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100-Watt/Channel Digital Car Booster Amplifier (p. 18)

- **...W APPLE IIGS ...NAL COMPUTER**

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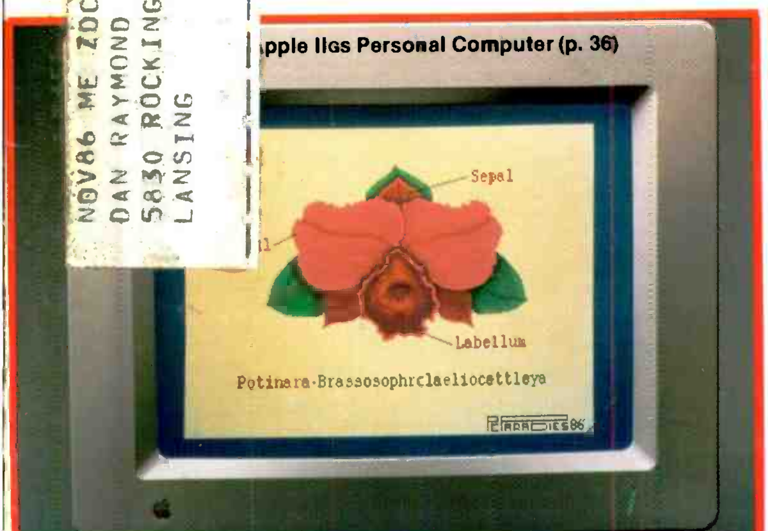

...pple IIgs Personal Computer (p. 36)

Ashton-Tate's dBase III Plus Data Manager (p. 74)

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Also: Forrest Mims's "Ultraminiature Radio Transmitters" ● Eric Grevstad "Looks Back at 1986's Best" ● Don Lancaster discusses Stroke Graphics, Temperature-Measurement Circuits and Stunning New Graphics Materials ● Evaluating Ashton-Tate's dBase III Plus Heavyweight Data Manager ● Electronic & Computer News . . . and more.

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More information on the R-5000 and R-2000 is available from Authorized Kenwood Dealers.

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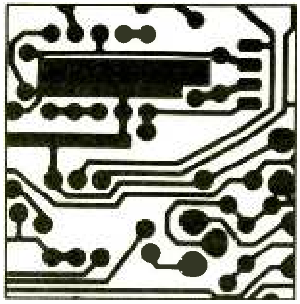
THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

DECEMBER 1986

VOLUME 3, NUMBER 12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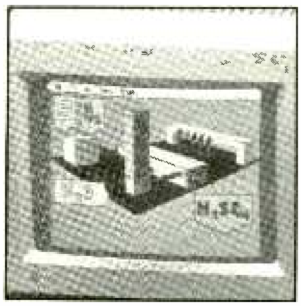
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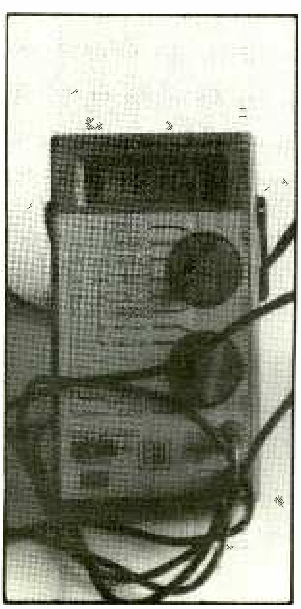
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COLUMNS

DEPARTMENTS

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EDITORIAL

The Gray & Green Lines

As we approach the Holiday season, you'll be seeing a lot of green trimmings surrounding all those enticing new electronic and computer products, as befits Christmas decorations. "Green" is the time of year when buyers turn out in droves to turn their bonuses and savings into gifts—a VCR, personal computer, Color TV receiver, or what-have-you.

It's also the time of year when many companies launch their newest models. For these, don't expect much of a discount, if any, since there is generally a limited supply and they contain enough novel, even innovative and useful geegaws to justify selling them at the suggested retail selling price (used to be called "List Price").

At this time, too, older models, some being phased out, *are* heavily discounted to move 'em all out in order to make room for 1987 and 1987½ models. Both are good buys in their respective ways.

At the same time, there are plenty of gray-market products; more than ever, it seems. A gray-market product is one that's sold by an unauthorized dealer. This doesn't make the dealer an illegal source, of course. It just means that the manufacturer sells only to "authorized" dealers who, in turn, sometimes sell products to "unauthorized" dealers.

This is done for a number of reasons. Some dealers, for certain very important product lines, must purchase a minimum number of units in order to retain an authorized dealership. In some instances, this minimum-order requirement is too high for the dealer's sales power. Rather than allow the equipment to gather dust, and to pay continuing financing charges, he (or she) "transships" excess units to an unauthorized dealer and picks up a few points of profit, to boot, while reducing finance charges, gaining more inventory space, and improving the business's cash-flow situation.

Nothing wrong with this Yankee ingenuity, right? Well, not entirely right. For one, it is possible that a manufacturer will not honor a warranty if the product is not purchased from an authorized dealer, though in most instances it does. More importantly, this cuts into other authorized dealers' assumed marketing area, adding new competition that could be undercutting selling price and profits because he doesn't have to have a fancy store front, high-class interior decoration, service support costs, customer relations hand holding, etc.

This has become a *cause celebre* in some product areas, such as computers (especially with IBM, Apple and Compaq computers sold through franchisees and franchisors). Some franchised dealers "caught" doing this have had their authorized status stripped away. High-flying computer brokers talk of meetings in darkened warehouses, where $½-million in cash is exchanged (no credit here).

Other Xmas caveats relate to dumping of merchandise from companies going out of business and, thus, no after-sales support will be available; obsolete products, such as the old-frequency wireless telephones sold about two years ago, which had been superseded by new frequencies, with FCC approval, to minimize interference; unawareness of new, updated models that carry the same model name, such as dBase III Plus *without* copy protection, an IBM XT *with* an 80286 CPU and no wait states, power supplies *without* UL approval, and so on.

The wary buyer, however, should be able to separate gray from green and ferret out the best from among many fine electronic and computer models offered for sale during the merry season, and enjoy the benefits for many years to come. Happy shopping!

Art Salsberg

Seasons Greetings from the Staff of Modern Electronics

LETTERS

• As a result of browsing through a newsstand in New York, I discovered *Modern Electronics.* What a refreshing experience! Throughout my hobby career I had subscribed to *Popular Electronics.* Somehow they did not know that the shot heard around the world was not because of equipment reviews but innovation. Hobby magazines have been the spark plug of American ingenuity and innovation. And so I'm delighted with your fine writing staff, Forrest Mims, and Don Lancaster. I was about to put the soldering iron and the junk box in a garage sale. As it is, I will hold on, and take a year subscription.

I would appreciate an index of articles so that I could obtain back issues.

Clifford Haynes
Chantilly, VA 22021

Your wish is our command. See our 1986 Cumulative Article Index in this issue; back issues cost $2.50.—Ed.

Author Updates

• Some errors appear in my "Digital Measuring System" article (August 1986), all in Fig. 1. They can be corrected as follows: (1) connect a line from the line coming from pin 2 of *J2* to the junction between R_Y and R_Z; (2) route the line that connects pin 1 of *U1* to pin 1 of *U2* to pin 7—*not* pin 8 as shown—of *J1*; and (3) route the line that connects pin 2 of *U1* and pin 7 of *U2* to pin 8—*not* pin 7 as shown—of *J1*. See also Letters in the November 1986 issue.

Charles R. Ball
Snellville, GA

• There is a minor error in Fig. 2 of my "Programmable Ni-Cd Recycler" (Oct. 1986). To rectify it, break the line linking *IC1* OUT with *IC2* IN to the right of the dot that joins the vertical line going to *S4A*. Then draw a line from *IC2* IN down to the line that goes to the top of *R7* and to pin 3 of *IC3*. If the project is wired as shown, it will function properly, though it will be wasteful of power because the charge circuit will be active even in the "zap" mode when it is not needed.

Peter A. Lovelock

• I've made an improvement in the "Fan Delay Timer for Air Conditioners" (July 1986) circuit. To more reliably trigger the 555 timer, the value of *C3* has been changed from 0.01 μF to 0.1 μF. I'll be happy to send a 0.1-μF capacitor to anyone who ordered the kit from the article.

I would also like to point out that the project will operate with heat during the winter. If you determine that warm air can be made to continue coming after the heat cycle ends by running the system fan, simply hook up the project by exchanging the white heating contactor wire with the yellow cooling contactor wire.

Also, we are now able to supply the High-Tech Sequencing Light (August 1986) parts kit for $49.95 instead of $59.95. Any one who purchased a kit at the higher price can write for a refund of the difference. Many requests have been received for information concerning the PU4110 transistor arrays. Those are available for $4.95 each from NRG Electronics, P.O. Box 24138, Ft. Lauderdale, FL 33307.

Bill Owen
Ft. Lauderdale, FL

MODERN ELECTRONICS NEWS

CD JUKE BOX. The Seeburg Corporation has introduced LaserMusic, a jukebox that opens a new pay-for-play era. Using a Sony Compact Disc player, the professional model holds 60 wear-proof CDs, giving patrons an opportunity to choose from up to 1,000 song titles compared to a selection of less than 200 on conventional juke boxes. The system features 200 peak watts per stereo channel, stereo three-way speaker systems, two background music level modes, and can be programmed by the owner to feature music themes. No more quarters, though. The machine accepts $1 and $5 bills, with a suggested play of three selections for $1.

A BREATHING BATTERY. Duracell, Inc. is marketing a line of zinc/air batteries that are sealed for long shelf life. When the seal is removed by a user, the battery "breathes" oxygen from the air for use as the cathode reactant. As a result of eliminating an active cathode, the cell can contain more anode reactant.

COMPUTER BUFF BOARD GAME. Black Box Corp. (P.O. Box 12800, Pittsburgh, PA 15240) has introduced a board game called "King Chip" that's made up of 4,000 questions (and answers) in six computer-related categories. There's board room for up to six players; the winner is dubbed "King Chip."

ELECTRONIC PRODUCT AWARD TIME. A variety of award winners were announced recently for electronic product development. Matsushita Electric won a Research & Development Award for excellence in Industrial R&D for the the seventh consecutive year. This time it was for development of a new automatic focusing system based on the human eye, called "Piezofocus." Unlike conventional focusing systems in cameras that measure camera-object distance with infrared rays, Piezofocus uses a change produced by high-frequency components in the video signals that represents a focus error signal. Two new ICs and a microcomputer chip are used to do this. Moreover, by eliminating an IR transmitter and receiver, it comes in at only one-third the size, uses half the power, and costs about two-thirds that of other automatic focusing systems....Emmy Awards were issued recently from the National Academy of Televisions Arts and Sciences, too. Here Matsushita got one in combination with its own Panasonic Company for their role in making and marketing consumer video tape recorders....M/A-Com got an Emmy, also, for its VideoCipher encryption system. This is the system that scrambles satellite-fed signals and is used by Home Box Office, Showtime, and Cable News Network, among others who deliver signals to cable TV affiliates and home satellite dish owners....Among other electronic companies honored by an Emmy were dbx, NBC, and Zenith Corp. for their role in development of television stereo sound.

COMPUTER HAPPENINGS. Microcomputer speeds were upped recently by new models. Compaq's Deskpro 386 uses Intel's latest, the 80386 32-bit processor, to double an IBM-AT's speed....IBM debuted yet another new XT model, this one with an Intel 80286 processor and zero wait-state to give it speed that sits between lesser XT models and the AT machine. Oh, yes, the model is named PC-XT, Model 286. A host of other makers also have "AT jrs" (or "XT Srs") in their lines....Digital Equipment Corp. has gone the IBM-compatible route, too, with its new VAXmate that's an AT-compatible that can link to the company's bigger VAX machines.

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Digital Signature Analyzer

A new instrument for troubleshooting digital circuits introduced by Quality Test Engineering (Scotts Valley, CA) performs digital "signature" analysis at frequencies up to 20 MHz. The hand-held Model SA20 analyzer employs a technique used in automatic test systems to detect and display the unique digital signatures from the bit stream of the circuit node under test and displays the compressed data as a 4-character alphanumeric signature. It compares actual signatures with the correct ones, usually reducing circuit debugging to simply back-tracing to the faulty node.

Only two connections are required to be made for synchronizing clock and trigger signals from the circuit under test. Logic levels measured by the data probe input are sampled by the clock edge. The trigger signal starts the data recording window, which is automatically terminated with a signature display. Claimed accuracy is 99.998% for single- or multiple-bit errors that occur within the sampling window. Using high-speed CMOS logic, the battery-powered instrument is suitable for a variety of debugging tasks on the bench or in the field. $395.

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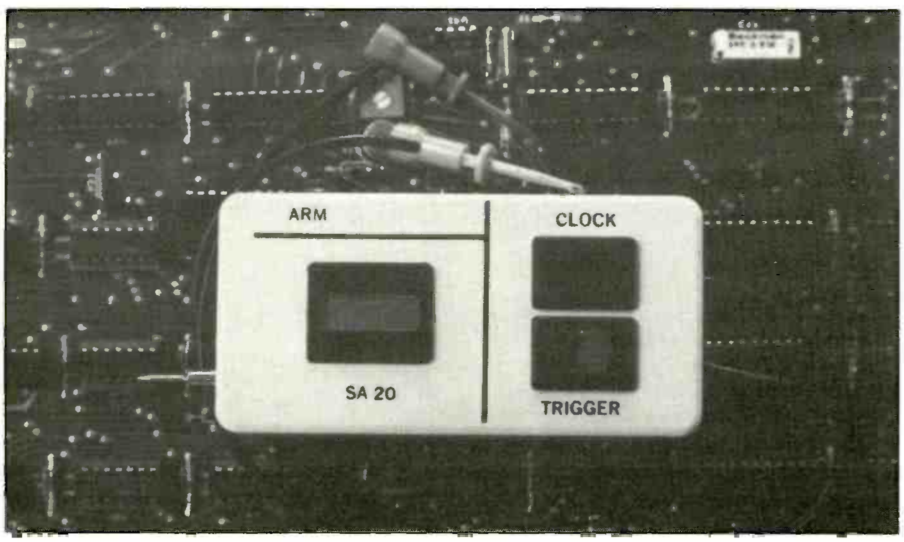

"Digital" Soldering Iron

A new soldering iron from Wellman Thermal Systems Corp. (Shelbyville, IN) features a scheme that allows soldering temperature to be set digitally in 1-degree increments. A solid-state

controller assures tight-tolerance temperature control. Featured are an easy-to-read digital setpoint and indicator lamps. A special tip design is claimed to allow 135 watts of power to be pumped into a 25-watt-size iron without danger of overheating. The unit occupies only 70 square inches of bench space.

CIRCLE 31 ON FREE INFORMATION CARD

VHS Camcorder

Panasonic's Model PV-220 all-in-one OmniMovie VHS camera/recorder offers lightweight portability and HQ (high-quality) circuitry. Its 0.5″ Newvicon pickup tube features a high-frequency striped filter for high resolution and high picture quality under even subdued lighting,

Miniature Clock Card Doesn't Use Up Computer Slot

SideClock from Innoventions, Inc. (Houston, TX) is a miniature clock card for the IBM PC, XT and compatibles that shares the same expansion slot with any other plug-in card. Measuring only 1.2″ wide by 3.8″ long, SideClock has a long rectangular slot down its center and contact fingers that plug into the computer's expansion slot in such a way that any other card can be plugged into the same slot. The product provides full clock/calendar functions and is powered by a 5-year lithium battery. It comes with control software on a 5.25″ floppy disk. $59.95.

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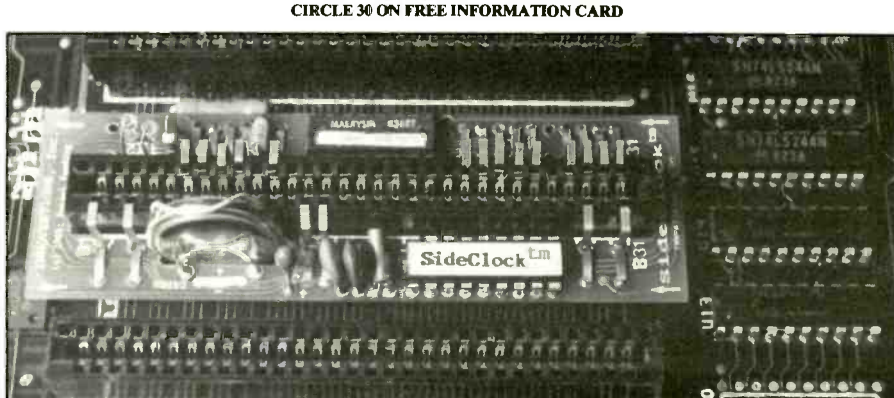


which can be as low as 7 lux. The lenssing system automatically focuses on the subject using a beam of infrared light. A 6:1 power zoom lens with macro function allows the user to record subjects as though they were six times closer or focus on miniatures from as close as 1″ from the lens.

A built-in automatic iris can adjust to almost any lighting ranging from full sunlight to candlelight. A white balance system automatically adjusts color balance. Additional features include a fade in/out function and an audio dubbing capability for narration. The camcorder can be powered via its rechargeable battery, its ac adapter or a dc car/vehicle battery cord. The rechargeable battery and ac adapter are supplied with the camcorder; the dc battery cord is an extra-cost option. $1,700.

CIRCLE 32 ON FREE INFORMATION CARD

Compact Disc Car Adapter

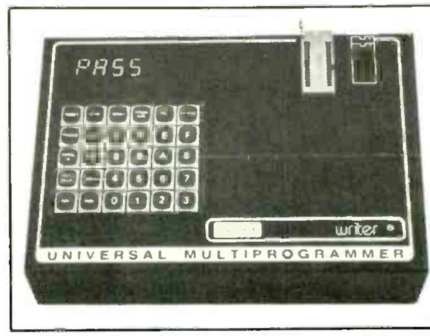
An adapter that lets listeners play portable Compact Discs and personal cassette players in automobiles has been unveiled by Ora Electronics (Chatsworth, CA). The Model CDA-1 adapter makes up for the lack of an auxiliary jack on a vehicle car radio by generating an FM stereo signal that is picked up by the car's radio antenna. The radio is then tuned to the adapter's transmit frequency just as you would tune an ordinary FM broadcast.

Two cable sets are supplied with the adapter. One connects a CD or cassette player's output to the adapter's input. The other connects the adapter's 9-volt output to the external player to provide power. Addons can also be powered from their own batteries. $59.95.

CIRCLE 33 ON FREE INFORMATION CARD

Stand-Alone EPROM Programmer

Writer-I™ from Bytek Corp. (Boca Raton, FL) is a new stand-alone, 8085-microprocessor-based programmer designed to handle MOS and CMOS EPROMs and EEPROMs up to 256K capacity, including 2716 on up to 27256 EPROMs and the 2816



EEPROM. The tabletop programmer has a single 28-pin zero-insertion-force (ZIF) socket and a 30-key keypad for manual programming. It also has a standard RS-232 serial interface for uploading and downloading to and from a personal computer or ASCII terminal at speeds ranging from 110 to 9,600 baud.

