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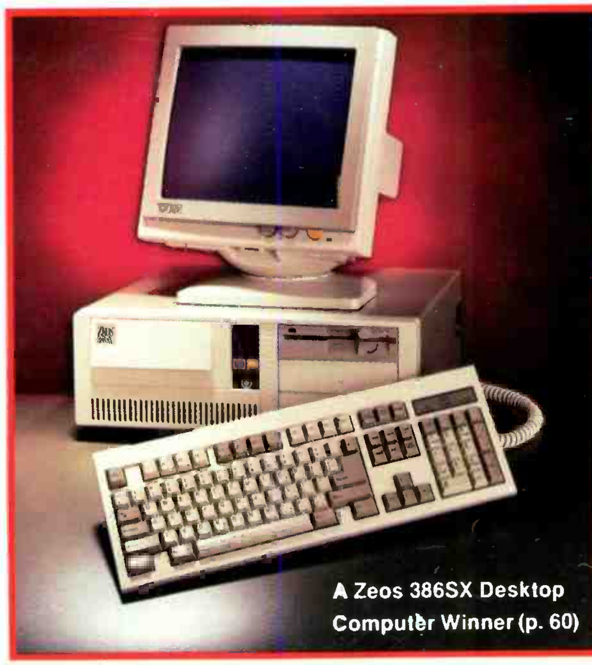
THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

## ■ Make PC Boards Without Photography

## ■ A Yuletide Song Telephone Ringer


A Zeos 386SX Desktop Computer Winner (p. 60)

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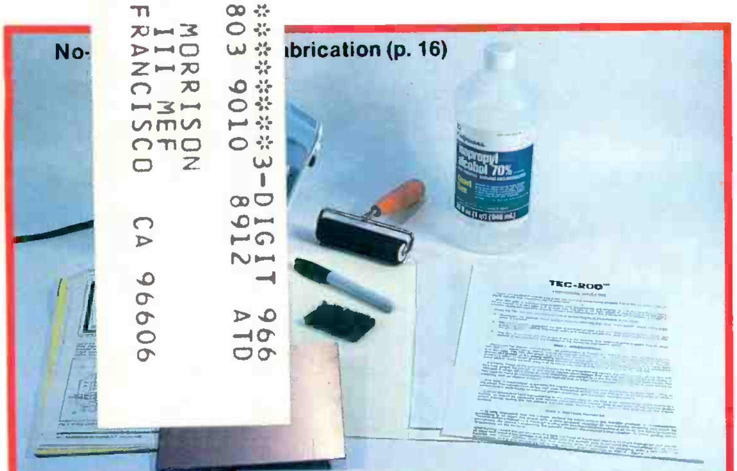
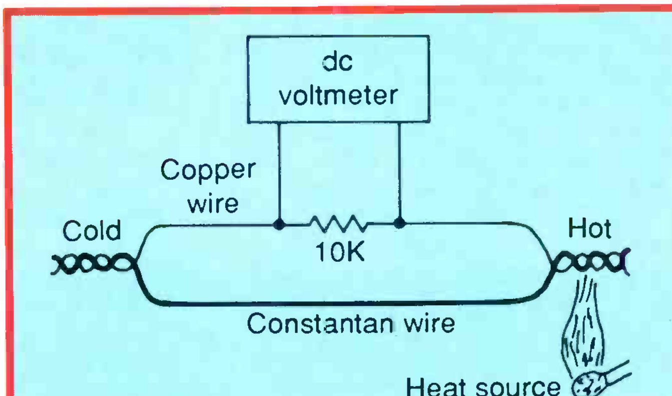

No- … brication (p. 16)



A Precision Thermocouple Thermometer Adapter (p. 28)

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HARDWARE NEWS

# New Dauphin LapPRO-386SX Packs a Powerful Punch for the Price

Dauphin Technology, an aggressive new Midwest-based laptop manufacturer, has come up with a high-performance 386SX-based laptop that offers 386 power at a 286 price. The price alone will turn a lot of heads. But a closer look at the machine itself reveals first-rate engineering, exceptional performance, and loads of standard features that would cost extra on most computers.

With a list price of $4,995 and an introductory price of only $3,695, Dauphin Technology has strategically positioned itself to compete head on with rival 286 models in the same price range. Since 386SX technology provides both present and future applications, the choice between a 286 and a 386SX of comparable cost will be an obvious one for many. Users opting for the LapPRO-386SX will have a laptop with more power, speed, memory and versatility along with the technology to serve them through the next decade and beyond.

Among its many prominent features is a 40 M-byte, 28 millisecond hard drive and 2 M-bytes RAM. Its ability to facilitate DOS, multitasking and multiuser functions, plus all the new 32-bit 80386 software makes it a necessity for anyone who requires the power of a high-end desktop model while away from the office.

Last Fall, Dauphin introduced its first laptop model based on an 80286 microprocessor. Though a late-comer to the market, the LapPRO-286 earned considerable praise for combining the most advanced features with quality engineering and price performance.

Both models from Dauphin Tech offer a 40 M-byte, 28 millisecond hard drive, a 3.5" floppy drive, two serial ports, one parallel port, a high contrast blue on white CGA/EGA LCD, an internal power supply offering four power options including battery pack, and a dedicated numeric keypad. Options include a 2400 or 4800 BAUD internal modem, math co-processor, 100 M-byte hard disk drive, and external floppy drive and keyboard ports.

The LapPRO-386SX sports a processor speed of 16 and 8 Mhz with zero wait states. It offers 2 M-bytes of Ram on board expandable to 4 M-bytes. Its external monitor port supports CGA, EGA and VGA.

**Dauphin Technology has priced its 80386SX laptop to compete head-on with rival 286-based models.**

Features include:

- 80386SX Processor, 8 & 16 Mhz, Zero Wait States
- Multitasking Capabilities
- Multiuser Access
- 32-bit Software Compatibility
- 40 M-byte, 28 Millisecond Hard Drive
- 3.5" Floppy Drive
- 2 M-bytes RAM, Expandable to 4 M-bytes
- Internal Modem Option

The LapPRO-286 provides 1 M-byte RAM which is expandable to 4 M-bytes and an 80286 processor running at 8 or 12 Mhz with zero wait states.

Both models offer the highly acclaimed Digital Research Operating System (a.k.a. DR DOS) which is similar to and compatible with MS DOS. The more distinguishing advantages of DR DOS include on-line help, system utilities such as file retrieval, special security features and an ability to embed software in ROM. Alphaworks integrated software and LapLink file transfer software are also included with each laptop.

Judging by its first two laptop offerings, Dauphin Technology could very well be on its way to becoming a major player in the hardware arena. Though Dauphin Technology is relatively new to the computer industry, Alan Yong, founder, is not. In 1981, Yong incorporated Manufacturing and Maintenance Systems which is now recognized as the leading manufacturer and distributor of industrial alignment systems worldwide. The MMS REACT Alignment Systems, used to align rotating equipment in manufacturing plants, employ a proprietary portable computer and software for alignment calculations and maintenance records.

Given Yong's prior experience in portable computer development, the shift toward developing laptops seemed like a natural move. Yong is determined to build another successful company and his determination shows in the design configurations of these first offerings, a promising start.

Distribution channels for Dauphin Tech products are indeed far reaching and ambitious and include dealers, VARs, OEMs (for private label distribution), along with corporate, educational and government sales. The private label arrangement offered by Dauphin represents an ideal opportunity for OEMs to get into the fast-moving laptop market quickly. And the discounts on corporate quantity purchases are so generous that corporate managers of information systems will undoubtedly regard Dauphin as a serious contender for their business.

In keeping with its aggressive sales approach, Dauphin Technology is currently offering an unbeatable introductory price on both models. End-users would be well advised to invest in a high-performance laptop from Dauphin Tech now.

For more information on Dauphin Tech's laptop line, contact Dauphin Technology in Lombard, Illinois at 312-627-4004. And in the meantime, watch for more surprises from this up-and-coming manufacturer.

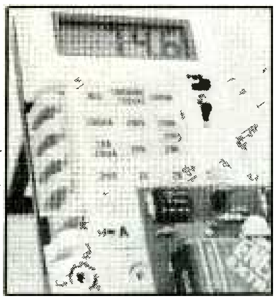


CIRCLE 67 ON FREE INFORMATION CARD

# MODERN ELECTRONICS

THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

DECEMBER 1989 VOLUME 6, NUMBER 12

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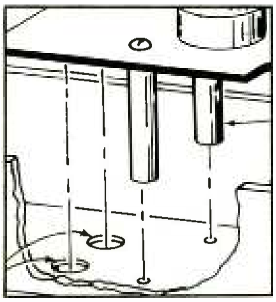

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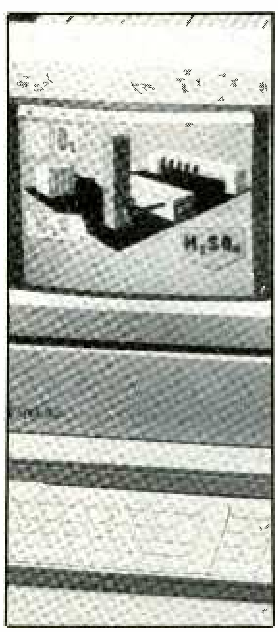

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## FEATURES



## COLUMNS



## DEPARTMENTS






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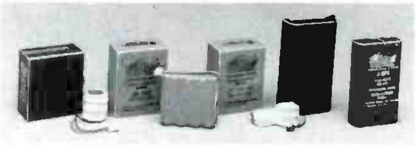
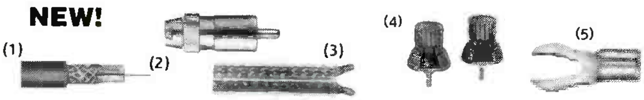


### High-Quality Cables and Connectors

NEW!



(1) **Oxygen-Free Copper A/V Cable.** 6mm dia., 6 ft. #278-1271 . . . **5.95**
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### Word-Recognizer on a Chip

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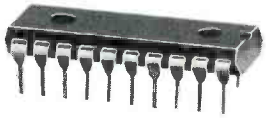
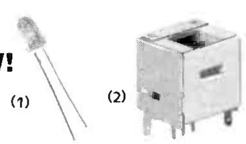


**VCP200.** Great experimenter's item—control circuits with your voice, or conduct research in robotics and computer technology. Recognizes spoken orders, even when different people give the commands. Five motion and two on/off or yes/no commands. Clipped analog input so A-to-D conversion circuit is not required. Few external parts needed. 20-pin DIP. #276-1308

### LED and IR Module

NEW!



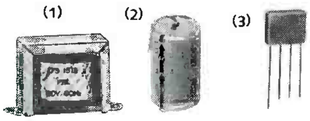
(1) **NEW! Jumbo Bright LED.** 5000 mcd! #276-086 . . . . . . **4.99**
(2) **IR Detector Module.** Combines detector, amp, demodulator, limiter filter, integrator, comparator. Requires 5VDC. #276-137 . . **3.49**

### Jumper and Plugs

NEW!

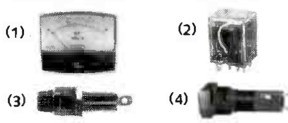
(1) **14" Jumper/Test Cables.** 'Gator clips. #278-1156, **Set of 10/3.99**
(2) **NEW! Stackable Banana Clips.** #274-734 . . . **Set of 2/1.59**
(3) **Multipurpose Posts.** 2 red, 2 black. #274-661 . . . **Set of 4/2.19**

### Supply Parts



(1) **Power Transformer.** Secondary: 18 volts. #273-1515 . . . . **8.99**
(2) **Electrolytic Capacitor.** 4700 µF. #272-1022 . . . . . . . . . . . . **3.59**
(3) **Full-Wave Bridge Rectifier.** 400 PIV, 4A. #276-1173 . . . . . **1.99**

### Builder's Helpers



(1) **Panel DC Voltmeter.** 0-15VDC. #270-1754 . . . . . . . . **7.95**
(2) **10A Relay.** #275-217 . . . **5.99**
(3) **Fuse Holder.** #270-364, **1.29**
(4) **SPDT Lighted Switch.** 3 amps at 120VAC. #275-676 . . . . . . **6.49**

### Electronics Books

NEW!

(1) **Getting Started in Electronics.** #276-4013 . . . . . . . . . . . **2.49**
(2) **NEW! Semicon Ref Guide.** 1990 edition! Lists over 80,000 types and their Radio Shack equivalents. #276-4013 . . . . . . . . **3.99**

### Instrument Cases

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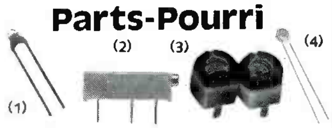
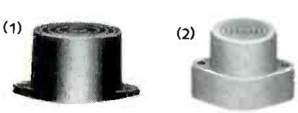
| Size | Cat. No. | Each |
|---|---|---|
| 3 1/16 × 8 1/4 × 6 1/8 | 270-274 | 10.49 |
| 1 15/16 × 8 1/4 × 6 1/8 | 270-272 | 8.49 |

### Parts-Pourri



(1) **Thermistor.** #271-110 . . . **1.99**
(2) **15-Turn Trimmer Pot.** PC mount. 3/4W. 1k #271-342, 10k #271-343, 20k #271-340. **Each 1.49**
(3) **Pkg. 2 Trimmer Caps.** 6-50 pF. PC-mount. #272-1340 . . . . **2/1.59**
(4) **Pkg. 50 Picofarad Caps.** 1-33 pF. #272-806 . . . . . . . . . . . . . **6.95**

### Chime and Buzzer



(1) **Doorbell Chime.** Produces musical "ding-dong". Rated 6 to 18VDC, 80 dB at 12VDC. #273-071 . . . . . . . . . . . . . . . **8.99**
(2) **Pulsing Buzzer.** Commanding 80 dB output at 2 Hz pulse rate. 12VDC, 20 mA. #273-058 . . **3.49**

### DVM/Capacitance Meter

NEW! **79.95**

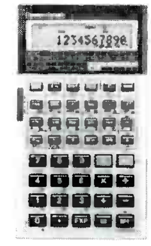
This single time-saving tool combines a 30-range DVM with capacitance and transistor gain meters! Measures to 1000VDC and 750VAC, 10 amps AC/DC, 20 megohms resistance, 20 µF capacitance and transistor DC gain. #22-194

### Breadboard & Jumpers

(1) **Universal Solderless Breadboard.** Accepts DIPs, components and jumper wires (kit below recommended). #276-169 . . . . . . . . . . . . . **19.95**
(2) **Jumper Wire Kit.** 140 insulated, prestripped wires. Case included. #276-173 . . . . . **Set 4.95**

### Electronics Calculator

**39.95**



**Radio Shack EC-4035.** Accepts input and displays output using popular electrical symbols—1000Ω × .5A = 500V. Has 110 functions including trig and statistics. Alphanumeric display with contrast control. Engineering keys. Includes batteries and case. #65-983

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# EDITORIAL

## *Changing Times*

**As the end of the year** 1989 approaches, we continue to observe important technological transitions from the old to the new as part of a continuous process. From time to time there are crossover points where old standbys are suddenly no longer dominant. They might fade away slowly in its secondary position or virtually disappear altogether. The ascendancy of another technology usually can be predicted as it makes its inroads.

In this respect, you'll be interested to know that 1989 marked the first year that digital oscilloscopes beat out analog oscilloscopes in terms of dollars spent, for example. (About 7 percent more.) The dramatic rise of digital scopes, growing at 30 percent per year, is even more remarkable when you consider that they've been premium-priced instruments. It's been projected that by 1992 sales dollars of digital scopes will double that of analog scopes. At the same time, paying a premium for digital will likely nearly disappear.

Even entrenched technology faces potential challenges, at least in some niche areas. For instance, binary logic in computers would appear to have taken it all. Lurking in the background, however, are other technologies. One particularly interesting one is "fuzzy logic." Instead of plain old "0" or "1" as truth values, fuzzy logic employs continuous ranges that establish a host of values for specific applications. This type of logic is expected to greatly improve artificial intelligence, improving human-to-computer interfacing. Japan has set up a Laboratory of International Fuzzy Engineering to pursue this end. It has attracted the participation of 48 leading businesses, including Hitachi, Sony, Toyota, and IBM Japan, among them. Not as fuzzy as you might have thought, eh?

Dot matrix printers are now facing the biggest challenge to their supremacy with the introduction of a lower-priced smaller-size laser printer from Hewlett-Packard that's expected to have a street price of under $1,000. This meets top-end dot matrix machines head on. Moreover, competitive laser models sure to join the fray will likely cause prices to erode.

Does anyone doubt that digital audio tape will usurp the number-one position long held by conventional audio tape methods for playing/recording good-quality music? At the same time, DAT promises to be a major player in computer data backup. Does anyone doubt, too, that 3.5-inch diskettes will push 5.25-inch ones into a subordinate position in the near future?

The electronics and computer worlds are never stagnant, which makes it an exciting area to be involved in at work or as a consumer. We'll all keep watch on these changes in the coming year, of course, modifying our product buying plans accordingly.

Seasons Greetings from the Staff of Modern Electronics

# LETTERS

**Addressing the Issue**

• Please note that an incorrect box number was given for orders for my "Talking Telephone" project article (October 1989). The correct box number is 5835. All items listed in the Note at the end of the article's Parts List are still available.

Steve Sokolowski

**Reader's Solar Observations**

• The SunGuard sunlight monitor project (May 1989) is described as a detector of the sun's ultraviolet radiation. However, the silicon solar cell recommended for this project has negligible response below 400 nanometers. The action spectrum of human erythema (sunburn) ranges from around 295 to 320 nm in the so-called UV-B region of the spectrum. While the SunGuard will apparently function as a dosimeter for the broad range of wavelengths received by its solar cell, it will not necessarily provide a reliable indication of safe tanning time. Variations in ozone, water vapor and other atmospheric parameters can cause significant nonlinearities in the relationship of UV-B and the spectrum of 400 to 1,100 nm detected by a common solar cell.

Solar cells and photodiodes sensitive to UV are available. However, they must be used in conjunction with an expensive UV-B filter to provide a usable sunburn meter. Incidentally, the SunGuard can be simplified and given a more linear response by using IC1C as a current-to-voltage converter. This can be accomplished by eliminating R1 and R2 and connecting the solar cell directly across the inputs of IC1C. Pin 10 of IC1C should be tied to ground.

Name Withheld

*You are correct that the silicon solar cell I specified responds to a broad band of wavelengths and not specifically to UV radiation. Solar cells that are responsive to UV radiation are indeed available and when used with the required filter become very expensive to be used in a low-cost project. SunGuard was never intended to be a laboratory-grade UV meter but a device that responds to cumulative sunlight that strikes the solar cell. It measures relative exposure, which varies with the angle of radiation as determined by the time of day and month of the year. As such, the project will measure the degree of* relative *UV exposure.*

*(Continued on page 79)*

**FUTURISTIC FAX TECHNOLOGY**. Ricoh Corp. demonstrated the first U.S. Group-4 "mixed-mode" facsimile transmission over ISDN (Integrated Services Digital Network). Group-3 is the popular format used today, which transmits information as image data in line or dot format. Group 4, in contrast, combines image files with character-coded data, minimizing line capacity required and thereby saving communication costs. With ISDN, which is expected to become widespread in the 1990s, one will be able to fax documents and speaks to the recipient at the same time. Ricoh expects the mixed-mode format to be highly effective for desktop publishing applications, transmitting to remote typesetting facilities camera-ready composition for both type and graphics. The prototype currently supports Aldus PageMaker software.

**SCI-FI CABLE CHANNEL**. The Sci-Fi Channel--a 24-hour national basic cable TV network featuring science fiction, horror and fantasy programming--is coming. A contract was signed with GE American Communications, Inc. for a protected transponder on its SATCOM C-4 satellite (to be launched in 1992). The Channel's official spokesman is Isaac Asimov, and "Star Trek" creator Gene Roddenberry sits on its board of directors.

**PORTABLE MAC ARRIVES**. Apple Computer finally adds a portable computer to its line with a 15 lb. active-matrix LCD machine. It's powered by a 2 lb. lead acid gel-type battery and a 9-volt battery for its "sleep" mode. A lead-acid battery holds its charge much longer than does nickel-cadmium types and recharge is essentially to 100 percent. The portable comes with a 1.44 MB Superdrive, 1 MB CMOS RAM, system ROM that's the same as the Mac SE and system 6.0.4 software. Its microprocessor is the quite old Motorola 68000. All for a rather high $5,799. Add about $700 for a 40 MB hard drive.

**AMATEUR MICROSATS**. Six amateur radio satellites are scheduled to go into orbit in November. Four of them are called "MicroSats" due to their small size, measuring 9 inches on each of its cubed sides. Design and construction of the MicroSats were coordinated and organized by the Radio Amateur Satellite Corp. (AMSAT) along with the ARRL and the Tucson Area Packet Radio Association.

**EE EMPLOYMENT NEWS**. Starting salary for June '88 electronics engineering graduates averaged $2,319 to $2,628 per month, reports the American Electronics Association. The AEA also reported that non-supervisory hardware engineers with bachelor's degrees averaged a 6.4% salary increase, while software engineers enjoyed a 5.9% increase. The company turnover rate for hardware engineers increased to 12.72% in 1988 compared with an average 10.01% in 1987. Turnover rate for software engineers in 1988 was much higher, averaging 17.09%.

# BOB HANSON
# MAY WELL HAVE HAD 200,000 FRIENDS.
# NOW HE NEEDS THEM ALL . . .

The world of communications has lost a great friend and devoted public servant. On Wednesday, May 8, 1989 Bob Hanson, W9AIF, passed away on the operating table during a delicate and enormously costly liver transplant operation.

Bob will be mourned by literally hundreds of thousands of individuals whose lives he touched throughout the world as a noted columnist . . . public service association executive (SCAN, REACT, Community Watch) . . . communications industry advertising and marketing manager . . . and active radio amateur.

But mourning alone cannot pay adequate tribute to Bob's total dedication to serving others—including his wife of 23 years, Marilyn, and two teenage sons, Peter and Andrew.

**Since liver transplants are regarded by some as "experimental surgery," not one dime of the expense—estimated in excess of $200,000—was covered by insurance. We simply cannot allow Bob's wonderful family to live with that impossible burden.**

Your help is desperately needed. Immediately. Please, please send your contribution today. Make checks payable to: **Organ Transplant Fund Inc./Robert Hanson** a legally constituted non-profit organization. Any funds collected in excess of those required to pay actual medical expenses will be used to relieve similar transplant victims.

## The Robert Hanson Fund.
## A Living Memorial.

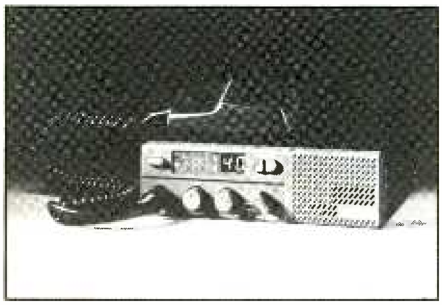
## Organ Transplant Fund Inc./Robert Hanson
## P.O. Box 766 • Morris, IL 60450-0766

# NEW PRODUCTS

***For more information on products described, please circle the appropriate number on the Free Information Card bound into this issue or write to the manufacturer.***

## *Mobile Weather Radio*

Truckers, RV owners and off-road enthusiasts can now choose from a number of mobile weather-radio 40-channel CB rigs from Cobra. These CB radios feature integrated National Weather Service receivers that provide a choice from among three most active frequencies via a front-panel control. Weather bands are received using the CB radio's standard antenna.

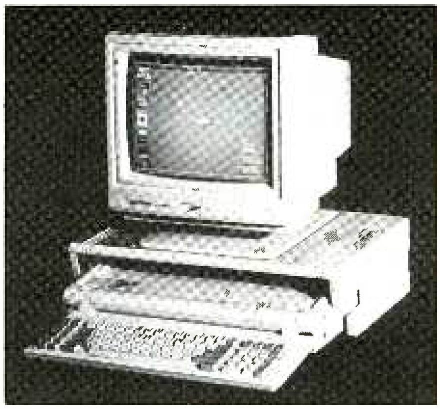


Three models currently make up the Cobra line of weather-radio CB units. The Model 18RV (shown; $129.95) has a front-firing speaker that enables easy installation under a seat and custom mounting in a dashboard or overhead instrument panel. The front-firing speaker is said to improve audio clarity. The Model 23 PLUS ($129.95) offers electronic tuning, automatic noise limiting, LED channel display, five-segment LED S/r-f meter, Channel Saver feature and an instant Emergency Channel 9 switch. Topping the line is the Model 41 PLUS ($169.95), which adds Cobra's "Dynamike" gain control, local/distant switch and anl/noise-blanker control.

CIRCLE NO. 101 ON FREE INFORMATION CARD

## *Friendly Home Computer*

"Explorer" is the name of a new home computer from Headstart Technologies Co. (Great Neck, NY)



designed to give the user the advantages of both the Apple and IBM/compatible camps. It is claimed to be the "friendliest" computer available. To achieve a high level of user-friendliness, it uses a Macintosh-like animated icon-based environment in an IBM-compatible CPU that guides the user with pictures and plain English through operation.

Built around an 8088-1 microprocessor running at 9.54/4.77 MHz (switchable) that makes it more powerful than a standard XT computer, the Explorer comes standard with 512K of RAM (expandable to 768K); preprogrammed ROM; built-in 720K 3.5-inch floppy-disk drive; CGA/MDA/Hercules graphics capability with custom 16-color CGA emulation; an external expansion slot; and serial, parallel, mouse and game ports. Programmed into ROM are DOS 3.31, word processor, calculator, datebook, file cabinet, preconfigured address and phone book software programs. Four floppy disks provided with the computer also offer such programs as Computer*Ease and ATI Skill Builder. When not in use, the computer's keyboard folds up and over the system unit.

Options like a modem, printer, mouse, joystick, hard disk and internal/external 5.25-inch floppy-disk drive simply plug into available slots or connectors. Unlike most other computers that require access to the interior of the system unit to install a hard disk, the Explorer has a slot on its right side into which the device plugs directly, without the need for tools, concern for cables or technical skills. $599 for basic system less video monitor.

CIRCLE NO. 102 ON FREE INFORMATION CARD

## *Portable Video Alignment Generator*

Offered in both kit and factory-assembled forms, Heath's new Model IG-5260 (kit)/SG-5260 (wired) portable video alignment generator offers versatility at a low price. The generator produces a series of crosshatch or dot video patterns to use in converging the guns of color picture tubes. A choice of six alignment patterns are provided: three crosshatch and three dot patterns. Also provided is an NTSC-compatible output for alignment of video monitors. Designed to simplify the color convergence procedure, the compact unit helps in identifying a color problem and adjustment of the TV receiver to correct it.

For low power consumption and long battery life, the generator employs CMOS circuitry. A TV Channel 3 r-f output is provided for easy connection to most antenna inputs of TV receivers. Two slide switches permit selection of test patterns and a third slide switch permits selection of OFF, CH 3 (RF) and VIDEO. Notches at the top of the plastic enclosure that houses the circuitry provide a convenient means for winding the attached test cable for storage.

The generator measures 6.25"W × 3.25"H × 1.125"D. $79.95, SG-5260 (assembled); $59.95, IG-5260 (kit).

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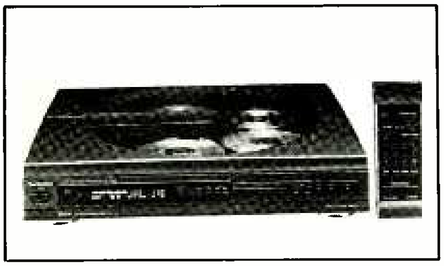
## CD Rotary Changer

Technics has a new rotary compact-disc changer, Model SL-PC20, that does away with the cumbersome disc magazine for multiple-disc playing. The top-loading player has a rotary platform that handles up to five CDs. The dust cover that protects the discs on the platform is clear plastic for easy view. It swings up to provide loading and unloading access.

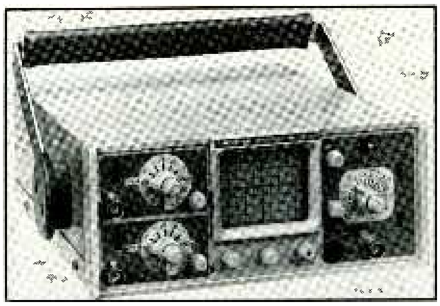


Featured is a linear motor transport that drives the laser pickup across the transverse mechanism. Movement from track to track is said to be quick and precise. The changer also features a high-resolution digital filter with quadruple oversampling at a 176.4-kHz rate. This moves unwanted noise bands out of the audio spectrum. Other features include: sequential play and repeat modes; direct access to any disc in the changer; 20-track random-access programming; random play; and a wireless remote-control system. The last duplicates most of the control functions of the switches located on the front panel of and has several that are not available there. $329.95.

CIRCLE NO. 104 ON FREE INFORMATION CARD

## Portable Oscilloscope

A compact dual-trace oscilloscope designed for field use in a variety of industries has been announced by B&K-Precision. Small enough to fit into an attache case, the Model 1422 portable scope offers 20-MHz response and 10-mV/division vertical sensitivity. It also offers an 8 × 10-division high-brightness rectangular CRT, front-panel X-Y operation, 18 sweep ranges (from 1



µs to 0.5 seconds per division) in a 1/2/5 sequence, variable between ranges, and 10× magnifier that extends maximum sweep rate to 100 ns/division.

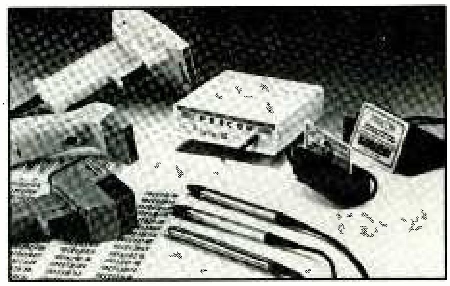
Built in is a video sync separator for use with video circuits and computer video terminals. The flat in-band response is said to facilitate using the Model 1422 to observe the sync and color levels in video equipment. The scope can be powered from the ac line, an optional internal battery or an external 10-to-16-volt dc source. Its optional battery pack fits entirely within the instrument's housing, without adding to its basic dimensions. It comes with two 10:1 probes, and a carrying handle that doubles as a tilt stand on the work-bench is included. A wide range of optional accessories are available. Dimensions are 12"D × 8.5"W × 4.5"H. $1,099.

CIRCLE NO. 105 ON FREE INFORMATION CARD

## RS-232C Barcode Interface

Percon, Inc.'s (Eugene, OR) Series 10 RS-232C barcode interface unit teaches itself to read multiple bar codes and offers ease of serial port parameter setting. "Auto-Learn" allows the user to quickly optimize the decoder for various types and lengths of barcode formats, including Code 39, UPC-A, EAN-8/JAN-8, EAN-13/JAN-13 (plus UPC/EAN/JAN extensions), Codabar, Code 128, Interleaved 2 of 5, Standard 2 of 5, Matrix 2 of 5, MSI, Code 93 and Code 11. Scanning two supplied codes readies the unit to the user's barcodes. Programmed barcode types remain in memory even when the unit is turned off and can be changed at any time. Also supplied are barcodes that self-program baud rate, data bits, parity, stop bits and XON/XOFF handshaking for the RS-232C port.

Optional data cables connect the Series 10 in stand-alone (connected to the computer's serial port) or eavesdrop (between terminal and computer) mode. When not reading codes, the unit is transparent and permits full use of terminal and keyboard. Compatible scanning devices



include visible-light and infrared wands and laser scanners, badge scanners, two sizes of CCD scanners and magnetic stripe readers with scanning heads for Track 1, Track 2 or Track 3. Other optional cables connect multiple magnetic-stripe reader or one stripe reader and one wand ID badge scanner to a single decoder. Maximum and minimum barcode character lengths can be set, and a preamble/postamble of up to seven ASCII characters can be assigned and added automatically to each code as it is read, with optional checksums that can be used to help ensure data accuracy. $545.

CIRCLE NO. 106 ON FREE INFORMATION CARD

## Static Sensor

A lightweight, hand-held device that measures static-electricity voltages on objects and surfaces is being marketed by HUB Material Co. (Canton, MA) as the 3M Model 709. It features an LCD display and two range settings. In the low setting, the instrument measures up to 1,990 volts, while in the high setting it measures up to 19,900 volts. Accuracy is rated

at ± 10 percent at a distance of 1 inch from the target.

The sensor is powered by a 9-volt battery and has a battery test circuit that displays battery voltage in the LCD window. For remote monitoring or permanent recording, the Model 709 has two pin-type jacks (+2.0-volt analog output with minimum load impedance of 50,000 ohms). The device measures 4⅜″ × 2⅞″ × 1⅝″ and weighs 7 ounces.

CIRCLE NO. 107 ON FREE INFORMATION CARD

## *Computer Volume Control*

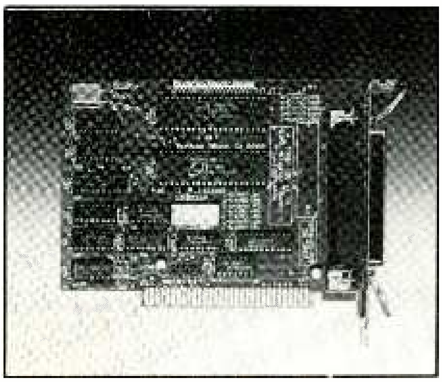
Reflex Development Co. (Chelmsford, MA) has a simple solution to computer noise pollution in its The Silencer. This handy little device gives the user control of the sound level produced by the speaker in his IBM or compatible computer, from full-off to full-on. The control is


mounted on a metal bracket that fits into any free expansion-slot cutout on the rear panel of the computer's system unit. The Silencer comes assembled, ready for installation. $19.95.

CIRCLE NO. 108 ON FREE INFORMATION CARD

## *PC Counter/Timer Digital I/O Board*

The Model 1524-PC counter/timer and digital I/O board from Industrial Computer Designs, Inc. (Westlake Village, CA) offers multiple functions for users of IBM PC/XT/AT and PS/2 Model 30 and compatible computers. It provides five 16-bit-wide counter/timers with software-configurable user outputs plus 24 bits of programmable digital I/O. The counter portion is based on the



AMD 9513A controller chip. The five counters can be linked to form an 80-bit counter. The 24 digital I/O lines can be configured as inputs or outputs in eight-line groups.

Features of this new board include: five 16-bit counters with selectable outputs; individual selection of counter inputs and gates; binary or BCD counting; frequency-output pin with selectable divide; built-in alarm register; software reconfiguration; IRQ2 through IRQ7 interrupt generation. The board comes with DOS drivers, sample configuration and operation software on diskette, and manual $295.

CIRCLE NO. 109 ON FREE INFORMATION CARD

*(Continued on page 72)*

# Making Printed-Circuit Boards Without Photography

## *How to use transfer film to copy an artwork image and transfer it to a pc blank as etchant resist*

**By Jan Axelson**


It's hard to beat a printed-circuit board as a method of construction when you want to give a professional internal appearance to your electronic projects. Many different techniques exist for fabricating pc boards, including the photographic approach, using press-on or rub-on transfers (so-called "dry-transfer" technique), and drawing directly on a copper-clad pc blank with an etch-resist pen.

In this article, I'll describe a new way to make pc boards using a specially coated TEC-2000 plastic film. The method to be described is especially useful when you have an existing conductor pattern and wish to make just one or a few copies of a board. You can use a published artwork like that which appears in many articles in *Modern Electronics*, or you can use a pattern that is taped on transparent Mylar film, drawn by hand on paper, or created with a computer with graphics software and a printer or plotter.

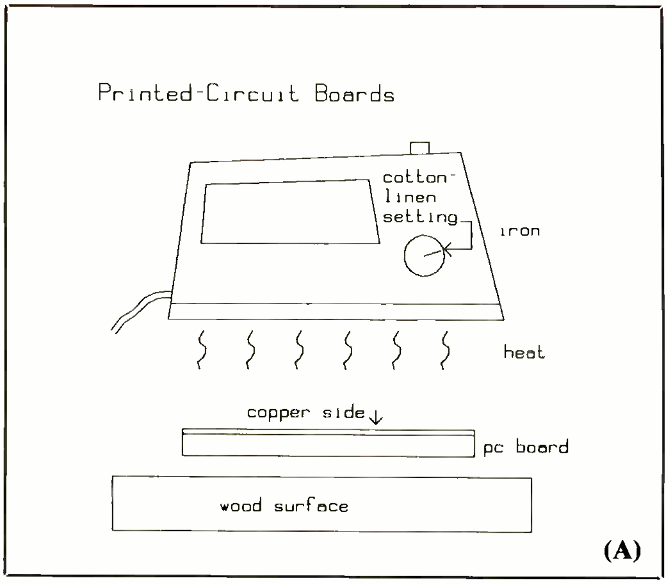
In the method described here, an ordinary photocopier first copies the pattern onto the film. A clothing iron is then used to transfer the image from the film to the printed-circuit blank by heating and pressing the two together. Thereafter, you etch and drill the board as usual. Of course, a little practice may be required in the beginning to master the transferring technique. But with some experience you can quickly and reliably create functional and professional-looking boards.

Fabricating a circuit board with this method requires three main steps: copying a pattern onto the film, transferring the pattern to the board, and etching and drilling the board. There's nothing special about the etching and drilling step; this is done exactly the same as with other methods. So in this article we'll concentrate on how to copy and transfer a pattern.

### *Materials & Equipment*

The Bill of Materials and Equipment box details what you need to make a printed-circuit board using this heat-transfer method. The TEC-200 film comes in 8½ by 11-inch sheets. Cost is around a dollar per sheet, and the film and an instruction sheet are readily available by mail from the suppliers listed in the Supplier Address box.

According to Meadowlake Corp., which distributes TEC-200 film in the United States, the film was created in Germany by a chemist who was looking for a more convenient way of creating circuit boards. This film has a Mylar base with a coating that loosely holds an image photocopied onto it. When heated, the copied image melts and then transfers and fuses to the copper surface of a pc blank.



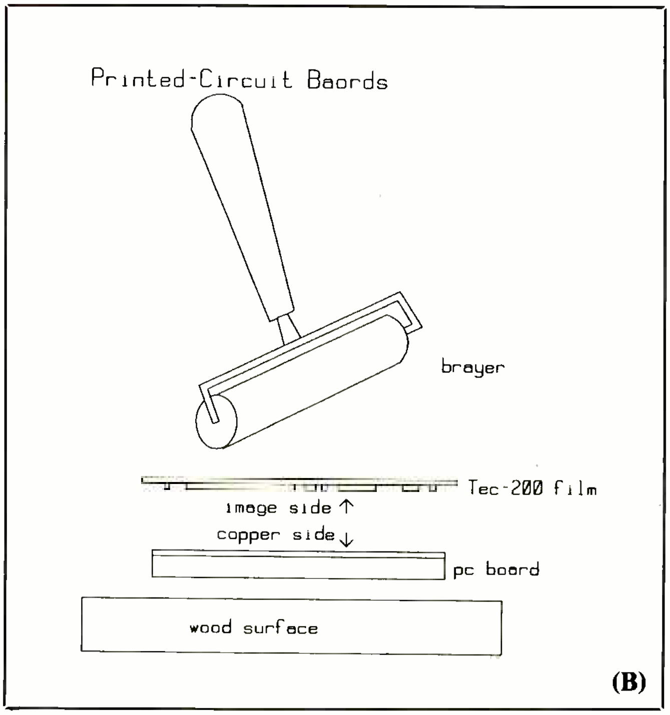




*Fig. 1. In brayer method of transferring conductor pattern to pc blank, clothes iron preheats copper cladding of blank (A); then transfer film is quickly placed on heated blank and brayer is drawn across it (B) to effect image transfer.*

The resulting transferred image forms a varnish-like, acid-proof coating that serves directly as the etch resist. When the board is placed in an etchant bath, the coating deposited on the pc blank during the transfer process prevents the etchant from dissolving the copper beneath it. Only exposed copper is dissolved. The result is a board with the conductor pattern etched in copper on it.

To copy a pattern onto the TEC-200 film, you can use any "plain-paper" copier that uses a heat-fusing toner (the dry ink that forms the image) to form the copy on the paper. This type of copier includes most traditional electrostatic photocopiers. Most copy shops will copy a pattern onto the film for a minimal charge.

An alternate method is to draw the desired conductor pattern using a computer and graphics software, then print it directly onto the TEC-200 film with a laser printer. We'll concentrate here on the photocopier method, since it's more widely available. If you have the necessary hardware and software, though, you can experiment with the laser-printer method as well.

