capacitor is charged up via the source impedance R_{out} . The output voltage, V_o will rise as an exponential with a time constant of $R_{out}C$; mathematically, this is:

$$V_o = (V_{in}(1 - \exp(-t/R_{out}C))) \quad \text{Eq. 1}$$

where t is the time between the start of sampling and the instant at which we are measuring V_o . The practical significance of this is that we allow the sampling period to get longer and longer, then V_o becomes closer and closer in value to the input voltage.

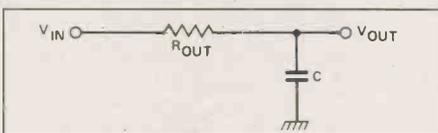


Fig. 2. The effect of the source impedance.

If we allow the sampling period to carry on for five time constants, V_o attains a value that is within 1% of the value of V_{in} ; this is shown in Fig. 3. Obviously, extending the sampling period leads to the value of V_o becoming even closer to V_{in} , and after nine time constants, the output voltage is within 0.01% of the input voltage.

The time required for the output to approximate to the input to within a given percentage accuracy is called the *acquisition time* for that particular accuracy and that particular sample and hold circuit. In

the above example, the acquisition time for 1% accuracy is five time constants, and nine time constants for 0.01% accuracy.

So, to recap on the sampling state. While the switch is closed and sampling is occurring, V_o will follow V_{in} to a certain degree of accuracy after the acquisition time has expired; this state of affairs is shown in Fig. 4. We'll now go on to examine what happens when the switch is opened and the circuit performs the hold function.

Holding On

The first thing to note is that the input voltage and its impedance, in theory, no longer have any effect on the capacitor due to the switch being open. In reality there is a slight delay in between the hold condition being initiated and the switch actually opening. This time is called the *aperture time* and during the output voltage will still follow the input: this is shown in Fig. 5. The aperture time is a function of the circuitry used to perform the switching and we'll look at it in greater detail when we go on to look at the practical implementations of these circuits.

In addition to the aperture time, there is the *settling time*, which is the time taken for the output to attain a value approximating the input voltage at the instant that the hold was initiated. The settling time also depends upon the degree of accuracy needed.

Once the hold stage has been set up with the capacitor isolated from the input voltage, then in the ideal situation with a perfect capacitor, the capacitor would retain the charge indefinitely. However, as nothing is truly perfect, the charge stored on the capacitor gradually leaks away and the held voltage falls. This decay is practically known as the *droop rate* and depends upon the capacitor value and the current that leaks through it. Mathematically:

$$\frac{dV_o}{dt} = \frac{I}{C} \quad \text{Eq. 2}$$

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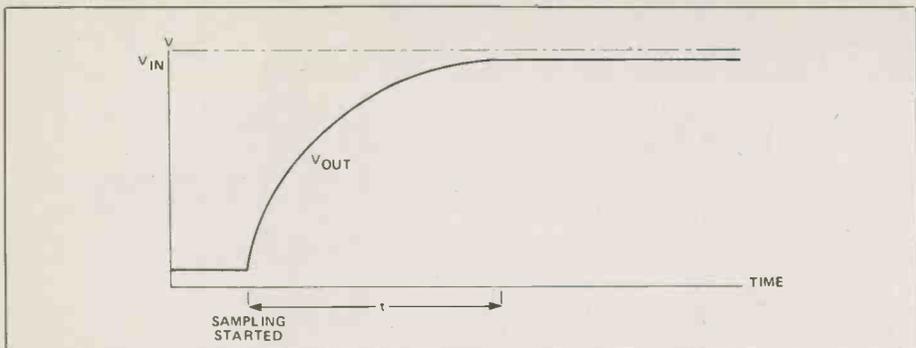


Fig. 3. The effect of the source impedance.

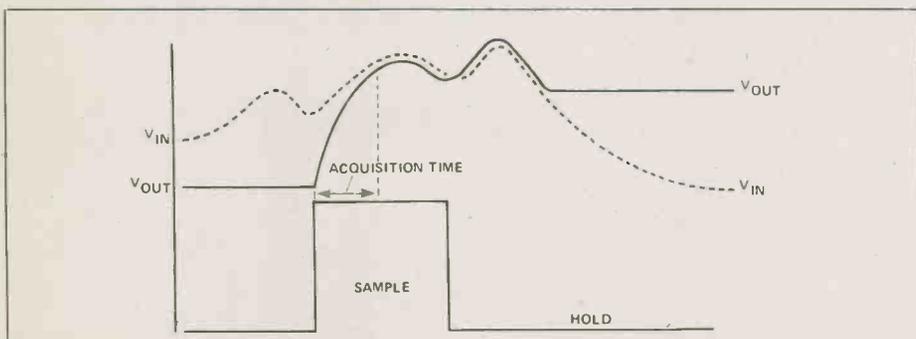


Fig. 4. The acquisition time.

where I is the leakage current, C is the capacitor value and dV_o/dt is the rate of change of the output voltage.

The leakage current in the circuit under consideration would be purely due to the leakage through the capacitor itself. However, in practical circuits, this current can leak away through other circuit elements. So, the output voltage will be constantly falling at the droop rate, during the hold period.

Building Blocks

Let's now look at some of the basic building blocks that we'll use to build a sample and hold circuit out of discrete components. The first circuit element that we'll consider is fundamental to the whole operation — the electronically controlled switch.

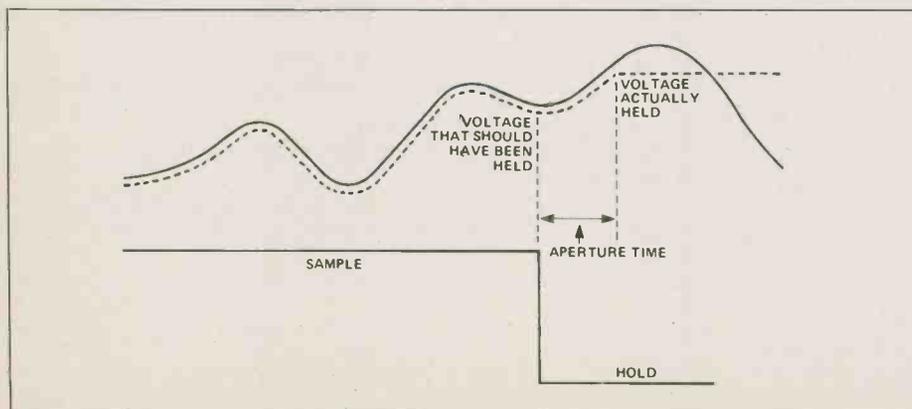


Fig. 5. Aperture time.

FET Switches: field effect transistors are obvious candidates for the job of an electronic switch due to their high resistance when they are not turned on, and their low on-resistance of between 30 and 200 ohms. MOSFET's are also used in this role (Fig. 6). However, these devices have drawbacks at high frequencies due to the capacitance that is inherent in them due to their construction. This stray capacitance, which is often between 20 and 50pF, reacts with the on resistance of the switch to give a low pass filter, thus limiting the input frequency that the switch can handle. If we do the addition, it turns out that the top limit of these FET switches is around 20 MHz. This is ample for most cases, however. The aperture time of these switches is about 100 ns.

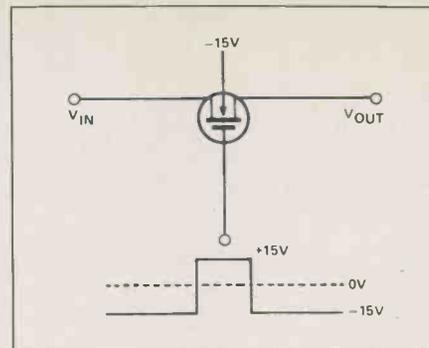


Fig. 6. N-channel MOSFET as a switch.

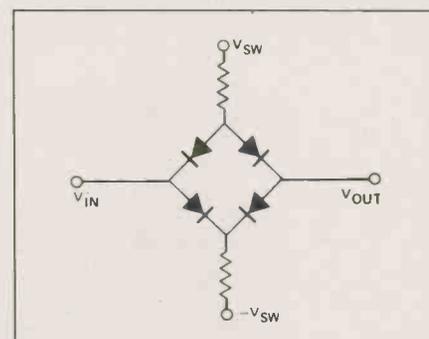


Fig. 7. Diode switch.

Diode array switches: diode arrays can be employed to give fast switching combined with short aperture times. The capacitance of these arrangements tends to be lower than that for the FET switches. A typical diode array switch is shown in Fig. 7. A voltage applied across the V_{sw} terminals will lead to the diode array switching.

CMOS switches: these use the sort of switches found in the 4016 package. They have a low on-resistance of between 30 and 200 Ω and have the advantage that they can be driven directly from CMOS chips used to implement the control logic of the sample and hold circuit. Other switching devices, such as relays, have been used in this role, but their obvious limitation is their low speed and high aperture time. Both of these parameters are due to the fact that these devices are mechanical.

We'll now go on to look at how we might implement sample and hold functions, first by using 'standard' devices, such as operational amplifier, and then by using integrated circuit packages designed specifically for the purpose. Figure 8 shows what is almost a classical design for a sample and hold circuit utilizing op-amps. This circuit still has the essential components of the ideal system, but we now introduce the additional components to do some signal conditioning on the input voltage and some isolation of the capacitor from the circuitry connected to the output.

The amplifier IC1 is connected as a unity gain amplifier, and it serves to take



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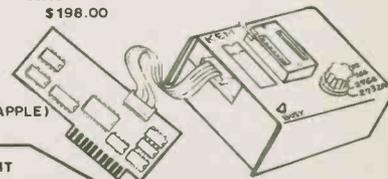
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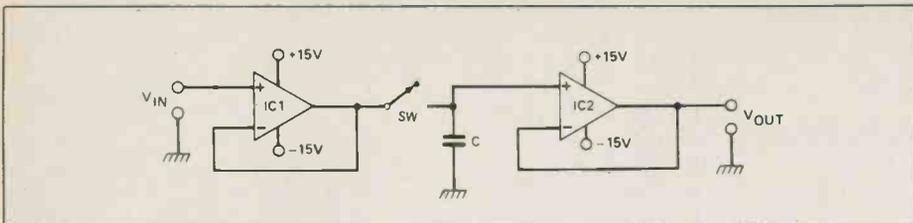


Fig. 8. A basic sample and hold circuit.

the input signal and provide a copy at the input to the switch that is identical but with a lower impedance. This impedance is the parameter R_{out} in the first system we considered, and we saw there how it is desirable to minimize this value. The switch in this circuit could be one of those found in a 4016 package.

The capacitor used here is a compromise value, as there are conflicting design factors. From the equation describing the droop rate (Eq. 2), a large value capacitor will minimize droop. However, if the capacitor is too large, it will reduce the maximum frequency at which the sample and hold circuit can operate, by acting as a low-pass filter in conjunction with R_{out} and the on resistance of the switch; and a large capacitor here will increase the acquisition time for a given percentage accuracy by increasing the value of the time constant of $R_{out}C$. Thus for the circuit to be able to follow high frequency signals, it is necessary that the capacitor should be fairly small.

An alternative to a large value of capacitance to minimize droop is to use some means of reducing the leakage current, I . It is best to stay clear of using aluminum electrolytic units in this role, as they have a very poor performance due to their relatively high leakage. Polyester, polypropylene and tantalum units can be employed here, depending upon the value of capacitance chosen.

Another source of leakage across the capacitor comes from whatever circuit element the capacitor 'looks into' when the switch is open. In this case, it is the input of an operational amplifier in a configuration that offers a high input impedance and so a low leakage. By putting this amplifier in the circuit, we give the capacitor a standard output to which any circuitry may be connected without increasing the droop rate. The op-amp used for IC2 should thus have a low input bias current, and this parameter is always given in the data sheets for such a device. The input bias current is the minimum required by the operational amplifier for correct operation. If the figure quoted is large, then the droop rate will increase. Thus we must have a good quality amplifier at this point in the circuit and operational amplifiers with JFET inputs are often used here due to their low input bias

currents. This makes it possible to choose the value of the capacitor to suit the frequency requirements of the circuit, rather than the droop rate requirements.

A final consideration that we must make is the amplifier IC1. It must be able to follow the input signal that is applied to it, and supply a copy of this input to the switch. The frequency characteristics of the circuit are thus dependent upon the characteristics of IC1 as well as the capacitor. The first parameter of the operational amplifier that we must look at here is the *slew rate* of the amplifier, a value that determines the frequency response of the device. This is best described in Fig. 9, which shows what happens when an input of sufficient magnitude to drive the output of the amplifier into saturation is applied very suddenly. Note how the output takes a finite time to assume the final output voltage level. The slew rate is the rate at which the output rises, usually quoted in volts per microsecond.

Obviously, if this parameter is fairly small, the output voltage will take a longer time to stabilize than if it were quite large. High speed amplifiers have high slew rates, such as 100 V/us. The unit we choose for IC1 should have a slew rate that is appropriate for the signals under consideration.

Another parameter of IC1 that is important for satisfactory operation of the circuit, is the ability of the output to provide current. In charging the capacitor during the sampling period, the amplifier will have to provide a charging current of:

$$I = C_1 \frac{dV}{dt} \quad \text{Eq. 3}$$

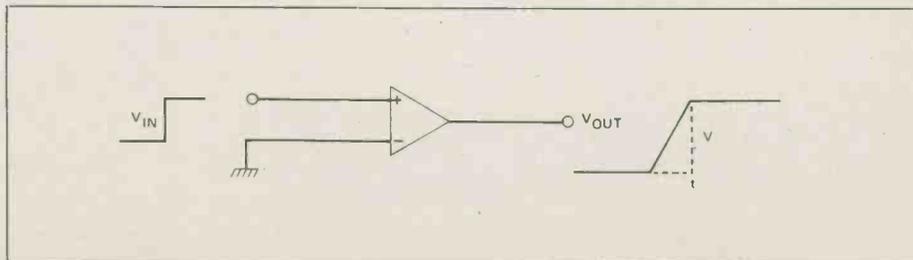


Fig. 9. Op-amp slew rate.

If the rate of change of voltage is quite large, a state of affairs that is not rare when we have a rapid sampling rate or a rapidly changing input signal, the current required can be considerable. Amplifiers used in this position in the circuit can suffer a rise in temperature.

It is often the current sourcing ability that limits the slew rate of the system as a whole. Consider an amplifier driving a signal, changing a 10 V/us into a 100 nF capacitor; the current it must supply is 10 mA.

It is the lower of the two slew rate parameters (op-amp slew rate and current supply capability) that limits the frequency operation of the circuit. The maximum current that an operational amplifier can source, can be found in data sheets for the device in question.

Figure 10 shows an alternative connection of the operational amplifier, but the principles outlined above still hold. However, this alternative connection minimizes the effects of the op-amp's offset voltages.

Before we go on to see some general rules of thumb about op-amp based sample and hold circuits, a few words about the rate of, and length, of sampling. The first point to make is that the sampling period should be longer than the acquisition time of the system so that when sampling takes place, for most of the sampling period, the output voltage into the capacitor follows the input voltage with reasonable accuracy. If the sample period is shorter than the acquisition time, then the output at hold will not be an accurate representation of the input. With regard to the rate of sampling, if the aperture time is longer than the time interval between separate samples being taken, then again inaccurate results will be obtained. To be quite safe, you should allow a good deal longer than the aperture time between samples.

Choosing Devices

First of all which amplifiers should we use? For IC1 in the circuit we have considered, the main requirements as we've seen are high slew rate and good current sourcing ability. The LM318 and the

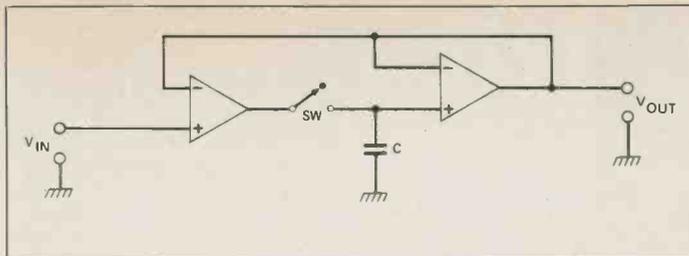


Fig. 10. Alternative sample and hold circuit.

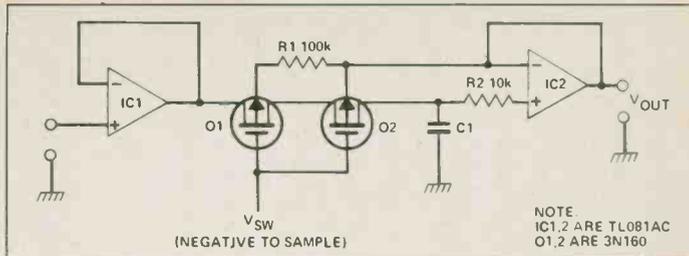


Fig. 11. Practical sample and hold circuit.

LF351 are both possible choices here. The ubiquitous 741 is not usually useful in this role as it has a low slew rate. The equally popular LM324 suffers from the same problem, but both of these devices can be used in low frequency applications as they have good current sourcing ability.

With regard to the switch used, this really depends on the speed of sampling that is to be used. For many applications, CMOS switches are quite adequate. The rate of sampling and the sample period can both be controlled by suitable astable and bistable circuits, or via signals from a microprocessor.

The value of the capacitor used should be chosen for the acquisition time required, as we can minimize droop effects by careful choice of the final op-amp. If a small acquisition time is needed,

which would be the case if we were sampling a rapidly changing signal, then the capacitor should be small.

The main requirement of the final op-amp is that it should have a low input bias current. Devices that come into this category are the LF356 and the LM308. The more common op-amps such as the 741 could be disappointing due to their relatively high bias current.

Some Practicalities

Figures 11 and 12 show practical versions of Figures 8 and 10 due to Texas Instruments, which is why they both use TI devices. Figure 11 uses two P-channel enhancement FETs to produce a very high degree of isolation between the capacitor and the input buffer IC1. Obviously, PCB layout can enhance the isolation still fur-

ther, and conversely poor lay-out can degrade it. If the value of C1 is chosen to be $1\mu\text{F}$, then the maximum drift should be around 0.2 mV per second.

Figure 12 is a high-accuracy sample and hold; since IC2 is within a closed loop, the effect of its offset voltage is negligible. IC1 is chosen to be a type with a very low offset voltage, maximum 0.5 mV at 25°C. Components C1 and R3 are to improve loop gain in the sampling mode. The one problem with this circuit is that during hold, DC feedback to IC1 is removed and it will saturate. It is therefore important to choose Q1 to withstand this possibility. Alternatively, a second FET could be put in parallel with C1 so as to provide feedback when Q1 is off.

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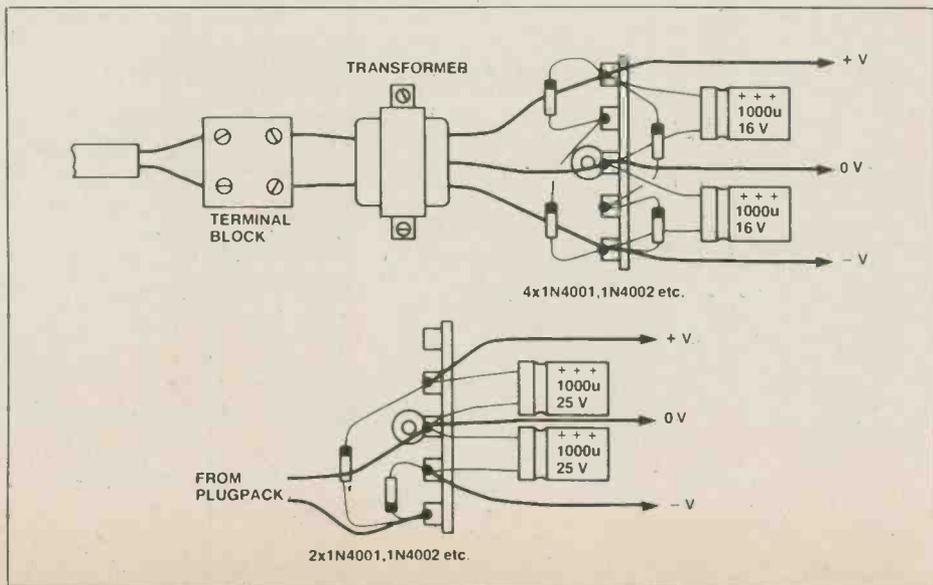
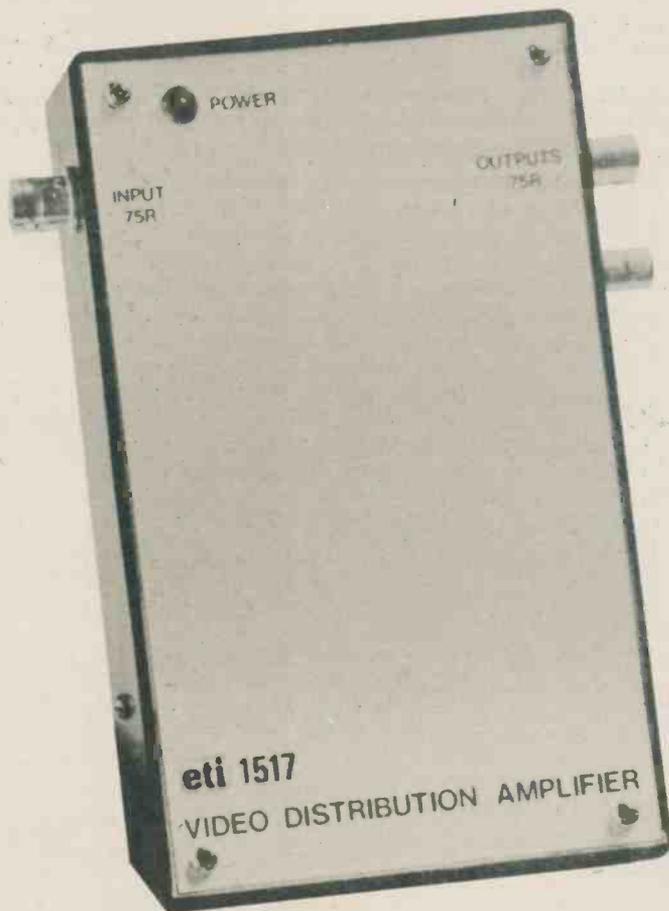
The requirements of a video distribution amplifier are quite straightforward. The unit must be able to take a single input and to drive the required number of outputs while retaining video fidelity. The bandwidth at full output level must be at least 5 MHz, or more, so as to retain video fidelity. The input and output impedances must be matched to standard 75 ohms widely used in video work and adding or subtracting units to or from the outputs should not affect any other device connected to an output. In essence, that's what this project does.

The heart of the unit is a transistor array IC — a CA3086. The transistors inside this package have been connected as a differential amplifier, the output of which drives a power output stage. Feedback provides a gain of one (i.e., unity) and ensures a wide bandwidth. Regulated ± 5 V supplies are used so that the whole amplifier can be direct-coupled, yet maintain the output on at DC ground potential. In practice, the 'DC offset' at the output is on the order of 100 mV or so (it could be positive or negative).

Construction

The video amplifier fits into a 50 x 95 x 158 mm project box along with its own power supply. This has the advantage of convenience, though it is possible to run the circuit off a 12 volt AC adaptor, which would make the whole a little cheaper if you already have the adaptor. These are also safer for the constructor who is unfamiliar with mains wiring, though more expensive in the first place. Anyway, details are given for both situations.

Select the connectors you intend to use. Some video systems use RCA sockets and cables rather than the more robust BNC type. You may not require the full five outputs which the unit is capable of driving. Thus you may elect to economize and fit only two BNC sockets. (BNC



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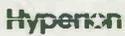
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1565 Carling Avenue, Carling Executive Park, Ottawa, Ont., K1Z 8R1 (613)728-3100
Sales, service and training for leading personal computers and UNIX-based multi-user small business computers. Authorized dealer for IBM, Apple, Compaq, Hyperion and Altos.

The Information Connection
City Centre, 880 Wellington St., Suite 808, Ottawa, Ont., K1R 6K5 (613)234-1387
Authorized dealer for IBM, Sperry Compaq, Hewlett-Packard. Complete line of software products including "The Manager" and "Imaginet" (LAN). "Goldcard" service, training and after-sale support.

Totalogic Systems Ltd.
#208, 1684 Woodward Dr., Ottawa, Ont., K2C 3R8
(613)727-1580
CAT FREE
Authorized dealer for Wang, Hewlett-Packard, Diablo, major software, full system integration.

Tracan Electronics Corp.
1419 Carling Ave. #3, Hampton Park Plaza, Ottawa, Ont., K1Z 7L7 (613)722-7667

Wackid Radio
312 Parkdale Ave., Ottawa, Ont., K1Y 1G3

Xerox Canada Inc.
234 Laurier Ave., W, Ottawa, Ont., K1P 6K6
(613)230-9266

Owen Sound

Data Terminal Sales (Canada) Ltd.
RR5 Owen Sound, Ont., N4K 5N7

ES Computing Ltd.
868 Third Ave. E., P.O. Box 463, Owen Sound, Ontario, N4K 5P7 (519)371-9795
Retail Sales: Apple, Hyperion, Alpha Micro, Qume, Centronics, Epson, Amdek. Supplies and books.

Parry Sound

Computer Images
56 James St., Parry Sound, Ont., P2A 1T5

The Book Worm Shoppe CN
56 James St., Parry Sound, Ont. P2A 1T5
(705)746-8813
MO
Products carried: Books, software. Computers: Columbia, Compaq, Kaypro, IBM, Apple compatibles. Printers: Qume, Gemini. Drives: Rana, Mitac.

Peterborough

Academy of Electronics
8th Line, Otonabee, Peterborough, Ont., K9J 6X8

CanCom Micro Source CN
161 King St., Peterborough, Ont.

Computerland
360 George St. N., Peterborough, Ont. K9H 7E7
(705)748-2266

Landmark Information Systems
753 Erskine Ave., Peterborough, Ont., K9J 7Y6
(705)876-1177
MO
Full sales & service. Apple dealer as well as AES word processors, Olympia Electronic typewriters.

Langerasp Ent.
Box 1942, Peterborough, Ont. K9J 7X7

Microman Computer Centre
161 King St., Peterborough, Ont., K9J 2R8
(705)748-5129
MO

Sales, service, leasing of Xerox, Columbia, Kaypro, Tomcat Computers. Sales of software, diskettes, computer supplies and printers.

Radio Shack
360 George St., Unit 33A, Peterborough Square, Peterborough, Ont., K9H 7E7 (705)743-8196
Radio Shack TRS-80 Models 4, 4P, 12, 16 and colour computers. Tandy 2000. Hardware and software plus related peripheral equipment.

RTC ETI/CN
816 Lansdowne St. W., Peterborough, Ont., K9J 1Z4 (705)748-2706
MO CAT FREE
Commodore Systems dealer. Providing "Total Service" business systems including maintenance contracts and custom software development. Buy and sell used equipment. Personal software, supplies and games.

Pickering

Systime Computer Services Ltd.
1035 Toy Avenue, Unit 7, Pickering, Ont., L1W 3N9
(416)683-1248
CAT FREE
Commodore, IBM, Victor, total supplies, diskettes, ribbons, paper, buy & sell used equipment.

Port Dover

Hanna Electronics
326 Main Street, Port Dover, Ont., N0A 1W0

Puslinch

Harchris Systems Services
RR2, Box 54 Puslinch, Ont., N0B 2J0, 824-1881

Renfrew

Renfrew Tech.
863 Kedrosky Dr., Renfrew, Ont., K7V 4C8

Rexdale

Comsec Marketing
44 Fasken Dr., Unit 1C, Rexdale, Ont., M9W 5M8

Data Terminal Mart
655 Dixon Road (Skyline Hotel), Rexdale, Ont., M9W 1J4 (416)245-4780
Terminals and microcomputers from Digital, Texas Instruments, Qume, Kaypro, Anderson-Jacobson as well as printers, modems and application software.

Electronic Supplies Inc. ETI/CN
Head Office, 306 Rexdale, Blvd., Rexdale, Ont., M9W 1R6 (416)741-4000
MO CAT FREE
Distributor's of Sperry PC's.

Fairview Electronics
1038 Albion Road, Rexdale, Ont., M9V 1A7

micro bazaar COMPUTER HOUSE

Micro Bazaar ETI/CN
23 Westmore Dr., Unit 5, Rexdale, Ont., M9V 3Y7
(416)745-4740
Full service and support for Morrow, Seequa, Columbia, Pled Piper, Kaypro, Xcomp hard disks and a wide range of printers. Maintenance contracts and programming.

Professional Computer Systems Ltd.
117 Skyway Ave., Rexdale, Ont., M9W 4Z4
(416)675-7818
Sales and service Commodore Business Systems as well as the C-64 and related peripherals.

Telecompute International
34 Kelfield Rd., Rexdale, Ont., M9W 2A5

Richmond Hill

Compucentre
9350 Yonge St., Hillcrest Mall, Richmond Hill, Ont., L4C 5G2 (416)883-0224
Personal computers from IBM PCjr, Commodore 64, Coleco Adam plus complete line of peripherals, accessories and software for business entertainment and education applications. Large variety of books and third party vendor products.

Richvale Telecommunications Limited
10610 Bayview Ave., Richmond Hill, Ont., L4C 3N8
(416)884-7752
MO CAT
We carry a full line of Commodore products including our own C-64 Link, Script 64 word processor, 1541 Express, Multilink Networking System, Supercopy and more.

Rockwood

Mandel Data Systems
143 Dennis St., Rockwood, Ont., N0B 2K0
(519)856-9566
MO CAT FREE
Selling Apple, Columbia, computers with interfaces and software for scientific and industrial laboratory applications. Other companies represented: Tecmar, Robographics, Trivector, International, Rana, Interactive Microwave.

Sarnia

Compucentre
Sarnia Eaton Centre, 150 Christina N., Sarnia, Ont., N7T 5T9 (519)337-7335
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business, entertainment and education applications. Large variety of books and third party vendor products.

Comp-Can
1477 Hunt St., Sarnia, Ont., N7S 3M8

Computerland
1362 Lambton Mall, Sarnia, Ont., N7S 5A1 (519)542-5568

Electronic Supplies Inc. ETI/CN
1173 Michener St., Unit 4, Sarnia, Ont., N7S 5G5 (519)344-2449
MO CAT FREE
Distributors of Sperry PC's.

Elite Office Sarnia
287 South Indian Rd., Sarnia, Ont., N7T 3W6

Keelan's Audio & Video
460 North Christina, Sarnia, Ont., N7T 5W4

Radio Shack Computer Centre.
Sarnia Eaton Centre, 150 N. Christina St., Sarnia, Ont., N7T 5T9 (519)337-4360
CAT FREE
All models of TRS-80 including the Tandy 2000, related software and hardware. Service and support. Pockets, portables (Model 100) and business systems.

The Computer Barn
866 Confederation St., Sarnia, Ont., N7T 2E5 (519)344-6934
Apple IIe, Apple IIc, Macintosh, Lisa. Business application specialist.

The Computer Terminal
1407 London Road at Intl. Plaza, Unit 6, Sarnia, Ont., N7S 1P6 (519)542-1133
MO
Zenith, Sperry, Sanyo, Olivetti, Hyperion, Altos, Tallgrass, PC Networking, Epson, Mannesmann-Tally, IBM peripherals. Hayes Modems. Full service department, hardware and software support. Customized programming. Specialize in business systems. Software, books, and computer accessories and supplies. Service contracts available.

Sault Ste. Marie

Canadian Software Distributors
393 Rowell Ave., Sault Ste. Marie, Ont., P6C 5L2 (705)949-9432
MO CAT \$2.00
Educational software.

Computerforce CN
424 Pim St., Sault Ste. Marie, Ont., P6B 2V1 (705)942-5770
MO
IBM, Xerox, Dec, Franklin

McClelland Dumanski
482 Queen St. E., Sault Ste. Marie, Ont., P6A 1Z8

M & D Computer Centre
44 Great Northern Rd., Sault Ste. Marie, Ont., P6B 4Y5 (705)949-6622

MD Computer Centre CN
c/o McClelland Dumanski, 482 Queen St. E., Sault Ste. Marie, Ont. P6A 1Z8

MD Data Systems
485 Queen St. East, Sault Ste. Marie, Ont., P6A 1Z9 (705)949-6622
Apple, Commodore, IBM, Dec Rainbow, Micom. Custom software — sales, service and support for above products.

Radio Shack Computer Dept.
44 Great Northern Road, Cambrian Mall, Unit 3, Sault Ste. Marie, Ont., P6B 4X5 (705)254-5324

Sault Office Machine
122 Poplar Ave., Sault Ste. Marie, Ont., P6B 2W9

Scarborough

BCC Business Computer Centre Inc. CN
209 Ellesmere Rd., Scarborough, M1R 4E2 (416)292-7672
IBM PC Corona PC and compatible fixed and removable hard disk drives, full and half height floppy disk drives, multi-function memory expansion board, letter quality and dot-matrix printers, complete line of business software, computer accessories and supplies, service contracts available.

Beacon Software Inc.
705 Progress Ave., Unit 17, Scarborough, Ont. M1H 2X1 (416)431-3200
CAT FREE
Manufacturer/distributor of business accounting software, mainly BPI systems. Other software lines include: Select Write, Bluebush Chess, Magnum Software (McPic), Canadian Payrolls.

Compucentre
Scarborough Town Centre, 300 Borough Drive, Scarborough, Ont., M1P 4P5 (416)296-0013
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business, entertainment and education applications. Large variety of books and third party vendor products.

Compucollege Stores
2432 Eglinton Ave. East, Scarborough, Ont., M1K 2P8

Computerland
3761 Victoria Park Ave., Unit 5, Scarborough, Ont., M1W 3S2

Computer Innovations
Scarborough Town Centre, 300 Borough Dr., Scarborough, Ont. M1P 4P5 (416)296-0023
IBM PC & XT, Apple IIe, III, DEC Professional, Lisa.

Computer Innovations Corp.
3761 Victoria Park Ave., Unit 2, Scarborough, Ont., M1W 3S2 (416)497-7522
IBM PC & XT, DEC Professional, AppleIIe, Apple III, Lisa

Computer Junction CN
3330 Pharmacy Ave., Scarborough, Ont., M1W 3V8 (416)494-2440

Computer Way
31 Progress Court, Unit 31 Scarborough, Ont., M1G 3V4 (416)439-9804

Cycorn Systems Ltd.
#1-3500 Pharmacy Ave., Scarborough, Ont., M1W 2T6

Dale Integrated
2250 Midland Ave., #17, Scarborough, Ont., M4P 1R7 (416)292-1146

Datascope of Canada
491 Brimley Rd., Scarborough, Ont., M1J 1A4

Eaton's Business Centre
Scarborough Town Centre, 300 Borough Drive, Scarborough, Ont., M1P 4P5 (416)296-5211 Ext. 372
Computers from IBM, Apple, and Zenith. One of the widest selections of business, educational and entertainment software. Training courses, leasing and financing are all available.

Epson Canada Ltd.
21 Progress Ct., Unit 18, Scarborough, Ont., M1G 3V4

Interactive Micro Systems
34 Hopecrest Cresc., Scarborough, Ont., M1K 2K4 (416)261-8411

Light Computer Centre
300 Borough Drive, Scarborough Town Centre, Scarborough, Ont., M1P 4P5 (416)296-2406
Authorized dealer for Apple.

MicroCanada Inc.

Business Computer and Resource Centre

Micro Canada Inc.
2250 Midland Ave., Unit 3&4, Scarborough, Ont., M1P 4R9 (416)291-2995

MO
Service department. Seminar facilities. After-sale support for IBM, Columbia, Zenith, Kaypro. IBM add-ons, hard disks, printers, modems, monitors, furniture, supplies. Well established.

Micro Canada
4271 Sheppard Ave. E., Scarborough, Ont., M1S 4G4 (416)291-2995

MO
Columbia, Kaypro, Atari computers. Peripheral cards for IBM, Apple, Mannesmann-Tally, Diablo, Epson printers. Anchor, Hayes modems. Printer buffers, monitors. Books, diskettes, furniture. Service, training.

Micro CTR of Toronto
56 Marblemount Cr., Scarborough, Ont., M5H 2H5

Microtrend Business Systems Ltd.
10161 Sheppard Ave. E., Scarborough, Ont. M1B 1G1 (416)281-1129

Micro Mart
4651 Sheppard Ave. E., Ste. 203, Scarborough, Ont., M1S 3V4 (416)293-9444

Mr. Software
Woodside Square, c/r Finch & McCowan, Scarborough, Ont., (416)291-3404

MO
Software, computers, accessories and furniture for the home and small business. Programs are available for education, productivity and entertainment. All major brands available.

Nigana Computing Syst.
136 Shepherd Rd., Scarborough, Ont., M1S 3S6

Radio Shack
1886 Eglinton Ave. E., Golden Mile Plaza, Scarborough, Ont., M1L 2L1 (416)757-2367
CAT FREE

Radio Shack Computer Centre
2985 Kingston Road, Cliffcrest Plaza, Scarborough, Ont., M1M 1P1 (416)265-3222
CAT FREE
Complete line of computers, peripherals and supplies, sales training and support for computers and software, TRSDOS, CP/M, MSDOS.

Radio Shack Computer Centre
4271 Sheppard Ave. E., Torchin Plaza, Scarborough, Ont., M1S 4G4 (416)292-6444
MO CAT FREE
Complete line of TRS-80 computers, peripherals and software. Service and training available for all TRS-80 products. Products include: Tandy 2000, TRS-80 Model 4, Model 16, Model 100 and Model 12.

Scarborough Computers ETI/CN
2190 Warden Ave., Unit 8, Scarborough, Ont., M1T 1V6 (416)491-3139
MO CAT
Hewlett-Packard H-P 150. Plotters, software, calculators, Epson QX-10 computer, printers, software. Atari computers, games, peripherals, monitors, diskettes. Smith Corona printers, Pied Piper computers, Sharp calculators.

Scitron Corp. ETI/CN
2300 Lawrence Ave. East, White Shield Plaza, Scarborough, Ont., M1P 2R2 (416)288-1244

The Computer Stop
3330 Pharmacy Ave., Scarborough, Ont., M1W 3V8 (416)494-2440
A wide range of microcomputers, peripherals, software and accessories.

Directory of Computer Stores

Titan Computers
15 Crockford Blvd., Unit 1, Scarborough, Ont., M1L 4J9 (416)759-8808
Franklin Ace

Toronto Micro
55 Winter Ave., Scarborough, Ont., (416)261-8411/267-1243
MO CAT FREE
Apple, IBM computers and peripherals. Epson, Gemini, Hayes, Quadram, Visicorp, Microsoft. Software for Apple, Macintosh, IBM PC & jr, Atari, Commodore 64, CP/M, DEC Rainbow.

Total Office Systems
1050 McNicoll Ave., Unit 14, Scarborough, M1W 2L8 (416)493-3575
MO CAT FREE
Sharp PC 5000 portable.

Shelburne

Remtek
1 Industrial Rd., Shelburne, Ont., L0N 1S0

Micro Can
16 Colborne St. N., Simcoe, Ont., N3Y 3T9

Smiths Falls

J-R Business Equip.
12 Russell St. E., Smiths Falls, Ont., K7A 1E8

Stirling

Computer Technology
49 Mill Street, Stirling, Ont., K0K 3E0

Stouffville

Zetetic Data Systems
RR2 Stouffville, Ont., L0H 1L0

Stratford

Chipon Computers and Electronics ETI/CN
137 Albert St., Stratford, Ont., N5A 3K5 (519)273-1412
Columbia PC, Sherry — IBM & Apple compatible. Series 2800, Super 400. Software, peripherals, books, printers, monitors, diskettes, computer care products.

St. Catharines

Computerland
318 Ontario Street, St. Catharines, Ont., L2R 5L8 (416)688-1187
Products 200 Vendors Include: Microcomputers, peripherals, software and accessories. IBM, DEC, Apple, Bytec, Hyperion, and Compaq computers; Epson, C-I/OH and OKidata Printers; IBM, Amdek, Electrohome and Princeton Monitors; and Lotus Visicorp, Helping Hands, Spinnaker and Mattel Software.

DMR Communications Inc.
1 St. Paul Street, St. Catharines, Ont., L2R 7L2 (416)688-5731

International Computer
117 St. Paul Street, St. Catharines, Ont., L2R 3M4 (416)682-7257

Megabyte Business Systems Ltd. CN
96 Niagara St., St. Catharines, Ont., L2R 4L4 (416)684-4366
Business and home computers. Dealer for Commodore, Ohio Scientific. Sales and shop or on-site service.