Device operations include: LOAD, PROGRAM, VERIFY, EDIT, DISPLAY and ERASED CHECK. System operations include transfer, file, serial in (download) and serial out (upload). Twelve translation formats are included: binary, Intel Intellec Standard Absolute Hex, Motorola Exorcisor, Tektronix HEX, MOS Technology, Fairchild F8, Signetics RAM Loader, straight hex data and ASCII.

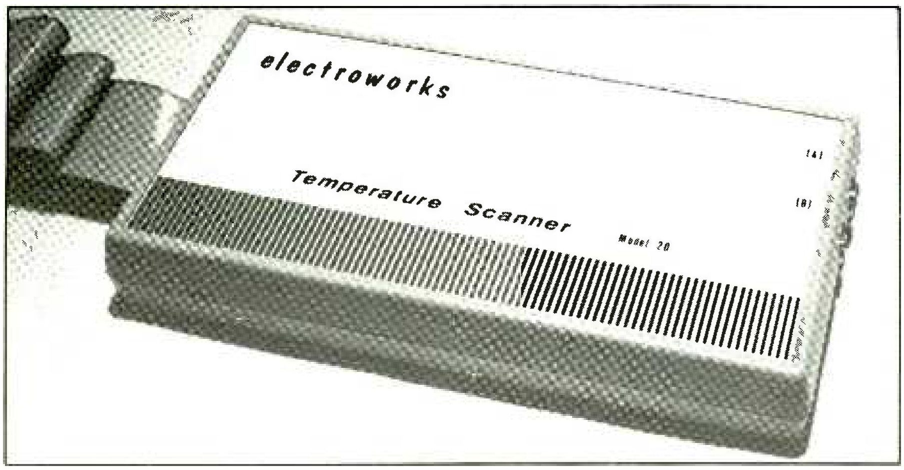
Standard features include 32K × 8 RAM (256K bits) and a large six-digit LED status display. No personality modules or adapters are required, and Bytek's PROMSoft software driver for IBM PCs and compatibles is optionally available. $495.

CIRCLE 34 ON FREE INFORMATION CARD

Temperature Scanner

Electroworks' (Ithaca, NY) Model 20 2-channel temperature scanner interfaces with selected personal com-

NEW PRODUCTS ...



puters to provide temperature monitoring. Its measurement range is from −2 to +100 degrees Celsius and provides degrees Fahrenheit equivalents. It has a rated accuracy of ±0.5 degrees C.

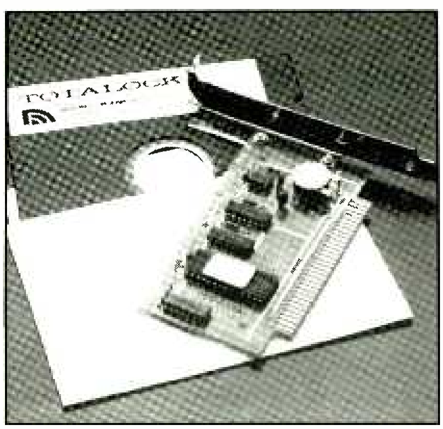
Supplied are two solid-state temperature sensors, one for each input channel. You can program the computer with which the Model 20 is used to display temperature in either Fahrenheit or Celsius, record temperatures at predetermined intervals, set audible alarms for high/low limits and display and record the temperature differential between the two sensors.

Currently, the Model 20 is available for Commodore 64 and Apple IIe computers. $179.

CIRCLE 35 ON FREE INFORMATION CARD

Computer Security System

Totalock from Netronics R&D Ltd. (New Milford, CT) is a new hardware-based data security system for the IBM PC, XT, AT, PC 3270



workstation and compatibles. It has been designed to extend computer protection far beyond the capabilities of current encryption or hardware schemes. Consisting of a half-size card, it plugs into a single expansion slot and provides one of 64,000 possible "locks." The system allows the user to select a password containing up to 19 characters.

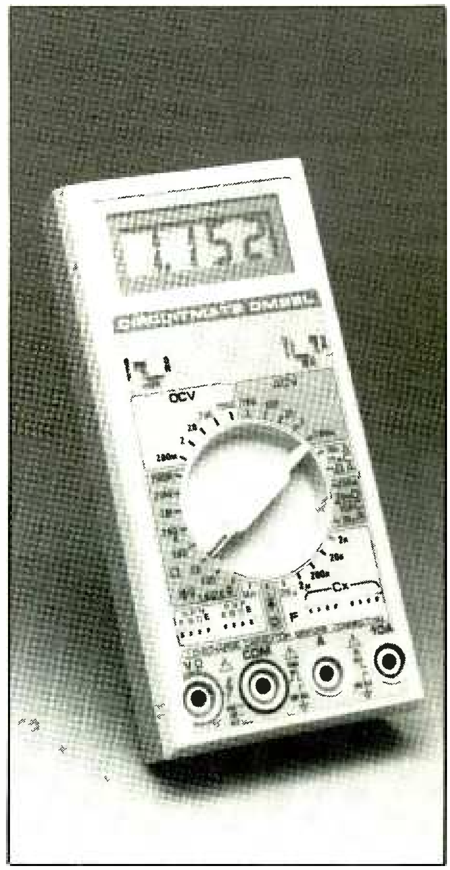
Accompanying software merges into DOS (Version 2.1 or higher) to prohibit unauthorized persons from gaining access to even the operating system. If an unauthorized system disk is used or the incorrect password is entered, Totalock automatically shuts down the computer and all its peripherals. This multiple level of locks is said to exceed the protection provided by the old data encryption standard (DES).

Totalock is designed for use in both stand-alone computers and mainframe/LAN-connected workstations. It is available as the Model 700-1 single-user password system for $100 and as the Model 700-4 four-user password system for $120.

CIRCLE 36 ON FREE INFORMATION CARD

Digital Multimeters With Built-In Logic Probe

Two new low-cost 3½-digit digital multimeters have been added to Beckman's Circuitmate line. The Models DM25L and DM23 are both full-size instruments and both have tilt bails, a single rotary function/range switch and LCD displays. Other features that both share in common include: transistor gain (H_{fe}) measuring and diode test functions; measurement capabilities to 750 volts ac/1,000 volts dc (10-meg-



ohm input impedance), 10 amperes ac/dc and resistance to 20 megohms; 6.3″ × 3.0″ × 1.4″ dimensions; and 11-ounce weight.

The Model DM25L also features a direct-reading 2,000-megohm resistance range, a built-in 20-MHz TTL logic probe that catches 25-nanosecond pulses (2.4 volts high and 0.7 volt low), and five capacitance ranges to 20 microfarads full-scale.

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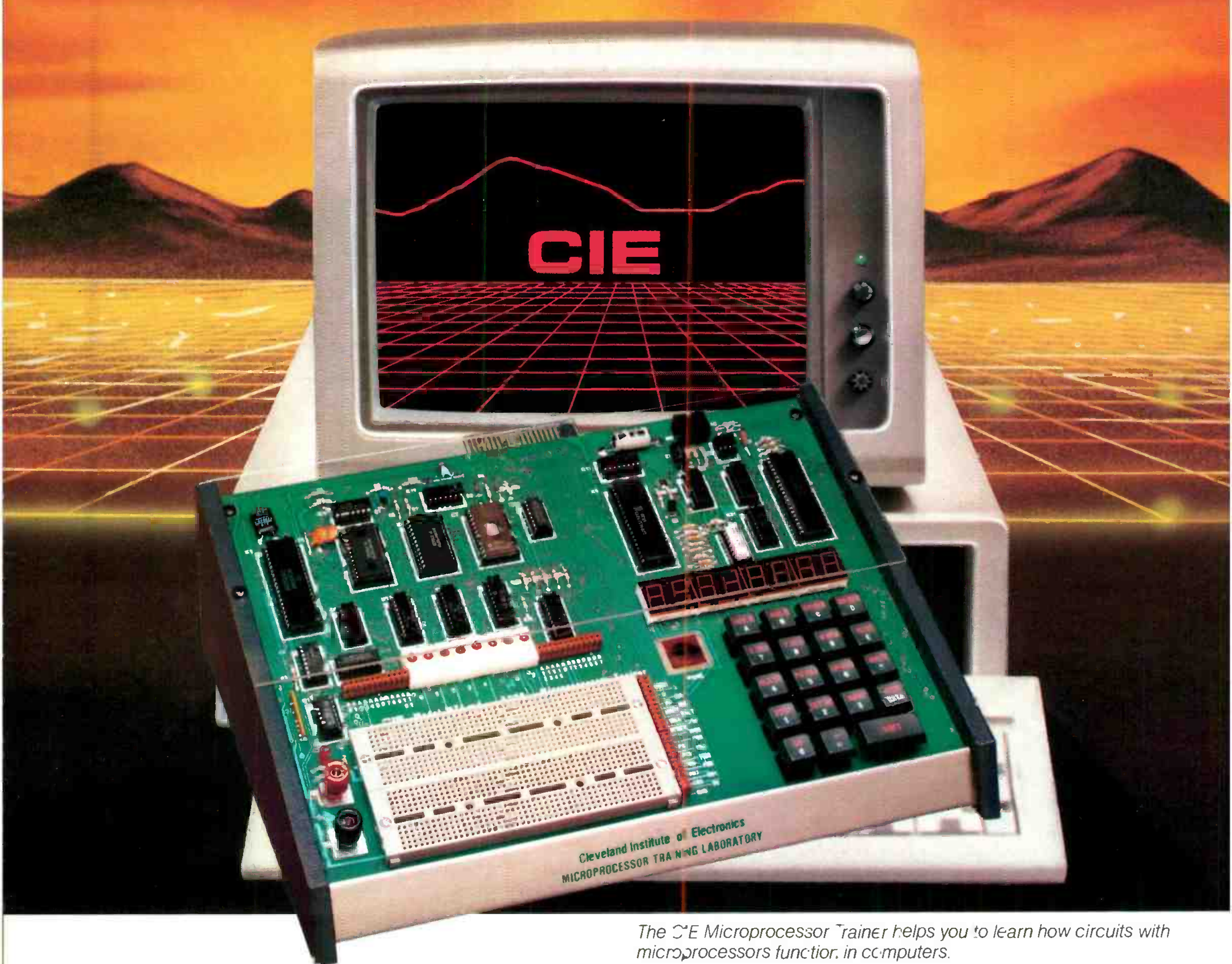

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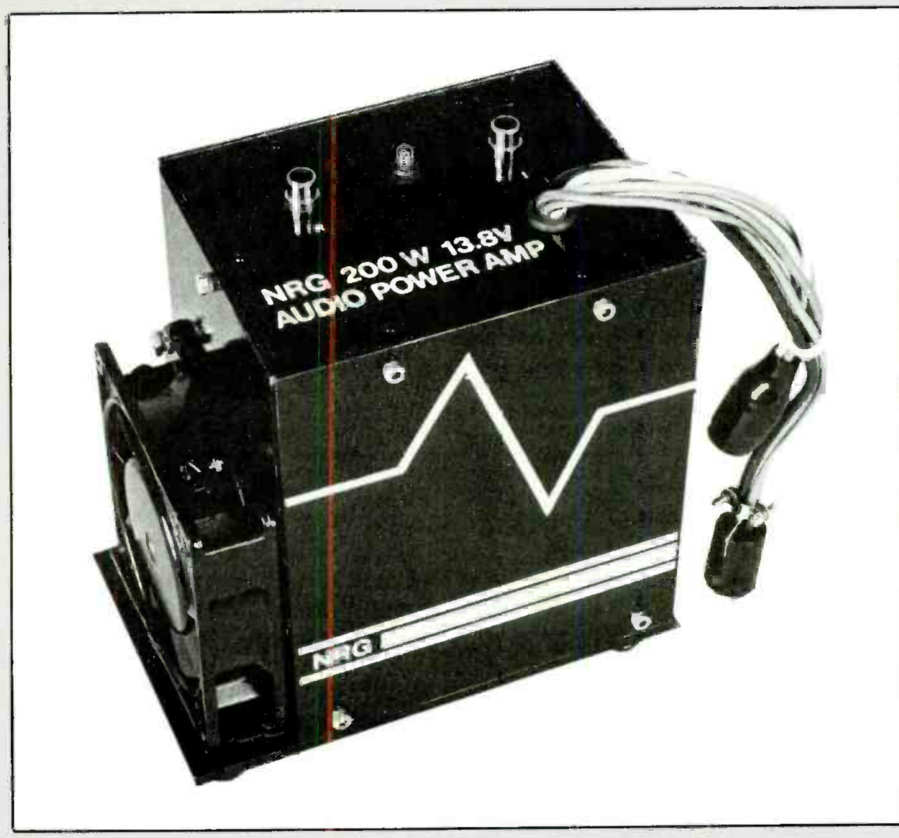
100-Watt/Channel, Distortionless *Digital* Audio Amplifier Booster

Get truly sharp, clear, high-power stereo sound with this $150 leading-edge-technology power amp booster for your car's radio, tape cassette or CD player system

By C. Barry Ward



Now you can obtain high-power audio from your automotive sound system without adding any distortion! Through use of digital technology, coupled with a 250-kilohertz-plus switching of a constant-frequency square-wave signal that drives power MOSFETs, the audio power booster to be described can pump the cleanest 100 watts/channel (at 4 ohms) into your speakers that you ever heard. All you need is at least 5 watts per channel output from your present car radio's output (maximum 25 watts) to get a 20-fold increase in power . . . 200 watts total from a system that measures only 6" × 6" × 4".

Designed for use in automotive vehicles or any other environment that uses a "12-volt dc" power supply, the amplifier has its own dc inverting power supply to step up the basic 13.2 volts of the typical vehicle electrical system to a level sufficient to ensure that the full 100 watts/channel of output power is always available to speakers. Moreover, with a suitable ac-line-operated power supply and a preamplifier to boost input signals to a power level sufficient to provide effective booster drive, the digital amp can be used to drive low-efficiency speaker systems and to dramatically increase room sound level from only moderate-power audio amplifiers—all while maintaining the low distortion level of the primary source program material and equipment.

Owing to its 250-kHz switching frequency, no sound whatsoever is audible with no input signal. With an input signal, the square wave becomes pulse-width modulated at an audio rate to convey the audio information to the speakers. The amplifier works on a principle very similar to that used in a CD player, whose high sound quality is renowned.

How it Works

Most people are familiar with conventional analog audio amplifiers that enlarge an input signal's voltage to provide the current that, in turn, drives the speakers. Ideally, the output waveform should be identical in shape to the input, the only difference being an increase in amplitude.

Unlike the analog amplifier that (again ideally) delivers no power to the speakers when no input signal is present, the digital amplifier described here outputs a constant-voltage square wave with a 50% duty cycle to the filter choke and speaker under the same input conditions. As cited earlier, the very high frequency of this square wave does not allow the speaker cones to move, and therefore no sound is heard. When an audio signal is applied to the amplifier's inputs, however, it off-balances the square wave in direct proportion to the input signal level to move the speaker cones in and out. A positive input signal that has 10% of the amplitude of the input range gives the square wave a duty cycle of 60% high and 40% low, which yields a net positive output.

If the square wave were to be sent directly to a speaker at an audio frequency, it would generate 180 watts of output power! But in the digital amplifier, two factors average the output to a level of less than one inaudible watt. One is the combined inductance of the speaker and filter, the other is the frequency of the square wave. The duty cycle of the square wave is modulated by an extremely linear triangle wave that is produced by the switching signal across a timing capacitor (*C14* in

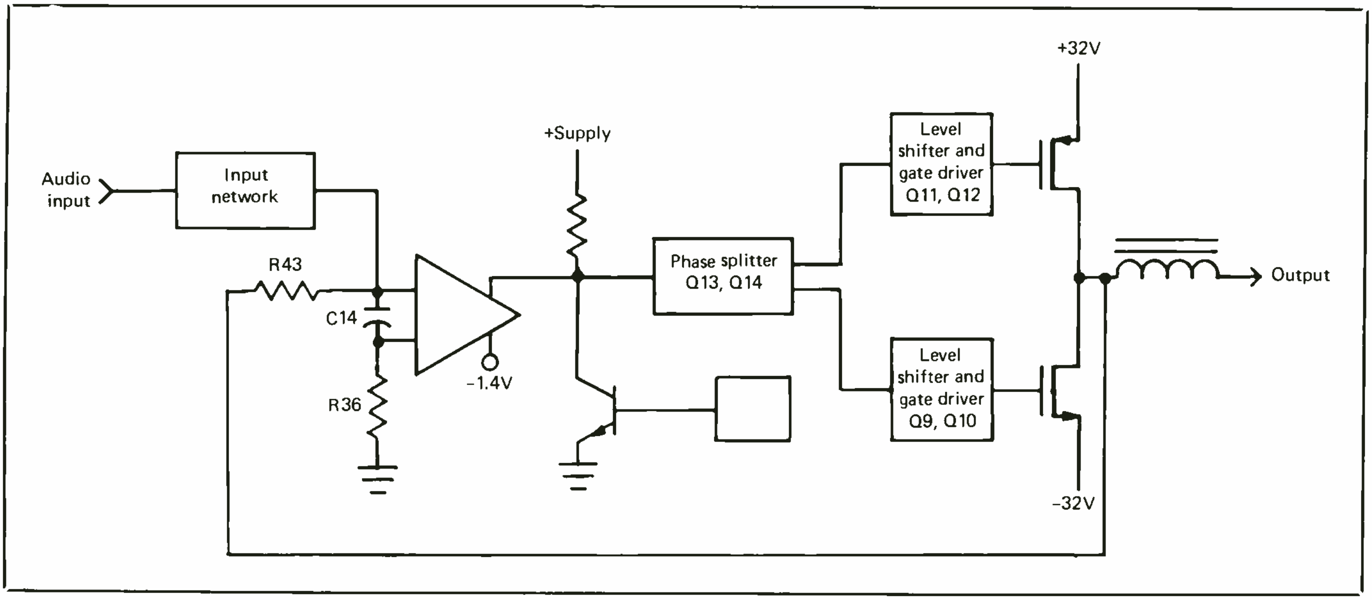


Fig. 1. Simplified block diagram of single channel of digital amplifier.

the single-channel simplified block diagram in Fig. 1). Tight waveform linearity is assured by the very large values of the timing resistor (*R36*) and timing capacitor.

Another factor that contributes to the linearity of the modulator is the 10-millivolt level of the triangle wave. This small voltage, combined with a large time constant, assures that only a small, very linear portion of the curve of the RC timing ramp is used (see Fig. 2).

Related directly to the square wave output signal, the triangle wave is compared to the audio input signal (Fig. 3). When the audio input goes in a positive direction, the output of the amplifier remains high for an increasingly longer percentage of the time available for that switching cycle. To keep the average voltage of the output within 10 mV of the input, the comparator must change state. This forces the output voltage to be error corrected to within 10 mV during every 2-microsecond switching cycle. Output clipping occurs just as it does in a conventional linear amplifier when the output can no longer be corrected to match the input signal's amplitude.

Figure 4 is the full schematic of both channels of the stereo power-MOSFET digital amplifier booster. Figure 5 illustrates the power supply schematic.

When power is first applied to the circuit, timing capacitor *C14* in the *U1* circuit is discharged. (Though we will discuss operation of only one channel, the following applies equally well to the other channel since both are identical.) This holds the comparator's output in an off state. Since *U1* is an open-collector device, its output very rapidly swings high. This high signal goes to phase-splitters *Q13* and *Q14*, where it is split into positive and negative excursions that are routed to positive level shifters *Q11* and *Q12* and negative level shifters *Q9* and *Q10*. Since the signal is going positive at this point, *Q11* and *Q12* turn on, which sends output p-channel power MOSFET *Q2* into conduction.