An additional recommended item is a brayer, or print roller. This is a small rubber roller that can be obtained from any photographic and art-supply outlet.

## Copying the Pattern

No matter what the source of your conductor pattern, an image that has high contrast—jet black against pure white—works best in this process. You can copy several small patterns, or several copies of one pattern, onto one sheet of TEC-200 film.

From here on, it will be assumed that you have an actual-size ready-to-be-copied conductor pattern ready to copy. The following techniques are presented for making a single-sided board—one with an etched pattern on one side only. Double-sided boards are also possible with this technique if the patterns are positioned accurately on the pc blank during the transfer process.

One of the most confusing parts about creating printed-circuit boards is keeping track of the orientation of the pattern. The two sides of a board may be thought of as the "component" side (where the components are mounted) and the "solder" side, (where the pattern is etched and the leads and pins of the components are soldered into place).

For the components to line up properly with the pattern on the solder side of the board, the solder side must be a mirror image of the component-side layout. In the transfer method described here, the pattern reverses when the image is transferred from the film to the board. This means that the pattern you copy onto the film should show the component-side orientation—or the reverse of how the pattern will look when etched onto the solder side of the board.

If you have a conductor pattern that shows the solder side, all you have to do is copy it onto an extra sheet of TEC-200 or transparent My-

**Bill of Materials & Equipment**

Printed-circuit-board pattern for your circuit
TEC-200 transfer film
Copper-clad pc blank
Isopropyl (rubbing) alcohol
Acetone, paint thinner, or other organic solvent
Paper towels
Etchant of choice
Photocopy machine or laser printer (see text)
Non-metallic scouring pad or mild abrasive cleanser
Scissors or hobby knife
Clothing iron
Brayer or small rubber print roller
Resist pen for touch-ups as needed

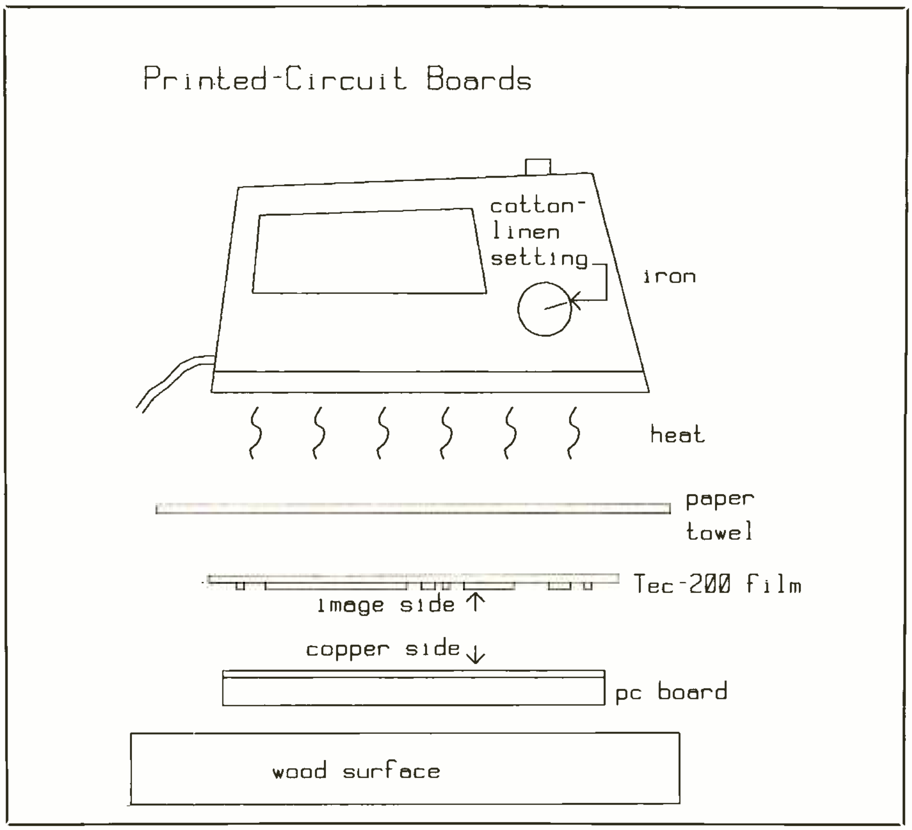



*Fig. 2. In direct method of pattern transfer, iron simultaneously heats transfer film and pc blank, causing pattern to transfer from film to blank.*

lar and flip the sheet over and you'll have the correct image to copy. Because they are solder-side views, the conductor patterns published in *Modern Electronics* must be reversed in this way.

Preliminary to copying any pattern, always check it over carefully. Look for hairline discontinuities in the trace lines and for traces or pads that are touching but should be separate. Correct any defects *before* you proceed to the copying stage.

When you have a pattern ready to copy, take it and the TEC-200 film to a photocopy shop. If you have an extra sheet or two of the film, it doesn't hurt to make extra copies. If you find you don't need the extra copies, you can wipe the copied patterns off and use the film again.

Bear in mind that most—if not all—photocopiers have distortion built into them. Some copiers have minimal distortion and will work fine for even fairly detailed conductor pattern copying. Others have excessive distortion that may be useless, especially if they do not provide reasonable spacing for DIP integrated circuits. If a copier you try has excessive distortion, try another and another until you've reduced the distortion to a negligible amount. Even moderate distortion will be unacceptable for larger-size conductor patterns.

Keep the film clean by handling it only by its edges and storing it in a manila folder for protection. At the copy shop, first make a trial copy of your pattern on paper. If your image is on transparent film, lay a sheet of white paper over the back of it when you copy to prevent any dirt or other images on the cover of the copier from copying onto the film along with the conductor pattern. If necessary, experiment with different darkness settings on the copier until you have a solid black image against a white background.

Bear in mind that the pattern must show the component-side view. If necessary, copy your pattern onto TEC-200 or transparent Mylar film and flip the copy over for the correct orientation. It's also a good idea for the pattern to include some way of identifying the view. One way to do this is to write "image side" just outside one edge of the pattern to be copied. Then after copying, you'll know that the side of the film with the readable label is the side that has the toner on it from the copier.

If your conductor pattern is enlarged or reduced, you must reduce or enlarge it accordingly to obtain an actual-size pattern. If you do enlarge or reduce the image, be sure to check for correct dimensions on your copy.

When you have your pattern in the correct orientation and you're satisfied with the photocopies of it on paper, it's time to copy onto the TEC-200 film. (*Caution:* When copying onto TEC-200 film, proper operating temperature of the copier is mandatory. The photocopying process uses heat to melt the toner that forms the image on the copy. Although TEC-200 film is highly heat-resistant to the heat ordinarily developed in photocopiers, it will begin to soften at around 325 degrees Fahrenheit.

If the copier temperature is set too high, the film and the copier may be damaged. Typical recommended operating temperatures for copiers are between 275 and 300 degrees Fahrenheit. Temperatures in this range should yield good results with the TEC-200 film. If you're not sure about the temperature setting on the copier you're using, ask for help at the copy shop.

You can copy onto either side of the TEC-200 film. Remember to handle the film only by its edges. Copy shop personnel can help you feed the film into the copier. When you have your copy or copies on the film, examine them for contrast and overall quality. Slight transparencies or pinholes in the image are not critical, since the melting toner will fill these in as it heats and transfers to the copper surface of the pc blank. Always handle the film with care because the coating will flake off it easily. An example of a photocopied conductor pattern on TEC-200 film is shown in Fig. 3.

## *Transferring the Pattern*

The pattern is now ready to be transferred onto a copper-clad pc blank. If necessary, cut the pc blank to size.

A scrupulously clean pc blank is essential to successful transference of the toner to it and reliable etching. Thoroughly scrub the copper cladding on the blank with a mild abrasive cleanser or non-metallic scouring pad such as Scotch-Brite. When the surface is clean and shiny and has a burnished copper appearance, give it a final, thorough cleaning with a clean rag or paper towel dipped in isopropyl alcohol.

Do not touch the copper surface of the pc blank once it has been cleaned.

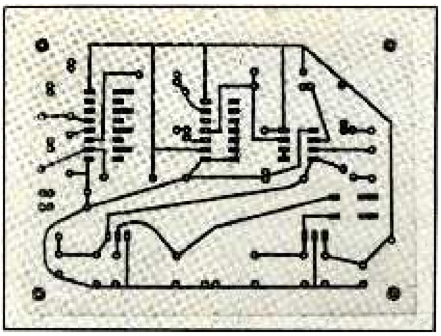


*Fig. 3. A sheet of TEC-200 film onto which image of desired pattern has been photocopied for transfer to copper cladding on a pc blank.*

Handle it only by its edges. While the blank dries, gather your clothes iron, film onto which the conductor pattern has been copied, and a brayer (if you're using the last item).

Prepare a work surface for ironing the pattern. I found the transfer process easiest to perform with the pc blank board resting on something firm, such as a wooden plank, rather than on the padded surface of an ironing board. Whatever surface you choose, though, make sure it can bear up under the heat of the iron.

Set the iron to the cotton-linen setting and give it a few minutes to come up to the needed temperature (265 to 295 degrees Fahrenheit). Carefully

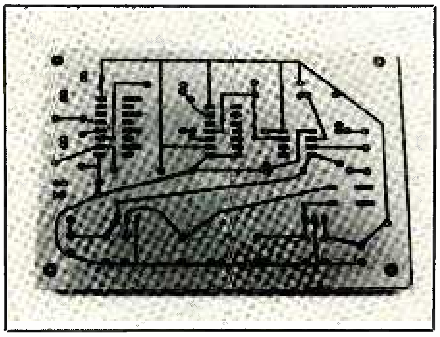


*Fig. 4. When conductor pattern has been transferred from TEC-200 film to copper cladding of pc blank, latter is ready to be etched, drilled and cleaned of residual resist.*

cut your conductor pattern from the film, leaving a border of half an inch or less all around the image. Once again, remember to handle the film carefully: don't touch the image, and set the film down with its image side (the component orientation) up. When the cleaned board is thoroughly dry, you're ready to transfer the pattern to it.

Two different methods for pattern transfer will be discussed:

• *Brayer Method.* In this method, the copper surface of the pc blank is heated. The film is then placed image-side-down on the copper surface of the hot blank and rolled on with a brayer. This method is illustrated in Fig. 1. The trickiest part of the procedure is the positioning of the pattern on the heated board. This must be done quickly and with good accuracy. Once the image touches the heated blank, it will begins to adhere; so you get just the one chance to lay the film correctly against the pc blank. The transfer procedure must be accomplished quickly, too, before the blank begins to cool.

Because it's such a critical step, it's a good idea to practice placing the film on an unheated blank before you do the actual transfer. To aid in accurately and quickly positioning the image, you can position the film and tape one end of the side of the film that is not coated to the blank. Then you can flip the film away from the blank as the latter is heating, and flip the film back over the blank to transfer the image. If you do this, be especially careful to keep the hot iron off the film.

When you're ready to heat the blank, place the preheated iron directly on its copper surface. If possible, cover the entire blank with the iron. If the blank is larger than the shoe of the iron, move the iron around to uniformly heat the entire blank. If you've taped the film to one end of the blank, be very careful to avoid touching the iron to the film as you heat the blank.

How long you must hold the iron on the blank must be determined by trial and error. In tests I've performed, I found that 30 to 60 seconds of contact with the hot iron should be sufficient to properly heat the pc blank to the desired temperature to accomplish the transfer of the image from the film to the copper surface of a small blank.

When the blank is hot enough, you're ready to transfer the pattern. This must be done quickly. Remove the iron and place the film image-side-down in its planned position on the heated copper surface. Immediately begin drawing the brayer across the film, using even, moderate pressure. Continue rolling as the blank cools. Make several passes from different angles, and be sure to roll across the entire pattern.

Do not lift the film or move the blank until the latter has cooled to room temperature. However, you can examine the blank while it is sitting undisturbed. Examine it carefully. You should be able to see where the image has left the film and is transferred to the blank. If you see sections that have remained on the film, you can briefly press the tip of the hot iron directly on the film at these locations. (Small areas can also be filled in later with a resist pen.) When you're finished, turn off the iron and leave the board to cool with the film still in place.

• *Direct-Transfer Method.* Using this method, the pattern is transferred directly with the iron, instead of with the brayer, as illustrated in Fig. 2. This method may work better for large patterns, but it requires much more careful monitoring.

Begin with a thoroughly cleaned and dried copper surface as described above. Lay the film image-side-down directly on the copper surface of the blank. Lay over this a paper towel, napkin, or thin cotton cloth. Then transfer the pattern by placing the heated iron directly on the covered board, using moderate pressure.

Check the blank frequently—every few seconds—by lifting the covering (but do *not* disturb the film) and examining the the blank to see if the pattern has successfully transferred. As was the case using in the brayer method, deciding on just how long the blank must be heated with the iron must be determined by trial and error. With this direct-transfer, method I found it very easy to heat too long and end up with a smeared and useless image; so check frequently as you heat.

When the pattern has successfully transferred, turn off the iron and leave the blank to cool without disturbing it or the film.

## *Examining & Etching*

Regardless of which of the two methods you use, when the blank has cooled you're ready to check the quality of the image. To do this, begin by carefully lifting the film from the blank. Figure 3 shows a blank that has an image successfully transferred onto it. If you're lucky, your complete conductor pattern will be fused onto your blank with solid and sharply defined lines and pads. Continue to handle the blank only by its edges, since the coating can chip off the copper cladding at this stage.

Your first attempt at transferring may result in a less-than-perfect effort. Differences in such factors as iron temperature, blank size, amount of pressure, and original pattern quality may cause differences in results. However, with a little practice and experimenting, you should be able to develop a technique that works reliably for you every time.

Here are some tips on what to do if your pattern transfer was flawed:

• If just a few small areas fail to transfer, you can transfer them by repositioning the film and touching the missed sections with the tip of a heated iron. Alternatively, you can draw in missing sections onto the copper cladding with a resist pen.

• If large sections of the image fail to transfer from the film to the pc blank, or if the lines and pads in your image came out smeared or broadened on the blank, you're better off starting over. You'll need another conductor pattern photocopied onto the TEC-200 film, of course, but you can reuse the pc blank—and even the film if you properly clean all toner from it first.

• If your first try yields an incomplete image on the pc blank, next time use more heat or pressure as you perform the transference. If this is the problem, turn up the iron temperature slightly, heat the pc blank for a slightly longer time, work more quickly in positioning the film with the conductor-pattern image on it on the blank and transferring with the brayer, or use slightly more pressure on the film with the brayer or iron.

• If the lines in the image aren't solid, you can also try the above suggestions for increased heat or pressure, or use an original image with better contrast. If the lines are smeared or broadened, use less heat or pressure. In this event, lower the temperature of your iron or use less pressure on the film with the brayer or iron.

• If you encounter any difficulties and must start over, remove the pattern from the pc blank with a mild abrasive cleanser or scouring pad, or use an organic solvent, such as acetone or paint thinner, following manufacturer's precautions. Clean the blank as detailed above, finishing with a final cleaning with isopropyl alcohol, and you're ready to try again.

When the image is successfully transferred onto a pc blank, etch and drill the board as usual. Follow the directions with the etchant of your choice, or see "Making Printed-Circuit Boards the Old-Fashioned Way" by Anthony Caristi in the December 1988 *Modern Electronics.*

After etching and rinsing the board, remove the resist pattern from the remaining copper on the board (it's now a board, no longer a

## Supplier Addresses

TEC-200, pc blanks, etchants
**DC Electronics**
P.O. Box 3203
Scottsdale, AZ 85271-3203
1-800-423-0070 (602-945-7736 in Arizona)

TEC-200
**Meadowlake Corp.**
P.O. Box 497
Northport, NY 11768

TEC-200, pc blanks, etchants
**Small Parts Center**
6818 Meese Dr.
Lansing, MI 48911
517-882-6447

"pc blank" since the only copper on it is the traces that serve as the wiring medium), using a cleanser, scouring pad or organic solvent, as described above. Figure 4 shows a pc blank onto which a desired etch-resist pattern has been successfully transferred from TEC-200 film. All that's left to do at this stage is etch the board, drill component-lead and holes, remove remaining resist from the copper conductor pattern and populate the board in the normal manner.

Examine your pc board for any broken copper traces. If you find any, you can repair the flaws with conductive ink, solder, or a small wire jumper soldered across the gap and "sweat-soldered" into place. The board is now ready for drilling, inserting components, and testing.

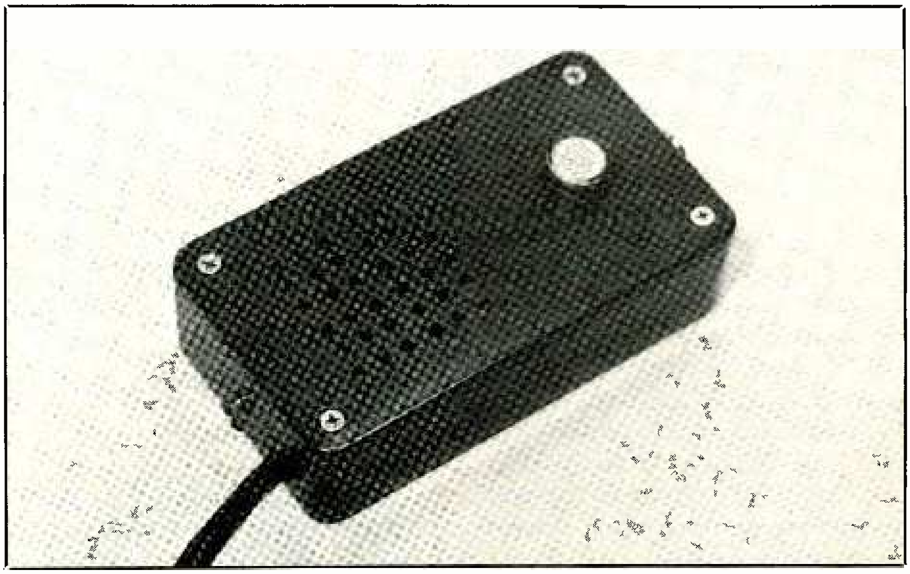
Whether you're new to printed-circuit-board fabrication, or you're looking for a new method of pc-board fabrication to try, you'll almost certainly discover that the transfer-film technique described here is a handy and practical alternative to the photographic and hand-drawn techniques you might have traditionally been using. In terms of neatness and freedom from the need to use chemicals alone, this technique is certainly worth a try. ME


*"You don't have a hard disk drive? How do you keep track of all us kids?"*

# Car Headlights Reminder

## *Alarm automatically sounds an audible alert and provides visual indication to tell you to turn on your vehicle's headlights at dusk*

**By Noel J. Mackisoc, Jr.**



Here is a handy little device that will remind drivers to turn on the headlights of their automobiles as night descends. Called the "Headlights Reminder," it sounds an audible alert and illuminates a light-emitting diode as lighting conditions become too low to provide enough visibility for other drivers and pedestrians to see your car. Once the alarm triggers, it continues to sound for 5 to 10 seconds, long enough to alert you even under conditions of high traffic noise. It then silences.

Our Headlights Reminder can be designed to be plugged into the cigarette-lighter receptacle on the dashboard of your car, or it can be wired directly into the car's electrical system. Installation is simple and straightforward. All you need do is mount the project in a location inside the passenger compartment where it will easily be heard and is out of the way and connect it to chassis ground and any point that is at +12 volts with the ignition on and is at 0 volt with the ignition off.

### *About the Circuit*

Shown in Fig. 1 is the complete schematic diagram of the Headlights Reminder circuit. As you can see, the circuit is divided into three separate function blocks—a power timer, a light-level decision circuit and a pulsed tone oscillator.

The purpose of the power timer function is to provide control of power to the rest of the circuit when the ignition switch of the vehicle in which the project is installed is on and to shut off the project 5 to 10 seconds after an alert is triggered. The light-level decision circuit monitors ambient light conditions and turns on the pulsed tone generator and LED if the detected light level is less than a certain preset threshold. The pulsed tone generator merely provides a pleasant "beeping" sound that serves as the audible alert.

Operation of the circuitry begins with turning on of the vehicle's ignition. When power is first applied to the circuit, resistor *R1* and capacitor *C2* provide a trigger pulse to input pin 2 that sets 555 timer *IC1* into operation. The 555 is configured here as a retriggerable one-shot multivibrator. It has an output pulse at pin 3 whose width is determined by the values of resistor *R2* and capacitor *C4*. This positive pulse turns on transistor *Q1* to provide +12 volts to the rest of the circuit.

When the pulse from the output of *IC1* goes low once again, *Q1* is biased into cutoff. At this time, power to the rest of the circuit is cut off. The maximum on time (output pulse from *IC1* positive) is approximately 10, seconds and is set by trimmer control *R4*. Diodes *D1* and *D2* and capacitor *C1* clean up the +12-volt supply line to assure reliable operation.

Switching *Q1* into conduction

causes the light-level decision circuit to become active. Cadmium-sulfide photocell *PC1* has a low resistance when fairly bright light is striking its sensitive surface and a high resistance when the device is in darkness. The photocell is not a simple on/off device but, rather, a variable-resistance device whose actual resistance at any given moment depends on the amount of light striking its sensitive surface.

Note here that photocell *PC1* is one element in a series voltage divider made up of this device and resistors *R4* and *R5*. Consequently, the actual potential delivered to the noninverting (+) input at pin 3 of comparator *IC2* depends on the level of light striking the sensitive surface of the photocell at any given moment.

Inverting (−) input pin 2 of *IC2* is connected to the middle of a second voltage divider, this one made up of *R6* and *R7*. The values of these two resistors are the same. Hence, the potential delivered to pin 2 of *IC2* is one-half the supply voltage, or +6 volts. This potential does not vary and, thus, serves as the reference against which the input at pin 3 of the IC is compared.

When trimmer potentiometer *R4* is set to the desired range, voltage comparator *IC2* switches on when the input at pin 3 exceeds +6 volts. At this point, transistor *Q2* is biased into conduction and couples +12 volts to the pulsed tone generator circuit and turns on light-emitting diode *LED1*.

The pulsed tone generator is a two-stage regenerative-feedback oscillator, with each stage made up of two of the four AND gates inside *IC3*. Each stage generates a tone at a different frequency, with the tone generated by the stage made up of *IC3C* and *IC3D* coupled from output pin 11 to input pin 1 of the stage made up of *IC3A* and *IC3B*. Thus the first tone "modulates" the second one. The resulting combined tone, available at output pin 4 of *IC3B*, is coupled through *C7* to speaker *SPKR*.

Frequency of oscillation is governed by the values selected for the resistor and capacitor elements in

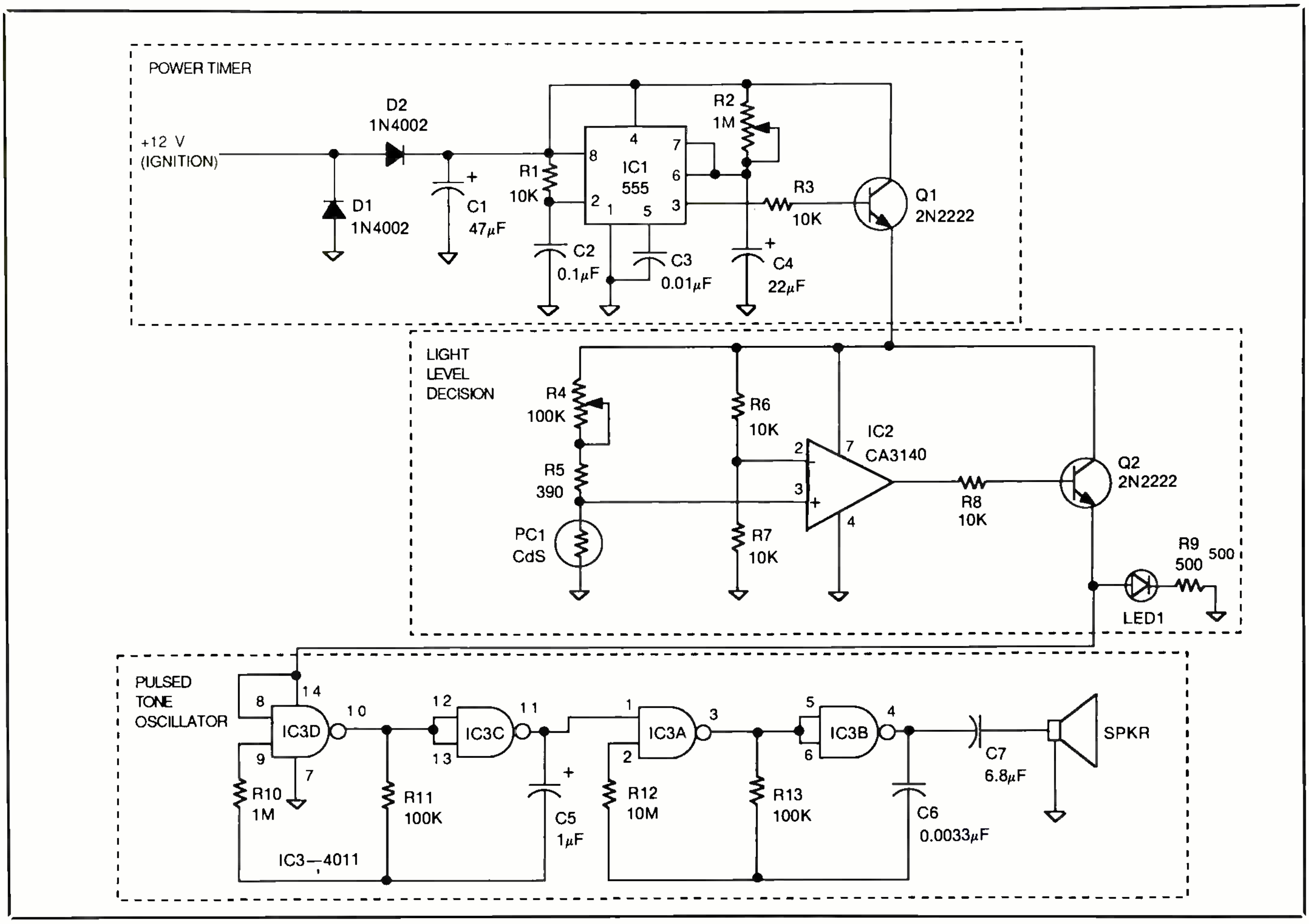



*Fig. 1. Complete schematic diagram of the Headlights Reminder circuit.*

## PARTS LIST

**Semiconductors**
D1,D2—1N4002 or similar silicon rectifier diode
IC1—555 timer
IC2—CA3140 voltage comparator
IC3—4011 quad 2-input NAND gate
LED1—Green 50-mA light-emitting diode
Q1,Q2—2N2222 or similar general-purpose npn silicon transistor

**Capacitors**
C1—47-$\mu$F, 25-volt electrolytic
C2—0.1-$\mu$F Mylar or polyester
C3—0.01-$\mu$F Mylar or polyester
C4—22-$\mu$F, 25-volt electrolytic
C5—1-$\mu$F, 25-volt electrolytic
C6—0.0033-$\mu$F Mylar or polyester (see text)
C7—6.8-$\mu$F, 25-volt nonpolarized

**Resistors** (¼-watt, 5% tolerance)
R1,R3,R6,R7,R8—10,000 ohms
R5—390 ohms
R9—500 ohms
R10—1 megohm
R11,R13—100,000 ohms
R12—10 megohms
R2—1-megohm pc-mount trimmer potentiometer
R4—100,000-ohm pc-mount trimmer potentiometer

**Miscellaneous**
PC1—Cadmium-sulfide photocell (Radio Shack Cat. No. 276-116A or similar)
SPKR—Miniature 8-ohm speaker (Radio Shack Cat. No. 40-245 or similar)
Suitable circuit board (Radio Shack Cat. No. 276-150 experimenter board—see text); suitable enclosure (Radio Shack Cat. No. 270-221 project box—see text); standoffs; Velcro fastener (see text); power cable terminated in automotive cigarette-lighter plug (optional—see text); machine hardware; stranded hookup wire; solder; etc.

each oscillator stage. The low-frequency output signal from the first stage modulates the higher-frequency signal developed by the second stage. The frequency of the audible tone is best changed by changing the value of capacitor *C6*. A value of 0.01 microfarad sounds like a "busy" signal on a telephone, while a value of 0.0033 microfarad generates a tone that is higher in pitch.

Once triggered, the pulsed tone from the oscillator will be heard from the speaker (and the light-emitting diode will remain on) until the power timer circuit times out. When the timed period is done, *Q1* will be cut off and the rest of the circuit will be deprived of power. At this time, the LED will extinguish and the tone will be silenced.

## *Construction*

Owing to its basic simplicity and the fact that nothing is critical about component layout and lead routing, you can assemble the Headlights Reminder circuit using just about any traditional wiring approach. For example, you can design and fabricate your own printed-circuit board, use a readily available "project board" with pre-drilled holes and solder pads or use perforated board with holes on 0.1-inch centers and suitable soldering or Wire Wrap hardware. The prototype of this project, shown in Fig. 2, was assembled on a Radio Shack project board.

Trim the circuit board material you have chosen to a size to fit inside the selected enclosure. If you are using an all-plastic enclosure, such as the one mentioned in the Parts List, cut whatever notches are necessary in the board for it to clear any internal hardware posts or other obstructions.

Whichever method of assembly you choose, it is a good idea to use sockets for the ICs. Use only premium sockets that assure positive gripping action so that the ICs will not work loose from them under the severe mechanical vibrations that normally occur in the automotive environment. However, if you cannot find sockets that will bear up to mechanical stresses, it is better to do without altogether and wire the ICs directly into the circuit. If you go this route, save installation of the ICs themselves until after you have performed preliminary voltage checks. Try to keep the circuit as compact as possible to permit mounting it inside a small enclosure that can be conveniently tucked away inside the passenger compartment where it will not get in the way.

Begin construction by mounting the IC sockets in their respective locations on the board. You can install the ICs in the sockets after you finish wiring the circuit-board assembly. When you do so, make sure each is in the correct socket and is properly oriented. Also, make sure that no pins overhang the sockets or fold under between ICs and sockets.

As you install each component on the board and wire it into the circuit, make sure it has the correct value or is the correct type before soldering any connections. Also, make certain you place polarity-sensitive components like diodes, electrolytic capacitors and ICs in the proper orientation on the board.

Mount the two trimmer controls—*R2* and *R4*— on the bottom, or wiring, side of the circuit board. This allows you to conveniently access their adjustment slots from holes drilled through the floor of the enclosure without having to open the enclosure. If the controls were mounted on the top of the board with the other components, they would not be accessible because of how the speaker is mounted to the top panel.

Note that the speaker mounts off the board and that you have the option of mounting the photocell directly on the board or on the top panel of the enclosure in which the circuit-board assembly will be housed (see Fig. 3). If you choose the former,

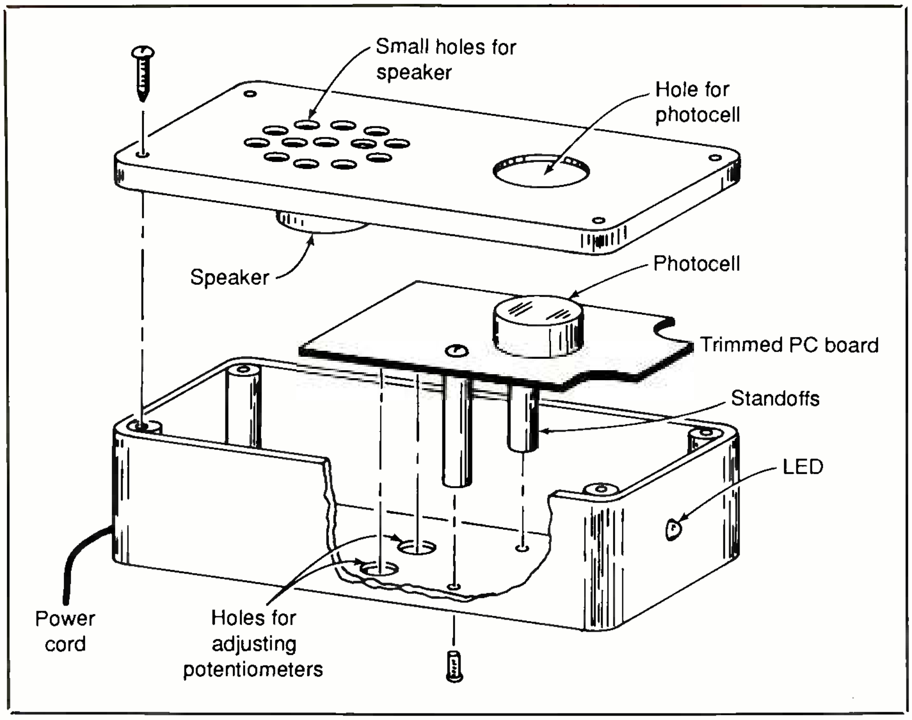



*Fig. 2. Assembly details for project. Here, the photocell is shown mounted on the circuit board behind a circular cutout.*

you must cut a hole in the top panel of the enclosure the same size as the top of the photocell to permit light to get at the sensitive surface of *PC1*. If you decide to mount the photocell on the top panel, make sure to drill holes for its leads or pins and interconnect it with the circuit-board assembly with stranded hookup wires.

Having wired the circuit-board assembly, proceed to preparing the enclosure. For the enclosure, you can use any type of project box that will comfortably accommodate the circuit-board assembly and speaker. You can use any of the commonly available project boxes on the market—all-plastic, plastic with a metal front panel or all-metal. The easiest to machine is all-plastic, of course, and such a one is mentioned in the Parts List.

Refer to Fig. 2 for details on preparing the enclosure. As you can see, the speaker mounts on the front panel, behind a series of holes drilled in the panel to allow the sound to escape. The light-emitting diode mounts in a hole drilled through one end wall of the enclosure. Size the hole for the LED for a press fit.

Now machine the main enclosure box as follows: First, drill two holes for mounting the circuit-board assembly inside the enclosure. Drill a third hole for routing the power leads to the circuit-board assembly. If you are using an all-metal enclosure, deburr this hole and line it with a small rubber grommet. Next, drill two ¼-⅜-inch holes exactly in line with where the adjustment slots of trimmer controls *R2* and *R4* will be when the circuit-board assembly is mounted in place.

Determine where inside the passenger compartment of your car you will mount the project. Pull apart the loop and hook portions of a 3-inch-long by about ¾-inch-wide piece of Velcro fastener strip. Cement in the selected location the strip that has the loops. Cement the other strip along one of the long side walls of the enclosure. For permanence, use fast-setting epoxy cement.

If you mounted the photocell directly on the circuit board, determine where the hole for it must be in the top panel of the enclosure. Unless you have a very large bit and a slow-speed drill, you will not be able to drill this hole directly. Fortunately, you can make quick work of the job with a nibbling tool or even a smaller drill bit and a tapered reamer.

If the photocell is to be mounted off the board, drill holes for its pins and leads in the appropriate locations of the top panel. If your photocell has solid wire pins, crimp and solder to each a 3-inch length of stranded hookup wire and feed the free ends of these through the holes. Otherwise, pass the free ends of the wire leads that come on the photocell through the holes. Mount the photocell in place with quick-setting epoxy or silicone cement. Then mount the speaker in place with a thick bead of silicone cement, centering it over the holes you drilled to permit the sound to escape. Set aside the panel assembly to allow the cement to set.

Meanwhile, prepare the power cable for the project. Use only heavy-duty stranded hookup wire for the cable. As mentioned above, you can select either of two options here. One is to terminate one end of the cable in a standard automotive cigarette-lighter plug; the other is to permanently wire the project into the vehicle's electrical system.

Whichever method you choose to go with, determine how long the two wires for the power cord must be and cut both to size. It is a good idea to use color-coded insulation here, black for vehicle ground and red for +12 volts. Strip ¼ to ⅜ inch of insulation from one end of both wires, tightly twist together the fine conductors at the stripped ends and sparingly tin with solder.

If you decided to permanently wire

the project into your car's electrical system, no terminating connector or plug is needed. However, if you decided to use the cigarette-lighter plug, crimp and solder the wires to the appropriate lugs on the plug. In most cases, the lug that goes to the center pin of the plug is the +12-volt contact. However, use a dc voltmeter or a multimeter set to the dc-volts function to check this before making the connections.

If you opted for the project to be permanently wired into your vehicle's electrical system, find a conductor in the system that is at 0 volt with the ignition turned off and at +12 volts with the ignition turned on.

With the ignition turned off, cut through the selected lead and strip ½ inch of insulation from both cut ends. Slide a 1½-inch length of small-diameter heat-shrinkable tubing over one end. Then twist together the fine wires at the cut ends to form an in-line splice and solder the connection. Remove an additional ¼ inch of insulation from the prepared end of the red-insulated wire and wrap this end around the in-line splice and solder this into place. Center the heat-shrinkable tubing over the connection and shrink it into place.

Terminate the stripped end of the black-insulated wire you prepared in a spade or ring lug and fasten this to the vehicle's chassis ground via an existing screw. Before doing so, however, remove the screw and rub down the area around the hole with fine emery cloth to obtain a bright metallic surface that will assure a good electrical connection.

If you terminated the wire in a ring lug, place this on the screw end, follow with an outside-tooth lockwasher and drive the screw solidly back into the hole from which it was removed. If you terminated the wire in a spade lug, place an outside-tooth lockwasher on the end of the screw and start the screw back in the hole. Slide the spade lug between screw head and lockwasher and fasten down the screw.

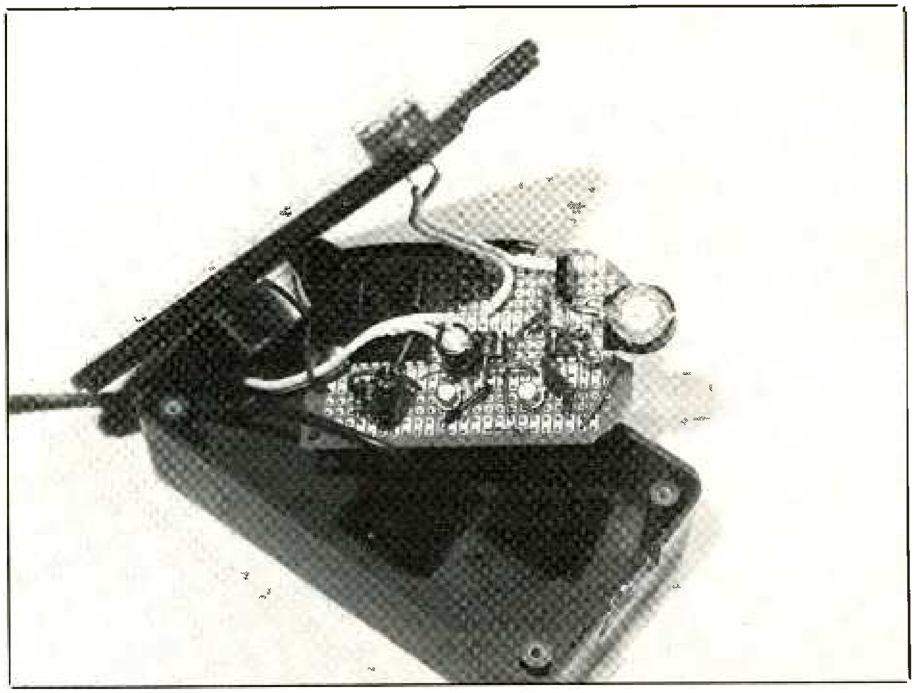


*Fig. 3. An alternative way to build the project, with the photocell mounted on the front panel of the enclosure. No holes are drilled through the floor of the enclosure for access to the adjustment slots of the trimmer controls.*

Whether you are using the cigarette-lighter plug or permanent electrical connection, loosely twist together the two wires and feed them through the hole you drilled for entry of the power cable or the rubber-grommet-lined hole. Tie a strain-relieving knot in the wire pair about 5 inches from the free end inside the enclosure. Then strip ¼ inch of insulation from the black-insulated wire, tightly twist together the exposed conductors and sparingly tin with solder. Connect and solder this wire to the ground bus of the circuit-board assembly. Repeat with the red-insulated wire, connecting this to the junction between *D1* and *D2* on the circuit-board assembly.

Strip ¼ inch of insulation from both ends of four (six if the photocell requires extra wire leads) 4-inch lengths of stranded hookup wire. Tightly twist together the fine conductors at both ends of all wires and sparingly tin with solder. Connect and solder one end of two of these wires to the emitter of *Q2* and free end of *C7* and another two wires to any convenient ground points in the circuit. If you mounted the photocell off the board, connect and solder another pair of wires to the junction between *R5* and pin 3 of *IC2* and another convenient ground point.