Micro Vision Software
96 Niagara Street, St. Catharines, Ont., L2R 4L4

Nelson Business Machines Ltd.
17A Second Dr., St. Catharines, Ont., L2N 1K9 (416)688-2311

Radio Shack Computer Centre
290 Glendale Ave., Burleigh Hill, St. Catharines, Ont., L2T 2L3 (416)227-2063

Radio Shack Computer Dept.
333 Ontario Street, St. Catharines, Ont., L2R 5L3

Rainbow Computer Systems
67 Queen St. St. Catharines, Ont. L2R 5G9 (416)682-4334
Niagara region dealers for Kaypro and Columbia microcomputers.

Xerox
63 Church St., Ground Floor, St. Catharines, Ont., L2R 3C4 (416)688-6862

Sudbury

A & B Office Equipment & Leasing Co. Ltd. ETI/CN
2148 LaSalle Blvd., Sudbury, Ont., P3A 2A7 (705)566-5300
MO CAT FREE

Commodore "systems" dealer, Epson, Brother, all hardware, software, peripherals, sales, service, leasing. Northern Ontario.

Computerland
Unit 19, Cedar Point Plaza, 1984 Regent St. S., Sudbury, Ont., P3E 5S1 (705)522-3663

Computerline
74 Cedar St., Sudbury, Ont., P3E 1A5 (705)674-3151
MO

Micromagnetics
7 Cedar St., Suite 102, Sudbury, Ont., (705)675-1717
MO CAT FREE
Agents for Libra software compatible with IBM XT, sale of IBM hardware PC and Xt. Also Maxell computer products, peripherals, supplies and support products.

MPM Business Products
653 Lorne St. S., Sudbury, Ont., P3C 4R3 (705)673-4464

North Star Computers Ltd.
100 Elm St. East, City Centre, Sudbury, Ont., P3C 1S8 (705)673-2010

North Star Computer Ltd. CN
598 Falconbridge Road, Unit 9, Sudbury, Ont., P3E 4K6 (705)566-6441/673-2010
MO

System sales supplier. Products include IBM, Apple, AES, Minolta and 3M micrographics.

Radio Shack Computer Centre
1609 LaSalle Blvd., Sudbury, Ont., P3A 1Z8 (705)560-5747
CAT FREE

TRS-80 computers, peripherals and software for business and personal use. Education department provides training for software and BASIC.

Sonic Northern Ltd. CN
298 Elm St. E., Sudbury, Ont., P3B 1N6 (705)674-0764
MO
Books, software, printers, supplies, parts, cables. Bulletin board (after hours) (705)674-5691

Timmins

Computer Power
Timmins Square, Timmins, Ont., (705)264-1550
Full support and service. Authorized Apple dealer. Courses and workshops available for all ages. In-store facilities. Wide range of software, accessories and books.

Timmins Computer Power Inc.
70 Balsam St. S., Timmins, Ont., P4N 2C8 (705)264-1302
Full support and service. Authorized Apple dealer. Training and workshop facilities. After sale support staff. Large selection of educational, personal and business software.

Timmins Stationery
135 Third Ave., Box 1064, Timmins, Ont., P4N 7J2

Thornhill

High Tech Plus Inc.
350 John St., Unit 8., Thornhill, Ontario, L3T 5W6 (416)731-9000
MO CAT \$1.00
Sales of the following products: IBM, Apple, Columbia, Pure Data, Quad RAM, Tallgrass, Hayes, Shugart, Mitac, Qume, TTX, Epson, Gemini.

Lamourie Data Products
154 Cottonwood Ct., Thornhill, Ont., L3T 5X1

MicroDoctor
350 John St., Unit 8, Thornhill, Ont., L3T 5W6 (416)731-9000
MO CAT \$1.00
MicroDoctor service, specializing in custom service to all makes of micro computer products. Also training, consulting, and service equipment rentals.

Thunder Bay

Allied Computer Centres Inc. ETI/CN
121 East Ave., Thunder Bay, Ont., P7B 5N1 (807)345-8031
Authorized dealer for: Apple computers, Epson computers & printers. Complete selection of software. Complete training facility.

A.S.C. Micro System
223 Algoma St. S., Thunder Bay, Ont.

Audio Service Centre
223 Algoma St. S., Thunder Bay, Ont., P7B 3C3 (807)345-7334

Computerland
1265 Arthur St. E., Suite 100, Thunder Bay, Ont., P7E 6E7 (807)623-5434
Software and hardware retailer. Software brands include: IBM, Peach Tree, BPI, Ashton-Tate, Micro Pro, I.U.S., PBSC, etc. Hardware includes: IBM Digital equipment, Compaq, Bytec, Epson, Centronics, Okidata, Apple.

Databay Ltd.
2826 Arthur St. E., Thunder Bay, Ont., P7E 5P4

Datalogic Systems
59 Hodge St., Thunder Bay, Ont., P7B 4H2

Toronto

Action Fast Elec. ETI/CN
351 Queen St. W., Toronto, Ont., M5V 2A4

Active Component Sales Corp. ETI/CN
14 Carlton St., Toronto, Ont., M5B 1K5 (416)977-7692
MO CAT \$2.00
Complete electronic components and computer products needs. Texas Instruments, Motorola, Fairchild, General Instruments, Keytronics keyboards, Star Micronics printers, Tandon drives, AMP, Ersin Multicore Solder, Ungar, Weller, OK Industries, Vaco, Xcelite.

Adcom Electronics Ltd.
310 Judson St., Unit 1, Toronto, Ont., M8Z 5T6

CODING KEY

ETI	ETI Magazine sold here
CN	CN! Magazine sold here
EC	Supplies Electronic Components
RTV	Sells Radio and TV parts
TG	Sells Test Gear
EK	Sells Electronic Kits
MO	Company does Mail Order
CAT	Catalogue available. The cost of this, or if it is free, is shown.

BCS

ELECTRONICS
LIMITED

1985



1984

1970

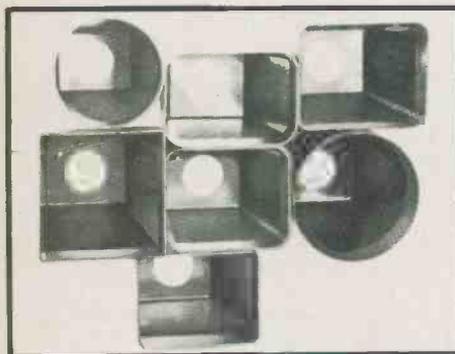
Instruments for Industry and Service

980 Alness St. Downsview, Ontario M3J 2S2 (416) 661-5585.

It's fast, simple to operate and will fit any oscilloscope

SHACKMAN 7000

oscilloscope camera



CAMERA HOODS

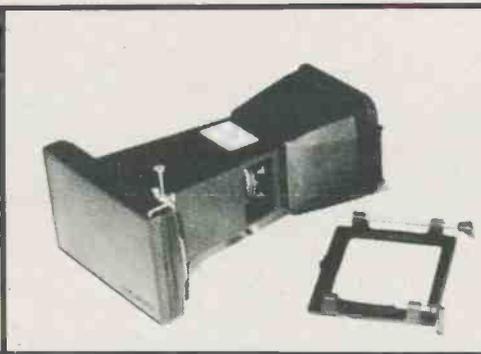
Picture quality from the Model 7000 is excellent with virtually no distortion. The oscilloscope mountings are arranged so that all the displayed information appears on the print.

Specification

- Camera Body:** High quality ABS moulding with attached Polaroid 101 series film back.
- Lens:** Moulded two element f3.5 70mm focal length with aperture control down to f32.
- Shutter:** Self cocking, mounted between lens. Speeds from 1 second to 1/125th inclusive, with 'B' for time exposures. Built in 'X' contact for event triggering. Shutter actuated by cable release.
- Focus:** Fixed by method of mounting for correct distance.
- Object to Image Ratio:** Up to 8 x 10cm displays 1:0.85 fixed
10 x 13cm displays 1:0.65 fixed
- Film:** Polaroid Black and White 8 exposure film packs
Type 107C 3000 ASA
Type 665 75 ASA Pos./Neg.
- Hoods and Spacer Bodies:** High Quality ABS Mouldings

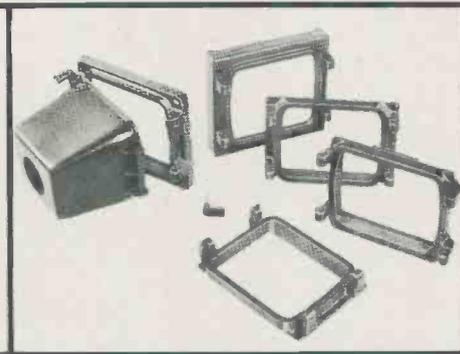
Polaroid is a Registered Trade Mark of the Polaroid Corp., U.S.A.

**Camera Hoods
are available for
practically all
makes of scopes.**



Exposures can be accurately controlled with a high quality fully speeded shutter and continuously variable aperture control.

To fit any HAMEG
\$448⁷⁵
complete

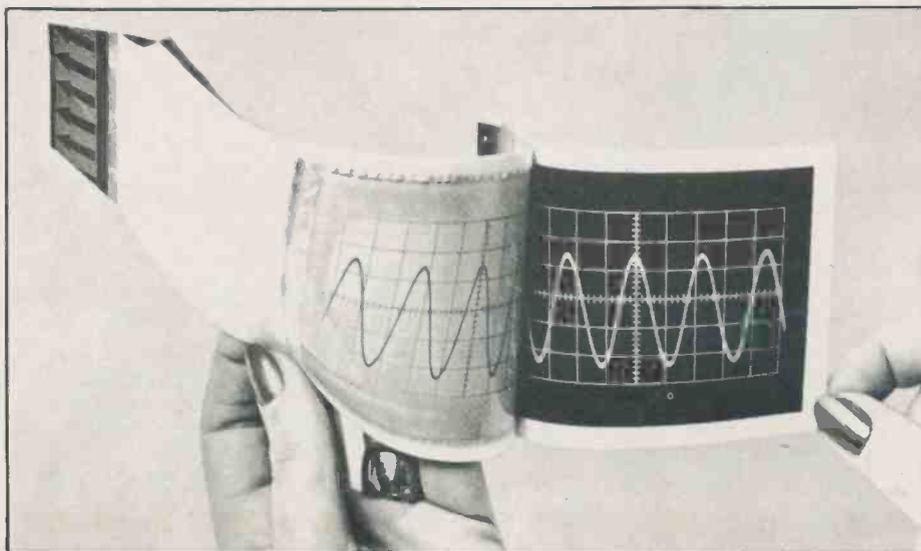


BEZEL ADAPTERS

By selecting the correct hood, you have a hand-held camera which fits quickly and easily to a number of oscilloscopes.

Hoods for Display Areas up to 8 x 10cm

**For other makes and
model oscilloscopes
ask or write**



With some oscilloscopes you may only require to hand hold the camera in place during exposure and with others prefer to have it permanently mounted to the oscilloscope. Whichever you require the Model 7000 will accommodate.

Specification

Vertical-Deflection (Y)

Bandwidth: DC to 10MHz (-3dB),
AC to 15MHz (-6dB).
Risetime: approx. 35ns.
Overshoot: maximum 1%.
Deflection coefficient: 12 calibrated steps,
5mV/cm to 20V/cm in 1-2-5 sequence,
variable control 1:2.5 to at least 2mV/cm
with full bandwidth.
Accuracy in calibrated position: ±3%.
Input impedance: 1MΩ || 30pF.
Input coupling: DC-AC-GND.
Input voltage: max. 400V (DC + peak AC).

Timebase

Time coefficients: 18 calibrated steps,
0.5μs/cm to 0.2s/cm in 1-2-5 sequence,
variable control 1:2.5 to at least 0.2μs/cm.
Accuracy in calibrated position: ±5%.
Normal length of sweep line: approx. 7cm.
Trigger system: Automatic or Normal
with manual level control.
Slope: positive or negative.
Source: internal or external (BNC connector).
Coupling: AC, TV (frame) low-pass filter.
Threshold: internal 5mm, external 0.4V.
Bandwidth: 2Hz up to at least 30MHz.

Horizontal Deflection (X)

Bandwidth: 2Hz to approx. 850kHz (-3dB).
Deflection coefficient: approx. 0.65V/cm.
Input: BNC connector (on front panel).
X-Y-phase shift: <3° up to 70kHz.

Component Tester

Test voltage: max. 7.5V rms (open circuit).
Test current: max. 23mA rms (shorted).
Test frequency: 50-60Hz (line frequency).
Test connection: 2 banana jacks 4mm dia.
One test lead is grounded (Safety Earth).

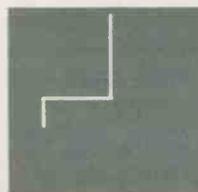
General Information

Cathode-ray tube: DG 10-119 (P43 phosphor),
rectangular screen, internal graticule 6x7cm.
Accelerating potential: 1800V.
Trace rotation: adjustable on front panel.
Calibrator: square-wave generator approx. 1kHz
for probe compensation and Y calibration;
output (on front panel): 0.2V ±1%.
Electronic regulation for all important
supply voltages including the high voltage.
Protective system: Safety Class I (IEC 348)
Line voltages: 110, 125, 220, 240V AC.
Permissible line fluctuation: ±10%.
Line frequency range: 50 to 60Hz.
Power consumption: approx. 21 Watts.
Weight: approx. 3.7kg.
Cabinet (mm): W 212, H 114, D 280.
Color: techno-brown.
Lockable tilt handle.
Subject to change.

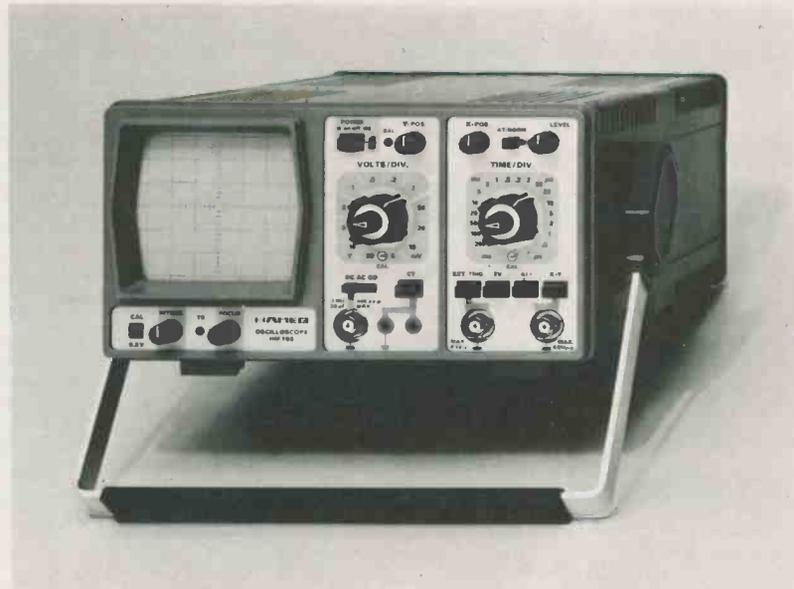
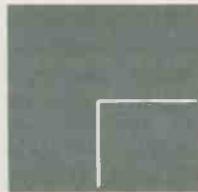
Test Displays

using the Component Tester

Transistor



Diode



10MHz Compact Oscilloscope

Y: 1 channel, DC-10MHz, max. sensitivity 2mV/cm;
X: 0.2μs/cm-0.2s/cm, triggering up to 30MHz;
built-in Component Tester.

This small Trigger Oscilloscope features a 6x7 cm screen. It was designed specifically for field service personnel and advanced electronic hobbyists. Maximum vertical input sensitivity at **full 10MHz bandwidth** is 2mV/cm, and is continuously variable. Displayed signals of as low as 5mm in amplitude are sufficient to **trigger** the horizontal sweep generator at frequencies **up to 30MHz**. Two triggering modes are available: automatic or normal, using a level control. A **TV low-pass filter** is incorporated to permit display of video signals at frame frequency.

A **Component Tester** is incorporated in this model for **checking semiconductors** or other electronic components, externally, or **in circuit**. A single pushbutton switches operation from oscilloscope to component testing and v.v. Problems can easily be located by comparing the faulty device with a functioning unit, and **test results are displayed on the screen**.

A bright, sharply focused **CRT with internal graticule** ensures **parallax-free viewing** — essential for a variety of maintenance and monitoring tasks. All critical **supply voltages** are **electronically regulated**. The display remains stable even under conditions of wide line-voltage fluctuations. A **squarewave calibration signal** is included for probe compensation and vertical gain calibration.

Compact design, light weight, rugged construction, **ease of operation** and long-term reliability make the HM103 an indispensable scope **for shop and field service** applications.

LIST \$550.00

Accessories optional

Probes 1X, 10X, 100X, 1X/10X (switchable); demodulating probe; test cables BNC-BNC and banana-BNC; 50Ω BNC feed-through termination; BNC-banana adapter; carrying case.

Specification

Operating Modes

Channel I, Channel II, Channel I and II alternate or chopped (chop freq. ≈ 0.5 MHz), sum or difference: Ch. II \pm Ch. I (with Invert button for Channel I).
X-Y mode: same sensitivity in both directions.

Vertical Deflection (Y)

Bandwidth of both channels: DC to 20 MHz (-3 dB), DC to 28 MHz (-6 dB).
 Rise time: ≈ 17.5 ns. Overshoot: max. 1%.
Deflection coefficients: 12 calibrated steps, 5 mV/cm to 20 V/cm in 1-2-5 sequence, with variable control uncal. 1:2.5 to 2 mV/cm. Accuracy in calibrated position: $\pm 3\%$.
Input impedance: 1 M Ω || 30 pF.
 Input coupling: DC-AC-GND.
 Input voltage: max. 400V (DC + peak AC).

Timebase

Time coefficients: 18 calibrated steps, 0.5 μ s/cm to 0.2 s/cm in 1-2-5 sequence, with variable control uncal. 1:2.5 to 0.2 μ s/cm, with **X-Magnification x 10** ($\pm 5\%$) to 20 ns/cm. Accuracy in calibrated position: $\pm 3\%$.
Trigger system: Automatic or Normal.
 Slope: positive or negative.
 Sources: Ch. I, Ch. II, line, external.
 Coupling: AC, DC, HF, LF (TV frame).
Threshold: internal 5 mm, external 0.6 V.
 Bandwidth: DC up to 40 MHz.

Horizontal Deflection (X)

Bandwidth: DC to 2 MHz (-3 dB).
 Input: via Ch. II (see Y deflection spec.).
 X-Y phase shift: $< 3^\circ$ up to 120 kHz.

Component Tester

Test voltage: max. 8.5 V rms (open circuit).
Test current: max. 24 mA rms (shorted).
Test frequency: 50-60 Hz (line frequency).
 Test connection: 2 banana jacks 4 mm dia.
 One test lead is grounded (Safety Earth).

General Information

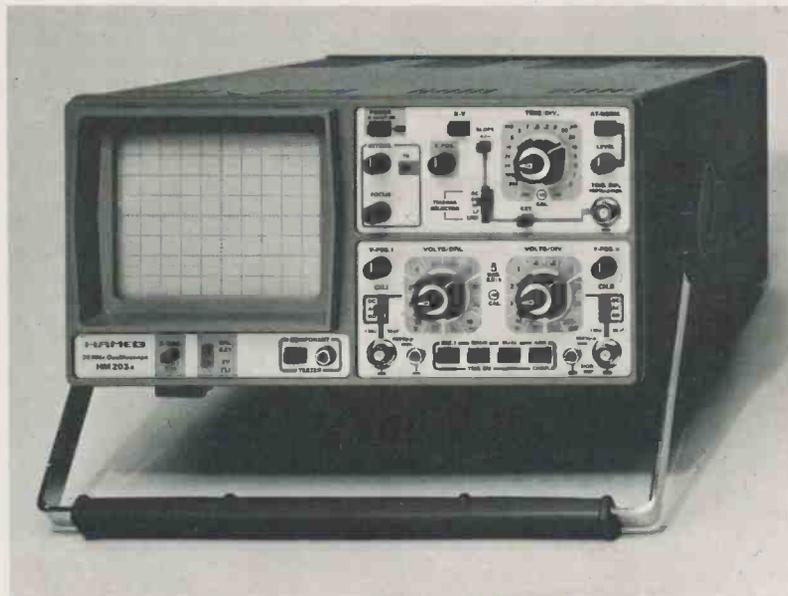
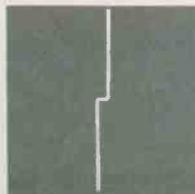
Cathode-ray tube: D14-362 P43/93, P7/93 optional (long decay characteristic), rectangular screen, internal graticule 8 x 10 cm.
 Acceleration potential: 2000 V.
 Trace rotation: adjustable on front panel.
Calibrator: square-wave generator ≈ 1 kHz for probe compensation. Output: 0.2 V + 2 V $\pm 1\%$.
Regulated DC power supplies: all voltages.
Protective system: Safety Class I (IEC 348).
 Line voltages: 110, 125, 220, 240 V AC.
 Permissible line fluctuation: $\pm 10\%$.
 Line frequency range: 50 to 60 Hz.
Power consumption: approx. 38 Watts.
 Weight: approx. 7.3 kg. Color: techno-brown.
 Cabinet (mm): W 285, H 145, D 380.
 Lockable tilt handle.
 Subject to change.

Test Displays

using the Component Tester

Resistor 510 Ω

2 diodes, antiparallel



20 MHz Standard Oscilloscope

Y: 2 channels, DC-20 MHz, max. sensitivity 2 mV/cm;

X: 0.2 s/cm - 20 ns/cm incl. x 10 magnification;

triggering up to 40 MHz; Component Tester.

The HM203 series is **Western Europe's best-selling oscilloscope**. Both vertical amplifiers incorporate **variable gain controls**, and maximum input sensitivity is **2 mV/cm** over the full bandwidth of the oscilloscope. Another feature permits display of the **sum and difference** of two signals.

Triggering facilities have also been expanded. In addition to **line** and **TV** triggering, **HF** and **DC** triggering are possible. The HM203-5 will **trigger** stably with a 5 mm display height up to at least **40 MHz**. Using the manual level control, even relatively complex signals can be stably triggered. The time resolution in horizontal direction is increased now, including **x10 magnification**, to max. **20 ns/cm**.

An 8x10 cm **internal graticule** permits **parallax-free viewing** over a wide angle. The effect of the earth's magnetic field upon horizontal trace position can be compensated for, externally, with a **trace rotation** control.

The HM203-5 has a built-in **Component Tester**, which is especially useful in maintenance and servicing work. Among other applications, this device enables rapid **in-circuit testing** of semiconductors. Test voltage and current are rated so that normal semiconductors or other components cannot be damaged. **Test results are displayed on the scope screen.**

The HM203-5 was designed for **general purpose applications** in industry and service. Its many operating modes, front panel layout, and **ease of operation** also make it an ideal oscilloscope for use in training engineers and technicians.

CSA APPROVED

LIST \$835.00

Accessories optional

Probes: 1X, 10X, 10X(HF), 100X, 1X/10X (switchable); demodulating probe; test cables BNC-BNC and banana-BNC; 50 Ω BNC feed-through termination; viewing hood; carrying case; etc.

Specification

Operating Modes

Channel I, Channel II, Channel I and II alternate or chopped (chop frequency ≈ 0.5 MHz), sum or difference Ch.II \pm Ch.I (with Ch.I INV. button)
X-Y mode: same sensitivity in both directions.

Vertical Deflection (Y)

Bandwidth of both channels
 DC to 20 MHz (-3 dB), DC to 28 MHz (-6 dB).
 Risettime: ≈ 17.5 ns, Overshoot: max. 1%.
Deflection coefficients: 12 calibrated steps, 5 mV/cm to 20 V/cm in 1-2-5 sequence, with variable control 2.5:1 up to at least 50 V/cm. Accuracy in calibrated position: $\pm 3\%$.
Y-Magnification x5 calibrated to 1 mV/cm, bandwidth: DC to 5 MHz (-3 dB).
Input impedance: 1 M Ω || 30 pF.
 Input coupling: DC-AC-GND.
 Input voltage: max. 400V (DC + peak AC).
Y-Output from Ch.I or Ch.II: ≈ 45 mV/cm into 50 Ω .
 Y-Overscanning indication: with 2 LEDs.
Delay line: to view leading trigger edge.

Timebase

Time coefficients: 21 calibrated steps, 0.1 μ s/cm to 0.5 s/cm in 1-2-5 sequence, with variable control 2.5:1 to at least 1.25 s/cm, with **X-Magnification x10** ($\pm 5\%$) to 10 ns/cm. Accuracy in calibrated position: $\pm 3\%$.
Hold-off time: variable control 10:1.
 Ramp output: approx. 5V (on rear panel).
Trigger system: Automatic (peak-to-peak value) or Normal Trig. LED indication for trig. action.
Single sweep Single-Reset buttons with LED.ind. Slope: positive or negative.
 Sources: Ch. I, Ch. II, alternate Ch.I/II, line, external.
 Coupling: AC-DC-HF-LF (TV frame).
Threshold: internal 5mm, external 50mV.
 Bandwidth: DC to 50MHz.
Sweep delay: 7 decade steps, 100ns to 0.1 s, with variable fine control, approx. 10:1 to 1 s.
 Modes: Search, Delay. With LED indication.

Horizontal Deflection (X)

Bandwidth: DC to 2 MHz (-3 dB).
 Input: via Ch. II (see Y deflection spec.).
X-Y phase shift: $< 3^\circ$ up to 120 kHz.

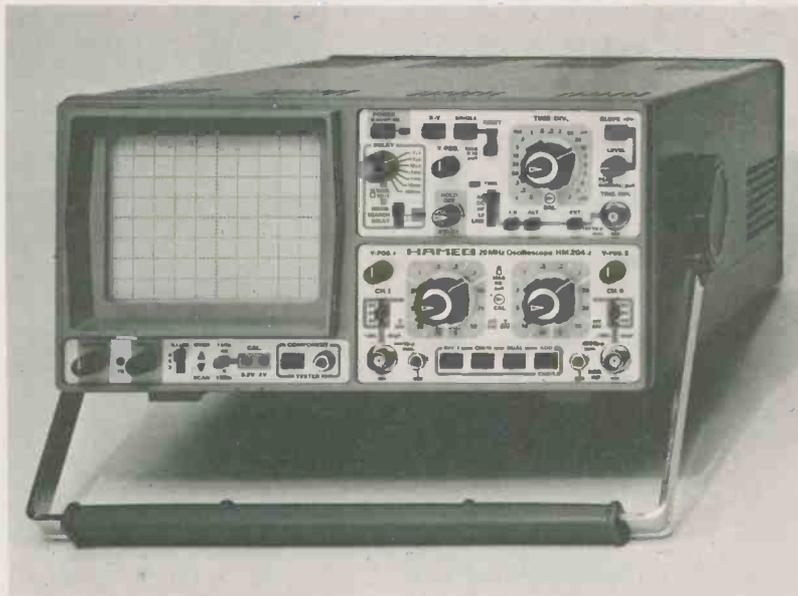
Component Tester

Test voltage: max. 8.5V rms (open circuit).
Test current: max. 24mA rms (shorted).
Test frequency: 50 or 60 Hz (line frequency).
 One test lead is grounded (Safety Earth).

General Information

Cathode-ray tube: D14-362 P43/93, P7/93 optional (long decay characteristic), rectangular screen, internal graticule 8 x 10 cm. Accelerating potential: 2000V.
 Graticule illumination: three-position switch.
 Trace rotation: adjustable on front panel.
 Z-Modulation input: positive TTL level = bright.
Calibrator: square-wave generator, ≈ 1 kHz/1MHz switchable, risetime < 5 ns, for probe compensation, output voltages: 0.2V and 2V $\pm 1\%$.
Regulated DC power supplies: all voltages.
Protective system: Safety Class I (IEC 348).
 Line voltages: 110, 125, 220, 240V AC.
 Permissible line fluctuation: $\pm 10\%$.
 Line frequency range: 50 to 400 Hz.
Power consumption: approx. 41 Watts.
 Weight: approx. 7.7 kg. Color: techno-brown.
 Cabinet (mm): W 285, H 145, D 380.
 Lockable tilt handle.

Subject to change.



20 MHz Multifunction Oscilloscope

Y: 2 channels, DC-20MHz, max. 1 mV/cm, delay line;
X: 1.25s/cm - 10 ns/cm incl. x10 magnification, delayed sweep; triggering up to 50MHz; var. hold-off time; Component Tester.

Particularly the **HM204** demonstrates the **high performance** standards and design philosophy found in **HAMEG's 20MHz-Oscilloscopes**.

The most outstanding features of this instrument are the maximum **time resolution** of up to **10ns/div.** (incl. 10x magnification) and the built-in **signal delay line** for viewing the trigger edge - features not found until now in this class and price range. Like instruments with a second timebase, the HM204's **variable sweep delay** enables detailed signal analysis by expanding any section of a waveform.

Other key features of this oscilloscope are normal and **peak-value triggering** up to **50MHz**, alternate trigger for display of two asynchronous signals, and single sweep operation. The **variable hold-off time** facilitates stable displays of complex and aperiodic waveforms.

A **Component Tester** for checking electronic components individually or in-circuit is also incorporated as an indispensable asset for troubleshooting. Yet another unique feature is the switchable **1kHz/1MHz calibrator** for checking transient response of scope and probes.

Despite its versatility, the HM204 has been specifically designed for durability and ease of operation. Operators comfort is increased by **LED indicators** for overscan, delay mode, single sweep, and trigger action. The overscan LEDs indicate if any part of a waveform passes the vertical screen limits. A fully shielded and burn-in resistant rectangular CRT with **illuminated internal graticule** and trace rotation underline the quality of this oscilloscope.

CSA APPROVED

LIST \$1120.00

Accessories optional

Probes: 1X, 10X, 10X(HF), 100X, 1X/10X; demodulating probe; test cables BNC-BNC and banana-BNC; 50 Ω BNC termination; 4-Channel Amplifier; viewing hood; carrying case; etc.

Specification

Operating Modes

Channel I, Channel II, Channel I and II alternate or chopped (chop frequency ≈ 0.5 MHz), sum or difference Ch.I \pm Ch.II (with Ch.I INV. button)
X-Y mode: same sensitivity in both directions.

Vertical Deflection (Y)

Bandwidth of both channels
 DC to 60 MHz (-3 dB), DC to 85 MHz (-6 dB).
 Risettime: ≈ 5.8 ns. Overshoot: max. 1%.
Deflection coefficients: 12 calibrated steps, 5 mV/cm to 20 V/cm in 1-2-5 sequence, with variable control 2.5:1 up to at least 50 V/cm.
 Accuracy in calibrated position: $\pm 3\%$.
Y-Magnification x5 calibrated to 1 mV/cm, bandwidth: DC to 5 MHz (-3 dB).
Input impedance: 1 M Ω || 30 pF.
 Input coupling: DC-AC-GND.
 Input voltage: max. 400V (DC + peak AC).
Y-Output from Ch.I or Ch.II: ≈ 45 mV/cm into 50 Ω .
 Y-Overscanning indication: with 2 LEDs.
Delay line: to view leading trigger edge.

Timebase

Time coefficients: 23 calibrated steps, 50 ns/cm to 1 s/cm in 1-2-5 sequence, with variable control 2.5:1 to at least 2.5 s/cm, with **X-Magnification x10** ($\pm 5\%$) to 5 ns/cm.
 Accuracy in calibrated position: $\pm 3\%$.
Hold-off time: variable control 10:1.
 Ramp output: approx. 5V (on rear panel).
Trigger system: Automatic (peak-to-peak value) or Normal Trig. LED indication for trig. action.
Single sweep: Single-Reset buttons with LED ind. Slope: positive or negative.
 Sources: Ch. I, Ch. II, alternate Ch.I/II, line, external.
 Coupling: AC-DC-HF-LF (TV frame).
Threshold: internal 5 mm, external 50 mV.
 Bandwidth: DC to at least 80 MHz.
Sweep delay: 7 decade steps, 100 ns to 0.1 s, with variable fine control, approx. 10:1 to 1 s.
 Modes: Search, Delay. With LED indication.

Horizontal Deflection (X)

Bandwidth: DC to 5 MHz (-3 dB).
 Input: via Ch. II (see Y deflection spec.).
X-Y phase shift: $< 3^\circ$ up to 120 kHz.

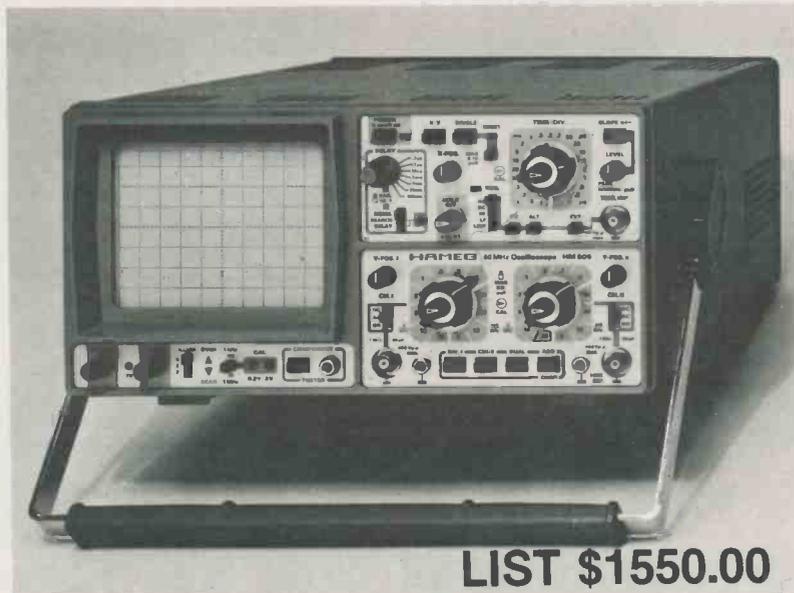
Component Tester

Test voltage: max. 8.5V rms (open circuit).
Test current: max. 24 mA rms (shorted).
Test frequency: 50 or 60 Hz (line frequency).
 One test lead is grounded (Safety Earth).

General Information

Cathode-ray tube: D14-370 P31/113R, P7/113R optional (long decay characteristic), internal graticule 8 x 10 cm.
 Total accelerating potential: approx. 15 kV.
 Graticule illumination: three-position switch.
 Trace rotation: adjustable on front panel.
 Z-Modulation input: positive TTL level = bright.
Calibrator: square-wave generator, ≈ 1 kHz/1 MHz switchable, risetime < 5 ns, for probe compensation, output voltages: 0.2V and 2V $\pm 1\%$.
Regulated DC power supplies: all voltages.
Protective system: Safety Class I (IEC 348).
 Line voltages: 110, 125, 220, 240V AC.
 Permissible line fluctuation: $\pm 10\%$.
 Line frequency range: 50 to 400 Hz.
Power consumption: approx. 43 Watts.
 Weight: approx. 7.5 kg. Color: techno-brown.
 Cabinet (mm): W 285, H 145, D 380.
 Lockable tilt handle.

Subject to change.



LIST \$1550.00

60MHz Multifunction Oscilloscope

Y: 2 channels, DC-60MHz, max. 1 mV/cm, delay line;
X: 2.5s/cm-5 ns/cm incl. x10 magnification, delayed sweep; triggering up to 80MHz; var. hold-off time; Component Tester.

The new **HM605** is a truly **versatile scope** satisfying a wide variety of exacting requirements in **laboratory, production, and service**. The maximum input sensitivity of **1mV/div.** facilitates the display of extremely low-level signals. Despite their high sensitivity, the HM605's vertical amplifiers are of **excellent stability and low drift** design with not more than 1% overshoot.

The built-in **delay line** permits viewing of the trigger edge at all times. The **overscan feature** indicates if any part of the trace passes the vertical limits of the CRT screen. An **analog Y-output**, switchable to Channel I or II, allows further processing of the signal.

Reliable triggering is ensured up to at least **80MHz**, and trigger facilities include vertical mode **alternate triggering**, line trigger and single sweep operation. Other trigger features are **variable hold-off time**, RF- and LF-filters at any sweep speed for TV frame and line displays, as well as normal and **automatic peak-value triggering**. An LED indicates when the sweep is triggered. Sweep ranges from **5ns/div. to 2.5s/div.** ensure optimum resolution of slow and fast signals. The **variable sweep delay** facility enables any section of the waveform to be expanded by **1000** and more for detailed signal analysis. A rectangular **14kV CRT** with illuminated graticule provides exceptionally bright and sharp displays.

A **unique feature** for scopes in this price range is the built-in **switchable 1kHz/1MHz squarewave generator** providing **0.2V** and **2V** calibration signals with a risetime < 5 ns. It is now possible to self-test instantly the transient response of the vertical amplifiers and compensation of **modular attenuation probes** for utilization of the **full bandwidth of scope and probe**.

A **Component Tester** is also incorporated. The HM605's **outstanding price/performance capability** is not likely to be matched by similar products in the near future.

Accessories optional

Probes: 1X, 10X, 10X(HF), 100X, 1X/10X; demodulating probe; test cables BNC-BNC and banana-BNC; 50 Ω BNC termination; 4-Channel Amplifier; viewing hood; carrying case; etc.

Specification

Normal Operating Modes

Channel I, Channel II, Channel I and II alternate or chopped (chop freq. ≈ 0.5 MHz), sum or difference: Channel II \pm Channel I.
X-Y mode: same sensitivity in both directions.

Vertical Deflection (Y)

Bandwidth of both channels:
 DC to 20 MHz (-3 dB) in the normal mode.
 Rise time: 17.5 ns. Overshoot: max. 1 %
Deflection coefficients: 12 calibrated steps, 5 mV/cm to 20 V/cm in 1-2-5 sequence, with variable control 2.5:1 up to at least 50 V/cm. Accuracy in calibrated position: ± 3 %.
Y-Magnification x5 calibrated to 1 mV/cm, bandwidth: DC to 5 MHz (-3 dB).
Input impedance: 1 M Ω || 30 pF.
 Input coupling: DC-AC-GND.
 Input voltage: max. 400 V (DC + peak AC).

Timebase

Time coefficients: 18 calibrated steps, 0.2 μ s/cm to 0.1 s/cm in 1-2-5 sequence, with variable control 2.5:1 up to at least 0.25 s/cm, with **X-Magnification x10** (± 5 %) to 20 ns/cm. Accuracy in calibrated position: ± 3 %.
Trigger system: Auto or Normal. LED indication. Slope: positive or negative.
 Sources: Ch. I, Ch. II, line, ext., ext. \rightarrow 10.
 Coupling: AC, DC, HF, LF (TV frame).
Threshold: internal 5 mm, external 50 mV.
 Bandwidth: DC to at least 40 MHz.
 Ext. trig. input: max. 100 V pp, imp. 1 M Ω || 30 pF.

Horizontal Deflection (X)

Bandwidth: DC to 2 MHz (-3 dB).
 Input: via Channel II (see Y deflection spec.).
X-Y phase shift: $< 3^\circ$ up to 150 kHz.

Digital Storage

Memory: 4096 x 8 bit. Ch. I: 2048 points/pattern. 2-channel: 1024 points/pattern. Backing memory: 1 x 2048 points or 2 x 1024 points.
Clock rate: Channel I max. 20 MHz, Channel I and Channel II: max. 10 MHz.
Vertical resolution: 256 points for 10 cm.
Horizontal resolution: 1024 points for 10 cm.
Modes: Roll, Refresh, Single, X-Y operation, addition: Ch. II \pm Ch. I, Hold Ch. I, Hold Ch. II, Pre-Trigger: 25-50-75-100%. Time exp.: 10x.
Plotter output: Y 0.1 V/cm, X 0.1 V/cm (± 10 %) for the stored signal of CH. I or CH. II.
 X and Y output impedance: 100 Ω .
 Plotter writing speed selectable in 3 steps:
 2-channel = 5 s/cm to 20 s/cm,
 1-channel = 10 s/cm to 40 s/cm (max. clock rate).
 Pen lift command: TTL and CMOS compatible.