When *Q2* conducts, a high positive voltage appears on one end of timing resistor *R43*, which charges *C14*.

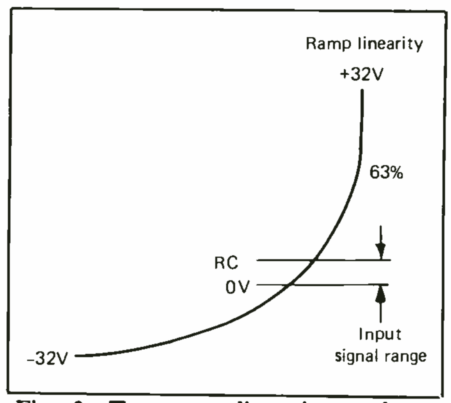


Fig. 2. To assure linearity, only a very small, linear portion of the charging ramp is used. Only 10 mV (0.00016%) of the 64 volts available charges the timing capacitor.

When the charge on *C14* reaches 10 mV, *U1*'s output switches state and the process reverses. Charging and discharging of *C14* is at a 250-kHz rate.

Note in Fig. 1 that the audio input goes to an Input Network. An ac-coupled 15-ohm resistor in this block provides a load for the car radio's output. (Some car radios require an output load to operate properly.) The output from the car radio's amplifier must be in a 5-to-20-watt range to be able to drive the amplifier to full power, as noted earlier. Inside the Input Network is also resistive decoupling between the timing ramp on *C14* and the input signal.

A small amount of preemphasis is added by the RC network made up of *R42* and *C13* (Fig. 4). This high boost minimizes the high-frequency rolloff caused by output filter inductor *L5*.

A time-delay circuit in the Input Network mutes the amplifier during the first few seconds after power is applied. This allows time for the amplifier and the car's radio to stabilize, removing the pops and thumps sometimes associated with high-power audio systems. The time delay is generated by timer IC *U2*. The high output of *U2*, held that way by *C5*, keeps *Q13* and *Q14* and output power MOSFETs *Q1* and *Q2* from conducting. When *C5* charges to ⅔ of the 12-volt supply, *U2*'s output goes low, turning off *Q15* and *Q18* and allowing the amplifier to oscillate and amplify.

Referring to Fig. 5, the power supply converts the 12 volts from the vehicle's electrical system to +32 and −32 volts. The power supply operates as a standard, self-oscillating inverter. Transistors *Q1* an *Q2* are driven from power transformer *T1*'s secondary winding. The third winding of *T1* provides the required output to rectifier diodes *CR1* through *CR4*. The pulsating dc from the output of the bridge circuit is filtered by capacitors *C2* and *C3* to produce the required output voltages. The power supply operates at a frequency of 25 kHz.

Power from the vehicle's electrical system can be applied to and removed from the amplifier's power supply with a switch or automotive relay. The booster should be turned on at the same time that the radio is turned on or after (*not* before). An electrically operated antenna can provide automatic turn-on when the radio is switched on with proper connections made to the antenna's power-control relay coil as illustrated.

Construction

Before you begin construction, separate the components for the power-supply and amplifier boards. Then in each case, separate the diodes and transistors according to type number. This way, you will be less likely to install these devices in the wrong locations, which could result in costly repairs. Keep in mind that the power MOSFETs are easily damaged by static elecricity. Therefore, practice the same safe handling procedures recommended for any other MOS-type device.

Due to the r-f nature of this project, printed-circuit construction is almost mandatory. Fabricate the amplifier and power supply boards using the actual-size etching-and-drilling guides given in Fig. 6. If you prefer not to fabricate your own boards, you can purchase ready-to-wire boards (and other individual parts or a complete kit of parts) from the source given in the Note at the end of the Amplifier Parts List.

When the boards are ready to be wired, indicate on each the hookup points for the power transformer on the power supply board, between-board wiring and off-board wiring. These include the numbers for *T1*'s windings on the power supply board and all numbers preceded by an E on both boards.

Wind toroid inductors *L5* and *L6* for the amplifier board. Due to the high operating frequency and high currents present in the output of the amplifier, a "multifilar" winding approach is recommended. Each turn is composed of several turns of small-diameter wire, wound in parallel with each other. Inductors wound in this manner exhibit much lower

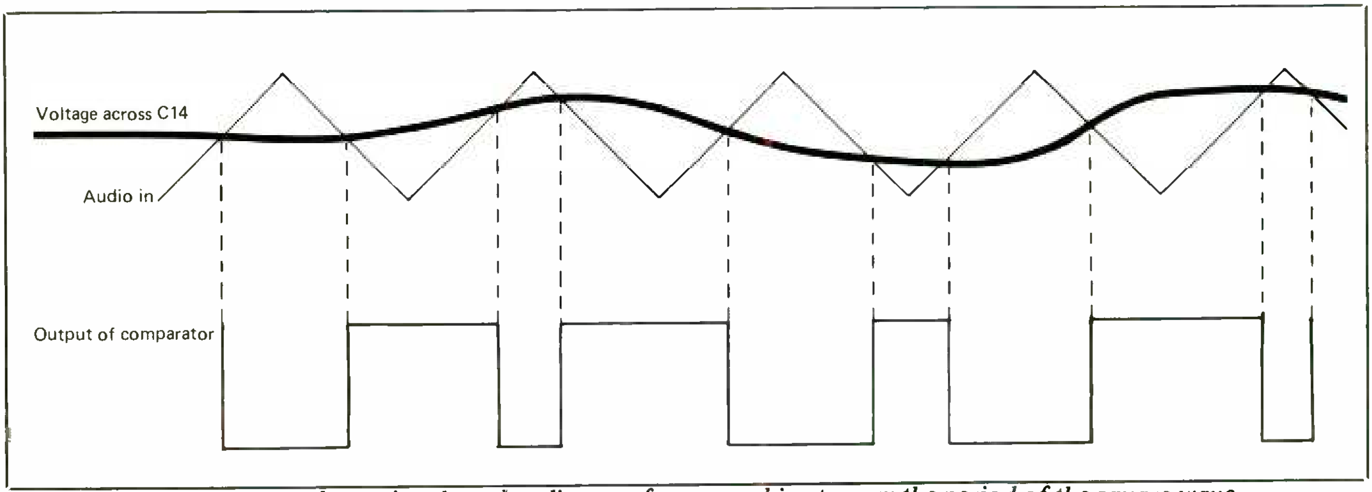


Fig. 3. Graph shows how triangle and audio waveforms combine to vary the period of the square wave.

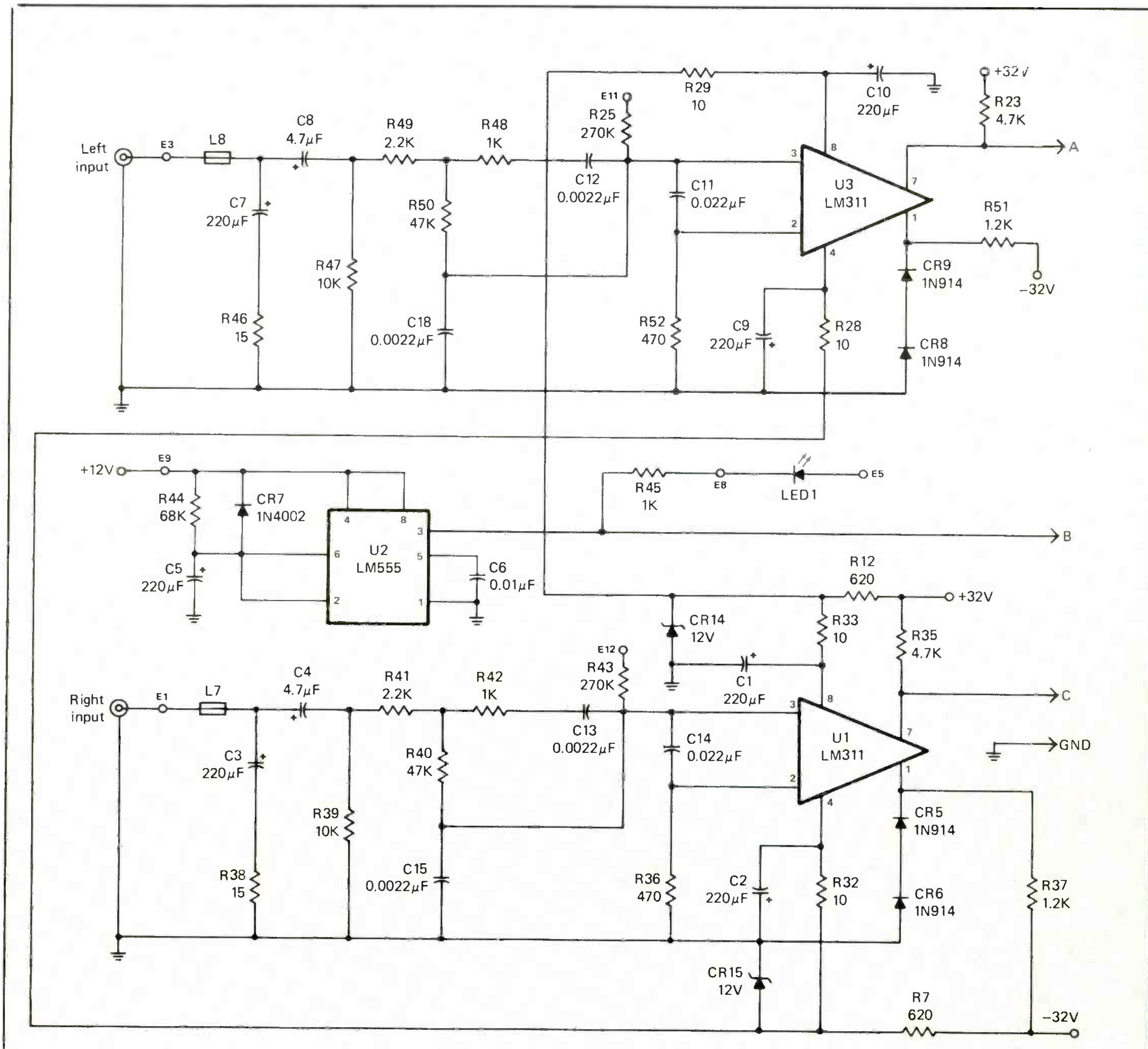
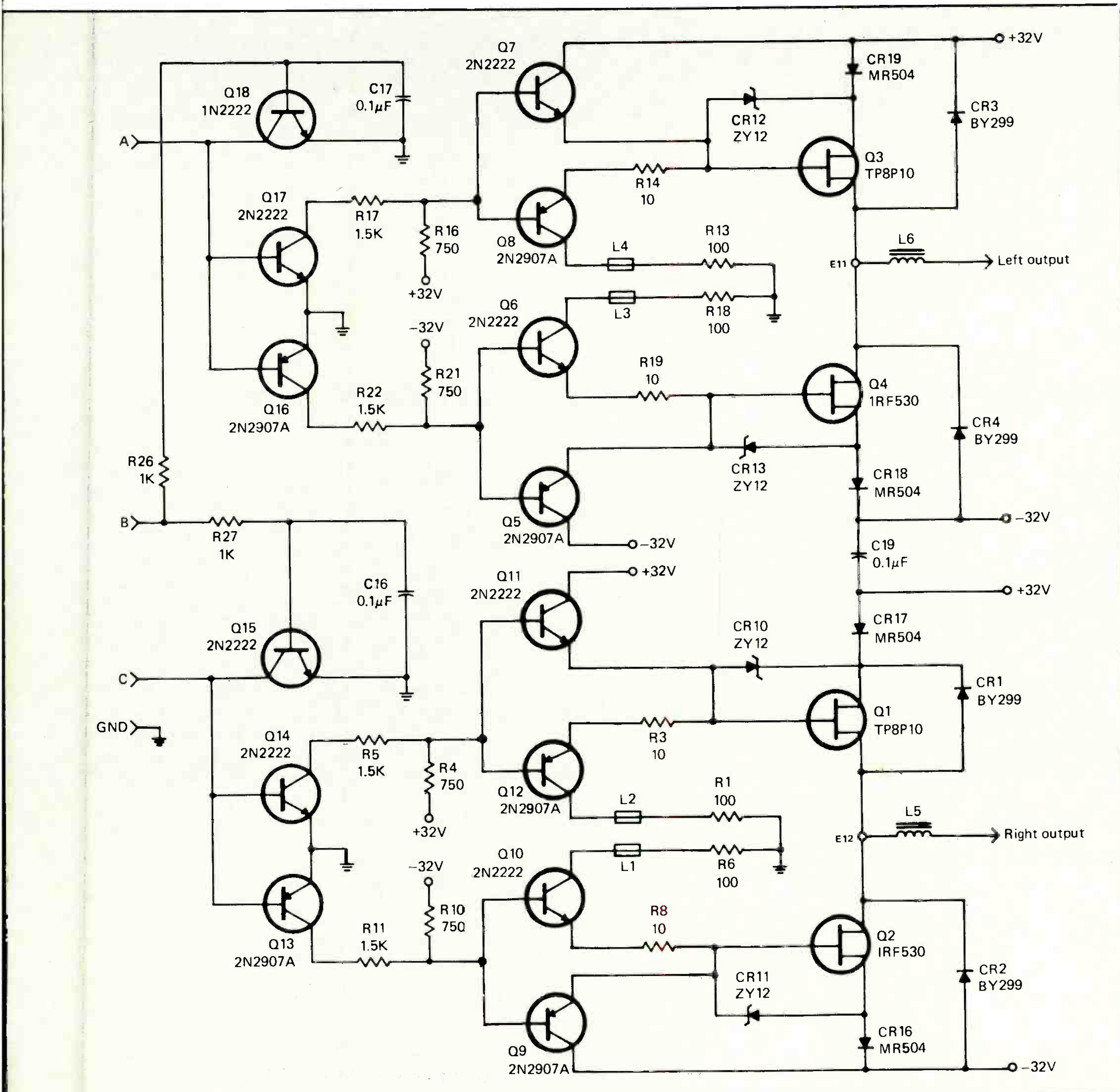


Fig. 4. Schematic diagram of amplifier portion of circuit shows both channels of basic amplifier but not inverting power supply.

losses at high frequencies. They are also easier to wind than if a large-diameter stiff wire were used.

Each inductor requires six strands of No. 25 AWG enameled copper wire, each approximately 6 feet long. Wind tightly, and avoid variations in the consistency of the wind. Wind both inductors in the *same* direction to eliminate any possible coupling between the two channels when *L5* and *L6* are wired into the circuit.

After winding the inductors, tightly twist together the conductors at each end and, using a soldering iron capable of developing at least 800°F tip temperature, tin the ends. Alternatively, scrape away ⅜" of enamel



from each wire end before twisting together the wires and then tin with a standard soldering iron. This latter approach is effective but tedious and time-consuming.

The multifilar winding technique is not appropriate for *T1* in the power supply because it could result in some undesirable side effects. Therefore, to avoid any problems, use solid wire to wind *T1*. Start with the primary winding, which is the most difficult because it consists of a very heavy and stiff No. 12 AWG enameled wire. Do not scrimp on the size of the primary wire. If you do, the power supply will develop less power and will overheat.

AMPLIFIER PARTS LIST

Semiconductors

CR1 thru CR4—BY299 or equivalent fast 2-ampere diode

CR5,CR6,CR8,CR9—1N914 or 1N4148 small-signal diode

CR7—1N4004 or similar 400-volt, 1-ampere diode

CR10 thru CR15—ZY12 or equivalent 12 volt, 1-watt zener diode

CR16 thru CR19—MR504 or equivalent 400-volt, 3-ampere diode

LED1—T-1¾ green light-emitting diode

Q1,Q3—TP8P10 or IRF953 p-channel-power MOSFET

Q2,Q4—IRF530 n-channel power MOSFET

Q5,Q8,Q9,Q12,Q13,Q16—2N2907A pnp transistor

Q6,Q7,Q10,Q11,Q14,Q15,Q17,Q18—2N2222A npn transistor

U1,U3—LM311 comparator

U2—555 timer

Capacitors

C1,C2,C3,C5,C7,C9,C10—220-µF, 25-volt electrolytic

C4,C8—4.7-µF, 50-volt electrolytic

C6—0.01-µF, 50-volt disc

C11,C14—0.022-µF, 50-volt stacked film

C12,C13,C15,C18—0.0022-µF, 50-volt polyester

C16,C17—0.1-µF, 50-volt ceramic disc

C19—0.1-µF, 50-volt polyester

Resistors

(Note: There are no resistors designated R2, R9, R15, R20, R24, R30, R31 and R34)

R1,R6,R13,R18—100 ohms, ¼-watt, 5% tolerance

R3,R8,R14,R19,R28,R29,R32,R33—10 ohms, ¼-watt, 5% tolerance

R4,R10,R16,R21—750 ohms, ¼-watt, 5% tolerance

R5,R11,R17,R22—1,500 ohms, ¼-watt, 5% tolerance

R7,R12—620 ohms, ½-watt, 5% tolerance

R23,R35—4,700 ohms, ¼-watt, 5% tolerance

R25,R43—270,000 ohms, ¼-watt, 5% tolerance

R26,R27,R42,R45,R48—1,000 ohms, ¼-watt, 5% tolerance

R36,R52—470 ohms, ¼-watt, 5% tolerance

R37,R51—1,200 ohms, ½-watt, 5% tolerance

R38,R46—15 ohms, 3-watt, 10% tolerance

R39,R47—10,000 ohms, ¼-watt, 5% tolerance

R40,R50—47,000 ohms, ¼-watt, 5% tolerance

R41,R49—2,200 ohms, ¼-watt, 5% tolerance

R44—68,000 ohms, ¼-watt, 5% tolerance

Miscellaneous

L1 thru L4,L7,L8—Ferrite bead

L5,L6—Toroid inductor (hand-wound; see text)

Printed-circuit board; heat sink, suitable enclosure (see text); 12-volt dc fan; transistor insulators; shoulder fiber washers; thermal grease or paste; hookup and magnet wire (see text); machine hardware; solder; etc.

Note: The following items are available from NRG Electronics, P.O. Box 24138, Ft. Lauderdale, FL 33307: Complete kit of parts, including power supply, enclosure and fan for $150.00 plus $4.50 P&H. Separate parts available are: amplifier pc boards for $10.00 each; power supply and amplifier heat sinks for $4.00 each; enclosure for $30.00; and fan for $15.00. Florida residents, please add appropriate sales tax. Other individual components and parts are also available (send SASE for parts/price list).