Now crimp and solder the wires coming from *C7* and ground to one lug of the speaker. Similarly, crimp and solder the wires coming from the junction of pin 3 of *IC2* and *R5* and ground to the off-the-board photocell. The two remaining wires will be terminated later, after the circuit-board assembly is mounted inside the enclosure.

Clip the cathode lead of the LED to ½ inch in length and form a small hook at the end of the stub. Slide a ½-inch length of small-diameter heat-shrinkable tubing over the free ends of a ground wire and the wire coming from the emitter of *Q2*. Crimp and solder the free end of the ground wire to the cathode lead of the LED. Then trim the anode lead of the LED to ½ inch, form a small hook in its end and crimp and solder the free end of the wire coming from the emitter of *Q2* to the anode lead of the LED. Slide the heat-shrinkable tubing over both connections and flush against the bottom of the case of the LED and shrink into place.

Push the dome of the LED into its hole in the front panel. If the fit is loose, apply a small daub of fast-setting epoxy cement to keep the LED in place. If the photocell is mounted off the board, crimp and solder the ends of the remaining two wires coming from the circuit-board assembly to its pins, or simply connect and solder its existing wire leads to the appropriate points on the circuit board.

Mount the circuit-board assembly inside the enclosure with the aid of two standoffs and suitable-length machine hardware. Check that the adjusting slots are easily accessible with the blade of a thin screwdriver. Button up the project by fastening the front panel to the enclosure, and mount your Headlights Reminder in the selected location.

## *Checkout & Adjustments*

When checking out and adjusting the project, you can use any dc power source capable of delivering +12 volts at at least 200 milliamperes, including the 12-volt electrical system of your vehicle. Before starting, though, set *R2* and *R4* to approximately the center of their rotation.

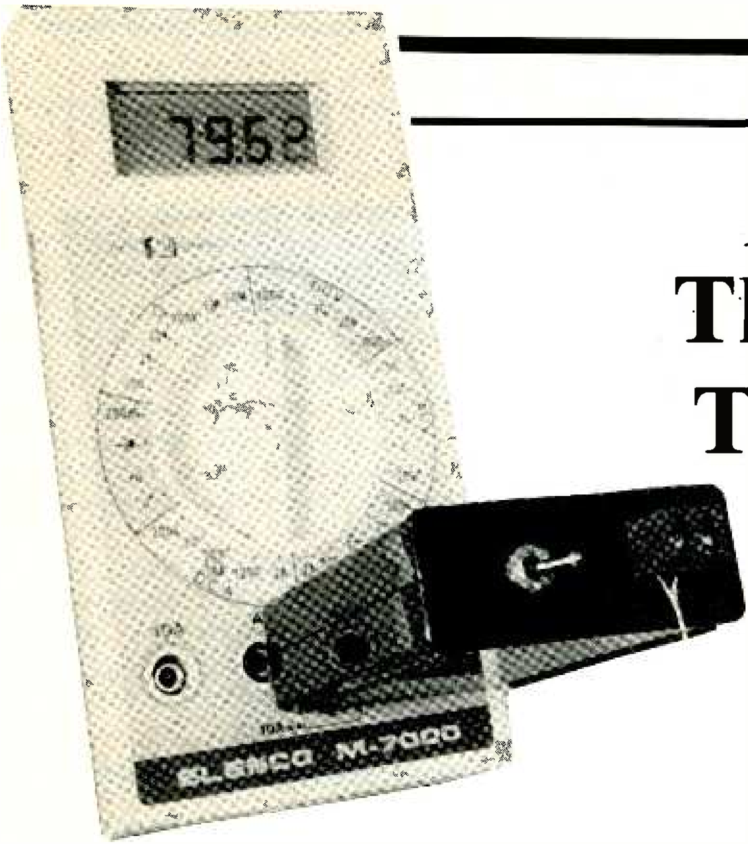
Turn on the dc power source (or turning on the ignition of the vehicle) while holding your thumb over the the photocell to simulate a dark condition. The project should beep and the LED should light. If the project does nothing, disconnect power from it and rectify the problem before proceeding.

Check all component installations for correct values and types and double-check all wiring against Fig. 1. Check particularly for improper orientations of the diodes, electrolytic capacitors, LED and transistors. Check also for any missed connections, connections you failed to solder and accidental short circuits.

When you are certain that your project is operating properly, adjust the setting of *R2* for the desired length of time you wish the beeping sound to continue.

Next, set the light threshold at which you want the project to trigger on by adjusting the setting of *R4*. To accomplish this, place the project in a fairly dark area in your car where the ambient level of light is similar to the lack of light level at which you want the project to trigger. Do this with no power applied to the project. Then when you apply power, if the tone sounds and the LED lights, adjust the setting of *R4* until no triggering occurs when you slightly increase the light level.

Final adjustment of threshold control *R4* should be done under actual changing of ambient-light conditions. Do this where street lighting will not influence the response of the project. ME




# A Precision Thermocouple Thermometer

***Voltmeter accessory lets you measure temperature with one-tenth-degree resolution***

**By Stephen R. Collins**

Thermometer adapters are among the more popular accessories that can be added to a dc voltmeter (or the dc-volts function of a multimeter). Over the years, many circuit schematics have been published for such a device. Most have used as a sensor element a diode, transistor or IC designed specifically for temperature-measuring applications. This article will show how to make a small accessory that will enable your voltmeter to read temperature in degrees Fahrenheit or Centigrade with 0.1-degree resolution, using thermocouples, which are the most versatile and economical of temperature sensors available.

## *About Thermocouples*

A bewildering variety of sensors are available for use in temperature-measuring applications. Among the types often specified for use in circuits published in magazine articles have been LM334 and AD590 integrated-circuit sensors and silicon diodes and transistors. These are not very useful because they are bulky, delicate to handle and use and slow in responding to temperature changes. Attempting to measure something as mundane as the temperature of the water in an aquarium requires that a special probe that must encapsulate the sensor to protect it from the water must be made. The bulk of the encapsulant would slow response time tremendously. So if you wanted to take a quick reading, such a probe would be frustrating to use. Being simply wire, the thermocouple sensor has no such disadvantages.

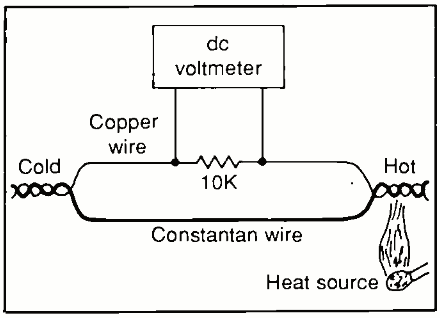



*Fig. 1. The most basic of thermocouple thermometer arrangements.*

Thermocouples rely on the Seebeck Effect, named after Thomas Seebeck who discovered in 1821 that couples of dissimilar metals produced a small voltage when heated. Some of the values for a particular type of thermocouple are listed in the Table. As you can see, the voltages are not very great, about 2.27 millivolts per 100 degrees Fahrenheit.

In the past, such low voltages, which had to be greatly amplified to be useful, were difficult to use and when used required prohibitively expensive circuitry for all but laboratory applications. Fortunately, modern electronics technology has come to the rescue with availability of low-cost, ultra-stable operational-amplifier integrated circuits and equally low-cost, high-accuracy analog-to-digital (A/D) converters, the latter in the form of dc voltmeters.

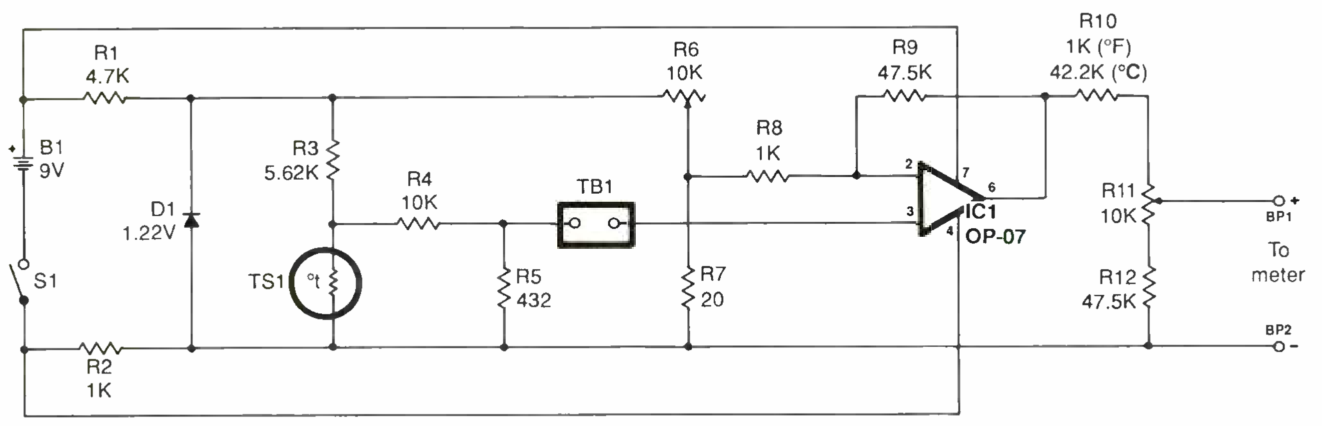
In building a circuit to measure temperature, a simple type T (copper-constantan) thermocouple might be used, as illustrated in Fig. 1. (Many types of thermocouples are available, but copper-constantan is handiest because of its relatively high voltage output and the desirable properties of copper.) The temperature-sensing element is simply thermocouple wire whose ends are twisted or soldered together to form a couple. A resistor in series with the copper wire serves as a load that permits you to observe the thermoelectric voltage. Observation is done with a dc voltmeter connected across the resistor as shown.

Initially, with the Fig. 1 arrangement, you would observe no voltage. However, if you were to place a lighted match under the junction to the right, you would soon see about 10 millivolts in the meter's display. If you were to heat the other couple, you would observe a negative voltage.

Moving the lighted match from the right couple would cause the potential across the resistor to drop to 0 volt. At this point, you might be wondering why you cannot see the 0.834 or so millivolt that corresponds to the ambient 70 degrees Fahrenheit given in the Table. The reason for this is that the 0.834 millivolt developed by the right couple is exactly opposed by 0.834 millivolt from the left couple. Because the two voltages cancel each other out, the voltmeter displays 0 volt.

Once there is no way to complete a thermocouple circuit without eventually joining the wires, two junctions always exist. In the past, this presented a problem that was often solved by placing the left couple in an ice bath. Then the voltage read by the meter was directly proportional to temperature in degrees Centigrade (Celsius). If a bath at 0 degree F could be found, the readings were proportional to the Fahrenheit temperature.

Most users of thermocouples have no desire to look for ice cubes whenever they want to take temperatures. Therefore, it is highly desirable to have an electronic circuit that acts as an ice bath. Such a circuit provides




## PARTS LIST

**Semiconductors**
IC1—OP-07 operational amplifier
D1—ICL 8069, TSC-9490, Motorola MP5010 1.22-volt precision reference (see text)

**Resistors**
*(¼-watt, 5% tolerance, carbon-film)*
R1—4,700 ohms
R2—10,000 ohms
*(1% tolerance, metal-film)*
R3—5,620 ohms
R4—10,000 ohms
R5—432 ohms
R7—20 ohms
R8—1,000 ohms
R9,R12—47,500 ohms
R10—1,000 ohms for Fahrenheit readings or 42,200 ohms for Celsius readings
R6—10,000-ohm trimmer potentiometer ⅜" square, vertical mount
R11—10,000-ohm single-turn, vertical-mount cermet trimmer potentiometer

**Miscellaneous**
B1—9-volt battery
S1—Miniature spst toggle switch with pc pins
TB1—Two-position terminal board with plug-in receptacles
TS1—KTY83-110 Silicon Temperature sensor (Amperex)
Printed-circuit board or perforated board and suitable Wire Wrap or soldering hardware (see text); suitable enclosure (Radio Shack Cat. No. 270-257 or 270-230 or similar—see text); banana plugs; wire terminals (Radio Shack Cat. No. 276-1388 or similar); eight-pin DIP IC socket; holder and snap connector for B1; 6 feet of Type T thermocouple wire; machine hardware; hookup wire; solder; etc.

**Note:** The following items are available from Collins Aviation, 72 Long Point Dr., Brick, NJ: Kit of all parts, including pc board but not enclosure, $19; ready-to-wire pc board, $5.50; 6 feet of Type T thermocouple wire, $5. Add $3.50 P&h. New Jersey residents, please add 6% sales tax.
D1 and IC1 are available from Active Electronics (1-800-ACTIVE4.) Thermocouple wire is available from Omega Engineering, 1 Omega Dr., Stamford, CT 06907; 203-359-1660.

*Fig. 2. Complete schematic diagram of Precision Thermocouple Adapter's circuitry. Thermocouple sensor connects into circuit via terminal board TB1.*

sembly with short lengths of hookup wire. Mount the battery holder with suitable machine hardware. Then mount the circuit-board assembly in the enclosure, fitting the threaded ring on the switch through its hole in the top panel and centering the terminal block in its cutout. Secure the assembly in place with the mounting nut for the switch.

Now make a simple thermocouple using about 36 inches of Type T thermocouple wire. Strip the insulation from one end and twist together the exposed wires to make the couple. This done, strip ¼ inch of insulation from both wires at the other end. Terminate the exposed wires in a plug that mates with the terminal block on the circuit-board assembly. In use, the red thermocouple wire goes to the top hole in the terminal board.

## *Checkout & Use*

With the IC still not installed in its socket, snap a fresh 9-volt alkaline battery into the connector and slide the battery into its holder.

Clip the common lead of a dc voltmeter or multimeter set to the dc-volts function to pin 4 of the *IC1* socket. Flip the POWER switch to "on." Now touch the meter's "hot" probe to pin 7 of the IC socket and note the reading obtained. If it is not approximately +9 volts, remove the meter, power down the circuit and rectify the problem before proceeding to actual operational tests and calibration.

Once you are certain that the circuit has been properly wired, power up again and check for the presence of approximately 1.22 volts across precision voltage reference *D1*. If all is well, power down and plug the op amp into the IC socket. Make sure you properly orient the IC and that no pins overhang the socket or fold under between IC and socket. If you are using the bare-bones version of the project, secure the battery to the clear area on the circuit-board assembly using double-sided foam tape.

Connect the project to a dc voltmeter or multimeter set to the dc-volts function and plug the thermocouple sensor into the terminal block. Turn on both the voltmeter and the project. The meter should now be displaying some numerical value. Now, warming the thermocouple by holding it between two fingers, you should observe that the meter reading increases in value. If it does not, the thermocouple is probably connected backwards.

Adjust the setting of trimmer control *R11* to approximately the middle of its range. Then adjust trimmer control *R6* so that the meter displays ambient temperature. Next, put the thermocouple in boiling water and adjust *R11* for a reading of 212 degrees Fahrenheit (or 100 degrees Celsius if that is the version of the project you built).

You might also want to use an ice bath for calibrating the low point of the instrument. If you do this, you must use an insulated container with crushed ice because a glass of water with ice cubes in it will yield a reading in the neighborhood of 40 to 50 degrees Fahrenheit.

The advantages of thermocouples come shining through when it comes time to actually make measurements. A single piece of thermocouple wire can be used to make dozens of thermocouples, which can be installed in the smallest of places.

This project began as a means for me to measure the temperature of the water in a salt-water tropical-fish aquarium. I considered using an AD-590 sensor (it would have been a bit easier to interface), but I had visions of trying to put a transistor-size housing into something that would stand up to salt water. Moreover, the measuring process would be slow; I would have had to wait for about a minute for the temperature to stabilize. A small thermocouple was the obvious solution because it responds in a fraction of a second. Moreover,

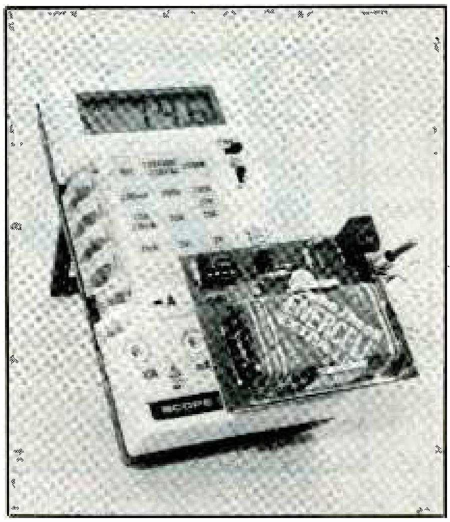


*Fig. 5. The pc board wired for use without an enclosure. Banana plugs on rear of assembly plug directly into meter's input jacks.*

since it is only wire, it cannot become water-logged.

In the electronics area, one often wishes to measure the temperature of a semiconductor, such as a transistor or IC chip. Since electronic parts are usually smaller than most IC sensors, it is almost impossible to mount anything on them. Even if you could, the mass of the sensor and the cooling effect of its lead wires would make any reading meaningless. On the other hand, a fine-gauge thermocouple can be touched to the device to give an instant reading.

In automobile servicing, there are numerous instances in which a fast, accurate temperature measurement can lead to a quick solution of a problem. Some examples of this include engine coolant temperature, oil temperature (just feed a thermocouple probe down the dipstick tube of a stopped engine), air conditioning (superheat readings), etc. In biology, fine wire probes can be implanted in things as small as a bug. Obviously, there are literally thousands of applications for a temperature-measuring device such as this Precision Thermocouple Thermometer.

*(Continued on page 82)*

# A Yuletide Telephone Ringer

***Simple add-on device to a standard telephone instrument sounds "Deck the Halls" to signal an incoming call***

**By Steve Sokolowski**

If you act quickly, you can easily and inexpensively transform your dull-sounding telephone ringer into a device that generates a festive mood during the Christmas season when someone phones you.

The secret is in an incredible Music Generator that costs less than postage/handling costs—only $1.00!—plus a couple of bucks for other parts. With it incorporated into your telephone system, it commences to play up to a 45-second rendition of "Deck the Halls" when a ring signal is detected. All it needs to operate is a source of power, a simple telephone interface circuit and a simple non-permanent modification of the telephone with which it is used.

## *About the Circuit*

To be able to use the microprocessor-controlled music synthesizer circuitry of the Yuletide Telephone Ringer, you must build a simple telephone interface circuit. The complete schematic diagram for this circuit is shown in Fig. 1.

The main function of the interface circuit is detection of the approximately 100-volt, 30-Hz signal that the telephone company's central office places on the line to signal the recipient that a call is incoming. This ring signal is used to operate the bells or other device used in the recipient's telephone instrument to audibly alert him to the incoming call.

To replace the sound of the alerting device in the instrument and cause this project to sound instead, some means must be used to detect the incoming ring signal and then convert it into a usable electrical pulse. This is the task of optical isolator *IC1*. When the ring signal comes down the line from the central office and appears across the green-insulated (+) and red-insulated (−) conductors of the telephone line, the LED inside *IC1* flashes in step with the ring pulses and causes the internal phototransistor to conduct and cut off in the same manner. The pulses generated by this action are coupled to the gate of silicon-controlled rectifier *SCR1*.

An ordinary 9-volt battery is used to power the circuit. Thus, with the anode of *SCR1* connected to +9 volts and the cathode connected to circuit ground through *IC2* as shown, the SCR conducts current. Even in the absence of gate current, *SCR1* continues to conduct (once it is triggered by a pulse from *IC1*). It is this latching action that permits the project to continue playing the tune during the brief 4-second "off" interval of the ring signal.

You may be wondering how *SCR1* can conduct at all being that it is connected to ground through an IC. The reason is that *IC2* is a 4066, which is an electronic on/off switch. In the standby mode, *IC2* is normally turned on by *R4*, which is why *SCR1* is able to conduct and remain conducting after detecting the first ring-signal pulse.

Resistors *R1* and *R2* maintain the telephone line's balance requirements while minimizing loading of the line when the project is installed.

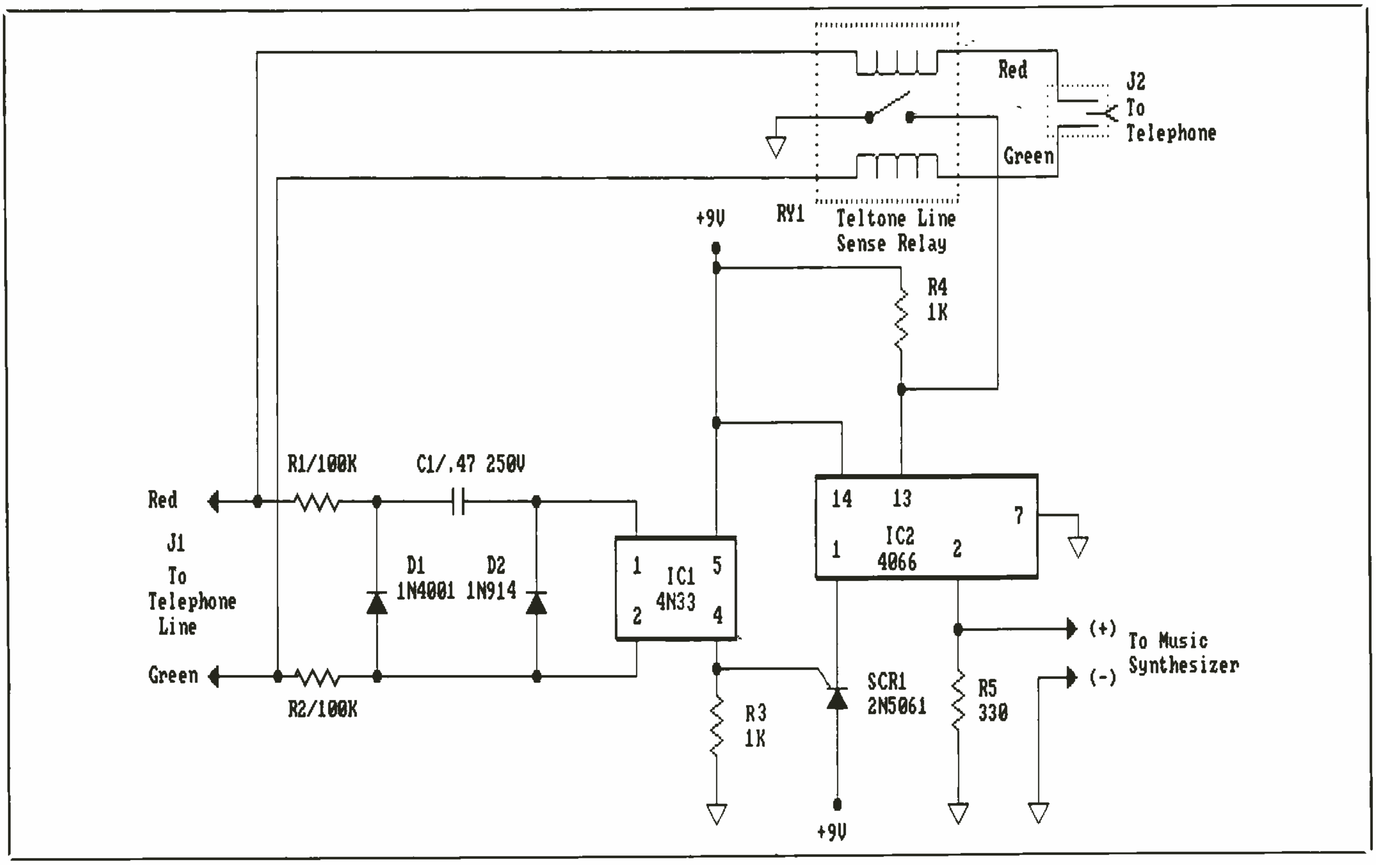



*Fig. 1. Schematic diagram of basic circuitry required to interface project to telephone line and telephone instrument with which it is to be used.*

Diodes *D1* and *D2* suppress "dial tapping," a term used to describe the activating of the telephone instrument's bell if the circuit is installed on a line that uses rotary (pulse) dialing.

The Melody Synthesizer (see Fig. 2) that generates the "Deck the Halls" tune is a small microcomputer that is normally powered by a 1.5-volt cell. For this project, this cell is not needed or even desired. Power for the synthesizer subassembly is obtained from the battery in the Fig. 1 interface circuit via *R5* and circuit ground. The power connections for this subassembly are detailed in Fig. 2.

When *SCR1* in Fig. 1 conducts, a voltage is developed across *R5*. This voltage is in the acceptable 1.5-volt range for the synthesizer module. With application of power to the synthesizer module, the on-board circuitry immediately goes into operation and plays the preprogrammed tune through the module's crystal transducer. If greater volume is desired, the transducer can be replaced with a larger telephone-type crystal receiver element.

While the tune is playing, let us assume now that the telephone receiver is lifted from the cradle to answer the incoming call. Teltone line sense relay *RY1* now goes into action to silence the synthesizer module to permit normal two-way conversation to take place. As the receiver is lifted from the cradle, a closing switch inside the telephone instrument completes the electrical path from the "talk battery," which is a term for the voltage that is applied by the telephone company to the line to allow a conversation to take place. In turn, this switch closure causes the internal contact of *RY1* to close.

With ground potential applied to one side of this *RY1* contact and the other side connected to pin 13 of *IC2*, the on/off status of the IC's internal switch is easily controlled. In the normal resting state, for example, pins 1 and 2 of *IC2* permit current to flow between the two, due to the positive voltage going to control pin 13. If the handset is lifted from the cradle, however, *RY1* energizes. This closes the instrument's internal contacts, which applies ground potential to pin 13 of *IC2* and prevents any further conduction of the IC.

When *IC2* shuts down, it deprives *SCR1* of sustaining current. As a re-

## PARTS LIST

**Semiconductors**
D1—1N4001 rectifier diode
D2—1N914 or similar small-signal silicon diode
IC1—4N33 optical isolator
IC2—CD4066 CMOS electronic switch
SCR1—2N5061 or equivalent silicon-controlled rectifier

**Capacitors**
C1—0.47-μF, 250-volt Mylar or disc

**Resistors** (¼-watt, 10% tolerance)
R1,R2—100,000 ohms
R3—1,000 ohms
R4—10,000 ohms
R5—330 ohms

**Miscellaneous**
J1,J2—Telephone extension cord terminated in RJ11 plug (see text)
RY1—Teltone line sense relay
Music synthesizer module (see Melody Generator box for details); printed-circuit board or perforated board with holes on 0.1-inch centers and suitable Wire Wrap or soldering hardware (see text); suitable enclosure (see text); sockets for ICs; 9-volt alkaline battery and snap connector hookup wire; electrical tape; solder; etc.

**Note:** The following items are available from Steve Sokolowski, P.O. Box 5835, Spring Hill, FL 34606: Ready-to-wire pc board (write for current pricing); Teltone line sense relay, $5.75. Add $1.25 P&H. Florida residents, please include state sales tax.

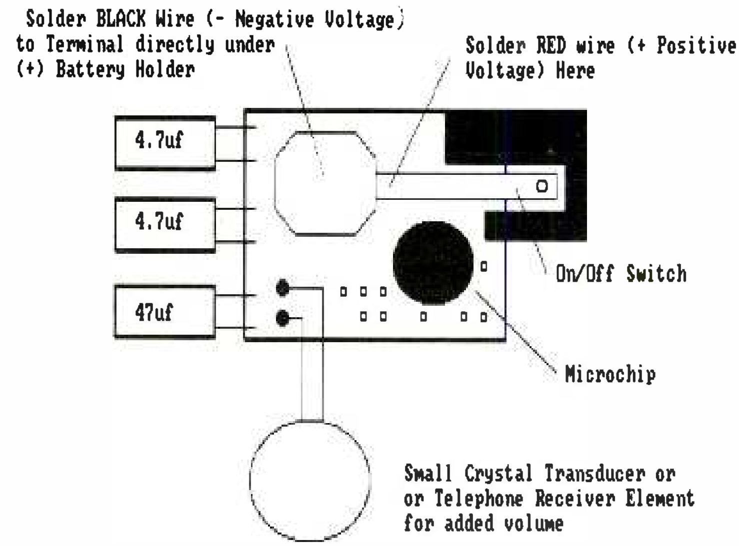



*Fig. 2. Layout and wiring details for music synthesizer module that plays the tune that replaces ringer sound.*

sult, the SCR also shuts down. Now, when this occurs, the voltage dropped across *R5* drops to zero and interrupts power to the synthesizer module, which stops playing the tune.

Replacing the telephone handset in its cradle causes pins 1 and 2 of *IC2* to become active again as a result of the ground to the IC by the closing contacts of *RY1* will be gone. Of course, the SCR, which is now not conducting, will remain in this state until another incoming ring signal is detected.

## Construction

For quick assembly of the telephone interface portion of this project, you can use perforated board with holes on 0.1-inch centers and suitable Wire Wrap or soldering hardware. Otherwise, you can design and fabricate a printed-circuit board or purchase a ready-to-wire board from the source given in the Note at the end of the Parts List on which to build the circuit. The synthesizer module requires no assembly; it comes wired and ready to be connected to the interface device.

Wire the board according to Fig. 1. Use sockets for *IC1* and *IC2*, whether you use a pc board or go the perforated board route. Refer to Fig. 3 for details on pinouts for the Teltone line sense relay.

Once the board is wired, carefully go over it to check for proper polarity of the diodes, basing of the SCR and orientations of the optical coupler and 4066 IC. Then double check all conductor runs and soldering.

When you finish installing all the components on the circuit board, prepare a pair of cables to connect the project to the telephone line and the telephone instrument with which the project is to be used. The most convenient way to go is to use an ordinary 6-foot or longer telephone extension cable terminated at both ends in standard RJ11 telephone plugs. Simply cut the cable in half. Then remove about 1½ inches of outer plastic jacket from the cut ends. Then clip away all but the red- and green-insulated conductors and remove ¼ inch of insulation from the remaining conductors. Tightly twist together the fine wires in each conductor and sparingly tin with solder.

Select an enclosure in which to house the project. This should be large enough to accommodate the interface assembly, synthesizer module and battery without crowding. It can be metal, plastic or a combination of the two. Drill two holes in the enclosure to provide entry for the two cables. If you drill these holes through metal, deburr them to remove sharp edges and line them with small rubber grommets. Feed the conductor ends of the cables through the holes into the enclosure and tie a strain-relieving knot in each 4 inches from the free ends inside the enclosure.

## The Melody Generator

The Melody Generator that this project uses is an inexpensive and easily obtained item. It is available from Hosfelt Electronics, 2700 Sunset Blvd., Steubenville, OH 43952 for $1 each or six for $5 plus $3.50 postage and handling. To place a credit-card order, call 1-800-524-6464.

The part number of the Melody Generator that plays "Deck the Halls" is TUNE-3. If you wish to use this project the year around and not have it sound like the yule season, you might want to order the TUNE-2 module, which plays the music for the song "More." An alternative is to incorporate both modules into the project and use a switch to toggle between the two tunes.

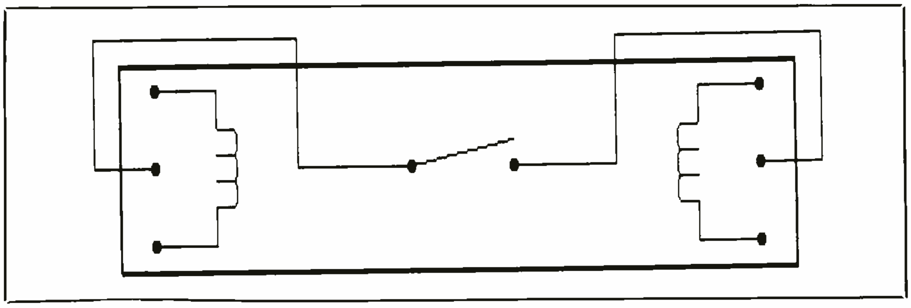


Fig. 3. Internal details and pinouts of Teltone line sense relay.

Connect one cable into the circuit at the "To Telephone Line" input shown in Fig. 1. Similarly, connect and solder the other cable to the appropriate lugs of *RY1*. Be sure to observe polarity all around. That is match color coding in both cases, green to green and red to red.

Strip ¼ inch of insulation from both ends of two 5-inch-long stranded hookup wires. It is best if you use red and black color-coded wires for this operation. Once the ends are stripped, tightly twist together the fine conductors at all ends and sparingly tin with solder. Now, referring to Fig. 1, connect and solder one end of the red-insulated wire to the junction of *R5* and pin 2 of *IC2* and one end of the black-insulated wire to any convenient circuit-ground point on the interface circuit-board assembly.

Wire a snap connector for a 9-volt battery into the circuit between the +9-volt and ground points in the interface circuit. Be sure to observe proper polarity. Then mount this interface assembly to the floor of the enclosure with thick double-sided foam tape.

Now wire the Melody Ringer synthesizer module to the interface assembly. Referring to Fig. 2, connect and solder the free end of the red-insulated wire to the specified point in the synthesizer module. Similarly, connect and solder the free end of the black-insulated wire to the specified point. Use thick double-sided foam tape to mount the synthesizer assembly inside the enclosure.

Snap a fresh 9-volt alkaline battery into the connector coming from the interface assembly. Then use another strip of thick double-sided foam tape to mount the battery to any remaining wall of the enclosure.

The circuitry is now ready to be tested. This is a simple procedure and does not require that the project be connected to either the telephone line or the instrument with which it will be used.

Begin the test by placing a wire jumper between pins 4 and 5 of *IC2*. This should cause *SCR1* to trigger on. If all is okay, you should now hear the notes of "Deck the Halls" coming from the sound-transducer element. If you do hear the tune, remove the shorting wire from *IC2*, disconnect the battery from the circuit to allow the SCR to unlatch, and snap the connector back onto the battery.

If you fail to hear the tune during the test, remove the short and disconnect the battery. Then double check all component installations for correct orientations and basings. If you find nothing wrong there, check all conductor runs for proper routing and terminations. Also check your soldering. If you missed any connections, solder them now. If any connection appears to be suspicious, reflow the solder on it and add some solder if needed. Check particularly for solder bridges between the closely spaced pins of the optical isolator and integrated circuit; if you locate any, remove them with desoldering braid or a vacuum-type desoldering tool. Finally, check the bridging wires between the two assemblies for both proper polarity and correct connection points. Do not attempt to put

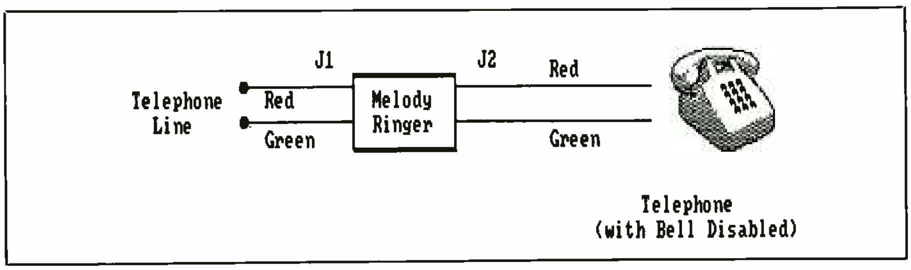



Fig. 4. Project installs between telephone line wall jack and telephone instrument.

### Still Available

Readers who are interested in purchasing items to build the "Talking Telephone" project that appeared in the October 1989 issue of *Modern Electronics* can still obtain the following items from Steve Sokolowski, P.O. Box 5835, Spring Hill, FL 34606: ready-to-wire, double-sided printed-circuit board with plated-through holes, $21.50; G8870 DTMF Receiver chip, $10.50; programmed 74188 EPROM, $5.75; 3.58-MHz crystal, $1.75; telephone T adapter; $2.25. Add $2.75 P&H per order. Florida residents, add state sales tax.

the project into service until you are sure it is working properly.

## *Installation & Use*

Installation of the Yuletide Telephone Ringer is straightforward. As you can see in Fig. 4, the project simply installs in series with the telephone line and telephone instrument with which it is to be used.

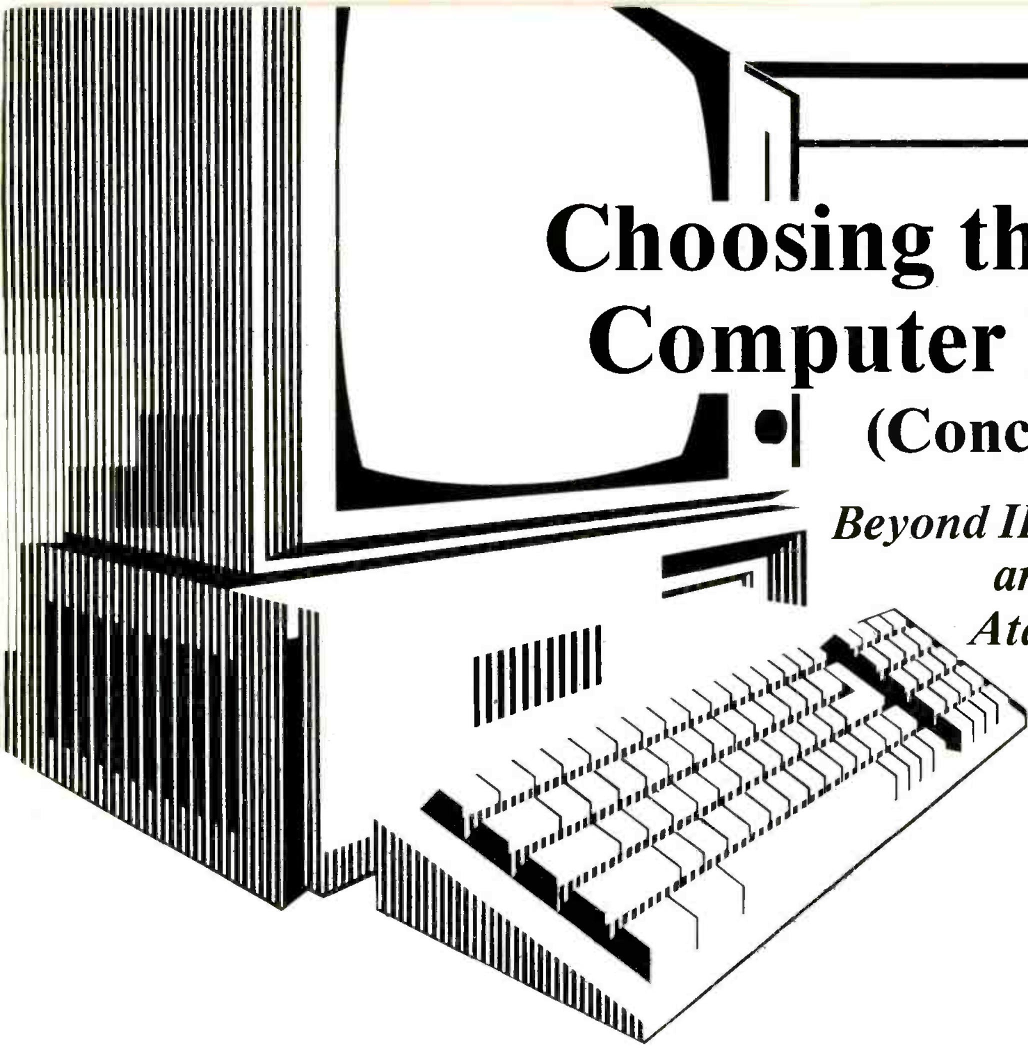
Simply unplug the instrument from the telephone line, plug the "To Telephone Line" cord from the project into the same wall jack and plug the project's other cord into an in-line adapter into which you then plug the telephone instrument's cord. Finish up by mounting the project to the wall or baseboard near the wall jack with double-sided foam tape.

With the project installed, you must now disable the telephone instrument's internal incoming-call signaling device. Open the instrument. If your instrument has a bell with two gongs, locate one of the four wires (coded red, black, red/slate and slate/red) that connects the bell to the line and disconnect it. Wrap the freed spade lug with insulating tape. If your instrument uses a bell with one gong, disconnect and insulate the red or black coded wire that connects it to the line.

If your telephone instrument uses a solid-state or crystal element as the alerting device, locate one of the wires that connect the element to the rest of the circuitry and disconnect it at whichever end is most convenient. Again, insulate the bare spade lug with electrical tape.

To test the installation, have a friend call your number on a telephone instrument that is not tied to your line. With the first ring pulse detected, your Yuletide Telephone Ringer should begin to play the "Deck the Halls" tune. When this occurs, simply lift the handset and note that the music ceases and you can conduct a normal conversation.

If the project fails to operate properly, even after initial checkout gave it a passing grade, either or both of the cables that connect it to the telephone line and telephone instrument may be wired in the wrong polarity. Correct the problem to get the project properly on-line. ME



# Choosing the Right Computer Power

## (Conclusion)

### *Beyond IBM and Compatibles and Apple Macintosh: Atari, Commodore and Apple-II Machines*

**By Joseph Desposito**

In the first installment of this series, we discussed IBM and compatible computers. The second installment focused on the Apple Macintosh series. In this final installment, our focus is on other offerings from Atari, Commodore and Apple.