General Information

Cathode-ray tube: D14-370 P31/113R, approx. 14 kV, rect. screen 8x10 cm, int. graticule, quick heating. Graticule illumination: three-position switch. Trace rotation: adjustable on front panel.
Calibrator: square-wave generator ≈ 1 kHz/1 MHz for probe compensation. Output 0.2 V and 2 V ± 1 %.
Regulated DC power supplies: all voltages.
Protective system: Safety Class I (IEC 348).
 Line voltages: 110, 125, 220, 240 V AC.
 Permissible line fluctuation: ± 10 %.
 Line frequency range: 50 to 60 Hz.
Power consumption: approx. 46 Watts.
 Weight: approx. 9 kg. Color: techno-brown.
 Cabinet (mm): W 285, H 145, D 380.
 With lockable tilt handle.

Subject to change.



LIST \$3350.00

20 MHz Digital Storage Oscilloscope

Y: 2 channels, DC-20 MHz, max. sensitivity 1 mV/cm;
X: 0.25 s/cm-20 ns/cm incl. x10 magnification, trig. to 40 MHz.
Storage: max. clock rate 20 MHz; Single and X-Y operation.

The new **HM208** can be used as a normal 20 MHz realtime oscilloscope or as a **digital storage instrument** featuring **20 MHz maximum digitizing rate** in single-channel, or 10 MHz in dual-channel storage mode.

All operating modes, such as single- or dual-channel operation, add- or differential mode, X- and Y-expansion, X-Y operation, as well as the **various trigger facilities** are also **available in storage operation**. The nature of digital storage offers still many more display possibilities, which are fully taken advantage of in the **HM208**. Single-shot mode, for example, enables the capture of periodic and aperiodic one time events. As a result of intermediate storage, the reduction of trace brightness, normally observed at higher frequencies, is avoided.

Extremely low-frequency events can be stored, where the waveform is no longer indicated by a moving dot, but is now **displayed in its entirety**. In **roll mode** the HM208 functions very similar to a chart recorder, with the signal running slowly from right to left with continuous trace. With the HM208, **pre-trigger history** can be set to four different values, max. 100 %. A periodically repeating signal acquisition is possible in the **refresh-mode**. In X-Y operation, characteristic curves, transfer loci, and Lissajous figures can be stored at low frequencies.

A special **background memory** provides the possibility of storing a reference signal, while another signal occupies the main memory with equal resolution. At any time and as often as required, **these signals can be displayed on the screen**. A 14 kV CRT ensures bright and clear displays in all modes.

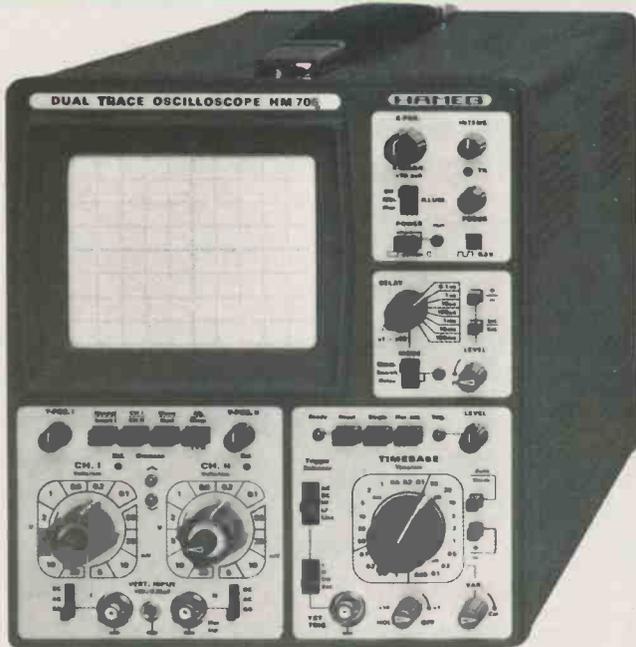
Stored waveforms may be recorded using a chart- or X-Y recorder. **Readout speed is variable** to match the required degree of resolution.

An **IEC-Bus option** is available (talk only) to transmit stored waveforms to a listener or controller.

Accessories optional

Probes: 1X, 10X, 10X(HF), 100X, 1X/10X; demodulating probe; test cables BNC-BNC and banana-BNC; 50 Ω BNC termination; viewing hood; carrying case; IEC-Bus for HM208.

HAMEG 70 MHz OSCILLOSCOPE HM 705



Y: DC-70MHz, max. 2mV/cm

X: 5ns/cm to 2.5s/cm

Triggering DC to 100MHz

Delayed Sweep Mode

The General-Purpose Oscilloscope HM705 with its multitude of operating modes and trigger facilities is designed for both laboratory and field service. The maximum Y sensitivity of 2mV/cm at full band-width shows the outstanding performance of both vertical amplifiers. The HM705 triggers even complex signals beyond 100MHz. Two non-synchronous signals, or a composite signal with a non-synchronous component, and also aperiodic events can likewise be triggered. Single-shot operation is also possible. The wide sweep range from 5ns/cm (including 10x magnification) to 2.5s/cm gives an excellent resolution. Additionally, it is possible to expand short signal periods by factor of 1000 using the sweep delay. Several LEDs facilitate easy handling and help prevent incorrect setting. The 14kV CRT with rectangular screen and illuminated internal graticule ensures an extremely bright and well defined display.

Limited Supply

\$1550.00

Component Tester



HZ65

LIST \$75.00

Test Cable —

4mm Banana

126074

Coaxial test cable; length 1.15m, characteristic impedance 50 OHM, cable capacitance 12pF. Input voltage max. 500Vp.

\$10.40

Test Cable BNC-BNC

126023

Coaxial test cable; length 1.2m, characteristic impedance 50 OHM, cable capacitance 126pF. Input voltage max. 500Vp.

\$9.48

Adapter 4mm Banana to BNC T627

Two 4mm binding posts (19mm between centers) to standard BNC male plus. Input voltage max. 500Vp.

\$11.50

50 OHM Through-Termination 805-53-000

For terminating systems with 50 OHM characteristic impedance. Maximum load 2W. Max. voltage 10Vms.

\$26.17

Carrying Cases

For HM203-1 and HM203-3 HZ42 **\$66.00**

For HM312, HM412, HM512, and HM705 HZ43 **\$48.00**

For HM307, HZ62, and HZ64 HZ44 **\$39.00**

For HM103 HZ45 **\$39.00**

For HM204-4, HM204, and HM605 HZ46 **\$73.50**

Viewing Hoods HZ47

For HM203, HM204, HM208, HM605, HM705, HM808, HM312, HM412, HM512, and HM812 **\$14.00 ea.**

Scope Tester HZ60

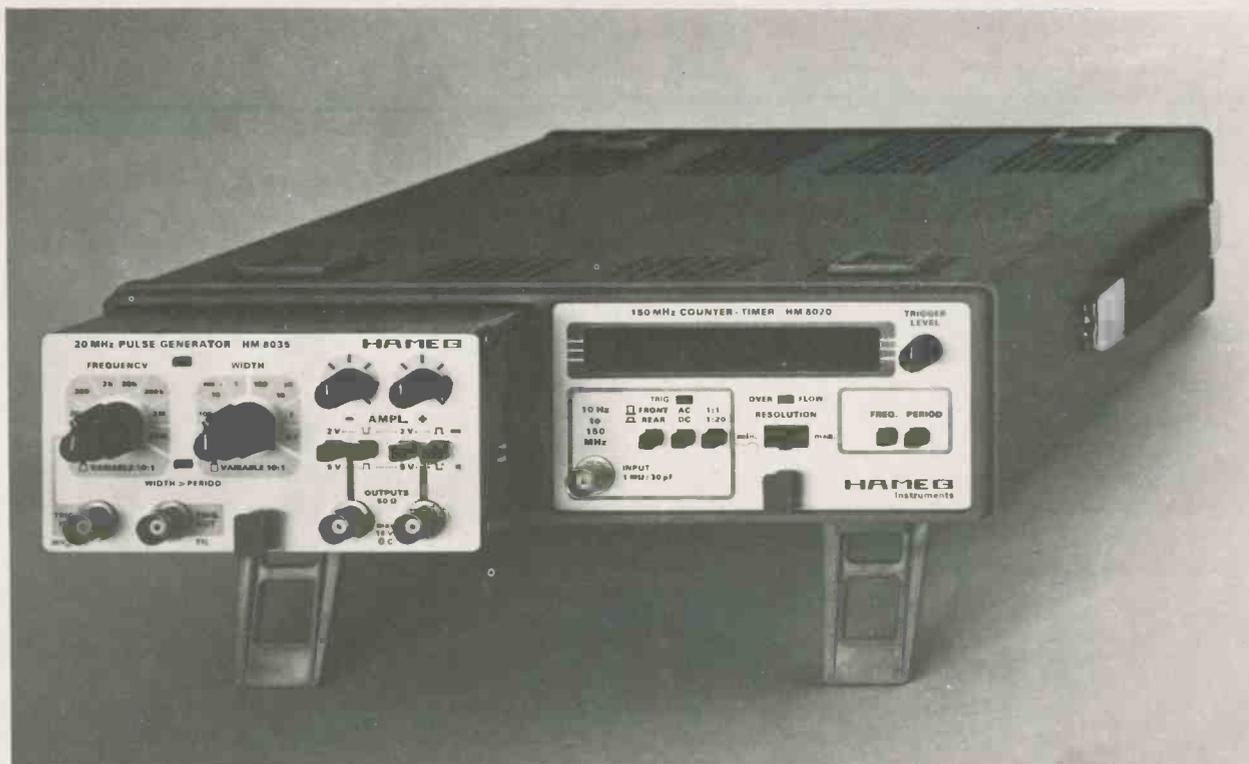
For checking the Y amplifier, timebase, and compensation of all probes, the HZ60 provides a crystal-controlled, fast-rising (typ.3ns) square-wave generator with switchable frequencies of 1, 10, 100kHz, and 1MHz. Three BNC outputs provide signals of 25mVpp into 50 OHM, 0.25Vpp (open circuit for 10X and 100X probes); accuracy $\pm 1\%$. Battery-powered or AC supply operated (optional). **\$63.75**

Indispensable for trouble-shooting in electronic circuits. Single component and in-circuit tests are both possible. The HZ65 operates with all scopes, which can be switched to X-Y operation (ext. horizontal deflection). Non-destructive tests can be carried out on almost all semiconductors, resistors, capacitors, and coils. Two sockets provide for quick testing of the 3 junction areas in any small power transistor. Other components are connected by using 2 banana jacks. Test leads supplied.

Examples of Test Display

Short circuit Capacitor 33 μ F Junction E-C Z diode <8V





More than 25 years of successful oscilloscope manufacturing experience are now being complemented by the introduction of the new **Modular-System HM8000**. It consists of a mainframe unit with built-in power supply and an increasingly wide selection of measurement and generator plug-ins. The mainframe, accommodating up to two plug-in modules, has been designed to match the new **HAMEG** flat-line oscilloscope series. The basic unit may be placed above or beneath the oscilloscope, or may be stacked together with other mainframes.

PWR MODULE HM 8001 **LIST \$325.00**

Specification of the mainframe

General

Accommodates any two modules. Two BNC connectors on rear panel for interfacing with each compartment.

Supply voltages for the modules

2x 8V AC, max. 0.5A each. 2x +5V DC, max. 0.8A each.
4x + or -10V to 25V DC, max. 0.5A to 0.5A each.
Power output: 2x 30 Watts (max. 30W per module).
Each individual voltage is floating (500V AC test voltage to chassis).

Other informations

Line voltage: 110, 125, 220, 240V AC. Line freq.: 50 to 60 Hz.
Power consumption: max. 75W. Protection: Safety Cl. I (IEC 348).
Dimensions: **H** 75, **W** 285, **D** 365 mm. Weight: approx. 5.5 kg.
Color: techno-brown. With handle and two tilt stands.

Subject to change

Compared to individual measuring instruments, the new **Modular System HM8000**, in combination with the **HAMEG** Oscilloscope, enables the user to assemble a complete variable test rack utilizing a minimum of space. Rear-panel interfacing capability between oscilloscope and mainframe enables several modules to benefit from and even extend the oscilloscope's functions. When changing measurement procedures, only the corresponding plug-in needs to be changed. The module technique avoids the expense of now superfluous multiple power supplies and equipment casing, thus considerably reducing the cost of the test setup.

Due to the extended measurement flexibility provided by the new **Modular System HM8000**, it is ideally suited for individual use just as much as for larger group test areas generally installed for Service, Development, Production Control, and Training.

This unique flexibility will be the future standard.

Accessories optional

Module rack HZ81 for four modules, suited also for wall-mounting.
Footrest HZ82. Adapter BNC-Banana HZ20.
Coaxial-cable BNC-BNC HZ85.

DIGITAL MULTIMETER HM8011



Apart from its **favourable price/performance ratio**, only on comparing features will be seen what this multimeter has to offer. Compared to most 3½ digit instruments with 2,000 counts, normally found in this price range, the **HM8011 features 4,000 counts**. This adds **one more digit of resolution** to all measured values in the top half of all ranges. In this way, the display corresponds to that of a 4½ digit multimeter with 20,000 counts.

The **HM8011** features excellent zero-stability which is better than in 4½ digit multimeters. **True RMS values** are measured and displayed in the AC voltage and current ranges, and the **100 ms integration time** effectively eliminates the influence of line disturbances at 50/60 Hz. The **high intensity 7-segment LED-display** is easy to read, even in high ambient light and from a distance. Over-range is indicated by a flashing display.

With its **26 measuring ranges** and 0.1% DCV accuracy, this multimeter module is ideally suited for general applications in industry, laboratory, service and education.

LIST \$460.00

Specification

Digital Multimeter with 3½ digits readout resolution, with automatic decimal point and polarity indication. Readout 4 digits 7 mm high. Blinking overrange indication. Input impedance for DC and AC voltages: 10MΩ || 100pF. Operating temperature range: +15 °C to +30 °C.

DC-Voltage:	Ranges: 400 mV, 4, 40, 400 and 1000 V. Accuracy: ±(0.1% of reading + 1 digit).
DC-Current:	Ranges: 400 μA, 4 mA, 40 mA, 400 mA, 4 A. Accuracy: ±(0.5% + 1 digit).
AC-Voltage:	Ranges: 400 mV, 4, 40, 400 and 750 V. Accuracy: 40Hz to 400Hz: ±(0.5% + 5 digit). 0.4, 4, 40V: 20Hz-20kHz: ±(1.5% + 5 digit).
AC-Current:	Ranges: 400 μA, 4, 40, 400 mA and 4 A. Accuracy: 40 to 500Hz: ±(0.5% + 5 digit).

True RMS capability for AC voltage and current.
Both current inputs are protected by fuses.

Resistance:	Ranges: 400 Ω, 4, 40, 400 kΩ, 4, 40 MΩ. Accuracy: ±(0.5% + 1 digit + 0.2 Ω).
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Accessories optional

Test lead set HZ88 with probe tips and shock-proof plugs. High voltage probe HZ89 1000:1 with 1 GΩ input resistance for maximum 40 kV.

DIGITAL MULTIMETER HM8012



This digital multimeter measures voltage, current, and resistance with **increased accuracy and resolution** (4½ digits, 10 μV), featuring professional **autorange** convenience. Measurements are taken periodically at 0.4s intervals. **True RMS** capability provides more accurate AC measurements on distorted, noisy, random, or other nonsinusoidal waveforms. 100ms integration time effectively eliminate adverse influence from line power disturbances.

Autorange can be disengaged for manual range selection, where a **rotary switch** ensures **smoother operation** than several individual pushbuttons. Overrange will be indicated by flashing of the **bright 5-digit LED display**. Negative polarity and correct decimal point are indicated automatically.

Special emphasis has been placed on **high voltage protection** and high input insulation against floating and chassis ground.

The **HM8012** provides exceptional flexibility in laboratory, maintenance, and production applications requiring **high accuracy and operating convenience**.

LIST \$590.00

Specification

Digital Multimeter with 4½ digits readout resolution, with automatic decimal point and polarity indication. Autoranging or manual range selection. Readout 5 digits 7 mm high. Blinking overrange indication. Input impedance for DC and AC voltages: 10MΩ || 100pF. Operating temperature range: +15 °C to +30 °C.

DC-Voltage:	Ranges: 200 mV, 2, 20, 200 and 1000 V. Accuracy: ±(0.03% of reading + 2 digit).
DC-Current:	Ranges: 200 μA, 2 mA, 20 mA, 200 mA, 2 A. Accuracy: ±(0.1% + 2 digit).
AC-Voltage:	Ranges: 200 mV, 2, 20, 200 and 750 V. Accuracy: 45Hz to 10kHz: ±(0.2% + 5 digit). 0.2, 2, 20V: 20Hz to 20kHz: ±(1% + 5 digit).
AC-Current:	Ranges: 200 μA, 2, 20, 200 mA and 2 A. Accuracy: 40 to 500Hz: ±(0.5% + 5 digit).

True RMS capability for AC voltage and current.
Both current inputs are protected by fuses.

Resistance:	Ranges: 200 Ω, 2, 20, 200 kΩ, 2, 20 MΩ. Accuracy: ±(0.1% + 2 digit + 0.2 Ω).
--------------------	----------------------------------------------------------------------------------------

Accessories optional

Test lead set HZ88 with probe tips and shock-proof plugs. High voltage probe HZ89 1000:1 with 1 GΩ input resistance for maximum 40 kV.

COUNTER-TIMER HM 8020



The capabilities of this counter/timer permit measurement of all frequencies from less than 1Hz up to 150MHz, as well as periods from 1 μ s to 100s. When operating the HM8020 as a system-unit, its input can be switched to provide rear panel interfacing capability between an oscilloscope and the mainframe unit HM8001.

In the period averaging mode, timing resolutions of 1 ns facilitate precise and reliable measurement in fast logic circuitry.

Measurement readout is provided by bright seven-segment LEDs in an eight-digit display with automatically positioned decimal point and blanked leading zeros.

Backed by the state-of-the-art LSI technology, this counter was designed and built to meet most measuring needs, with maximum performance and operating convenience at low cost.

LIST \$415.00

HM8021 Counter-Timer

Frequency counter plug-in 10Hz to 1GHz
Similar to above

LIST \$590.00

Specification

Frequency Measurement

Frequency range: DC to 150 MHz.
Accuracy: ± 1 Digit \pm timebase error.
DC input: 0 to 150 MHz. **AC input:** 30 Hz to 150 MHz.
Sensitivity: 20 mV RMS to 100 MHz, 50 mV RMS to 150 MHz for sine-shaped signals.
Input impedance: 1 M Ω || 30 pF.
Input switch-selected: front/rear panel HM8001.
Trigger level: continuously variable up to max. ± 2 V, with attenuator button 20:1 (-26 dB).
Gate time: 10ms, 100ms, 1s, 10s.

Period Average

Range: 1 μ s to 100s (DC to 1 MHz).
Events averaged (N): 1, 10, 100, 1000.
Resolution: 1ns with N = 1000.
Accuracy: ± 1 digit \pm timebase error \pm trigger jitter/N.
Timebase: 1 MHz, accuracy $1 \cdot 10^{-7}$ (+10 $^{\circ}$ C to +40 $^{\circ}$ C).

Displays

8-digit 7-segment LED readout; leading zero suppression; automatic decimal point positioning corresponding to resolution; LED indic. for kHz, MHz, ms and μ s, overflow and trigger action.

Accessories optional

50 Ω test cable (BNC-BNC) HZ34. Probes X1, X10, X100 (HZ50 to 54).

FUNCTION GENERATOR HM 8030



The various signals available from this module make the HM8030 a versatile signal source for most applications in test and measurement. The low frequency ranges are particularly well suited to simulate mechanical and servo techniques.

Frequencies are read out on a 4-digit LED display. Two variable (fine and coarse) frequency controls facilitate accurate frequency adjustments.

Special quality features are the relatively low distortion factor and impressive, constant amplitude flatness throughout the entire frequency range. When operated in the offset mode, the limitations of the output levels are indicated by LEDs. All outputs are short-circuit-proof. The HM8030 can also be used in the sweep mode with an external signal source.

LIST \$415.00

Specification

Operating Modes

DC-Sine-Square-Triangle (with or without DC offset).
Generator free running or externally frequency modulated.

Frequency Ranges

0.1Hz to 1MHz, subdivided in 7 decade steps.
Variable $\times 0.08$ to $\times 1.2$ (1:15), fine var. approx. $\pm 2\%$.
Freq. stability: 0.1%/h or 0.5%/24h (at const. amb. temp.).

Characteristics

Sine distortion: max. 0.5% 0.1 Hz to 100 kHz, max. 1.5% 100 kHz to 500 kHz, max. 3% 500 kHz to 1 MHz.
Squarewave risetime: max. 70 ns (10-90%).
Triangle non-linearity: max. 1% up to 100 kHz.

Displays

Frequency readout with digital LED display (four-digit):
1% ± 1 digit up to 100 kHz, 3% ± 1 digit 100 kHz to 1 MHz.
Overdrive indication: with 2 LEDs.

Outputs

50 Ω : max. 12.5Vp into 50 Ω , max. 25Vp open circuit
Attenuation approx. -60 dB: 2 steps -20 dB ± 0.1 dB each, at least -20 dB additional with AMPL. control.
Amplitude flatness: error $< 2\%$ from 0.1 Hz to 1 MHz.
DC offset: continuously variable (disconnectible).
Offset range: ± 6.25 V into 50 Ω , ± 12.5 V open circuit.
Trigger output: approx. 4V (TTL), short-circuit-proof.

VCF Input (FM)

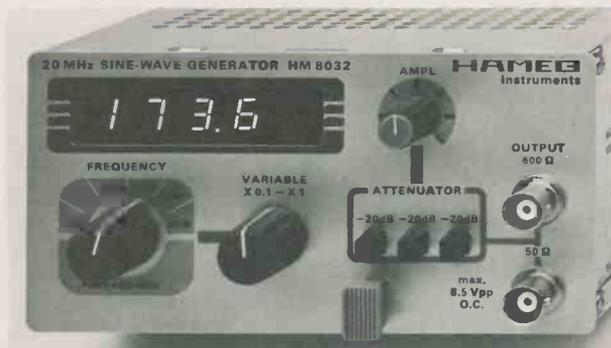
Frequency change: max. 100:1 with max. +5V input amplitude.
Input impedance: 50 k Ω || 25 pF.

Accessories optional

50 Ω test cable BNC-BNC HZ34. Adapter BNC-Banana HZ20. 50 Ω through-termination HZ22.

SINE WAVE GENERATOR HM8032

PULSE GENERATOR HM8035



Outstanding characteristics of this sine wave generator are the **wide frequency range** and the exceptionally **high amplitude stability**. It is especially useful for wideband measurements on linear amplifiers and systems up to **approx. 20MHz**. As a high quality signal source, however, the **HM8032** is equally suitable for many other applications as test oscillator with **low total harmonic distortion**, e.g. in the audio and video sectors.

The **internal frequency counter** with 4-digit LED display enables exact adjustments of the desired frequency.

The use of high quality components in the frequency-determining circuitry provides a **long term stability of better than 0.3%** in 24 hours. Both outputs are short-circuit-proof.

The convenient and clear arrangement of the front panel ensures that even operators with limited experience in the measurement field will soon become familiar with the **HM8032**.

LIST \$415.00

HM8037 (not shown)

Constant amplitude sine-wave-generator
plug in 5Hz to 50KHz.

\$325.00

Specification

Operating Mode

Sine-wave-generator, free running, with AGC.

Frequency Range

20Hz to 20MHz, subdivided into 6 decade steps.
Variable control x0.1 to x1.2 (1:12).

Freq. stability: 0.1%/h or 0.3%/24h (at const. amb. temp.).

Displays

Frequency readout with digital LED display (four-digit).

Accuracy: 0.1% ± 1 digit.

Indication for Hz, kHz, and MHz with 3 LEDs.

Sine distortion

20Hz to 500kHz: max. **0.2%**, 500kHz to 1MHz: max. **1%**,
1MHz to 20MHz max. **5%**.

Outputs

50Ω and 600Ω: amplitude max. 3V rms (= 8.5Vpp) open circuit,
max. 1.5V rms (= 4.25Vpp) into nominal load.

Attenuation approx. -80dB: 3 steps -20dB ±0.1dB each,
at least -20dB additional with AMPL. control.

Amplitude flatness: ±0.2dB from 20Hz to 2MHz,
±0.5dB from 2MHz to 20MHz.

Accessories optional

50Ω test cable (BNC-BNC) HZ34. Adapter BNC-Banana HZ20. 50Ω through-termination HZ22.

The pulse generator HM8035 is an extremely **versatile 20MHz signal source** for analog, digital and logic applications in laboratory, production and maintenance.

Key features of this module are its wide range of variable pulse frequencies and pulse period durations, the constant **fast rise and fall time (<3.5ns)**, a calibrated position for squarewave output with 1:1 duty factor, normal or **complementary dual outputs**, as well as external trigger capability using TTL-pulses or sinewave signals in all ranges for **waveshaping** in conjunction with the TTL-level trigger output. An **error-LED** indicates when pulse width is greater than pulse period. Output amplitudes are variable or with preset, giving max. **5V into 50Ω** or max. **10V at open circuit**, positive or negative relative to ground. All outputs are **short-circuit protected**. Its impressive performance, **compact design**, and **ease of operation** make the HM8035 well-suited to a large variety of digital and analog applications: Testing logic interfacing within systems or to peripherals, differential input amplifiers and multiplexers, wide-band amplifiers, or simulation of line drivers, opposite phase clocks, and switching cycles.

LIST \$635.00

Specification

Frequency Range

2Hz to 20MHz, subdivided into 7 decade steps,
continuously variable 10:1.

Pulse Width

20ns to 200ms, subdivided into 7 decade steps,
continuously variable 10:1.

Square-wave, 2Hz to 2MHz: duty factor 50% ±10ns,
2MHz to 20MHz: duty factor 50% ±5% ±10ns.
LED indication if pulse width > period time.

Dual Output

A: Amplitude **+5V into 50Ω** to ground,
+10V open circuit, variable 1:2.5.

B: Amplitude **-5V into 50Ω** to ground,
-10V open circuit, variable 1:2.5.

For each of the two independent outputs:

- attenuator 1:2.5 (-8dB) with pushbutton,
- pulse/interval inverter pushbutton,
- rise and fall time: <3.5ns,
- top ripple: <5% of pulse amplitude.

Trigger Input

TTL-level, sine signal 1Vpp to 30Vpp or
pulse signal, minimum pulse width 10ns.

Trigger Output

TTL-level, in same phase as Output A.

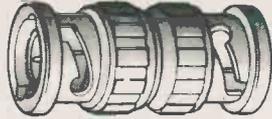
Accessories optional

test cable (BNC-BNC) HZ34. Probes X1, X10, X100
(HZ50 to 54). 50Ω through-termination HZ22.

CONNECTORS

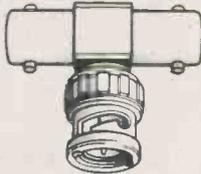
COLINE CONNECTORS. CONFORM TO THEIR RELEVANT MIL IEC AND DEC STANDARDS - (MADE IN ENGLAND)

SERIES BNC STRAIGHT ADAPTOR
50 Ohm Part no. 105-14-000



UG-491 B/u \$4.70 ea

SERIES BNC T ADAPTOR
50 Ohm Part No. 105-03-000



UG274A/u
\$7.22
ea.

50 or
75 Ohm
Specify

75 Ohm Part No. 107-03-000

SERIES BNC STRAIGHT ADAPTOR
50 Ohm Part No. 105-13-000



UG-914/u
\$4.83
ea.



SERIES BNC PLUG

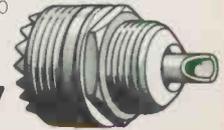
50 Ohm Part No. 125-01-010
Use with 55B/U, 58C/U, 141A/U,
142A/U Cable
75 Ohm Part No. 127-01-025
Use with 59B/U, 62A/U, 140/U, 210/U
cable.

UG-1785/u
UG-1789/u

\$2.73 ea.
Specify
Which NR

STANDARD
50 OHM

SERIES UHF BULKHEAD SOCKET
Part No. 230-28-000



UG-223/u \$3.07

SERIES BNC PLUG
50 Ohm Part No. 115-01-010
Use with 55B/U, 58C/U,
141A/U, 142A/U cable.
75 Ohm Part No. 117-01-025
Use with 59B/U, 62A/U,
140/U, 210/U cable

UG-88E/u
\$359.00



SERIES UHF PANEL SOCKET
Part No. 236-31-000

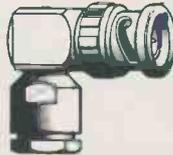


SO-239

\$1.71

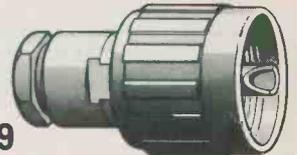
SERIES BNC ELBOW PLUG
50 Ohm Part No. 115-05-010
Use with 55B/U, 58C/U,
141A/U, 142A/U cable.
75 Ohm Part No. 117-05-012

UG-913/u
\$6.87



SERIES UHF PLUG
Part No. 210-01-010

Use with 55B/U, 58C/U, 141A/U, 142A/U cable.

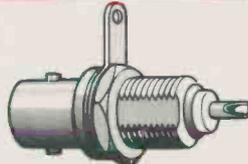


\$5.29

SERIES BNC BULKHEAD SOCKET
50 Ohm Part No. 135-22-000

UG1094A/u

\$3.16



SERIES UHF PLUG
Part No. 210-01-001

Use with 8A/U, 11A/U, 63B/U, 133A/U, 149/U,
165/U, 213/U cable.

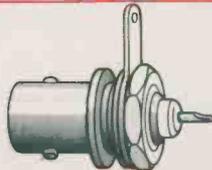


\$6.62

SERIES BNC BULKHEAD SOCKET
50 Ohm Part No. 135-22-000
75 Ohm Part No. 137-20-000

UG-1094/u

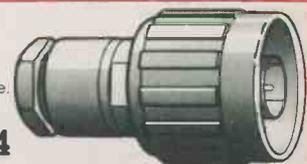
\$1.95
\$2.39



SERIES N PLUG
50 Ohm Part No. 315-01-010
Use with 55B/U, 58C/U, 141A/U, 142A/U cable.

UG-536B/u

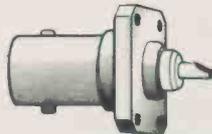
\$4.74



SERIES BNC PANEL SOCKET
Part No. Hole Size
135-32-000 Tapped 3-56 UNF
135-33-000 Drilled .110" Dia.
135-34-000 Drilled .120" Dia.

UG-290A/u

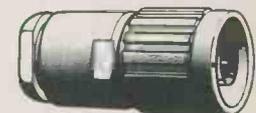
\$3.16
\$2.73
\$2.73



SERIES N PLUG
50 Ohm Part No. 315-01-001
Use with 8A/U, 11A/U, 63B/U, 133A/U, 149/U,
165/U, 213/U cable.

UG1185

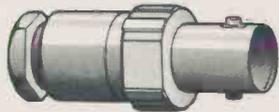
\$5.29



SERIES BNC JACK
50 Ohm Part No. 115-04-010
Use with 55B/U, 58C/U, 141A/U,
142A/U cable.

UG89CU

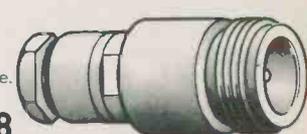
\$3.84



SERIES N JACK
50 Ohm Part No. 315-04-010
Use with 55B/U, 58C/U, 141A/U, 142A/U cable.

UG1185

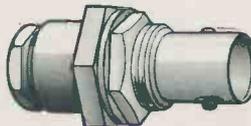
\$4.48



SERIES BNC BULKHEAD JACK
50 Ohm Part No. 115-07-010
Use with 55B/U, 58C/U, 141A/U,
142A/U cable.

UG909B/U

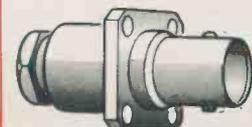
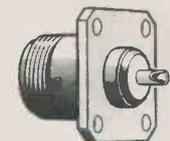
\$5.17



SERIES N PANEL SOCKET
50 Ohm Part No. 335-31-000

UG-58u

\$4.53

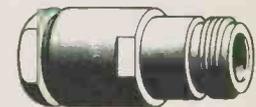


SERIES BNC PANEL JACK
50 Ohm Part No. 115-38-010
Use with 55B/U, 58C/U, 141A/U,
142A/U cable.

UG291B/u
\$4.01

SERIES N JACK
50 Ohm Part No. 315-04-001
Use with 8A/U, 11A/U, 63B/U, 133A/U, 149/U,
165/U, 213/U cable.

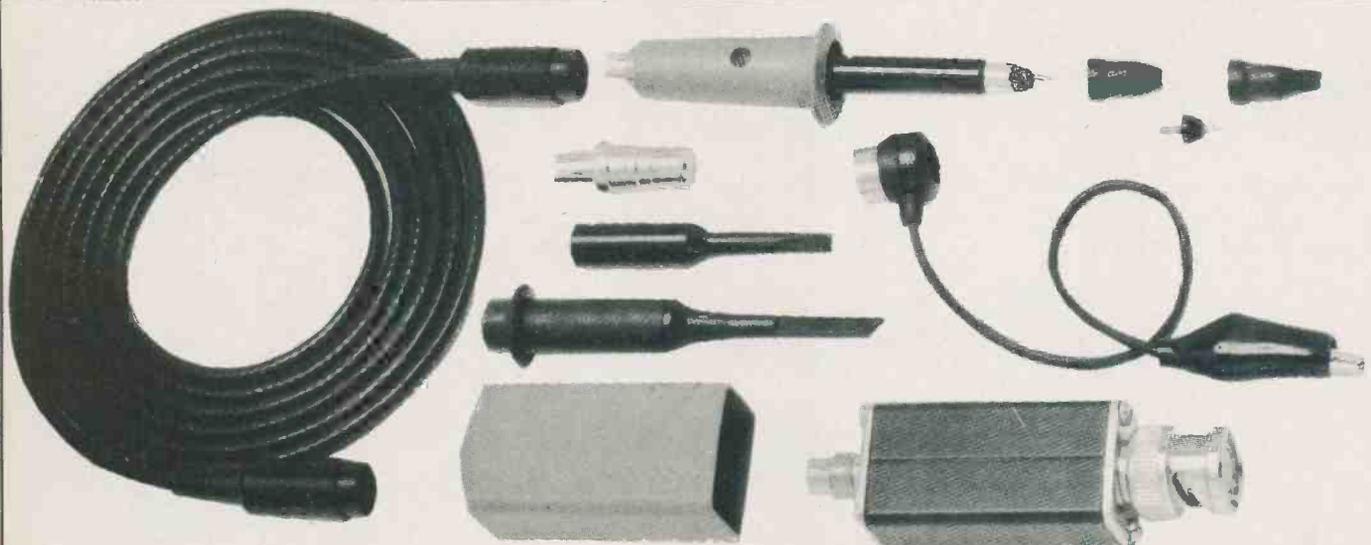
\$4.40



ALL PRICES INCLUDE F.S.T. ASK FOR QUANTITY OR OEM PRICES

Modular Oscilloscope Probes

A comprehensive range of high quality probes and accessories to assist in making a wide variety of oscilloscope measurements. The modular types feature pencil slim heads, detachable earth leads, wide bandwidths, excellent pulse response and field replaceable parts.

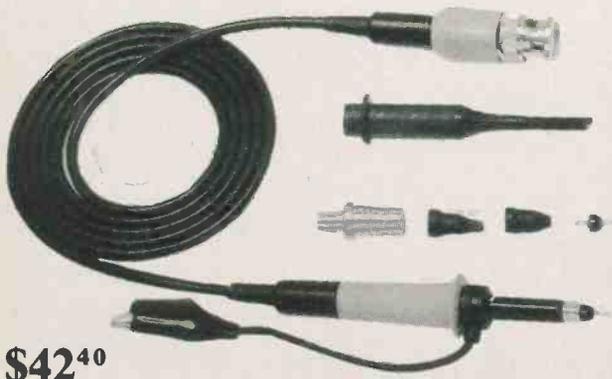


M15 × 10HF Modular × 10 High Frequency Probe

Attenuation Ratio	10:1	Maximum Input Voltage	600 Volts DC Including peak AC, derating with frequency
Bandwidth	DC - 300 MHz	Working Temperature Range	-25 to +70°C
Rise Time	1.2 nS	Cable Length	1.5 Metres
Input Capacitance	Nominal 16 p.F.	Input Resistance	10 MΩ When used with oscilloscopes which have 1 MΩ Input. (Probe resistance 9 MΩ ±1%)
Compensating Range	10-60 p.F.		
Standard Length		M20X10HF	M30X10HF
\$80³⁰		2 Metres Long \$87⁰⁰	3 Metres Long \$93⁷⁰

M12 X 1 Modular X 1 Probe

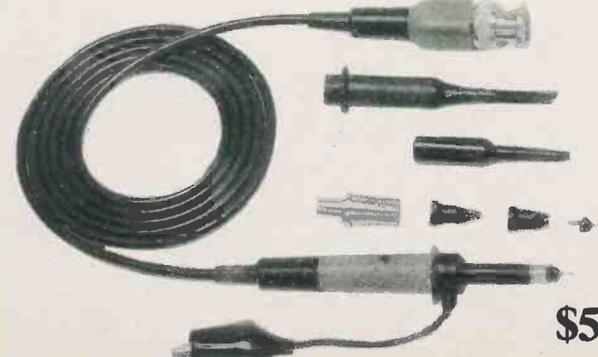
Attenuation Ratio	1:1
Bandwidth	DC - 30 MHz
Rise Time	11 nS
Input Capacitance	45 p.F. + Oscilloscope Input Capacitance
Input Resistance	1 MΩ (Oscilloscope Input resistance)
Maximum Input Voltage	600 Volts DC Including peak AC
Working Temperature Range	-25 to +70°C
Cable Length	1.2 Metres



\$42⁴⁰

M12 × 10 Modular × 10 Probe

Attenuation Ratio	10:1
Bandwidth	DC - 250 MHz
Rise Time	1.4 nS
Input Capacitance	Nominal 16 p.F.
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	1.2 Metres

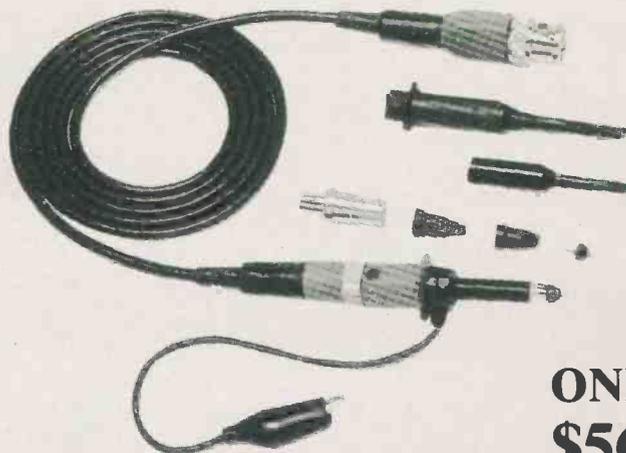


\$50¹⁰

Modular Oscilloscope Probes

M12SW Modular Switch Selectable $\times 1/\times 10$ Probe

$\times 1$ POSITION	
Attenuation Ratio	1:1
Bandwidth	DC-10 MHz
Rise Time	35 nS
Input Capacitance	40 p.F. + Oscilloscope Input Capacitance
Input Resistance	1 M Ω (Oscilloscope Input)
Maximum Input Voltage	600 Volts DC Including peak AC, derating with frequency
Working Temperature Range	-25 to +70°C
Cable Length	1.2 Metres
$\times 10$ POSITION	
Attenuation Ratio	10:1
Bandwidth	DC - 250 MHz
Rise Time	1.4 nS
Input Capacitance	Nominal 18 p.F.
Compensating Range	10-60 p.F.
Input Resistance	10 M Ω When used with oscilloscopes which have 1 M Ω Input. (Probe resistance 9 M Ω $\pm 1\%$)



**ONLY
\$56⁸⁰**

M12DM Modular RF Detector Probe

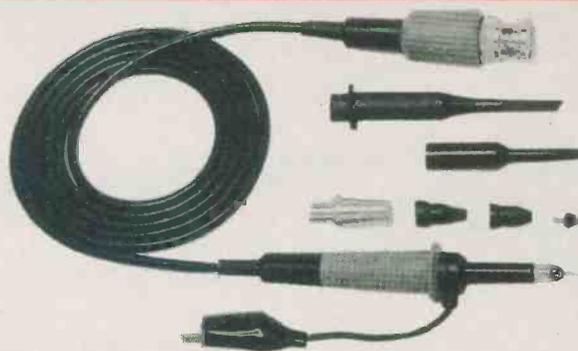
Bandwidth	100 KHz to 500 MHz ± 1 dB 100 KHz to 750 MHz ± 3 dB
Input Capacitance	Approx. 5 p.F.
Maximum AC Input Voltage	50 Volts RMS
DC Isolation Voltage	200 Volts DC Including peak AC
Diode Turn On Voltage	250 mV
Working Temperature Range	-25 to +70°C
Cable Length	1.2 Metres



\$53⁵⁰

M15 $\times 100$ Modular $\times 100$ Probe

Attenuation Ratio	100:1
Bandwidth	DC - 250 MHz
Rise Time	1.4 nS
Input Capacitance	Nominal 6.5 p.F.
Compensating Range	15-50 p.F.
Input Resistance	100 M Ω When used with oscilloscopes which have 1 M Ω Input. (Probe resistance 99 M Ω $\pm 1\%$)
Maximum Input Voltage	1200 Volts DC Including peak AC, derating with frequency.
Working Temperature Range	-25 to +70°C
Cable Length	1.5 Metres



\$56⁸⁰

Longer Length Modulares

Original Model	2 Meter Length	Price	3 Meter Length	Price
M12X1	M20X1	\$49.10	M30X1	\$55.80
M12X10	M20X10	\$56.80	M30X10	\$63.50
M15X100	M20X100	\$63.50	M30X100	\$70.20
M12DM	M20DM	\$60.20	M30DM	\$66.90
M12SW	M20SW	\$63.50	M30SW	\$70.20

Now activate your Tektronix Scope LED display exactly as the original. Model AP120485 fits most modular probes. Specify your model.