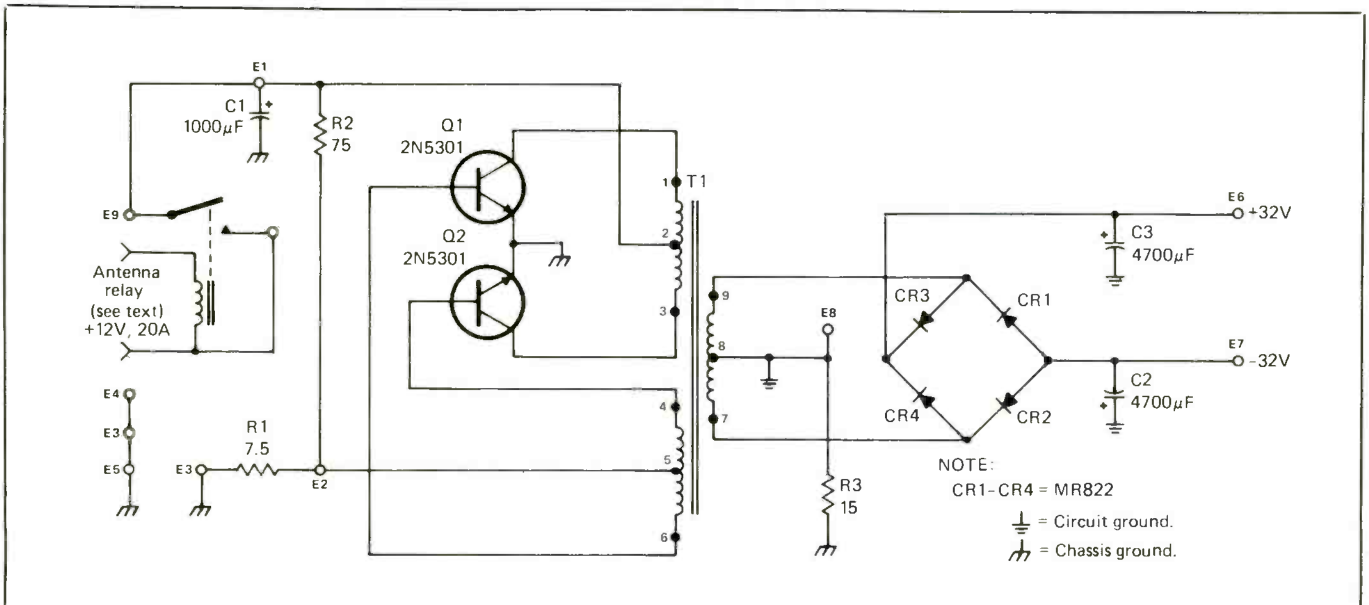
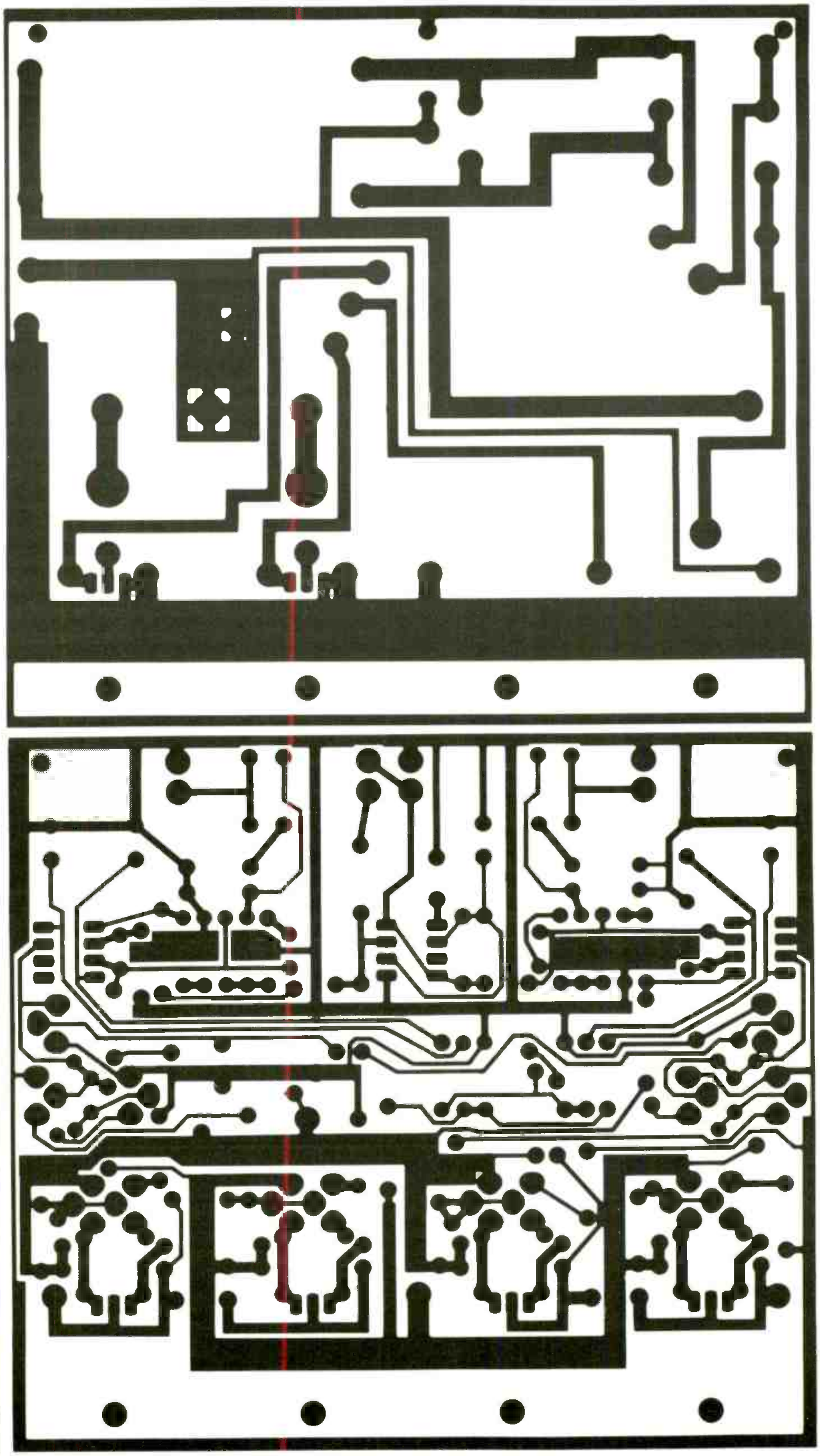


Fig. 5. Schematic of power supply. This is a basic inverter built around a hand wound toroid power transformer (T1).

Fig. 6. The actual-size etching-and-drilling guides for the power supply (upper) and amplifier (lower) printed-circuit boards.



Starting with a 3″ leader labeled with the number 1, wind a 48″ length of this wire onto the toroid core. Pause at exactly seven turns to form the center tap by making a loop that, when folded on itself, is 3″ long. Twist this loop to form the center lead of the transformer's primary and label it number 2. Wind exactly seven more turns in the same direction. Trim the remaining wire to a convenient length (about 3″) and label this last lead number 3.

Wind the secondary in a similar manner, using 72″ of No. 14 enameled wire. This winding consists of 38 turns, with a 3″-long center tap at the 19th turn. Label the beginning, center tap and end of this winding with the numbers 7, 8 and 9, respectively. Wind in the *same* direction as you wound the primary.

Easiest to wind is the third (tertiary) winding because it consists of only eight turns (with a center tap at the

POWER SUPPLY PARTS LIST

C1—1,000-μF, 25-volt electrolytic capacitor
C2,C3—4,700-μF, 40-volt electrolytic capacitor
CR1 thru CR4—MR822 or equivalent fast 200-volt, 5-ampere rectifier
R1—7.5-ohm, 5-watt power resistor
R2—75-ohm, 5-watt power resistor
R3—15-ohm, 3-watt power resistor
Q1,Q2—2N5301 npn power transistor in TO-3 case
T1—Ribbon toroid transformer (see text)
Misc.—Printed-circuit board; heat sink; TO-3 transistor insulators; thermal grease or paste; machine hardware; heavy-duty stranded hookup wire; solder, etc.

Note: See Amplifier Parts List for availability of kits and individual components.

fourth turn) of easily managed 16-gauge enameled wire. Label the beginning, center tap and end of this winding with the numbers 4, 5 and 6, respectively, and wind in the same direction as the primary and secondary.

Trim all power transformer leads to 1" long, measured from the body of the toroid, except leads 2 and 3, which should be 1½" and 2" long, respectively. Carefully scrape ¼" of the enamel from each lead and lightly tin with solder. Group the three leads from each winding so that they align with the appropriate holes in the power supply board.

Wire the power supply board as shown in Fig. 7 (Pay careful attention to the orientations of the electrolytic capacitors, transistors and diodes on both boards.) Leave *T1* for last. Bolt the heat sink to the board via only the two left holes.

Liberally coat both sides of two TO-3 insulators with thermal grease or paste and position them on the heat sink so that their holes line up with those in the heat sink. Mount *Q1* and *Q2* in their respective locations and bolt them down with 6-32 × ¾" machine hardware with shoulder fiber washers between the heat sink and board. Make absolutely certain that the narrow necks of the shoulder fiber washers seat into the holes in the heat sink so that the transistors are fully insulated from the heat sink. Solder the base (B) and emitter (E) pins of *Q1* and *Q2* to the copper pads. The holddown screws make the collector connections.

Tie together and solder one lead each of power resistors *R1* and *R2*. Slip insulating tubing over each of the leads of both resistors, install them in holes E1, E2 and E3 and solder into place. Position these resistors so that they sit on the heat sink as shown. Finally, install *T1* on the board. Make sure all solder connections are mechanically and electrically secure.

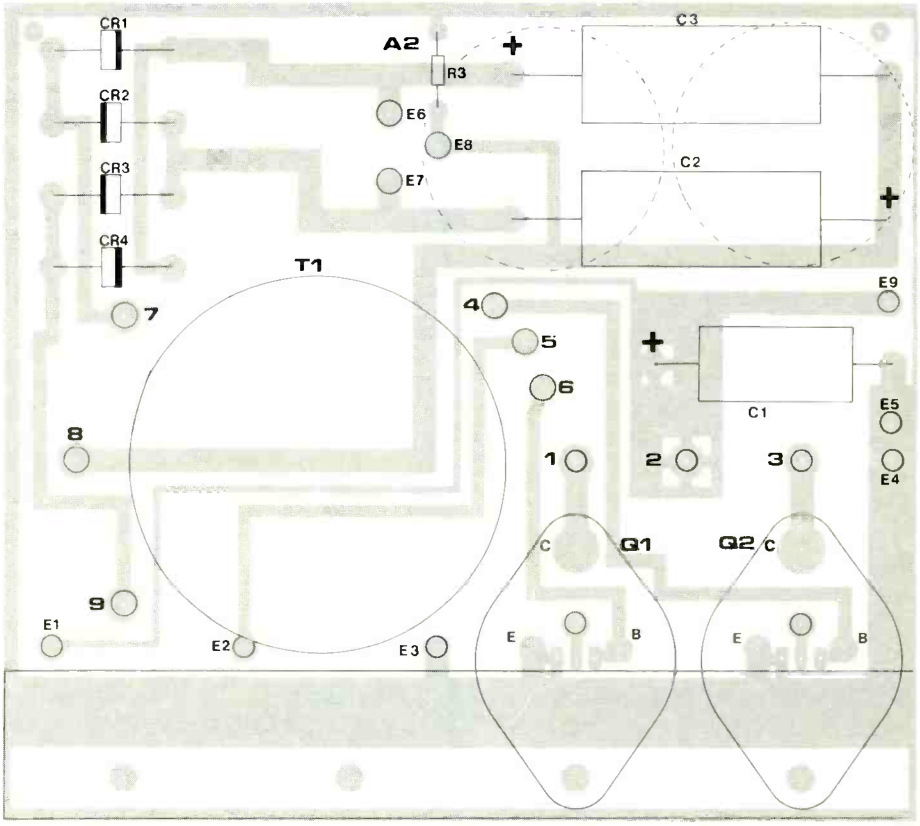


Fig. 7. Wiring guide for power supply board.

Wire the amplifier board as shown in Fig. 8. Start with the resistors, diodes and wire jumpers. The jumpers, identified by the letter with a number suffix, should all be solid wire, and J3, J5 and J6 should be insulated.

Install *Q5* through *Q18*. Make certain you install the correct transistor in each location. Any error in installation can cause instant (and expensive) component failure when the amplifier is first powered up. Mount *Q5* through *Q18* about ⅜" above the board's surface and be sure to slip a ferrite bead over the collector leads of *Q6*, *Q8*, *Q10* and *Q12* before plugging them into the board.

Note that *Q5* through *Q18* can be in either a plastic or a metal package. With the plastic package's flat facing up and the bottom facing toward you, the leads are the emitter, base and collector from left to right. With the round metal package's bottom facing you, the leads are the emitter, base and collector reading clockwise from the tab on the case.

Install the capacitors, making sure that you properly polarize the electrolytics. Install the ICs directly on the board, soldering their pins to the copper pads. You can use sockets for the ICs, if you wish, though this is not necessary (nor is it recommended for an automotive environment that is normally subjected to mechanical stresses) because these low-current devices rarely fail if they are good to start with.

Install *L5* and *L6*, seating them on the heat sink as shown with double-sided foam tape. Then connect and solder *C15* and *C18* from pin 1 of *U1* and *U3*, respectively, to circuit ground on the *bottom* of the board. Solder these capacitors directly to

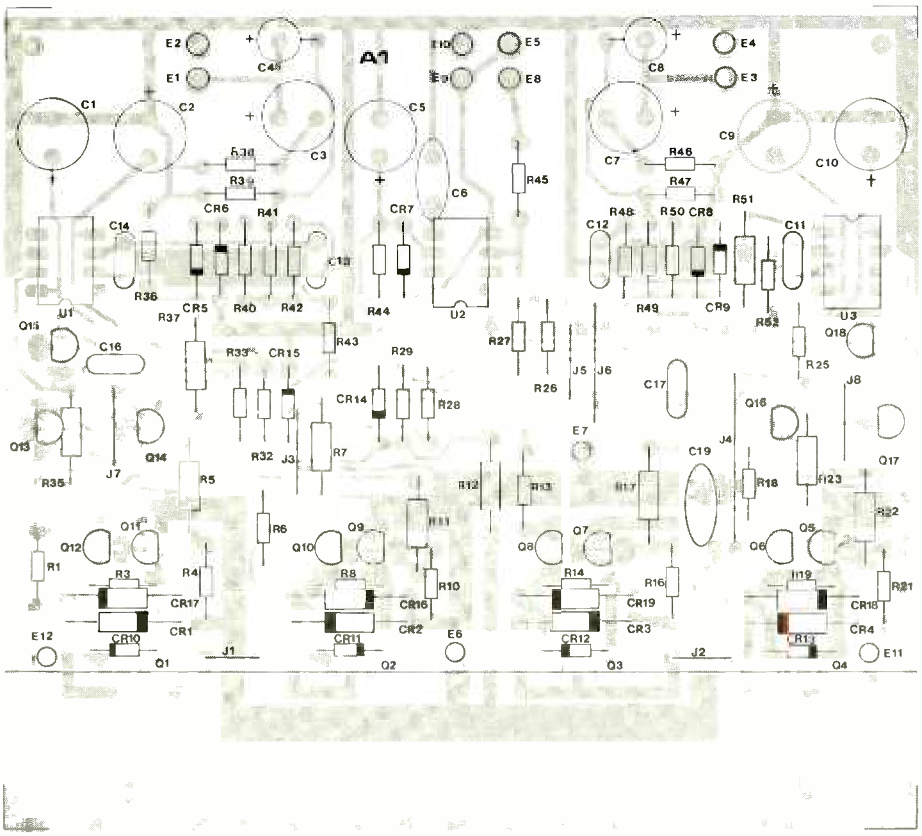


Fig. 8. Wiring guide for amplifier board.

the pin 1 stubs to get them as close as possible to the ICs.

Power MOSFETs *Q1* through *Q4* are in flat three-lead plastic packages that bolt down to the board and heat sink. As cautioned above, use safe handling procedures when working with these transistors to avoid damaging them with static electricity. Bend the transistor leads toward the rear metal surfaces of the cases at the point where they go from wide to narrow.

Coat both sides of four transistor insulators with thermal grease or paste and align them with the holes in the heat sink. Feed four 6-32 × ¾" machine screws through the four holes at the bottom of the amplifier board from the solder side. Drop a shoulder fiber washer onto each screw, narrow neck up, and lower the heat sink onto the screw ends. Carefully seat the necks of the fiber washers in the holes in the heat sink. Install the appropriate n- or p-channel power MOSFET in the *Q1* through *Q4* locations. Do not forget to use safe-handling procedures when handling these MOS devices. Drop onto each screw end a lockwasher and follow up with a 6-32 machine nut. Make the hardware only finger tight.

When mounting the power MOSFETs, be exceptionally careful to insulate them from the heat sink, due to the high r-f difference in potential between the metal parts.

Solder the leads of *Q1* through *Q4* to the copper pads on the bottom of the board. These must be solid electrical and mechanical connections. Make sure that you do not create any solder bridges between the closely spaced pads. Then tighten the hardware only enough to mechanically secure the assembly in place. Do not overtighten or you will crack the cases of the transistors.

Operational Checkout

A full operational check is highly recommended before you install the amplifier in your vehicle (see "Bench Testing the Amplifier" box). Be extremely careful as you check out the amplifier section. Keep in mind that the power supply produces dangerous voltages and currents. Do not short the power supply's outputs. If you do, the pc board's foil can be damaged. Also, shorting anything on the amplifier board will almost certainly destroy some of the semiconductors.

Check the power supply first, using an ohmmeter to verify that there are no short circuits between the 12 volt input and either of the two outputs to ground. If you have a 12- to 14-volt dc power supply, connect it in proper polarity across *C1* in the power supply.

When you turn on the power, you will hear a brief "chirp" from the power supply as the filter capacitors charge. With a dc voltmeter, you should measure +32 and −32 volts to ground at the positive and negative sides of *C2* and *C3*, respectively. If the voltage is low or zero, check the phasing of *T1*'s primary (terminals 1, 2 and 3) and of the feedback winding (terminals 4, 5 and 6). If there is no output at one side of the supply and you hear a high-pitched squeal coming from *T1*, that side has a direct short.