## 68000 Series Computers: Atari Mega & Commodore Amiga

**One of the few** microcomputer companies that dates as far back as Apple Computer is Commodore Business Machines. Originally a calculator company, Commodore produced the PET computer back in the late 1970s and had a fair degree of success with it. But Commodore really made its name with a computer it introduced in 1983, and which it still sells today, called the Commodore 64 (discussed later in this article). Under the leadership of the fiery Jack Tramiel, Commodore eventually slashed the price of the Commodore 64 to where it was about one-fifth the price of computers with comparable power. The Commodore 64 thus became the first mass-market microcomputer with real computing power.

By the mid-1980's, however, Commodore's fortunes took a turn for the worse and large-scale changes were made. One of the changes was in management—Jack Tramiel left the company and eventually took over the reins at rival Atari—and another change was in the product line—Commodore introduced the Amiga, its first 68000-based microcomputer.

Today, there are several models in the Amiga line, the most powerful of which is the Amiga 2500. The Commodore Amiga 2500 uses a 15-MHz Motorola 68020 microprocessor, 68881 math coprocessor, and 68851 memory management unit. This puts the Amiga at a distinct power disadvantage when compared to the newest Apple Macintosh computers that use the 68030 microprocessor.

Some of the standard features of the 2500 are 2 MB of 32-bit RAM (expandable to 4 MB), 256K ROM (which includes the Kickstart 1.3 operating system), 1 MB of 16-bit RAM, a 40-MB (28-ms) hard-disk drive, a 3.5-inch 880K floppy-disk drive, 94-key keyboard, and a mouse. The hard disk comes pre-formatted and pre-loaded with system software and utilities. The 2500 also features built-in RS-232 serial and Centronics parallel ports, right and left audio ports, two input-device (mouse/joystick/lightpen) ports, video (RGB analog, RGBI, and monochrome) ports, and external disk drive port.

The Amiga 2500 has a proprietary

bus with five 100-pin expansion slots (see Fig. 1). It also has four expansion slots that are compatible with the 8-bit IBM XT or 16-bit IBM AT bus. To gain IBM XT or AT compatibility, you can purchase an optional Bridgeboard, which may be placed in slot 3 or 4 (see Fig. 1). If placed in slot 3, the user has two XT or AT card slots and three Amiga card slots available; if placed in slot 4, the user has three XT or AT card slots and two Amiga card slots available. The XT Bridgeboard has a suggested list price of $699, while the AT Bridgeboard sells for $1,599.

Notice also in Fig. 1 that there is a separate slot for CPU and video. The CPU expansion slot holds the A2620 processor card that contains the 68020, 68881, and 68851, as well as the 2 MB of 32-bit RAM. The video slot is for internal NTSC/PAL encoding of composite video, and internal genlock.

The Amiga 2500 features three custom chips. One is an "animation" chip that performs several functions: it controls DMA; it contains a coprocessor that can directly control the other two chips in relation to the video beam; and it contains a "blitter," which is a device that quickly draws lines, fills areas with a given color, and manipulates rectangular blocks of pixels. The second custom chip is a graphics chip that manipulates the visible display. It permits up to two independent bit-mapped images and eight sprites. A third custom chip is a sound/input-output chip that has four channels of sound, a disk controller, an interrupt controller, and interfaces for the serial port and the mouse/joystick port.

The Amiga 2500 has a variety of graphics modes ranging from 320 × 200 to 740 × 480 with a palette of 4096 colors. It has four-voice, two channel stereo sound and a speech synthesizer with controls for rate, pitch, volume, inflection and gender of voice. The suggested retail price of the Amiga 2500 is $4,699.

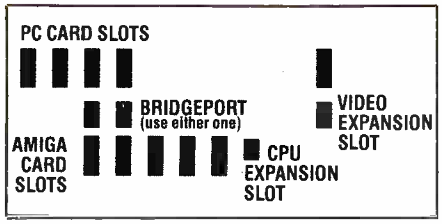



*Fig. 1. The Amiga 2500's proprietary bus has five 100-pin expansion slots and four slots that are compatible with the eight-bit IBM XT or 16-bit IBM AT bus. IBM XT or AT compatibility is obtained with an optional Bridgeboard.*

The Amiga 2000 model is virtually identical to the Amiga 2500 except that it has an 8-MHz Motorola 68000 microprocessor. Also, the A2620 processor card and the hard disk are options rather than standard features. The suggested list price of the Amiga 2000 is $2,195.

Commodore's entry-level Amiga, the Amiga 500, has features similar to the more powerful models, such as the 68000 processor and the three custom chips. However, it comes standard with just 512K of RAM (expandable internally to 1 MB), and its only expansion capability is through an 86-pin edge connector. The suggested list price of the Commodore Amiga 500 is $799.

The Amiga series of personal computers all use a graphical operating environment and a true multitasking operating system.

An important option for the Amiga 2500 and 2000 is Commodore's Internal Genlock board (or a third-party board with similar functions). This board fits into the video slot shown in Fig. 1. It allows users to combine the Amiga display with output from a VCR, video camera, or laser disk. The combined display may be viewed on an Amiga RGB monitor, and titles, captions, and multilayered effects may be recorded on video tape. The board is suitable for use in a semi-professional (non-broadcast) environment and is avail-

*Commodore's Amiga 2500 uses a 15-MHz Motorola 68020 microprocessor, 68881 math coprocessor and 68851 memory management unit.*

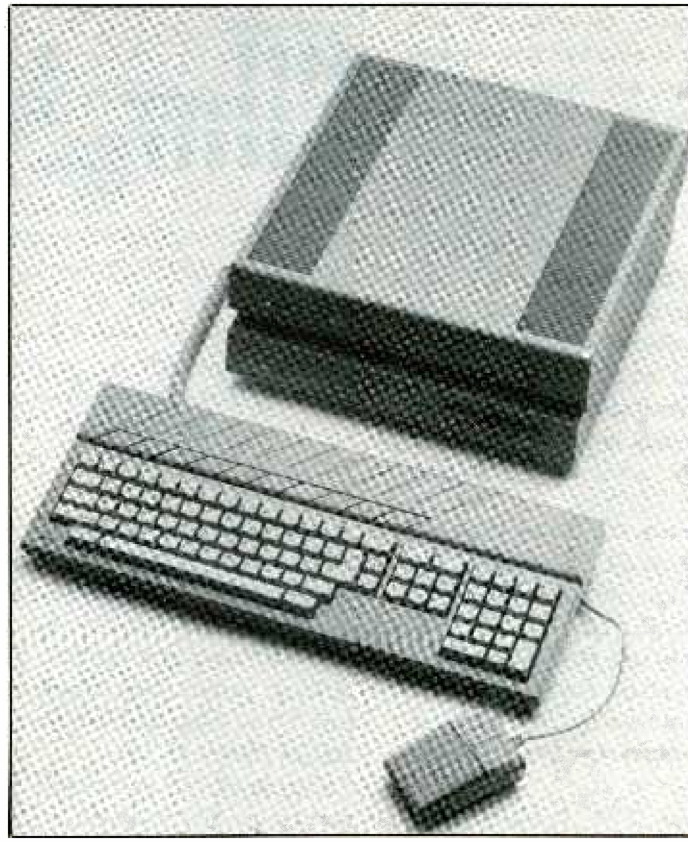
able in both NTSC and PAL versions. The suggested list price of the Internal Genlock board is $399.

## *Pros and Cons Of the Amiga*

Despite its technical capability, the Amiga is not a mainstream business computer. Although it's certainly powerful enough to accomplish any business computing task, it is commonly used in the graphics and music industries and for professional and corporate video production.

A decision to purchase an Amiga computer should be based on your knowledge of its special capabilities for graphic design, music applications, pre- and post-production video and live presentations, desktop publishing, CAD (computer-aided design), entertainment, and multimedia applications.

Although the Amiga's IBM compatibility (with the addition of a Bridgeboard) is a plus, it's also an expensive addition to the computer. A purchase of this kind makes the most sense in a professional setting where the Amiga is performing a specialized task in an otherwise IBM or compatible computing environment.



*The Atari Mega uses an 8-MHz Motorola 68000 microprocessor. It comes with either 2 MB of RAM (Mega 2) or 4 MB of RAM (Mega 4), 192K of ROM, built-in 3.5-inch floppy drive, keyboard and mouse.*

## *The Atari Mega*

The Atari story started with Nolan Bushnell and a game called Pong. This simple video game was the forerunner of the more complex games that would skyrocket Atari to fame, making it one of the fastest-growing companies of the time. Propelled by its success with video game machines, Atari introduced two computers, the 400 and 800. However, they were only mildly successful.

By the mid-1980s, the bottom had dropped out of the video game market and Atari faced major financial problems. The company was eventually taken over by the former head of Commodore, Jack Tramiel. Shortly after his arrival, Atari introduced its first 68000-based computer, the Atari ST, of which there are now two models. Atari's most powerful and costly personal computer to date, is the Atari Mega.

The Mega uses an 8-MHz Motorola 68000 microprocessor and comes standard with either 2 MB of RAM (Mega 2) or 4 MB of RAM (Mega 4). Other features include 192K ROM, built-in 720K, 3.5-inch floppy disk, 94-key keyboard, and mouse. There are RS-232 serial and Centronics parallel ports, floppy disk, hard disk, and two mouse/joystick ports. The Mega also features a built-in MIDI (musical instrument digital interface) port. MIDI interfaces are available on Apple, Commodore and IBM/compatible computers, too, but only as extra-cost options.

The Mega uses a custom graphics chip called the Blitter, which speeds up graphics operations. Graphics can be displayed in either 640 × 200 (four colors) or 320 × 200 (sixteen colors) modes. The palette is 512 colors. It also has three programmable sound channels.

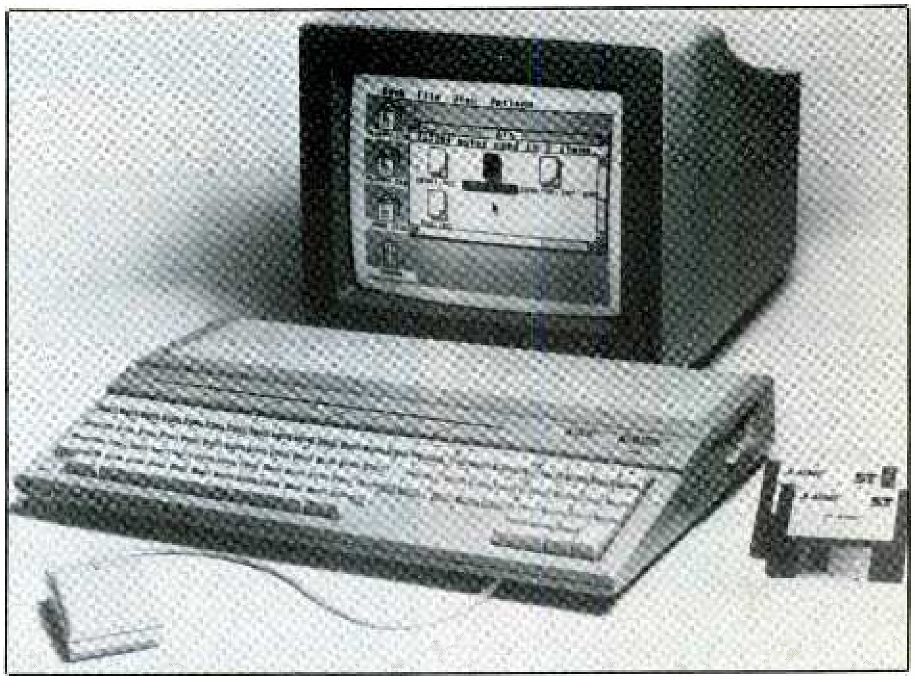
The Mega uses Digital Research's GEM operating environment, which is a graphical user interface similar to Microsoft Windows and the Apple Macintosh environment. Suggested list price of the Atari Mega 2 is $1,699 for a monochrome system; for the Mega 4 it's $2,399 for a monochrome system. Color systems add $200 to the base price.

Still members of the Atari line of computers, the Atari 520ST and 1040ST each use the 68000 microprocessor operating at 8 MHz. Like the Mega, the main difference in the two computers is the amount of RAM that comes standard: 512K in the 520St and 1 MB in the 1040ST. Both computers have 192K of ROM.

The Atari 520ST comes with an external 260K disk drive, while the 1040ST features an internal 3.5-inch 720K floppy drive. The 1040ST also has a hard-disk drive port (DMA) for adding a 20-MB hard disk.

Like the Mega, a MIDI port is built into both Atari STs. Of the custom ST chips, the video chip displays a resolution of 640 × 400 pixels for monochrome and 640 × 200 pixels for color with four colors from which to choose and 320 × 200 with 16 colors from a 512-color palette; a three-voice sound chip has a range from 30 Hz to beyond 20 kHz; and a controller chip transfers data at a rate of 1.33 megabytes per second. Both STs use the GEM operating environment and are priced at less than $1,000.

Atari is one of the few companies that offers a complete desktop publishing system. The system includes the Atari Mega 4 personal computer, the PostScript compatible SLM804-PCV laser printer, a Megafile 30 hard disk drive, 50 typefaces, and the Timeworks Desktop Publisher software and carries a suggested retail price of $3,995.



*Atari's 1040STF computer has an 8-MHz 68000 microprocessor, 1 MB of RAM, 192K of ROM, built-in 3.5-inch floppy drive and a port for adding a 20-MB hard disk.*

### *Pros and Cons Of the Mega*

Like the Amiga, the Mega is not a mainstream business computer, although it, too, is powerful enough to accomplish any business computing task. People who buy a Mega do so for its music and graphics capabilities. Typical applications are MIDI-based applications, desktop publishing, and CAD. Atari publicists are quick to point out that Dave Grusin, who was honored for Best Original Score at the 1989 Academy Awards, uses an Atari Mega 2. Grusin received the award for his score for the motion picture, "The Milagro Beanfield War." This is an example of how Atari computers can excel for special-interest computing needs.

Keep in mind, though, that while Atari can serve a small percentage of computerists very well, most of the computing world has given its allegiance to other standards.

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## 6502/6510 Computers: Apple II Series & Commodore 64/128

**The Apple II,** introduced by Apple Computer in 1977, used a 6502 microprocessor. Unbelievably enough, in 1989, both Apple and Commodore sell computers that use microprocessors compatible with the 6502. These computers are typically less expensive than computers with 68000 microprocessors. In most cases, you can purchase a complete system including disk drives and monitor (and sometimes even a printer) for less than $1,000.

Steve Jobs of Apple Computer once declared "Apple II forever." So far, his statement holds true. Twelve years and many technology leaps later, the Apple II computer is still an integral part of Apple Computer's line of computers.

The most powerful Apple II is the Apple IIGS. The IIGS is the first of the Apple IIs to use the 65C816 (C for low-power CMOS) microprocessor. However, this processor is compatible with the 6502 and thus can run software designed to run on the original Apple II. But one does not buy an Apple IIGS just to run old Apple II software. Current software for the IIGS takes advantage of the computer's many features.

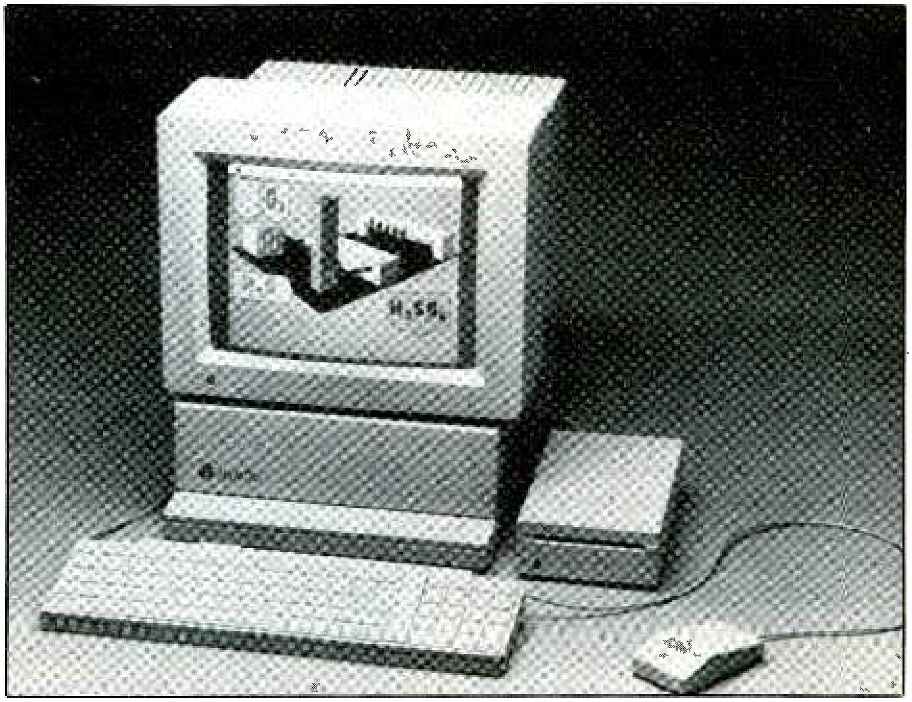
Besides the dual-speed (3-MHz and 1-MHz) 65C816 processor, the IIGS comes standard with 1M of RAM, and 256K of ROM. (It's reported that the IIGS will come with full RAM.) The IIGS contains a chip called Ensoniq, which is a 32-oscillator digital synthesizer chip with 64K of dedicated RAM. The chip produces up to 15 voices simultaneously and can output sound through an internal speaker, external speaker or headphones (via an audio output jack).

Other standard features are a keyboard, mouse, seven expansion slots (an eighth slot is used for memory expansion), two Apple Desktop Bus connectors, two serial ports, a disk drive port, video port for analog RGB, video port for composite color, audio port, and game port. Note that disk drives are optional (though necessary) accessories with the IIGS.

The IIGS has several video modes, the best of which can produce a resolution of 320 × 200 with 256 colors from a palette of 4,096 colors or 640 × 200 resolution with 128 colors from a palette of 4,096 colors.

Two Apple II models that have been Apple products for several years are the Apple IIc Plus and the Apple IIe. Both use a dual-speed (4-MHz and 1-MHz) 65C02 microprocessor. The main differences between the two computers are style and expandability. The IIc Plus is a sleek design weighing just 7 pounds and only 2.5 inches high. The IIe, on the other hand, retains the design of the original Apple II computer.

The IIC Plus lacks expansion slots, but most essential features are built in. It has an 800K, 3.5-inch floppy-disk drive, an external disk drive port, two RS-232 serial ports, a composite (NTSC) video port, a video expansion port, and a mouse/joystick



*The Apple IIGS has a 3-MHz Apple II software-compatible CMOS 65C816 microprocessor, 512K of RAM (expandable 1.25 MB) and 128K of ROM. It also has a 15-voice digital synthesizer chip with 64K of dedicated RAM.*

port. The IIC Plus comes standard with 128K of RAM, which is expandable internally to 1.15 MB, and 32K of ROM. Its best video resolution is 560 × 192 with 16 colors. The keyboard is built into the computer.

The IIe is built for expandability. In fact, the only built-in ports are for composite (NTSC) video and a joystick. It uses a 1-MHz 65C02 processor and contains 128K RAM (expandable to 1.12 MB) and 16K ROM.

There are seven expansion slots and one video/auxiliary slot that's occupied by an 80-column text display/64K RAM card. Its 81-key keyboard is built in. To obtain any degree of functionality with the IIe, you must purchase options such as disk drives, floppy disk controller, serial or parallel ports, and a monitor. There are plenty of expansion cards available for the IIe, and it can even be upgraded to have all the capabilities of the IIGS.

One of the options that Apple offers is the Apple II Video Overlay Card that can be used with an Apple IIGS or IIe computer. The card lets you superimpose Apple II screen images on video from sources such as a VCR, videodisc, video camera, or television. It also lets you display the combined images on an RGB or composite monitor and to record them on a VCR. The card contains genlock circuitry that synchronizes Apple II timing to external video timing.

## Pros and Cons Of the Apple II

Although the Apple II series of computers has an enormous software base, the bulk of it was written in the early 1980s when the Apple II was very much a part of the business and educational worlds. Nowadays, the II series is used by schools (kindergarten to 12th grade) for educational purposes. But very small businesses are still targeted by value-added resellers.

Among the major reasons to purchase a computer such as the Apple IIGS are either because your child's school uses it or because of its relatively low price. Any Apple II computer is a fine general purpose home computer for such applications as word processing, spreadsheets, databases, education, and entertainment. However, an IBM compatible is also good for all of these things, and you might also gain the extra benefit of having the same computer at home as you have at work. Nevertheless, the combination of vertical business software and modest cost still finds the model popularly used in, say, a videocassette rental store.

## *6510 Computers: The Commodore 64*

One of the most popular computers of all time with sales of over 10-million is the Commodore 64. This computer took the home computer world by storm in the mid-1980s when its price was reduced to less than $200 and it was marketed through such retail giants as Toys 'R Us.

A powerful computer for its time, the Commodore 64 (now the 64C) is still an attractive buy for beginning computerists. The 64C uses a 1-MHz 6510A microprocessor and has 64K RAM and 20K ROM. Its features include a built-in keyboard, serial port, expansion port, two joystick ports, video port, r-f TV port, and user port.

The 64C also includes a Sound Interface Device that allows programmers to control three independent tone generators. The 64C text display, however, is limited to 40 columns by 25 lines, which is only one-half the character width of standard typing paper (8½ inches wide).

The Commodore 128 is more than just a 128K RAM version of the 64C. It contains three different processors, which allows it to run in three different modes: 64C, 128, and CP/M. The latter is an operating system for 8-bit microprocessors that preceded the 16-bit MS-DOS system that bears a similar "feel."

In 64C mode, it employs a 6510 compatible processor running at 1 MHz. It uses a 6581 Sound Interface Chip and has 64K RAM and 16K ROM. In Commodore 128 mode, it uses a dual-speed (2-MHz or 1-MHz) 8502 microprocessor, and has 128K of RAM expandable to 512K), 64K ROM, and the Sound Interface Chip. Its text mode supports the conventional 80 characters by 25 lines. In CP/M mode, it uses a Z80A microprocessor running at 2 MHz and has 128K of RAM (expandable to 512K). The CP/M Plus Version 3.0 operating system is included.

Standard features of the Commodore 128 are a user port, r-f TV port, audio input and output ports, composite video port, a serial port, two game ports, a cartridge port, and a digital RGBI video port. A 92-key keyboard is built into the unit. Peripherals such as external disk drives and monitor are options.

The Commodore 128D computer is similar in function to the 128 except it has a built-in 5.25-inch floppy disk drive and detachable keyboard.

## *Pros and Cons Of the Commodore 64*

The Commodore 64C, which can be found selling for under $100, is a computer that almost anyone can afford. It has enough power to perform word processing, spreadsheet, database, education, and entertainment applications. Although many millions of these computers have been sold and there is, therefore, a relatively large software base of applica-

**Product Comparison Chart**

| Computer | Company | Processor | Speed* | Coprocessor | RAM | Slots** |
|---|---|---|---|---|---|---|
| Macintosh IIcx | Apple | 68030 | 15.667 | 68882 | 1M | 3 |
| Macintosh IIx | Apple | 68030 | 15.667 | 68882 | 1M | 6 |
| Macintosh II | Apple | 68020 | 15.667 | 68881 | 1M | 6 |
| Macintosh SE/30 | Apple | 68030 | 15.667 | 68882 | 1M | 1 |
| Macintosh SE | Apple | 68000 | 7.83 | | 1M | 1 |
| Macintosh Plus | Apple | 68000 | 7.83 | | 1M | 0 |
| Amiga 2500 | Commodore | 68020 | 14.26 | 68881 | 3M | 5 |
| Amiga 2000 | Commodore | 68000 | 7.13 | | 1M | 5 |
| Amiga 500 | Commodore | 68000 | 7.16 | | 512K | |
| Mega 4 | Atari | 68000 | 8 | | 4M | 0 |
| Mega 2 | Atari | 68000 | 8 | | 2M | 0 |
| Atari 1040ST | Atari | 68000 | 8 | | 1M | |
| Atari 520ST | Atari | 68000 | 8 | | 512K | |
| Apple IIGS | Apple | 65C816 | 2.8/1.02 | | 512K | 7 |
| Apple IIc Plus | Apple | 65C02 | 4/1 | | 128K | 0 |
| Apple IIe | Apple | 65C02 | 1.02 | | 128K | 7 |
| Commodore 128 | Commodore | 6510 compatible | 1.02 | | 64K | 0 |
| | | 8502 | 2.04/1.02 | | 128K | |
| | | Z80A | 2.04 | | 128K | |
| Commodore 128D | Commodore | 6510 compatible | 1.02 | | 64K | 0 |
| | | 8502 | 2.04/1.02 | | 128K | |
| | | Z80A | 2.04 | | 128K | |
| Commodore 64C | Commodore | 6510A | 1.02 | | 64K | 0 |

*Speed is in megahertz (MHz)
**Total number of internal expansion slots

tions, much of the software was written years ago. Nevertheless, there are still some newer software packages being produced.

As for the Commodore 128, it adds CP/M capability, but does not really address the needs of today's users. Purchasing either the 64C or 128 would be the result of a decision based heavily on price alone or because of circumstances such as a child using a similar computer in school or parents wishing to get a child started with computers for a minimal cost.

## In Conclusion

In this three-part article on personal computers we looked at IBM and compatible computers, and non-IBM-type computers from Apple Computer, Commodore Business Machines, and Atari Computer. We used the computer's microprocessor as a means of comparing models from different companies as well as within the same company.

In Part I, we concluded that computers using the 80386 processor would dominate the IBM and compatible world in the 1990s. As Parts II and III indicate, it seems just as clear that computers based on the Motorola 68000 series of microprocessors will continue to be a major force throughout the 1990s, especially the 68030.

In the IBM and compatible world, the MicroChannel bus and Classic PC bus will both play major roles throughout the next decade. Probably the latter will be in the form of the upcoming EISA bus. Interestingly, a manufacturer recently introduced a board that can be used with both MCA and EISA bus formats. It has appropriate edge connectors on opposite sides of the board for this purpose. Just flip the board to mate with the proper bus. And it appears that the Macintosh NuBus will develop and prosper in the '90s.

Consumers faced with the decision as to which personal computer to buy should carefully examine their own reasons for purchasing a system. If it's a major purchase with far reaching business consequences, only an IBM or compatible 80386 computer or Apple Macintosh II-series computer should be considered if finances permit. These computers have proven track records in a business environment, can run exceptional business software, and have an abundance of hardware options that can be used with them.

A fallback position would be an IBM or compatible computer with an 80386SX microprocessor or a Macintosh SE/30 built around a 68030 microprocessor.

If you have special professional needs related to graphics or music, you should examine the capabilities of the Amiga, Mega and ST computers. But don't neglect to compare them against the capabilities of an IBM or compatible computer or Macintosh II with special add-in boards, or a Macintosh SE with special add-on peripherals.

If you plan to purchase a computer for personal use, you should first check your finances and then check out the computers used in your outside computing environment (business, school, etc.). Then try to match your computer to your computing environment as closely as possible.

Make sure you inquire about standard features versus add-on options. Most IBM PC and compatible computers have very little in the way of standard ports and video. On the other hand, the IBM PS/2 computers have built-in ports, disk controller and VGA video. A Macintosh SE/30, SE or Plus comes standard with a variety of ports and a built-in video display, too, but the latter is black and white. For most other computers, however, the video display is an expensive option.

Finally, don't let the decision-making process bog you down. Whether you are purchasing a personal computer for the first time or upgrading to a more powerful model, you will receive much more benefit and enjoyment from making your computer purchase now, even if you have to settle for some undesirable tradeoffs, than by waiting to make your purchase sometime in the future when either the technology or the price will hopefully be just right. ME

# Wave Propagation and Reflection

By Forrest M. Mims III

**Electronic circuits** that emit or detect energy are subject to several very important physical laws that you should know about. Typical energy-emitting circuits and devices include radio transmitters, infrared (IR) remote controllers and audio speakers. Typical energy-receiving circuits and devices include radio receivers and lightwave and microphones.

Some of the physical laws that affect energy sources and detectors can be very complex. Fortunately, some of the basic laws that determine how energy waves are projected and reflected are simple. I like to think of these as geometrical laws.

Even though the geometrical laws that control energy distribution are very simple, they are often overlooked when energy-emitting and energy-receiving circuits are designed. It's particularly easy to overlook these laws when the energy being emitted or detected is sound outside the range of human hearing or invisible radiation, such as ultraviolet, infrared and radio-frequency waves.

This time around, I'll explore some of the basic geometrical laws that very much affect the operation of circuits that emit or detect energy. I'll also present some experiments you can perform to test their validity. First, however, let's pause for a brief analysis of why these laws are so important.

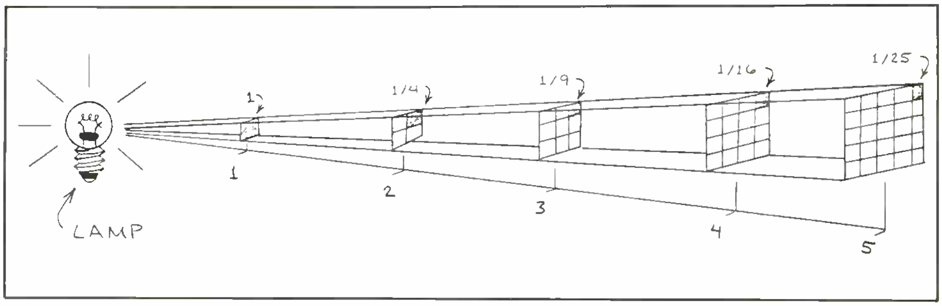


*Fig. 1. Illustration of the inverse square law.*

## Light, Sound & Radio Waves

The intensity of the light waves reflected from this page that permit you to read these words is determined by two principal parameters. The first is the intensity of the light source that strikes the page and the distance the source is from the page. The second is the distance of the page from your eye. Other parameters that determine exactly how much light enters your eyes include the diameter of the pupils of your eyes, the clarity of the air and stray light reflected from walls and even your own body.

The intensity of any sound waves you happen to be hearing as you read these words is similarly affected by the circumstances of your surroundings. The chief parameters that control the intensity of what you're hearing are the sound level at its source and the distance from the source to your ears. Sound-reflecting objects, such as flat walls, tables and even this page you're reading, may boost or reduce the intensity of a sound you hear.

Sound-absorbing surfaces may reduce the intensity of what you're hearing. Or they may absorb sounds within a particular frequency range so that you can better hear sounds that are at other frequencies. Temperature, motion and relative humidity of the air may also have an affect.

Are you listening to a radio as you read these words? The intensity of the electromagnetic waves received by a radio or television receiver is also very much affected by the power of the transmitter and the distance of the transmitter from your radio receiver. Atmospheric ducting effects and reflections from the ionosphere, buildings and aircraft in the vicinity and may alter the intensity of the signal.

Several physical laws apply to the distribution of energy in each of these examples. The most important is the "inverse square law."

## The Inverse Square Law

The inverse square law holds that the intensity of an energy wave is inversely proportional to the square of the distance of the wave from its point of origin. For example, if the distance of the wave from its source is 3, the intensity of the wave is 1/9 ($1/3^3$) the intensity of the wave at a distance of 1.

While its name and definition may at first seem rather intimidating, the inverse square law is very easy to understand. You can even perform some simple experiments to test and verify it.

Figure 1 is a pictorial representation of how the inverse square law works with a bare light bulb. This drawing can also be applied to a radio transmitter or sound source. We could also take into consideration all the light emitted by the lamp. But it's easier to consider a square crosssection of light projected outward.

Let's assume that the light from a bare flashlight bulb has an irradiance of 100 microwatts per square centimeter at a point 1 meter from the bulb. According to the inverse square law, the irradiance at 2 meters will be $1/2^2$ the irradiance at 1 meter, or 1/4 of 100 microwatts/$cm^2$, which factors out to 25 microwatts/$cm^2$. The irradiance at 3 meters will be only $1/3^2$ that at 1 meter, or ⅑ of 100 microwatts/$cm^2$, which now factors out to 11.11 microwatts/$cm^2$.

Table 1 shows what happens to the irradiance of our imaginary flashlight bulb out to a range of 10 meters. The values given in the table are plotted in graph form in Fig. 2. From the values in the Table and Fig. 2 graph, it is readily apparent why the signal from, say, a LED transmitter falls off very rapidly at first and then decreases much more gradually as it's moved away from the receiver.

Thus far, we've looked at how the inverse square law is supposed to work under ideal conditions. In the real world,

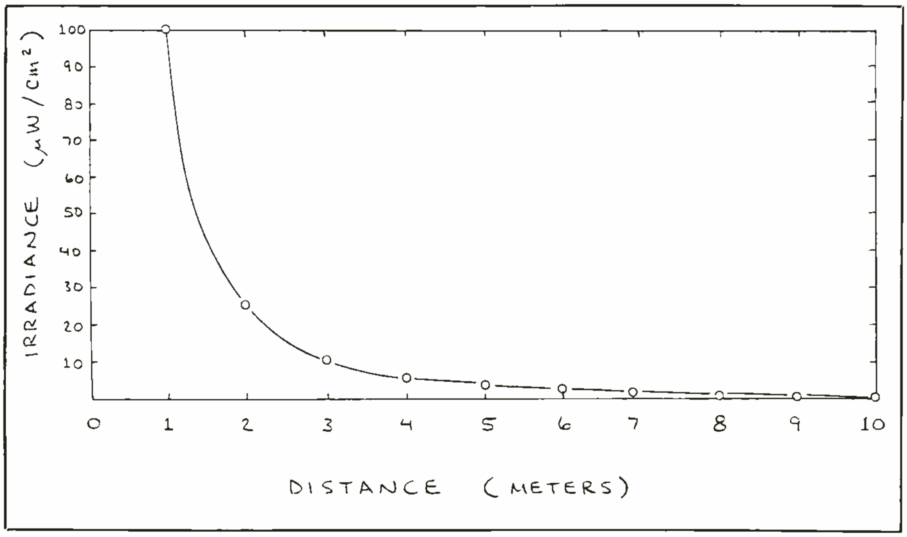



*Fig. 2. Plot of the predicted irradiance from a small lamp.*

many factors—often unsuspected ones—can alter the shape of the theoretical curve shown in Fig. 2. For example, the size of the source should be as small as possible. Generally, the size of the source should be at least one tenth or smaller than the size of the area being considered at the first measuring point (1 in Table 1). If the size of the source is any larger than this, the inverse square law will not hold true until the distance from the source becomes great enough to rule out the error.

The inverse square law will not necessarily hold true for energy waves that are projected as a beam. If the beam is very uniform and fairly broad, the law may hold true. However, if the beam is very narrow, the law will not hold true. This is the case with beams from most lasers and highly collimated light sources.

## *Testing the Inverse Square Law*

You can test the inverse square law with the help of a light meter and light source. The success of your test will be determined by your care in performing the measurements. The light source should be as close as possible to a point source. An incandescent bulb with a clear glass envelope is a good choice for the light source. Absolutely no light other than that from the source must be allowed to strike the light meter's detector. Even light from the source that's reflected from its base and nearby objects and then back toward the detector will distort your measurements.

To meet these requirements, you should conduct your test in a darkened room. All reflecting objects should be moved away from the detector's field of view. If this isn't possible, cover these objects with a diffusely reflecting black cloth. Also, you should wear dark clothing for the same reason.

If you don't have a light meter, you can make a suitable substitute from a silicon solar cell and a multimeter. The meter should be able to measure currents as low as tens of microamperes.

You'll obtain even better results with the circuit shown schematically in Fig. 3. Use a silicon photodiode or small-area silicon solar cell for the sensor. The operational amplifier should have a low input bias current and low offset voltage. For

**Table 1. Irradiance Figures for an Imaginary Flashlight Bulb**

| Distance (meters) | Ratio ($1/d^2$) | Irradiance ($\mu W/cm^2$) |
|---|---|---|
| 1 | 1/1 | 100.00 |
| 2 | 1/4 | 25.00 |
| 3 | 1/9 | 11.11 |
| 4 | 1/16 | 6.25 |
| 5 | 1/25 | 4.00 |
| 6 | 1/36 | 2.78 |
| 7 | 1/49 | 2.04 |
| 8 | 1/64 | 1.56 |
| 9 | 1/81 | 1.24 |
| 10 | 1/100 | 1.00 |

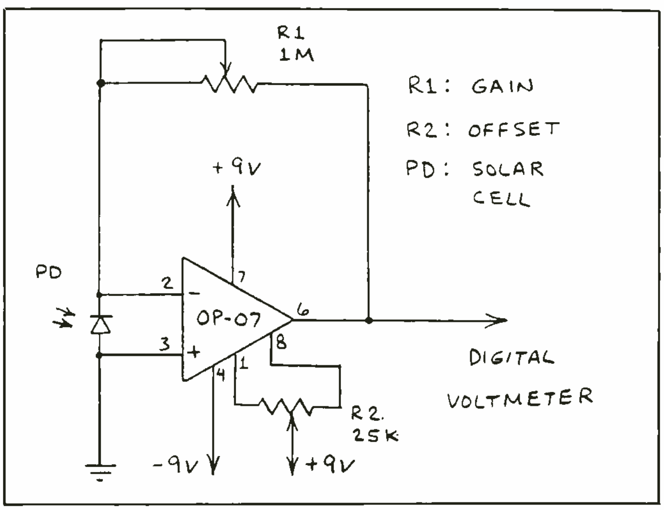



*Fig. 3. Schematic diagram of a simple light-measuring circuit.*

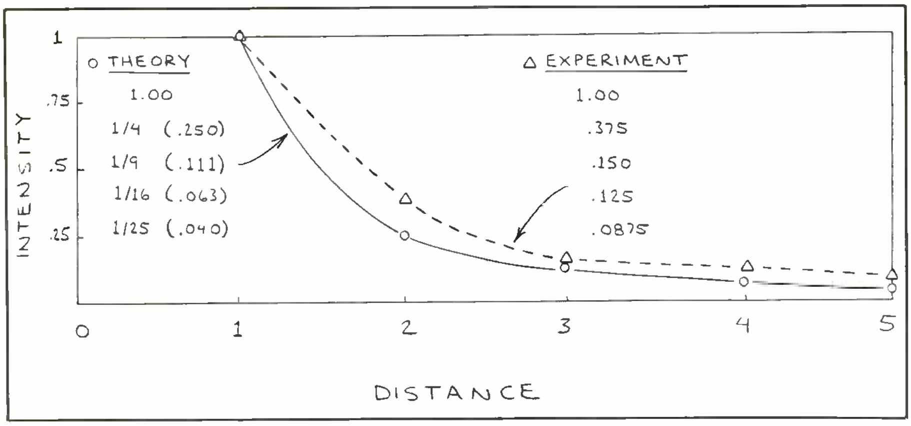



*Fig. 4. Plot of an experimental test of the inverse square law.*

**Table 2. Lambert's Law Predictions for a Perfectly Diffuse Reflector**

| Angle (degrees) | Cosine | Reflected Intensity ($\mu W/cm^2$) |
|---|---|---|
| 0 | 1.000 | 100.0 |
| 15 | 0.966 | 96.6 |
| 30 | 0.866 | 86.6 |
| 45 | 0.707 | 70.7 |
| 60 | 0.500 | 50.0 |
| 75 | 0.259 | 25.9 |
| 89 | 0.017 | 1.7 |

best results, especially at very low light levels, use a high-quality op amp like the OP-07 or OP-77 from Precision Monolithics or an LM607 from National Semiconductor. These and other precision op amps will yield much more accurate results when the photocurrent falls to very low levels. However, be sure to adjust the OFFSET trimmer to give an output of 0 volt when the solar cell is dark.

You can use a common 741 op amp in the circuit in Fig. 3 if precision isn't absolutely necessary. All connections will remain the same, except for the OFFSET trimmer. Connect this trimmer to the negative supply rail.

The photocurrent from a silicon photodiode or solar cell is linear over a wide range of incident light intensities. The output voltage from the op amp in the Fig. 3 circuit is equal to the photocurrent times the feedback resistance ($R_f$). Therefore, the output voltage from the circuit in Fig. 3 is linear with respect to the intensity of the light falling on the detector.

Figure 4 shows the measurements I made of the intensity of a bare flashlight bulb out to a distance of 5 feet. For this experiment, the detector was a small solar cell. The gain of the amplifier was set to give an output of 1 volt when the lamp was 1 foot away from the detector. There was no need to calibrate the system in terms of absolute sensitivity since the amplifier's output is almost perfectly linear. Therefore, the measurements are relative with respect to each other.