\$17⁰⁰ ea.



Fixed Lead Oscilloscope Probes

1P20 ×1 Oscilloscope Probe

Attenuation Ratio	1:1
Bandwidth	DC – 20 MHz
Rise Time	17 nS
Input Capacitance	55 p.F. + Oscilloscope Input Capacitance
Input Resistance	1 MΩ (Oscilloscope Input Resistance)
Maximum Input Voltage	600 Volts DC Including peak AC
Working Temperature Range	–25 to +70°C
Cable Length	1.5 Metres

Also available with cable lengths of 2 & 3 metres, details on request.

each \$31⁶⁰



LG3 Logic Analyser Probe

Attenuation Ratio	10:1
Bandwidth	DC – 100 MHz
Rise Time	Less than 1 nS
Input Capacitance	Nominal 12 p.F.
Compensating Range	10–50 p.F.
Input Resistance	10 MΩ When terminated in 1 MΩ
Maximum Input Voltage	500 Volts DC Including peak AC
Cable Length	2 Metres

The LG3 is a miniature passive probe for use with logic analysers and general purpose oscilloscopes. The probes can be supplied in sets of nine and are then fitted with coloured markers for easy identification.

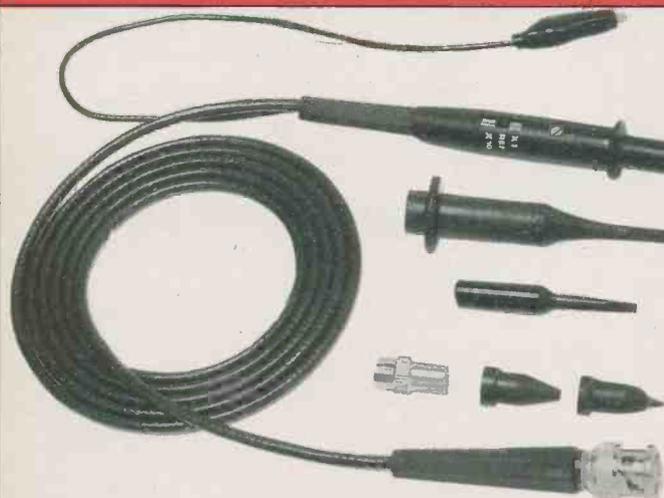
The grabber can be removed so that the probe may be directly attached to the I.C. test clips etc.

can also be had
in kits of
10 colours



LG3
each \$36⁷⁰

SP100 Switch Selectable ×1/×10 Probe 3 Position Switch



×1 POSITION	
Attenuation Ratio	1:1
Bandwidth	DC – 10 MHz
Rise Time	35 nS
Input Capacitance	55 p.F. + Oscilloscope Input Capacitance
Input Resistance	1 MΩ (Oscilloscope Input)
Maximum Input Voltage	600 Volts DC Including peak AC, derating with frequency
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
Bandwidth	DC – 100 MHz
Rise Time	3.5 nS
Input Capacitance	Nominal 16 p.F.
Compensating Range	10–60 p.F.
Input Resistance	10 MΩ When used with oscilloscopes which have 1 MΩ Input. (Probe resistance 9 MΩ ±1%)

**Fits All
Makes & Model Scopes
SP100 — \$50¹⁰ each**

Fixed Lead Oscilloscope Probes

P100 × 10 Oscilloscope Probe

Specification

Attenuation Ratio	10:1
Bandwidth	DC – 100 MHz
Rise Time	3.5 nS
Input Capacitance	Nominal 15 p.F.
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

Also available with cable lengths of 2 & 3 metres, details on request.



\$40⁰⁰

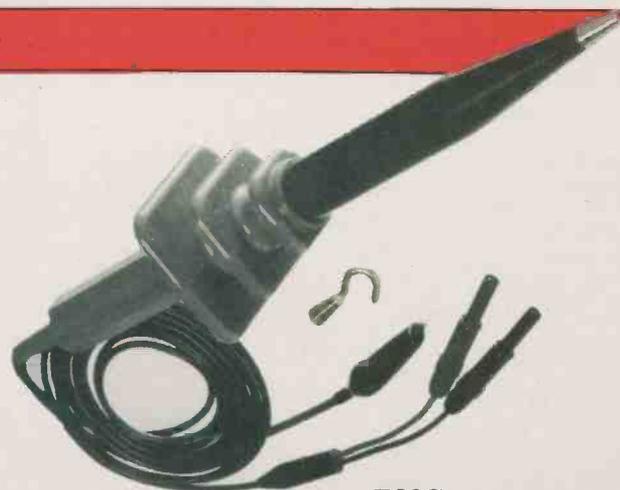
HV40BNC High Voltage Probe

This is a high voltage probe for use with any high impedance measuring instrument i.e., oscilloscopes, DMMs etc.

Specification

Maximum Input Voltage	40 Kv DC
Bandwidth	DC – 300 Hz
Voltage Division Ratio	2000:1 When adjusted for use with oscilloscopes with 1.MΩ Input. 1000:1 when adjusted for instruments with Input resistances of 10 MΩ and above. Approx. 1000 MΩ
Input Resistance	

Please specify instrument Input resistance when ordering.



**BNC
or BANANNA \$83⁰⁰**

BNC Patchcords 50 Ohm

Interfaces available: BNC, N and UHF complete with moulded on cable reliefs, using RG58 C/U cable.

1 Metre long
#126023 **\$9⁴⁸**

1.5 Metres long
#126024 **\$9⁹¹**

2.0 Metres long
#126050 **\$10³⁵**

Other lengths to customer specifications.
Standard finish of connectors: bright nickel plate.



BNC Flying leads 50 Ohm

Interfaces available: BNC, N and UHF complete with moulded on cable reliefs, using RG58 C/U cable, together with shielded plugs and crocodile clips.

1.5 metres
**Ideal for schools
or hobbyists**
#126083

\$9²³ each

Other lengths and combinations available to customer specifications.
Standard finish of connectors: bright nickel plate.



Stackable Leads



A range of lead assemblies that can enable safe multiple connections to be made to a single 4mm socket.

They are available in a choice of five colours and four standard lengths and may be substituted or used in conjunction with the TLS 2000 and STLS 2000.

UL Listed. File No. E79581

Length	Black	Red	Yellow	Green	Blue	Cost
0.5m	121185	121186	121187	121188	121189	\$4.70
1.0m	121190	121191	121192	121193	121194	\$5.40
1.5m	121195	121196	121197	121198	121199	\$6.10
2.0m	121200	121201	121202	121203	121204	\$6.75

Volatile content of silicone cable – less than 1.0% as required by British Telecom specification M230A.

TLS 2000 Test Lead Set

A high quality test lead set suitable for use with analogue or digital multimeters.

The leads are flexible copper conductors with a tough silicone rubber sheath and terminated with 4mm safety plugs.

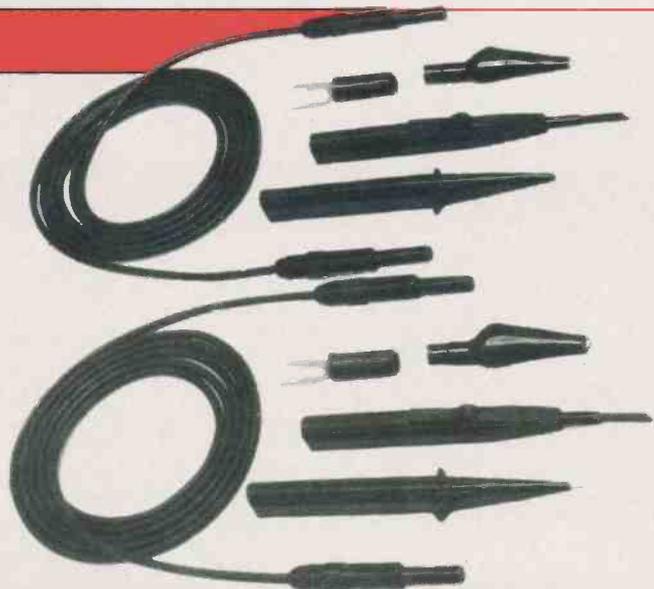
The kit comprises of the following parts:

1.5m Cable Red	Part No. 121144	1.5m Cable Black	Part No. 121143
Sprung Hook Red	120227	Sprung Hook Black	120226
Prod Red	121533	Prod Black	121532
Crocodile Clip Red	120250	Crocodile Clip Black	120249
Spade Terminal Red	121538	Spade Terminal Black	121537
Plastic Storage Wallet	118031		

Maximum Working Voltage 1000 Volts
Maximum Current 10 Amps
UL Listed. File No. E79581

Volatile content of silicone cable – less than 1.0% as required by British Telecom specification M230A.

Complete Set \$21.64



STLS 2000 Test Lead Set

A reduced version of the TLS 2000 is available comprising of the following parts:

1.2m Cable Red	Part No. 121211	1.2m Cable Black	Part No. 121210
Sprung Hook Red	120227	Crocodile Clip Black	120249
Prod Red	121533	Prod Black	121532
Plastic Storage Wallet	118031		

Maximum Working Voltage 1000 Volts
Maximum Current 10 Amps
UL Listed. File No. E79581

Volatile content of silicone cable – less than 1.0% as required by British Telecom specification M230A.

only \$14⁵⁸

This is a test lead set suitable for use with analogue and digital multimeters.

The test prods are permanently attached to the silicone rubber covered leads which are terminated with 4mm safety plugs. The prods have an insulation piercing .080" phone tip with a radial notch for wire bus layover.

An 8-32 UNC threaded section of the tip permits the addition of various accessories.

TL 1000 Test Lead Set



TL 1000 only \$11.17

Fused Prods

Test prods similar to those used with the TLS 2000 but fitted with integral fuseholders to accept standard 1.25" cartridge fuses.

\$4⁷⁸ each

Red 122518 Black 122517

BNC SHUNT



Part No. 805-53-000

A 50 Ω through termination useful for correctly terminating a transmission system when testing with a high impedance measuring instrument such as an oscilloscope.

Specification

Resistance Tolerance: $\pm 1\%$
 Frequency Range: D.C. to 1GHz
 Maximum Power: 2 Watts Average (1kW Peak)

\$29⁵⁰

BNC ATTENUATORS



Part No. 120085

A range of 50 Ω attenuators with BNC mating faces, available in values of 3dB, 6dB, 10dB and 20dB.

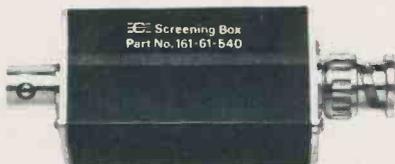
3dB Part No. 120082
 6dB Part No. 120083
 10dB Part No. 120084
 20dB Part No. 120085

\$31⁸⁰ each

Specification

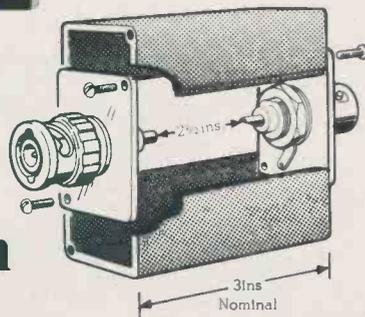
Impedance: 50 Ω
 Frequency Range: D.C. to 1GHz
 Accuracy: ± 0.2 dB
 Maximum Power: 1 Watt Average (1kW Peak)
 VSWR: Less than 1.2:1 at 1GHz

BNC SCREENING BOX



Part No. 161-61-540

Screening box with BNC interfaces for making up attenuators, networks, detectors etc.



\$17⁴⁰ each

BNC TERMINATION

A small 50 Ω termination with low VSWR up to 2GHz.

Specification

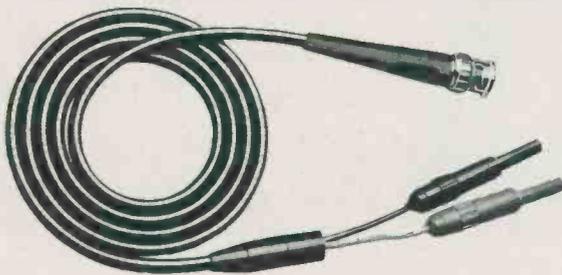
Resistance Tolerance: $\pm 1\%$
 Frequency Range: D.C. to 2GHz
 Maximum Power: 1Watt Average (1kW Peak)
 VSWR: Less than 1.2:1 at 2GHz



Part No. 105-52-000

\$13⁷⁰ each

BNC FLYING LEADS 50 Ohms to Banana (4 mm)



(Available in 3 Lengths)

1 metre	#126074	\$10⁴⁰
1.5 metre	#626059	\$10⁷⁸
2.0 metre	#126060	\$11¹⁷

BNC Switched Attenuator

Part No. 129000

Now Only \$110⁰⁰

A switched attenuator enabling attenuation ratios to be selected in 1 dB steps from 0 dB to 31 dB.

Specification

Attenuation	0-31 dB in 1 dB steps
Impedance	50 Ω
Frequency Range	DC - 1 GHz
Maximum Power	1 Watt Average (1 kW peak)
VSWR	Less than 1.5:1



QUANTITY DISCOUNTS ARE AVAILABLE ON ALL ITEMS. PLEASE CALL US AS TO YOUR NEEDS.

TEL: (416) 661-5585

TELEX 065-28169

Stepped Adaptors

4mm adaptors to permit connection of the stackable and test lead set cables to the Bach-Simpson range of multimeters.

Part No.
Black 122528
Red 122529

UL Listed File No. E79581

\$2⁸⁴ each



Straight Adaptors

4mm in line adaptors to permit extension of stackable and test lead set cables.

Part No.
Black 122021
Red 122022

UL Listed File No. E79581

\$2⁸⁴ each



Safety Plugs

Red or black \$3.23 each

4mm plugs with a retracting shield that covers the contact area when the plug is disconnected from a terminal.

Max Cable Dia. 0.150"
Black Part No. 122505
Red Part No. 122506

UL Listed File No. E79581



Binding Posts to BNC Male

This adapter covers a BNC female to miniature 19.00 mm (750) spaced binding posts.



T627

**NOW ONLY
\$11⁵⁰ each**

BNC Female to double Banana Plug

This adapter allows a BNC male to be used with equipment having 19.00 mm (750) spaced 4 mm dia banana jacks. Excellent for adapting test equipment to standard coaxial cables.

UPPER: BNC female.

LOWER: Miniature double banana plug



T620

**\$10⁷⁰
each**

**REPLACEMENT PINS
FOR MODULAR PROBES
#121589 only \$2.40 each**

Are you a bonafied ... STUDENT?



If so, supply us with your registration number or in lieu of this, proof of regular attendance and you can enjoy a student grant for your next purchase on many of the items in this catalogue. Ask us for details.



Model 300

- 3-1/2 Digits.
- 0.5% DC Volts Accuracy.
- 2000 Hour Battery Life.
- Diode Test Function.

The Model 300 is ideal for repairing televisions, appliances, stereos, and common electrical problems. This model is a workhorse designed to handle a wide variety of basic repairs and testing.

High performance is achieved through a combination of special features, including RF shielding to prevent stray signals from affecting the reading. The Diode Test feature allows checking of diodes and transistor junctions. The 22 megohm input impedance on all DC voltage ranges reduces circuit loading.

Model 300 is designed to get the job done. The 2000 hour battery life keeps the Model 300 working for up to two years. The convenience of the meter is enhanced by the easy-to-use single rotary switch and the multi-position tilt bail.

Backed by a one-year, no-fault warranty and rapid service turnaround time, the Model 300 comes complete with test lead set, battery, spare fuse, and operator's manual.

\$179⁸⁵



Model 310

- 10 Amp Current Range.
- 0.25% DC Volts Accuracy.
- Insta-Ohms
- 2000 Hour Battery Life.

The 310 group measures up to 10 amps AC or DC without special adaptors. The 2 amp range is protected with a 2 amp/600V fuse. The 10 amp range is unfused and can withstand up to 20 amps for 30 seconds. Voltage ranges can withstand transients of up to 6KV in 10 microseconds.

The Insta-Ohms Quick Continuity test provides a visual symbol in the display. The 310 group comes complete with test lead set, battery, spare fuse, and operator's manual.

\$216⁹¹

Model 310B.

The Model 310B features an audible continuity beeper for busy technicians who need to perform repeated continuity checks. Within 100 milliseconds, the meter's beeper signals continuity.

Model 310T.

- Temperature Function.
- 10 Amp Current Range.
- Diode Test Function.

Model 310T features a built-in temperature function which uses any K-type thermocouple having a standard miniature or subminiature connector to measure up to 1999 μ f with one degree resolution. A single adjustment allows the meter to read in Fahrenheit or Celsius.

\$228⁹⁰

\$245²⁵



Model 320

- 0.1% DC Volts Accuracy.
- 10 Amp Current Range.
- Diode Test Function.
- 2000 Hour Battery Life.
- Insta-Ohms Quick Continuity.

The 320 group is designed for the professional who desires high accuracy in a reliable hand-held meter. The highest quality state of the art technology provides overload and transient protection diode test, 10 amps AC/DC current range, Insta-Ohms Continuity Test, and 22 megohms input impedance.

The easy-to-use rotary switch and contamination resistant case make the Model 320 very popular in the electronics field service industry. The 320 group comes complete with test lead set, battery, spare fuse and operator's manual. The meters are backed by a one-year, no-fault-warranty and 100% factory testing.

Model 320B.

The Model 320B is designed for situations that require an audible continuity beeper and high accuracy. The "beep" allows a technician to check circuit continuity without having to look at the LCD display. This feature is an excellent aid in troubleshooting. The momentary beep requires very little power which helps retain the 2000 hour battery life.

\$267⁰⁵

\$282³¹



Model 330.

- True RMS.
- 0.1% DC Volts Accuracy.
- 10 Amp Current Range.
- 2000 Hour Battery Life.
- Insta-Ohms Quick Continuity.

The Model 330 features True RMS (AC + DC coupled) voltage and current capability. The True RMS capability provides accurate measurements of nonsinusoidal waveforms, such as the square waves found in digital circuitry and the output of rectifiers and transformers. True RMS is also the most accurate measurement of the irregular waveforms of SCR's and TRIAC's found in power control equipment.

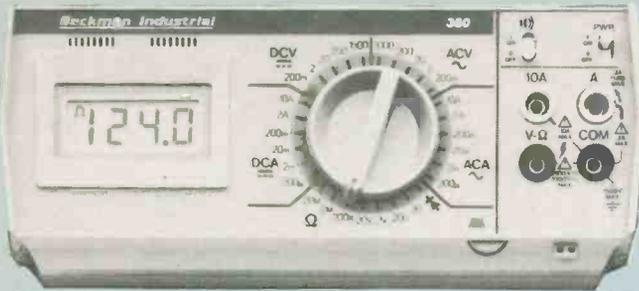
The Model 330 includes an adaptor capacitor accessory (Model BC-047), which allows decoupling of the AC and DC signals. This is very handy for measuring the AC ripple in the output of a DC power supply.

Model 330 also features a 10 amp current range, 2000 hour battery life, a diode test function, Insta-Ohms Quick Continuity Test, and 22 megohm input impedance. Model 330 also offers a wide, 100KHz, AC bandwidth which is ideal for communications, radio and medical applications. The Model 330 comes complete with test lead set battery, spare fuse, BC-047 accessory and operator's manual.

\$325⁹¹

Beckman Industrial Professional series digital multimeters.

Model 350 bench/portable



- 20 Ohm Resistance Range.
- 0.1% DC Volts Accuracy.
- Diode Test Function.
- 10 Amps Current Range.
- Audible Continuity Beeper.
- 12,000 Hour Battery Life.

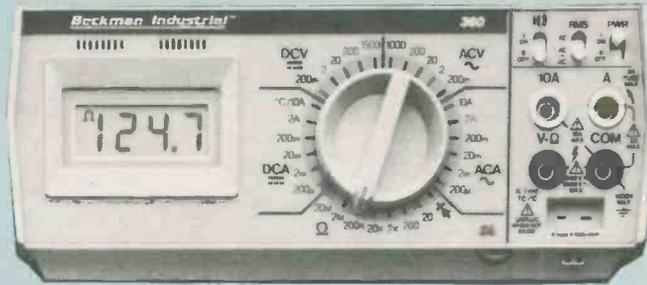
The Model 350 is truly portable. With its 12,000 hour battery life, the Model 350 will operate for up to four years without having to replace the batteries. The multi-position tilt stand and single rotary function/range switch make the meter very easy and convenient to operate. The sturdy ABS plastic case contains a handy storage compartment suitable for test leads, spare fuses, and other small tools.

A unique feature of the Model 350 is the 20 ohm resistance range which offers 10 milli-ohm resolution. An adjustment is provided for zeroing out the basic resistance of the test leads. This feature is ideal for testing motor windings for checking circuit board traces.

The Model 350 also features a separate diode test function, 10 amps current capability, and an audible continuity beeper. The continuity beeper has a separate on/off switch which gives added versatility. Model 350 includes test lead set, batteries, spare fuse, and operator's manual.

\$337⁹⁰

Model 360 bench/portable.



- True RMS.
- Temperature Function.
- 20 Ohm Range.
- 0.1% DC Volts Accuracy.
- Diode Test Function.
- Audible Continuity Beeper.
- 12,000 Hour Battery Life.

In addition to the functions that can be performed by Model 350, the Model 360 offers True RMS (switchable between AC plus DC coupling and AC only coupling) and temperature measurement capability. Temperature readings in Centigrade may be made with any K-type thermocouple.

The True RMS feature makes the Model 360 an ideal meter for testing power supplies. A decoupling switch allows the AC ripple of a DC power supply to be easily measured. With its complete portability, provided by the 12,000 hour battery life and unique 20 ohm resistance range with zero-adjust control, the Model 360 provides a tremendous value for both field and lab use.

The Model 360, like the Model 350, provides high overload protection and dependability. All units are 100% factory tested and calibration is guaranteed for one year. The storage compartment on the top of the meter will hold the test lead set, spare fuse, and an operator's manual.

\$430⁵⁵

Model 4410

- 4-1/2 Digits.
- True RMS.
- 0.05% DC Volts Accuracy.
- 10 Amp Current Range.
- Insta-Ohms Quick Continuity.
- Diode Test Function.



The Model 4410 offers 4-1/2 digits in all meter functions, plus the ability to measure the True RMS value (AC coupled) of all signals regardless of the waveform. The True

RMS feature is ideal for testing switching power supplies, heating elements, flyback transformers, motors, electronic flashes, and SCR or TRIAC controlled power supplies.

Model 4410 is protected from voltage overloads up to 6KV for 10 microseconds. All resistance ranges are protected to 500 volts DC or RMS AC. The 2 amp current range is protected by a 2 amp/600 volt fuse, and the 10 amp range (unfused) can withstand up to 20 amps for 30 seconds.

The Model 4410 offers an excellent value in a dependable and high performance unit. The meter comes complete with test lead set, battery, spare fuse, operator's manual, and is backed by a one-year, no-fault warranty.

\$354²⁵

Model HD-100

- Heavy-Duty Design.
- 0.25% DC Volts Accuracy.
- 2000 Hour Battery Life.
- Diode Test Function.
- Insta-Ohms[®] Quick Continuity.



The HD-100 is built to be an indispensable tool in any environment. The tough fire-retardant case and the O-ring seals make the meter drop-proof and waterproof. The meter can withstand 600 volts without failure on all resistance ranges. Voltage ranges can withstand 6KV transients for 10 micro-seconds, and the 2 amp current ranges are protected by a 2A/600V fuse.

The HD-100 is built for accuracy under rugged conditions. The LCD is shock-mounted to reduce break-age. An easy-to-use rotary switch is recessed to prevent damage when the meter is in a tool box. The diode test function allows accurate measurements of forward voltage drops across diodes and transistor junctions.

The 2000 hour battery life eliminates worry when you leave the shop headed for a repair site. The HD-100 will operate up to two years between battery changes.

The HD-100 includes a test lead set, battery, spare fuse, and operator's manual. The meter is backed by a one-year, no-fault warranty.

\$249⁶¹



Model HD-110

- Heavy-Duty Design.
- 10 Amp Current Range
- 0.25% DC Volts Accuracy.
- 2000 Hour Battery Life.
- Diode Test Function.
- Insta-Ohms.

The HD-110 is used with confidence by transportation companies, electrical contractors, and maritime operators. This workhorse is at home in a shop or up a power pole. The case is extra thick so it won't crack or

chip even if the meter is dropped from 10 feet. The sensitive components are shock-mounted, and O-ring seals keep out all dirt, grime, and liquids. The display window is ultrasonically welded into place. Contamination cannot get inside the meter and affect a reading.

The HD-110 can measure 10 amps AC or DC without use of special adaptors. The 10 amp current range is protected to 20 amps for 30 seconds (unfused). The bright yellow case makes the meter easy to see and helps to prevent accidental misplacement.

Other features include: 2000 hour battery life, diode test function, RF shielding, and the Insta-Ohms Quick Continuity Function for easy continuity tests. Each HD-110 includes test lead set, battery, spare fuse, operator's manual, and is backed by a one-year, no-fault warranty.

\$282³¹



Model HD-110T.

- Heavy-Duty Design.
- Temperature Function.
- 10 Amp Current Range.
- 2000 Hour Battery Life.
- 0.25% DC Volts Accuracy.
- Diode Test Function.
- Insta-Ohms Quick Continuity.

HD-110T is a hard hat meter designed for tough environments. It's a valuable tool for service in the heating, ventilation and air conditioning industry because of its ability

to measure temperature. A simple field adjustment is all that is required to switch from Fahrenheit to Centigrade, and there is no need to recalibrate the meter. Any K-type thermocouple with a standard miniature or subminiature connector can be used with the HD-110T. The meter comes set in the Fahrenheit model and is capable of measuring up to 1999°F with one degree resolution.

HD-110T has an easy-to-use rotary switch; Insta-Ohms Continuity Indicator, RF shielding, 22 megohm input impedance, 10 amps with AC/DC current capability, dedicated Diode Test Function, and a 2000-hour battery life.

The HD-110T comes with test lead set, battery, spare fuse, operator's manual and a K-type thermocouple wire (Accessory Model TP-255) good for up to 392°F (200°C).

\$315⁰¹



Model HD-130

- Heavy-Duty Design.
- True RMS.
- 10 Amp Current Range.
- 0.1% DC Volt Accuracy.
- 2000 Hour Battery Life.
- Diode Test Function.
- Insta-Ohms Quick Continuity.

HD-130 is built to withstand industrial factory, and automotive applications. The tough fire-retardant thermoplastic case provides protection from damage that could occur

from the rigors of hard use.

The True RMS (AC + DC coupled) feature allows accurate measurements of complex waveforms. This feature is desirable in testing motor and speed controls, communications, and numerous applications where accurate measurement of complex waveforms is required. The HD-130 includes the Adaptor Capacitor Accessory (Model BC-047), which allows decoupling of the AC and DC signals. This is useful for measuring the AC ripple in the output of a DC power supply.

The HD-130 has a 2000 hour battery life, diode test function, Insta-Ohms Quick Continuity Indicator, and input impedance of 22 megohms. The HD-130 includes test lead set, battery, spare fuse, BC-047 Accessory, and operator's manual.

\$354²⁵



Model HD-140

- Heavy-Duty Design.
- 4-1/2 Digits.
- True RMS.
- 0.05% DC Volts Accuracy.
- 10 Amp Current Range.
- Diode Test Function.
- Insta-Ohms

The HD-140 is designed for production testing, field servicing, industrial maintenance, and design engineering applications. The 4-1/2 digit display provides high resolution and accuracy. The True RMS

feature permits accurate measurement of complex wave signals found in switching power supplies, motor and speed controls, SCR and TRIAC circuits, and digital equipment.

The HD-140 has the same overload protection found throughout the Heavy-Duty Series: 6KV transient protection for all voltage ranges; 600V protection on all resistance ranges; and 2 amp/600 volt fused current range. The 10 amp current range can withstand up to 20 amps for 30 seconds.

The easy-to-use rotary switch with patented long life design is a feature you will appreciate for years to come. With 100% factory test of each function and range, and our no-fault warranty, you can depend on the high performance of the HD-140.

Model HD-140 comes complete with test lead set, battery, spare fuse, and operator's manual.

\$386⁹⁵

Beckman Industrial

Complete Line of Accessories

Current Clamp Accessories.

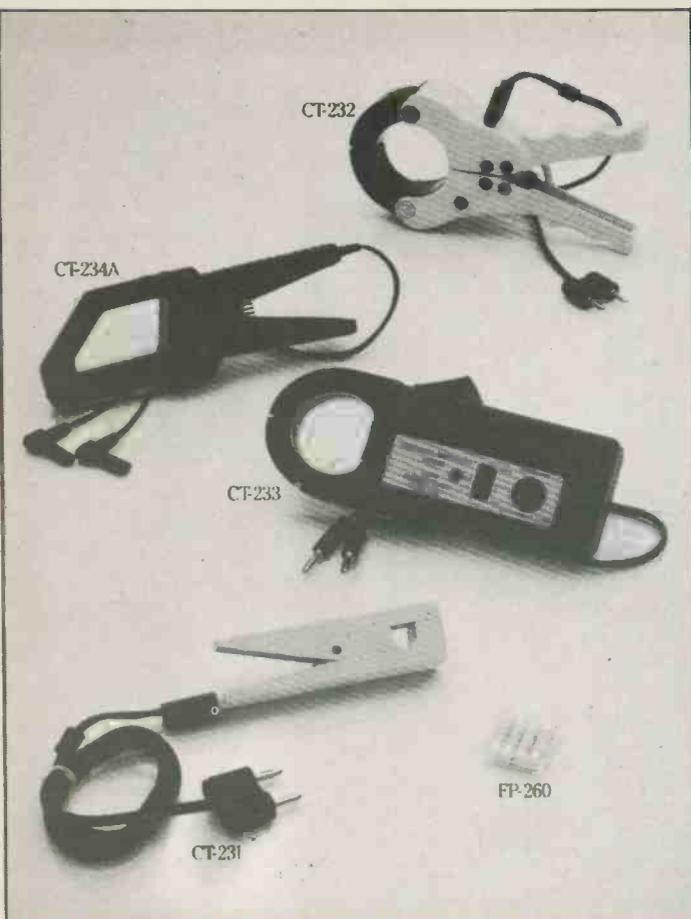
AC Current Clamp (CT-231) Extends the AC current measuring range to 150 amps using a 1000 to 1 current transformer. Opens for cables up to 7/16 inches diameter. Accuracy is 3% at 60Hz. Frequency range up to 1KHz. **\$103⁵⁵**

Large Jaw AC Current Clamp (CT-232) Large jaw clamp measures up to 1000 amps AC and to 1KHz using a 1000 to 1 current transformer. Accuracy is 1% at 60Hz. Jaw opens for cables up to 2 1/2 inch diameter. **\$249⁶¹**

Replacement Fuses (FP-260) Package of four 2A/600 volt fuses for use with professional and Heavy-Duty Series Digital Multimeters. **\$3⁸²**

AC/DC Current Clamp (CT-233) Extends both the AC and DC current measurement capability of a digital multimeter to 600 amps. Opens for cables up to 1.33 inches. Basic accuracy is 2% of reading. Frequency response is up to 400Hz. **\$321⁵⁵**

Medium Jaw AC Current Clamp (CT-234A) Measures up to 400 amps AC and 1KHz using a 1000 to 1 current transformer. Jaw opens for cables up to 1 3/8 inches diameter and fits bus bars up to 2 1/2 inches wide. Accuracy is 3%. **\$86¹¹**



Temperature Accessories.

TC-253 Universal Temperature Converter converts any multimeter to read temperature from -50°F to 1652°F (-50°C to 900°C) using an industry standard K-type thermocouple. Self-contained unit is switchable to provide either Centigrade or Fahrenheit. Resolution with most 3 1/2-digit multimeters is 0.1 degree. **\$97⁰¹**

TP-254 K-type immersion probe with inconel sheath and wooden handle for measurements up to 2012°F (1100°C). **\$75²¹**

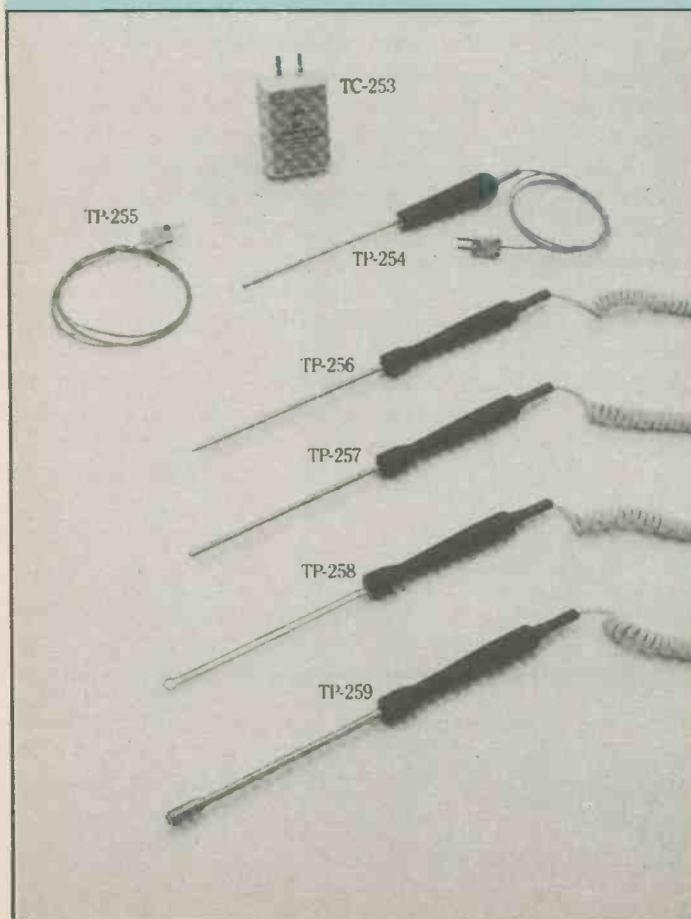
TP-255 Four foot long K-type thermocouple wire has an industry standard miniature connector plug attached and measures surface or air temperatures up to 392°F (200°C). **\$16⁹⁰**

TP-256 K-type needle probe with a coiled lead. Maximum temperature is 2000°F (1100°C). **\$118⁸¹**

TP-257 General purpose K-type immersion probe with handle and coiled lead for measurements up to 2000°F (1100°C). **\$118⁸¹**

TP-258 Exposed K-type sensing element measures air flow temperature up to 1800°F (1000°C). **\$118⁸¹**

TP-259 K-type surface probe for measurements on any relatively flat surface up to 1500°F (800°C). **\$118⁸¹**



Beckman Industrial



Test Leads.

Replacement Test Leads.

TL-27 for Models DM15, DM20, DM25 and DM77.

\$7⁹⁶

TL-73 for Model DM73.

\$6²⁷

TL-242 for older Series 3000 and Tech Series DMM's.

\$9⁹¹

TL-245 for Series 300, Series 3000, Tech Series and Heavy-Duty Series DMM's.

\$9⁹¹

Optional Test Leads.

AL-73 Alligator test lead for Model DM73 features an insulated alligator clip.

\$8⁶⁷

DL-243 Test lead accessory kit has safety designed test leads with push-on probes, banana plugs and insulated alligator clips in a vinyl case.

\$20⁷¹

TL-246 Heavy-duty insulated alligator clips for electrical service.

\$13⁶³

DL-241 Same as Model DL-243 except for 90° input connectors for older Series 3000 and Tech Series DMM's.

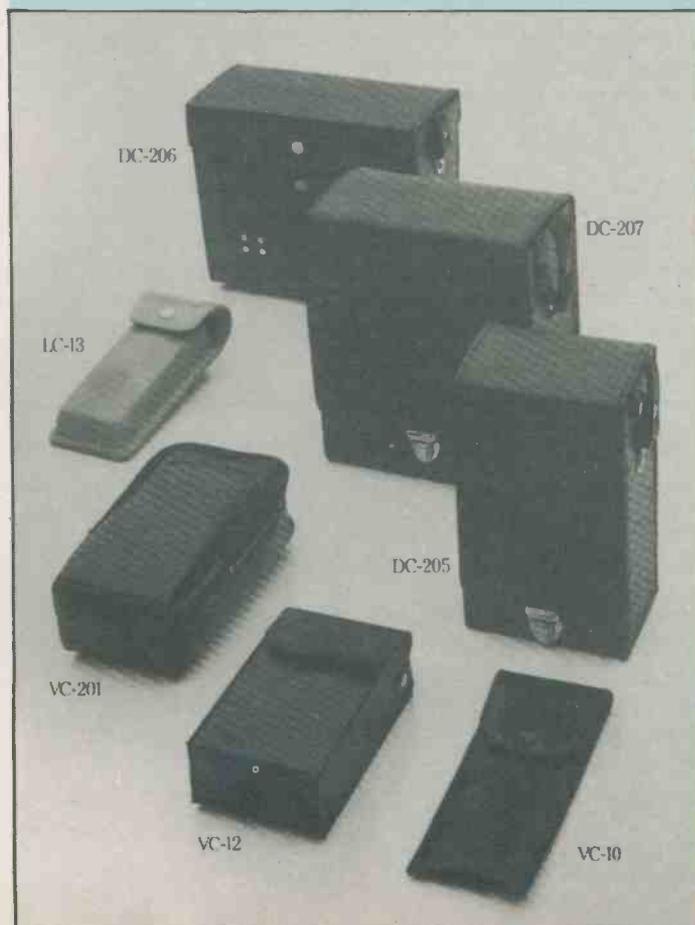
\$20⁷¹

DL-248 Deluxe test lead kit includes safety designed test leads with push-on probes plus banana plugs, insulated alligator clips, long needle tips, medium size clip-on prods and large size clip-on prods all in a rugged cordura nylon pouch with velcro closures.

\$13⁶³

BC-047 True RMS Conversion Adaptor contains a 0.047µF capacitor for decoupling the AC signals when using an AC plus DC coupled True RMS DMM.

\$9⁹¹



Carrying Cases.

Leather Carrying Case (LC-13) Natural leather case for the Model DM73 featuring a snap release belt loop and snap front closure.

\$27²⁰

Vinyl Carrying Case (VC-10) Padded vinyl case for the Model DM73 features a velcro closure.

\$5⁴⁵

Vinyl Carrying Case (VC-12) Vinyl carrying case for Models DM15, DM20, DM25, and DM77.

\$7⁵⁸

Vinyl Carrying Case (VC-201) Padded vinyl case with a zipper, belt loop, and clip.