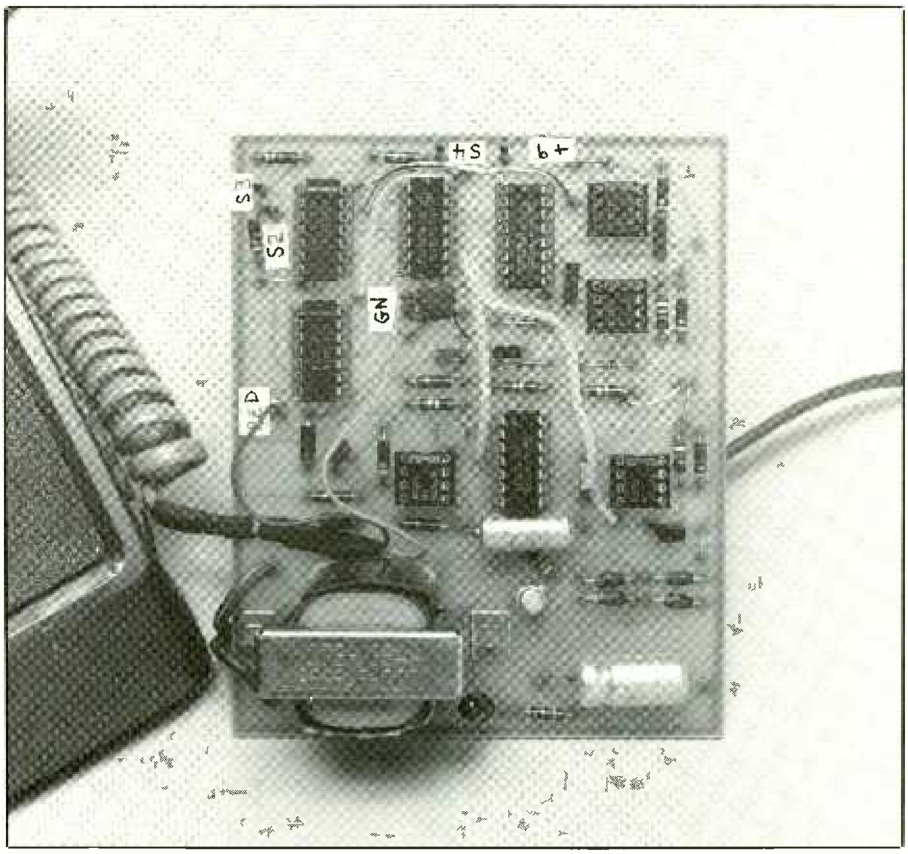
After checking the power supply, disconnect power from it and discharge the *C2* and *C3* with a 10-ohm, 5-watt resistor. Connect the power supply's output (leads E6, E7 and ground) to the amplifier circuit

(Continued on page 86)

TattleTale

A unique home/office intruder and emergency monitor that you phone to find out if all is well

By Anthony J. Caristi



Have you ever wondered what's happening at home or your office when you're away? Does the thought of a break-in, fire or other calamity worry you? If so, Tattletale can put to rest your anxiety. Just a telephone call puts this project on the line so that it reports to you no matter how far away you might be.

TattleTale monitors and reports on up to three possible emergency situations, completely automatically. It can easily be activated each time you leave your home or office and has a LED that tells you when it is armed.

Emergency situations like break-ins, fire, flood, heating/cooling system failure, etc., can be monitored by connecting three independent normally open switches or thermostats to TattleTale's three sensor terminals. Additionally, a simple modification of the basic circuit lets you use normally closed switches.

With TattleTale armed, all you have to do is telephone the number of the premises being monitored. TattleTale immediately answers the phone and transmits a series of tones or beeps. If you hear one beep every couple of seconds, all is well. However, if you hear two, three or four beeps, one or more sensors have been tripped. The number of beeps you hear tells you the nature of the emergency, allowing you to take the appropriate corrective action. TattleTale continues to report back to you for about a minute and then hangs up and rearms itself. You can check TattleTale's status as many times as you wish.

About the Circuit

As shown in Fig. 1, TattleTale's circuit consists of two basic sections: the logic section composed of all ICs except *IC4* and *IC9* and the remaining circuitry that answers the telephone and places coded pulse tones on the telephone line.

NOR gate *IC1A* detects when any of the sensor switches, identified as *S2, S3* and *S4*, has been tripped. If no switches are tripped, *IC3A* is enabled and the second output at pin 7 of *IC5* triggers one-shot multivibrator *IC7* via *IC3A* and *IC1B*. If any of the sensor switches is activated, *IC3A* is disabled and one of the succeeding outputs of *IC5* triggers *IC7* in a similar manner.

Astable multivibrator *IC8* operates at about 3 Hz and clocks binary counter *IC5*. The first output, at pin 9, of *IC5* is half the clock frequency and each succeeding output has a period that's twice as long as that of the preceding stages.

The start of the reset pulse generated by *IC7* is determined by the out-

Regency "Scanner Answer" Giveaway

Here's your chance to win a complete monitoring package from Regency Electronics and Lunar Antennas. 18 scanners in all will be awarded, including a grand prize of the set-up you see above: the Regency HX1500 handheld, the Z60 base station scanner, the R806 mobile unit, and a Lunar GDX-4 Broadband monitoring/reference antenna.

55 Channels to go!

When you're on the go, and you need to stay tuned into the action, take along the Regency HX1500. It's got 55 channels, 4 independent scan banks, a top mounted auxilliary scan control, liquid crystal display, rugged die-cast aluminum chassis, covers ten public service bands including aircraft, and, it's keyboard programmable.

Compact Mobile

With today's smaller cars and limited installation space in mind, Regency has developed a new compact mobile scanner, the R806. It's the world's first microprocessor controlled crystal scanner. In addition, the R806 features 8 channels, programmable priority, dual scan speed, and bright LED channel indicators.

Base Station Plus!

Besides covering all the standard public service bands, the Regency Z60 scanner receives FM broadcast, aircraft transmissions, and has a built-in digital quartz clock with an alarm. Other Z60 features include 60 channels, keyboard programming, priority control, digital display and permanent memory.

Lunar Antenna

Also included in the grand prize is a broadband monitoring/reference antenna from Lunar Electronics. The GDX-4 covers 25 to 1300 MHz, and includes a 6 foot tower.

Send in a photo (like this one of Mike Nikolich and his Regency monitoring station) and receive a free gift from Regency. Be sure to include your name, address and phone number.

Regency ELECTRONICS INC.
7707 Records Street
Indianapolis, IN 46226

Grand Prize (1 awarded)
1—Regency Z60 Base station scanner
1—Regency HX1500 Handheld scanner
1—Regency R806 Mobile scanner
1—Lunar GDX-4 Antenna

First Prize (5 awarded)
1—Regency Z60 Base station scanner
1—Regency R806 Mobile scanner

Second Prize (5 awarded)
1—Regency HX1500 scanner

Contest rules: Just answer the questions on the coupon, (all answers are in the ad copy) fill in your name and address and send the coupon to Regency Electronics, Inc., 7707 Records Street, Indianapolis, IN 46226. Winners will be selected from all correct entries. One entry per person. No purchase necessary. Void where prohibited by law. Contest ends June 30, 1987.

1. The Regency Z60 is
   - ☐ a digital alarm clock ☐ an FM radio
   - ☐ a scanner ☐ all of the above
2. The Regency R806 is the world's first ________ controlled crystal scanner.
3. The Regency HX1500 features
   - ☐ 55 channels ☐ Bank scanning
   - ☐ Liquid crystal display ☐ all of the above
4. The Lunar GDX-4 antenna covers ____ to ____ MHz.

Name: ________

Address: ________

City: ________ State: ________ Zipcode: ________

I currently own ________ scanners.

Brands owned: ________

CIRCLE 24 ON FREE INFORMATION CARD

PARTS LIST

Semiconductors
D1 thru D4—1N4001 or similar rectifier diode
D5—1N4004 or similar 300 PIV rectifier diode
D6,D7,D8—1N4148 or similar switching diode
IC1—CD4002B dual 4-input NOR gate
IC2,IC3—CD4081B quad 2-input AND gate
IC4,IC7,IC8,IC9—LM555 timer
IC5—CD4040B 12-stage binary counter
IC6—CD4011B quad 2-input NAND gate
LED1—Light-emitting diode (Radio Shack Cat. No. 276-041 or similar)
Q1—MPSA42 or similar 300-volt silicon npn transistor
Q2—2N3904 or similar silicon npn transistor

Capacitors (15-volt)
C1—1,000-μF electrolytic
C2—0.47-μF ceramic disc
C3—0.22-μF ceramic disc
C5,C6—0.1-μF ceramic disc
C7—47-μF electrolytic
C8,C9,C10—0.01-μF ceramic disc
C4—0.1-μF, 200-volt ceramic or Mylar

Resistors (¼-watt, 5% tolerance)
R1,R2,R3,R18—10,000 ohms
R4—1.5 megohms
R5,R8,R12—1 megohm
R6—390,000 ohms
R7—22 ohms
R9,R10,R11—100,000 ohms
R13—2,200 ohms
R14—150 ohms
R15—39,000 ohms
R16—15,000 ohms
R17—680 ohms

Miscellaneous
F1—1-ampere fuse
S1—Spst slide or toggle switch
S2,S3,S4—sensor switches or thermostats (see text)
T1—6.3-volt, 300-mA transformer (Radio Shack Cat. No. 273-1284A or similar)
Z1—Varistor (Radio Shack Cat. No. 276-570 or similar)
Printed-circuit board or perforated board and suitable soldering or Wire Wrap hardware; sockets for ICs; suitable enclosure; ac line cord with plug; telephone cord with modular plug; panel-mount LED lens clip; rubber grommets; machine hardware; hookup wire; solder; etc.

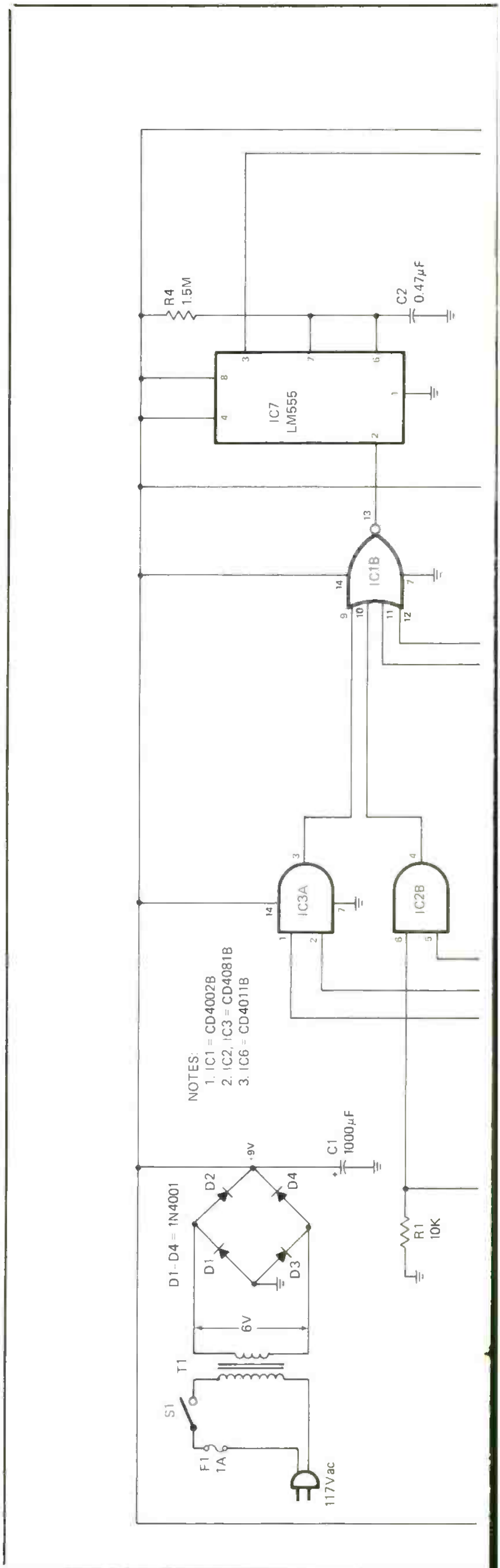
Note: The following items are available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463: Pc board for $8.50; IC1 and IC3 for $2.50 each; IC5 for $3.50. Add $1.00 P&H. New Jersey residents, please add state sales tax.

put of *IC5*, which is permitted to pass through AND gates in *IC2* and *IC3* in accordance with the status of the sensor switches. In this way, the count length of *IC5* is controlled by the switches, and pin 9 of *IC5* will have one, two, three or four pulses that are used to enable 200-Hz tone generator *IC9*. Since *IC7* holds *IC8* and *IC5* in reset for 1 or 2 seconds each time it's triggered, tones generated by *IC9* are in groups of one, two, three or four bursts.

To answer the ringing telephone, TattleTale is designed to respond to the 90-volt, 20-Hz ring signal. The flip-flop "latch" composed of *IC6A* and *IC6B* has two stable states. When power is first applied to the circuit, the output at pin 4 of *IC6B* will be high, forward biasing *Q2* and turning on *LED1* to indicate that the circuit is armed and ready.

Any ring signal that appears on the telephone line is applied to pin 1 of *IC6A* and causes the latch to change state. The negative-going output at pin 4 of *IC6B* then triggers one-shot multivibrator *IC4*, causing its pin 3 output to go positive. Forward bias to *Q1* now connects *R14* across the telephone line and answers the call.

Since *IC4* has a time period of about a minute, the circuit will hold the line open for that period of time and then automatically hang up. The negative-going pulse at pin 3 of *IC4* is then used to reset the latch circuit



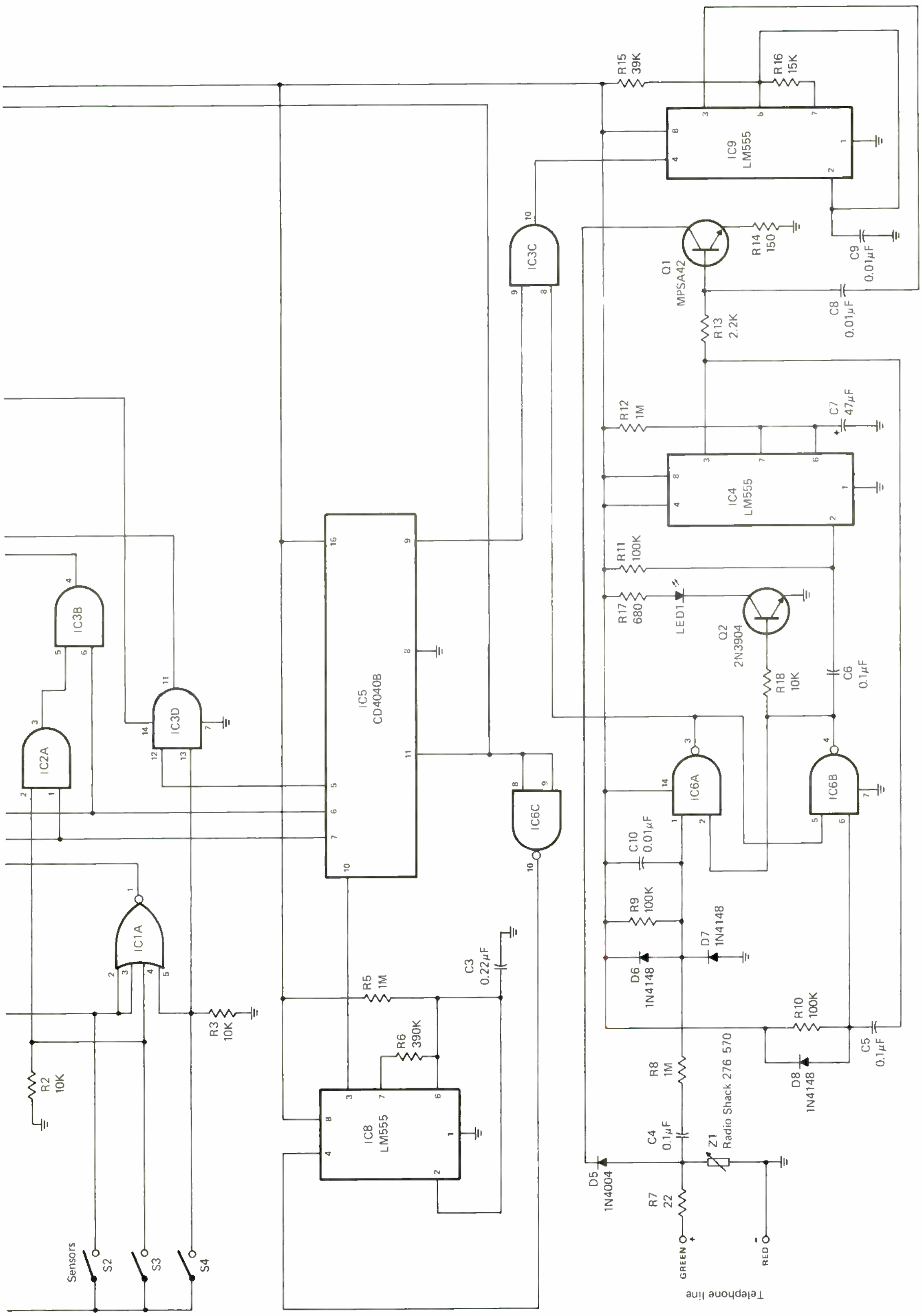


Fig. 1. Schematic diagram of complete project.

to the armed condition so that the project is ready to answer a later call when it arrives.

During the time *Q1* is conducting, tone bursts from *IC9* are fed to the base of the transistor and are thus fed into the telephone line. This provides you with the audio information that indicates the status of the sensor switches connected to TattleTale.

Note that the circuit is designed to work with normally open sensors. If one or more of the sensors you are using is a normally closed type, it can be used only if you add an inverter to the circuit for each. This inverter reverses the logic so that it conforms to the requirements of the basic circuit. Figure 2 illustrates this modification using a normally closed switch and *IC6D* (the spare gate in *IC6*) in place of *S2* in Fig. 1.

Examining Fig. 2, you will note that *R1*, which is normally connected to pins 2 and 3 of *IC1*, now connects to pins 12 and 13 of *IC6D*. With this circuit modification, *S5*, which is used in place of *S2*, must be a normally closed switch. This results in pins 2 and 3 of *IC1* being at logic 0 when no emergency exists, due to the inverting action of *IC6D*.

If your system calls for use of more than one normally closed sensor, you must add another chip to the Fig. 2 circuit. This chip can be a CD4011B or a CD4069B. Remember, though, that when using one section of a CD4011B as an inverter, you must connect both inputs together and that digital CMOS chips should never have input terminals that are left floating.

Construction

There's nothing critical about component layout. Therefore, any convenient means of assembly can be used to build Tattletale, including perforated board and soldering or Wire Wrap hardware and, preferably, a printed-circuit board. Use sockets for all ICs.

If you wish to fabricate your own pc board, use the actual-size etching-and-drilling guide shown in Fig. 3. When you're finished fabricating the board, drill a small hole 1½ " in from the right and ¼ " in from the top edges of the board with the board oriented as shown in Fig. 3. Drill a second small hole about ¼ " immediately to the right of the first hole. These two holes will be used to secure the telephone cord to the board to prevent it from pulling loose. If you prefer not to fabricate your own pc board, you can purchase a ready-to-wire one from the source given in the Note at the end of the Parts List.

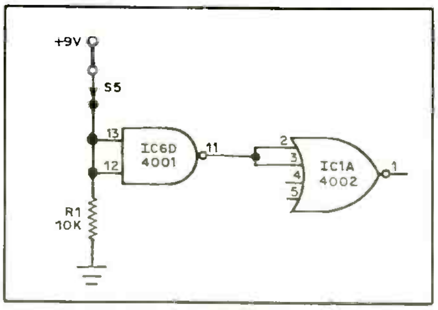


Fig. 2. Circuit modification for using normally closed sensors.

Referring to Fig. 4, install and solder into place sockets for all ICs. Do *not* install the ICs in the sockets at this time. Next, install the resistors, followed by the capacitors, varistor, diodes, transistors and LED. Make sure the electrolytic capacitors, LED, diodes and transistors are properly oriented before soldering their leads to the pads on the board.