Superimposed on Fig. 4 is a plot of the intensity of the lamp as predicted by the inverse square law. As you can see, the theoretical curve is displaced downward from the experimental curve.

There are several possible reasons for the difference between the predicted and actual curves shown in Fig. 4. The chief reason, however, is probably due to the first measurement point being too close to the lamp. Light reflected toward the detector by the lamp holder probably caused most of the error at the first measurement point.

Another possible error source is the requirement that the source dimensions be small with respect to the distance between the source and detector. These factors are why manufacturers of calibration lamps specify a minimum separation distance between a lamp and a detector before the inverse square law can be applied with any reliability.

While light was the energy source for this simple test of the inverse square law, keep in mind that the same principle applies to sound, radio waves, ultraviolet radiation, x-rays and so on. The same kinds of errors also apply. In the case of sound, changes in the transmission medium, which is usually air, can cause major errors. For example, layers of warm and cool air can channel or disperse sound waves, thereby greatly altering the sound received by a microphone. Major problems can also be caused by reflections from nearby surfaces.

## *Reflected-Energy Waves*

When a wave of energy strikes a surface, the energy that isn't transmitted through or absorbed by the surface is reflected away from the surface. You can better appreciate what happens to radar beams, radio waves, sound waves and beams of light if you understand some simple principles of reflectance. There are two principal types of reflection: diffuse and specular. Some reflectors have both diffuse and specular properties.

Diffuse reflectors reflect or scatter an oncoming beam away from their surfaces in the form of very broad beams. Specular reflectors, on the other hand, are like mirrors; they reflect an oncoming beam of energy with little or no change in the beam's divergence.

The surface of a diffuse reflector is rough in comparison to the dimensions of the wavelength of radiation that it reflects. The surface of a specular reflector is smooth in comparison to the dimensions of the wavelengths it reflects.

As an example of the above, the surface of this page you are reading is rough in comparison to the wavelengths of visible light. Therefore, this page is a very good diffuse reflector of light. On the other hand, sound waves are huge compared to the roughness of this page. Therefore, when this page is perfectly flat, it's a good specular reflector of sound waves.

Figure 5(A) shows how light is reflected from a perfectly diffuse reflector. The reflection of light from a perfect diffuser follows Lambert's cosine law, which holds that the intensity of a ray of light reflected from a diffuse surface varies with the cosine of the angle the ray makes with an imaginary line normal (perpendicular) to the surface of the reflector.

Table 2 shows what Lambert's law predicts for a perfectly diffuse reflector that is illuminated by a beam of light perpendicular to the surface of the reflector. The reflected intensity in the light level is a constant distance away from the point at which the incoming ray strikes the reflector. The reflected intensity is found by multiplying the intensity at the normal angle (0 degree) by the cosine of the angle of the reflected ray.

In my work to develop various kinds of infrared travel aids for the blind, I've found that many surfaces come close to being perfect diffuse reflectors. Good examples are some fabrics, wall paper and surfaces coated with flat paint.

Figure 5(B) shows how light is reflected from a perfect specular reflector. If the surface of the specular reflector is perfectly flat, the reflected beam follows three laws:

(1) The angle of the reflected ray is equal to the angle of the oncoming ray.

(2) The oncoming and reflected rays lie in the same plane as an imaginary normal line extended perpendicularly from the surface of the reflector.

(3) The divergence or spread of the reflected beam is equal to that of the oncoming beam.

Most mirrors are made by applying a thin film of aluminum or silver to the back of a sheet of glass. Therefore, these so-called second-surface mirrors have two specular reflecting surfaces. The front surface of the glass acts as the first reflector, while the reflective coating applied to the rear surface of the glass functions as the second reflector. This means that second-surface mirrors will reflect an oncoming ray of light as two parallel rays. This effect is magnified as the mirror is tilted with respect to the angle of the oncoming ray.

Many natural and artificial surfaces exhibit both diffuse and specular reflectance properties. Consider what happens when light strikes the shiny surface of a leaf or a freshly waxed car. In both cases, the waxy surface of the material is very smooth and partially transparent. Since the surface is very smooth, it functions as a specular reflector. The tissue or paint below the wax usually has a rougher surface and functions as a diffuse reflector.

Figure 5(C) illustrates how an object can exhibit both specular and diffuse reflectance. In the real world, the reflections can be much more complicated than is shown in this simplified drawing. For example, if the specular front surface has a thin coating of dust, it alone will also produce both a specular and a diffuse reflection. Too, the diffuse reflection from the second surface can be altered in various ways as it passes through the front layer of specular reflecting material.

It's interesting to note that changing the shape of a specular reflector can cause it to simulate a diffuse reflector. For example, a flat sheet of polished metal is a specular reflector. Bending the metal into a cylinder will cause an oncoming beam of light to be reflected as a broad, diffuse (spread out) beam.

A flat sheet of aluminum foil is a spec-

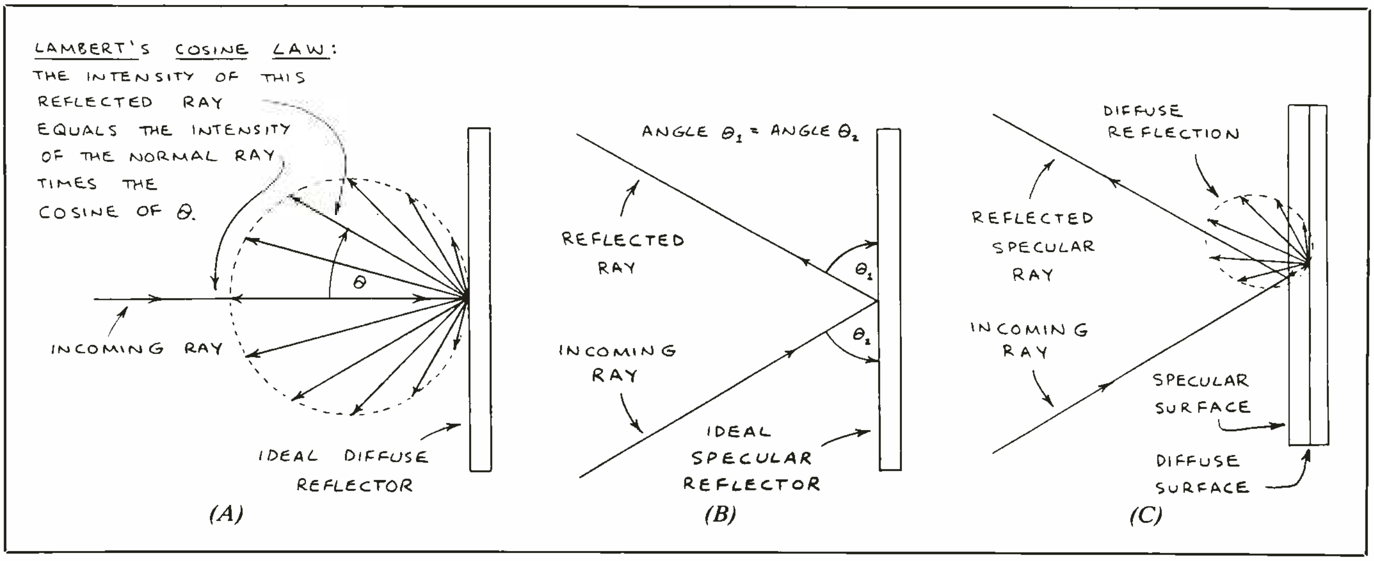



*Fig. 5. Illustrating the reflection from (A) a diffuse surface, (B) a specular reflector and (C) a combination of the two.*

| Table 3. Diffuse Reflectance for 3M Nextel White Reflectance Coating | | | |
|---|---|---|---|
| Angle (degrees) | Cosine | Measured Intensity ($\mu$A) | Error (%) |
| 0 | 1.000 | 84.0 | .0 |
| 5 | 0.996 | 83.5 | − 0.216 |
| 10 | 0.985 | 82.0 | − 0.883 |
| 15 | 0.966 | 80.0 | − 1.422 |
| 20 | 0.940 | 75.0 | − 5.246 |
| 30 | 0.866 | 70.0 | − 3.923 |
| 45 | 0.707 | 56.0 | − 6.066 |
| 60 | 0.500 | 40.0 | − 5.000 |
| 70 | 0.342 | 26.0 | −10.499 |
| 80 | 0.174 | 12.0 | −21.554 |

ular reflector. If you crumple the foil and then open it back into a sheet, it will simulate a diffuse reflector. Of course, the reflected light won't have the uniform energy distribution of a true diffuse reflector.

Thus far, I've applied the principles of reflectance to only waves of light. Yet the reflectance of energy waves greatly affects every aspect of life as we know it. In the ultraviolet spectrum, for example, most things are very poor reflectors. Therefore, if we could see only UV radiation, we would live in a drab world of grays and blacks.

Stealth aircraft technology uses radar-absorbing coatings and structures to minimize radar reflections. Sharply angled structures, such as wing roots and engine intakes, are carefully contoured to minimize specular reflections. These steps greatly reduce what is known as the aircraft's radar cross-section.

Auditoriums must be carefully designed to avoid unwanted "hot" and "cold" sound sots caused by specular reflections from flat surfaces. This is accomplished by means of sound-absorbing acoustical tiles and curtains.

Look around you. You'll see countless examples of how your perception of the environment is very much affected by diffuse and specular reflectors.

## *Testing Diffuse Reflectors*

Since the wavelengths of sound and radio waves are so long, it's difficult to make tests of diffuse reflectance in a small space. Light waves and microwaves have much shorter wavelengths, making diffuse reflectance tests very easy to perform.

The easiest way to test the diffuse reflectance of a surface at visible-light wavelengths is to illuminate the surface with the narrow beam from a helium-neon laser. Place a small light detector a fixed distance away from the surface and measure the power of the reflected light. Thereafter, repeat the measurement for various angles.

I've conducted diffuse reflectance tests against wood, concrete block, tar paper, magnesium oxide and other surfaces. Table 3 shows the measurements I made of the diffuse reflectance of a coating of 3M Nextel white reflectance coating. The Error column gives the difference in intensity between the measured and predicted intensities for a perfect diffuse reflector.

Even though the error becomes fairly large at high angles, the error is almost negligible at small angles. Consequently, this reflectance coating is an excellent diffuse reflector in most applications.

## *Going Further*

While I've used light to illustrate the application of the inverse square law and the basic principles of reflection, be sure to remember that these laws also apply to sound waves as well as beams of electromagnetic radiation. An interesting experiment you can conduct is to test the application of the inverse square law to sound. For best results, conduct the experiment outdoors in a large field on a still, cool day. Place a piezoelectric tone generator on a tripod. Measure the intensity of the sound level over a range of distances and plot your results on a graph. When I conducted this test, my results agreed closely with the inverse square law. **ME**

# An AM-Stereo Chip from Motorola & Power-Supply Solutions

By Joseph Desposito

**With more than** 700 C-QUAM broadcasting stations now operating worldwide, Motorola (Phoenix, AZ) has recently introduced a low-cost single-chip C-QUAM AM-Stereo receiver IC. The device, the MC13024, is expected to be widely used in inexpensive headset type of portable radios. The MC13024 is a complete receiver from antenna to low-level audio and is capable of receiving high-fidelity AM-stereo from C-QUAM stations. All that is needed to make a complete AM-stereo radio is the addition of the appropriate audio output amplifier. A schematic diagram for a manually tuned headphone radio is shown in Fig. 1.

The MC13024 contains a wide-dynamic-range mixer, i-f, agc, afc, C-QUAM decoder, stereo pilot-tone detector, and a signal-quality detector. Stereo decoding and pilot detection are similar to those used in Motorola's MC13020, except for two things: reduced peripheral components; and now the phase-locked loop used for the L-R detection is looped around the entire receiver. In other words, the PLL controls the tuner local oscillator (vclo), rather than a detector loop after the i-f. The advantage of this, in manually tuned AM-stereo, is significant, because it assures that the signal will always be properly centered in the i-f bandpass, which is critical to good channel separation. This architecture also gives the radio an afc tuning behavior that makes it easy to tune. The PLL has two "speeds," provided by current ratios of 50:1, which give fast lock and low distortion, respectively.

The MC13024 operates over the range of 1.8 to 8.0 Vdc. Typical operation will be from two AA cells at approximately 3 V with just 5 mA of current required. The

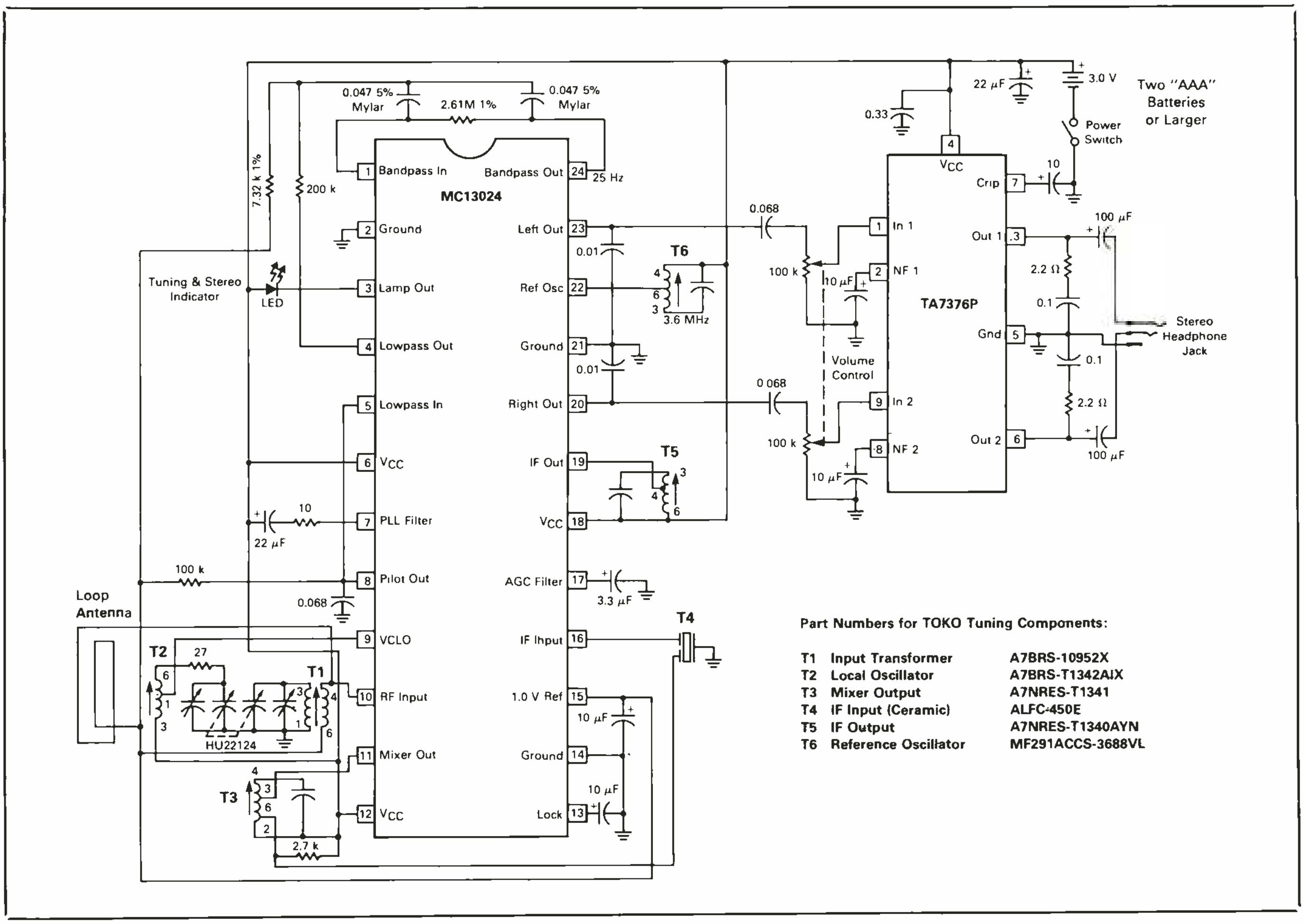
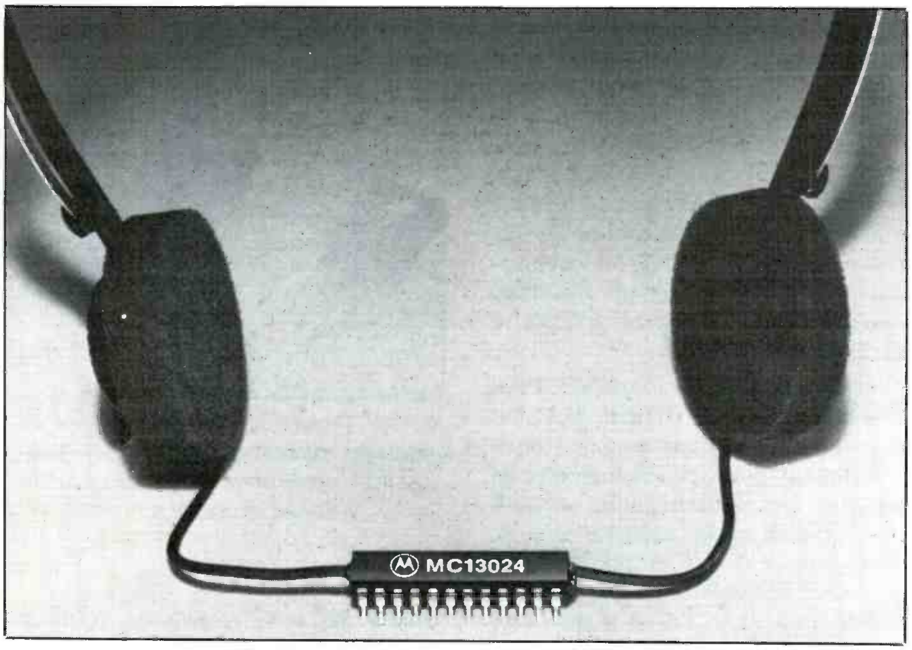



*Fig. 1. Schematic diagram of a manually tuned headphone radio receiver built around Motorola's MC13024 chip.*




*Motorola's MC13024 low-cost AM-stereo receiver IC provides all functions required to receive and decode hi-fi AM-stereo broadcasts from any C-QUAM station.*

chip's tuning indicator output level will keep a display LED dark with no signal or a weak signal; show half brilliance with a usable mono or stereo signal (non-C-QUAM); and light the LED to full brilliance with a valid C-QUAM stereo signal.

Additionally, the MC13024's "smart" signal-quality detector simultaneously examines the lock condition, the C-QUAM 25-Hz pilot-tone level, interference-caused phase modulation, and changes in the station tuning circuit. Any conditions that prevent good stereo reception are immediately identified, and the receiver drops gently back into mono mode without a transition "pop" effect. Other performance specs include less than 1% distortion and stereo channel separation of more than 25 dB. All the features of the MC13024 should combine to give the listener the same "feel" and audio quality that has previously been provided with a good-quality FM portable radio.

Price of the MC13024 AM-Stereo receiver chip is $1.93 in quantities of 10,000 and up.

## *Power-Supply Solutions*

• *Low-dropout Regulators.* Designers looking for an effective means to supply power for low-voltage (3.3-to-3.6-V) logic from standard +5 V logic supplies should take a look at Linear Technology Corp.'s (Milpitas, CA) family of positive adjustable low-dropout regulators. The regulators, which include the LT1083, LT1084, LT1085 and LT1086, are rated at 7.5, 5, 3, and 1.5 A, respectively.

Many regulators have dropouts of 2 to 3 V, which is too high to be used with a standard 5-volt logic power supply and still produce the necessary 3.3 to 3.6 V. All the low-dropout regulators can run at supply voltages lower than the standard logic supply of 5 V and produce the required 3.3 V, since the maximum dropout

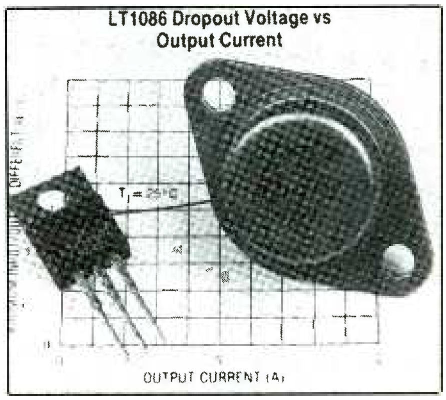
# SOLID-STATE DEVICES...

of the devices is 1.5 V maximum at maximum current. Dropout decreases for each of the devices at lower currents, down to about 1 V.

The LT1083 and LT1084 are available in TO-3 metal cans or TO-3P plastic packages. The LT1085 and LT1086 are available in TO-3 metal cans or TO-220 plastic packages. Pricing for commercial-grade parts in 100-up quantities ranges from $2.75 for the LT1086 to $7.70 for the LT1083.

• *Encapsulated Power Supplies.* Total Power International (Lowell, MA) has introduced a fully encapsulated dual-and-triple output ac/dc linear power supply series with standard pinout compatibility. The 12 models available offer 5-, ±12-, and ±15-Vdc output combinations and up to 10 W of power. The split-bobbin transformer design of these supplies offers high isolation and improved heat dissipation. All supplies have continuous short-circuit protection and offer optional international input ranges.

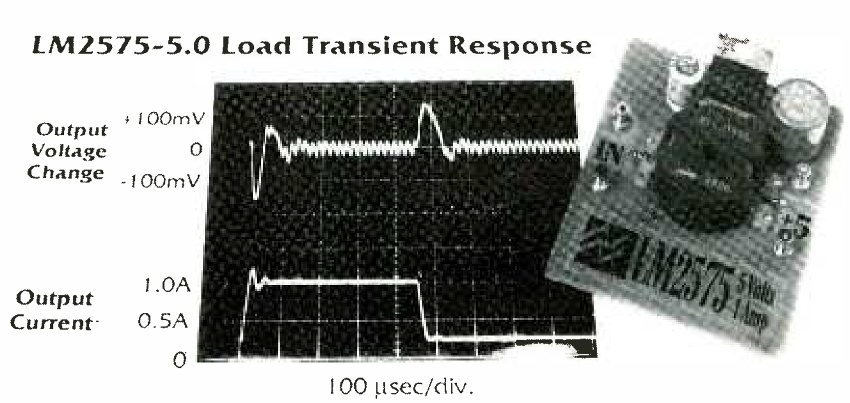
Dimensions are from 3.5"L × 2.5"W × 0.88"H to 1.56"H and availability is pc- or chassis-mount versions, the latter with a screw-terminal barrier strip. Prices start at $49.95 for quantities of 100.



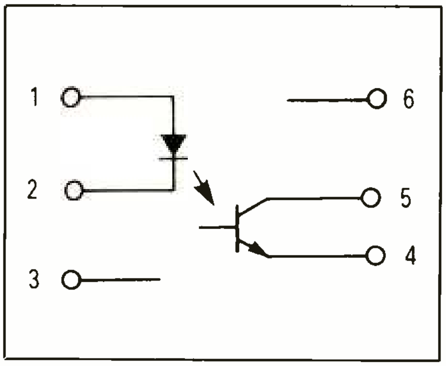

*Linear Technology's LT1086 is one of four new voltage regulators for low-voltage logic applications that require 3.3 to 3.6 volts of supply power.*

• *New Switching Regulators.* National Semiconductor (Santa Clara, CA) has introduced the first in a family of new switching regulators that are supposed to make switching-regulator design much easier.

The LM2575 step-down switching regulator comes in a five-pin package and incorporates all active functions: pulse-width-modulated control circuitry, pow-




*National Semiconductor's LM2575 simple switching voltage regulators greatly ease the task of the systems designer.*




*Pinouts and internal details of Motorola's MOC81xx series optical isolators for power-supply applications.*

er switching transistor, and protection circuitry necessary to implement a switching regulator.

A major advantage of the LM2575 is that it can be used by designers without extensive knowledge in the analysis, design, and optimization of switching power-supply circuitry. Switching power supplies have become increasingly popular in the last 20 years because they are much more efficient than linear power supplies, and they reduce the heat-sinking required. However, industry-standard voltage regulators have not been replaced by switching regulators, partly because of their more complex circuitry.

The LM2575 attempts to solve these problems by reducing the number of external components required and handling many of the design-intensive tasks on the chip itself. All that is required of the designer is to determine the voltage and current values desired, and then look up the required external inductor in a table supplied by National Semiconductor.

The LM2575 steps the voltage down from a higher to a lower potential at 1 A, and can handle an input potential range of from 7 to 35 V. The device requires just four external components. Its standby mode uses only 200 $\mu$A maximum, as compared to 8 mA during operation.

The LM2575 is available in a five-pin TO-220 package with a −40 to +125 degrees centigrade temperature range. The LM2575 is priced at $2.75 each in 100-unit quantities.

• *Optoisolator for Power Supplies.* Motorola (Phoenix, AZ) has introduced an optoisolator that is designed, specified, and controlled to meet the requirements of switch-mode power supplies and other applications requiring very closely matched current-transfer ratios (CTRs). The MOC8101 optoisolator consists of a gallium-arsenide infrared-emitting diode that is optically coupled to a monolithic silicon phototransistor detector. The optoisolator offers a high-output isolation potential of 3,750 Vac (rms) and a 0.2-pF coupling capacitance to minimize common-mode effects.

The MOC8101 combines with three other optoisolators—the MOC8102, MOC8103, and MOC8104—to offer four different CTR selections. The six-pin devices have full UL, VDE approvals and are available in three lead-form options, including surface-mount. Prices range from $0.64 to $0.71 in 100-up quantities depending on CTR selection.

# Pocket Telephone Autodialers & Film-to-Video Converters

By Curt Phillips

**Last month,** I reviewed two sophisticated and expensive "electronic organizers" (Sharp's "Wizard" and Casio's "B.O.S.S."), among whose features was the ability to store a myriad of telephone numbers. However, when these units "remember" a phone number, all they do is display it on an LCD screen. *You* have to push the buttons on the telephone instrument to effect actual dialing.

A less-expensive class of portable phone-number memory devices is the automatic pocket tone dialer, like those in a line offered by Radio Shack. In the Radio Shack line are three models, which include a tone dialer with no memories for $15.95 and a unit with an LCD display and 60 memories for $39.95, but I think that its 33-memory dialer (Cat. No. 43-141) at $24.95 is the best value. (Also being marketed is a Duofone-brand desktop dialer for $39.95.)

When I reviewed a Panasonic memory phone some months ago, I told you I had several memory phones at my home and office. So why should I need a portable autodialer? The question here is really, "Is it just another gadget or a useful toy?" While I'd be the first to admit my susceptibility to gadgets, this item is truly a useful and productivity-enhancing tool.

First of all, I frequently work from clients' offices, where memory dialers are either unavailable or not mine to use. With the access requirements of a couple of long-distance credit cards, it has often seemed to me that telephone button pushing was becoming a career in itself. A pocket autodialer can substantially improve the telephone's ease of use in situations like these.

I also make non-business phone calls through the vhf ham radio set in my car. Dialing while driving can be hazardous. I don't have a cellular phone, but for those without autodialing capability, these units would be similarly useful.

## How They Work

On pocket autodialers, phone numbers are stored in memory, as in "electronic organizers." However, when they are recalled, rather than simply displaying them on an LCD screen, they are converted into phone-system-compatible tones played through a speaker at the bottom of the units. With the speaker placed over the mouthpiece of an ordinary telephone instrument, these tones are essentially indistinguishable to the phone system from those generated by a directly connected instrument.

*Typical tape-to-film converter.*

There is a rubber gasket to provide a limited seal with the telephone mouthpiece so that all but extreme levels of background noise will not interfere with the transducer's dialing process. In a quiet office setting, even though the dialer's tones are audible, they are not loud enough to disturb others nearby.

Radio Shack's Cat. No. 43-141 autodialer will store up to 33 phone numbers. Each number can consist of up to 32 digits, but having a maximum total memory of 495 digits, it can average only 15 digits per memory location. Since a phone number, including area code, is only 10 digits long, this limitation is relatively unimportant.

It is easy to program and operate this autodialer. You can use the keyboard to generate tones, which makes it useful for remote control of some answering machines. Several digital PBXes I have encountered generate each tone for only a fraction of a second, necessitating a device like this one. The Phone-Mate machine I reviewed a few months ago required a 3-second continuous tone to access its remote.

The Pocket Dialer dials the numbers programmed into its memories so fast that it occasionally is too fast for some older central offices that can be encountered in some rural areas. However, the dialer has a pause function that can be programmed into the memory locations.

I have found that programming a number such as "555[PAUSE]1212" or as "1[PAUSE]195551212" will slow it down enough for most phone systems. The PAUSE function takes up the same memory as *two* digits, though; so using it a lot could cause you to exceed the digit total before you had programmed all of the memory locations.

Radio Shack's Memory Pocket Tone Dialer also features three priority memories that permit one-button automatic dialing, a low-battery indicator and a phone index on the unit's back. It uses three AAA cells. Although it is small enough to be carried in a pocket (it measures $2\frac{3}{8} \times 4\frac{1}{4} \times \frac{5}{8}$ inches wide, long and thick), its thickness makes it more comfortably placed in a briefcase. If your activities cause you to make a substantial number of phone calls away from your home or office, a portable dialer like this one can significantly reduce your button-pushing time.

These inexpensive telephone autodialers do not provide time around the world, as did last month's electronic organizers. However, your local Federal Express office has a small folder advertising its world-wide service that includes a circular "slide-rule"-type world time calculator for 91 different cities. It won't impress your friends like the "Wizard" or "The B.O.S.S.," but it is free.

## Film-to-Video Converters

While the convenience and flexibility of camcorders retired most 8-mm cameras to their owners' back closets, the heavy and bulky film projector and screen still have to be set up and the room darkened every time old films are to be viewed.

To allow film owners to view their pictures with the ease of a video tape, several companies sell film-to-video converters.

Fordham Radio (260 Motor Pkwy., Hauppauge, NY 11788), for example, markets a device they call the "BP Video-Cine Converter." Like most of its competitors' units, it is an optical device that places the film image on a rear-projection screen. The converter, Fordham's Model V-1701, is priced at $39.95. Accessories include a Model V-14 macro lens ($14.95) and a Model CSP4-5 close-up lens ($19.95) for use with Carousel slide projectors. The converter stands 8¼ inches high on a 6-inch-square pedestal base.

Using the Video-Cine is simple, but it isn't totally easy. That is, all you have to do is direct the image from the film projector into the side of the Video-Cine and then focus the camcorder on the Video-Cine's screen and start taping. But getting all these pieces to work correctly together is where it gets complicated.

To explain, with the projector and Video-Cine on the same table or counter top, the Video-Cine has to be set on several catalogs for its projection window to be vertically aligned with the projector's lens. The distance between the projector and Video-Cine should be adjusted so that the image completely fills the screen with nothing lost outside the screen area. The projector must then be carefully aligned with the front edge of the Video-Cine, lest the image appear skewed.

Because of the close proximity of the units to each other, this alignment requires precise adjustment (and a lot of patience) to achieve. The projector focus is operated normally and was no more difficult to perform than is typical.

Next, the camcorder must be placed in front of the Video-Cine's screen. I found that putting the camcorder on a tripod was the best way to align it vertically with the Video-Cine. However, for the two units to be close enough for proper focusing, I had to move (and realign) both projector and Video-Cine to the edge of the table. As with the projector, the camcorder's lens and Video-Cine's screen must be parallel to each other to avoid frame and image distortion problems.

The distance between the camcorder and the Video-Cine's screen also must be adjusted so that the screen fills the entire focal area of the camcorder, which is another patience-trying operation. However, if you are careless in the placement of these devices, the resulting flawed video tapes will be disappointing. If this is the case, you will probably end up retaping them—I speak from experience.

Final placement of camcorder and Video-Cine will almost always have the two very close together. So the camcorder should have a macro focus capability to focus properly at this range. Most camcorders manufactured in the past several years have this capability. The 1986-vintage camcorder I use has it. If your camcorder does not have it, you should add a macro lens attachment for the Video-Cine.

Until I used the Video-Cine, I had never used the macro focus capability of my camcorder. The camcorder in its macro mode requires very "fine-tuning" for good focus I learned. So if you are beginning to think that patience is the watchword of the film-to-tape operation, you are correct.

With the focus adjusted, the camcorder set for artificial light and the devices aligned, taping is ready to begin. The camcorder I used has a "backlight" switch for use when videotaping a subject with the primary source coming from behind. Since the image on the Video-Cine screen is projected from the rear, I thought this switch might be needed. It wasn't! Whatever its utility in regular videotaping, the backlight switch is not needed with the Video-Cine. However, since the camcorder lens is not sealed against the Video-Cine, lowering the room ambient light level seemed to slightly increase contrast and picture quality.

Remember, unless you disable the camcorder microphone, it will record in audio along with the video from the film (including any expletives caused by impatience). Although you could do a narrative or record music simultaneously with the conversion taping, the projector noise and other factors make this less than absolutely ideal. Many table-top VCRs include the capability for recording a sound track independent of video, which works much better in terms of quality for creating a narrative and/or musical background audio.

Using a properly set up projector, Video-Cine and camcorder combination, good-quality copies of home movie film certainly can be made by an amateur onto video tape. Both slides and 16-mm film can also be transferred to video tape with this system. However, it *is* a tedious process that requires both time and patience to achieve a good result. The cost of the Video-Cine or equivalent converter is small compared to the effort required to do the conversion job. More importantly, you'll be able to play back your old film much more conveniently, organize sections on tape if you never took the time to do so before by splicing various film segments, and enhance your silent films with narration or/and music.

*Your comments and suggestions are welcome. You can contact me through Delphi (CURTPHIL), CompuServe (73167, 2050) or at P.O. Box 678, Garner, NC 27529.* ME

# A Zeos 386SX Winner

**By Ted Needleman**

It always happens. Just when you thought you could finally standardize on the 80386 CPU, Intel announces a new microprocessor chip. The i486 CPU won't be available in quantity until some time next year, but that hasn't stopped vendors from announcing systems based on it. At the same time, vendors are strongly pushing systems based on Intel's 386SX CPU. This is a variant of the standard 80386, now renamed the 386DX, which has an internal 32-bit bus, but interfaces to the outside world (that is, the rest of the computer) with a 16-bit bus like the 80286.

Even staid IBM, which is usually pretty slow to jump on the technology bandwagon, couldn't resist. Although yet to announce the availability of a 33-MHz 386-based PC, IBM was the first vendor to demonstrate a 486 system: the 486/25 Power Platform upgrade board for its PS/2 model 70-A21. In the short time since IBM announced (and demonstrated) its 486 upgrade board, at least five other vendors have announced either upgrades for their 386 systems, or entirely new PCs based on this chip. New announcements are being made almost daily.

While it's easy to get excited about major new technological innovations and advances, it eventually always boils down to whether this newest, greatest, and most wonderful gizmo is something that you're going to want, or need, to spend your dollars on. And making that decision is usually a matter of determining what benefits the acquisition offers in relationship to its cost. An important part of making this decision is understanding what these new CPUs represent; how they are different from what is currently available.

The 386SX CPU is allowing vendors to produce PCs with much of the power of the standard 386DX systems at greatly reduced prices. Because this CPU has a 16-bit bus interface with the rest of the PC, it works well with motherboards originally designed for AT-class 80286 systems. At the same time, the high level of integration and fast clock speed allow much better performance on tasks such as desktop publishing, database management, and CAD, which all benefit from increased processor power.

An added benefit is that the SX version is a full 32-bit chip internally, which allows it to run all 32-bit software. Of course, at the moment there is almost nothing available that actually requires a 32-bit CPU to run, except for MS-WINDOWS/386, DesqView/386, and several versions of the XENIX operating system. However, as the 386 and 486 CPUs become the new standard in PCs, you can expect to see more 32-bit-specific software being written.

While I was initially very skeptical about a "limited" version of the 386, a recent experience with one of these SX machines has changed my mind. The Zeos system discussed below offers very similar performance to my current Acer 386 at less than half the price.

Making a purchasing decision about the i486 is more difficult. The 486, like its predecessors (80386, 80286, and 8088 and 8086), is a general-purpose microprocessor. It differs from the 386 in its level of integration—the number of components and capabilities the CPU chip itself contains. In other aspects, it is quite similar to the 80386. In fact, one of its selling points is that it will run almost all 386 software with no modification.

Like the 80386, the i486 is a 32-bit CPU. It has a very similar instruction set (the commands that the microprocessor can execute) and will run, at least initially, at similar clock speeds (25 and 33

MHz), though it is rumored that a 50-MHz i486 is in the works. Its major difference is in the number of components and functions it contains. The current 386 CPU chip contains about 100,000 transistors in a small 1-inch-square package. The i486, on the other hand, packs over a million transistors into the same size package!

Some of these transistors (and other components) make up the CPU, while others perform the functions that are now, with the 386, performed by additional IC chips on the PC's motherboard. These include a built-in numeric coprocessor and a small amount of RAM that serves as a system cache. This extra built-in RAM acts as a buffer between the fast CPU and slower chips on the PC's motherboard, greatly improving system performance.

Placing more of the PC's functions on the chip means that more of the processing can take place within the CPU itself, rather than having to have data traveling along the bus and circuit board, which takes place at a much slower rate. In turn, this means that more computation can take place in the same amount of time. It also means that the computational power of the i486 is influenced more by the clock speed of the chip (which affects how quickly it can execute an instruction), and less by the clock speed of the system components.

In fact, IBM's 486/25 Power Platform upgrade, which operates at the same 25-MHz clock speed as the Model 70's 386 CPU, has almost twice the raw computational power of the 80386 it supplements. This raw computational power is a bit misleading; the system's overall throughput is still greatly affected by the speed of its I/O devices and RAM. If they are slow, the overall system speed will be greatly compromised.

However, this large amount of raw computational capability makes i486-based PCs very attractive in computer-oriented applications. 486 PCs will generally offer a performance improvement in all applications, but their higher price (at least several thousand dollars more than high-end 386 systems) will make them not so attractive for use in dedicated applications like word processing. Additionally, there will be relatively few spreadsheet users willing to pay several thousand dollars to have their worksheets recalculate a few seconds faster.

Where 486s will shine, though, is as network servers, database engines, multi-user systems, graphics, desktop publishing, and other high-power tasks. These are the same applications, in fact, that have benefited from the availability of faster 386 machines.

Whether these users will be willing to pay the price is the question. High-end 386 systems cost between $6,000 and $10,000. 486 PCs should be even more. Chances are, however, that i486-based systems, as they become commonly available, will be embraced with the same fervor that 386s have been. After all, when the 386 first became available several years ago, many people were skeptical about them replacing 286 PCs. As applications became more powerful, the 386s have provided a powerful upgrade path for those 286 users whose systems have run out of steam.

The 386 CPU architecture has some inherent limitations imposed by physical constraints. By incorporating more of the system support right in the chip, the i486 overcomes many of these limitations and offers the 386-user base the next step up in power. And just as the 386s have come down in price as they became more popular, the 486s will become more affordable in time. As that occurs, the question will no longer be "Should I buy a 486?," but "What 486 should I buy?"

## *Zeos International 386SX*

In the past, I've been a little hesitant about recommending 386SX machines. After all, it didn't seem to make much sense going for a 32-bit CPU that deliberately cut its outside access to the rest of the PC down to 16 bits. Granted, it is less expensive, but I figured it was worth some extra dollars to get the full 32-bit address capability of the DX version of this powerful CPU. Recently, though, several things have occurred to make me reverse my stand on the SX version of the 386. The first is that I realized that even the DX (full 32-bit) version PCs have 16-bit expansion slots for everything except vendor-specific memory boards. There are really no standard 32-bit peripherals (other than RAM boards from the particular system's manufacturer) that can take advantage of the wider data bus.

The second realization is that the SX-based systems are considerably less expensive than 386DX systems; it's not just a few dollars. The clincher, however, was actually benchmarking the Zeos PC discussed in this review, against a similarly configured 386DX PC. For this review, I ran the same benchmarks on a Zeos 16-MHz 386/SX and an ACcer 1100, which is a 16-MHz 386 DX machine. Both systems had equivalent RAM. The Zeos, at a configured price of less than $2,000, was about half the cost of the equivalent Acer. The results of these tests really surprised me.

To understand what all the shouting is about, you must first understand the concept of internal and external data bus width and why they are theoretically important. This is because the major difference between the SX and DX versions of the 386 are their external data bus width.