\$16⁹⁰

Deluxe Carrying Case (DC-205) Made of durable ruggedized, foam-padded leather-grained vinyl with straps to allow hands-free use without removing the meter. A large compartment will fit test leads plus other small tools.

\$49⁰⁵

Deluxe Carrying Case (DC-206) Ruggedized leather-grained vinyl case fits the bench/portable multimeter Models 350 and 360. Comes with carrying straps and access flaps to allow use of the meter while in the case.

\$59⁹⁵

Deluxe Carrying Case (DC-207) Ruggedized leather-grained vinyl provides extra storage space for test leads and a current clamp.

\$59⁹⁵

**Pocket-sized.
Model DM15.**

- 24 Ranges.
- 0.8% VDC Accuracy.
- 10A AC/DC Measurements.
- Diode Test Function.
- Low Price.

The pocket-size DM15 offers you full-function digital multimeter capabilities, with 24 ranges to measure AC/DC voltages, AC/DC current, and resistance.

The DM15 provides high quality at an extremely low price, giving you all the basics with 0.8% basic VDC accuracy. Also included are a 10A current measurement capability and a separate diode test function to test junction forward bias.



\$92⁶⁵

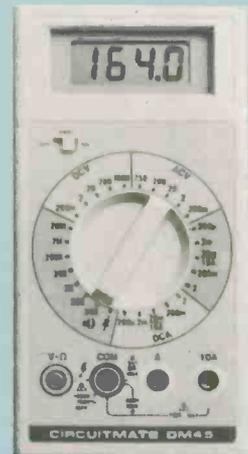
The DM15 is overload protected to 500 VDC/350 VAC on the 2V range, and 1200 VDC/800 VAC on all other ranges.

Model DM45.

- Continuity Beeper.
- 28 Ranges.
- 0.5% VDC Accuracy.
- 10A AC/DC Measurements.

The DM45 digital multimeter provides all of the features and measurement capabilities of the DM40. Added features in the DM45 model provide for audible continuity checking (continuity beeper) and 10A AC/DC current measurements.

The DM45 has a total of 28 ranges to measure AC/DC voltages, AC/DC current, and resistance with 0.5% basic VDC accuracy.



\$137³⁴

Model DM20.

- Transistor Gain Checking.
- Dual Voltage Resistance Test.
- Conductance Measurements.
- 28 Ranges.
- 0.8% VDC Accuracy.

For taking transistor gain and conductance measurements, the DM20 is your best bet. The DM20 has all the basic functions offered by the DM15. Added high-performance features include the conductance measurement capability that lets you measure extremely high resistance values. In addition, a switch is used to measure voltage resistances above or

\$101³⁷



below the breakover voltage of a diode, depending on whether the test is performed in-circuit or out-of-circuit.

The DM20 has 28 ranges to measure AC/DC voltages, AC/DC current, resistance, and conductance with a 0.8% VDC accuracy.

**Full-size, hand-held.
Model DM40.**

- Diode Test Function.
- 26 Ranges.
- 0.8% VDC Accuracy.

The full-size hand-held DM40 offers you maximum convenience in digital multimeters. Its tilt bail and anti-skid pads keep the meter steady for easy reading. Also featured is a recessed LCD display window for long life, and recessed jacks for maximum safety.

The DM40 measures AC/DC voltages, AC/DC current, and resistance in 26 ranges with 0.8% basic VDC accuracy. It also provides a separate diode test function.



The DM40 is overload protected to 500 VDC/350 VAC in 0.2V range, and 1200 VDC/800 VAC in the other ranges.

\$107⁹¹



Model DM25.

- Capacitance Measurements.
- Continuity Beeper.
- Dual Voltage Resistance Test.
- Conductance Measurements.
- 30 Ranges.
- 0.8% VDC Accuracy.

The DM25 is specifically designed to measure capacitance at up to 20µF. As compared with the DM15 and DM20 Models, the DM25 incorporates all the basic functions offered by the DM15,

and the added features of dual voltage resistance test and conductance measurements offered by the DM20.

Another added feature unique to the DM25 is an audible continuity beeper to facilitate circuit tracing.

The DM25 measures AC/DC voltages, AC/DC current, resistance, capacitance, and conductance using 30 ranges with 0.8% basic VDC accuracy.

\$122⁰⁸

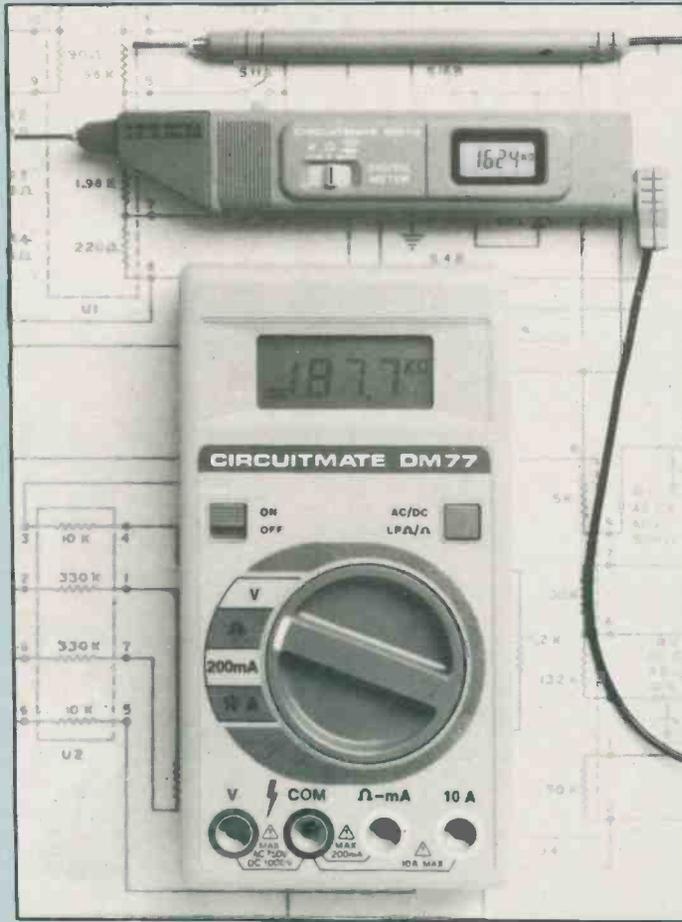
**Autorangers.
Model DM73.**

- Probe Size.
- "Touch Hold" Button.
- Continuity Beeper.
- 0.5% Basic Accuracy.

The probe-size DM73 is the smallest digital multimeter on the market. Its probe-style design makes it ideal for taking measurements in hard-to-reach test areas and fits easily into a tool kit or pocket.

The autoranging capability is available on all functions. Simply slide the selector switch to AC/DC voltages, or resistance, and the DM73 automatically sets the required range. The DM73 provides 12 ranges and measures voltages up to 500 VAC or VDC with 0.5% basic VDC accuracy.

The DM73's function annunciator gives immediate verification (on the display) of the function you selected. A "touch hold" button allows you to "freeze" a measurement on the display at the moment it is taken. And the continuity beeper sounds when a short or ground is detected. **\$100²⁸**



Model DM77.

- Continuity Beeper.
- Dual Voltage Resistance Test.
- 0.5% Basic Accuracy.
- 10A AC/DC Measurements.
- Autoranging.

The full-size hand-held DM77 is designed to give you the convenience of complete autoranging, plus 200mA or 10A AC/DC current measurement capability with 0.5% basic VDC accuracy. Simply set the function you want with the rotary dial to AC/DC voltages, or resistance, the DM77 automatically sets the required range (up to 18 ranges are provided).

A continuity beeper sounds instantly when continuity is established. Two function annunciators give immediate verification (on the display) of the selected function.

The DM77 measures voltages at up to 600 VAC and up to 1000 VDC. You can also select voltages for resistance tests in a range above or below the diode breakover voltages.

\$119⁹⁰

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- DC207 Deluxe Carrying Case
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- TP255 K-Type Thermocouple

Includes

Price **\$525.00**

**model UC10
universal counter.**

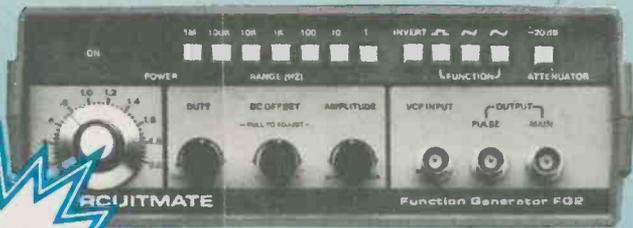
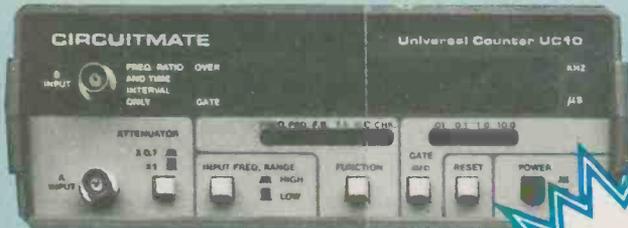
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- 8-Digit LED Display.

\$478⁵¹

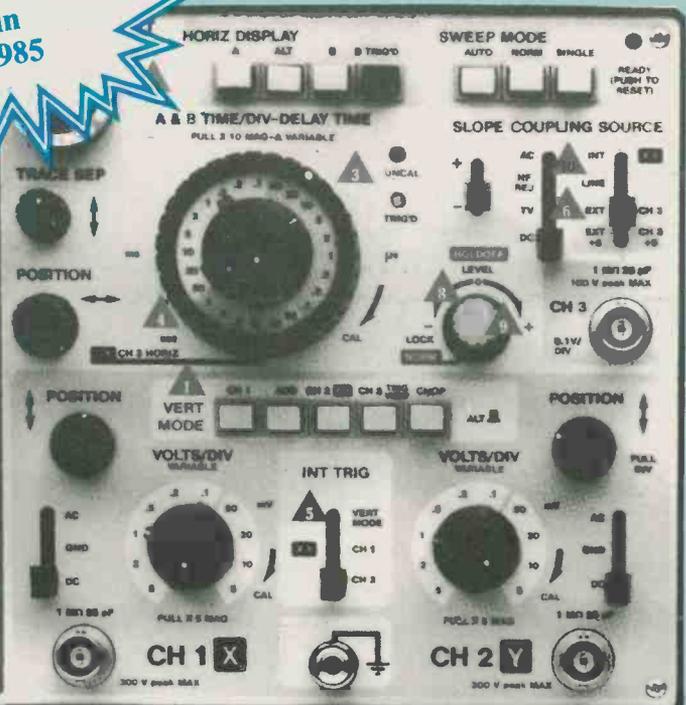
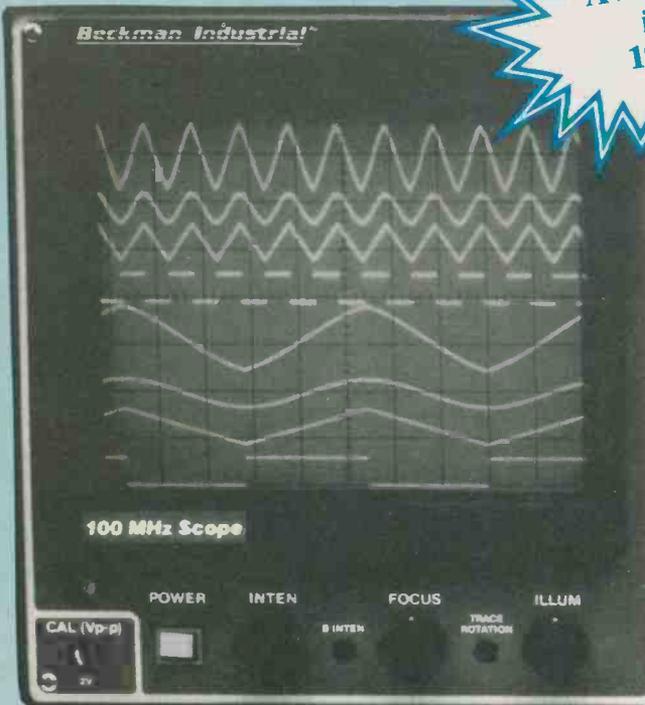
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- 7 Ranges: 0.2Hz to 2MHz.
- Outputs: Square, Triangle, Sine, Waves and TTL Pulses.
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- VCF Input.
- Variable/Fixed Attenuators.
- Variable DC Offset Control.
- Inversion Feature.

\$304¹¹



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- Channel 1 Output.
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\$29⁴³

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capacitance
meter.**

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\$196²⁰



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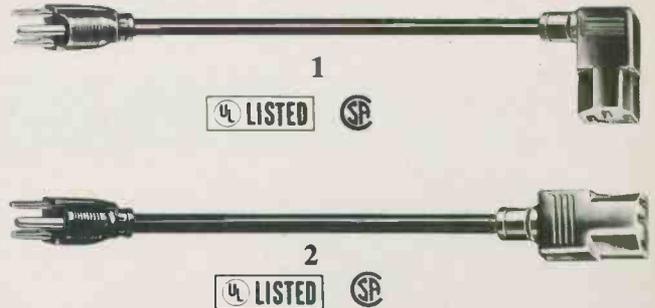
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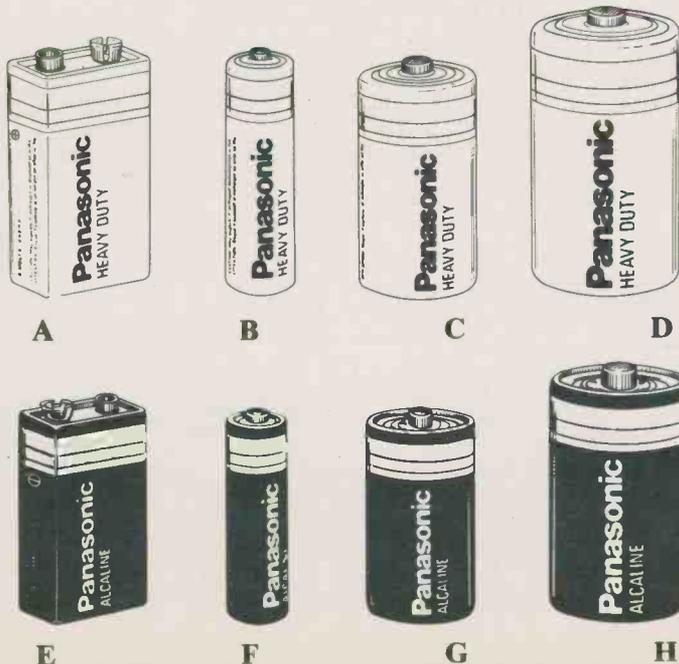
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Panasonic



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BEST FOR METERS

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FIG	TYPE	REPLACES	CAT #	PRICE
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H	1.5v D	E95	AM1	Pkg 2/4.69



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CC-70

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P-100
P-101
P-102

AP-8015-A

MODEL AP-8015-A Preamplifier provides 25 dB gain typ 1 MHz to 1 GHz, 10 dB gain at 1.3 GHz, noise figure less than 5.5 dB, input/output impedance 50 Ohms nominal, VSWR less than 2.2:1 reverse isolation more than 32 dB, max input ± 13 dBm, gain flatness + 1.0 dB. The preamp can be used with frequency counters, spectrum analyzers, network analyzers, sampling scopes, and other types of instrumentation within its frequency range. The power requirement is 9 - 14 VDS @ 65 - 85 mA and can be powered from OPTO electronics frequency counters having probe power jacks on the front panel or may be powered from the AC adaptor supplied. Dimensions: 3.8" long x 1" high x 1.2" wide, weight: 3 oz.

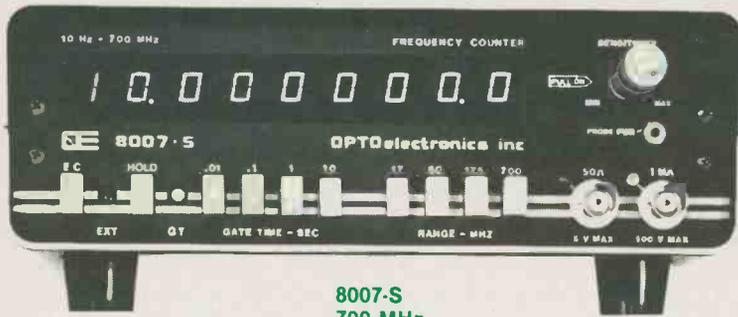
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8007-S
700 MHz

MODELS 8007-S, Deluxe series with frequency ranges of 10 Hz to 700 MHz, 1 GHz and 1.3 GHz. Standard features include: external clock input/output, excellent sensitivity, sealed ± 1 PPM 10 MHz TCXO time base, 4 gate times, 9 digit resolution to 175 MHz, front panel power jack for optional Broadband Preamp accessory, 115 V AC or 12 V DC operation, high quality compact construction housed in rugged aluminum cabinet. Optional features: internal Ni-Cad rechargeable battery operation, precision ± 0.1 PPM TCXO or ± 0.05 PPM proportional oven (OCXO) time base. All time base oscillators, including the standard TCXO, have 10 turn calibration adjustment accessible from rear panel. Size 3" H x 7 1/2" W x 6 1/2" D. 2 3/4 lbs.

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EXCLUSIVE NEW LED BAR GRAPH FEATURE ON MODELS 8010-S & 8013-S



8010-S/1



8013-S/1.3 GHz

#8010-S & 8013-S These models have all features of #8007-S plus extended ranges to 1 GHz and 1.3 GHz. Additionally, these models now have the all new signal strength LED bar graph. This 10 segment bar graph is located immediately to the right of the digital display and indicates relative input signal amplitude. The graph is active using either input on any range at any frequency within the bandwidth of the instrument.

The new signal bar graph feature instantly responds to input signal changes in amplitude which can indicate a low transmitter output or signal variance during a counter gate time explaining an erroneous reading, etc., etc.

The new signal bar graph is now a standard feature and only available on Models 8010-S and 8013-S.

- #8010-S 1 GHz COUNTER WITH BAR GRAPH **\$839.00**
- #8013-S 1.3 GHz COUNTER WITH BAR GRAPH **\$965.00**

- OPTIONS:**
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MODEL	RANGE (FROM 10 Hz)	TIME BASE		AVERAGE SENSITIVITY		GATE TIMES	MAX RESOLUTION				SENSITIVITY CONTROL	EXT CLOCK INPUT/OUTPUT	METAL CASE	PROBE POWER JACK
		FREQ	STAB-DESIGN	BELOW 500 MHz	ABOVE 500 MHz		12 MHz	17 MHz	60 MHz	175 MHz				
K-7000-AC	550 MHz	5.24288	± 1 PPM-RTXO	45 mV -24 DBM	N/A	(2) .1, 1 SEC	10 Hz		100 Hz		No	No	Yes	No
7010-S/1 GHz	600 MHz	10.0 MHz	± 1 PPM-TCXO ± 0.1 PPM-TCXO	10 mV -27 DBM	20 mV -21 DBM	(3) .1, 1, 10 SEC	.1 Hz	1 Hz	40 Hz		Yes	No	Yes	No
8007-S	700 MHz													
8010-S	1 GHz	10.0 MHz	± 1 PPM-TCXO ± 0.1 PPM-TCXO ± 0.05 PPM-OCXO	10 mV -27 DBM	20 mV -21 DBM	(4) .01, .1, 1, 10 SEC	.1 Hz	1 Hz	10 Hz		Yes	Yes	Yes	Yes
8013-S	1.3 GHz													

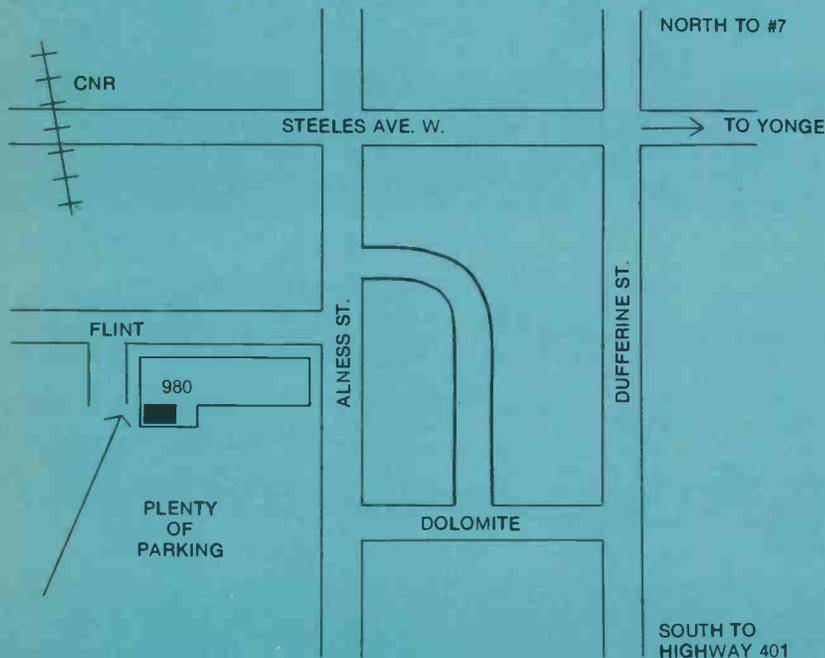
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Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business entertainment and education applications. Large variety of books and third party vendor products.

Computer Innovations CN
Simpsons Centre D'Achats Fairview, 7555 Autoroute Trans-Canadienne, Pointe Claire, Que., H9R 1C3 (514)694-4550

Compu-Nord Inc.
61 Place Frontenac, Pointe Claire, Que., H9R 4Z7
(514)842-4696

Informatique PC Ltd.
23 Valois Bay Ave., Pointe Claire, Que., H9R 4B4

Tracan Electronics Corp.
6600 Trans Canada Hwy #650, Pointe Claire, Que., H9R 4S2

Port Cartier

Informatex Cote Nord
1 Trudel, Port Cartier, Que., G5B 2N6

Quebec City

Cesco Micro-ordinateurs
909 Charest Ouest, Quebec City, Que., G1K 6W8
(418)687-4231
Depositaire des produits: Apple, Televideo, Certronics, Texas Instruments, Corvus, 3M. Le meilleur a Quebec par la qualite de son service.

Compucentre
Les Galeries de la Capitale, 5401 Blvd. Des Galeries, Quebec City, Que., G2K 1N4
(418)627-3689
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business entertainment and education applications. Large variety of books and third party vendor products.

Computerland Micro-Ordinateurs
888 Rue St. Jean, Quebec, Que., G1R 5H6
(418)628-2271
MO

Authorized: IBM, Apple, Compaq, Digital, Tallgrass, Epson, Amdek. Specialized in service: 4 full-time technicians, factory trained. Service contracts available. Closed Thursday and Friday evenings.

CODING KEY

ETI	ETI Magazine sold here
CN	CN! Magazine sold here
EC	Supplies Electronic Components
RTV	Sells Radio and TV parts
TG	Sells Test Gear
EK	Sells Electronic Kits
MO	Company does Mail Order
CAT	Catalogue available. The cost of this, or if it is free, is shown.

Future Byte
1356 Chemin, Ste. Foy, Quebec City, Que., G1S 2N6

Micro I-D Inc. ETI/CN
32185 - 1st Ave., Quebec City, Que., G1L 3R2
(418)622-0842

MO
Franklin Ace, Columbia, Teletideo, Spectravideo, TEO Tiger. Moniteurs, Logiciels, Imprimantes, Librairie.

PME Ordinateurs
1375 Charest Blvd., Quebec, Que., G1N 2E7
(418)683-5140

Quebec Elect.
621 St. Jean St., Quebec, Que., H1R 1P7

Selectronic
600 Belevedere, Quebec, Que., G1S 3E5

Simco Inc.
900 Place D'Youville, Quebec, Que., G1R 3P7
(418)692-4430

Xerox
888 Rue St. Jean, Main Floor, Quebec City, Que., G1R 5H6

Repentigny

Info-Base
100 Boul. Brien, Repentigny, Que., J6A 5N4
581-4162
Sharp, Commodore, NEC, Epson, Texas Instruments, Gemini, Golden II

Rigaud

Villeneuve Elec.
121 St. Jean Baptiste Est., Rigaud, Que., J0P 1P0

Rimouski

Centre D'Ordinateurs Atlantique Ltee.
419 Boul. Jessop, Rimouski, Que., G5L 7Y5
(418)722-0606
Ordinateurs: Commodore, Sanyo 550-555-555/2. Imprimante Epson, FX 80, RX 80, RX 80FT etc. Logiciels varies, service de techniciens et programmeurs. Moniteurs Hitachi, Commodore, Sanyo, Zenith.

Doneltronique
Plaza Aurthur Buies, 411 Sirois, Rimouski, Que., G5L 8B2

J.L. Orninateur Ltee. CN
133 St. Germain O., Rimouski, Que., G5L 4B6
(418)724-6800
MO CAT \$1.50
Computers: Apple, Commodore, Digital, Gescom, Sharp. Software: Edlciel, Logidisque, Vifi Sogiciel. Monitor: Zenith, Amdek. Printer: Epson, Centronics, C-IOTH Electronics Inc. Accessories: Talos.

Systems Ormic Ltee. ETI/CN
133 St. Germain O., Rimouski, Que., G5L 4B6
(418)724-6800
Authorized: Apple, Commodore, Eagle, NEC, Gimix, Epson, Centronics, Sharp. Complete library, full software, supplies and Ormic diskettes. Complete line of computer furniture.

Riviere-du-Loup

Le Messenger Micro
298 Boul. Theriault, Ctr. Commercial, Rivier Du Loup, Que., G5R 4C2

Riviere Du Loup Clavigraph (1979) Ltee:
383, rue Lafontaine, Riviere-du-Loup, Que., G5R 3B5 (418)862-7234
Apple, Canon, Olympia, Centronics, Epson, Micro computer products, peripherals, accessories, software and furniture.

Roberval

Turcotte Antoine
789 Blvd. Marcotte, Roberval, Que. G8H 2A2

Rouyn

Centre D'Informatique Abitibi Inc.
338 Gamble O., Rouyn, Que., J9X 2R3

Logicon (Rouyn) Inc.
15 Gamble Est, Rouyn, Que., J9X 3B6
(819)762-7775
Computers sales. Computer installation. Data processing services. System programmation consultant.

Rosemere

Radio Shack
315 Boul. Labelle, Galeries des Mille Iles, Rosemere, Que., J7A 2A7 (514)437-1211
Radio Shack TRS-80 Models II, III, 16 and colour computers. Hardware and software plus related peripheral equipment.

Sept Iles

Services Informatiques de Sept-Iles Inc.
461 Brochu, Suite 202, Sept-Iles, Que., G4R 2X1
(418)968-8910
Commodore and 3M dealers for computer products. Books on computing from beginners to programmer. Software and games from various sources.

Shawinigan

Antras Micro-ordinateurs Inc.
553 Place Du Marche, Shawinigan, Que., G9N 1S3
(819)536-5823
Distributeur autorise Apple, Vifi logiciel, 3M, Epson, Papier, Logiciel compatible, Apple, IBM, Commodore.

Sherbrooke

Compucentre
Carrefour de L'Estrie, 3050 Boul. Portland, Sherbrooke, Que., J1L 1K1 (819)562-2212
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business entertainment and education applications. Large variety of books and third party vendor products.

Computerland
2524 Rue King Ouest, Sherbrooke, Que., J1J 2E8
(819)564-1534

D.O.S. Sherbrooke
1578 Rue King Ouest, Sherbrooke, Que., J1J 2C3

Futur Byte
1576 King St. West, Sherbrooke, Que., J1J 2C3
(819)564-1202
Consulting, analysis, programming, supplies. Authorized dealer for Apple, Commodore, Teletideo, Xerox plus various lines of peripherals.

Les Systems Data du Canton Inc.
Centre Commercial King, 2341 rue King Ouest, Sherbrooke, Que., J1J 2G5 (819)564-4448
Apple.

Radio Shack
3050 Boul. Portland, Carrefour de L'Estrie, Sherbrooke, Que., J1K 1L1 (819)562-3677

Visiontroniques Ltd.
218 Rue Alexandre, Sherbrooke, Que., J1H 4S7

Ste. Anne Des Mont

Dani-L'Ordinateur
26 Route Du Parc, Ste. Anne Des Moht, Que., G0E 2G0

St. Bruno

Compucentre
Promenade St. Bruno, 162 Boul. des Promenades, St. Bruno, Que., J3V 5K1 (514)461-1121
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business entertainment and education applications. Large variety of books and third party vendor products.

Micro-Mars Inc.
1364 Roberval St., St. Bruno, Que., J3V 5J2

Radio Shack
271 Boul. des Promenades, Les Promenades, St. Bruno, Que., J3V 5K3 (514)653-4122

St. David

Micro-Contact Inc.
463 Route 132, St. David, Que., G6W 1H5

Selectronic Levis CN
563 Trans-Canada Ouest, St. David Levis, Que., G6W 1H5 687-6525, 835-1515
MO
We stock Commodore, Sanyo, and Sony computers. Epson printers.

Ste. Foy

Compucentre
2700 Laurier Blvd., Ste. Foy, Que., G1V 2L8
(418)653-5150
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business entertainment and education applications. Large variety of books and third party vendor products.

Computerland
2600 Boulevard Laurier, Ste. Foy, Que., G1V 2L1
(418)659-6540

Data Terminal Mart
1990 Ouest boul. Charest, Bureau 101, Sainte-Foy, Que., G1N 4K8 (418)687-3560

D.O.S.
3440 Quatre-Bourgeois, Ste. Foy, Que., G1W 4T3
(418)651-1882
MO
Also D.O.S. centres at Moncton, Montreal, Sherbrooke. We are also a builder for the Felix microcomputer.

Hewlett-Packard
2323 Blvd. Due Versant Word., Ste. Foy, Que., G1N 4P4

Irisko Du Quebec
1990 West Blvd., Charest #118, Ste. Foy, Que., G1N 4K8

MAI Canada Inc.
1963 Boul. Charest Ouest, Ste. Foy, Que., G1N 2E6

Micro-Logic Inc.
2796, Chemin Ste. Foy, Ste. Foy, Que., G1V 1V8
(418)658-6624

Ordinateurs IRISCO
2014 Boul. Charest Ouest, Suite 100, Ste. Foy Que., G1N 4N6 (418)681-0061
Commodore, Hewlett-Packard & Columbia dealers.

Ormic Ste. Foy CN
999 De Bourgogne, Ste. Foy, Que. G1W 4S6
(418)659-3858
Authorized: Apple, Commodore, Eagle, NEC, Gimix, Epson, Centronics, Sharp. Complete library, full software, supplies and Ormic diskettes. Complete line of computer furniture.

Radio Shack
2700 Boul. Laurier, Ste. Foy, Que., G1V 2L8
(418)658-7365

Directory of Computer Stores

Radio Shack Computer Centre
2095 Charest Blvd. W., Ste. Foy, Que., G1N 4L8
(418)683-2149

Selectronic
2651 Hochelaga, Ste. Foy, Que., G1V 2J5

St. Gabriel De Brandon

Beaulieu Electronics
130 Dequoy, St. Gabriel De Brandon, Que., J0K 2N0

St. Georges de Beauce

Lariviere Electronics
11020 Lere Avenue, St. George De Beauce, Que., G5Y 5S3

Les Ordinateurs PMC
12220 2nd Ave., St. George, Que., G5Y 1X4
(418)228-5504

Retailer of Televideo, Victor 9000, Sanyo, Epson, Okidata, C-ITOH, Hayes, and associate supplies. Software: specialize in business applications. Full service.

SYSMIC Ent.
11197-2 Leme Ave., St. Georges de Beauce, Que., G5Y 1V9 (418)228-0005
MO

Microcomputer products, peripherals & accessories, software. Cdn. General Electric computer products, Memorex, Visicorp, Centronics. Authorized Apple dealer.

St. Hubert

Brousseau Ateliers
3256 Grande Allée., St. Hubert, Que., J4T 2S5

St. Hyacinthe

Microstast Inc. CN
740 Casavant West Blvd., St. Hyacinthe, Que., J2S 7S3 (514)773-1361
Everything for IBM, Commodore, Apple, Sharp computers. JOLIDATA systems dealer. Hardware, software, peripherals. Other store: 1275 des Cascades, St. Hyacinthe, Que., J2S 3H2 (514)773-5858

Salon De L'Elect.
2783 Rue Nichols, St. Hyacinthe, Que., J2S 2X2

Simco Inc.
2060 Des Cascades West, St. Hyacinthe, Que., J2S 3J6 (514)773-7843
Apple dealer. Peripherals and software. Apple only at 3 stores.

St. Jean sur Richelieu

Info Service Electronique Inc.
224 Champlain, St. Jean-sur-Richelieu, Que., J3B 6V8 (514)347-3375
MO
Apple, GBC, Sharp, diskettes and accessories. Maintenance, customized systems.

St. Jerome

Academie De L'Ordin
Carrefour Du Nord, 900 Blv. Grignon, St. Jerome, Que., J7Z 3S7

Infovideo Inc.
291 LaBelle, St. Jerome, Que., J7Z 5L2 (514)431-1414
Apple computers, Texas Instruments, Televideo systems, Epson, Comrex. Livres et revues.

St. Laurent

asap Computer Products
6969 Trans Canada Hwy., Suite 114, St. Laurent, Que., H4T 1V8 (514)337-2280
MO
Authorized dealers for: IBM Personal Computer, Hyperion, IBM compatible software and hardware.

Compucentre
3131 Cote Vertu, Place Vertu, St. Laurent, Que., H4R 1Y8 (514)336-3058
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business entertainment and education applications. Large variety of books and third party vendor products.

CompuDesign
Le Bazar Shopping Centre, 3680 Cote Vertu, St. Laurent, Que., H4R 1P8 (514)335-2000
MO
Dealer of Apple, Apple compatibles, IBM compatibles, Epson printers, peripherals and software for Apple and IBM, computer supplies and publications.

Epson Canada Ltd.
6000 Vanden Abele St. Laurent, Que., H4S 1R9

Hamilton Avnet
2670 Sabourin, St. Laurent, Que., H4S 1M2

JMT Inc.
2400 Modugno St., St. Laurent, Que., H4R 1W6 (514)337-6139

Lareon Micro Systems Inc.
3300 Cote Vertu, Ste. 108, St. Laurent, P.Q., H4R 2B8 (514)335-2725
Turnkey IBM and Apple systems. Accounting applications. Data entry. Hands-on end-user training.

MAI Canada Ltd.
7355 Trans Canada, Ste. 100, St. Laurent, Que., H4T 1T3

MBA Microsystems
627 Stinson St., St. Laurent, Que., H4N 2E1 (514)744-3376
We are a computer services organization. We do customized programs for small to medium size businesses, turnkey solutions on all brands of micro computers.

Protec Microsystems Inc.
725 Decarie Blvd., Suite 202, St. Laurent, Que., H4L 3L4 (514)744-3363
MO CAT FREE
Z-80 based micro computer kits, designed for teaching and industrial applications.

Radio Shack Computer Dept.
3205 Cote Vertu, Pl. Vertu Shop., St. Laurent, Que., H4R 1Y8 (514)332-0246

Radio Shack Computer Centre
8092 S. Service Rd., St. Laurent, Que., H4S 1M5 (514)337-2741

St. Laurent De L'Ord
835 Boul. Decarie, St. Laurent, Que., H4L 3M5

St. Laurent Micro Computers
824 Decarie Blvd., St. Laurent, Que., H4L 3L9 (514)744-4956
Timex/Sinclair, Franklin, Basis, Kaypro, Epson printers.

Universal Infor.
5990 Vanden Abele, St. Laurent, Que., H4S 1R9

Xerox
Ste.100, 7575 Place Trans Canadienne, St. Laurent, Que., H4T 1V6

St. Leonard

Universal Computer Systems
6955 Lacordaire, Suite 302, St. Leonard, Que., H1T 2K5 (514)255-5501
MO CAT FREE
Computer distribution.

Zone 2000 Inc. CN
5130 Boul. Metro E., St. Leonard, Que., H1S 2V1

St. Philippe De Ne

Dionne Electronique
123 Route 230, St. Philippe De Ne, Que, G0L 4A0

St. Pierre De Sorel

Pierre Elect. Centre
201A Marie Victorin, St. Pierre De Sorel, Que., J3P 5J2

St. Ursule

Indusol Industrial Control Ltd.
2050 Rue Principale, Ste. Ursule, Que., J0K 3M0 (819)228-9500
MO
Indusol process control micro computers, Zenith data systems.

Stoneham

Micro Basic Systems
2075 Tewkesbury, Stoneham, Que., G0A 4P0

Thetford Mines

Lessard Eq de Bureau
236 Notre Dame Sud, Thetford Mines, Que., G6G 1J6

Ordinatel
806 Champlain, Thetford Mines, Que., G6G 4A3

Ordinatel Inc.
236 Notre Dame Sud, Thetford Mines, Que., G6G 1J6 (418)338-2365 or 335-5172
Apple compatible, and Televideo line of computer and associate supplies.

Thetford Elect.
163-4th St. W., Thetford Mines, Que., G6G 5A3

Tracy

Pro-Micro
6870 Plaza Blvd., Tracy, Que., J3R 4L7 (514)743-2825

Trois Rivieres

Futur Byte
1366 Boulevard de Recollets, Trois Rivieres, Que., G8Z 4L5
Products: IBM, Commodore, Hyperion, Televideo, DEC. Printers: Epson, Centronics, Smith Corona. Software.

Matteau Electronics
2045 Rue Royale, Trois Rivieres, Quebec, G9A 4L3

Micord Enterprises
1675 Royal, Trois Rivieres, Que., G9A 4K2
(819)373-2441
MO

Ordinateurs Columbia, Kaypro, Imprimantes Epson, Brother, Logiciel, Produit informatique service de consultation.

Ormic Trois Rivieres
1500 Notre Dame, Trois Rivieres, Que., G9A 4X5
(819)373-7020
Authorized: Apple, Commodore, Eagle, NEC, Gimix, Epson, Centronics, Sharp. Complete library, full software, supplies and Ormic diskettes. Complete line of computer furniture.

Radio Shack
4375 Boul. Des Forges, Centre Les Rivieres, Trois Rivieres, Que., G8Y 5N9 (819)379-3036
Radio Shack TRS-80 Models II, III, 16 and colour computers. Hardware and software plus related peripheral equipment.

Valleyfield

Claude Gendron Elect.
173 Rue Victoria, Valleyfield, Que., J6T 1A6

Deltronc Solare Inc. ETI/CN
83 Rue Alexandre, Valleyfield, Que., J6S 3G7
(514)371-5720
Authorized Commodore, Televideo and G.A. dealer. Hardware, software and programmer service on-site.

Magisystem Inc.
16 Rue Nicholson, C.P. 98, Valleyfield, Que., J6S 4V5

Val D'Or

Centre D'Informatique Abitibi Inc.
548-3rd Ave., Val D'Or, Que., J9T 1S4

Victoriaville

Co-Ordinateur 551 Inc.
551 Boul. Bois-Francis Sud, Victoriaville, Que., G6P 5X6

Ville D'Anjou

Compucentre (H.O.)
9200 Claveau, Ville D'Anjou, Que., H1J 1Z4
Head office is not an authorized dealer.

Compucentre (H.O.)
9001 Louis H. Lafontaine, Ville D'Anjou, Que., H1J 1Z4
Head office is not an authorized dealer.

Ville LeMoynes

Gregoire Elect.
200 Rue Charron, Ville LeMoynes, Que., J4R 2K6

NEW BRUNSWICK

Bathurst

Bayco Business Products Ltd.
212 Main St., Bathurst, N.B. E2A 1A9 (506)548-4558
MO
Olivetti, Corona, Commodore computers. Printers by Epson, Okidata and Mannesmann-Tally. Specializing in legal and accounting software. Complete sales, service and support.

Business World Ltd.
379 St. Patrick St., Bathurst, N.B., E2A 1E2

Dieppe (Moncton)

Datamaster
438 Paul St., Dieppe, N.B., E1A 4Z2 (506)855-2277
Apple, TI, DY-4 micros and local area networks. Specialize in business applications. Software, including proprietary software accounting package.

Computerland
550 Paul St., Dieppe, N.B., E1A 5T5 (506)855-6696
Retailer of IBM, Apple, Digital, Hyperion & Compaq hardware and software. Complete line of peripherals including Epson, Okidata, C-TOH, Mannesman Tally printers. Full service centre on-site.