If you plan on installing TattleTale inside an enclosure, don't mount the LED on the enclosure's top. Instead, install 4" lengths of hookup wire in the holes in the board, preferably using black insulation for the cathode wire and red insulation for the anode wire. Slip over either wire a 1" to 1½" length of insulating tubing. Then solder the free ends of the wires to the LED's leads, making sure you observe proper polarity. When the connections have cooled, push the tubing all the way up to the bottom of the LED's case

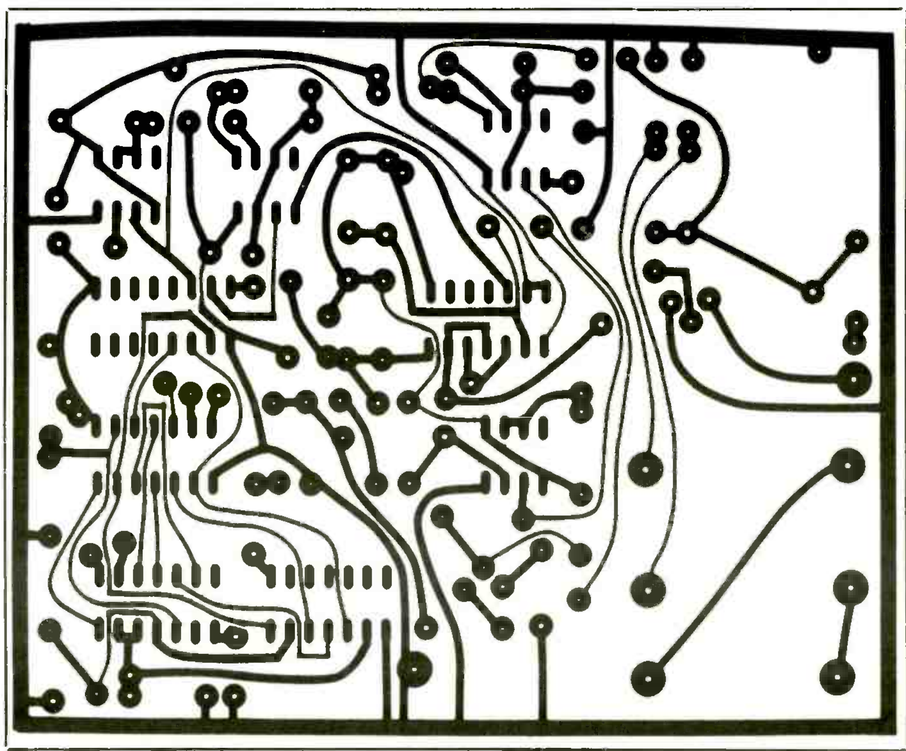


Fig. 3. Actual-size etching-and-drilling guide for fabricating pc board.

to make sure the connections and leads are well insulated from each other.

If you substitute components for those specified in the Parts List, keep in mind that because *Q1* must withstand the 90-volt rms ring signal, the transistor selected for it must have at least a 300-volt collector to emitter rating. The same applies to *D5*.

The Archer power transformer from Radio Shack indentified as *T1* in the Parts List mounts directly on the board as shown in the lead photo and indicated in Fig. 4, without the need for machine hardware to hold it in place. Be sure when you mount the transformer that its primary and secondary winding pins go into the appropriate holes. The pins for the primary and secondary are readily identified on the Archer transformer. If you use a different transformer that doesn't fit on the board, you can mount it on one wall of the enclosure in which you house the project and wire it to the board.

When all components have been installed on the board, you should have no trouble locating the holes for the jumper wires. Use solid bare wire for the shorter jumpers and insulated hookup wire for those that start between *IC1* and *IC3* and between *IC3* and *IC5*.

Trim ¼″ of insulation from both ends of four 5″-long lengths of hookup wire. Install and solder these in the board holes identified as S2, S3, S4 and S2,S3,S4. These four wires go to a screw-type terminal strip that serves as the means for connecting the external sensor switches to the main circuitry.

Select a large enough enclosure to accommodate the pc-board assembly, POWER switch, power transformer (if it's going to be mounted off the board), a 4-position screw-type terminal strip and the fuse holder. The last can be a block type holder that mounts inside the enclosure or a more convenient through-the-wall bayonet type.

Machine the enclosure to permit mounting the pc-board assembly on the floor of it. If the power transformer is to be mounted off the board, drill mounting holes for it through the floor or rear wall. Now drill holes through the rear panel for the fuse holder and entry of the telephone and ac power cords and through the front panel for the POWER switch and the LED through the front panel. Then cut a rectangular slot and drill the mounting holes for the screw-type terminal strip through the rear panel.

Deburr all cut and drilled edges with a file. Line the telephone and line cord holes with rubber grommets and drop a panel-mount lens clip into the LED hole, or line it with a small rubber grommet that will hold the LED in place by friction. Prepare the free end of the line cord by separating the two conductors about 5″ and trimming away ¼″ of insulation from both. Tightly twist together the fine wires in each conductor and sparingly tin with solder.

Similarly, trim ¼″ of insulation from the green and red wires at the end of the telephone cord opposite the end that terminates in the modular plug. If spade clips are on the end being prepared, remove and discard them and then trim away the insulation. Sparingly tin the conductors with solder. Slip over the prepared end of the cable a 2″ length of small-diameter heat-shrinkable tubing, push it far enough back to leave 3″ to 4″ of the red and green conductors free and shrink it tight.

Pass the prepared end of the line cord through its grommet-lined hole into the enclosure and tie a knot just beyond the point where the two conductors meet. Then pass the prepared end of the telephone cord through its grommet-lined hole.

Mount the components—not the pc-board assembly— on the enclosure walls in their respective locations. If the transformer you are using must mount off the board and

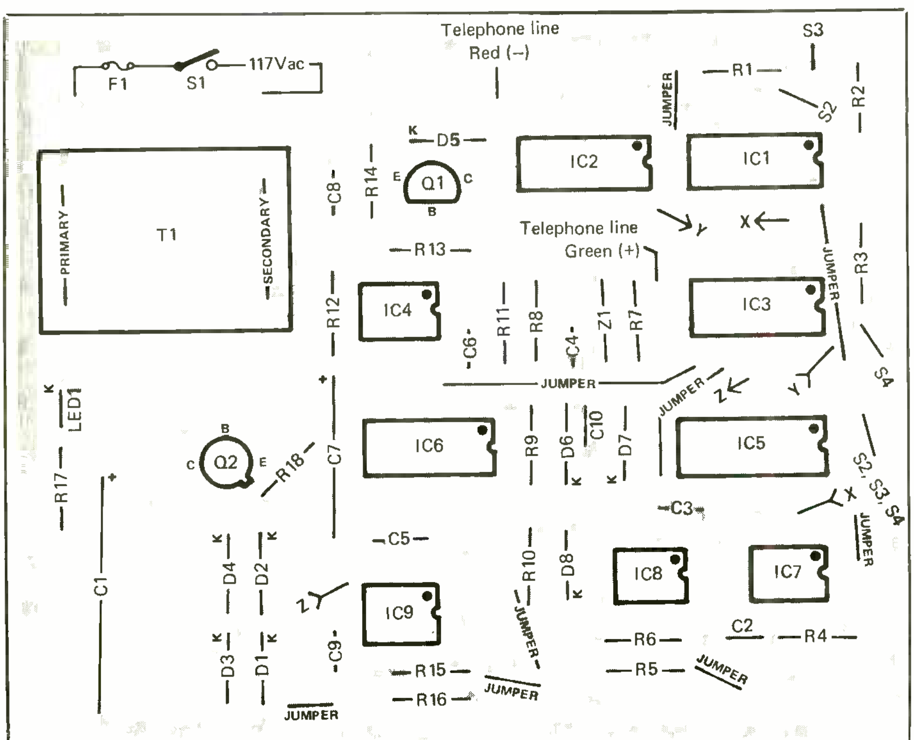


Fig. 4. Components-placement/orientation diagram for wiring pc board.

has lugs rather than leads for accessing its windings, connect and solder to its secondary lugs 4″ lengths of heavy stranded hookup wire. If the transformer has wire leads, remove ¼″ of insulation from all of them. Then mount the transformer on the enclosure.

Place the pc-board assembly near the enclosure and insert one conductor of the line cord in the second hole from the right at the top of the board and solder it to the pad. Connect and solder the other line cord conductor to one lug of the POWER switch. Then connect and solder appropriate lengths of wire from the other POWER switch lug to one lug on the fuse holder and from the other lug on the fuse holder to the indicated pad on the pc board. If the power transformer is mounted off the board, connect and solder the free ends of the wires previously installed on the board to its primary and secondary lugs or plug in and solder its leads to the appropriate pads. Make sure you wire the transformer into the circuit properly!

Solder the green and red conductors of the telephone cord as indicated in Fig. 4. Secure it to the board with lacing or other heavy-duty cord, via the two small holes you drilled for this purpose.

Use ¼″ spacers and 6-32 or 4-40 × ¾″ machine hardware to mount the pc-board assembly to the floor of the enclosure. Connect and solder the free ends of the remaining wires coming from the board to the lugs of the terminal strip. Then plug the LED into its lens clip or rubber grommet and install the fuse.

Checkout and Installation

Before putting TattleTale into service, examine it for poorly soldered connections and solder bridges, the latter especially between the closely spaced pads around the IC socket pins. Correct any faulty soldering immediately.

With the ICs still not installed in their sockets, plug the project's line cord into an ac outlet. Connect a dc voltmeter across *C1*, polarity as indicated in Fig. 4, and note the reading, which should be 9 volts. Leave the common probe connected to the negative side of *C1* and touch pin 8 of the 8-pin sockets, pin 14 of the 14-pin sockets and pin 16 of the 16-pin sockets with the positive probe and note the readings. If everything is wired correctly, all readings should be the same as across *C1* (9 volts).

If you obtain the proper readings, disconnect the line cord from the wall socket and allow time for *C1* to fully discharge. Then carefully install the ICs in their respective sockets, making sure that each is oriented as shown in Fig. 4 and that all pins go solidly into their socket contacts.

To check out the circuit, it's best to use an oscilloscope to observe waveforms. However, if you don't have a scope, use a voltmeter that has a 1-megohm or greater input resistance to check the dc levels of slow-moving waveforms.

When you turn on the ac power to TattleTale, the LED should light. With a piece of wire, momentarily short pin 1 of *IC6* to ground. The LED should extinguish and then, after about a minute, come back on. If you don't get the proper response, check the latch circuit by examining pin 4 of *IC6* as you momentarily short to ground first pin 1 and then pin 6 of this IC. This should cause the logic level at pin 4 to go first high and then low.

Check the one-shot action of *IC4* by momentarily shorting pin 2 of this IC to ground while examining the pin 3 output. This should go to about 9 volts when you trigger *IC4* at pin 2. It should then remain at 9 volts for about a minute and then drop back to 0 volt.

Set sensor switch *S4* to the closed position but leave switches *S2* and *S3*

(Continued on page 92)

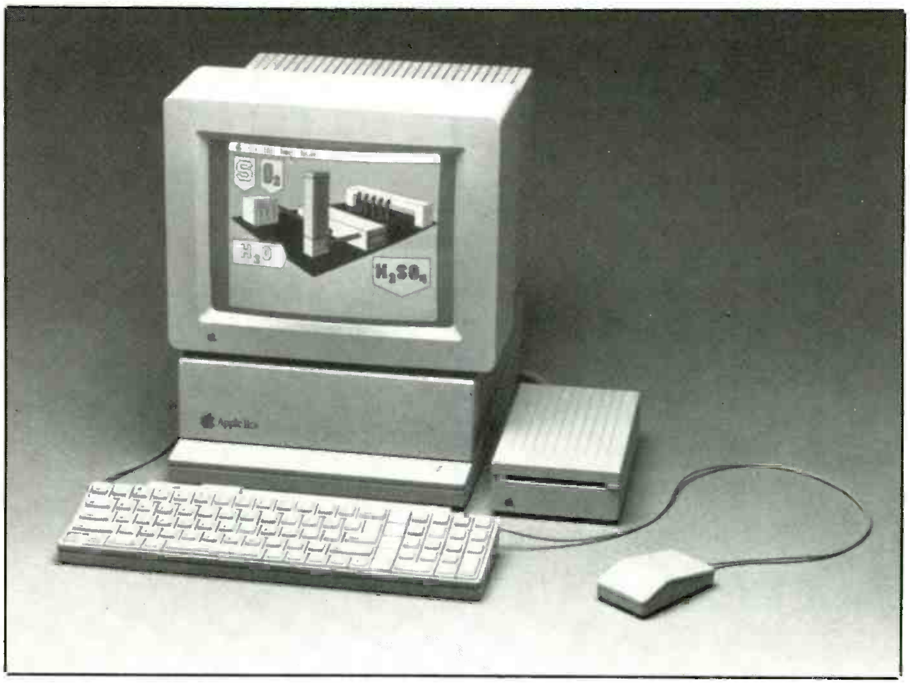
The New Apple IIGS Personal Computer

Macintosh-like (G)raphics and high-performance (S)ound capabilities mark the leading qualities provided by Apple Comuter's new top-end leader of its Apple II family of personal computers. Additionally, it features much more memory capacity and faster processing speed than the Apple IIe and Apple IIc models.

By Alexander W. Burawa

Apple Computer's new model IIGS, expected to be on many dealers' shelves just about now, is an evolutionary advance in the company's Apple II line. It adds a machine that provides faster 16-bit processing than the earlier Apple IIe and IIc could muster with their 8-bit microprocessors, addresses considerably more memory, borrows from the Apple Macintosh's graphics and mouse capabilities, and offers dramatically enhanced sound capabilities for voice and music.

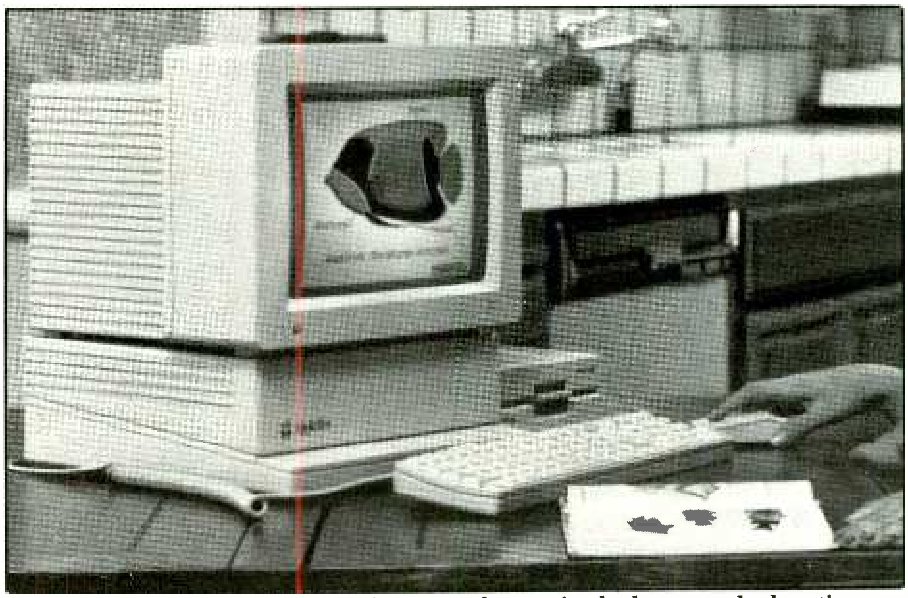
Among other features noted, the IIGS has seven extra input/output expansion slots, better color resolution capability, and a high degree of compatibility with existing Apple software and hardware, and a detached keyboard with a numeric keypad. Throw in an unusually strong commitment by many third-party companies which have readied a bevy of hardware and software products designed to take advantage of the new computer's capabilities, and you can see that the Apple IIGS is truly a thoroughly new model that has retained its ties to other Apple II models. The basic Apple IIGS carries a suggested selling price of $999.



Apple Computer avows that the IIGS isn't intended to make any existing computer in its line obsolete or to replace any of them in the marketplace. Whereas the Apple Macintosh's market niche is said to be business markets and universities, and the Apple IIc is popularly used at home for educational and entertainment purposes, the IIGS seems to be aimed at the same market that the IIe is rooted in, which is elementary and secondary schools insofar as new sales are concerned at this time. In fact, a $499 Apple IIe upgrade kit to give it IIGS capabilities will be available.

As the highest-performing member of the Apple II family, the IIGS doesn't come cheap. This is reflected in the IIGS $999 for the basic system, which comes with 256K of RAM and

128K of ROM, both of which are expandable. Depending on the buyer's choice of video display monitor ($129 for monochrome to $499 for RGB color), disk drive ($299 for a 5.25" floppy drive plus $69 for a controller kit, $399 for a 3.5" microfloppy and $1,299 for a 20M hard disk and $129 for the required controller card), the entry price can easily be boosted to between $1,500 and more than $3,000 less any available discounts. Figures exclude memory expansion, printer and application software.


The Apple IIGS computer is intended for use in the home and education.

System Overview

The Apple IIGS has a detached low-profile, ergonomically curved, 80-key keyboard that includes an 18-key numeric keypad, but no separate function keys. Its system unit houses all the circuitry for the CPU, memory, I/O, video, sound and power supply. Also inside the system unit are eight expansion slots, one of which is dedicated to RAM/ROM expansion with the remaining seven for I/O and special-purpose use. Any disk drive used with the IIGS must be external, since there are no facilities for internal mounting of disk or tape drives.

Much narrower than the width of the keyboard, the system unit has a clean, uncluttered appearance, which makes it resemble a base for the user's choice of monochrome or color video display monitor more than it does a system box.

Built into the system unit are two serial ports, a jack for headphones or an external speaker (with programmable volume control), an I/O sound connector, a joystick port, a clock for file date stamping, ports for analog RGB and composite-video color monitors, an interface for both 5.25" and 3.5" disk drives (two maximum) and a new Apple DeskTop Bus™ port for keyboard, mouse and other input devices. All of these are accessible through connectors on the rear of the system unit.

Seven video display modes are available. Text can be displayed in either 40- or 80-column by 24-row format. In graphics, the Apple IIGS repeats the existing Apple IIe and IIc resolution: 40H × 48V pixels in 16 colors; 80H × 48V pixels in 16 colors; 140H × 192V pixels in 16 colors; 280H × 192V pixels in 6 colors; and 560H × 192V pixels in monochrome. The two new graphics modes added by the IIGS are 320H × 200V pixels in 16 colors and 640 × 200V pixels in 4 to 16 colors, both from a palette of 4,096 colors.

Besides improved graphics, the Apple IIGS's sound capabilities have also been dramatically enhanced over those of earlier Apple IIs. The IIGS has a 32-oscillator chip that can play up to 15 voices simultaneously for synthesizing both music and human speech. This is achieved with an Ensoniq sound chip, using the dedicated 64K of RAM. (The Ensoniq chip is the same one used in professional-quality music synthesizers.)

Apple supplies with the IIGS a one-key mouse that plugs into either side of the keyboard, the ProDOS 16 disk operating system for the 16-bit side of the computer (the 8-bit DOS is an optional extra-cost item) and utilities, a training disk and four manuals. Other operating systems that can be used in the IIGS include ProDOS 8, Dos 3.3, Pascal and CP/M, the last requiring that an optional Z80 card be installed. The training disk provides two hours of hands-on tutoring for the Apple IIGS computer. The manuals consist of a setup guide, a 200-page owner's manual, a guide to AppleSoft BASIC and a system disk manual.