Whether internal or external, the data bus is the path that information takes traveling within the computer itself. The internal data bus is the data path within the CPU chip itself, while the external data bus consists of the paths that exist within the PC as a whole, such as the data path to the expansion slots and RAM and ROM memory. The width of these paths (16 or 32 bits) is important because it determines how much information can be transferred in a given amount of time (assuming a constant system clock speed).

To visualize this, think of the data bus as a superhighway and the bits of information as cars that must travel along this road. Given a ten mile stretch of road, 500 cars will be able to maintain a higher average speed if the road is 32 lanes wide rather than just 16 lanes in width. The

## PC CAPERS...

data bus inside the PC works in a similar manner. The wider the bus, the greater the data transfer rate should be within the machine. Both the SX and DX versions of the 386 CPU have 32-bit wide internal data buses. The 386DX CPU also has a 32-bit wide external data bus, which when compared to the SX's 16-bit wide external data bus should yield significantly better overall performance. At least it should in theory. In the real world, even DX systems use a 16-bit bus width to everything other than motherboard-based RAM and ROM memory.

The Zeos International 386SX-16 system is an inexpensive system, it only costs $1695. The above price, though, includes a 16-MHz 386SX-based PC with 512K of RAM on the motherboard, 1.2-MB, 5.25-inch floppy disk, 32-MB hard disk, an enhanced-AT style keyboard, two parallel and two serial ports, Hercules MDA video adapter, and a 12-inch amber monochrome monitor. The only things not included are the MS-DOS operating system ($98 for version 3.3, $119 for version 4.01, both with GW-BASIC) and a printer. This is contained in a compact case 17 inches square by 6.5 inches high.

The case has room for three half-height drives and eight expansion slots. The compactness of the system is largely achieved through use of Chips & Technologies' NEAT chip set, which greatly reduces the number of ICs on the motherboard and permits a very small motherboard design. Topping off the design is a hefty 200-watt power supply that should be more than adequate for the peripheral cards you may want to fill the empty slots with.

The Zeos SX system has eight expansion slots, six of them for 16-bit cards, the other two for 8-bit cards. In the system we received for review, one of the 8-bit slots was filled by the Hercules MGA (Monochrome Graphics Adapter) card. This card, incidentally, is not a Hercules-compatible, but a genuine Hercules-brand card. It yields a resolution (on a suitable monochrome monitor) of 720 by 348 (which is comparable to the standard 640 by 480 VGA resolution) and comes with an Owners Guide and utility software disk.

While the system features six 16-bit slots, only three are available. The other three are taken up by an Adaptec combination floppy- and hard-disk controller card and the serial/parallel I/O card. The latter has four I/O ports (two each serial and parallel) but only two connectors appear on the card itself. The other two are mounted on a separate bracket that is placed in the back panel opening adjacent to the card. Unfortunately, the back of these connectors protrude far enough into the PC to make it difficult to use the open slot behind them. In total, though, you will have four open slots, which may be more than sufficient for your needs.

The Adaptec disk controller, by the way, can drive two floppy disks of different sizes and/or capacities (720K or 1.44-MB 3.5-inch or 360K or 1.2-MB 5.25-inch) and two hard-disk drives. The hard-disk drives must be of the RLL variety, and our review system contained a Seagate ST-138, a 32-MB 3.5-inch drive. A second RLL drive can be added by simply plugging in a cable and physically installing the drive. Be aware, however, that you cannot mix the more common MFM hard disk with one using RLL encoding, the controller cards are different. RLL is a method of encoding the data so that more storage can be stored on a disk.

My review unit contained a BIOS chip set from "Pro," version 4.39. This is a BIOS vendor less well known than Phoenix, Award, or AMI, the most popular suppliers of this type of firmware. I did not, however, encounter any incompatibilities in using the system with a variety of applications software packages or benchmarks. One unusual thing I did notice is the back-up battery for the CMOS set-up RAM. In many systems, this is a lithium battery. In the Zeos, there are four Rayovac AA alkaline cells in a battery holder that is "Velcroed" to the power supply. Not only are four AA cells less expensive than a replacement lithium battery (about $6 versus $20), they are also considerably easier to find locally. This is a nice touch, especially in such a low-cost machine.

Getting the system ready for the benchmark tests was easy. I just unpacked it and plugged it in. The monitor, a Packard Bell PB 1272A 12-inch amber monochrome display has the power cord and signal cable already attached. Just plug the signal cable into the Zeos and the power cable into the wall. This monitor is very nice. It has a tilt and swivel base, power, brightness and contrast controls on the right side of the display, and it provides a very crisp image on the screen, with just a slight bit of edge distortion (pincushioning) when high-resolution graphics are displayed. This pincushioning, where the side of the displayed screen pulls in slightly towards the center, is very common with displays of high-resolution graphics. It was not distorting enough to be distracting.

The system had the optional MS-DOS operating system (version 3.3) already installed on the hard disk and was ready to be used as soon as the monitor was attached and power cord plugged in. If you order MS-DOS at the time the system is purchased, Zeos will partition and format the hard disk, and install DOS on it for you. If, however, you already have MS-DOS, or decide to purchase the operating system elsewhere, you will have to perform these tasks yourself. These tasks are not particularly difficult, but will add about a half-hour to the set-up time. The total set-up time in my case was about five minutes.

The set-up procedure, by the way, is detailed in the user guide provided with the system. This guide is comprehensive, but it is not particularly well organized. Depending on the configuration you order, there can be separate sections for motherboard features, I/O ports, the disk controller card, and the graphics card. There is no single index for the documentation, which is assembled out of a variety of parts. The documentation is usable, though, and I'd much rather have an amalgam of documentation than no information on the component parts of the system.

To determine the PC's performance, I ran a variety of benchmarks. These included the Chips & Technology MIPS test, which measures how many Millions of Instructions Per Second the PC can execute on several different types of instruction tests, The SI (System Information) test from the Norton Utilities, TouchStone Software's CheckIt benchmarks, and a real-world application.

The real-world application I chose was BitStream's FontWare, a font-generating package. The reason I chose this particular application is that FontWare is both disk- and I/O-intensive. In generating the fonts, it continuously accesses the disk, and the generation of the fonts themselves uses a great deal of computational power. Therefore, it provides a realistic approximation of use of many other actual applications.

These benchmarks were run both on the Zeos 386/SX and the Acer 1100, a similar system that uses the DX version of the 386 CPU. The Acer 1100/16 is a 16-MHz 386DX-based system with 640K of standard RAM and 2-MB of expansion memory installed. It is equipped with a slightly slower 40-MB hard disk. In short, it is almost identical to the Zeos except for using the full 32-bit DX version of the 386 and a price about twice that of the Zeos system.

To say I was surprised by the results would be an understatement. The Zeos came close to equaling the Acer's results in every test I ran. Furthermore, its actual performance is just a hair below the much more expensive Acer. When you consider that the Acer is not an overly expensive 386 system, the Zeos' performance becomes even more impressive.

The most telling benchmark, though, is the font-generation test. In this test, I asked FontWare to generate five printer and five screen fonts. On a 20-plus minute compute and I/O-intensive task, the Zeos took only two and a half minutes longer to complete the job. This is about a 10-percent performance differential for a 50-percent price difference. In many common applications, this performance difference would not even be noticeable.

The Zeos 386SX/16 turned me around on the topic of SX-based PCs. For $1,695 you get a fully equipped system, and Zeos offers a long list of reasonably priced options. If you are thinking about a 386 system, look at this one. In fact, you should consider the ZEOS 386SX/16 even if you're in the market for a 286 system; it costs less than most and offers more.

*For more information, contact Zeos International, Ltd., 530 Fifth Ave., N.W., St. Paul, MN 55112, telephone 800-423-5891.* **ME**

**CIRCLE 49 ON FREE INFORMATION CARD**

# A Football Handicapper's Dream Program

By Joseph Desposito

**Although Oregon** is just the second state in the Union to legalize gambling on professional football games, the practice, as everyone knows, is widespread throughout the country. So it is natural that people trying to pick against the pointspread would enlist the aid of their personal computers. And if ever there was a program meant for these pro football handicappers, Pointspread Analyzer from Best Bet Software (3104 Shattuck Ave., Berkeley, CA 94705) is it. The program, written in Turbo Pascal, contains a database of National Football League (NFL) games from 1979 through 1988. The 1989 schedule is also on the disk. The program also contains the means to search the database in many different ways and displays the results almost instantaneously in most cases.

The program we reviewed is contained on a single 5.25-inch disk for use in the IBM PC and compatibles. However, it is also available on 3.5-inch disks and for the Macintosh. The NFL program, which includes the disk and a 36-page manual, sells for $75. Also available is the company's college football program, the NCAA Pointspread Analyzer, for $75. Both programs can be purchased together for $125.

## About the Program

The Pointspread Analyzer contains four different parts: the Analyzer, Heat Seeker, Editor, and Matchups. The heart of the program is the Analyzer.

To use the analyzer you type "gonfl" at the DOS prompt, and then type A at the opening menu. A screen appears with three windows as shown in Fig. 1(A). In the right-hand window are parameter settings that enable you to search the database. By using the PgDn key on the PC, you can examine two other pages of parameters.

To start the search you enter information in the parameter-setting window. For example, in Fig. 1(A), we want to find out how the New York Giants have fared against the Washington Redskins for the years 1985 through 1989 during the regular season when the Giants were the underdogs. You enter the information as shown in the figure and then begin the search.

Figure 1(B) shows the results of the search as they appear in the left-hand windows. Summary statistics are given as well as home and away results. These results are found within a few seconds, even on a 4.77-MHz IBM PC.

There are 36 parameters in all that cover just about any circumstance that you can think of. Some examples are artificial turf, Monday night games, if a team or its opponent scored less or greater than a certain amount of points last week, etc.

```
                  --> P O I N T S P R E A D   A N A L Y Z E R <--
 -----------SUMMARY STATISTICS-----------   -------PARAMETER SETTINGS------
                                            Year                  = 85,89
                                            Month                 =
                                            Type                  = REG SEASON
                                            TEAM                  = NY GIA
                                            OPPonent              = WAS
                                            Spread   NY GIA       = .5,50
                                            Last Game, NY GIA=
 --------------LIST OF GAMES--------------  Last Game, WAS      =
                                            Last Opp,  NY GIA=
                                            Last Opp,  WAS      =
                                            Two Back,  NY GIA=
                                            Two Back,  WAS      =
                                            Days Rest, NY GIA=
                                            Days Rest, WAS      =
                                            Game Nbr            =
                                            Artificial Turf     =
                                            Day of Week         =
                                            * BEGIN SEARCH **
                                                          PgUp/PgDn  1/3
 F1 for Help (ON/OFF)        X to Clear Settings         Q to Quit Analyzer

                  --> P O I N T S P R E A D   A N A L Y Z E R <--
 -----------SUMMARY STATISTICS-----------   -------PARAMETER SETTINGS------
 Games on List =   5                        Year                  = 85,89
                   0                        Month                 =
 ALL GAMES            Straight Up    vs Spread   Type             = REG SEASON
 NY GIA vs WAS        -----------    ---------   TEAM             = NY GIA
                      Nbr    %       Nbr    %    OPPonent         = WAS
 NY GIA         Won    2   40.0       2   50.0   Spread   NY GIA  = .5,50
                Lost   3              2          Last Game, NY GIA=
                Tied   0              1          Last Game, WAS   =
 ---------------HOME AND AWAY-------------   Last Opp,  NY GIA=
                                            Last Opp,  WAS      =
 NY GIA         Won    0    0.0       0    0.0   Two Back,  NY GIA=
 Home           Lost   1              1          Two Back,  WAS   =
                Tied   0              0          Days Rest, NY GIA=
                                            Days Rest, WAS      =
                                            Game Nbr            =
                                            Artificial Turf     =
 NY GIA         Won    2   50.0       2   66.7   Day of Week      =
 Away           Lost   2              1          * BEGIN SEARCH **
                Tied   0              1                   PgUp/PgDn  1/3
 F1 Help   L List Games    O O/U    A Average Pts   P Print   Q Quit Summary
```

*Fig. 1. Pointspread Analyzer is about to determine how much the NY Giants fared against the Washington Redskins (A) from 1985 through 1988 when the Giants were the underdogs. The results of the search (B) show that five games meet the criteria; summary, home and away statistics are shown.*

*Author Bio: Joseph Desposito was formerly a professional sports and racing handicapper for a New York daily newspaper. He holds an electrical engineering degree from Manhattan College, NY.*

Besides the summary statistics, the analyzer provides you with a list of results of all the games that satisfied the search criteria, provides over/under stats, and gives you average points. A really nice feature is the analyzer's ability to plot a graph of the distribution of point differences and point totals for the games found in the search. Any of these results can be printed, too.

For people who are interested in questions like: "How have NFC teams done against AFC teams for the past ten years?" you move the cursor to TEAM on parameter settings and then press F3. A list of team groups appears, such as AFC East Division, NFC Conference, etc. You can enter your own sets of football teams.

To clear settings, you simply press X, and to get context-sensitive help, you press F1. Most actions throughout the program are performed with a single keystroke.

Another part of the program, the Editor, is used to enter the results of games for the 1989 season. Best Bet Software provides you with the 1989 schedule, so only the pointspreads and results need to be entered. If entering data is anathema to you, the company has a modem downloading service to which you can subscribe.

The Matchups feature lets you enter a year and a game number to find the NFL team matchups for that particular game of the season. It gives stats that were current at the time, such as a team record, pointspread record, and points scored for and against. By pressing S, you can also get the standings at that point of the season. Pressing V gives the pointspread standings. A problem with this feature is that sometimes pointspreads don't appear, even though they seem to be in the database.

The last feature of the program is the Heat Seeker. This feature is designed to find extreme patterns. It works somewhat like the Analyzer, but with the Heat Seeker, you can enter more than one value for each parameter. So if you want to investigate, for example, five parameters with five values each, you get 3,125 different combinations. The program checks all the combinations and then selects the best combinations. This feature takes considerably more time than the Analyzer, the time depending on the number of combinations to be searched.

The Heat Seeker ranks situations according to a statistical measure known as the Z-value. The Z-value takes into account the number of occurrences as well as the win-loss percentage. If you would rather use win-loss percentage, though, you can make the change by typing P for preferences.

## *Using the Program*

The Pointspread Analyzer is not copy protected and can be run from either a floppy or hard disk. Using the program is straightforward and takes little time to learn. However, getting exactly what you want can sometimes be a problem.

We used the program to analyze the opening games of the 1989 NFL season. Some of the information that was useful were facts like: Cleveland has covered the spread against Pittsburgh in two-thirds of its games, both home and away; and San Diego has covered just 35 percent of the time against the LA Raiders. In both cases, the patterns held true this season.

One stat that was difficult to find was this: How do Superbowl winners and losers fare against the spread on opening day? There is no way to enter a group like this, so you must find out who the teams are first and then make individual searches. For example, to find the Superbowl stats, you enter S for Type, and begin the search. Then you press L to list the games. Now that you know the results of Superbowl games for the past ten years, you can find out how each team did in its first game the following season by entering the name of the team, the year and the game number (1).

## *Conclusions*

We found the Pointspread Analyzer relatively easy to use and a pleasure to work with. The program is an excellent example of how the personal computer can give you helpful information in a few seconds that would take quite a long time to find otherwise.

Keep in mind that this program does not select probable winners according to a formula. There are many programs on the market that do use formulas to determine the best teams of the day. The Pointspread Analyzer provides information. The handicapper, in turn, uses that information along with other information that he might have to help him determine the best percentage plays of the day.

We found a few faults with the program as noted, but for the most part the Pointspread Analyzer performed remarkably well. We highly recommend the Pointspread Analyzer for those of you who want a solid database of NFL information at your fingertips. And if you're also interested in college football, and basketball, Best Bet Software offers those databases, too.

CIRCLE 34 ON FREE INFORMATION CARD

# *A Video Dog*

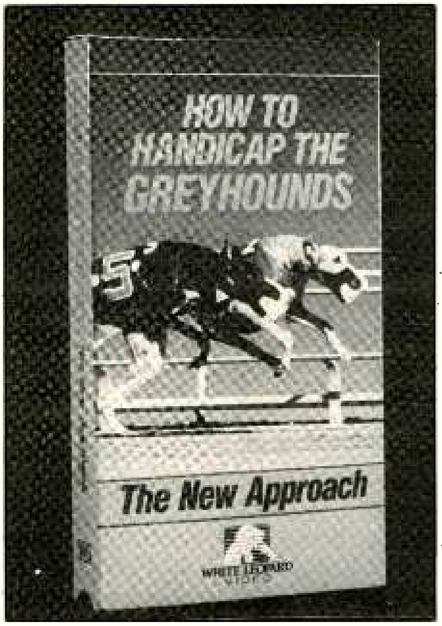
**By Joseph Desposito**

**"Greyhound Handicapping: A New Approach"** is a 45-minute VHS tape from White Leopard Video (1454 30 St., West Des Moines, IA 50265) that teaches a systematic approach to handicapping greyhounds. A brainchild of Dennis Barsky, introduced in the tape as both an owner and handicapper of greyhounds, the system is supposed to help take the guesswork out of selecting the best dog in the race. The tape and a 19-page study guide has a suggested retail price of $39.95.

According to the video, Mr. Garsky, a bearded bespectacled guru type, studied 1,200 greyhound races from six different states. He came up with 62 factors and then used MBA math techniques and a behavioral knowledge of greyhounds to narrow the factors to six. These key factors are: Class, first turn speed, closing ability, running style, bullet speed, and consistency. Throughout the tape each of the factors is discussed in detail.

To work with the system, the tape suggests using a hand-held calculator, a chart sheet, and a greyhound racing program. However, if you have a personal computer and a spreadsheet program, you could easily enter the information into your pc. A blank copy of the chart sheet is in the study guide. You can also use a blank worksheet in the guide.

To handicap, you examine a particular factor, make some calculations, and then place an X on the chart sheet if a dog




qualifies for that factor. After checking all six factors, you multiply each X by a "weighting" number. This gives more weight to one factor than another. An interesting idea of Barsky's is to make the weights of the numbers dependent on the class of the dog. For example, in a maiden race (the lowest class) the weights given to class and bullet speed are 10 and 30, respectively. In other words, for a low-class dog, raw speed is more important. On the other hand, the weights for class and bullet speed used in an A race (the highest class) are 30 and 20, respectively. Now the class of the dog is given much more weight.

One thing to understand about the system is that Barsky uses the track program for all his information, which is a logical thing to do, of course. However, the track program is not very helpful when it comes to specific information, such as the time it takes for a particular dog to race to the first turn. The program simply gives the position of the dog at the turn. This and other deficiencies of the program lead Mr. Barsky into some mathematical acrobatics when he tries to rate each dog. Consider the First Turn Speed factor as an example.

To decide whether a dog has first turn speed, which Barsky defines as the ability to be among the first four dogs at the first turn, you must make the following calculations. First you determine the fastest two races the dog participated in of the last three. You then add together the times. Then you use par times, provided in the study guide, to adjust the sum based on class. Finally, you sum the first turn positions, subtract two, multiply by five and add the result to the adjusted time. This is not only confusing, but doesn't make much sense to me.

In the video, an expert guy is teaching the system to a novice gal and she comments about the formula: "That's an awful lot of time to add. Are you sure?" He replies: "That's the way it works. The system is statistically sound. That's what I rely on. If I start making judgments based on personal evaluation, then everything just becomes a matter of guesswork instead of sound statistical judgment." She answers: "I get your point."

Well, I don't get the point. How can something that is not mathematically sound be statistically sound? Consider this: The time of the race is adjusted according to par times given in the study guide. Most handicappers use par times, which are the average times of individual classes, to determine a track variant for a particular night of racing. In other words, to determine if the track surface on average was faster or slower than usual. Barsky's use of par times seems arbitrary and doesn't appear to have any basis in sound handicapping practice. Then, after using par times to adjust the final time of the race, he then subtracts position from it! What can time minus position possibly give you, even when position is multiplied by five?

Let's see how easily the formula can produce incorrect results. Suppose that two dogs race in the same class but in different races. We'll call the dogs Baron and King. In the first race, Baron shoots out to the lead with three other dogs and is fourth by one-half length at the first turn. In other words, all four dogs are abreast coming to the first turn. In the second race, one dog sprints out quickly to a five-length lead, another dog is second by two lengths and King starts out third, seven lengths behind at the first turn. Now suppose both races were won in identical times. If these two dogs were in the same race the following week, King could get a better rating because the program would have a 3 for King and a 4 for Baron at the first turn.

It's unfortunate that this and a few of Barsky's other formulas are so suspect, for during the course of the video he gives good verbal insight into what is important and what is not when handicapping the greyhounds. For example, in one part of the video, Barsky explains that greyhounds are athletes and, as such, the good ones have many of the same qualities as good athletes, such as heart. In another part, Barsky explains that greyhounds often run the same path from race to race, on the rail, in the middle of the track, or on the outside, and you should note a dog's running style versus his current post position.

After all system calculations are made, Barsky gives this betting advice. Take the top-rated dog and play a quinella bet with that dog and the rest of the field (quinella wheel). What Barsky doesn't say is that this type of bet accounts for one-fourth of the total quinella combinations available. Thus, even by picking a dog with a hatpin, you would win one of every four bets. Barsky gives no indication about how much better you would fare using the system he explains.

## *About the Video Production*

This tape is an excellent example of how to produce an interesting educational video. There are four segements to the tape: on-location scenes of the greyhounds racing and the patrons at the track, the expert and novice discussing the system in his living room, Mr. Garsky giving his insight into greyhound racing, and video shots of the program, worksheet and chart sheet. The video taping is done in a high quality, professional, and interesting way.

## *Conclusions*

The greyhound handicapping system presented in the video leaves much to be desired. As a way of figuring out which dog to back in the race, I consider it a waste of time. Did I go to a greyhound track and try it? No I didn't. However, I do think the video has other merits. First of all, I think Mr. Garsky presents some good ideas about handicapping, though he fails to implement his ideas correctly when it comes to the figures. I also think the tape is a good model for people who are interested in developing and producing instructional tapes.

As I mentioned earlier, the deficiencies of the track program make it very difficult to come up with a solid numerical way of rating the dogs. However, Barsky, in my opinion, doesn't even make a good try. And then he compounds his failure with his conservative betting advice. Who wants to spend all that time handicapping for what would likely be a very meager return?

To sum up, the video has its strong and weak points. On the one hand, the video is professionally done, entertaining, and contains some sound handicapping ideas. On the other hand, the formulas used throughout the system render it suspect, and rather than back up his claims with results, the expert in the video appears to want you to take his word on faith, in the name of statistics.

If you have an interest in the greyhounds or in instructional videos, $39.95 is not too high a price to pay for what this product has to offer. If you are looking for a winning system that you might be able to use on your computer, I suggest you look elsewhere. ME

CIRCLE 33 ON FREE INFORMATION CARD

# BOOKS

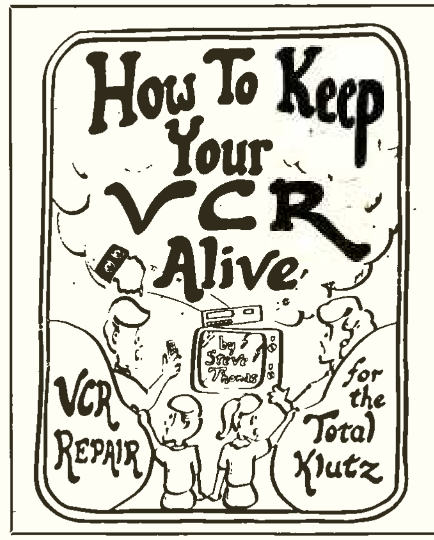
**How to Keep Your VCR Alive.** *By Steve Thomas. (Worthington Publishing Co., 6707-202 Halifax River Dr., Tampa, FL 33617. $24.95.)*

This 8½" × 11" large-size book aims to show even the person with no technical background how to repair a videocassette recorder. On the whole, it is successful, living up to its subtitle "VCR Repair for the Total Klutz." Problems covered are limited to basically the mechanical and electromechanical, which account for more than 90 percent of all common VCR problems. Succinct text and many hundreds of excellent drawings guide the reader through the troubleshooting and repair steps.

Using only the table of contents (there is no index, nor is there a need for one), the book directs the reader to the chapter in which a particular kind of trouble is discussed. There are 21 chapters listed, preceded by a section that explains how to use the book. The first three chapters deal with connecting a VCR to a TV receiver and cable or antenna, how a VCR works, and cleaning a VCR. The fourth describes a basic universal VCR checkout and diagnostic procedure. Each of the remaining chapters deals individually with a particular symptom, some separately for top- and front-loading mechanisms.

Look-up of the chapter for a given symptom involves simply finding the chapter name that corresponds with it. Symptoms covered include: failure of a VCR to properly power up; refusal to eject and accept a cassette; cassette ejects automatically right after loading; cassette that does not sit properly in VCR; improper fast-forward or rewind action; improper tape motion in play mode. Five chapters deal with signal-related problems and their cures, the final chapter with failure of the VCR to record.

Seven appendices contain vital information ranging from descriptions of the tools and materials needed to repair VCRs, to sources of materials, to how to open VCR cabinets. One appendix pictures and lists generic belts and common idler part numbers. Others tell how to make a VCR run with no cassette for diagnostic purposes, give drawings of the reel tables in VCRs, and tell how to remove and realign front-loading assemblies. Specific information is given




throughout the book for popular makes of VCRs, accounting for the great majority of machines currently in use.

Whether an amateur repairer or professional technician, this practical book is highly recommended for anyone anticipating doing any VCR machine repairs. Its thoughtful, descriptive step-by-step approach will save one considerable frustration. Get it!

**Portable Electronics Data Book.** *By John Douglas-Young. (Prentice-Hall. Hard cover. 360 pages. $33.)*

Unlike typical books, this 9 × 3 × ¾-inch one may be carried around wherever a technical specialist might go in the performance of his duties. Crammed with useful technical electronics data, this is one of those rare books that is almost certain to be reached for whenever one is stumped for a formula or other information that just cannot be dredged up out of your memory.

An abbreviated encyclopedia of electronic facts, the book is arranged in alphabetical order for quick, easy look-up. Also like an encyclopedia, major and minor references are cross-referenced to give the reader maximum information on a topic being referenced. A reader might look under "battery" for a portable power source and, when found, be directed to "power sources," which is the major topic of reference. Because of this format, there is no need for an index or table of contents. To look up a definition, formula or other detail, one simply goes directly to its alphabetical location in the book.

Material covered in this book ranges across the entire technology. It includes technical definitions, theory of just about any type of circuit one can imagine, formulas, constants and more. The book is profusely illustrated with schematic diagrams, waveform drawings, tables and line drawings. There is even a generous sprinkling of computer programs written in BASIC that simplify making electronic component and circuit calculations. With the wealth of information this well-illustrated book contains and its ease of use, it is a must-have technical library addition.

## NEW LITERATURE

**Computer Product Catalog.** The Winter 1989/1990 mini-size catalog of single-board computers and industrial controllers is now available from Micromint. The 32-page color catalog lists, pictures and fully describes (including prices) the complete SB, BCC and RTC families of computers and controllers, as well as peripherals, power supplies, hardware development tools and components. It also lists Micromint's cross-compilers from Avocet and the MCnet affordable networking software for distributed microcontroller applications. Other listings are provided for software, accessories, ROMs, and a serial EPROM programmer. For a free copy, write to: Micromint, Inc., 4 Park St., Dept. ME, Vernon, CT 06066.

**Engineering Software Catalog.** BSOFT Software has just released its Fall/Winter Catalog #2, which offers 16 pages of listings for low-cost commercial and shareware software tools for engineers. Full descriptions, along with prices, are given for programs on: computer-aided mathematics, schematic drawing, computer-aided waveform viewing, computer-aided circuit design, logic circuit emulation and a computer-aided waveform generator. Shareware and public-domain software listed include circuit-analysis, Morse-code, ac and dc, filter-design and antenna-design programs. Finally, basic productivity tools listings include dc network analysis, ac network analysis, electronic calculations and circuit-analysis programs. For a free copy, write to BSOFT Software, 444 Colton Rd., Dept. ME, Columbus, OH 43207.

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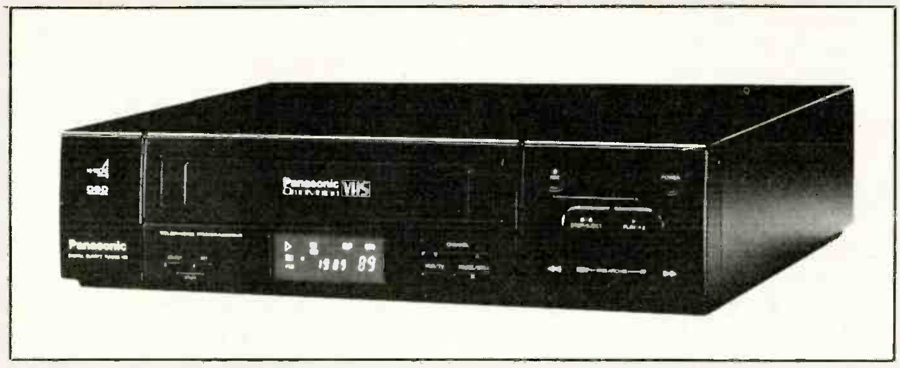
**Projects**



**Test & Service**

## *High-Tech VCRs*




Panasonic's standard VHS Model PV-4926 and S-VHS Model PV-S4986 VCRs offer a choice between telephone, bar-code and remote on-screen programming. The first two feature vocal programming guidance and automatic voice confirmation. To telephone program either VCR, the user simply punches in an access code and follows simple spoken programming directions, using buttons on the telephone keypad. Bar-code technology makes at-home programming as simple. The user passes a scanner over the appropriate codes printed on a laminated sheet to load time on, time off, channel and date into the scanner. He then points the scanner toward the VCR and presses a button to load the instructions into the VCR.

Commands are verified during an on-screen programming procedure with video graphics as they are transmitted from the remote controller. This function also has an Auto Prompter feature that automatically provides step-by-step instructions for each phase of programming. On-screen programming can also be used to verify such functions as auto set, standby one-touch recording, tape counting, time, and play, rewind, fast-forward and still tape functions.

Panasonic's Hi-Tech 4 video head system is based on the double azimuth head design. It is said to allow the VCRs to produce excellent special effects in both the SP and SLP modes by reading twice as much information as previous Panasonic four-head systems. Every field—not just every other field—is read to eliminate the "step-action" effect from slow-motion playback.

Synchro Edit, a special feature, utilizes a cable and input jacks to join two VCRs for editing with synchronized start and stop of the master and dubbing VCRs for smooth editing.

In addition to the above, the Model PV-S4986 adds compatibility with the Super-VHS video format to produce more than 400 lines of picture resolution (depending on program source). It also has: VHS Hi-Fi Stereo quality sound with a dynamic range of 90 dB and frequency response from 20 Hz to 20 kHz; a 51-function learning remote-control system that enables the user to control the VCR and other IR remote-controlled home-entertainment components; a flying erase head for clean edits between recorded segments; and variable audio output to an external stereo amplifier.

CIRCLE NO. 110 ON FREE INFORMATION CARD

## *Video Enhancer/Audio Mixer*

Ambico's (Norwood, NJ) Model V-0629 A/V Maestro is a video enhancer/stereo audio mixer in one product. It allows the user to orchestrate a professional mix of narration and background music on the sound track of home videos while at the same time enhancing the quality of the video image.

Three audio inputs are provided.

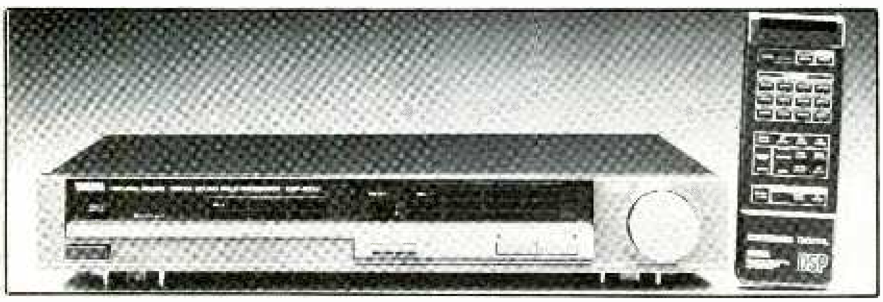
Each has its own volume control. The user can mix and fade between camcorder audio, music and narration. Microphone narration is included. The unit can boost each audio input up to 14 dB, and a master volume control lets him adjust the overall volume of the audio mix. The video portion of a camcorder tape provides signal boosting up to 6 dB with slide-control action. $69.95.

CIRCLE NO. 111 ON FREE INFORMATION CARD

## *Parallel Printer Cable Extension Kit*

Data Spec's (Chatsworth, CA) new Para-Link™ Model PTREX300 is a cable extension kit that allows parallel printers to be located up to 300 feet away from a computer. The easy-to-install system features gold-plated pins. Designed for IBM and compatible systems, it does not require an outside source for operation. The system permits printing equipment to be shared between two, three and four users. $129.95.

CIRCLE NO. 112 ON FREE INFORMATION CARD



## *Sound-Field Processor*

Yamaha's Model DSP-100U digital sound-field processor uses analog-to-digital (A/D) and digital-to-analog (D/A) converters and memory devices to recreate the acoustic personalities of actual musical environments in Europe, the U.S. and Japan at the user's command. Acoustic characteristics that differentiate one actual environment from another, stored in memory, can be recalled to act upon an audio signal the way the original environment acts upon live music. Environments stored in memory include great music performance concert halls, jazz clubs and churches.

Twelve preset positions and 33 different environments (with nearly infinite variations) are possible. Nine presets offer two options each and each preset permits certain parameters (room size, liveliness and initial delay) to be altered and saved as user programs. When used with a video monitor, the DSP-100U displays settings and changes on-screen. All settings and changes can be made manually or from the unit's wireless remote-control transmitter.

Two presets are of synthesized optimal, rather than sampled, environments. Movie Theatre 1 surround setting for contemporary movies has an Adventure setting that takes advantage of soundtracks and a Standard setting that simulates the sound most often heard in movie theaters. Movie Theater 2 has a Live setting for direct projection of music and dialogue and a Concert setting that simulates the classical movie theater, especially for mono sound tracks.

Dolby Surround enhances enjoyment of video programs by maintaining the positioning of the dialogue in front and the background music and effects coming from the sides. This preset can be altered by adjusting the delay time to enhance or diminish the effect and optimize it for the room in which it is being produced. $699.

CIRCLE NO. 113 ON FREE INFORMATION CARD

## *Magnetic Radiation Detector*

A low-cost meter designed to detect and measure low-frequency magnetic fields emanating from video display terminals and power lines is available from Safe Computing, Inc. (Needham, MA). The Safe Meter displays magnetic radiation across seven analog scales and has a range of from less than 0.01 to beyond 300 milligauss. Accuracy is rated at ±5 percent. An option to measure electric fields is also available. Power for the solid-state instrument is provided by a single 9-volt battery. The easily portable meter weighs approximately 11 ounces. $145; $50 for optional electric-field adapter.

CIRCLE NO. 114 ON FREE INFORMATION CARD

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## VIDEO

**DESCRAMBLERS.** All brands. Special: Combo Jerrold 400 and SB3 $165. Complete cable descrambler kit $39. Complete satellite descrambler kit $45.00. Free catalog. MJO INDUSTRY, Box 531, Bronx, NY 10461-0531.

**VHS-VCR** Repair Solutions Sets I, II, III, IV, V. Each contains 150 symptoms and cures, cross reference chart, free assistance, $11.95 each all five $49.95. Eagle Electronics Box A, 52053 Locks Lane, Granger, IN 46530.

**VIDEO TAPE REPAIR KIT** - has all you need to make a quick permanent repair: a roll of adhesive tapes, VHF leader tape, Beta leader tape, blade, splicing jig, plus instructions. Satisfaction guaranteed. $8.95 + $2.40 SH & I. Montraco, 745 Place, Fortier, #709, St. Laurent, Quebec H4L 5A6, Canada.

## ELECTRONICS

**VOICE** Disguisers! FM Bugs! Telephone Transmitters! Phone Snoops! Bug Detectors! More! Catalog $1.00: XANDI ELECTRONICS, Box 25647, "SS", Tempe, AZ 85285-5647.

**TUBES**, New, up to 90% off, S.A.S.E., Kerby, 298 West Carmel Drive, Carmel, IN 46032.

**ELECTRONIC COMPONENTS Free** 192 page catalog including capacitors, resistors, relays, connectors, soldering equipment and supplies. Box 699, Mansfield, TX 76063. **1-800-992-9943.**

**LASER LISTENER** II, other projects. Bugging, descrambling, false identification, information. Plans, kits, other strange stuff. Informational package $3.00 refundable. DIRIJO/BOND ELECTRONICS, BOX 212, LOWELL, NC 28098.

**DETECTION**—Surveillance, Debugging. Plans, Kits, Assembled Devices. Latest High-Tech Catalog $5. DETECTION SYSTEMS, 2515 E. Thomas, #16-864H, Phoenix, Arizona, 85016.

**KINETIKITS** from **KINETICO:** electronic kits outputting light or sound. Free catalog: **KINETICO,** P.O. Box 1634, NY, NY 10114-0508.

**PROTECT YOUR HOME AND BUSINESS** FROM ELECTRONIC EAVESDROPPING AND WIRE TAPPING! COMPLETE COUNTER MEASURES CATALOG, $3.00 "REFUNDABLE." **DIVERSIFIED WHOLESALE PRODUCTS,** BOX 1275-ME, REDONDO BEACH, CA 90278.

**ELECTRONIC** Test Equipment, Laboratory Equipment, Experimenter's Items.—Industrial and Government Surplus and priced cheap! Send $1.00 for catalog to: Lehman, R.D. 1, Box 580, Wrightsville, PA 17368.

**MINIATURE** Electronics like James Bond. Catalog $3.00, refundable. F & P Enterprises, Box 51272, Palo Alto, Calif. 94303-H.

**POWER SUPPLY**—versatile! +1-15V (3A), −1-15V (1.5A) and +5V (1.5A), with **Digital Display** of voltage, current. Includes 60Hz TTL output. **Detailed Plans** US $4.95. SASE brings information. Classic Designs, Box 142, Lachine, Que., Canada H8S 4A6.

## COMPUTERS

**AMIGA - COMMODORE UPGRADES PARTS, ETC;** 1.3 kickstart ROM upgrade/$27.95, 6526/$12.25, 6567/$15.95, 6581/$10.95, PLA/$12.95, 901 ROMS/$10.95, A501/801 upgrade RAM module/$129.50 . . . NEW AMIGA UPGRADE - 1 MEGABYTE "Fatter Agnus" 8372/$109.50 instructions . . . Just out—Commodore Diagnostician II, A newly revised/updated version that locates faulty chips on all "64/128" computers including 1541 drives. This fantastic tool sold to over 10,000. (Fantastic full page review in 3/88 Computer Shopper). Cost is $6.95 prepaid. The Grapevine Group, Inc., 35 Charlotte Drive, Wesley Hills, NY 10977, 1-800-292-7445/(914) 354-4448. (MC/VISA). Send for catalog.

**ENGINEERING** Software, PC/MSDOS. Hobbyists - Students - Engineers. Circuit Design $59, FFT Analysis $69, Mathematics $49, Logic Simulation $49, Circuit Analysis $29. FREE Catalog, (614) 491-0832, **BSOFT SOFTWARE,** 444 Colton Rd., Columbus, OH 43207.

**KJV** OT/NT BIBLE SOFTWARE, CONCORDANCE, SEARCH KEY in IBM-MACINTOSH, SPECIAL $99 /NT $49.00. COMSPEC, BOX 5601, EVERETT, WA 98206.