Fredericton

Concept Audio-Visuel
573 King St., Fredericton, N.B., E3B 1E8
(506)455-1119.

Computerland
1133 Regent St., Fredericton, N.B. E3B 3Z2
(506)454-1122
IBM, Compaq, Hyperion, Apple, Epson, Okidata, Lotus, Ashton-Tate. Full service and support.

Datamaster
414 York St., Fredericton, N.B., E3B 3P7
(506)454-8953
Apple, TI, DY-4 micros and local area networks. Specialize in business applications. Software, including proprietary software accounting package.

Interactive Computer Systems Ltd.
554 Queen St., Fredericton, N.B., E3B 1W9
(506)454-7691.
MO
Retailer of IBM, Corona, Olivetti, Kaypro, Brother, Epson, Okidata. Specialize in business applications. Complete line of supplies and accessories for all micros. Full service department.

MacDonald Ventures (Sof Tec) Ltd.
30 Main St., Fredericton, N.B., E3A 1B8
(506)472-1678
MO
BASF magnetic media distributor for the Atlantic provinces. Apple & IBM compatible computers. Customized software. Supplies and accessories for all micro computers.

Radio Shack
148 Dunderdall St., Fredericton, N.B., E3B 1W8
(506)454-0930
MO CAT FREE

Moncton

D.C.T. Systems Inc.
15 Archibald St., P.O. Box 832, Moncton, N.B., E1C 5H8 (506)389-1222
Data consulting and timesharing (PDP 11/34) Xerox microcomputer and software. Pearl software, RDM Pascal data base, and micro peripherals.

Interactive Computer Systems Ltd. CN
827 Main St., Moncton, N.B., E1C 1G1
(506)389-3333
MO
Retailer of IBM, Corona, Olivetti, Kaypro, Brother, Epson, Okidata. Specialize in business applications. Complete line of supplies and accessories for all micros. Full service department.

Radio Shack Computer Centre
801 Main St., Moncton, N.B., E1C 1G1
(506)854-2203
MO CAT FREE
TRS-80 computers and software. Printers, peripherals and user items.

CODING KEY

Codings are: MO (the company supplies mail order), CAT (catalogue available), Price is indicated if not free.

Saint John

Compucentre
Brunswick Sq. Fashion Centre, 1 Brunswick Square, Saint John, N.B., E2L 4V1 (506)652-7580
Personal computers from IBM PCjr, Commodore 64, Coleco Adam, plus complete line of peripherals, accessories and software for business entertainment and education application. Large variety of books and third party vendor products.

Datamaster
156 Union St., Saint John, N.B., E2L 1A8
(506)693-1132
Apple, TI, DY-4 micros and local area networks. Specialize in business applications. Software, including proprietary software accounting package.

Interactive Computer Systems Ltd.
28 King Street, Saint John, N.B., E2L 1G3
(506)693-7937
MO
Retailer of IBM, Corona, Olivetti, Kaypro, Brother, Epson, Okidata. Specialize in business applications. Complete line of supplies and accessories for all micros. Full service department.

Radio Shack Computer
621 Fairville Blvd., Lancaster Mall, Saint John, N.B., E2M 4X5 (506)674-1926
Complete line of TRS-80.

S&M Industrial Supply
220 Milford Road, St. John, N.B., E2M 4R4

NOVA SCOTIA

Armdale

Epson Canada Ltd.
Box 4146, Armdale, N.S., B3L 4M7

Micro Computer Atlantic
Box 20, Site B, RR3 Armdale, N.S., B3L 4J3

Dartmouth

Computer Innovations
Simpson's, 21 Mic Mac Blvd., Dartmouth, N.S., B3A 4K7 (902)465-3766
Authorized dealer for IBM, Apple and Compaq microcomputers. Line of printers include: NEC, Daisywriter, Epson, Toshiba, Mannesman Tally, C-TOH. All major software packages.

Data Terminal Mart
800 Windmill Road, Dartmouth, N.S., B3B 1L1
(902)469-3782
Kaypro, DEC, Hewlett-Packard, Texas Instruments, Sperry computers; DEC, Qume, Hewlett-Packard terminals; Qume, DEC, Hewlett-Packard, Okidata printers; Hewlett-Packard Plotters; modems, cables, software.

MAI Canada
Townsend Pl., Ste. 1151, 800 Windmill Road, Dartmouth, N.S., B3B 1L1

Mensa Computer Systems Ltd.
#7-10 Akerley Blvd., Dartmouth, N.S., B3B 1J4
(902)469-1171.
Full line Apple dealer carrying Apple II, Apple III, Macintosh and Lisa. Specializing in service to small businesses. An authorized dealer for NEC computers.

Radio Shack Computer Centre
133 Wyse Rd., Dartmouth, N.S., B3A 4K9
(902)463-4910 or 463-4917
MO CAT FREE
Classroom with educator in back of store, teaching computer courses, programming.

Greenwood

Innovative Systems Ltd.
P.O. Box 130 Greenwood, N.S., B0P 1N0
(902)765-4222
Apple computers, peripherals and software for Apple computers.

Directory of Computer Stores

Hallfax

Atlantis Microcomputer
1558 Argyle St., Halifax, N.S., B3J 2B7
(902)422-3500

Basic Computer Sales
6100 Young St., Halifax, N.S., B3K 2A4
(902)454-8344
MO CAT FREE
Texas Instruments TI-99/4A computers, peripherals and software, Okidata microline printers, Smith Corona and Panasonic. Hewlett-Packard calculators and PC's. Texas Instruments calculators.

Computer Access 5121 Sackville Street, Halifax, N.S., B3J 1K1

Computerland
6021 Young St., Halifax, N.S., B3K 2A1
(902)454-8676
MO
Retailer of IBM, Apple, Digital, Hyperion and Compaq hardware and software. Complete line of peripherals including Epson, Okidata, Hewlett-Packard. Full service centre and classroom facilities.

CPU Consulting
5161 George Street, #1016, Halifax, N.S., B3J 1M7

Mensa Computer Systems
1867 Granville St., Halifax, N.S., B3J 1Y1
(902)421-1127
MO
Lisa dealer carrying Apple computer products. Dealer for NEC computers.

Mincomp Systems Ltd.
6174 Quinpool Road, Halifax, N.S., B3L 1A3
(902)421-7122
Full system Commodore dealer.

The Xerox Store
1809 Barrington St., Halifax, N.S., B3J 3K8
(902)425-6400
We sell Xerox 820-II, Xerox 16/8, Xerox 860, Hyperion, Apple Lisa, and Macintosh, as well as Diablo and Epson printers.

Kentville

Future World Computers Inc.
142 Aberdeen St., Kentville, N.S., B4N 4H8
(902)678-0101

Lunenburg

Bluenose Computer Shop
35 Falkland St., Lunenburg, N.S., B0J 2C0
(902)634-8856
MO
Apple dealer.

New Glasgow

Brigadoon Enterprises
872 East River Road, New Glasgow, N.S., B2H 3S7

New Minas

Kobetek Systems Limited
1113 Commercial St., New Minas, N.S., B4N 3E6
(902)678-9800
MO CAT FREE
Commodore systems and Actrix portables. Distributor for Superclerk Integrated W/P, data manager and accounting package; statistical package for Commodore, coin control joysticks, Time Accountant for professionals.

North Sydney

Lantz Electronics Ltd.
115 King St., P.O. Box 459, North Sydney, N.S., B2A 3M5 (902)794-7273
MO
Commodore and Corona PC dealer. Complete line of software. In-store custom programming and service/maintenance. Selection of peripherals.

Saulnierville

Orion Electronics Limited
Saulnierville, N.S., B0W 2Z0 (902)769-3059
CAT FREE
Dealers for Columbia computers.

Stellarton

Byte Control
263 Fiord St., Box 1615, Stellarton, N.S., B0K 1S0

Timberlea

Micro Computer Atlantic
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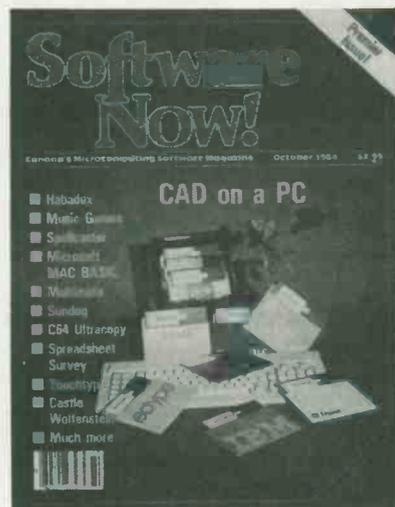
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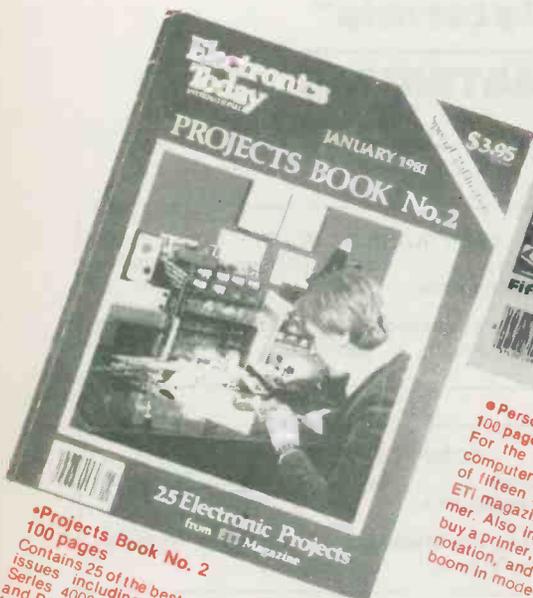
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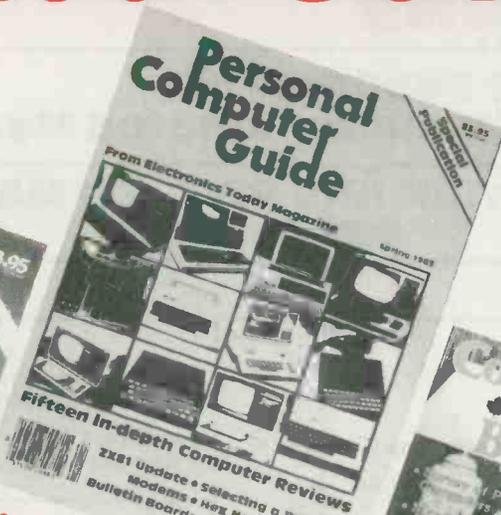
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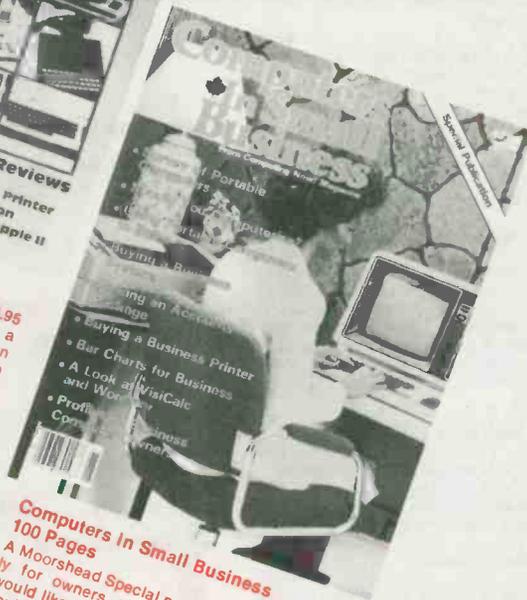
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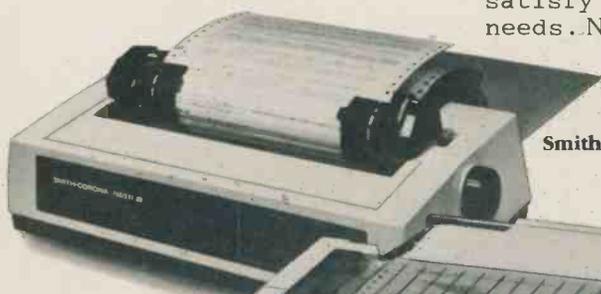
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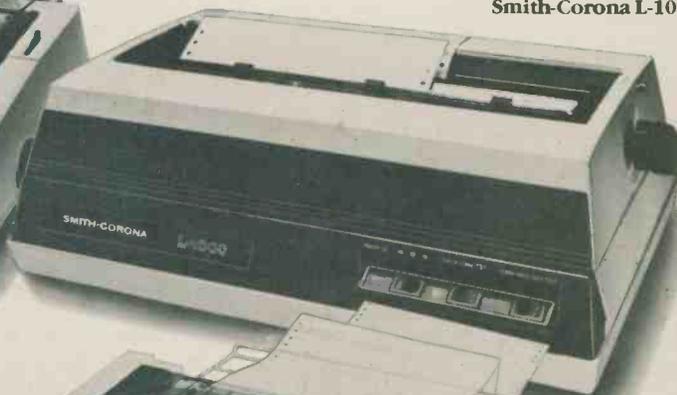
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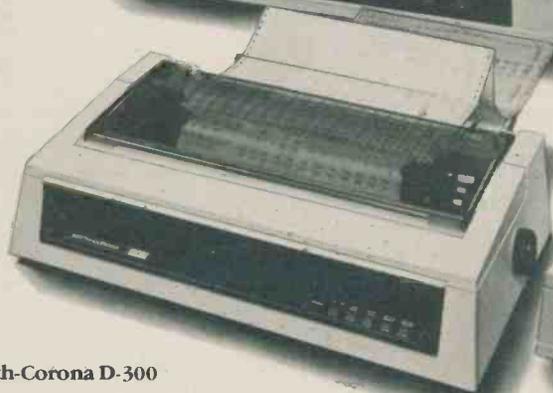
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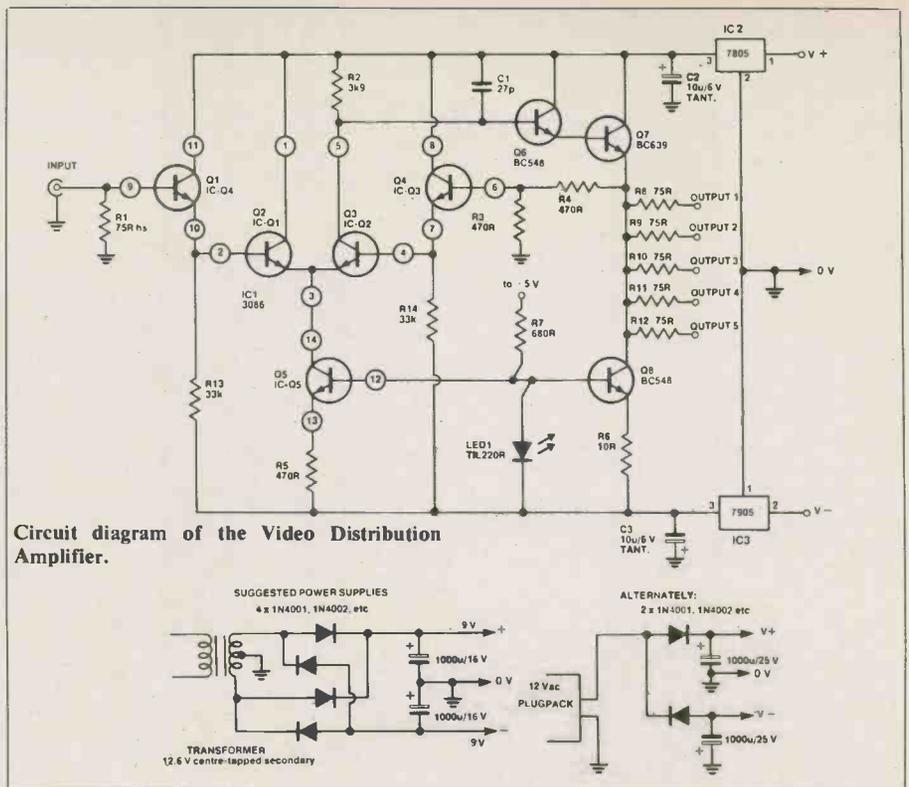
The differential input stage is created from a CA3086 IC (IC1) which counts five discrete transistors. Four (Q1 to Q4) are used to provide a Darlington long-tailed pair, with the fifth transistor (Q5) acting as the current source for the stage. The use of this IC, rather than having five discrete transistors guarantees good thermal matching for low offset and good matching of the transistors for predictable balance and gain.

The open loop bandwidth of the circuit is defined by the capacitor C1 in conjunction with the 3k9 load resistor, R2, and other minor effects.

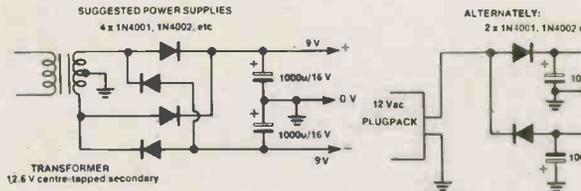
Transistor Q6 is a common collector circuit which buffers the differential pair output and provides a negative dc shift of about 0.6 volts. Q7 and Q8 form the output stage. Q8 is a current source setting the output quiescent current to about 100 mA which is required (worst case) to drive five parallel output lines of 75 Ohms each. Q7 is a common collector stage which drives the output. Q8 also uses the LED as a voltage reference.

Specifications of the Video Distribution Amplifier

Number of outputs up to five
Peak output 2 V peak-to-peak
Power bandwidth 8 MHz (-3 dB @ 1 Vp-p output)
Small signal bandwidth 26MHz (-3dB @ 200 mVp-p output)
Input impedance 75 ohms
Output impedance 75 Ohms (any port)



Circuit diagram of the Video Distribution Amplifier.



Resistors R3 and R4 form the feedback ratio defining resistors. High stability metal film types have been specified here. In practice, they define the gain of the whole amplifier and hence should be precise enough to ensure that the standard video levels are maintained. However, their value is not critical, only that they should be equal. It would be possible to use a pair of selected resistors of any value from 330 to 560 Ohms.

The input termination resistor and the output termination resistors are also

specified as metal film types. This is in order to minimize mismatches with the cables used to connect to other video systems. It would be possible to use 47 or 51 Ohm metal film resistors if your system is 50 Ohm. In this case, the output stage could handle only four parallel loads.

The amplifier runs off + and -5 volts, provided by two three-terminal regulators. These are prevented from oscillating by the two tantalum capacitors, C2 and C3, which also provide supply rail bypassing over a wide bandwidth.

sockets, if good ones, are not cheap). Or, you may fit two BNC's and an RCA type, in case. Note that solder lugs are needed for grounding.

Having selected the connectors, you must decide on the power supply. Included are the full power transformer, rectifier, filter and so on, all of the components for which came to about half the cost of an adaptor. I recommend this approach as cost effective as well as convenient. (You cannot easily lose the parts you bolt in, like you can lose an adaptor.)

Next, drill the box to allow the entry of the power cable or the mounting of an adaptor connector as appropriate. Also, mounting holes for the connectors, the LED, printed circuit board and power transformer, if applicable, will be needed.

Once the drilling is finished, fit the components to the pc board after checking that all holes are correctly drilled and

that all the tracks are OK. Be sure to get the IC's and the tantalum capacitors and transistors the correct way around. Attach short lengths of hookup wire to the pc board input, output and power connections. These can be trimmed and soldered to their respective destinations once the board is bolted in place.

Next fit the transformer, power cable and connectors in their respective positions in the box. Clamp the power cable carefully and connect it to the terminal block, along with the transformer wires.

Now wire up the tagstrip, following the diagram carefully. Solder onto it the transformer secondary wires and the wires leading to the pc board. Mount the tagstrip and the pc board. Run a ground lead to each of the connector ground lugs, as shown in the wiring diagram, and then the 0 V point to the pc board. Finally, connect the input and output leads and

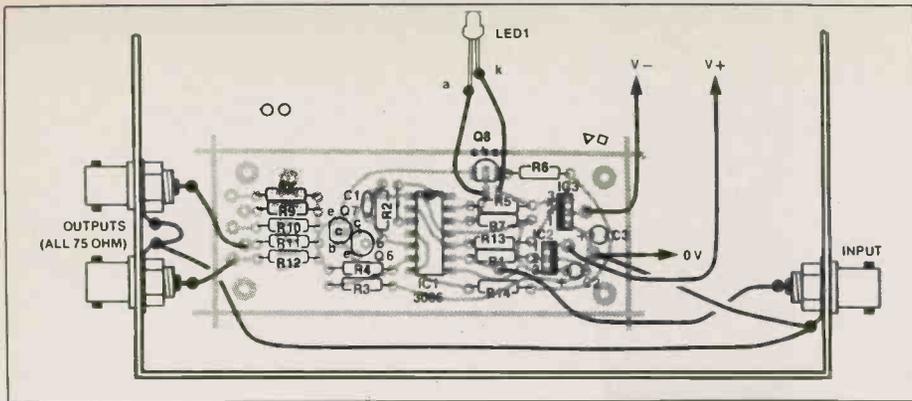
the LED wires.

Test

To test it, apply power and check that the rectifier outputs are correct. If you're using the 12 VCT transformer, you should measure around 9 V across each of the 1000µ filter capacitors. If you're using the adaptor supply, you should get around 16-17 V across the 1000µ filter capacitors. If they're okay, check the outputs of the two regulators. These should each be 5 V. The LED should be lit.

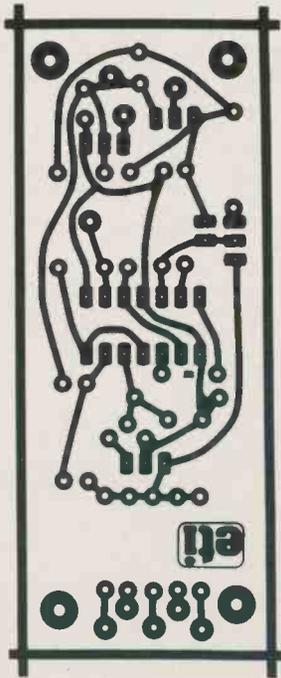
If there are any faults to this stage, switch off and sort them out before continuing. A wiring error is the usual culprit.

If all's well, connect it up and try it out.



Overlay and wiring diagram. Showing how the pc board is assembled and wired up.

ET



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R2	3k9
R3, R4	470R, 1%
R5	470R
R7	680R
R13, R14	33k

Capacitors

C1	27p
C2, C3	10u/6 V tant.

Semiconductors

IC1	CA3086, LM3086
IC2	LM7805, LM340/T5
IC3	LM7905, LM345/T5.0
Q6, Q7, Q8	2N5818
LED1	TIL220R red LED

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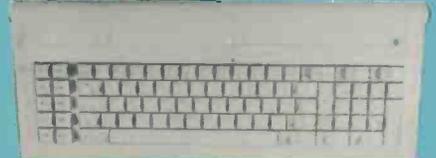
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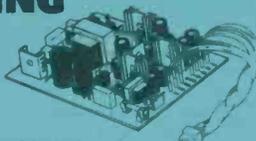
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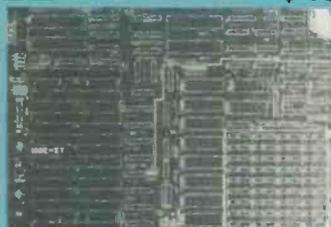
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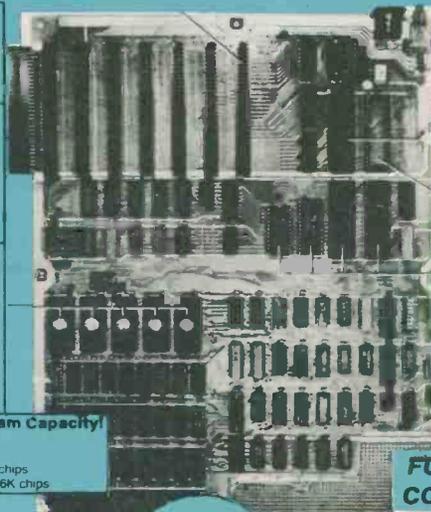
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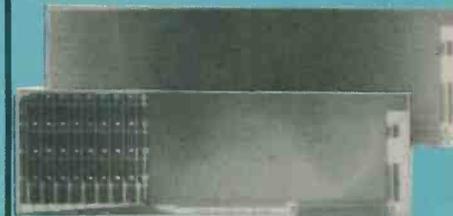


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A Look at Video

Video Cameras

By Bill Markwick

IF YOU have made videotapes in the recent past, you'll be familiar with the former struggle: video cameras were bulky, heavy, and required large battery packs. They played back through a huge, expensive VCR; you looked like a walking TV studio. Not only was this awkward (and costly), but the imposing equipment probably made your audience nervous.

There was one reasonably inexpensive alternative, the 8 mm movie camera, but this meant a long delay for processing, and editing became a tedious mechanical chore.



Technology to the Rescue

The microchip has resulted in the ability to insert complex circuitry into a space the size of a wristwatch, and in turn, has spurred an accompanying drive to miniaturise mechanical components. There are few examples of this miniaturisation as remarkable as the new generation of handheld video cameras. They now amount to tiny TV studios weighing one or two kilograms, and are so unobtrusive that your audience will soon forget that the machinery is there.

Most manufacturers will probably have a handheld version soon; here are some of the readily available models, with our apologies to anyone we missed.

The Hardware

On our cover this month, the intrepid John Rudzinski of *Computing Now!* sports a JVC GR-CIU VideoMovie while riding a bike with one hand. That's how light and easy they are to use; he was actually taping as he went, and could review the tape whenever he was ready.

The JVC (who can remember a number like GR-CIU?) weighs in at 1.9 kg, and fairly bristles with feather-touch pushbuttons. The same machine is available from Zenith, also with the VideoMovie name. It's one of the few handhelds with complete playback features; in addition to fast forward and rewind, you can also do a high-speed shuttle search at about three times normal speed. There's also a freeze-frame effect when you press the Pause button. The tape is contained in a tiny cassette which gave 20 minutes of playing time; an adapter is available for playing the mini-cassette through a regular VHS machine. About 45 minutes of power comes from a snap-on battery pack about the size of a cigarette package; the included recharger takes about one hour to fill it up again. Incidentally, should you buy a JVC, you'll definitely want a spare battery pack or the optional AC adapter; you'll soon be involved enough to run down the pack and then have to wait an hour for recharge.

The picture quality was very good indeed, once the white balance was set by pointing the camera at a white surface and pressing a button. An internal filter compensated for the lack of blues in artificial lighting, and the electronics even managed to subdue the usual greenish-yellow cast from fluorescent tubes.

The JVC was certainly the most flexible of the units we tried, and lists at about \$2000.

The Sony Betamovie, also on our cover, is a different sort of handheld. It has record-only, and is somewhat larger; it makes up for this by the fact that you can insert a full-size video cassette in it. The viewfinder is an optical through-the-lens type rather than a tiny monitor, and made for very bright, easy focussing. Like the JVC, it had pushbutton white balance.



The lack of playback facilities is compensated for by the very high image quality of the Beta format and the longer recording time.

RCA's entry in the miniature division is their Small Wonder model. It does not contain tape, but must be used with a VCR, although RCA points out that the combined weight of the camera and VJP900 recorder is just over ten pounds. It can be switched to operate with VHS recorders as well. Features include totally automatic white balance, remote VCR pause, and a Review mode for quick playback through the VCR. Unlike the JVC, which had automatic Standby to conserve battery power, the RCA must be switched to Standby manually. The usual image tube has been replaced with a MOS solid-state sensor; it's not only smaller, but eliminates the long persistence that causes burning or streaking of the picture in tube-types. The Small Wonder lists at \$1199.95.



The Sanyo VSC800 is fairly new on the market. Like the RCA, it does not contain tape and must be used with a VCR, either Beta or VHS. Features include automatic focus and white balance, MOS image sensor, and a weight of just over one kilogram. One of its interesting features is a C-mount removable lens; this means that it will accept many 35 mm SLR camera lenses.

Lenses

All the cameras mentioned had very similar optical systems. The lenses were all f1.2 with a power-assisted 6:1 zoom. The JVC had the widest wide-angle at 8 mm, the Sony's was 9, and the others 12.5 mm. All cameras had macro-focus, the ability to focus right up to the lens; we obtained

sharp images of a telephone dial less than 10 mm from the lens. The units mentioned also had automatic control of the iris to suit various lighting levels; you can also override this manually for backlighting or fadeout effects.



Sound

All the cameras had built-in microphones; this naturally means that the sound quality will be dependent on the room acoustics, generally mediocre. Fortunately, they allow you to remove the microphone and use a remote cable, greatly improving things. Another drawback to built-ins is the pickup of handling noise, particularly the motor rumble when you operate the power zoom. Of course, they'll all zoom manually as well.

A more serious fault lies in the units which carry their own tape; manufacturers have yet to install hi-fi in the portable cameras. You'll find the sound quality more than adequate for interviews, but musical instruments will soon point up the noticeable wow and flutter. If you're taping music, you may prefer a camera which feeds into a VCR.

Video Cassette Recorders

By Ed Zapletal

ON any given day, in any of Canada's major newspapers, you can find a multitude of advertisements listing hundreds of deals on various pieces of home-entertainment equipment, specifically video cassette recorders. Fierce competition, new technology, and low movie rental costs are making the ownership of VCRs very attractive. Of course there's nothing new about the video craze; it's been with us for some time. Even some of the new advances in the industry are ones which we would expect rather than be surprised at. New compact designs, hi-fi capability, and soon-to-be introduced stereo TV

broadcasts are things which the video consumer has been waiting for. Here's a brief look at what's out there, with some insight into what's new.

VHS or Beta?

Stand in any crowd of video enthusiasts and ask the obvious question: 'Which is better, VHS or Beta?'. At this point you'd better stand back. What you would witness is a debate more heated than that over the chicken and the egg. 'There are more tapes available for VHS' or 'the picture quality is better with Beta'. Now,

there is a certain amount of truth to be had from both these statements, but how do you settle it?

To satisfy my own curiosity, I contacted Gary Tsuyuki of G & G Electronics in Toronto, who stocks both formats. According to Mr. Tsuyuki, Beta comes first under the wire due to the better picture quality produced as a result of the faster writing speed onto the tape. That would seem to wrap it up right there, but what about the popularity of VHS?

A trip to any movie rental outlet will yield a far greater choice of VHS movies

continued on page 60

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Computer Review: Power 3000

Would you believe a ZX-81 clone? And it's packed with improvements.

By John Rudzinski

'WAY BACK when, my father-in-law gave me a wedding present that resulted in two occurrences worthy of note: I spent the better part of four hundred dollars on supporting hardware and horrible literature, and my wife suddenly had to compete for attention that was rightfully hers. We had an unusual honeymoon.

Underneath that wrapping was a Sinclair ZX-81. A pitiful machine really, when compared to the 32-bit behemoths that are rolling out of Cupertino these days, but at the time it was a technological wonder. On a PCB practically no wider than the span of an adult's hand lay the mysterious workings of a computer.

My knowledge of computers at the time was cloudy at best. A brief look at the computer rooms in Deep River based Atomic Energy of Canada Limited led me to believe that all computers were huge, hulking monstrosities that ate cards by the bushelful and demanded PhDs from all who dared approach them.

The ZX-81 changed my viewpoint considerably. But as I became more familiar with its operation, I also took

note of a number of its inherent shortcomings. Its keyboard is a comedian's delight. A good sneeze will fill its RAM. CPUs in motion tend to stay in motion, but a ZX-81 admires the scenery... there's more, but in short, it falls short.

Power to the People

Enter the Power 3000. A cursory glance, noting its 'eraserhead' keys and rectangular size would put it in league with the VZ-200 and the Sord M-5. But wait... a closer peer at those rubber keys confirms the impossible. The Power 3000 is a ZX-81 clone.

Measuring 29 1/2 millimetres by 14 1/2 mm and 5 1/4 mm deep, the Power 3000 is roughly twice the size of its mentor. The added bulk is necessary to incorporate both the keyboard and the extra ports... we'll get to those in a bit.

The keyboard on the Power 3000, as alluded to earlier, is indeed of the rubber keycap variety. While many of the characters are similar to those available on the ZX, there are a number of distinct differences in both the way the characters are laid out, and the way the keypresses are handled by the computer. Each key on the ZX-81 serves at least two functions. The majority of them can produce five characters or keywords with appropriate fumbblings with the shift and function keys.

The Power 3000's keys don't necessarily jibe in this respect. Of the

computer's 42 keys, only a little more than half can produce more than two keywords or characters. Where the 'R' key on the ZX-81, for example, can be convinced to print the character 'F', the keywords FOR, FAST, SGN and the half black, half checkered graphics character, the corresponding key on the 3000 produces the letter 'F', the keyword EXP and a right-angled isosceles triangle graphics character.

The two extra keys on the Power 3000 — the ZX-81 has 40 — are for automatic line numbering and resetting the machine.

Powering Up

Setting up the Power 3000 is a simple task. A standard RCA cord is plugged into either the monitor or television output (depending on which display you have handy at the time) and attached to the appropriate display. The 12 volt power supply's inline plug connects snugly to the computer's power jack. A marked improvement over the ZX-81, whose programs would cheerfully crash if the machine was casually jiggled.

Plugging the power supply into the nearest wall outlet rewards you with the power LED lighting, the on-board speaker beeping, and an inverse 'READY' at the top of the screen. The capitals-only character set is more or less the same as the ZX-81's with the exception of some graphics characters.



Yes, I did mention a speaker. As there is no true tactile feedback to the rubber keys, each keypress elicits a small 'bip' from the speaker to assure you that the struck key registered. After you pick up your typing speed, however, the audio feedback starts to sound like a bad rendition of *Popcorn*. Typing a quick 'NOBEEP' will silence the cacophony.

All in all, the Power 3000 is capable of some passable music from its one-channel speaker. The MUSIC command is followed by the note to be played and the measure of time you want it played. MUSIC "C6D2E3" will play the first three notes to *Oh, Susanna*. The speed of your compositions can be controlled with the TEMPO command, and sound effects like footsteps and explosions can be had with creative manipulations of the SOUND command.

Clone Power

Straight out of the box, and connected to a standard cassette player, the Power 3000 can load and run BASIC ZX-81 programs. Of course, any program listings for the ZX-81 that you type in from magazines or books will run as well, though you may want to make some aesthetic changes...

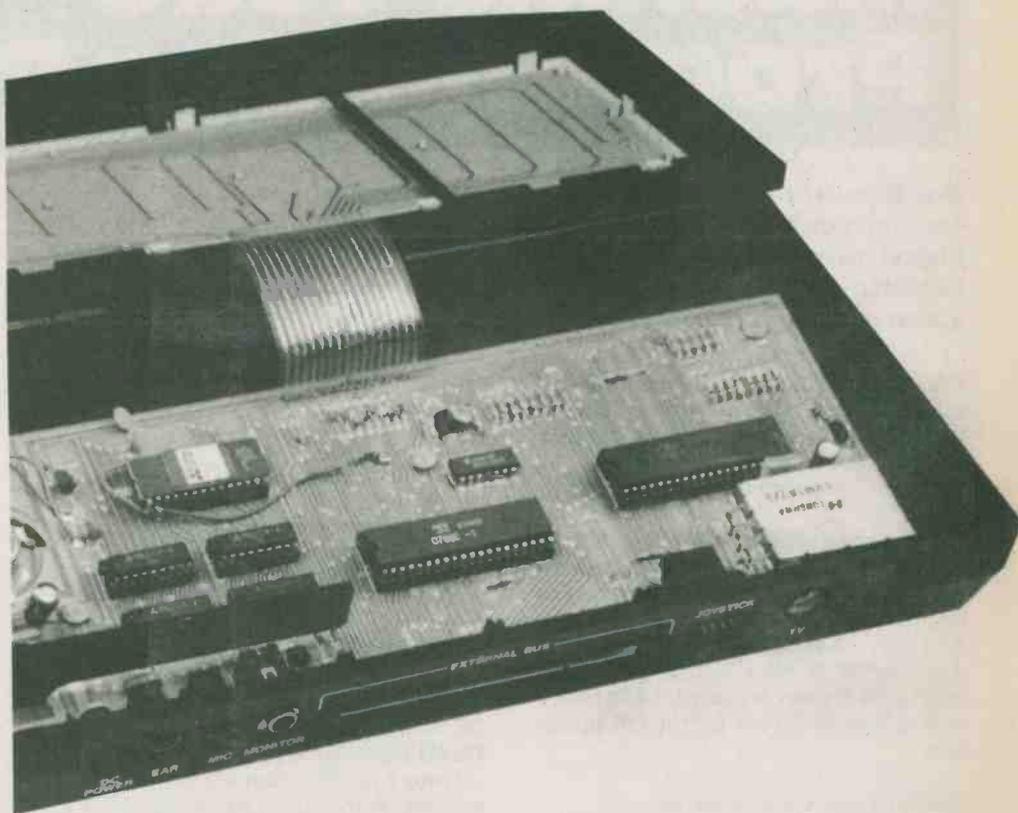
The 3000 has four graphics characters: three space invader aliens and a race car, that improve the credibility of ZX-81 arcade games tremendously. Music can be added to the programs, and, as the Power 3000 has an Atari joystick port, joystick control can be added to the program as a final improvement. The joystick locations are read with the INKEY\$ command.

Actually, you can add considerably more lines to your ZX-81 programs; the 3000's standard RAM configuration is 8K, which may be expanded by attaching either Power 3000 or ZX-81 memory cartridges to its ZX-81 compatible bus. Power 3000 RAM packs are available in 32, 64 or 128K configurations.

Put through our patented torture test, the Power 3000 operated admirably. It didn't crash when left on for extended periods of time, its rugged hard plastic exterior stood up to merciless keyboard poundings, and few choice USR commands (jumps to ROM or RAM from BASIC) caused irrevocable crashes. Most crashes could be exited by a deft jab at the reset key. As a bonus, BASIC listings remain intact after a hard reset, assuming the routine USR'ed to didn't write to program RAM.

Powering Down

In all, the Power 3000 is a perfectly acceptable acquisition for someone who either wants to learn BASIC, or likes the simplicity of the ZX-81 but wishes it could do more. As a beginner's computer,



the low price and good performance of the machine will seem attractive. The 3000's 66-page manual provides, albeit with a few grammatical errors, a fairly extensive but easy to understand introduction to BASIC, and all commands are well documented with examples.

Error codes are less cryptic on the 3000. An SF at the bottom of your screen indicates a 'screen full' error, much easier to remember than the ZX-81's '0/5' error code. As with any language, the easier error codes are to comprehend, the easier the errors are to fix.

The software base for BASIC ZX-81 programs is a fairly healthy one, and as the Power 3000 is compatible with these it will never want for applications. A Centronics parallel interface is available for the 3000 so you needn't worry about printing your listings on aluminum paper.

The Power 3000 seems headed for further expansion not documented in its accompanying literature. Three commands; INK, PAPER and BORDER show up when you print out its character set. Shades of the Sinclair Spectrum, this.

The Power 3000 is available from Koller Engineering Products, Limited, 2 Thorncliffe Park Drive, Unit 30, Toronto, Ontario M4H 1H2 (416) 425-5050.

Quick Reference Power 3000

Retail Price:	\$29.95
CPU:	Z80
RAM:	8K
Software Included:	BASIC
Screen Format:	32x24
Outputs:	TV, composite monochrome
Other:	Joystick port, ZX-81 compatible bus, programmable speaker.

ET

Machine Code Programming Part 5

Bob Bennett completes his look at the operation of the three main logical instructions and goes on to consider ways of moving programs around in memory.

LAST month I told you that there are usually three logical instructions that can be used and looked at the first of these, the AND instruction. We begin this month by looking at the two remaining instructions.

The second binary operation that we can use is OR, which will have the same register format as for AND. Loading Register A with COh, and register B with AA; Fig. 20 shows the result of the instruction OR,B. Note that, as with AND, only the A register is altered.

11000000 @ Register A before the instruction
10101010 = Register B before, and after, the instruction
11101010 = Register A after the instruction

Fig. 20 The operation of the instruction OR,B.

Because machine code is so very fast it is prudent to have delay loops at certain points in the program. A delay loop just wastes time for a while in a manner similar to, but smoother than, the PAUSE instruction in BASIC. The simplest way of obtaining a loop would be to load a register with a count and then decrement the count to zero, using the zero flag to indicate that condition. However, counting down even FFh is incredibly fast, so it seems that a register pair is required to hold a larger number. Alas, although a register pair can be decremented, there is no flag indication to let us know when zero has been reached. Study carefully the delay loop in Fig. 21 which has instructions from the Z80 set. The instruction 20h — JR NZ,e means jump back (on this occasion) by e, until register A reaches zero. This loop can be finely 'turned' by adjusting the low (in C), or high (in B), count.