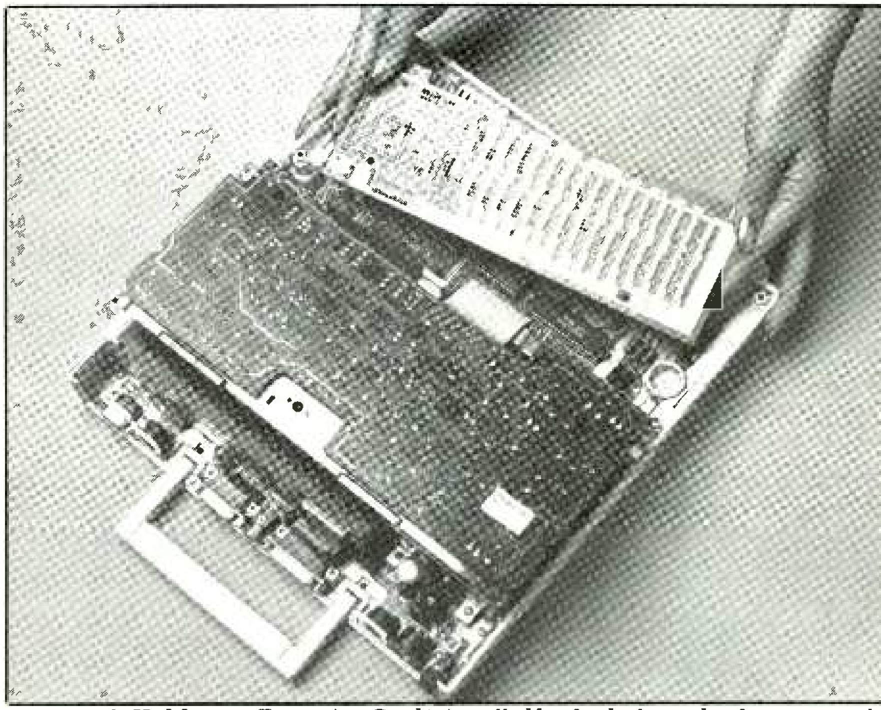
Inside the Computer

Among the key design ingredients that make the IIGS different from other Apple II computers is its 65C816 microprocessor. This is the first Apple II to enter the 16-bit world of processing while maintaining 8-bit compatibility with the 6502 series processors used in earlier Apple II computers. This 8/16-bit processor is faster (2.8 MHz clock speed) than the previously used 8-bit-only processors (1.02 MHz clock speed) and can address up to 16M bytes of mixed RAM and ROM (though Apple limits this to 9M bytes, of which 8M bytes can be RAM and 1M byte can be ROM). The 65C816 also has new addressing

Apple IIc Memory Expansion

Though the Apple IIc was originally designed to be nonexpandable internally, Apple is now offering a new, *enhanced* IIc model that has a redesigned logic board that accepts a new Apple IIc Memory Expansion Card with 256K of RAM. The dealer-installable card, priced at $269, provides up to 1 megabyte of extra RAM in increments of 256K bytes. (Dealer installation costs are extra.)

Current Apple IIc owners can take advantage of this enhancement with $269 Apple IIc Memory Expansion *Kit*. Contained in the Kit are a new logic board *and* the Expansion Card. So owners of older Apple IIcs get a new logic board free when expanding memory. The exra memory provided by this upgrade allows IIc users to create larger documents and run more sophisticated software. The Expansion Card can be used as an internal disk drive, or RAM disk, to provide speedier access to programs and larger data files than is possible from a floppy.



The Apple IIc Memory Expansion Card is installed by the dealer under the computer's keyboard. It provides up to 1M byte of extra RAM.

A supplemental System Utilities Disk included in the Expansion Card package provides a formatting utility that allows many software programs to recognize and utilize the extra memory. Some existing software, such as the new version of AppleWorks 2.0, automatically use the extra memory provided by the Expansion Card. A few mouse-based programs, however, will require modification to operate correctly on new and upgraded IIcs.

modes that add to those available in the 6502 and 65C02.

Like the Macintosh, the IIGS incorporates a communications chip that supports the AppleTalk network, giving the new computer the potential to print on a LaserWriter and to connect to other Apple computers. Also like the Macintosh, the IIGS has in ROM the "Quick Draw" graphics routines that make possible pull-down menus, windows and icons.

The Third Parties

It's reported that at least 40 new products from third-party developers will be available by Christmas, such is the clout that Apple Computer has and the confidence in mass sales of the product that outside hardware and software obviously share with Apple.

For memory expansion, AST Research has announced a 1M-byte memory card; MDIdeas has a 256K to 8M RAM card; Orange Micro a RamPak with a standard 512K that's user-expandable to 4M of RAM for $259; and Applied Engineering with a card that expands up to 1.5M bytes with an additional 2M byte piggyback one for a 3.5M total.

In the hard-disk area, AST Research also announced a 3.5" drive, while ProAPP brings in a 40M-byte system with an average access time of less than 30 ms for $1,995. Hayes Microcomputer Products has embraced the entire Apple II line, including the IIGS model, with the announcement of a new internal 1200 bps modem for $439. Street Electronics introduced its Echo IIb plug-in board for text-to-speech applications for $129.95, while MDIdeas announced its SuperSonic peripheral card that will let the Apple IIGS produce stereo sound for $59.95. Orange Micro's new ProGrappler, which replaces its popular Grappler+, is a parallel printer interface that has special support for the IIGS, making possible inverted and rotated graphics, graphics windowing, enlargement and printing the IIGS's super-hi-resolution screens.

Further, DataDesk International debuted its IBM Selectric-like keyboard for the Apple IIGS, which has a host of features to make typing eas-

(Continued on page 91)

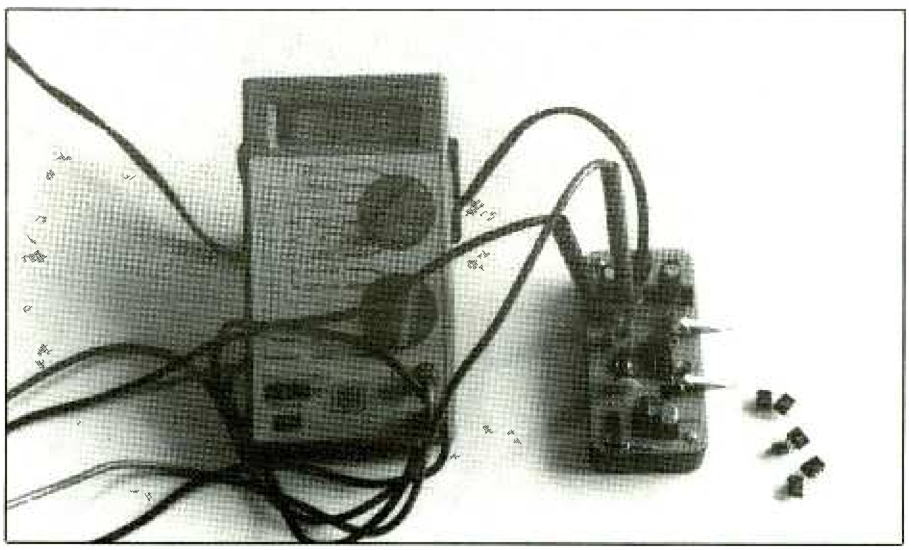
The Optical Isolator

(Conclusion)

Last month, in the first part of this series, we introduced you to the various types of optical isolators available to experimenters and hobbyists, their technical characteristics and some typical applications for these devices. In this concluding part, we present construction details for building an inexpensive and versatile tester that can be used in conjunction with a dual-channel oscilloscope and a digital multimeter to test all types of optical isolators in dual-inline packages, low-voltage zener diodes and 9-volt batteries.

Building an Opto Tester

By Ralph Tenny



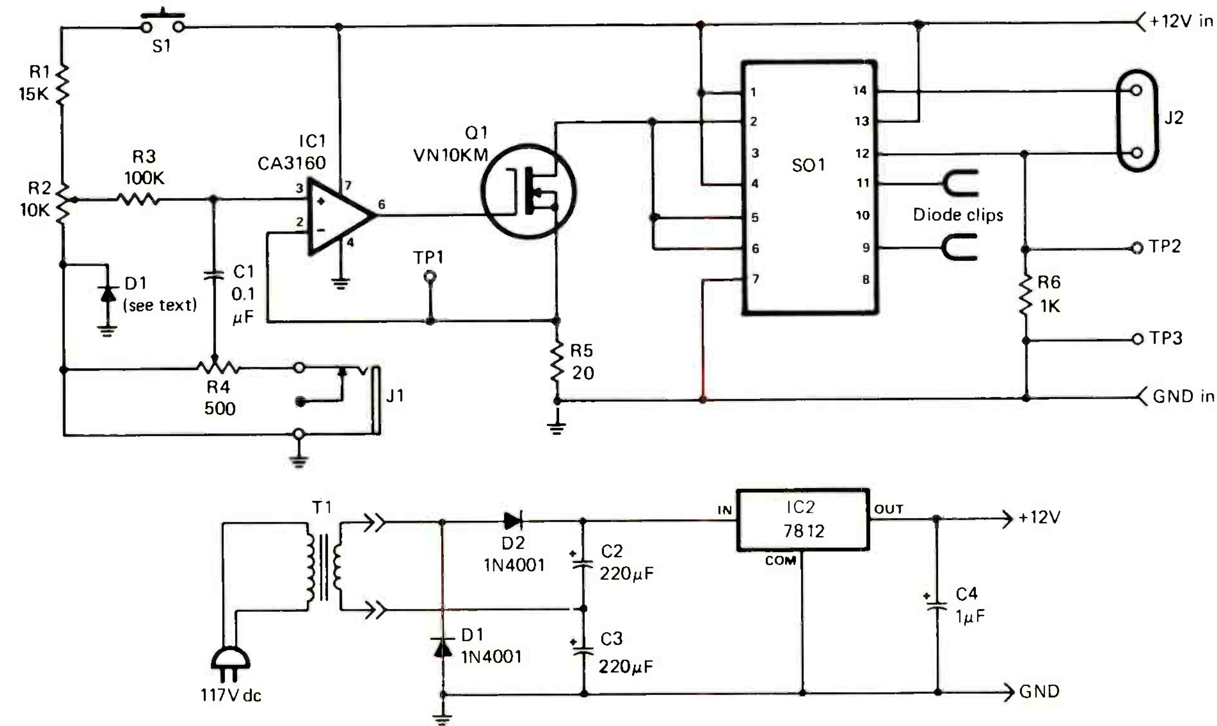
When designing with and using optical isolators, careful attention must be paid to their current transfer ratios (CTRs). Failure to take into account the CTR can result in electrical stress that can damage an optical isolator enough to change its CTR. It's also often important to match optical isolators—even if all are stamped with the identical part or type number—to obtain uniform performance. The only way to be sure you're using your devices properly and that a selected device is indeed operating at all is to test each one as you use it.

The Opto Tester described here is a handy accessory to test and match all types of optical isolators. In conjunction with an ordinary voltmeter and an oscilloscope it allows you to test optical isolators of unknown quality to determine if they are working and how well they are working. The latter is particularly important if you need optical isolators that must respond to a given signal. It lets you sort through a group of devices until you have as many with the same or nearly the same characteristics as are needed for a given application. As a bonus, the Opto Tester can also be used to test low-voltage zener diodes and 9-volt transistor batteries.

About the Circuit

The entire schematic diagram of the Opto Tester, including its ac power supply, is shown in Fig. 1. The Opto Tester's current source is made up of *IC1* and *Q1*. Because operational amplifier *IC1* continuously forces the voltage between its two inputs at pins 2 and 3 to be equal, external circuitry must be brought into play for an output other than 0 volt to be obtained.

Pin 3 is *IC1*'s noninverting (+) in-



PARTS LIST

Semiconductors
D1,D2—1N4001 rectifier diode
D3—Small-signal diode
IC1—CA3160 (RCA) or TLC-271 (Radio Shack Cat. No. 276-1748)—see text
IC1—7812 + 12-volt regulator
Q1—VN10KM enhancement-mode FET (Siliconix)

Capacitors
C1—0.1 µF film
C2,C3—220-µF, 25-volt electrolytic
C4—1-µF tantalum

Resistors (¼-watt)
R1—15,000 ohms, 5%
R3—10,000 ohms, 5%
R5—20 ohms, 1%
R6—1,000 ohms, 1%
R2—10,000-ohm, 15-turn potentiometer
R4—500-ohm potentiometer

Miscellaneous
J1—Miniature phone jack
J2—See text
S1—Spst normally open pushbutton switch
SO1—14-pin side-wipe IC socket (Radio Shack Cat. No. 276-1999—see text)
T1—Power transformer (Digi-Key Cat. No. T200-ND or similar)
TP1,TP2,TP3—Pc-mount pin jack—see text
Printed-circuit board or perforated board and suitable soldering or Wire Wrap hardware; suitable enclosure (Radio Shack Cat. No. 274-1565 or similar); component platform adapters (Radio Shack Cat. No. 276-1980); socket for IC1; plug to match jack on end of T1's power cord (see text); small alligator clips or other suitable connectors for Diode Test Clips (see text); solder posts; machine hardware; hookup wire; solder; etc.

Fig. 1. Schematic diagram of the Opto Tester.

put, which means that if a voltage more positive than that is on the pin 2 inverting (−) input is applied to this pin, the output at pin 6 will be positive as well. Conversely, if a voltage more positive than that on pin 3 is applied to pin 2, the output at pin 6 will be a negative voltage.

When power is applied to the circuit and *S1* is open, *R1*, *R2*, *R3* and pin 3 of *IC1* will all be 0 volt. This would cause the output of the op amp to go negative if it were powered from a dual-polarity power supply. However, since *IC1* in this project has no negative power supply line referenced to circuit ground, its output can't swing to a negative voltage. Therefore, pin 6 will go only to 0 volt with a positive voltage applied to pin 2, pulling the gate and source of *Q1* and pin 2 of *IC1* also to 0 volt.

Closing *S1* puts pin 3 of *IC1* at some positive voltage determined by the setting of *R2*. This drives the gate of *Q1* positive and causes the transistor to conduct until the voltage at pin 2 of *IC1* is equal to that on pin 3. If the potential on pin 3 of *IC1* is 0.2 volt, the current through *R5* is 0.2

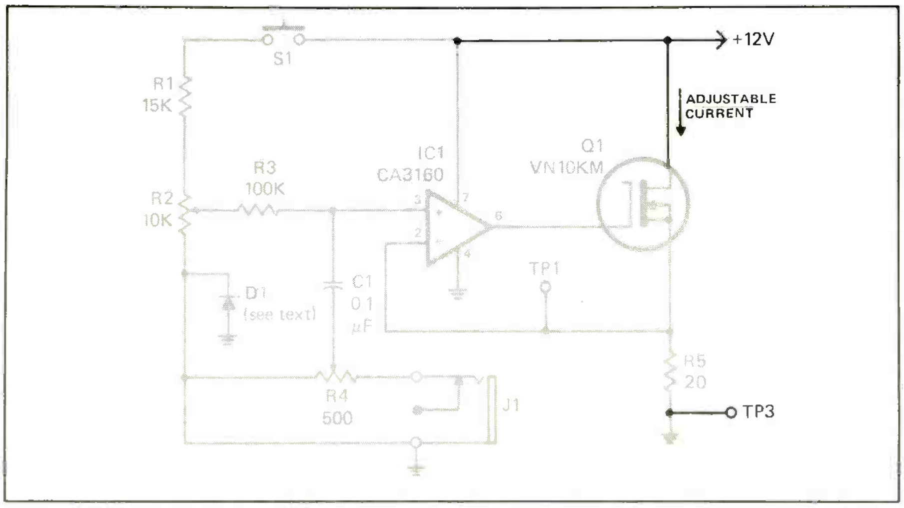


Fig. 2. Simplified schematic diagram illustrates adjustable current source.

volt/20 ohms, or 10 mA. The same current flows from the +12-volt power supply through the sink lead of *IC1*, as illustrated in the simplified schematic in Fig. 2.

With *R4*, *C1* and *J1* in the circuit, it's possible for the Opto Tester to dynamically test optical couplers for rise time and data rate (see Fig 3). A signal from a square-wave or pulse generator is injected into the test circuit through *J1*. The level of this signal is set as needed with trimmer control *R4* and is then coupled through *C1* to pin 3 of *IC1*.

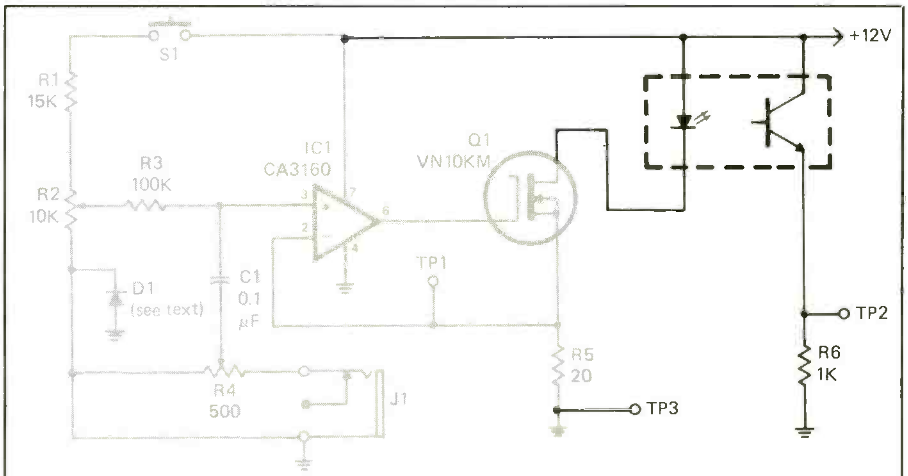
Input protection for *IC1* is provided by *D1*, which clamps the negative-going edge of the square-wave input test signal from the generator to a safe level. The base of the optical coupler's internal transistor can be connected to its emitter through a 22,000- to 100,000-ohm resistor via *J2* to improve response time of the optical coupler, though this is done at the expense of the CTR with some devices.

The input and output waveforms are monitored with an oscilloscope during dynamic testing. The input waveform is monitored between *TP1* and *TP2*, the output waveform between *TP2* and *TP3*.

It's possible to use the Opto Tester's adjustable current source for testing low-voltage zener diodes and batteries when adapters are used. Zener diodes are not perfect regulators, and some are less perfect than others. In the curve shown in Fig. 4, note that at lower currents the zener diode's "regulated" voltage can change quite a bit, while at higher currents the response settles out to a more linear voltage slope. With the Opto Tester, you can display the operating curve of zener diodes to determine if they are working and how well.

The wiring of the two test adapters is shown in Fig. 5. With Adapter 1 plugged into test socket *SO1* via the pins indicated, the Diode Test Clips shown in Fig. 1 become active. Figure 6 shows the Opto Tester circuit with the zener diode connected via the clips. This arrangement allows a particular bias current to be set by monitoring the voltage between *TP1* and *TP3* with a voltmeter and then applying a varying current to measure zener impedance.

When testing a zener diode, the slope of its waveform can be expressed as a change in voltage for a given change in current, such as millivolts per milliampere. For example, if a given zener diode's slope is 2.5 millivolts per milliampere, output impedance is 0.0025 volt/0.001 ampere, or 2.5 ohms. As a point of re-



R2 Voltages for Various Drive Currents

R3 (mV)	Current (mA)	R3 (V)	Current (mA)
20	0.001	0.2	0.010
40	0.002	0.3	0.015
60	0.003	0.4	0.020
80	0.004	0.5	0.025
100	0.005	0.6	0.030

Fig. 3. Equivalent Opto Tester circuit for dynamic testing of opto isolators.