# Digi-Key CORPORATION — 1-800-344-4539

AK, Puerto Rico — 218-681-6674  FAX — 218-681-3380  TWX — 9103508982 DIGI KEY CORP

## INTEGRATED CIRCUITS

### 7400 TTL

| Part | Price |
|---|---|
| 7400N | .35 |
| 7401N | .35 |
| 7402N | .35 |
| 7403N | .35 |
| 7404N | .35 |
| 7405N | .43 |
| 7406N | .48 |
| 7407N | .48 |
| 7408N | .43 |
| 7409N | .43 |
| 7410N | .43 |
| 7414N | .50 |
| 7416N | .35 |
| 7417N | .35 |
| 7420N | .33 |
| 7426N | .33 |
| 7427N | .43 |
| 7430N | .30 |
| 7432N | .35 |
| 7437N | .40 |
| 7438N | .40 |
| 7440N | .48 |
| 7442N | .55 |
| 7445N | .98 |
| 7446AN | .98 |
| 7447AN | 1.20 |
| 7450N | .42 |
| 7451N | .48 |
| 7453N | .34 |
| 7459N | .30 |
| 7460N | .34 |
| 7473N | .48 |
| 7474N | .48 |
| 7475N | .50 |
| 7476N | .48 |
| 7485N | .70 |
| 7486N | .48 |
| 7489N | 7.50 |
| 7490N | .55 |
| 7493AN | .55 |
| 7495N | .53 |
| 74107N | .53 |
| 74109N | .53 |
| 74121N | .60 |
| 74123N | .58 |
| 74125N | .60 |
| 74132N | .75 |
| 74145N | 1.03 |
| 74148N | 1.10 |
| 74150N | 1.58 |
| 74151AN | .63 |
| 74153N | .63 |
| 74154N | 1.58 |
| 74155N | .80 |
| 74157N | .80 |
| 74161AN | .75 |
| 74164N | .75 |
| 74166N | .90 |
| 74173N | 1.00 |
| 74174N | .63 |
| 74175N | .63 |
| 74180N | .90 |
| 74181N | 2.50 |
| 74182N | 1.15 |
| 74184N | 3.45 |
| 74185AN | 3.37 |
| 74191N | .90 |
| 74193N | .90 |
| 74194N | .90 |
| 74197N | 1.05 |
| 74251N | 1.17 |
| 74365N | .65 |
| 74367N | .70 |
| 74368N | .70 |
| 75450N | .70 |
| 75451N | .50 |
| 75452N | .50 |
| 75453N | .50 |
| 75454N | .50 |
| 75491N | 1.00 |
| 75492N | 1.12 |
| 75493N | 1.38 |
| 75494N | 1.38 |

### 74LS00 TTL

| Part | Price |
|---|---|
| 74LS00N | .32 |
| 74LS02N | .32 |
| 74LS03N | .32 |
| 74LS04N | .31 |
| 74LS05N | .32 |
| 74LS08N | .32 |
| 74LS09N | .32 |
| 74LS10N | .32 |
| 74LS11N | .32 |
| 74LS12N | .32 |
| 74LS14N | .45 |
| 74LS15N | .36 |
| 74LS20N | .32 |
| 74LS21N | .32 |
| 74LS26N | .32 |
| 74LS27N | .32 |
| 74LS30N | .32 |
| 74LS32N | .32 |
| 74LS37N | .33 |
| 74LS38N | .33 |
| 74LS42N | .60 |
| 74LS51N | .45 |
| 74LS55N | .38 |
| 74LS73AN | .42 |
| 74LS74AN | .42 |
| 74LS75N | .42 |
| 74LS78N | .52 |
| 74LS83AN | .66 |
| 74LS85N | .66 |
| 74LS86N | .39 |
| 74LS90N | .51 |
| 74LS93N | .51 |
| 74LS107AN | .48 |
| 74LS109AN | .45 |
| 74LS112AN | .45 |
| 74LS122N | .68 |
| 74LS123N | .63 |
| 74LS125AN | .48 |
| 74LS126AN | .60 |
| 74LS132N | .63 |
| 74LS136N | .54 |
| 74LS138N | .54 |
| 74LS139N | .60 |
| 74LS151N | .51 |
| 74LS153N | .57 |
| 74LS154N | 1.44 |
| 74LS155N | .60 |
| 74LS156N | .57 |
| 74LS157N | .54 |
| 74LS158N | .54 |
| 74LS161AN | .69 |
| 74LS163N | .69 |
| 74LS164N | .69 |
| 74LS169N | 1.23 |
| 74LS174N | .57 |
| 74LS175N | .57 |
| 74LS190N | .81 |
| 74LS191N | .81 |
| 74LS193N | .91 |
| 74LS195AN | .78 |
| 74LS221N | .93 |
| 74LS240N | .66 |
| 74LS241N | .66 |
| 74LS243N | .66 |
| 74LS244N | .66 |
| 74LS245 | .88 |
| 74LS249N | 1.24 |
| 74LS251N | .60 |
| 74LS253N | .60 |
| 74LS257BN | .60 |
| 74LS258BN | .60 |
| 74LS279N | .54 |
| 74LS283N | .78 |
| 74LS290N | .90 |
| 74LS293N | .40 |
| 74LS352N | 1.17 |
| 74LS365AN | .54 |
| 74LS366AN | .54 |
| 74LS367N | .54 |
| 74LS368AN | .54 |
| 74LS373N | .66 |
| 74LS374N | .66 |
| 74LS670N | 1.44 |
| 81LS95N | 1.91 |
| 81LS96AN | 1.89 |
| 81LS97AN | 1.89 |
| 81LS98N | 1.89 |

### 74S00 TTL

| Part | Price |
|---|---|
| 74S00N | .35 |
| 74S02N | .35 |
| 74S03N | .35 |
| 74S04N | .35 |
| 74S05N | .35 |
| 74S08N | .35 |
| 74S09N | .38 |
| 74S10N | .38 |
| 74S11N | .38 |
| 74S15N | .50 |
| 74S20N | .38 |
| 74S22N | .54 |
| 74S30N | .46 |
| 74S32N | .46 |
| 74S40N | .46 |
| 74S51N | .45 |
| 74S64N | .45 |
| 74S65N | .55 |
| 74S74N | .43 |
| 74S86N | .45 |
| 74S112N | .50 |
| 74S113N | .50 |
| 74S114N | .82 |
| 74S133N | .45 |
| 74S134N | .71 |
| 74S135N | 1.12 |
| 74S138N | .88 |
| 74S139N | .88 |
| 74S140N | .58 |
| 74S151N | .85 |
| 74S153N | .85 |
| 74S157N | .85 |
| 74S158N | .85 |
| 74S161N | 2.38 |
| 74S163N | 2.38 |
| 74S174N | .63 |
| 74S175N | .63 |
| 74S181N | 2.48 |
| 74S182N | 1.75 |
| 74S188N | 1.70 |
| 74S194N | 1.43 |
| 74S195N | 1.43 |
| 74S240N | 1.63 |
| 74S241N | 1.63 |
| 74S243N | 3.50 |
| 74S244N | 1.63 |
| 74S251N | 1.05 |
| 74S253N | .90 |
| 74S257N | 1.30 |
| 74S258N | .90 |
| 74S280N | 1.68 |
| 74S283N | 1.63 |
| 74S287N | 2.00 |
| 74S288N | 1.70 |
| 74S373N | 1.75 |
| 74S374N | 1.75 |
| 74S387N | 1.95 |
| 74S412N | 4.80 |
| 74S471N | 4.80 |
| 74S474N | 4.80 |
| 74S475N | 4.80 |
| 74S570N | 3.75 |
| 74S571N | 3.75 |
| 74S572N | 4.50 |
| 74S573N | 5.00 |
| 74S940N | 3.50 |
| 74S941N | 3.50 |

### 74C00 CMOS

| Part | Price |
|---|---|
| 74C00N | .45 |
| 74C02N | .45 |
| 74C04N | .28 |
| 74C08N | .45 |
| 74C10N | .45 |
| 74C14N | .33 |
| 74C20N | .45 |
| 74C30N | .45 |
| 74C32N | .48 |
| 74C42N | 1.05 |
| 74C48N | 1.33 |
| 74C73N | .65 |
| 74C74N | .63 |
| 74C76N | .65 |
| 74C83N | 1.60 |
| 74C85N | 1.60 |
| 74C86N | .28 |
| 74C89N | 5.00 |
| 74C90N | 1.23 |
| 74C93N | 1.23 |
| 74C95N | 1.50 |
| 74C107N | .65 |
| 74C150N | 3.98 |
| 74C151N | 2.60 |
| 74C154N | 3.98 |
| 74C157N | 2.60 |
| 74C160N | .83 |
| 74C161N | .83 |
| 74C162N | .83 |
| 74C163N | .83 |
| 74C164N | 1.23 |
| 74C165N | 1.23 |
| 74C173N | .80 |
| 74C174N | .55 |
| 74C175N | .55 |
| 74C192N | 1.10 |
| 74C193N | 1.10 |
| 74C195N | .78 |
| 74C221N | 1.50 |
| 74C240N | 1.98 |
| 74C244N | 1.98 |
| 74C373N | 2.23 |
| 74C374N | 2.23 |
| 74C901N | .55 |
| 74C902N | .55 |
| 74C903N | .55 |
| 74C904N | .55 |
| 74C905N | 8.25 |
| 74C906N | .55 |
| 74C907N | .55 |
| 74C908N | 1.33 |
| 74C909N | 2.45 |
| 74C910N | 6.88 |
| 74C911N | 10.45 |
| 74C912N | 10.45 |
| 74C914N | .95 |
| 74C915N | 1.63 |
| 74C917N | 10.45 |
| 74C918N | 1.60 |
| 74C922N | 4.23 |
| 74C923N | 4.23 |
| 74C925N | 6.38 |
| 74C926N | 6.38 |
| 74C927N | 6.38 |
| 74C928N | 6.38 |
| 74C932N | 1.23 |
| 74C941N | 1.98 |
| 74C945N | 11.25 |
| 74C947N | 11.25 |

| Part | Price |
|---|---|
| 80C95N | .55 |
| 80C96N | .55 |
| 80C98N | .55 |
| 82C19N | 3.98 |

### 74HC00 CMOS

| Part | Price |
|---|---|
| 74HC00N | .28 |
| 74HC02N | .28 |
| 74HC04N | .28 |
| 74HC08N | .28 |
| 74HC10N | .28 |
| 74HC11N | .28 |
| 74HC14N | .39 |
| 74HC20N | .28 |
| 74HC27N | .28 |
| 74HC30N | .28 |
| 74HC32N | .28 |
| 74HC42N | .72 |
| 74HC73N | .39 |
| 74HC74AN | .36 |
| 74HC75N | .39 |
| 74HC76N | .50 |
| 74HC85N | .85 |
| 74HC86N | .45 |
| 74HC107N | .53 |
| 74HC112N | .53 |
| 74HC113N | .53 |
| 74HC123N | .98 |
| 74HC125N | .48 |
| 74HC126N | .53 |
| 74HC132N | .38 |
| 74HC138N | .45 |
| 74HC139N | .45 |
| 74HC147N | .73 |
| 74HC151N | .55 |
| 74HC153N | .55 |
| 74HC154N | 1.13 |
| 74HC157N | .63 |
| 74HC158N | .63 |
| 74HC160N | .68 |
| 74HC161N | .63 |
| 74HC162N | .63 |
| 74HC163N | .63 |
| 74HC164N | .63 |
| 74HC165N | .58 |
| 74HC174N | .58 |
| 74HC175N | .58 |
| 74HC193N | .78 |
| 74HC194N | .78 |
| 74HC195N | .78 |
| 74HC221N | 1.10 |
| 74HC240N | .75 |
| 74HC241N | .75 |
| 74HC242N | .78 |
| 74HC243N | .78 |
| 74HC244N | .75 |
| 74HC245N | .82 |
| 74HC251N | .80 |
| 74HC253N | .65 |
| 74HC257N | .63 |
| 74HC259N | .75 |
| 74HC266AN | .38 |
| 74HC280N | .90 |
| 74HC299N | 1.35 |
| 74HC354N | 1.10 |
| 74HC356N | 1.10 |
| 74HC365N | .78 |
| 74HC366N | .78 |
| 74HC367N | .78 |
| 74HC368N | .78 |
| 74HC373N | .75 |
| 74HC374N | .75 |
| 74HC390N | .70 |
| 74HC393N | .70 |
| 74HC533N | .98 |
| 74HC534N | .98 |
| 74HC564N | 1.53 |
| 74HC574N | 1.10 |
| 74HC640N | 1.75 |
| 74HC643N | 1.75 |
| 74HC688N | .88 |
| 74HC4002N | .28 |
| 74HC4020N | .93 |
| 74HC4040N | .93 |
| 74HC4049N | .70 |
| 74HC4050N | .70 |
| 74HC4060N | 1.10 |
| 74HC4075N | .28 |
| 74HC4078N | .30 |
| 74HC4306 | 1.64 |
| 74HC4514N | 1.50 |
| 74HC4538N | 1.05 |
| 74HC4543N | 1.37 |

### 4000 CMOS

| Part | Price |
|---|---|
| 4001BCN | .27 |
| 4002BCN | .40 |
| 4006BCN | .63 |
| 4007CN | .28 |
| 4008CN | .65 |
| 4009CN | .35 |
| 4010CN | .38 |
| 4011BCN | .28 |
| 4012BCN | .28 |
| 4013BCN | .30 |
| 4014BCN | .70 |
| 4015BCN | .55 |
| 4016BCN | .30 |
| 4017BCN | .70 |
| 4018BCN | .70 |
| 4019BCN | .35 |
| 4020BCN | .60 |
| 4021BCN | .60 |
| 4022BCN | .55 |
| 4023BCN | .28 |
| 4024BCN | .45 |
| 4025BCN | .28 |
| 4027BCN | .33 |
| 4028BCN | .55 |
| 4029BCN | .75 |
| 4030CN | .30 |
| 4031B | .83 |
| 4034BCN | 1.13 |
| 4035BCN | .75 |
| 4040BCN | .60 |
| 4041CN | .63 |
| 4042BCN | .63 |
| 4043BCN | .63 |
| 4044BCN | .63 |
| 4046BCN | .65 |
| 4047BCN | .75 |
| 4048BCN | .35 |
| 4049CN | .33 |
| 4050BCN | .33 |
| 4051BCN | .55 |
| 4052BCN | .55 |
| 4053BCN | .55 |
| 4060BCN | .58 |
| 4066BCN | .33 |
| 4071BCN | .28 |
| 4072BCN | .50 |
| 4073BCN | .28 |
| 4075BCN | .28 |
| 4081BCN | .28 |
| 4082B | .28 |
| 4089BCN | 1.00 |
| 4093BCN | .30 |
| 4099BCN | .78 |
| 4503BCN | .33 |
| 4510BCN | .80 |
| 4511BCN | .80 |
| 4512BCN | .80 |
| 4514BCN | 1.08 |
| 4515BCN | 1.08 |
| 4516BCN | .83 |
| 4518BCN | .83 |
| 4519BCN | .48 |
| 4520BCN | .73 |
| 4522BCN | .90 |
| 4526BCN | 1.03 |
| 4527BCN | .88 |
| 4528BCN | .83 |
| 4529BCN | .83 |
| 4541BCN | .78 |
| 4543BCN | .90 |
| 4723BCN | .95 |
| 4724BCN | .83 |

### Linear

| Part | Price |
|---|---|
| LF347N | 1.20 |
| LF351N | .60 |
| LF353N | 1.05 |
| LF355N | 1.20 |
| LF356N | 1.20 |
| LF357N | 1.50 |
| LF398N | 3.36 |
| LF411CN | 1.05 |
| LF412CN | 1.74 |
| LF441CN | .90 |
| LF444CN | 1.80 |
| LF13741N | .78 |
| LM10CLN | 2.70 |
| LM11CLN | 2.55 |
| LM34CZ | 6.00 |
| LM35CZ | 8.00 |
| LM301AN | .57 |
| LM307N | .75 |
| LM308N | .90 |
| LM311N | .54 |
| LM317K | 4.95 |
| LM317LZ | .92 |
| LM317MP | .86 |
| LM317T | .99 |
| LM318N | 1.65 |
| LM319N | 1.50 |
| LM320LZ 5.0 | .72 |
| LM320LZ 12 | .60 |
| LM320LZ 15 | .72 |
| LM320MP-5 | 2.25 |
| LM320MP-12 | 1.90 |
| LM320MP 15 | 1.95 |
| LM322N | 2.40 |
| LM323K | 8.25 |
| LM324N | .54 |
| LM325N | 5.12 |
| LM326N | 6.00 |
| LM327N | 3.38 |
| LM329DZ | .81 |
| LM331N | 5.25 |
| LM334Z | 1.65 |
| LM335Z | 2.10 |
| LM336Z 2.5 | 1.20 |
| LM336Z-5.0 | 1.20 |
| LM337K | 7.65 |
| LM337MP | 1.80 |
| LM337T | 1.95 |
| LM338K | 10.20 |
| LM339N | .51 |
| LM340KC-5 | 2.10 |
| LM340KC 12 | 2.10 |
| LM340KC 15 | 2.10 |
| LM340T 5 | .87 |
| LM340T 12 | .87 |
| LM340T 15 | .79 |
| LM341P 5 | .90 |
| LM341P-12 | 1.00 |
| LM341P 15 | .90 |
| LM346N | 1.65 |
| LM348N | .90 |
| LM349N | 1.35 |
| LM350K | 7.50 |
| LM350T | 4.95 |
| LM358N | .51 |
| LM359N | 2.40 |
| LM380N | 1.50 |
| LM380N 8 | 1.50 |
| LM381N | 2.61 |
| LM382N | 1.86 |
| LM383AT | 4.05 |
| LM384N | 2.55 |
| LM386N-1 | .81 |
| LM387N | 1.65 |
| LM389N | 1.38 |
| LM390N | 1.32 |
| LM391N 60 | 2.00 |
| LM391N-100 | 2.40 |
| LM392N | .75 |
| LM393N | .51 |
| LM395P | 2.40 |
| LM395T | 3.00 |
| LM395K | 10.50 |
| LM396K | 21.00 |
| LM555CN | .75 |
| LM556CN | .90 |
| LM565CN | 1.95 |
| LM566CN | 1.56 |
| LM567CN | 1.11 |
| LM709CN | .75 |
| LM723CN | .75 |
| LM725CN | 2.70 |
| LM733CN | .84 |
| LM741CN | .51 |
| LM747CN | .72 |
| LM748CN | .72 |
| LM1458N | .54 |
| LM1496N | 1.50 |
| LM1800N | 1.95 |
| LM1801N | 1.35 |
| LM1812N | 12.30 |
| LM1830N | 2.55 |
| LM1870N | 3.00 |
| LM1871N | 2.40 |
| LM1872N | 2.55 |
| LM1875T | 5.25 |
| LM1889N | 2.16 |
| LM2900N | 1.50 |
| LM2901N | .60 |
| LM2902N | .60 |
| LM2903N | .57 |
| LM2904N | .57 |
| LM2905N | 3.90 |
| LM2907N | 1.80 |
| LM2907N-8 | 2.70 |
| LM2917N | 2.25 |
| LM2917N 8 | 2.25 |
| LM2924N | 2.61 |
| LM2931Z-5.0 | .66 |
| LM2931T-5.0 | .95 |
| LM2931CT | 1.65 |
| LM3046N | 1.35 |
| LM3080N | 1.26 |
| LM3086N | .84 |
| LM3089N | 2.55 |
| LM3301N | .99 |
| LM3302N | .99 |
| LM3401N | 1.02 |
| LM3524N | 3.75 |
| LM3900N | .69 |
| LM3905N | 1.80 |
| LM3909N | 1.50 |
| LM3911N | 2.25 |
| LM3914N | 2.85 |
| LM3915N | 2.85 |
| LM3916N | 2.85 |
| LM78L05ACZ | .48 |
| LM78L12ACZ | .54 |
| LM78L15ACZ | .54 |
| LM7905CT | .93 |
| LM7912CT | .96 |
| LM7915CT | .96 |
| LM13080N | 1.80 |
| LM13600 | 1.44 |
| MF10CCN | 4.20 |
| AN7805 | .75 |
| AN7806 | .75 |
| AN7807 | .75 |
| AN7808 | .75 |
| AN7809 | .75 |
| AN7810 | .75 |
| AN7812 | .75 |
| AN7815 | .75 |
| AN7818 | .75 |
| AN7820 | .75 |
| AN78L04 | .43 |
| AN78L05 | .43 |
| AN78L06 | .43 |
| AN78L07 | .43 |
| AN78L08 | .43 |
| AN78L09 | .43 |
| AN78L10 | .43 |
| AN78L12 | .43 |
| AN78L15 | .43 |
| AN78L18 | .43 |
| AN78L20 | .43 |
| AN78L24 | .43 |
| AN78M05 | .63 |
| AN78M06 | .63 |
| AN78M07 | .63 |
| AN78M08 | .63 |
| AN78M09 | .63 |
| AN78M10 | .63 |
| AN78M12 | .63 |
| AN78M15 | .63 |
| AN78M18 | .63 |
| AN78M20 | .63 |
| AN78M24 | .63 |
| AN7905 | .75 |
| AN7906 | .75 |
| AN7907 | .75 |
| AN7908 | .75 |
| AN7909 | .75 |
| AN7910 | .75 |
| AN7912 | .75 |
| AN7915 | .75 |
| AN7918 | .75 |
| AN7920 | .75 |
| AN7924 | .75 |
| AN79L04 | .43 |
| AN79L05 | .43 |
| AN79L06 | .43 |
| AN79L07 | .43 |
| AN79L08 | .43 |
| AN79L09 | .43 |
| AN79L10 | .43 |
| AN79L12 | .43 |
| AN79L15 | .43 |
| AN79L18 | .43 |
| AN79L20 | .43 |
| AN79L24 | .43 |
| AN79M05 | .33 |
| AN79M06 | .33 |
| AN79M07 | .33 |
| AN79M08 | .33 |
| AN79M09 | .33 |
| AN79M10 | .33 |
| AN79M12 | .33 |
| AN79M15 | .33 |
| AN79M18 | .33 |
| AN79M20 | .33 |
| AN79M24 | .33 |

### Memory

| Part | Price |
|---|---|
| MM2147N | 17.[illegible] |
| MM5257N | 2.[illegible] |
| 74C200N | 9.[illegible] |
| 74C910N | 6.[illegible] |
| 74S188N | 1.[illegible] |
| 74S189N | 2.[illegible] |
| 74S287N | 2.[illegible] |
| 74S288N | 1.[illegible] |
| 74S289N | 2.[illegible] |
| 74S387N | 1.[illegible] |
| 74S472AN | 4.[illegible] |
| 74S473AN | 4.[illegible] |
| 74S474AN | 4.[illegible] |
| 74S475AN | 4.[illegible] |
| 74S570N | 3.[illegible] |
| 74S571N | 3.[illegible] |
| 74S572N | 4.[illegible] |
| 74S573N | 4.[illegible] |

### Micro.

| Part | Price |
|---|---|
| COP402N | 7.[illegible] |
| COP470N | 4.[illegible] |
| COP498N | 5.[illegible] |
| COP499N | 5.[illegible] |
| DP8212N | 3.[illegible] |
| DP8216N | 2.[illegible] |
| DP8224N | 3.[illegible] |
| DP8226N | 2.[illegible] |
| DP8228N | 6.[illegible] |
| DP8238N | 6.[illegible] |
| DP8300N | 6.[illegible] |
| DP8303AN | 2.[illegible] |
| DP8304BN | 1.[illegible] |
| DP8307AN | 3.[illegible] |
| DP8308N | 2.[illegible] |
| DP8310N | 5.[illegible] |
| DP8311N | 5.[illegible] |
| INS8035LN 6 | 3.[illegible] |
| INS8035N 11 | 3.[illegible] |
| INS8039N 6 | 3.[illegible] |
| INS8039N 11 | 5.[illegible] |
| INS8154N | 17.[illegible] |
| ISP 8F 352 | 25.[illegible] |
| MM58167AN | 10.[illegible] |
| MM58174AN | 10.[illegible] |
| NSC800N | 18.[illegible] |
| NSC800 1 | 9.[illegible] |
| DM8334N | 2.[illegible] |

### A/D & D/A

| Part | Price |
|---|---|
| ADC0803LCN | 7.[illegible] |
| ADC0804LCN | 4.[illegible] |
| ADC0805LCN | 5.[illegible] |
| ADC0808CCN | 8.[illegible] |
| ADC0809CCN | 4.[illegible] |
| ADC0816CCN | 18.[illegible] |
| ADC0817CCN | 11.25 |
| ADC0833CCN | 5.[illegible] |
| ADC1001CCJ | 32.[illegible] |
| ADC3511CCN | 8.[illegible] |
| ADC3711CCN | 8.[illegible] |
| ADD3501CCN | 8.[illegible] |
| ADD3701CCN | 8.[illegible] |
| DAC0800LCN | 1.35 |
| DAC0807LCN | 1.[illegible] |
| DAC0808LCN | 1.35 |
| DAC0830LCN | 6.[illegible] |
| DAC0832LCN | 3.[illegible] |
| DAC1020LCN | 7.[illegible] |
| DAC1022LCN | 5.[illegible] |
| MM5369AAN | 1.33 |
| MM5369EST | 1.53 |

### Interface

| Part | Price |
|---|---|
| DS1488N | .35 |
| DS1489AN | 1.20 |
| DS1489N | .35 |
| 75450N | .37 |
| 75451N | .70 |
| 75452N | .70 |
| 75453N | .70 |
| 75454N | .70 |
| 75491N | 1.30 |
| 75492N | 1.32 |
| 75493N | 1.37 |
| 75494N | 1.37 |

## SILICON TRANSISTORS

| Digi-Key Part No. | Pac Price | Digi-Key Part No. | Pac Price | Digi-Key Part No. | Pac Price |
|---|---|---|---|---|---|
| 2N3117 | 1.37 | 2N5416 | 2.00 | MPS3393 | .27 |
| 2N3055 | 1.47 | 2N5457 | .60 | MPS3565 | .23 |
| 2N3439 | 1.75 | 2N5550 | .30 | MPS3638A | .23 |
| 2N3440 | 1.40 | 2N5679 | 2.55 | MPS3641 | .30 |
| 2N3700 | 1.00 | 2N5680 | 2.50 | MPS3646 | .52 |
| 2N3724 | 1.06 | 2N5681 | 2.60 | MPS3704 | .27 |
| 2N3903 | .23 | 2N5682 | 2.60 | MPS5172 | .23 |
| 2N3904 | .23 | 2N5769 | .32 | MPS5551 | .65 |
| 2N3905 | .14 | 2N5771 | 1.25 | MPS6514 | .24 |
| 2N3906 | .23 | 2N5772 | .31 | MPS6515 | .28 |
| 2N3962 | 1.16 | 2N5830 | .65 | MPS6520 | .24 |
| 2N4030 | 1.12 | 2N5831 | .70 | MPS6560 | .41 |
| 2N4032 | 1.12 | 2N5833 | .75 | MPS6561 | .45 |
| 2N4033 | 1.24 | 2N5961 | .51 | MPS918 | .45 |
| 2N4036 | 1.40 | 2N6715 | .35 | MPSA10 | .27 |
| 2N4037 | 1.40 | 2N6725 | .49 | MPSA12 | .52 |
| 2N4123 | .23 | 2N6727 | .35 | MPSA13 | .52 |
| 2N3124 | .23 | 2N697 | 1.30 | MPSA14 | .30 |
| 2N4125 | .23 | 2N718A | 1.15 | MPSA42 | .45 |
| 2N4126 | .23 | 2N1132A | 2.04 | MPSA43 | .45 |
| 2N4208 | 1.25 | 2N1613 | .92 | MPSA92 | .45 |
| 2N4209 | 2.10 | 2N1893 | 1.14 | MPSA93 | .45 |
| 2N4234 | 2.10 | 2N2218 | .95 | MPSL01 | .36 |
| 2N4235 | 2.30 | 2N2218A | .95 | PN2222 | .24 |
| 2N4236 | 2.30 | 2N2219 | .76 | MPSL51 | .36 |
| 2N4237 | 2.30 | 2N2219A | .76 | PN2222A | .23 |
| 2N4238 | 2.30 | 2N2221 | .80 | PN2369 | .25 |
| 2N4239 | 2.30 | 2N2221A | .80 | PN2369A | .25 |
| 2N4400 | .23 | 2N2222 | .60 | PN2484 | .30 |
| 2N4401 | .23 | 2N2222A | .60 | PN2907 | .23 |
| 2N4402 | .23 | 2N2369 | .60 | PN2907A | .23 |
| 2N4403 | .23 | 2N2369A | .60 | PN3251 | .39 |
| 2N4410 | .36 | 2N2405 | 1.45 | PN3565 | .28 |
| 2N4896 | 2.90 | 2N2484 | .84 | PN3566 | .31 |
| 2N5086 | .28 | 2N2904 | .95 | PN3567 | .28 |
| 2N5087 | .28 | 2N2904A | .95 | PN3569 | .24 |
| 2N5088 | .28 | 2N2905 | .76 | PN3639 | .30 |
| 2N5089 | .28 | 2N2905A | .76 | PN3640 | .30 |
| 2N5210 | .29 | 2N2906 | .80 | PN3641 | .30 |
| 2N5224 | .24 | 2N2906A | .80 | PN3643 | .23 |
| 2N5225 | .23 | 2N2907 | .60 | PN3644 | .32 |
| 2N5226 | .23 | 2N2907A | .60 | PN3645 | .32 |
| 2N5227 | .23 | 2N3013 | .90 | PN4121 | .35 |
| 2N5320 | 2.30 | 2N3014 | 1.10 | PN4122 | .32 |
| 2N5321 | 2.60 | 2N3019 | 1.04 | PN4248 | .34 |
| 2N5322 | 2.30 | 2N3020 | 1.04 | PN4249 | .34 |
| 2N5323 | 1.84 | 2N3053 | 1.04 | PN4250 | .34 |
| 2N5400 | .31 | 2N3107 | 1.30 | PN4250A | .40 |
| 2N5401 | .31 | 2N3108 | 1.30 | PN4258 | .30 |
| 2N5415 | 1.80 | MPS2907A | .23 | PN4274 | .29 |
| | | MPS2924 | .36 | PN4275 | .29 |
| | | MPS3392 | .24 | PN4355 | .36 |

## SILICON TRANSISTORS

### 1 AMP SILICON RECTIFIERS

| Part No. | Description | Pkg. | 1 | 10 | 1000 | 1,000 |
|---|---|---|---|---|---|---|
| 1N4001 | 50 PIV | DO-41 | — | .70 | 5.60 | 49.00 |
| 1N4002 | 100 PIV | DO 41 | — | .75 | 6.00 | 52.50 |
| 1N4003 | 200 PIV | DO 41 | — | .80 | 6.40 | 56.00 |
| 1N4004 | 400 PIV | DO-41 | — | .85 | 6.80 | 59.50 |
| 1N4005 | 600 PIV | DO-41 | — | .88 | 7.00 | 61.25 |
| 1N4006 | 800 PIV | DO 41 | — | .98 | 7.80 | 68.25 |
| 1N4007 | 1000 PIV | DO-41 | — | 1.08 | 8.60 | 75.25 |

### 5% CARBON FILM RESISTORS
**Available in 1/8, 1/4 & 1/2 Watt**

**How To Order:** Take any standard resistor value (i.e. 3.2) and add an "E" for 1/8 watt or a "Q" for 1/4 watt or an "H" for 1/2 watt (i.e. 3.2Ω for 3.2Ω 1/4 watt), this is the Digi-Key part number.

| Pricing | 5 | 200 | 1,000 |
|---|---|---|---|
| 1/8 Watt | .25 | 6.40 | 25.00 |
| 1/4 Watt | .25 | 3.40 | 13.00 |
| 1/2 Watt | .25 | 3.50 | 16.00 |

**1/8 Watt Resistor Assortments**

**RS112** Set of 5 each of the 73 standard 5% 1/8 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pieces). **$9.90**

**RS212** Set of 5 each of the 72 standard 5% 1/8 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pieces). **$9.90**

**1/4 Watt Resistor Assortments**

**RS125** Set of 5 each of the 73 standard 5% 1/4 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pieces). **$9.90**

**RS225** Set of 5 each of the 72 standard 5% 1/4 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pieces). **$9.90**

**1/2 Watt Resistor Assortments**

**RS150** Set of 5 each of the 73 standard 5% 1/2 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohms (365 total pieces). **$9.90**

**RS250** Set of 5 each of the 72 standard 5% 1/2 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pieces). **$9.90**

### 5% WIREWOUND REC. RESISTORS
**Available in 5 & 10 Watt**

**How To Order:** Take any standard resistor value (i.e. 7.5) and add "W5" for 5 watt, or add a "W10" for 10 watt (i.e. 7.5W5 for 7.5Ω 5 watt), this is the Digi-Key part number.

| Pricing | 1 | 10 | 100 | 500 | 1,000 |
|---|---|---|---|---|---|
| 5 Watt | .36 | 3.25 | 26.90 | 100.80 | 162.00 |
| 10 Watt | .41 | 3.78 | 31.90 | 118.00 | 212.00 |

**5 Watt Metal Resistor Assortments**

**RS105** 5 each of values 0.30Ω to 0.91Ω (300 total pieces) **$20.10**

**RS205** 4 each of values 1.0Ω to 9.1Ω (384 total pieces) **$31.30**

**RS305** 4 each of values 10Ω to 91Ω (384 total pieces) **$31.30**

**RS405** 4 each of values 100Ω to 2.0KΩ (288 total pieces) **$31.30**

**10 Watt Resistor Assortments**

**R110** 2 each of all 10 watt standard resistor values listed in the Digi-Key catalog. (196 total pieces) **$68.95**

### 5% METAL OXIDE FILM RESISTORS
**Available in 1 & 2 Watt**

**How To Order:** Take any standard resistor value (i.e. 1.5K) and add a "W1" for 1 watt, or add a "W2" for 2 watt (i.e. 1.5KW1 for 1.5KΩ 1 watt), this is the Digi-Key part number.

| Pricing | 1 | 5 | 100 | 500 | 1,000 |
|---|---|---|---|---|---|
| 1 Watt (0.47-0.91Ω) | .21 | .98 | 12.60 | 56.00 | 101.50 |
| 1 Watt (1.0-1.0MΩ) | .15 | .70 | 9.00 | 40.00 | 72.50 |
| 2 Watt (0.47-0.91Ω) | .23 | 1.06 | 13.15 | 59.40 | 109.40 |
| 2 Watt (1.0-1.0MΩ) | .18 | .85 | 10.50 | 47.50 | 87.50 |

**1 Watt Metal Resistor Assortments**

**RS101** 5 each of values 0.47Ω to 56Ω (255 total pieces) **$26.95**

**RS201** 5 each of values 62Ω to 7.5KΩ (255 total pieces) **$26.95**

**RS301** 5 each of values 8.2KΩ to 1.0M (255 total pieces) **$26.95**

**2 Watt Resistor Assortments**

**RS102** 5 each of values 0.47Ω to 56Ω (255 total pieces) **$29.95**

**RS202** 5 each of values 62Ω to 7.5KΩ (255 total pieces) **$29.95**

**RS302** 5 each of values 8.2KΩ to 1.0M (255 total pieces) **$29.95**

### 1% METAL OXIDE FILM RESISTORS
**Available in 1/4 Watt**

**How To Order:** Take any standard resistor value (i.e. 1.69K) and add an "X" (i.e. 1.69KX), this is the Digi-Key part number.

| Pricing | 5 | 200 | 1,000 |
|---|---|---|---|
| 1/4 Watt | .50 | 7.80 | 30.00 |

**1/4 Watt Metal Film Resistor Assortments**

**RS1X** 5 each of values 10Ω to 97.6Ω (480 total pieces) **$29.95**

**RS2X** 5 each of values 100Ω to 976Ω (480 total pieces) **$29.95**

**RS3X** 5 each of values 1.00KΩ to 9.76KΩ (480 total pieces) **$29.95**

**RS4X** 5 each of values 10.0KΩ to 97.6KΩ (480 total pieces) **$29.95**

**RS5X** 5 each of values 100KΩ to 1.00MΩ (480 total pieces) **$29.95**

## PANASONIC® SU SERIES
**Miniature Aluminum Electrolytic Capacitors**

| WV/Cap. (VDC/µF) | Axial Lead Digi-Key Part No. | Price 1 | Radial Lead Digi-Key Part No. | Price 1 |
|---|---|---|---|---|
| 6.3/47 | P6301 | .25 | — | — |
| 6.3/100 | P6302 | .25 | P6201 | .21 |
| 6.3/220 | P6303 | .35 | P6202 | .21 |
| 6.3/330 | P6304 | .42 | P6203 | .22 |
| 6.3/470 | P6305 | .46 | P6204 | .23 |
| 6.3/1,000 | P6306 | .64 | P6205 | .38 |
| 6.3/2,200 | P6307 | .81 | P6206 | .62 |
| 6.3/3,300 | P6308 | .95 | P6207 | .81 |
| 6.3/4,700 | P6309 | 1.13 | P6208 | 1.01 |
| 6.3/6,800 | P6310 | 1.48 | P6209 | 1.22 |
| 6.3/10,000 | P6311 | 1.97 | P6210 | 1.62 |
| 6.3/15,000 | P6312 | 2.67 | P6211 | 2.64 |
| 6.3/22,000 | P6313 | 3.82 | — | — |
| 10/22 | P6314 | .21 | — | — |
| 10/33 | P6315 | .27 | P6212 | .14 |
| 10/47 | P6316 | .28 | P6213 | .14 |
| 10/100 | P6317 | .33 | P6214 | .16 |
| 10/220 | P6318 | .41 | P6215 | .22 |
| 10/330 | P6319 | .49 | P6216 | .24 |
| 10/470 | P6320 | .53 | P6217 | .33 |
| 10/1,000 | P6321 | .73 | P6218 | .42 |
| 10/2,200 | P6322 | .99 | P6219 | .65 |
| 10/3,300 | P6323 | 1.16 | P6220 | .87 |
| 10/4,700 | P6324 | 1.49 | P6221 | 1.19 |
| 10/6,800 | P6325 | 1.86 | P6222 | 1.62 |
| 10/10,000 | P6326 | 2.65 | P6223 | 2.31 |
| 10/15,000 | P6327 | 3.79 | — | — |
| 10/22,000 | P6328 | 5.10 | — | — |
| 16/22 | P6329 | .27 | P6224 | .14 |
| 16/33 | P6330 | .28 | P6225 | .15 |
| 16/47 | P6331 | .33 | P6226 | .16 |
| 16/100 | P6332 | .29 | P6227 | .21 |
| 16/220 | P6333 | .47 | P6228 | .24 |
| 16/330 | P6334 | .53 | P6229 | .31 |
| 16/470 | P6335 | .63 | P6230 | .39 |
| 16/1,000 | P6336 | .82 | P6231 | .50 |
| 16/2,200 | P6337 | 1.13 | P6232 | .95 |
| 16/3,300 | P6338 | 1.53 | P6233 | 1.24 |
| 16/4,700 | P6339 | 1.75 | P6234 | 1.62 |
| 16/6,800 | P6340 | 2.14 | P6235 | 2.31 |
| 16/10,000 | P6341 | 4.04 | — | — |
| 16/15,000 | P6342 | 5.16 | — | — |
| 25/10 | P6343 | .21 | — | — |
| 25/22 | P6344 | .26 | P6236 | .15 |
| 25/33 | P6345 | .29 | P6237 | .16 |
| 25/47 | P6346 | .34 | P6238 | .20 |
| 25/100 | P6347 | .42 | P6239 | .22 |
| 25/220 | P6348 | .49 | P6240 | .33 |
| 25/330 | P6349 | .57 | P6241 | .42 |
| 25/470 | P6350 | .66 | P6242 | .50 |
| 25/1,000 | P6351 | .89 | P6243 | .82 |
| 25/2,200 | P6352 | 1.35 | P6744 | 1.24 |
| 25/3,300 | P6353 | 1.71 | P6245 | 1.74 |
| 25/4,700 | P6354 | 2.55 | P6246 | 2.48 |
| 25/6,800 | P6355 | 3.79 | — | — |
| 25/10,000 | P6356 | 4.95 | — | — |
| 35/4.7 | P6357 | .21 | P6247 | .14 |
| 35/10 | P6358 | .26 | P6248 | .14 |
| 35/22 | P6359 | .29 | P6249 | .20 |
| 35/33 | P6360 | .35 | P6250 | .21 |
| 35/47 | P6361 | .42 | P6251 | .23 |
| 35/100 | P6362 | .46 | P6252 | .26 |
| 35/220 | P6363 | .56 | P6253 | .42 |
| 35/330 | P6364 | .66 | P6254 | .53 |
| 35/470 | P6365 | .72 | P6255 | .65 |
| 35/1,000 | P6366 | 1.03 | P6256 | .97 |
| 35/2,200 | P6367 | 1.71 | P6257 | 1.74 |
| 35/3,300 | P6368 | 2.24 | P6258 | 2.48 |
| 35/4,700 | P6369 | 3.47 | — | — |
| 35/6,800 | P6370 | 4.88 | — | — |
| 50/0.47 | — | — | P6259* | .13 |
| 50/1.0 | — | — | P6260* | .13 |
| 50/2.2 | — | — | P6261* | .13 |
| 50/3.3 | P6371 | .21 | P6262* | .14 |
| 50/4.7 | P6372 | .26 | P6263* | .14 |
| 50/10 | P6373 | .26 | P6264* | .16 |
| 50/22 | P6374 | .35 | P6265* | .22 |
| 50/33 | P6375 | .41 | P6266* | .23 |
| 50/47 | P6376 | .45 | P6267* | .24 |
| 50/100 | P6377 | .49 | P6268* | .38 |
| 50/220 | P6378 | .70 | P6269* | .53 |
| 50/330 | P6379 | .79 | P6270* | .77 |
| 50/470 | P6380 | .95 | P6271* | .90 |
| 50/1,000 | P6381 | 1.38 | P6272* | 1.34 |
| 50/2,200 | P6382 | 2.52 | P6273* | 2.38 |
| 50/3,300 | P6383 | 3.63 | — | — |
| 50/4,700 | P6384 | 4.79 | — | — |
| 63/0.47 | P6385 | .21 | P6274 | .14 |
| 63/1.0 | P6386 | .21 | P6275 | .14 |
| 63/2.2 | P6387 | .21 | P6276 | .15 |
| 63/3.3 | P6388 | .21 | P6277 | .16 |
| 63/4.7 | P6389 | .29 | P6278 | .16 |
| 63/10 | P6390 | .34 | P6279 | .18 |
| 63/22 | P6391 | .42 | P6280 | .24 |
| 63/33 | P6392 | .47 | P6281 | .27 |
| 63/47 | P6393 | .50 | P6282 | .40 |
| 63/100 | P6394 | .59 | P6283 | .53 |
| 63/220 | P6395 | .78 | P6284 | .77 |
| 63/330 | P6396 | .92 | P6285 | .97 |
| 63/470 | P6397 | 1.12 | P6286 | 1.14 |
| 63/1,000 | P6398 | 1.75 | P6287 | 1.74 |
| 63/2,200 | P6399 | 3.53 | — | — |
| 63/3,300 | P6400 | 4.83 | — | — |
| 100/0.47 | P6401 | .21 | P6288 | .21 |
| 100/1.0 | P6402 | .21 | P6289 | .22 |
| 100/2.2 | P6403 | .26 | P6290 | .23 |
| 100/3.3 | P6404 | .29 | P6291 | .24 |
| 100/4.7 | P6405 | .34 | P6292 | .26 |
| 100/10 | P6406 | .42 | P6293 | .31 |
| 100/22 | P6407 | .48 | P6294 | .40 |
| 100/33 | P6408 | .54 | P6295 | .46 |
| 100/47 | P6409 | .57 | P6296 | .52 |
| 100/100 | P6410 | .82 | P6297 | .81 |
| 100/220 | P6411 | 1.22 | P6298 | 1.09 |
| 100/330 | P6412 | 1.54 | P6299 | 1.30 |
| 100/470 | P6413 | 2.02 | P6300 | 1.89 |
| 100/1,000 | P6414 | 3.84 | — | — |
| 160/0.47 | — | — | P6415 | .23 |
| 160/1.0 | — | — | P6416 | .24 |
| 160/2.2 | — | — | P6417 | .27 |
| 160/3.3 | — | — | P6418 | .36 |
| 160/4.7 | — | — | P6419 | .37 |
| 160/10 | — | — | P6178 | .46 |
| 160/22 | — | — | P6179 | .65 |
| 160/33 | — | — | P6180 | .85 |
| 160/47 | — | — | P6181 | 1.13 |
| 160/100 | — | — | P6182 | 1.25 |
| 160/220 | — | — | P6183 | 2.15 |
| 250/1.0 | — | — | P6184 | .40 |
| 250/2.2 | — | — | P6185 | .42 |
| 250/3.3 | — | — | P6186 | .43 |
| 250/4.7 | — | — | P6187 | .43 |
| 250/10 | — | — | P6188 | .61 |
| 250/22 | — | — | P6189 | .87 |
| 250/33 | — | — | P6190 | .98 |
| 250/47 | — | — | P6191 | 1.28 |
| 250/100 | — | — | P6192 | 2.19 |
| 450/1.0 | — | — | P6193 | .47 |
| 450/2.2 | — | — | P6194 | .55 |
| 450/3.3 | — | — | P6195 | .73 |
| 450/4.7 | — | — | P6196 | .79 |
| 450/10 | — | — | P6197 | .98 |
| 450/22 | — | — | P6198 | 1.57 |
| 450/33 | — | — | P6199 | 2.04 |