Even longer delays, and more precise 'tuning' can be achieved by the use of a single register to hold a count which represents the number of times we go through the loop. For example, suppose we wish to run through the loop 4 times; just before the loop in figure 21, load a register with 4d then PUSH that register.

After going through the loop, POP the register, decrement it, and if not zero jump back to PUSH again. Any register

01	Ld BC,mn
FF	low byte
FF	high byte
0B	dec BC
78	Ld A,B
B1	OR C
20	JR NZ,e
FB	e =

back to dec BC

Fig. 21 A delay loop.

pair could be used for the loop, except of course AF, provided you use the instructions pertaining to the register pair. You could use register A to hold the count outside the loop if you wanted, because even though register A is used inside the loop, the count would be preserved by the PUSH instruction.

Using Fig. 20 to sum up; the use of OR will ensure that the corresponding bit in the A register is set if that bit in either A or B is set. To remind you, set is 1, and reset is 0.

The Exclusive Set. . .

The last binary logic operation we can use is Exclusive OR, which is shown as XOR. Put into words, and using registers A and B as examples, it goes like this; the corresponding bit in register A will be set if either, but not both, bits in each register are set. Loading register B with COh, and register A with DAh, Fig. 22 shows the result of the instruction XOR,B. XOR,A will clear register A, and reset the carry flag for you. By studying the binary pattern of the data that you are manipulating, and the binary pattern of the expected answer, a knowledge of the logical operations may help you decide what to do. If they don't help, what about the next lot?

11000000 = Register A before the instruction
11011010 = Register B before, and after, the instruction
00011010 = Register A after the instruction

Fig. 22 The operation of the instruction XOR,B.

Left, then Right

Movement of data within a register is quite feasible, and the Z80 set has a number of instructions that will do just that. These are the rotate, and shift in-

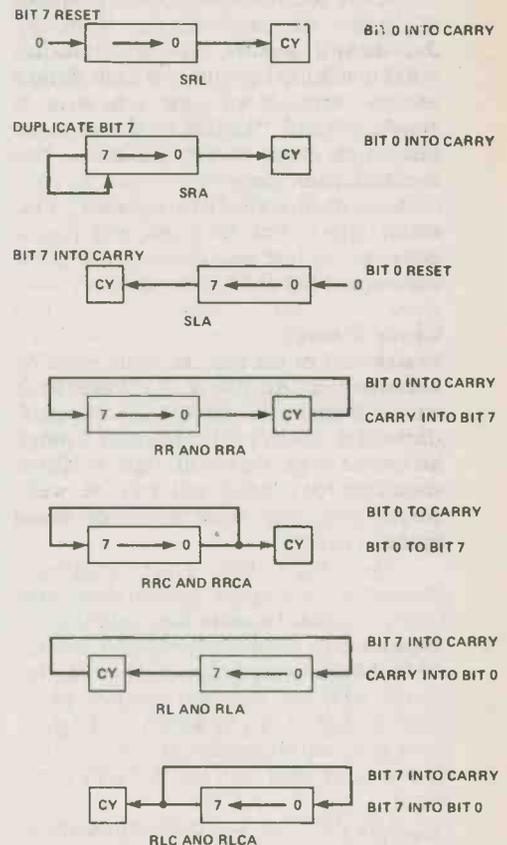


Fig. 23 The operation of the Rotate and Shift instructions.

structions, which will allow movement of data, either to the right or to the left. Because there are so many instructions, doing similar things, I have 'lumped' all the drawings together, but explanations are in order. Those instructions which involve register A, such as RLA — Rotate Left A, will only affect the carry flag, with two exceptions which I'll explain below. Rotate or Shift instructions involving registers other than A will affect all of the flags. To find out what happens after a Rotate or Shift instruction, write down the binary code before, and after, the operation, and convert both to decimal, but watch out for the carry flag if it is involved.

Figure 24 shows the two exceptions that I mentioned above from the Z80 set; these are half a byte (or nibble) manipulations. RLD or Rotate Left Decimal (don't confuse this with RL D, which is Rotate Left, D register), is the first of the nibble

manipulations. In this operation bits 0 to 3 of (HL) are moved over to occupy the most significant nibble position, that is they become bits 4 to 7 of (HL). The first four bits, 0 to 3, of register A are now moved to occupy bits 0 to 3 of (HL). The previous bits, 7 to 4, of (HL) now occupy bits 0 to 3 of register A. How it is done, and in what order, doesn't matter, but the result will be as described. RRD or Rotate Right Decimal, as you can see from Fig. 24, does a slightly different 'shuffle'. RRD and RLD operations affect all flags except carry. Notice also the use of brackets, (HL); this means that it is the data in the address pointed to by HL that is manipulated.

Because of the lack of registers in the 6502 CPU, most data manipulation is done with the accumulator (register A), via the index registers and/or memory locations. However, sometimes the index registers themselves can be used, as in this example. The instruction E0h — CPX will compare the byte in index register X with a memory location, in fact the address after the byte E0. The result would affect the sign, carry, and zero flags. I shouldn't have to tell you that the example was in the immediate addressing mode.

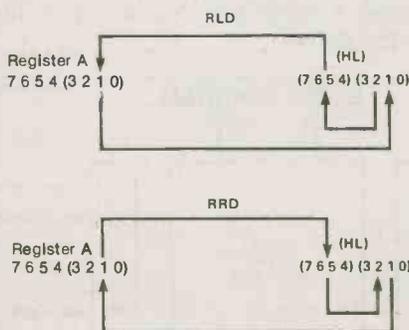


Fig. 24 The half-byte (or nibble) movement.

A Bit At A Time. . .

Bit instructions fall into two categories; one will actually alter the bit, either set it or reset it, while the other will just test whether the particular bit is set or not. The result of testing will be either zero or not zero, which can be the indicator for the next instruction. If you can't think of a use for testing a bit, how about this example: suppose that you wanted to print, to the screen, a certain number of squares, alternating between, for example, black and white. Load a register with the total number of squares that you wish to print. Point a register pair, or if using zero page, the appropriate index register, to the first colour that you wish to print. Print that, using the form (); for example, if you were using the HL pair, (HL), then decrement the counter, test bit 0, then either decrement, or increment the pointer to point at

the other colour. Test the counter for zero and jump back if not yet zero. As you can see, the codes for the coloured squares only need occupy two locations. To test how it works, assume that the count was 16d, write down the binary for 16, then underneath that the binary for 15, then 14, and so on until zero, then examine the pattern of bit zero, the rightmost bit. If you then write with the address of black, then do the same for white opposite the 1s, you need only do this for 3 or 4 squares before the 'pattern' of the program becomes apparent.

A Moving Story. . .

Often, when developing a machine code program, I can never be sure how many bytes the program will ultimately occupy. One method I use is to put the control program approximately where it should go and write the bulk of the program well out of the way. If I leave room either side of this bulk of program then I can extend in either direction. When I am satisfied that the program works I move the bulk down towards the control program. This usually means altering a few addresses, but that's far better than having to re-write the program because I didn't leave enough room in the first place. So how is a program moved about in memory? Study carefully the program in Fig. 25, which uses instructions from the Z80 set. The HL pair is pointing to the address from which we wish to start moving the program. The DE pair point to the address to which we are going to move the program, and the number in the BC pair represents the number of bytes we wish to move. Register A is now loaded with the byte held in the address pointed to by HL, in other words, let A equal PEEK (HL). This byte is then loaded into the address pointed to by DE, in other words POKE (DE) with the contents of register A. Both HL and DE are then incremented, and BC decremented, and this goes on until BC reaches zero.

Although that little program works quite well, take a look at the program in Fig. 25, which illustrates the use of an automatic instruction to load (DE), (HL), increment those two registers, decrement BC and repeat until BC reaches zero, which is exactly what happened in my program. As you would expect, because the automatic program is slightly shorter it will work a little faster. I have provided two examples for two reasons: First, if your CPU does not have any automatic instructions the first example should give you an idea how to make up a program of your own. Second, to introduce the automatic and semi-automatic instructions from the Z80 set. There are two very important things to note regarding the automatic instruction in Fig. 26. The first is that the transfer of bytes is from (HL)

21	Ld HL,nn
	low byte
	high byte
11	Ld DE,nn
	low byte
	high byte
01	Ld BC,nn
	low byte
	high byte
7E	Ld A,(HL)
12	Ld (DE),A
23	inc HL
13	inc DE
0B	dec BC
78	Ld A,B
B1	OR,C
20	JR NZ,e
e	= F7
C9	ret

Fig. 25 Left. Moving a block of memory.

Fig. 26 Right. Moving a block of memory using an automatic instruction.

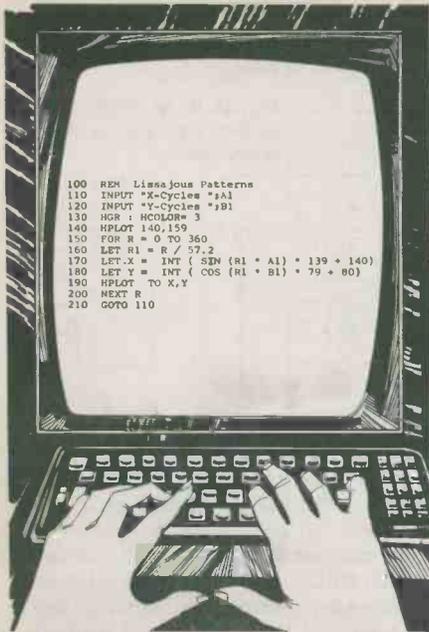
21	Ld HL,nn
	low byte
	high byte
11	Ld DE,nn
	low byte
	high byte
01	Ld BC,nn
	low byte
	high byte
Ed	LDIR
B0	
C9	ret

to (DE) only, so make sure which way round you are working. The second point is that when BC has reached zero the zero flag will not be affected, so the only flag you can use is the Parity/Overflow flag which will be reset on BC reaching zero.

Another automatic instruction is ED88h — LDDR which still loads from (HL) to (DE) but this time HL and DE are both decremented along with BC, and again, only the P/O flag is affected. A very useful instruction in this group is EDB1h — CPIR which can be used to search a block of memory for a particular byte. It works like this; load HL with the starting address of the memory to be searched, load BC with the number of bytes you wish to search through, and load register A with the byte that you are looking for. If you remember, a compare instruction will only compare something with what is held in the A register. This time the comparison will be made with the byte in the address that is pointed to by HL, in other words, compare A with (HL). The program will stop either if a match has been found, in which case the zero flag will be set, or when BC has reached zero, in which case the P/O flag will be reset. Until either condition has been met HL will be incremented, and BC decremented. The other automatic instruction for comparing is EDB9h — CPDR which works in the same way but HL is decremented instead of incremented.

The four instructions that I have just described each have a non-automatic instruction format. The two byte moving instructions are EDA0h — LDI and EDA8h — LDD which only perform the operation once. You will have guessed by now that the I in the instruction stands for Increment, the D stands for Decrement, and the R for Repeat. The non-automatic comparison instructions are EDA1h — CPI and EDA9h — CPD. One very useful instruction in the Z80 set which is automatic in operation is 10h — DJNZ,e this stands for Decrement, Jump if Non Zero, by the amount of the offset byte e. This instruction only works on the B register but as I said, it is very useful indeed.

ET



There are lots of programmable memory chips available to the user; here's a guide to the many types available.

Computing Today

Compatibility Between EPROMs

By Yin H. Pun

ALL computers require some sort of non-volatile memory ready to be executed as soon as the system is turned on. This is called "firmware". The minimum amount of "firmware" needed would be a "bootstrap"; loader, a small program to initiate the loading of the disk operating system and/or a language into RAM. Firmware may contain software such as BASIC or drivers on a peripheral card. Traditionally, firmware is kept in ROM (Read Only Memory). As the name implies, the program in ROM is forever etched in patterns of silicon and cannot be altered. However, there are many ROM substitutes, many which are functionally identical to ROM but may be programmed by the user.

The EPROM

EPROMs, an acronym for Erasable Programmable Read Only Memory, are the most popular non-volatile, user-programmable memories. Masked-programmed ROMs (or simply ROMs) hold the finalized programs of a computer and are extremely cheap when mass-produced in the thousands. However, for prototyping or small quantity production of computers, EPROMs are an alternative to ROMs. EPROMs may be programmed with an inexpensive EPROM programmer. Each memory cell is individually charged with a voltage of 20-25V and the presence or absence of the charge denotes a "1" or a "0". EPROMs are distinctive from ROMs in that they have a little epoxy window so that the actual silicon chip may be seen. The memory is erased by exposing the chip to ultraviolet radiation for about 20 minutes. Then the EPROM is ready for reprogramming. EPROMs are functionally equivalent to their respective ROMs since they are pin to pin compatible.

Different Types Galore

There are several types of EPROMs, with the pin-out all standardized among most manufacturers. In 1972, there was the 1702A and it was probably the first mass-produced EPROM. It held 2K of information organized by 256 8 bit cells and had an access time of 650 nanoseconds (the access time is how quickly a memory device

include the 2732 and 2532, 32K EPROMs and the 2764, a 64K EPROM holding a full 8 kilobytes of memory. All EPROMs have their ROM counterparts; therefore, this makes it easy for firmware pirates to copy a legitimate system's ROMs, such as Apple firmware, into EPROMs, enabling a clone computer to be produced. It breeds a whole new controversy of the copyright laws.

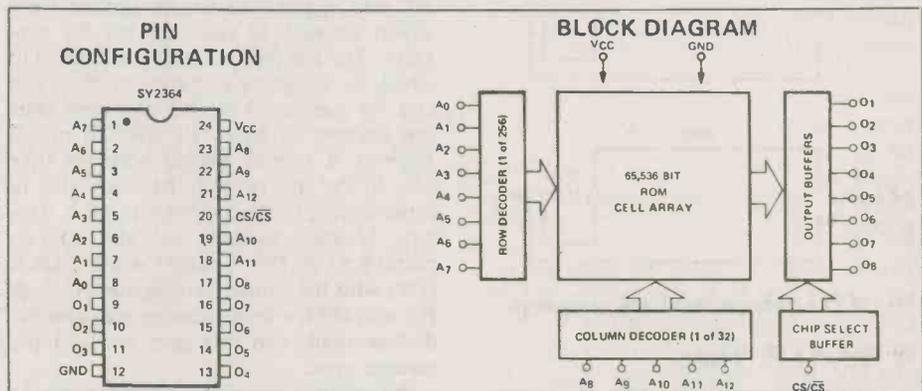


Fig. 1 The pinout and block diagram of a standard non-programmable ROM chip, the 2364. It has 64K bits, or 8K bytes.

can output its information when it is requested; a nanosecond (ns) is a billionth of a second). It dissipated a full watt of power and required three supply voltages: 5V, -5V and 12V. Today's faster microprocessors require memory with faster access times. A high performance 16/32 bit MC68000 requires memories with access times of 200ns for it to run at full speed without wait states. However, many 8-bit microprocessors such as the 6502 and the Z-80 still need only a 450ns access time. The 5V family of EPROMs are in widespread use today. The popular 2716, a 16K (2048 x 8) EPROM compatible with the 2316 ROM, is used in many computer systems. More recent EPROMs

The 2716

EPROMs, as well as many other memory devices and microprocessors, used to need three supply voltages. The 2708 was the last of those dinosaurs. In 1977, the single five volt 2716, a 16K EPROM, was introduced by the Intel Corp. It quite appropriately came simultaneously with the 4116 16K dynamic RAM. Texas Instruments came out with an identical one numbered 2516. The 2716 represented a large step in the evolution of EPROMs. It offered twice the memory capacity on a chip only 20% larger than the 2708. It needed only 5V and had low power stand-by mode, in which it dissipated only 125

mW when it was deselected by the system. Also, it required only TTL inputs to program it, whereas the 2708 required 12V. Today, however, the 2716 is slowly being phased out. Higher density EPROMs have been released and are becoming less expensive than the 2716.

Compatibility Discrepancies

The 2716 is totally pin-to-pin compatible with its ROM counterpart, the 2316, and was standard among all manufacturers. Compatibility discrepancies started to arise with the conception of the 32K EPROMs. There are two contending pin-outs, the 2532 Texas Instruments version and the 2732, the Intel version. Both of these EPROMs are upward compatible with the 2716, meaning that they could be plugged into EPROM sockets designed for 2716s and work. The only difference is the location of the new All address line. Texas Instruments places All at pin 18, which is an active low chip enable input for the 2716. The first half of addresses in the 2532 would be selected if it is plugged into a 2716 socket. Intel places All at pin 21, which is the programming voltage supply pin -Vpp of the 2716, normally kept at 5V. The second half of the addresses in the 2732 would be selected if it is used as a 2716. Vpp is placed on pin 20 and serves a dual function: as a chip enable during normal use and a 25V programming source input during programming.

With a little re-wiring a 2732 can be made to fit into a 2532 socket or vice-versa. Just reroute the correct signals to the corresponding pins.

High Performance 32K EPROM

There exists the 2732A, a high-density, high-speed 32K EPROM. Its chip is half as large as its 2732 counterpart, and requires a 20V programming voltage instead of a 25V. In the computer, the 2732 can be directly replaced with the 2732A but not always the other way around. However, the 2732A should be used in conjunction with higher performance microprocessors which demand its 200 ns access time.

Major Discrepancies of 64K EPROMS

As memory density doubles again, more differences arise. Intel and Texas Instruments opt for a 28-pin package while Motorola is going with a 24-pin package. Motorola's 24-pin package allows easy upgrading from 32K to 64K, but Intel and TI argue that a 28-pin package should be the basis for upward expansion of larger memories which will require a 28-pin package. There will be no more pins for the address lines. Many other companies

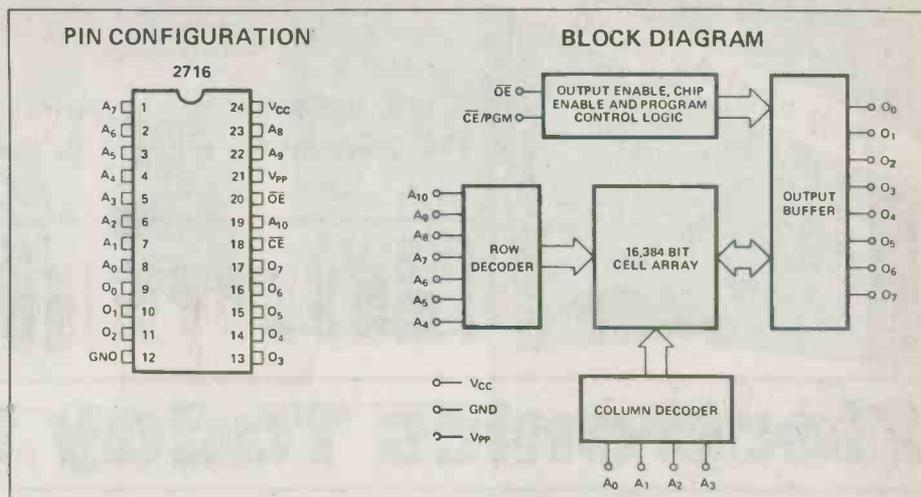


Fig. 2 The pinout of a 2716 EPROM. It is pin-compatible with the chip shown in Fig. 1, but can be programmed by the user.

follow either the Intel or TI pin-out, but the Intel is pretty well the standard. By using scaled NMOS technology, the proportional shrinking of each individual memory cell, these new 64K EPROMs achieve higher densities and speed. The 64K chip takes about as much space as the old 16K 2716 chip. Its 200 ns access time and 500 mW active power consumption set a new standard. The chip automatically powers down to a standby power of 100mW when deselected.

The Next Steps

The EPROM Evolution continues each time its memory capacity doubles; therefore, growing at an exponential rate. The next EPROMs to be aware of are the 128K and the 256K EPROM. At this time of writing, the 27128 (128K EPROM) should be on the market.

Static RAMs and ROMs

Static RAMs, as opposed to dynamic RAMs, require no refreshing to keep their memory intact and therefore are much easier to use, since they require less circuitry. A refreshing circuit for dynamic RAMs is essentially a counter which reads and then writes back every memory location in the RAM. However, static RAMs usually hold less memory (typically 1/4) than their dynamic RAM counterparts.

Most static RAMs follow no convention in pin-outs. The 2114 1K x 4 RAM is the most widely used. Manufacturers, with their increasing ability to put more memory in less space, introduce static RAMs to be pin-to-pin compatible with ROMs. The extra requirement that a RAM needs is the inclusion of the read/write signal, commonly labelled R/W or RW. R/W controls the direction of data flowing in the data bus. If it is high, the microprocessor is reading memory and if it is low the microprocessor is writing memory. The

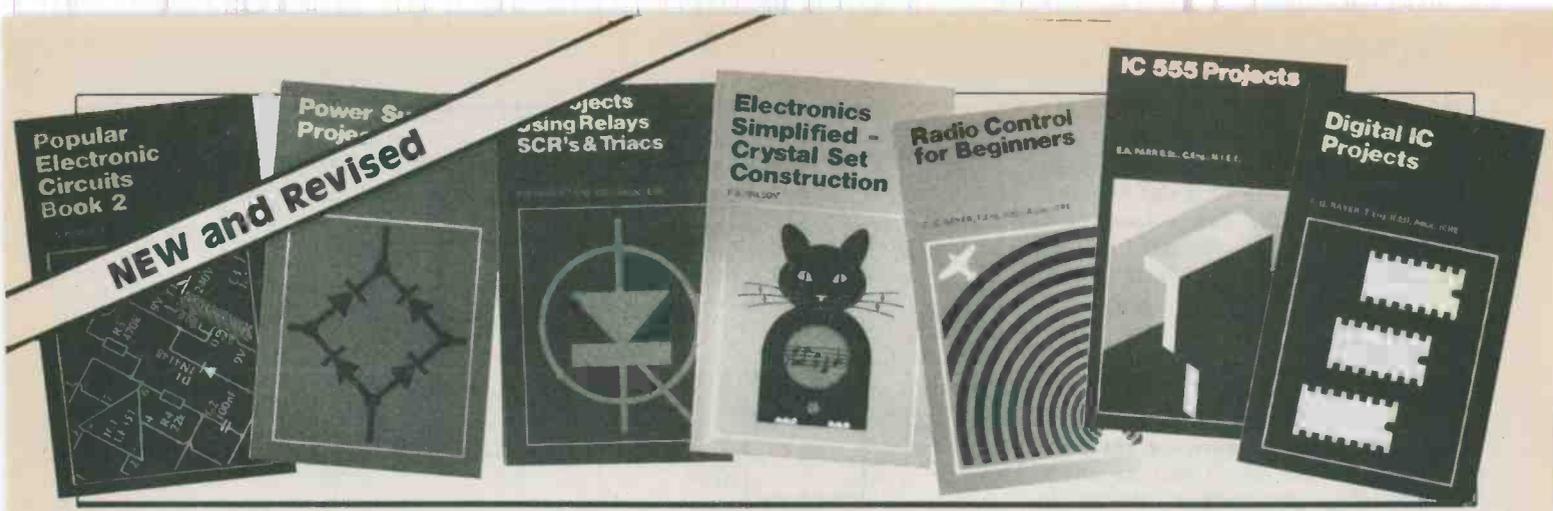
2016 and 6116 are 16K (2K x 8) RAMs compatible with the 2716. The 2016 is a N-MOS version and the 6116 is a low-power C-MOS version. Vpp, pin 21, is changed to the R/W signal. The rest of the pins are compatible with the 2716. Recently, non-volatile RAMs (NOVRAMs) came out. They are used as RAMs except that they retain their memory when the power is turned off. They are C-MOS RAMs with lithium battery backup built into the DIP itself. The access time of these devices is 150 to 200 ns, certainly better than most EPROMs and about the same as dynamic RAMs.

The New EEPROMs

Another ROM device which is pin-to-pin compatible with the 2716 EPROM is the 2816 EEPROM, which represents Electrically Erasable Programmable Read Only Memory. Like EPROMs, these devices can directly replace mask programmed ROMs, but the difference is that they do not need an ultraviolet light source to erase them; the 25V programming voltage can do this. These EEPROMs fit into applications where in-system program/erase is required because they are non-volatile and electrically erasable. It abandons the conventional battery back-up approach.

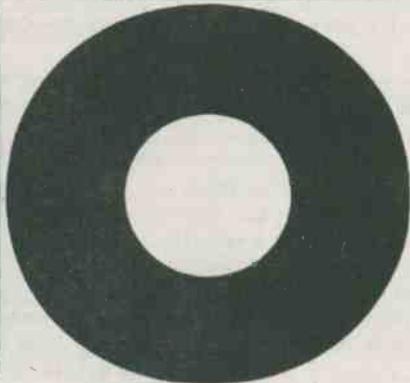
ROMs Never Forget

The diversity of the kinds of ROMs is vast, but their function in a computer system is the same: to hold programs forever. Today, EPROMs are the most popular substitution for ROMs since they are the most inexpensive user-programmable ROM devices. EPROM densities are doubling constantly. The 2Kbit 1702A has evolved into a 256Kbit 27256, a increase of 128 times. However, new technologies of non-volatile user-programmable memory have arisen and the trend would be toward EEPROMs and battery backed-up NOVRAMs. ET



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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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R.TORRENS
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.
- BP71: ELECTRONIC HOUSEHOLD PROJECTS** \$ 7.20
R. A. PENFOLD
Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer', Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

Electronics Today Bookshelf

RADIO AND COMMUNICATIONS

BP96: CB PROJECTS \$7.60
R.A. PENFOLD
 Projects include speech processor, aerial booster, cordless mike, aerial and harmonic filters, field strength meter, power supply, CB receiver and more.

222: SOLID STATE SHORT WAVE RECEIVERS FOR BEGINNERS \$7.60
R.A. PENFOLD
 In this book, R.A. Penfold has designed and developed several modern solid state short wave receiver circuits that will give a fairly high level of performance, despite the fact that they use only relatively few and inexpensive components.

BP91: AN INTRODUCTION TO RADIO DXing \$7.60
 This book is divided into two main sections one to amateur band reception, the other to broadcast bands. Advice is given to suitable equipment and techniques. A number of related constructional projects are described.

BP105: AERIAL PROJECTS \$7.60
R.A. PENFOLD
 The subject of aerials is vast but in this book the author has considered practical designs including active, loop and ferrite aerials, which give good performances and are reasonably simple and inexpensive to build. The complex theory and math of aerial design are avoided.

BP125: 25 Simple Amateur Band Aerials \$7.60
E.M. NOLL
 Starting from simple dipoles through beam, triangle and even mini-rhombics (made from TV masts and 400ft of wire) this title describes several simple and inexpensive aerials to construct yourself. A complete set of dimension table are included.

BP46: RADIO CIRCUITS USING IC'S \$5.40
J.B. DANCE, M.Sc.
 This book describes integrated circuits and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. The chapter on amplitude modulated (a.m.) receivers will be of most interest to those who wish to receive distant stations at only moderate audio quality, while the chapter on frequency modulation (f.m.) receivers will appeal to those who desire high fidelity reception.

BP92: ELECTRONICS SIMPLIFIED - CRYSTAL SET CONSTRUCTION \$6.80
F.A. WILSON
 Aimed at those who want to get into construction without much theoretical study. Homewound coils are used and all projects are very inexpensive to build.

BP70: TRANSISTOR RADIO FAULT-FINDING CHART \$2.50
CHAS. E. MILLER
 Across the top of the chart will be found four rectangles containing brief descriptions of various faults; viz: — sound weak but undistorted; set dead; sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

AUDIO

205: FIRST BOOK OF HI-FI LOUSPEAKER ENCLOSURES \$3.75
B.B. BABANI
 This book gives data for building most types of loudspeaker enclosure. Includes corner reflex, bass reflex, exponential horn, folded horn, tuned port, klipschorn labyrinth, tuned column, loaded port and multi speaker panoramic. Many clear diagrams for every construction showing the dimensions necessary.

HOW TO BUILD A SMALL BUDGET RECORDING STUDIO FROM SCRATCH \$15.95
TAB No.1166
 The author, F. Alton Everest, has gotten studios together several times, and presents twelve complete, tested designs for a wide variety of applications. If all you own is a mono cassette recorder, you don't need this book. If you don't want your new four track to wind up sounding like one, though, you shouldn't be without it.

BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING \$7.75
M.K. BERRY
 Electronic music is the new music of the Twentieth Century. It plays a large part in "pop" and "rock" music and, in fact, there is scarcely a group without some sort of synthesiser or other effects generator.
 This book sets out to show how electronic music can be made at home with the simplest and most inexpensive of equipment. It then describes how the sounds are generated and how these may be recorded to build up the final composition.

BP81: ELECTRONIC SYNTHESISER PROJECTS \$6.80
M.K. BERRY
 One of the most fascinating and rewarding applications of electronics is in electronic music and there is hardly a group today without some sort of synthesiser or effects generator. Although an electronic synthesiser is quite a complex piece of electronic equipment, it can be broken down into much simpler units which may be built individually and these can then be used or assembled together to make a complete instrument.

ELECTRONIC MUSIC SYNTHESIZERS \$10.95
TAB No.1167
 If you're fascinated by the potential of electronics in the field of music, then this is the book for you. Included is data on synthesizers in general as well as particular models. There is also a chapter on the various accessories that are available.

TEST EQUIPMENT

BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION \$6.80
F.G. RAYER, T.Eng. (CEI), Assoc. IERE
 This book covers in detail the construction of a wide range of test equipment for both the Electronics Hobbyists and Radio Amateur. Included are projects ranging from an FET Amplified Voltmeter and Resistance Bridge to a Field Strength Indicator and Heterodyne Frequency Meter. Not only can the home constructor enjoy building the equipment but the finished projects can also be usefully utilised in the furtherance of his hobby.

THE POWER SUPPLY HANDBOOK \$15.95
TAB No.806
 A complete one stop reference for hobbyists and engineers. Contains high and low voltage power supplies of every conceivable type as well mobile and portable units.

REFERENCE

BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE \$11.75
ADRIAN MICHAELS
 This book will help the reader to find possible substitutes for a popular user-orientated selection of modern transistors. Also shown are the material type, polarity, manufacturer selection of modern transistors. Also shown are the material type, polarity, manufacturer and use. The Equivalents are sub-divided into European, American and Japanese. The products of over 100 manufacturers are included. An essential addition to the library of all those interested in electronics, be they technicians, designers, engineers or hobbyists. Fantastic value for the amount of information it contains.

BP108: INTERNATIONAL DIODE EQUIVALENTS GUIDE \$8.95
ADRIAN MICHAELS
 This book is designed to help the user in finding possible substitutes for a large user orientated selection of the many different types of semiconductor diodes that are available today. Besides simple rectifier diodes also included are Zener diodes, LEDs, Diacs Triacs, Thyristors, Photo diodes and Display diodes.

BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES \$5.75
B.B. BABANI
 This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Great Britain, USA, Japan, Germany, France, Europe, Hong Kong, and includes types produced by more than 120 different manufacturers.

BP14: SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES \$6.75
B.B. BABANI
 The "First Book of Transistor Equivalents" has had to be reprinted 15 times. The "Second Book" produced in the same style as the first book, in no way duplicates any of the data presented in it. The "Second Book" contains only additional material and the two books complement each other and make available some of the most complete and extensive information in this field. The interchangeability data covers semiconductors manufactured in Great Britain, USA, Germany, France, Poland, Italy, East Germany, Belgium, Austria, Netherlands and many other countries.

TOWER'S INTERNATIONAL OP-AMP LINEAR IC SELECTOR \$17.95
TAB No.1216
 This book contains a wealth of useful data on over 5,000 Op-amps and linear ICs — both pinouts and essential characteristics. A comprehensive series of appendices contain information on specs, manufacturers, case outlines and so on.

CMOS DATABOOK \$12.50
TAB No.984
 There are several books around with this title, but most are just collections of manufacturers' data sheets. This one, by Bill Hunter, explains all the intricacies of this useful family of logic devices — the missing link in getting your own designs working properly. Highly recommended to anyone working with digital circuits.

See order form in this issue.

ROBOTICS

THE COMPLETE HANDBOOK OF ROBOTICS \$15.95
TAB No.1071
 All the information you need to build a walking, talking mechanical friend appears in this book. Your robot can take many forms and various options — light, sound, and proximity sensors — are covered in depth.

HOW TO BUILD YOUR OWN SELF PROGRAMMING ROBOT \$13.95
TAB No.1241
 A practical guide on how to build a robot capable of learning how to adapt to a changing environment. The creature developed in the book, Rodney, is fully self programming, can develop theories to deal with situations and apply those theories in future circumstances.

BUILD YOUR OWN WORKING ROBOT \$10.95
TAB No.841
 Contains complete plans — mechanical, schematics, logic diagrams and wiring diagrams — for building Buster. Buster is a sophisticated experiment in cybernetics you can build in stages. There are two phases involved: first Buster is leashed led, dependent on his creator for guidance; the second phase makes Buster more independent and able to get out of tough situations.

VIDEO

BP100: AN INTRODUCTION TO VIDEO \$7.60
D.K. MATHEWSON
 Presents in as non-technical a way as possible how a video recorder works and how to get the best out of it and its accessories. Among the items discussed are the pros and cons of the various systems, copying and editing, international tape exchange and understanding specifications.

Tab1519: ALL ABOUT HOME SATELLITE TELEVISION \$22.95
 Covers such aspects as where to buy, problems in setting up your TVRO station and how to solve them, antenna siting and equipment selection.

Tab1490: VIDEO CASSETTE RECORDERS: BUYING, USING AND MAINTAINING \$14.95
 A complete handbook for the video enthusiast. You'll learn about how the systems work and how to choose as well as take a technical look at the inside workings. There are also sections on making your own video recordings.

MISCELLANEOUS

PH255: COMPLETE GUIDE TO READING SCHEMATIC DIAGRAMS, 2nd Edition \$11.95
J. DOUGLAS-YOUNG
 Packed with scores of easy-to-understand diagram and invaluable troubleshooting tips as well as a circuit finder chart and a new section on logic circuits.

BP101: HOW TO IDENTIFY UNMARKED IC'S \$2.75
K.H. RECORR
 Originally published as a feature in 'Radio Electronics', this chart shows how to record the particular signature of an unmarked IC using a test meter, this information can then be used with manufacturer's data to establish the application.

BASIC TELEPHONE SWITCHING SYSTEMS \$17.95
TALLEY
HB27
 The Revised Second Edition of this book, for trainee and engineer alike, includes updated statistical data on telephone stations, and new and improved signaling methods and switching techniques. It also includes E & M signaling interface for electronic central offices and automatic number identification methods used in step-by-step, panel and crossbar central offices.

PH252: DIGITAL IC'S: HOW THEY WORK AND HOW TO USE THEM \$10.95
A. BARBER
 The dozens of illustrations included in this essential reference book will help explain time-saving test procedures, interpreting values, performing voltage measurements, and much more!

AUDIO AND VIDEO INTERFERENCE CURES \$8.95
KAHANER
HB21
 A practical work about interference causes and cures that affect TV, radio, hi-fi, CB, and other devices. Provides all the information needed to stop interference. Schematic wiring diagrams of filters for all types of receivers and transmitters are included. Also, it supplies simple filter diagrams to eliminate radio and TV interference caused by noisy home appliances, neon lights, motors, etc.

BP121: How to Design and Make Your Own PCBs \$7.60
R.A. Penfold
 The emphasis is on practical rather than theoretical techniques. Starts by giving simple methods of copying from magazines, carries on with photographic methods of producing PCBs and continues with layout design.

Electronics Today Bookshelf

BP49: POPULAR ELECTRONIC PROJECTS \$7.75

R.A. PENFOLD

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 \$7.60

R.A. PENFOLD

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.

BP95: MODEL RAILWAY PROJECTS \$7.60

Electronic projects for model railways are fairly recent and have made possible an amazing degree of realism. The projects covered include controllers, signals and sound effects: stribroad layouts are provided for each project.

BP93: ELECTRONIC TIMER PROJECTS \$7.60

F.G. RAYER

Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

BP113: 30 Solderless Breadboard Projects-Book 2 \$8.85

R.A. Penfold

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 \$8.85

Owen Bishop

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 electro-cardiograph.

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.

BP84: DIGITAL IC PROJECTS \$7.60

F.G. RAYER, T.Eng.(CEI), Assoc. IERE

This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS \$7.05

F.G. RAYER, T.Eng.(CEI), Assoc. IERE

Numeral indicating devices have come very much to the forefront in recent years and will, undoubtedly, find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.

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

BP99: MINI-MATRIX BOARD PROJECTS \$7.60

R.A. PENFOLD

Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

BP103: MULTI-CIRCUIT BOARD PROJECTS \$7.60

R.A. PENFOLD

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

BP107: 30 SOLDERLESS BREADBOARD PROJECTS - BOOK 1 \$8.85

R.A. PENFOLD

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

BP106: MODERN OP-AMP PROJECTS \$7.60

R.A. PENFOLD

Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

CIRCUITS

How to Design Electronic Projects

BP127

Although information on standard circuit blocks is available, there is less information on combing these circuit parts together. This title does just that. Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

Audio Amplifier Construction

BP122

A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or strip-board layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

Electronic Circuits for Model Railways

BP213

Lots of circuits including three types of controllers including one with simulated inertia and one with high power. Signalling and lighting systems are discussed at length and the suppression of RF interference. There are also 4 "steam whistle" and "chuffer" circuits.

BP80: POPULAR ELECTRONIC CIRCUITS - BOOK 1 \$7.75

R.A. PENFOLD

Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings: Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 \$8.85

R.A. PENFOLD

70 plus circuits based on modern components aimed at those with some experience.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS \$6.75

F.G. RAYER, T.Eng.(CEI), Assoc. IERE

Field effect transistors (FETs) find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.

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

BP87: SIMPLE L.E.D. CIRCUITS \$5.40

R.N. SOAR

Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

BP42: 50 SIMPLE L.E.D. CIRCUITS \$5.75

R.N. SOAR

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

THE ACTIVE FILTER HANDBOOK \$13.95

TAB No.1133

Whatever your field - computing, communications, audio, electronic music or whatever - you will find this book the ideal reference for active filter design.

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

MASTER HANDBOOK OF 1001 PRACTICAL CIRCUITS \$26.50

TAB No.800

MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS \$23.95

TAB No.804

Here are transistor and IC circuits for just about any application you might have. An ideal source book for the engineer, technician or hobbyist. Circuits are classified according to function, and all sections appear in alphabetical order.

BP88: HOW TO USE OP AMPS \$8.85

E.A. PARR

A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

BP65: SINGLE IC PROJECTS \$6.05

R.A. PENFOLD

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

BP117: PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 \$7.60

Virtually any electronic circuit will be found to consist of a number of distinct stages when analysed. Some circuits inevitably have unusual stages using specialised circuitry, but in most cases circuits are built up from building blocks of standard types.

This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.

The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

223: 50 PROJECTS USING IC CA3130 \$5.00

R.A. PENFOLD

In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I - Audio Projects II - R.F. Projects III - Test Equipment IV - Household Projects V - Miscellaneous Projects.

224: 50 CMOS IC PROJECTS \$5.25

R.A. PENFOLD

CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.

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

THE MASTER IC COOKBOOK \$17.95

TAB No.1199

If you've ever tried to find specs for a so called 'standard' chip, then you'll appreciate this book. C.L. Hallmark has compiled specs and pinout for most types of ICs that you'd ever want to use.

BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - Book 2 \$7.60

R.A. PENFOLD

This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

BP24: 50 PROJECTS USING IC741 \$6.75

RUDI & UWE REDMER

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

BP83: VMOS PROJECTS \$7.70

R.A. PENFOLD

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

BP50: IC LM3900 PROJECTS \$5.40

H. KYBETT, B.Sc., C.Eng.

The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and the Hobbyist. It provides the groundwork for both simple and more advanced uses, and is more than just a collection of simple circuits or projects.

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

ELECTRONIC DESIGN WITH OFF THE SHELF INTEGRATED CIRCUITS \$12.95

AB016

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

See order form in this issue.

This Month in

Computing! NOW!

Canada's Personal Computing Magazine

Celestial Mechanic for the IBM PC

A program for a fascinating perspective display of the Solar System. Take bets on whether Uranus will out-orbit Neptune.

Apple Hashing

A look at sort routines for the Apple computer.

CP/M Sorted Directory

Don't just DIR when you can use this program to present a display of a sorted, byte-sized file directory.

New Shoes for the 64

Add commands lacking in the Commodore 64's BASIC and increase the string-handling capabilities.

Plus:

Apple IIc Review

The latest computer from Apple, sort of a IIc that's sort of portable, gets put through its paces.



Recorders Buying, Using, Maintaining

by Bill Pastemak

List Price: \$14.95

Number TAB1490

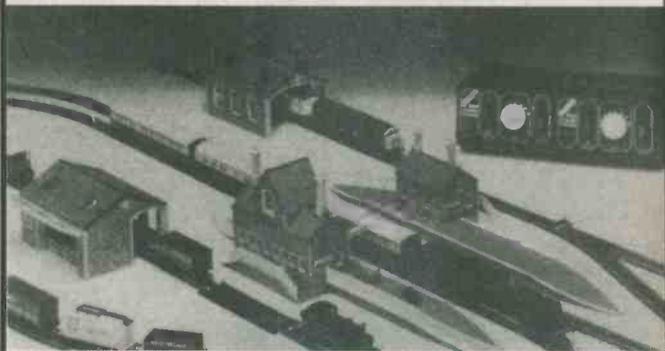
A complete handbook for the video enthusiast. You'll learn how to choose, and the technical side of how the units work. There are also sections on making your own video recordings.



Available from: Moorshead Publications 25 Overlea Blvd.
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See order form in this issue. All prices include shipping. No sales tax applies.

ETI NEXT MONTH



Model Railroad Electronics

Hi-tech meets model railroading: we look at some of the computer-controlled systems available that allow up to sixteen trains to run independently on the same track. We also look at some of the solid-state speed controllers.

Model Railroad Signals Project

TTL logic gates provide control of red, green, and amber signal lights for trains; modules can be added for any number of track sections.

RS232 Explained

Promised before and held due to space restrictions, we present an explanation of the RS232 communications port used on computers.

10 Short Projects

continued from page 24

Audio Millivoltmeter

by T. Louie

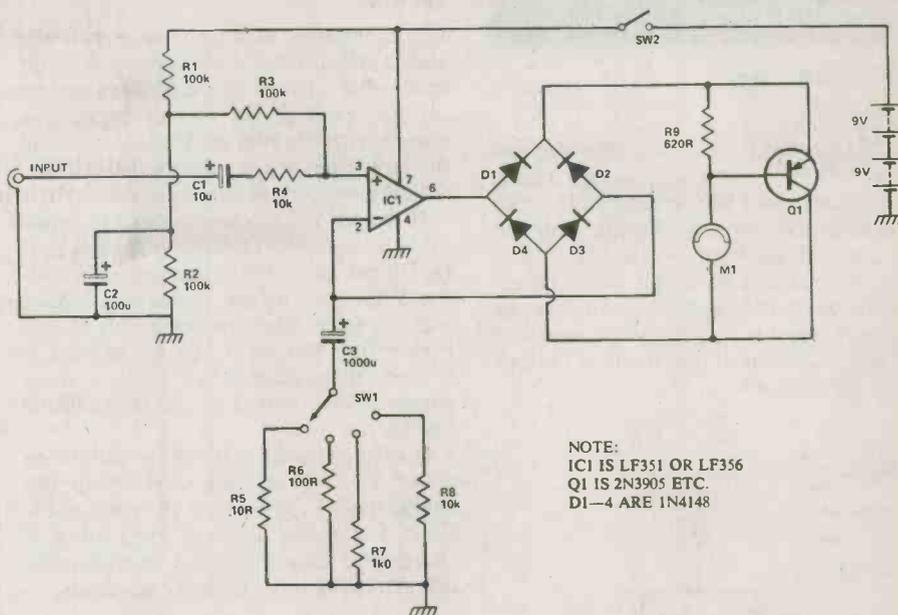
DESCRIBED simply, the project is a sensitive voltmeter with a switchable full-scale deflection (FSD) of 10 mV to 10 VRMS. (RMS means root mean squared — you can think of this as being the average size of an AC voltage). Unlike most published circuits which do the same job, this one uses only one IC and as such the project is simple-to-build and an ideal project for beginners and long-standing hobbyists alike.

Construction

Start construction with the Veroboard. Carefully make the breaks in the tracks, indicated in Fig. 2 using a cutting tool or a small (about 1/8") hand-held drill bit. Check that no small pieces of copper swarf produced by this track-cutting process bridge adjacent tracs, forming short circuits.

Finally, mount the circuit board in the case and then wire-up your project as the connection details show. Note that the input lead (both inside the project and also the probe lead) should be of screened cable, which will help to reduce interference and hum pick up.

The Audio Millivoltmeter requires no setting up since the resistors have been scaled to read the RMS value of sinewaves. Simply switch on and you're ready to go.



NOTE:
IC1 IS LF351 OR LF356
Q1 IS 2N3905 ETC.
D1-4 ARE 1N4148

Figure 1. Audio Millivoltmeter circuit.

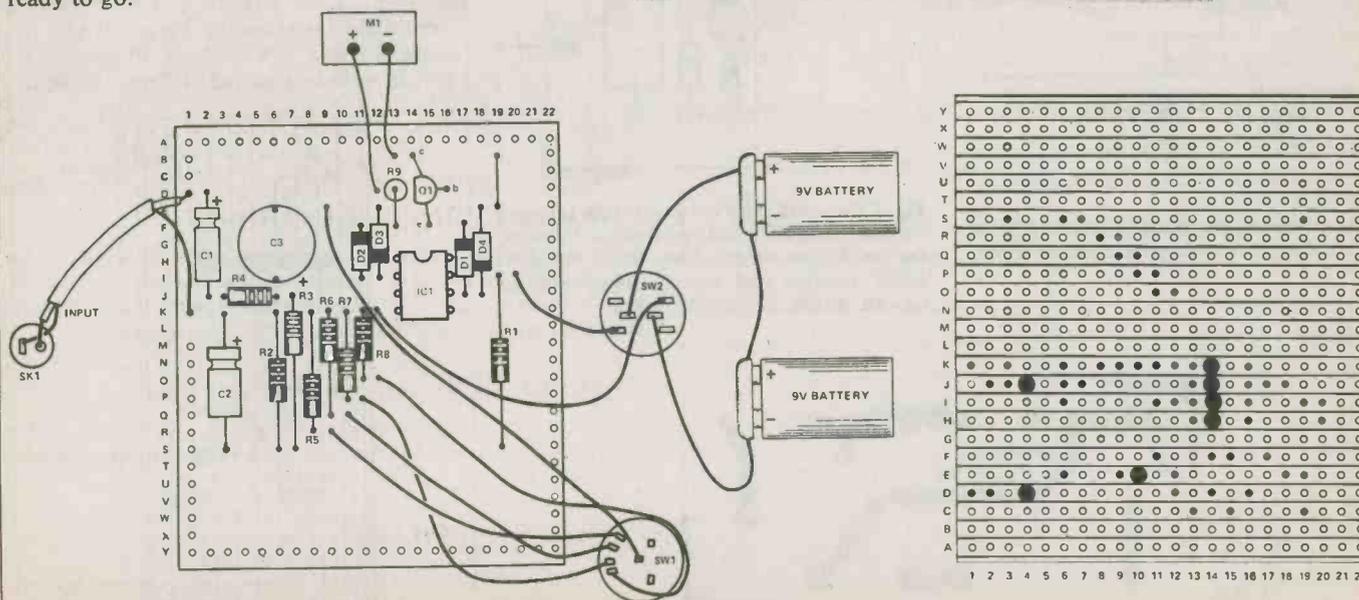
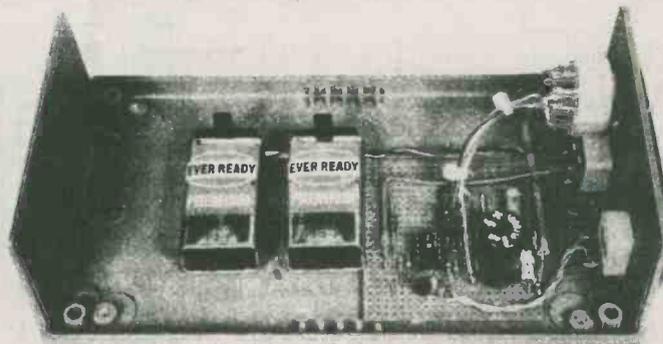


Figure 2. Veroboard layout of the project, showing component positions, track breaks underneath the board and connection details. Make sure you use screened cable for the input lead then mount the board and meter in a suitable case.

10 Short Projects

Dry Cell Charger

by Vivian Capel.

BECAUSE this project uses 120V AC and none of the circuitry is isolated, a good deal of care must be exercised in the construction and housing. Furthermore, in use but with an open circuit, the + battery terminal will be at full mains potential, so the switching of the unit must be arranged so that it cannot be operated while any sections of the circuit or the batteries are exposed.

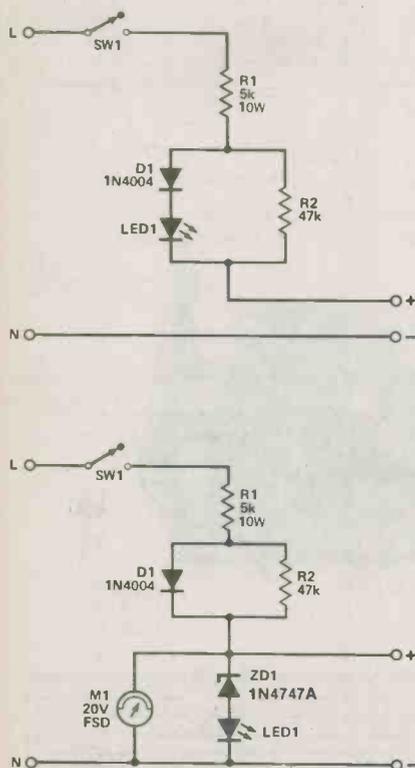


Fig. 1 Two circuit diagrams: (a) (top) the 'standard' version; (b) (bottom) the de-luxe version.

In Use

Large batteries such as lantern batteries and D cells are the most successful, while small ones such as AA cells have limited success. Perhaps the loss of capacity is more noticeable with the smaller cells, and the large ones are usually discharged well within their current capability.

If the cell voltage has dropped to below 1.1V, a successful recharge is far less likely. Do not therefore, discharge your batteries too far before recharging. Make 1.25 the lower limit but preferably charge even before that point. A good practice is to keep them topped up, giving a short charge after a period of use to bring the voltage up.

During charging, cell voltage will rise to about 1.6V or a little over. Stop the charge then. In some cases the voltage will climb to around 1.8V or even more if charging is continued, but overcharging can affect the cell's capacity adversely.

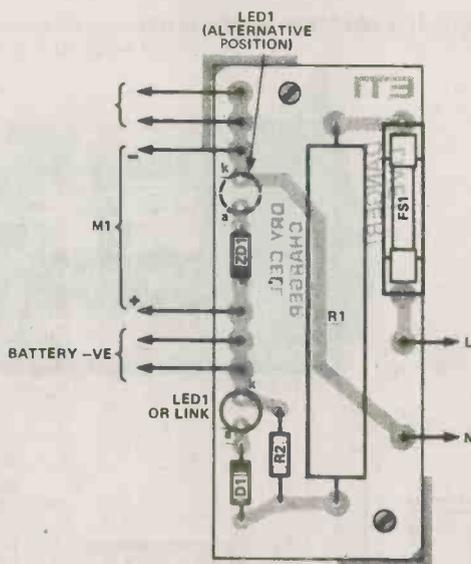
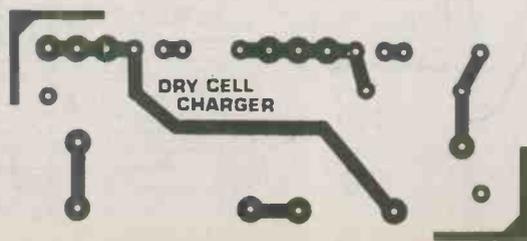


Fig. 2 The component overlay; for the standard version, omit ZD1 and connections to meter; for the de-luxe version, link across the lower LED1 position and use the upper position (shown dotted) for the LED itself.



Heads and Tails Game

by T.J. Quinn

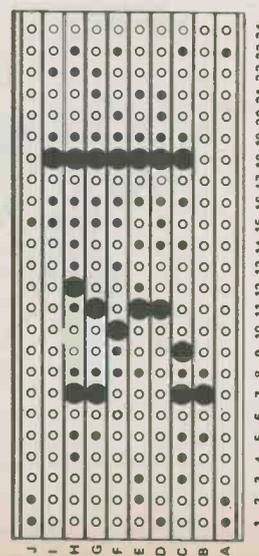
TO 'spin' the electronic 'coin' you press a button — when you release the button the 'coin' falls on one 'side' and the initial letter of that side is displayed.

NOR gates IC1 a and b are coupled together, along with capacitor C1 and resistor R1, as an astable multivibrator, oscillating at about 700 Hz. The frequency of oscillation of the astable is controlled by the values of components C1 and R1. If either component is increased in value, the frequency of oscillation decreases: if either component value is decreased, the frequency increases. Chosen frequency (ie 700 Hz) is not critical, incidentally, so don't be afraid to insert other values if you don't have the exact values specified.

The squarewave output of the astable is applied, via push-button PB1, to a bistable multivibrator formed by NOR gates IC1c & d. The two bistable outputs are in antiphase ie one is on when the other is off, and they control LED segments c and d of the seven-segment display.

LED segments e, f and g are coupled together, through a 680R resistor to 0V and are permanently on forming the letter 'b'; the seven-segment display will show the letters 't' or 'h' only when the push-button is operated.

Construction is simple. The project is built-up on a 10 strip by 24 hold piece of Veroboard (as shown in Figure 2) and is powered by a 9 V battery. It shouldn't take more than a couple of hours to build.



10 Short Projects

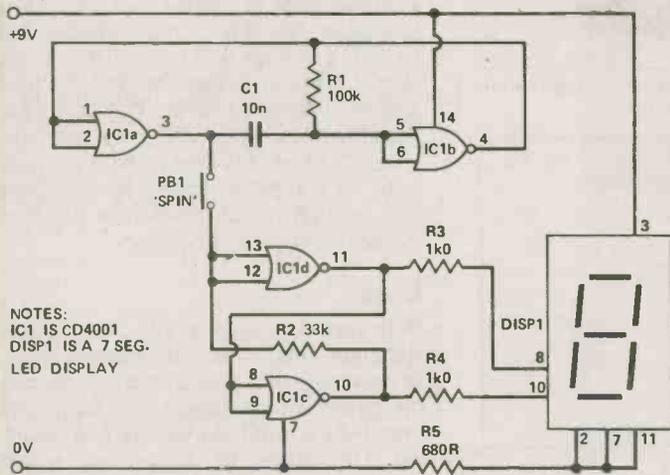


Figure 1. Circuit of the Heads and Tails Game.

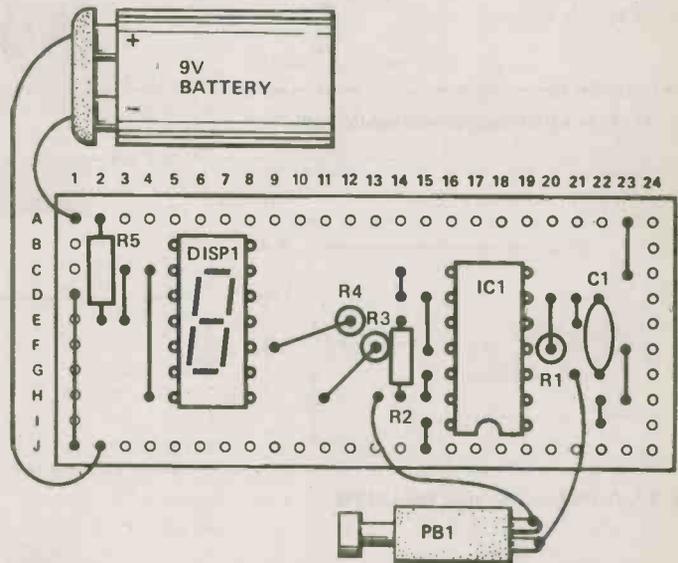


Figure 2. Veroboard layout of the project, showing component locations and track breaks underneath the board.

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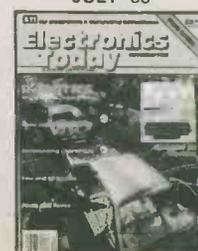
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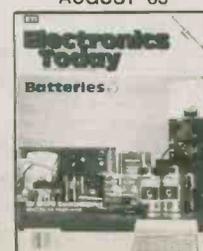
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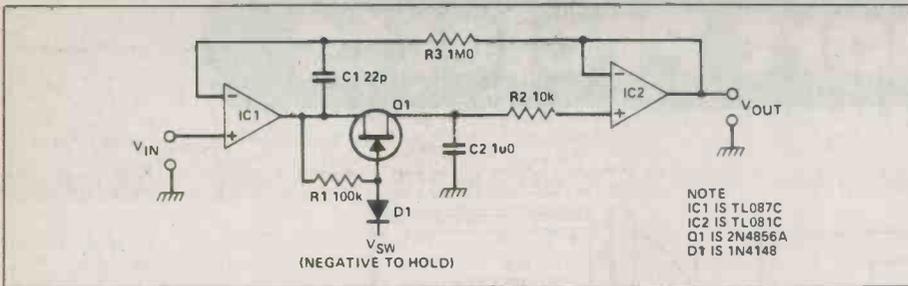


Fig. 12. Low offset sample and hold circuit.

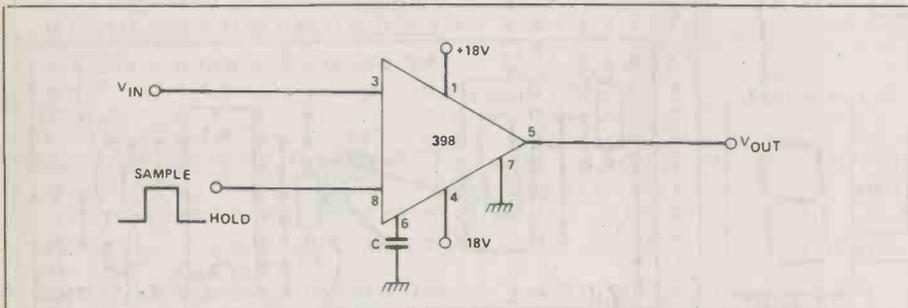


Fig. 13. A ready-made unit, the LM398.

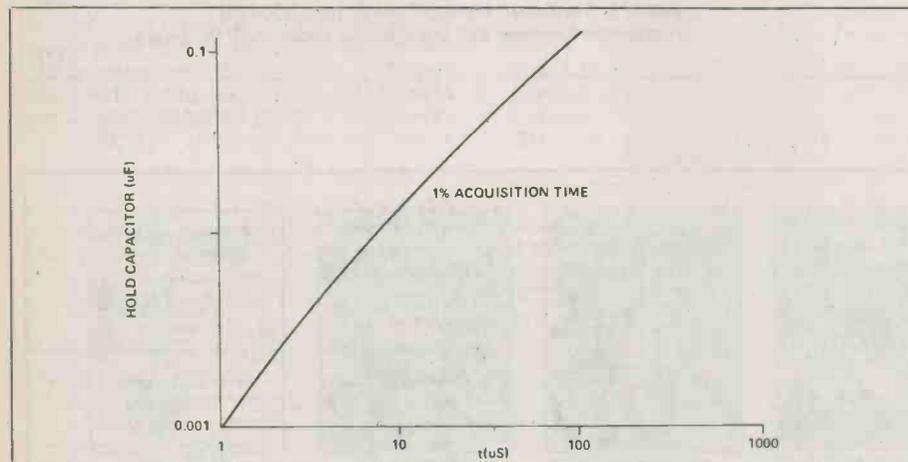


Fig. 14. Choosing the capacitor value for Figure 13.

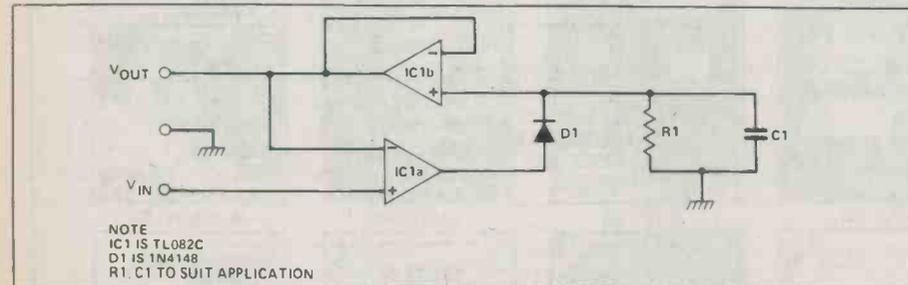


Fig. 15. A simple 'peak picker' circuit.

its internal circuitry is very similar to the configuration that we have looked at in this article, with the difference that the capacitor is an external component to the chip. This device makes the construction

of a simple sample and hold circuit much more straightforward. A typical configuration is shown in Fig. 13. The signal that is being sampled is put in to pin 3 of the device, and the output is taken from

pin 5. C_h is the capacitor that stores the voltage at hold, and the value of this capacitor is best estimated from the graph in Fig. 14. Taking pin 8 to a logic 1, say 5 volts, will cause sampling to take place, and restoring it to a logic 0 will cause a hold state to ensue.

A capacitor of a value of 1n0 will give a settling time of around 5 μ S, indicating that after this time, after sampling has started, a voltage will be available at the output. Thus after this time you can hold and get an accurate result. This device has found use in analog to digital conversion systems, where it is used to hold a typical value of a rapidly varying analog signal long enough for digitization to occur to the desired degree of accuracy.

Uses

With regard to applications, the field of computer interfacing is the most obvious. In an analog to digital conversion system, the circuit would sample the input and then hold it until conversion had occurred. Obviously, the device used would need to be fast enough to follow the input, but would also require a droop rate which was low enough to allow the conversion to occur before the voltage held on the capacitor had decayed substantially. In this type of application, we would be using the sample and hold circuit to make it possible for a relatively slow analog to digital converter, providing values of a fast moving waveform at regular intervals. Without the sample and hold circuit, the input waveform would have changed before conversion was complete, thus giving an inaccurate reading.

Digital instrumentation is a similar field of application. Electronic synthesizers also utilize them, enabling complex electrical signals to be used to control voltage controlled amplifiers, filters and oscillators.

Slightly modified sample and hold circuits are also used in circuits known as "peak pickers". These circuits continuously sample the input signal, but have as their output, a value representing the highest signal that they've experienced within a given time. The output voltage shows droop, but these circuits find use in estimating rapid transients that have occurred in circuits. Figure 15 shows one peak picker due to TI.

I hope that this article has given you some insight into the sample and hold circuit — a circuit that is finding new applications in the field of data conversion.

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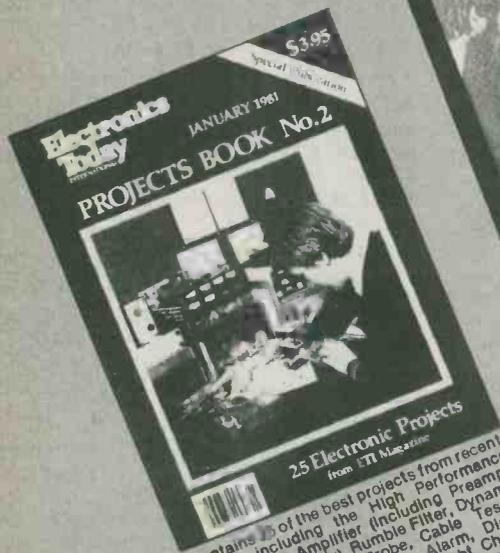
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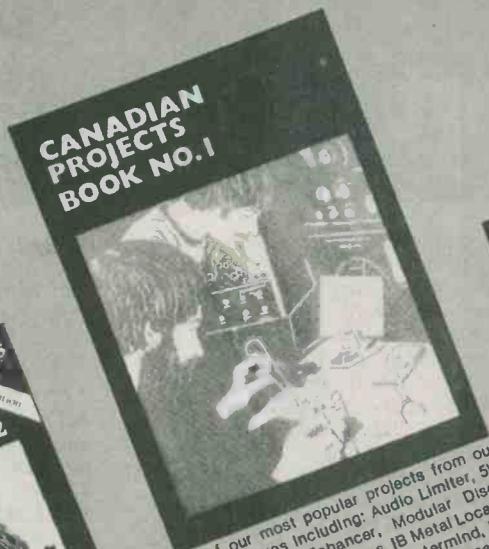
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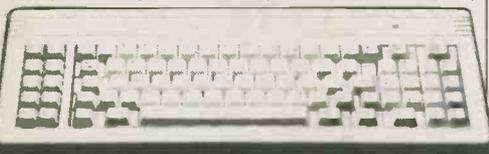
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continued on page 62

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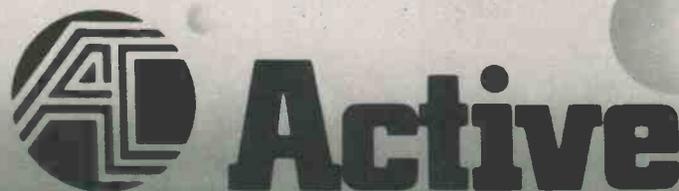
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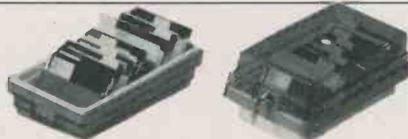
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ETI—OCTOBER—1984—59



than Beta. Why? The answer is simple; there are more manufacturers of VHS models than Beta. The greater the supply of VHS format machines, the more tapes, and so on.

Who's Got The Goods?

Without question, it can be said that Sony has been a strong influence on the video industry; after all, they were the ones who made the Beta system popular on the home front back in the mid to late seventies. But since then, a large number of home-entertainment manufacturers have also jumped into the fray with a fair amount of success. JVC, Toshiba, Panasonic, Sanyo, RCA, Mitsubfshi, Zenith, Fisher, Electrohome, Sylvania; the list is endless. The only video playback device which did not gain success on the market was the short lived disc player. RCA discontinued production of its disc

player system earlier this year. It's definitely a buyer's market, though, with no shortage of choice; hence the difficulty in choosing a system.

The best (and most often heard) advice is to shop around and compare. Don't fall into the old slick salesman's filthy clutches before you've checked out his 'absolutely best deal'. There's new paraphernalia coming out on the shelves almost daily, and if you're waiting for a slightly new and improved machine, chances are that you'll never take the plunge. When you think you've found the system which suits you the best, functionally and economically, that's the time to get your feet wet. So what's new out there?

Microprocessor Widgetry

For the past two or three years we have been plagued with computer controlled

this and microprocessor controlled that. Everything from blenders to the toilets on the space shuttle (and even those toilets aren't reliable). First came the standard VCR which you had to operate by getting up from your chair. Then came the wired remote control which wasn't really a remote control at all. Finally the full infra-red remote, which in turn is used with your TV's remote, gives you total freedom to tinker from your lazyboy.

Digital tuning, clocks, counters, and feather-touch controls are all the rage now, but don't forget; the fancier you get, the more you pay.

Slim-line designs and front-loading are making it easier to accommodate the units into your decorating scheme. Imitation leather tape storage cases, disguised as antiquarian books, can really give your tape library that classy look.

On The Go

If you're not satisfied with staying home with your VCR, you might want to consider one of the new portables, such as the Sony SL2000 or SL2001. Units such as these are great for those who just can't get away from home without taking the kitchen sink. (I suspect that in the near future there will be a waterproof VCR for windsurfers. Keep watching those beer commercials for all the latest gadgetry.)

...And The Latest

In preparation for those for-ever promised stereo TV broadcasts, manufacturers are now offering VHS and Beta hi-fi models. Sony has four new Beta hi-fi units to offer, and JVC has had great success with their HRD 725 VHS hi-fi unit which carries a list price of \$1999. Sony is also offering a new two piece hi-fi VCR for 1985, which is really a regular VCR with an add-on hi-fi adapter, for those who want to wait until the craze sets in. The cost of the VCR portion is \$799, and the hi-fi adapter is around \$300. It should be noted here that a fairly good quality machine (non-hi-fi) will run around \$600-\$700, and a comparable quality hi-fi model will start at a minimum of \$1000.

Finally...

Apart from the video cassette recorder itself, the industry is now offering the consumer component TV. What's that? Well, much in the way that home stereos became component oriented, TV manufacturers are doing the same thing. It is now possible to get separate monitors, tuners, and loudspeakers for your video system, as it is now referred to.

A glance at the back of your old TV will have you thinking that you're back in the dark ages of Ozzie and Harriet. The number of connectors on the back of a new 'video component system' might require an engineering degree before one is

successful at tuning in to a favourite show.

Whenever it is that you decide to become a video fanatic, remember, shop around. Whether you chose Beta or VHS, hi-fi or not, it is just as important to get the best price as it is to get reputable service. Resist the urge to buy a unit which may have an extremely low figure on the price-tag (such as units being sold out of trunks of cars, etc.); the history of these machines may be questionable. Common sense is the best defense for any consumer.

ET would like to thank G & G Electronics, 4371 Kingston Rd., West Hill Ontario., for their assistance with this article.

The Oxisound

By Bill Markwick

If you take pains to obtain good sound, you're probably disappointed when you feed your videotape into a television set and hear it played back through a speaker the size of a quarter. The same applies to watching music programs; it's frustrating to hear, say, the New York Philharmonic come squeaking and tootling out of the glorified earphones that pass for audio systems in TVs.

If you have a VCR or TV with audio outputs, your problem is solved. If not, investigate the Oxisound Model 84 HF converter. It's made in Canada by Oxin Electronics, 1523 Warden Avenue, Scarborough, Ontario M1R 4Z8, and available from audio/video stores at a list price of \$69.95.

It consists of a small plastic case and a 28 VDC plug-pack. The case is fitted with a length of standard 75-ohm cable which goes to your VCR, and your TV connects to the 75-ohm output jack from which comes Channel 3. A 3-metre cable terminated in two RCA plugs goes to your stereo amp; although the output is mono, a double lead is used to feed both your channels. Plug it in, and that's it.

Wow! You should *hear* what you've been missing! Bands and orchestras thunder to life, dialogue sounds human, sound effects rattle the windows. You'll discover, among other things, that TV producers don't take as much care with sound as do film people; you'll detect all kinds of stage noises and hollow acoustics. Oddly, these add a certain realism to dramas; perhaps it's suddenly knowing that it isn't being done by robots after all, but by real actors doing their best to slam a cardboard door.

The unit will work with any 75-ohm system, which is all of the commercial cable systems and VCRs. Some TVs with built-in converters may not be suitable, because you have to have access to the

Channel 3 RF input. The audio output is rated at 30 Hz to 20 KHz plus-or-minus 2 dB, and the emitter-follower output delivers about 1 volt to your stereo. The output noise is not listed, but a listening test showed that any noise you hear is coming from the broadcast studio, not the Oxisound. The same goes for distortion; the Oxisound caused no problems whatsoever.

Someone asked what would happen if the Oxisound should fail while you're watching television. We pulled the

plugpack out of the wall socket, and the TV continued on; the unit is straight-through as far as RF goes.

One disadvantage is that you'll either want to move your stereo amp nearer to your chair or you'll want a cable converter with remote control of the audio, because commercials, loud enough normally, just coming roaring at you. Oh, and another thing: the sound is so good it makes that 14-inch picture tube kind of inadequate, and there's that 24-inch model that you've been eyeing... **ET**

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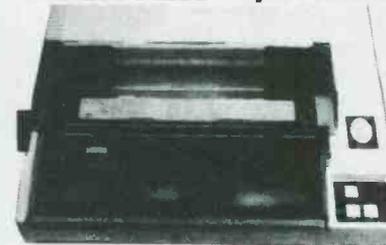
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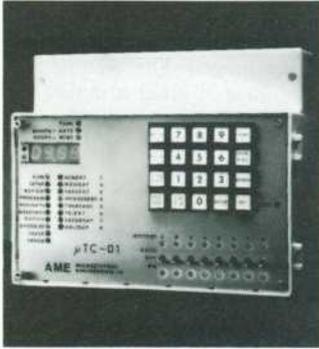
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for your information

Energy Management Controller

An 8-channel energy management timer/controller, the uTC-01, has been designed by AME Micro-



systems Engineering Ltd. Using microprocessor technology, it is suitable for the use in small to medium-size plants and offices to reduce energy consumption of heating, air-conditioning, industrial processes and lights. It is claimed that energy costs can be cut by up to 30%, using the uTC-01 controller. It features 8 different operating schedules. One for each day of the week, plus a holiday schedule. 36 dates may be designated as holidays, up to 365 days in advance, and are automatically erased from memory when passed. Both permanent and temporary manual override of outputs is provided. Contact them at: 156 Old King Road, Bolton, Ontario L0P 1A0, (416) 265-0543.

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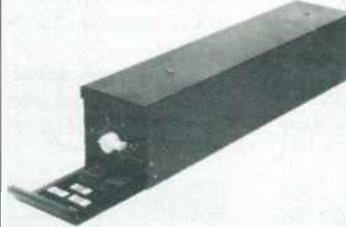
Electronic Typewriter

New from Sharp Electronics of Canada Ltd. is the PA-1000 Portable Intellwriter, a lightweight, battery-operated unit. Suggested retail price is \$399. Unique features of the PA-1000 include automatic underlining, automatic centering of columns and titles, quiet, thermal printing on plain or thermal paper, bold-type lettering and an advanced memory system. A 70-digit liquid crystal display lets

the typist see what's been typed before it's actually printed. This function permits copy changes, corrections, removal of unwanted material and insertion of additional text. The PA-1000 has a memory to store and edit text. Information can be coded at 26 locations, so that any one item may be recalled and printed at the touch of a key. The memory stores approximately 2,200 characters and is expandable to approximately 8,700 characters.

EPROM Eraser

B.T.W. Electronic Parts announces the UV-1 EPROM eraser for \$199.95. It will erase up to 70 EPROMs at one time in 15 minutes, and has a built-in timer. A safety switch shuts off the lamp



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Motorola Semiconductors has announced a new series of single-chip TV colour processors. The TDA3300 series of chips provides colour IF, colour killer, colour demodulators, and more. They'll work with the European PAL system as well as the North American NTSC, and are suitable for TV, monitors, games, etc.

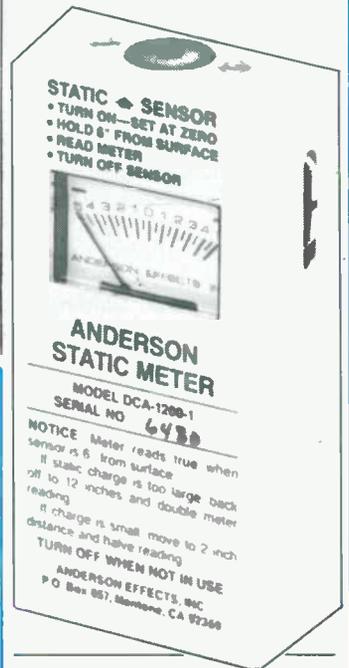
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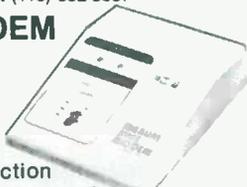
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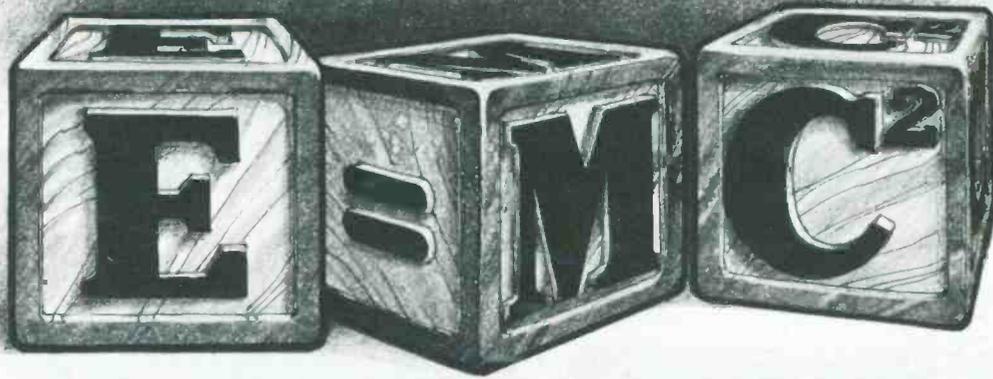
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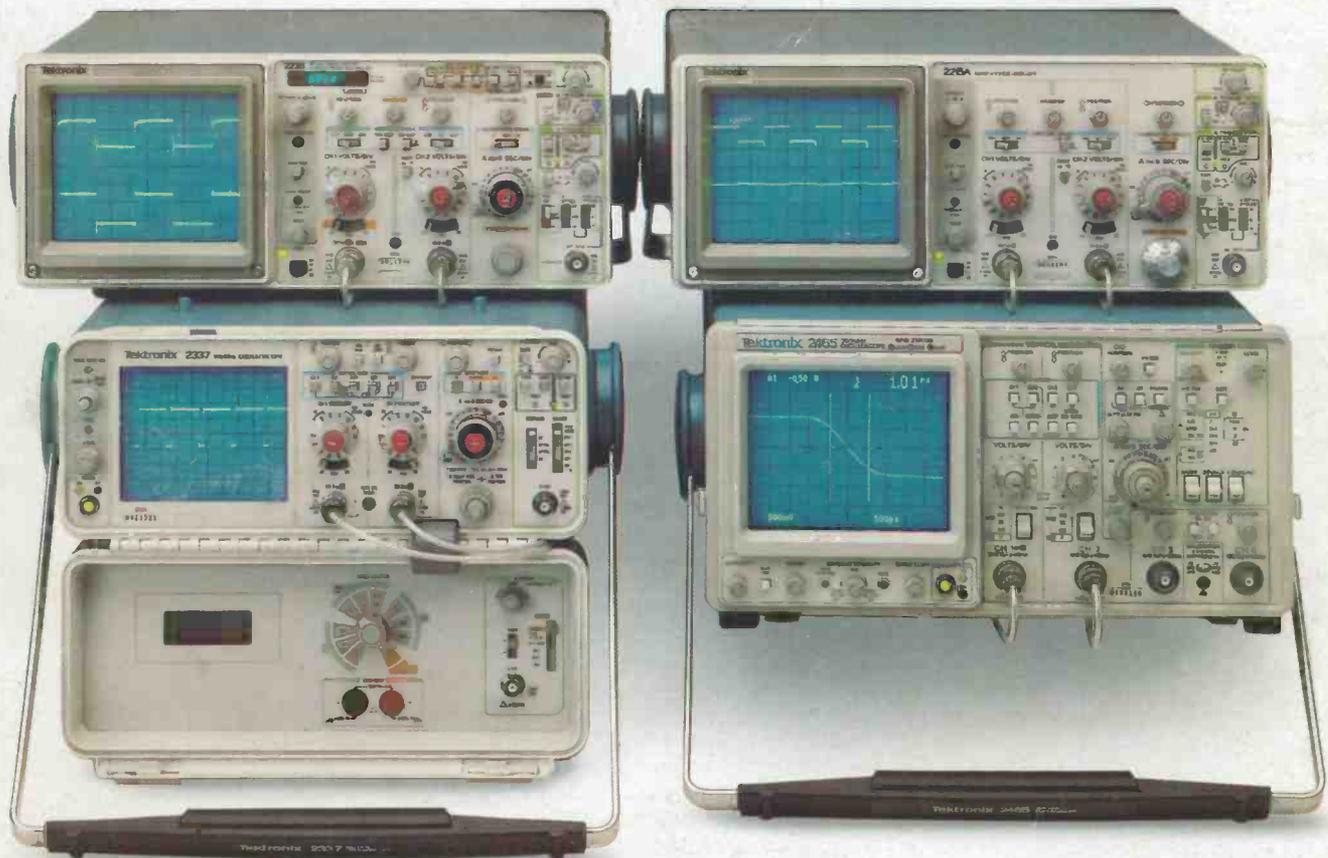
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