## DISC CAPACITORS

| Part No. | Cap./Volt. (pf)/(V) | Price 10 | Part No. | Cap./Volt. | Price 10 |
|---|---|---|---|---|---|
| P4000 | 10/500 | .71 | P4158 | 10000/50 | 1.24 |
| P4001 | 15/500 | .64 | P4159 | 15000/50 | 1.35 |
| P4002 | 18/500 | .64 | P4160 | 22000/50 | 1.95 |
| P4003 | 22/500 | .64 | P4102 | 100/500 | .68 |
| P4004 | 27/500 | .64 | P4103 | 180/500 | .68 |
| P4005 | 33/500 | .64 | P4104 | 220/500 | .68 |
| P4006 | 39/500 | .64 | P4105 | 270/500 | .68 |
| P4007 | 47/500 | .64 | P4106 | 330/500 | .68 |
| P4008 | 56/500 | .64 | P4107 | 390/500 | .68 |
| P4009 | 68/500 | .64 | P4108 | 470/500 | .79 |
| P4010 | 82/500 | .71 | P4109 | 560/500 | .79 |
| P4011 | 100/500 | .71 | P4110 | 680/500 | .79 |
| P4141 | 1000/25 | .98 | P4111 | 820/500 | .79 |
| P4142 | 1500/25 | .98 | P4112 | 1000/500 | .94 |
| P4143 | 2200/25 | .98 | P4114 | 1500/500 | .94 |
| P4144 | 3300/25 | .98 | P4116 | 100/1K | 1.28 |
| P4145 | 4700/25 | 1.09 | P4117 | 120/1K | 1.28 |
| P4146 | 6800/25 | 1.09 | P4118 | 150/1K | 1.28 |
| P4147 | 10000/25 | 1.13 | P4119 | 180/1K | 1.28 |
| P4148 | 15000/25 | 1.20 | P4120 | 220/1K | 1.28 |
| P4149 | 22000/25 | 1.20 | P4121 | 270/1K | 1.28 |
| P4150 | 33000/25 | 1.76 | P4122 | 330/1K | 1.99 |
| P4152 | 1000/50 | 1.09 | P4123 | 390/1K | 1.99 |
| P4153 | 1500/50 | 1.09 | P4124 | 470/1K | 1.99 |
| P4154 | 2200/50 | 1.09 | P4125 | 560/1K | 1.99 |
| P4155 | 3300/50 | 1.09 | P4126 | 680/1K | 1.99 |
| P4156 | 4700/50 | 1.09 | P4127 | 820/1K | 1.99 |
| P4157 | 6800/50 | 1.24 | P4128 | 1000/1K | 2.25 |

## DISC CAPACITORS

| Part No. | Cap./Volt. | Price | Part No. | Cap./Volt. | Price |
|---|---|---|---|---|---|
| P4129 | 1200/1K | 2.25 | P4307 | .047µf/25 | .79 |
| P4130 | 1500/1K | 2.25 | P4311 | .1µf/25 | 1.61 |
| P4131 | 1800/1K | 2.25 | P4418 | 1000/25 | .75 |
| P4132 | 2200/1K | 2.93 | P4419 | 1500/25 | .75 |
| P4133 | 2700/1K | 2.93 | P4420 | 2200/25 | .75 |
| P4134 | 3300/1K | 2.93 | P4421 | 3300/25 | .75 |
| P4135 | 3900/1K | 4.46 | P4422 | 4700/25 | .75 |
| P4136 | 4700/1K | 5.36 | P4423 | 6800/25 | .83 |
| P4137 | 5600/1K | 5.36 | P4424 | 10000/25 | .83 |
| P4138 | 6800/1K | 8.44 | P4425 | 15000/25 | .90 |
| P4139 | 8200/1K | 8.44 | P4426 | 22000/25 | .94 |
| P4140 | 10000/1K | 8.44 | P4427 | 33000/25 | .94 |
| P4161 | 10000/50 | .86 | P4428 | 47000/25 | 1.55 |
| P4162 | 22000/50 | .94 | P4429 | 68000/25 | 1.73 |
| P4163 | 47000/50 | 1.01 | P4430 | 100000/25 | 1.91 |
| P4164 | 100000/50 | 1.13 | P4431 | 1000/50 | .86 |
| DH682 | 6800/50 | .90 | P4432 | 1500/50 | .86 |
| P4200 | 1000/100 | .68 | P4433 | 2200/50 | .86 |
| P4202 | 1500/100 | .68 | P4434 | 3300/50 | .86 |
| P4203 | 2200/100 | .79 | P4435 | 4700/50 | .86 |
| P4205 | 3300/100 | .79 | P4436 | 6800/50 | .94 |
| P4206 | 4700/100 | 1.09 | P4437 | 10000/50 | 1.01 |
| P4209 | 6800/100 | .71 | P4438 | 15000/50 | 1.01 |
| P4300 | .01µf/25 | .56 | P4439 | 22000/50 | 1.09 |
| P4303 | .022µf/25 | .64 | P4440 | 33000/50 | 1.73 |
| P4305 | .033µf/25 | .64 | P4441 | 47000/50 | 1.73 |

**NPO NPO NPO NPO NPO NPO NPO**

| Part No. | Cap./Volt. | Price | Part No. | Cap./Volt. | Price |
|---|---|---|---|---|---|
| P4400 | 10/500 | .68 | P4409 | 56/500 | 1.13 |
| P4402 | 15/500 | .79 | P4410 | 68/500 | 1.28 |
| P4403 | 18/500 | .79 | P4411 | 82/500 | 1.91 |
| P4404 | 22/500 | .79 | P4412 | 100/500 | 1.91 |
| P4405 | 27/500 | .79 | P4413 | 120/500 | 1.91 |
| P4406 | 33/500 | .98 | P4414 | 150/500 | 2.03 |
| P4407 | 39/500 | .98 | P4415 | 180/500 | 2.70 |
| P4408 | 47/500 | 1.13 | P4416 | 220/500 | 2.70 |

## TANTALUM CAPACITORS

| Part No. | Cap./Volt. (µF)/DC | Price 1 | Part No. | Cap./Volt. | Price 1 |
|---|---|---|---|---|---|
| P2011 | 4.7/6.3 | .31 | P2045 | 2.2/25 | .34 |
| P2012 | 6.8/6.3 | .34 | P2046 | 3.3/25 | .42 |
| P2013 | 10/6.3 | .42 | P2047 | 4.7/25 | .54 |
| P2014 | 15/6.3 | .50 | P2048 | 6.8/25 | .65 |
| P2015 | 22/6.3 | .60 | P2049 | 10/25 | 1.06 |
| P2016 | 33/6.3 | .72 | P2050 | 15/25 | 1.19 |
| P2017 | 47/6.3 | .85 | P2051 | 22/25 | 1.68 |
| P2018 | 68/6.3 | 1.18 | P2052 | 33/25 | 2.36 |
| P2019 | 100/6.3 | 1.82 | P2053 | 0.1/35 | .27 |
| P2020 | 150/6.3 | 3.60 | P2054 | 0.15/35 | .27 |
| P2094 | 220/6.3 | 7.85 | P2055 | 0.22/35 | .27 |
| P2095 | 330/6.3 | 11.65 | P2056 | 0.33/35 | .27 |
| P2022 | 2.2/10 | .28 | P2057 | 0.47/35 | .27 |
| P2023 | 3.3/10 | .31 | P2058 | 0.68/35 | .28 |
| P2024 | 4.7/10 | .34 | P2059 | 1.0/35 | .31 |
| P2025 | 6.8/10 | .42 | P2060 | 1.5/35 | .34 |
| P2026 | 10/10 | .50 | P2061 | 2.2/35 | .42 |
| P2027 | 15/10 | .60 | P2062 | 3.3/35 | .51 |
| P2028 | 22/10 | .72 | P2063 | 4.7/35 | .65 |
| P2029 | 33/10 | .85 | P2064 | 6.8/35 | .90 |
| P2030 | 47/10 | 1.18 | P2065 | 10/35 | 1.19 |
| P2031 | 68/10 | 1.62 | P2066 | 15/35 | 1.88 |
| P2032 | 100/10 | 3.60 | P2100 | .047/35 | .43 |
| P2083 | 150/10 | 6.98 | P2101 | .068/35 | .43 |
| P2084 | 220/10 | 9.63 | P2102 | 22/35 | 2.56 |
| P2033 | 1.5/16 | .23 | P2103 | 33/35 | 4.46 |
| | | | P2067 | 47/35 | 13.36 |
| P2034 | 2.2/16 | .31 | P2068 | 0.1/50 | .28 |
| P2035 | 3.3/16 | .33 | P2069 | 0.15/50 | .30 |
| P2036 | 4.7/16 | .42 | P2070 | 0.22/50 | .30 |
| P2037 | 6.8/16 | .50 | P2071 | 0.33/50 | .33 |
| P2038 | 10/16 | .60 | P2072 | 0.47/50 | .33 |
| P2039 | 15/16 | .74 | P2073 | 0.68/50 | .37 |
| P2040 | 22/16 | .88 | P2074 | 1.0/50 | .50 |
| P2041 | 33/16 | 1.18 | P2075 | 1.5/50 | .84 |
| P2042 | 47/16 | 1.82 | P2076 | 2.2/50 | .90 |
| P2043 | 68/16 | 3.60 | P2077 | 3.3/50 | 1.48 |
| P2086 | 150/16 | 9.08 | P2078 | 4.7/50 | 1.89 |
| P2096 | 100/16 | 6.98 | P2104 | 6.8/50 | 3.90 |
| P2044 | 1.5/25 | .31 | P2093 | 10/50 | 5.40 |
| | | | | 15/50 | 8.37 |

## PANASONIC® V SERIES
**Stacked Metalized Film Capacitors**

| Part No. | Cap./Volt. (µF)/VAC | Price 10 | Part No. | Cap./Volt. | Price 10 |
|---|---|---|---|---|---|
| | | | P4535 | 0.68/50 | 4.83 |
| | | | P4536 | 0.82/50 | 5.74 |
| P4513 | 0.01/50 | 1.23 | P4537 | 1.0/50 | 6.62 |
| P4514 | 0.012/50 | 1.26 | P4713 | 0.01/100 | 1.81 |
| P4515 | 0.015/50 | 1.28 | P4714 | 0.012/100 | 1.38 |
| P4516 | 0.018/50 | 1.31 | P4715 | 0.015/100 | 1.81 |
| P4517 | 0.022/50 | 1.35 | P4716 | 0.018/100 | 1.81 |
| P4518 | 0.027/50 | 1.38 | P4717 | 0.022/100 | 1.85 |
| P4519 | 0.033/50 | 1.41 | P4718 | 0.027/100 | 1.89 |
| P4520 | 0.039/50 | 1.44 | P4719 | 0.033/100 | 1.93 |
| P4521 | 0.047/50 | 1.47 | P4720 | 0.039/100 | 1.96 |
| P4522 | 0.056/50 | 1.54 | P4721 | 0.047/100 | 2.03 |
| P4523 | 0.068/50 | 1.63 | P4722 | 0.056/100 | 2.10 |
| P4524 | 0.082/50 | 1.73 | P4723 | 0.068/100 | 2.23 |
| P4525 | 0.1/50 | 1.69 | P4724 | 0.082/100 | 2.25 |
| P4526 | 0.12/50 | 1.88 | P4725 | 0.1/100 | 2.30 |
| P4527 | 0.15/50 | 1.95 | P4726 | 0.12/100 | 2.57 |
| P4528 | 0.18/50 | 2.01 | P4727 | 0.15/100 | 2.69 |
| P4529 | 0.22/50 | 2.10 | P4728 | 0.18/100 | 2.75 |
| P4530 | 0.27/50 | 2.45 | P4729 | 0.22/100 | 2.94 |
| P4531 | 0.33/50 | 2.79 | P4730 | 0.27/100 | 3.34 |
| P4532 | 0.39/50 | 3.10 | P4731 | 0.33/100 | 3.81 |
| P4533 | 0.47/50 | 3.45 | P4732 | 0.39/100 | 4.22 |
| P4534 | 0.56/50 | 4.14 | P4733 | 0.47/100 | 4.71 |

## PANASONIC® B SERIES
**Polyester Capacitors**

| Part No. | Cap./Volt. (µF)/VAC | Price 10 | Part No. | Cap./Volt. | Price 10 |
|---|---|---|---|---|---|
| | | | P4556 | .0027/50 | 1.05 |
| | | | P4557 | .0033/50 | 1.05 |
| P4551 | .001/50 | 1.05 | P4558 | .0039/50 | 1.05 |
| P4552 | .0012/50 | 1.05 | P4559 | .0047/50 | 1.05 |
| P4553 | .0015/50 | 1.05 | P4560 | .0056/50 | 1.05 |
| P4554 | .0018/50 | 1.05 | P4561 | .0068/50 | 1.05 |
| P4555 | .0022/50 | 1.05 | P4562 | .0082/50 | 1.05 |

## QUARTZ CRYSTALS

| Freq. MHz | Digi-Key Part No. | Case | Pricing 1 | Pricing 10 |
|---|---|---|---|---|
| 1.000 | X045 | HC-33 | 10.08 | 84.00 |
| 1.0000 | X066 | HC-18 | 9.65 | 79.50 |
| 1.8432 | X046 | HC-33 | 3.96 | 33.00 |
| 1.8432 | X067 | HC-18 | 3.42 | 28.50 |
| 2.000 | X001 | HC-33 | 3.78 | 31.50 |
| 2.0000 | X068 | HC-18 | 3.24 | 27.00 |
| 2.4576 | X047 | HC-33 | 3.78 | 31.50 |
| 2.4576 | X069 | HC-18 | 3.06 | 25.50 |
| 2.5000 | X070 | HC-18 | 3.42 | 28.50 |
| 3.000 | X048 | HC-33 | 3.78 | 31.50 |
| 3.2768 | X022 | HC-18 | 1.73 | 14.40 |
| 3.579545 | X005 | HC-33 | 2.34 | 19.50 |
| 3.579545 | X049 | HC-18 | 1.62 | 13.50 |
| 3.6864 | X071 | HC-18 | 1.62 | 13.50 |
| 3.700 | X012 | HC-6/U | 2.60 | 22.00 |
| 4.000 | X006 | HC-18 | 1.62 | 13.50 |
| 4.0320 | X072 | HC-18 | 1.62 | 13.50 |
| 4.194304 | X007 | HC-18 | 1.62 | 13.50 |
| 4.91520 | X050 | HC-18 | 1.62 | 13.50 |
| 5.000 | X051 | HC-18 | 1.62 | 13.50 |
| 5.0688 | X052 | HC-18 | 1.62 | 13.50 |
| 5.1850 | X053 | HC-18 | 1.62 | 13.50 |
| 5.9904 | X073 | HC-18 | 1.62 | 13.50 |
| 6.000 | X026 | HC-18 | 1.62 | 13.50 |
| 6.144 | X054 | HC-18 | 1.62 | 13.50 |
| 7.3728 | X074 | HC-18 | 1.62 | 13.50 |
| 8.000 | X056 | HC-18 | 1.62 | 13.50 |
| 9.2160 | X075 | HC-18 | 1.62 | 13.50 |
| 10.000 | X057 | HC-18 | 1.62 | 13.50 |
| 11.0592 | X078 | HC-18 | 1.98 | 16.50 |
| 12.000 | X058 | HC-18 | 1.62 | 13.50 |
| 14.31818 | X059 | HC-18 | 1.62 | 13.50 |
| 15.000 | X060 | HC-18 | 1.62 | 13.50 |
| 16.000 | X077 | HC-18 | 1.80 | 15.00 |
| 18.000 | X060 | HC-18 | 1.80 | 15.00 |
| 18.432 | X061 | HC-18 | 1.80 | 15.00 |
| 20.000 | X062 | HC-18 | 1.98 | 16.50 |
| 22.1184 | X063 | HC-18 | 1.98 | 16.50 |
| 48.000 | X065 | HC-18 | 1.98 | 16.50 |

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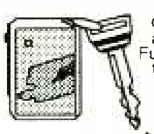

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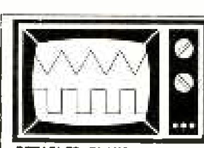

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## LETTERS . . . *(from page 7)*

*I disagree with your circuit simplification in which IC1C can be used as a current-to-voltage converter. The solar cell is a device that develops a current, up to 300 mA, that is proportional to sunlight energy. Its terminal voltage is not significant. Thus, the cell* must *be loaded down with a low value of resistance (R1 in the project) to absorb the current. In this circuit, R1 is a simple, perfect current-to-voltage converter and eliminates the problem of absorbing the heavy 300-mA current in the IC amplifier circuit, which then must be offset by the 9-volt battery. —Tony Caristi.*

**More, More, More**

• I'm writing to tell you how much I like *Modern Electronics*. The major thing I would ask for is more, more, more.

I especially like the writings of Forrest Mims. He always comes up with interesting topics. This is typical, though, because although *ME* doesn't have as many regular columns as do some other magazines, the ones you do have are excellent. "Software Focus" does a better job than most of the reviews I've seen in computer magazines. "Computer Capers" is also very good.

I like the wide variety of topics covered in "Electronics Omnibus," as well as in the features section. Although I don't get to build as many projects as I would like to, the telephone circuits you've published have been very interesting, as were the circuits for weather monitoring and the barometer.

More articles on shortwave listening and circuits to aid in this hobby would be good. There are very few articles anywhere on circuits to improve SWLing.

Keep up the good work!

David B. Lee
Plano, TX

**Number, Please?**

• Thank you for the Kenwood Amateur Radio bulletin-board item in the November 1989 issue. The system has been "on-line" for some six months, and we have over 700 users. By the way, the BBS data line number is 213-761-8284.

Wayne T. Yoshida
Kenwood U.S.A. Corp.
Long Beach, CA



MODERN ELECTRONICS
76 N. Broadway, Hicksville, NY 11801

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| 4164-120 | 65536x1 | 120ns | 16 | 2.89 |
| 4164-100 | 65536x1 | 100ns | 16 | 3.39 |
| TMS4464-12 | 65536x4 | 120ns | 16 | 9.95 |
| 41256-150 | 262144x1 | 150ns | 16 | 3.99 |
| 41256-120 | 262144x1 | 120ns | 16 | 4.49 |
| 41256-100 | 262144x1 | 100ns | 16 | 4.99 |
| 41256-80 | 262144x1 | 80ns | 16 | 5.49 |
| 41256-60 | 262144x1 | 60ns | 16 | 7.99 |
| 414256-100 | 262144x4 | 100ns | 20 | 14.95 |
| 414256-80 | 262144x4 | 80ns | 20 | 16.95 |
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| 1 MB-100 | 1048576x1 | 100ns | 18 | 14.95 |
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| 41256A9B-80 | 256K x 9 | 80ns | SIMM/PC | 59.95 |
| 421000A8B-10 | 1MB x 8 | 100ns | SIMM/MAC | 159.95 |
| 421000A9B-10 | 1MB x 9 | 100ns | SIMM/PC | 159.95 |
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| HM6264LP-15 | 8192x8 | 150ns | 28 | 8.95 |
| HM6264LP-12 | 8192x8 | 120ns | 28 | 9.95 |
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The co-processor you need is specific to the type and speed of processor. For 8088/86 and 80386 based machines, the general rule is to use an 8087 or 80387 of the same speed as the processor, i.e. an 80386-25 requires an 80387-25.

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Derick Moore, Director of Engineering

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| 2716-1 | 2048x8 | 350ns | 25V | 24 | 3.95 |
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| 2764-250 | 8192x8 | 250ns | 12.5V | 28 | 3.69 |
| 2764-200 | 8192x8 | 200ns | 12.5V | 28 | 4.25 |
| 27C64 | 8192x8 | 250ns | 12.5V | 28 | 4.95 |
| 27128 | 16384x8 | 250ns | 12.5V | 28 | 4.25 |
| 27128A-200 | 16384x8 | 200ns | 12.5V | 28 | 5.95 |
| 27256 | 32768x8 | 250ns | 12.5V | 28 | 4.95 |
| 27256-200 | 32768x8 | 200ns | 12.5V | 28 | 5.95 |
| 27C256 | 32768x8 | 250ns | 12.5V | 28 | 5.95 |
| 27512 | 65536x8 | 250ns | 12.5V | 28 | 8.95 |
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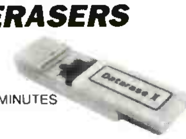

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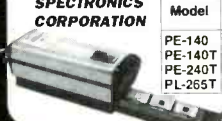

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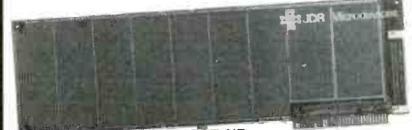

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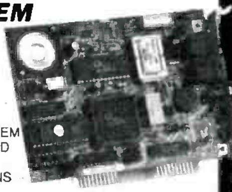

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**VGA-MONITOR**

### RELISYS MULTISYNCH $429

- FULL FEATURED MULTISCAN MONITOR WITH UNLIMITED COLORS
- 1024 X 768 RESOLUTION, 14" NON-GLARE DISPLAY
- AUTO SWITCHING
- TTL/ANALOG VIDEO INPUT

**JDR-MULTI**

*EGA SPECIAL! CARD & MONITOR--JUST $479*

| | | |
|---|---|---|
| EGA-MONITOR | 14" RGB MONITOR | $339.00 |
| NEC-MULTI-3D | DIGITAL 1024X768 RESOLUTION | $649.95 |
| JDR-MONO | 12" TTL MONOCHROME-GREEN | $69.95 |
| JDR-AMBER | 12" TTL MONOCHROME-AMBER | $69.95 |

## HARD DISKS

20 MB $199
30 MB $219
40 MB $339
60 MB $389
80 MB $569

## KITS

20 MB $249
30 MB $279

Seagate

| SIZE | MODEL | AVG. SPEED | FORM FACTOR | DRIVE ONLY | XT KIT | AT F/H KIT |
|---|---|---|---|---|---|---|
| 20MB | ST-225 | 65 MS | 5-1/4" | $199 | $249 | $309 |
| 30MB RLL | ST-238 | 65 MS | 5-1/4" | $219 | $279 | $379 |
| 40MB | ST-251-1 | 28 MS | 5-1/4" | $339 | $389 | $449 |
| 60MB RLL | ST-277-1 | 28 MS | 5-1/4" | $389 | $449 | $549 |
| 80MB | ST-4096 | 28 MS | 5-1/4" | $569 | — | $679 |
| 120MBRLL | ST-4144R | 28 MS | 5-1/4" | $699 | $759 | $859 |
| 20MB | ST-125 | 40 MS | 3-1/2" | $259 | $299 | $373 |
| 30MB RLL | ST-138 | 40 MS | 3-1/2" | $289 | $339 | $429 |

## DFI HANDY SCANNER 3000 PLUS

**$199.95**

NEW LOW PRICE!

- IMPROVED CLARITY, HIGHER SPEED!
- SCANS UP TO 4.1" WIDE IMAGES
- 100, 200, 300, 400 DPI BOTH DIRECTIONS
- B&W & 3 HALF-TONE MODES
- 32 LEVELS OF GRAY SCALE
- HERCULES, CGA, EGA AND VGA COMPATIBLE

**HS-3000** WITH HALO DPE & IMAGE EDITOR SOFTWARE

**OCR-SOFT** CHARACTER RECOGNITION SOFTWARE $99.95

## QUALITY KEYBOARDS

**STANDARD KEYBOARDS:**

| | | |
|---|---|---|
| BTC-5060 | AUTOSENSE FOR XT/AT | $59.95 |
| MAX-5060 | WITH TACTILE FEEDBACK | $64.95 |

**ENHANCED KEYBOARDS:**

| | | |
|---|---|---|
| BTC-5339 | AUTOSENSE FOR XT/AT, AUTOREPEAT | $69.95 |
| K103-A | AUDIBLE "CLICK" STYLE | $84.95 |
| MAX-5339 | MAXI-SWITCH W/TACTILE FEEDBACK | $84.95 |

## 150MB ESDI DRIVE KIT $1049

5-1/4" HARD DISK, FLOPPY/HARD CONTROLLER, CABLES, MOUNTING HARDWARE & SOFTWARE. 1355-PKG

## MINI UPRIGHT CASE $249.95

SMALL FOOTPRINT MINI-UPRIGHT FOR 8088 OR MINI 286/386 MOTHERBOARDS

- ROOM FOR 6 EXPANSION CARDS
- HOLDS 3 5-1/4 & 1 3-1/2 DRIVES (1/2 HT)
- 200 WATT POWER SUPPLY
- 2-DIGIT LED SPEED DISPLAY
- 12" H X 16"L X 8" W

new!

**CASE-120**

## UPRIGHT CASE $299.95

SPACE SAVING DESIGN HOLDS ALL SIZES OF MOTHERBOARDS AND INCLUDES:

- 250W POWER SUPPLY
- MOUNTS FOR 3 FLOPPY & 4 HARD DRIVES
- TURBO & RESET SWITCH
- LED SPEED DISPLAY
- POWER & DISK LED'S
- ALL HARDWARE, FACEPLATES & SPEAKER

**CASE-100**

| | | |
|---|---|---|
| CASE-FLIP | FOR 8088 MB'S | $39.95 |
| CASE-SLIDE | FOR 8088 MB'S | $39.95 |
| CASE-70 | FOR 286 MB'S | $89.95 |
| CASE-50 | FOR MINI 286 MB'S | $59.95 |
| CASE-JR | MINI-286 W/150W PS | $149.95 |

## 1.44MB 3-1/2" DRIVE

**$99.95**

- ULTRA HIGH DENSITY
- READ/WRITE 720K DISKS, TOO

**FDD-1.44X** BLACK FACEPLATE
**FDD-1.44A** BEIGE FACEPLATE
**FDD-1.44 SOFT** SOFTWARE DRIVER $19.95

**1/2 HEIGHT FLOPPY DISK DRIVES:**

| | | |
|---|---|---|
| FD-55B | 5-1/4" TEAC DS/DD 360K | $99.95 |
| FD-55G | 5-1/4" TEAC DS/HD 1.2M | $129.95 |
| FDD-360 | 5-1/4" DS/DD 360K | $69.95 |
| FDD-1.2 | 5-1/4" DS/HD 1.2M | $95.95 |

## MODULAR CIRCUIT TECHNOLOGY

**DRIVE CONTROLLERS:**

| | | |
|---|---|---|
| MCT-FDC | FLOPPY DISK CONTROLLER | $29.95 |
| MCT-FDC-HD | 1.44MB FLOPPY CONTROLLER | $49.95 |
| MCT-HDC | HARD DISK CONTROLLER | $79.95 |
| MCT-RLL | RLL CONTROLLER | $89.95 |
| MCT-FH | FLOPPY/HARD CONTROLLER | $139.95 |
| MCT-AFH | 286/386 FLOPPY/HARD | $149.95 |
| MCT-AFH-RLL | 286/386 RLL CONTROLLER | $199.95 |

**DISPLAY ADAPTOR CARDS:**

| | | |
|---|---|---|
| MCT-MGP | MONOCHROME GRAPHICS | $59.95 |
| MCT-CG | COLOR GRAPHICS ADAPTOR | $49.95 |
| MCT-EGA | ENHANCED GRAPHICS ADAPTOR | $149.95 |
| MCT-VGA-8 | 8-BIT VGA, ANALOG OUTPUT | $169.95 |
| MCT-VGA-16 | 16-BIT VGA, ANALOG OUTPUT | $249.95 |
| MCT-MGMIO | MONOGRAPHICS MULTI I/O | $119.75 |
| MCT-MGAIO | 286/386 MONOGRAPHICS I/O | $99.95 |

**MULTIFUNCTION CARDS:**

| | | |
|---|---|---|
| MCT-MIO | MULTI I/O FLOPPY CONTROLLER | $79.95 |
| MCT-IO | MULTI I/O CARD | $59.95 |
| MCT-AMF | 286/386 MULTIFUNCTION | $139.95 |
| MCT-AIO | 286/386 MULTI I/O CARD | $59.95 |

**MEMORY CARDS:**

| | | |
|---|---|---|
| MCT-RAM | 576K RAM CARD | $59.95 |
| MCT-EMS | EXPANDED MEMORY CARD | $129.95 |
| MCT-AEMS | 286/386 EMS CARD | $139.95 |

## LOGITECH MICE

- THREE-BUTTON SERIES 9
- 320 DPI RESOLUTION
- SERIAL PS/2 COMPATIBLE

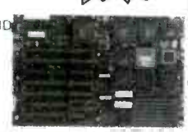
| | | |
|---|---|---|
| LOGC9 | SERIAL MOUSE | $98.95 |
| LOGC9-C* | SERIAL MOUSE | $79.95 |
| LOGC9-P | SERIAL MOUSE WITH PAINTSHOW | $109.95 |
| LOGC9-PC | SERIAL MOUSE WITH PAINT/CAD | $154.95 |
| LOGB9 | BUS MOUSE | $89.95 |
| LOGB9-P | BUS MOUSE WITH PAINTSHOW | $104.95 |
| LOGB9-PC | BUS MOUSE WITH PAINT/CAD | $149.95 |

*NOT PS/2 COMPATIBLE

## MOTHERBOARDS

UPGRADE YOUR MOTHERBOARD!

### 20MHZ 386 $699



- 16/20 MHZ
- 16 MB RAM CAPACITY - 8MB ON-BOARD(ØK), 8 MB RAM CARD
- USES 256K OR 1MB SIP RAMS
- 8 SLOTS: 1X32-BIT RAM 2X 8-BIT & 5X 16-BIT
- MEMORY INTERLEAVING
- AMI BIOS
- XT-SIZE BOARD

**MCT-M386-20**

| | | |
|---|---|---|
| MCT-C386-25 | 25MHZ MINI 386 W/CACHE | $1499.00 |
| MCT-M386-M | 8MB RAM CARD (ØK) | $149.95 |
| MCT-386MB20 | 10/20MHZ 386 | $799.00 |
| MCT-386MB25 | 10/25MHZ 386 | $999.00 |
| MCT-386-M | 8MB RAM CARD (OK) | $149.95 |

### 10MHZ MINI-286 $199.95

- AT COMPATIBLE
- KEYBOARD SELECTABLE 6/10MHZ
- EXPANDABLE TO 4MB ON-BOARD WITH 1MB DRAMS (ØK)
- SIX 16-BIT & TWO 8-BIT SLOTS
- AMI BIOS
- LED SUPPORT

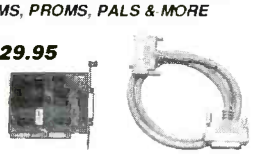
**MCT-M286**

| | | |
|---|---|---|
| MCT-M286-12 | 8/12MHZ MINI-286 | $249.95 |
| MCT-M286-16 | 8/16MHZ 286 | $369.95 |
| MCT-M286-20 | 10/20MHZ 286 | $429.95 |
| MCT-XMB | STANDARD 4.77MHZ 8088 | $87.95 |
| MCT-TURBO | 4.77/8MHZ 8088 | $95.95 |
| MCT-TURBO-10 | 4.77/10MHZ SINGLE CHIP 8088 | $99.00 |

## MODULAR PROGRAMMING SYSTEM

*INTEGRATED MODULAR SYSTEM EASILY EXPANDS! ALL MODULES USE A COMMON HOST ADAPTOR CARD--USE JUST ONE SLOT TO PROGRAM EPROMS, PROMS, PALS & MORE*

### HOST ADAPTOR CARD $29.95



- UNIVERSAL INTERFACE FOR ALL THE PROGRAMMING MODULES!
- SELECTABLE ADDRESSES PREVENTS CONFLICTS
- MOLDED CABLE

**MOD-MAC**

### UNIVERSAL MODULE $499.95

- PROGRAMS EPROMS, EEPROMS, PALS, BI-POLAR PROMS, 8748 & 8751 SERIES DEVICES, 16V8 AND 20V8 GALS (GENERIC ARRAY LOGIC) FROM LATTICE, NS, SGS
- TESTS TTL, CMOS, DYNAMIC & STATIC RAMS
- LOAD DISK, SAVE DISK, EDIT, BLANK CHECK, PROGRAM, AUTO, READ MASTER, VERIFY AND COMPARE
- TEXTOOL SOCKET FOR .3" TO .6"W. IC'S (8-40 PINS)

**MOD-MUP**

### EPROM MODULE $119.95

- PROGRAMS 24-32 PIN EPROMS, CMOS EPROMS & EEPROMS FROM 16K TO 1024K
- HEX TO OBJ CONVERTER
- AUTO, BLANK CHECK/PROGRAM/VERIFY
- VPP 5, 12.5, 12.75, 13, 21 & 25 VOLTS
- NORMAL, INTELLIGENT, INTERACTIVE & QUICK PULSE PROGRAMMING ALGORITHMS

**MOD-MEP**

| | | |
|---|---|---|
| MOD-MEP-4 | 4-EPROM PROGRAMMER | $169.95 |
| MOD-MEP-8 | 8-EPROM PROGRAMMER | $259.95 |
| MOD-MEP-16 | 16-EPROM PROGRAMMER | $499.95 |

### DIGITAL IC MODULE $129.95

- TESTS TTL, CMOS, DYNAMIC & STATIC RAM
- AUTO SEARCH FOR UNKNOWN PART NUMBERS
- USER-PROGRAMMABLE TEST PROCEDURES

**MOD-MIC**

### PAL MODULE $249.95

- PROGRAMS MMI, NS, TI 20 & TI 24 PIN DEVICES
- BLANK CHECK, PROGRAM, AUTO, READMASTER, VERIFY & SECURITY FUSE BLOW

**MOD-MPL**

CUPL SOFTWARE—ENTRY-LEVEL PAL DEV. KIT
**MOD-MPL-SOFT** $99.95

## EPROM PROGRAMMER $129.95

- PROGRAMS 27XX AND 27XXX EPROMS UP TO 27512
- SUPPORTS VARIOUS PROGRAMMING FORMATS & VOLTAGES
- SPLIT OR COMBINE CONTENTS OF SEVERAL EPROMS OF DIFFERENT SIZES
- READ, WRITE, COPY, BLANK CHECK & VERIFY
- SOFTWARE FOR HEX AND INTEL HEX FORMATS

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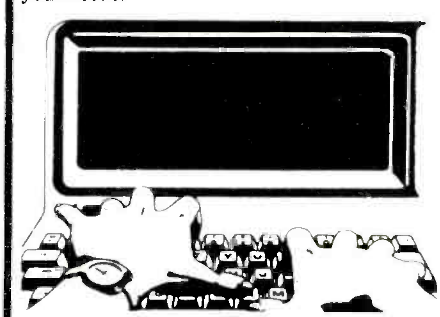

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## Thermometer *(from page 34)*

With all its advantages, though, the thermocouple does have its limitations. Although the thermocouple is among the most linear of temperature sensors, it is not perfectly linear, as you can see by examining the Table. There are various ways to make linearization corrections to thermocouple readings. A simple one is to examine the tables of values and to make your own correction chart.

This project could also be combined with the Tempwatch (see "Microprocessor Control With BASIC" Part 1 and Conclusion in the April and May 1989 issues of *Modern Electronics*). If this is done, linearization can easily be done in software.

For more exotic temperature measurements, it is often desirable to use special-purpose probes. A fascinating variety of such probes and other thermocouple hardware is available from Omega Engineering of Stamford, CT.

### *Further Observations*

Almost any integrated-circuit operational amplifier—even the ubiquitous 741, will work in this project. The OP-07 specified in the Parts List is an excellent choice. Its tight specifications, including low input offset voltage and low input offset voltage drift, are requirements for an accurate and stable thermometer. A further improvement could be made by substituting a chopper-stabilized op amp. This was not done in this project because of their greater expense and difficulty in finding them.

If you wish to be able to measure both Fahrenheit and Celsius temperatures with this Thermometer accessory, you can incorporate both values specified for *R10* in the Parts List into the project and rig a switching arrangement that will let you select between the two. Of course, you will have to make minor modifications to the printed-circuit board to be able to incorporate this function into the project. ME

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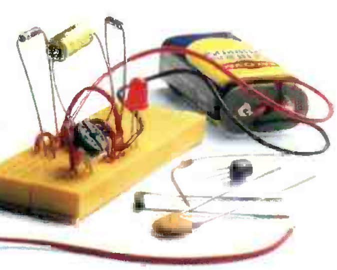

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