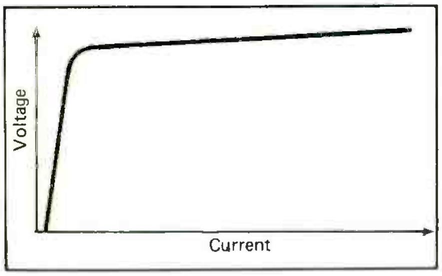


Fig. 4. Voltage-versus-current response curve of a typical zener diode.

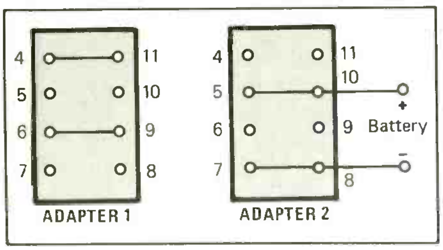


Fig. 5. Test adapters required for using Opto Tester to test zener diodes (Adapter 1) and batteries (Adapter 2).

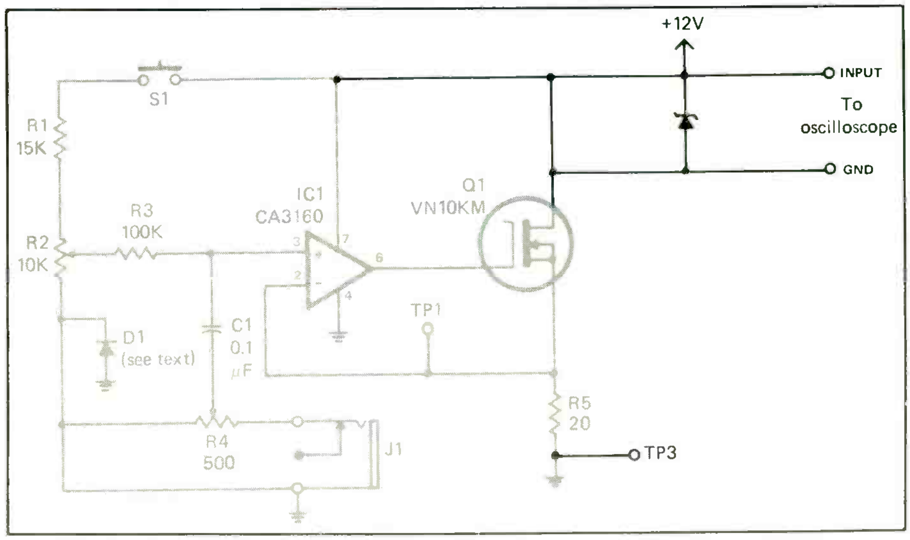


Fig. 6. Equivalent circuit with zener diode connected to Opto Tester.

ference, keep in mind that the ideal zener regulator has zero ohm of impedance.

Adapter 2 in Fig. 5 allows the output impedance of a battery to be tested. This test is conducted in a manner similar to that for the zener diode with one exception. The Fig. 7 test circuit shows that the negative terminal of the battery being tested goes to the Opto Tester's ground. This allows the output variation from the battery to be measured between *TP3* and the battery's + terminal.

The Opto Tester's power supply (Fig. 1) is driven from the 117-volt ac line through a plug-in ac wall transformer that delivers between 9 and 12 volts ac at not less than 200 mA. A higher-voltage transformer can be used if a full-wave bridge rectifier is used in place of the full-wave doubler shown. Just reconfigure the power supply as a standard bridge circuit and use a large value of capacitance (say, 220 microfarads or more) for a filter at the output from the bridge rectifier. In either case, *C4* should be a tantalum capacitor to improve the transient response of regulator *IC2*.

Construction

As shown in the lead photo and Figs. 8 and 9, this is a simple project to build. It's very compact and has very few components. Therefore, it can easily be assembled on a small piece of perforated board. Cut the board to fit (and replace) the top of the small project box specified in the Parts List. Use suitable soldering (or Wire Wrap) hardware to mount the components and a socket for *IC1*.

There's nothing critical about circuit layout. Just arrange the components in any way that lets you plug them into the board without crowding. Figure 8 shows the top of the board on which the prototype was assembled and a suggested layout. Simply plug in the components and wire them according to Fig. 1.

The socket recommended for *SO1* in the Parts List is a side-wipe type that assures good reliability. The Radio Shack part number was for this type of socket at the time this was written. If Radio Shack has changed suppliers in the meantime, you may not get the recommended type of socket and will, therefore, have to shop around to locate the preferred type.

Two different op amps are specified in the Parts List for *IC1*. The preferred op amp is the RCA CA3160. The Radio Shack part number is for a TLC-271, which has a more limited frequency response that will limit the frequency range possible during dynamic testing of optical isolators. If you should use the TLC-271, make sure to tie pin 8 to pin 7 during wiring.

For *TP1*, *TP2* and *TP3*, you have a choice of solder posts, small pin jacks or any other convenient devices. For the Diode Test Clips shown in Fig. 1, you can use small alligator clips, small pin jacks or any suitable test clips at the ends of flexible test-lead wire connected into the circuit at the appropriate points.

When wiring the circuit according to Fig. 1, use broad copper strips or heavy-duty solid wire for the V+ and ground buses between the power supply and circuit proper to assure good low-impedance connections. Figure 9 shows the underside of the wired board using self-stick copper strips and printed-circuit patterns.

Mount on the board or one of the walls or the box a jack that matches

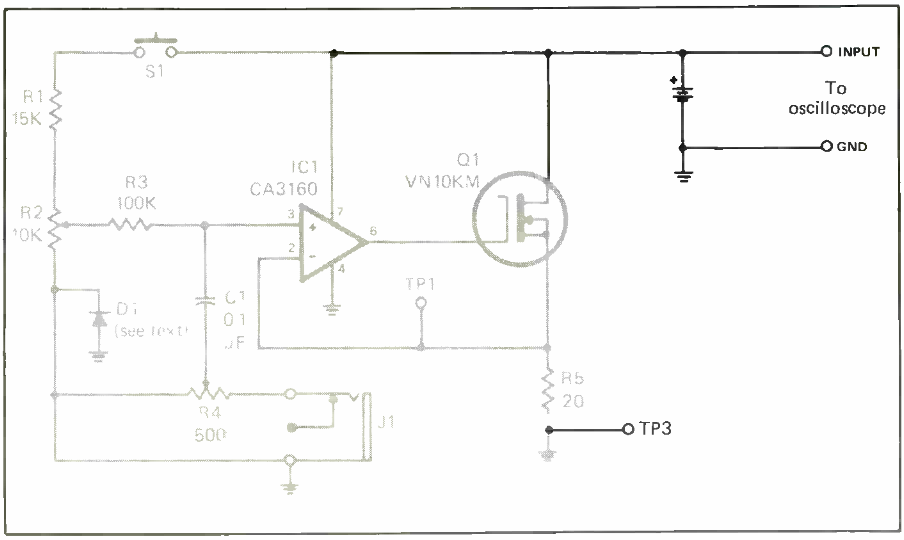


Fig. 7. Equivalent circuit set up for testing 9-volt batteries.

the connector on the end of the plug-in transformer's cord. Alternatively, cut off the transformer cord's connector, route the cord through a hole in the box and permanently wire it into the circuit. Pushbutton switch *S1* mounts either on the board or on one of the walls of the box. However, jacks *J1* and *J2* should mount on one of the walls of the box and on the board, respectively.

Finally, wire the test adapter as shown in Fig. 5, using component platform adapters that directly plug into *SO1* on the Opto Tester. Use solid bare hookup wire to make the pin-bridging connections, and for Adapter 2 connect and solder the red and black wires of a 9-volt battery snap connector to the battery + and − posts, respectively; as indicated.

Use Tips

The main function of this project, of course, is to test optical isolators. Since these are 6-pin DIP devices and *SO1* is a 14-pin socket, it's important that you insert the optical isolator in the socket properly, as indicated by the numbers in the parentheses shown in Fig. 10.

With an optical isolator plugged into *SO1* and a voltmeter (preferably digital for best resolution) connected between *TP1* and *TP3*, the Opto Tester is ready to test the CTR of the optical isolator. When using the tester in this manner, press (close) *S1* and adjust the drive current as you monitor the voltage across *R5*. Set this voltage by adjusting *R2* (the Table that accompanies Fig. 3 shows the voltages across *R2* for various drive currents). Each volt measured across *R5* is equal to 1 mA. (Note: All actual tests are made with *S2* in the closed position.)

An alternate test is to close *S1* and adjust *R2* until a 1-volt drop is measured across *R5*. Then check the voltage drop across *R3*. Optical isolators that have the same drive current range are well-matched.

When conducting a dynamic test, care must be exercised in setting it up to avoid erroneous results. Connect the two channels of the oscilloscope and plug a signal generator into *J1*, as detailed above, to obtain displays of the input and output waveforms. Then set up a large enough dc drive current to give a reasonable output current.

Slowly increase the setting of *R4* to add an ac component to the drive current until the output waveform begins to distort on the bottom of the

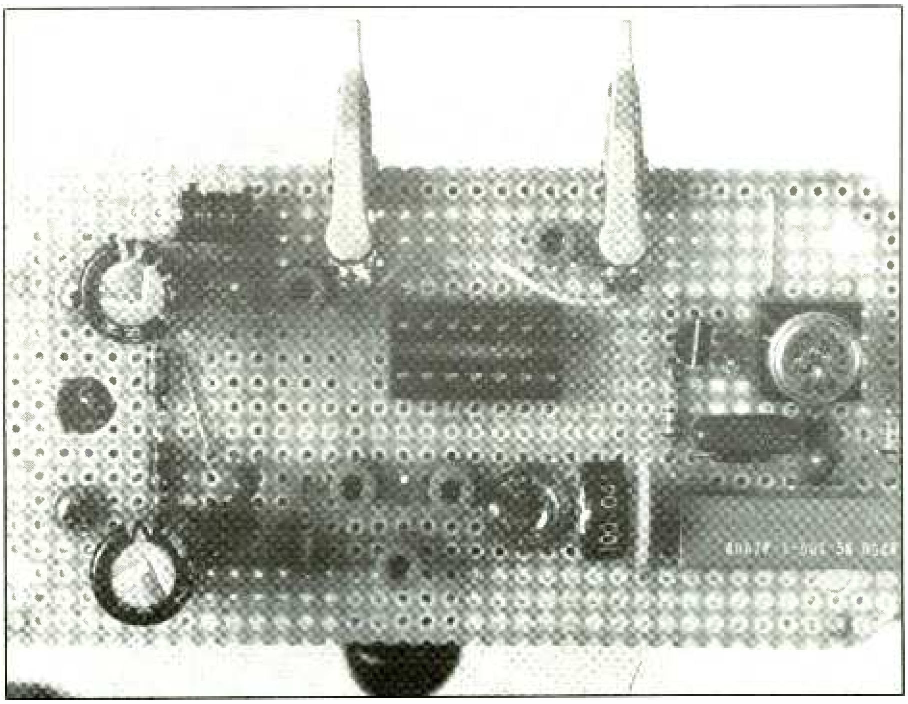


Fig. 8. Project is simple enough to assemble on small perforated board. Note how small alligator clips (Diode Test Clips) overhang one side of board.

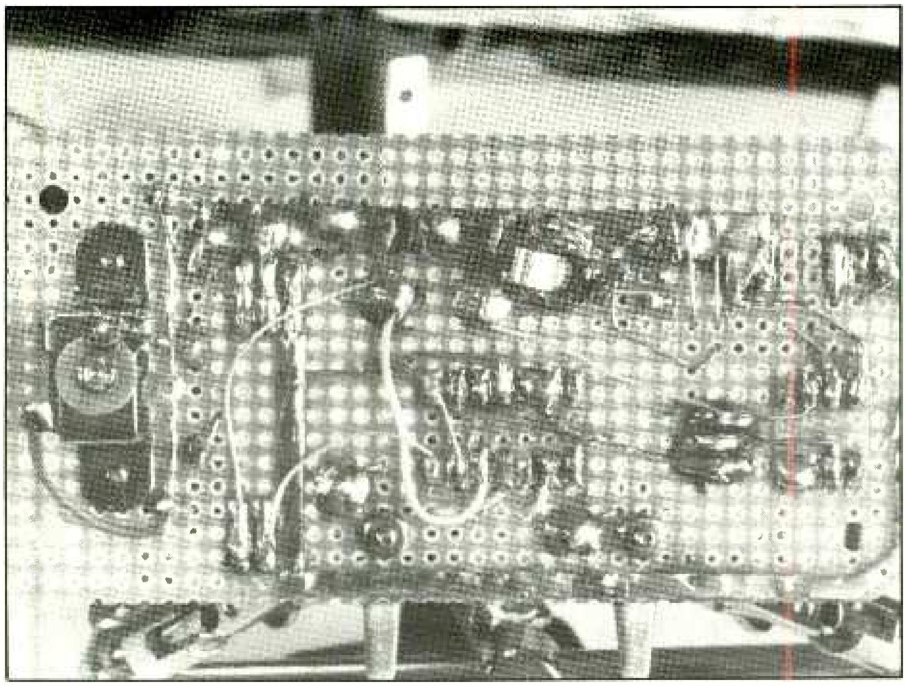


Fig. 9. Wiring and soldering details of underside of board shown in Fig. 8. Note the wide copper foil conductors used for power distribution and self-stick pc-type patterns used for component mounting.

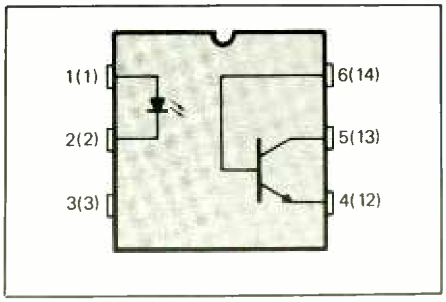


Fig. 10. Details of typical general-purpose optical isolator. Numbers in parentheses indicate SO1 pins into which the device plug.

trace. This excessive drive current will force the output current to turn off. Reduce the drive current to at least 15% below where the distortion began and then make your measurements.

Interpret the waveforms obtained as follows: for an input of 0.4 volt peak-to-peak across the 20 ohms of *R5*, the drive current is 0.4 volt/20 ohms, or 20 mA peak-to-peak. On the output waveform, 1.9 volts peak-to-peak across the 1,000 ohms of *R6* becomes 1.9 volts/1,000 ohms, or 1.9 mA. Now, CTR is 1.9 volts/20 ohms, or 9.5%.

The dynamic test has a more important purpose. Using a square-wave test signal from the generator, you can adjust the test frequency until the leading edge of the output waveform just begins to slow up. The amount of delay will be visible between the displayed input and output waveforms and can be interpreted in microsecond increments by interpreting the settings of the scope's front panel calibrating controls. This delay can be an important consideration when choosing an optical isolator for a given application, allowing you to choose a device with a faster response when needed.

When checking low-voltage zener diodes, use Adapter 1 in Fig. 5 and the Diode Test Clips on the Opto Tester. Connect a voltmeter to *TP1* and *TP2* and an oscilloscope across the diode. The meter serves as an indicator as you set the bias current for the test. The oscilloscope is used to set the variable drive current and to measure the resulting changing voltage across the zener diode.

An oscilloscope can't measure the ac drive and output voltages simultaneously. Therefore, it must be set to ac input coupling and its test leads must be connected to *TP1* and *TP3* to measure the ac drive. Then the scope leads are connected directly across the zener diode under test and the varying voltage across the zener diode is recorded.

Compute the diode's impedance as detailed above. A typical test of a 1N758 zener diode using a 20-mA bias current and a 30-mA peak-to-peak drive current from a signal generator plugged into *J1* might change the output by 75 mV peak-to-peak, and impedance might then be 0.075 volt/0.03 ampere = 2.5 ohms.

A battery test is simple and is performed in a manner similar to that used for the zener diode. Simply plug Adapter 2 (Fig. 5) into *SO1* on the Opto Tester and clip the snap connector onto the battery being tested. Then adjust the bias and peak-to-peak drive currents and view the waveform displayed on the oscilloscope's screen. A typical test using a 6.8-mA dc bias current and a 10-mA peak-to-peak drive current might yield an output variation of 0.028 volt from the battery. This gives an impedance of 0.028 volt/0.01 ampere, or 2.8 ohms.

From the foregoing it's easy to see that the Opto Tester fills a real need in your test equipment lineup if you use optical isolators. With it and your present digital multimeter and dual-channel osclloscope, you have a complete instrument that will assure you that all your optical isolators are working properly and are essentially matched before you put them into operation in your own circuit designs or replace faulty devices in other circuits. **ME**

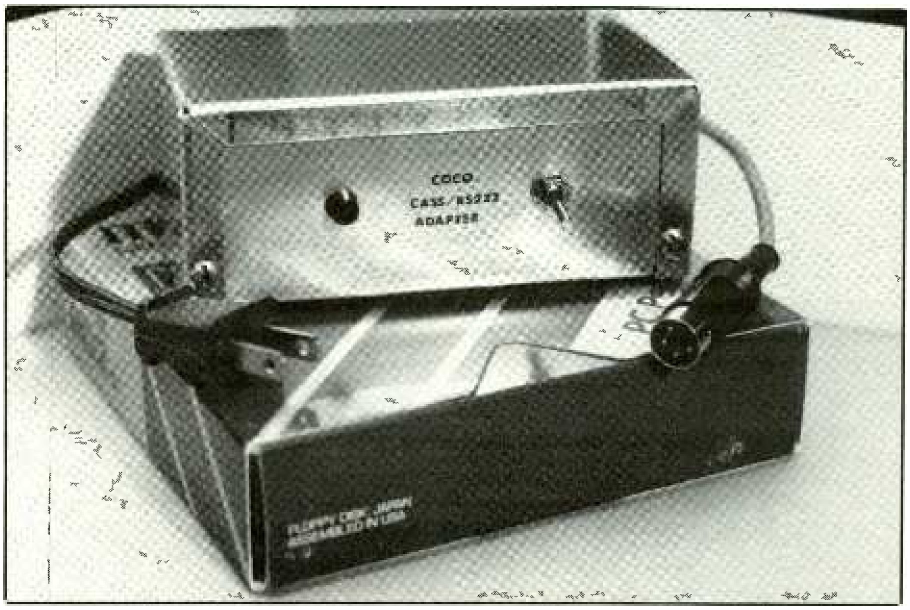
A Cassette-to-RS232 Adapter For Radio Shack Color Computers

Connects a printer to the cassette port of Radio Shack Color Computers and doubles the number of available serial ports

By Duane M. Perkins

Radio Shack's Color Computer has only one built-in RS232 serial port and no provisions for a second. With only one serial port available, you can use a printer or a modem but not both in a given session. The CoCo CASS/RS232 Adapter to be described offers a simple solution. It converts the CoCo's cassette port into a second RS232 serial port that can accommodate a printer. The conversion isn't permanent; anytime you want to use your cassette deck for storing and loading programs, simply unplug the Adapter and plug in the cassette deck.

With the CASS/RS232 Adapter plugged into the cassette port of your CoCo, you can download data from a bulletin board or similar service and run out a hard copy. You don't have to first save the data to disk or tape and then go off-line and replace the modem with your printer.

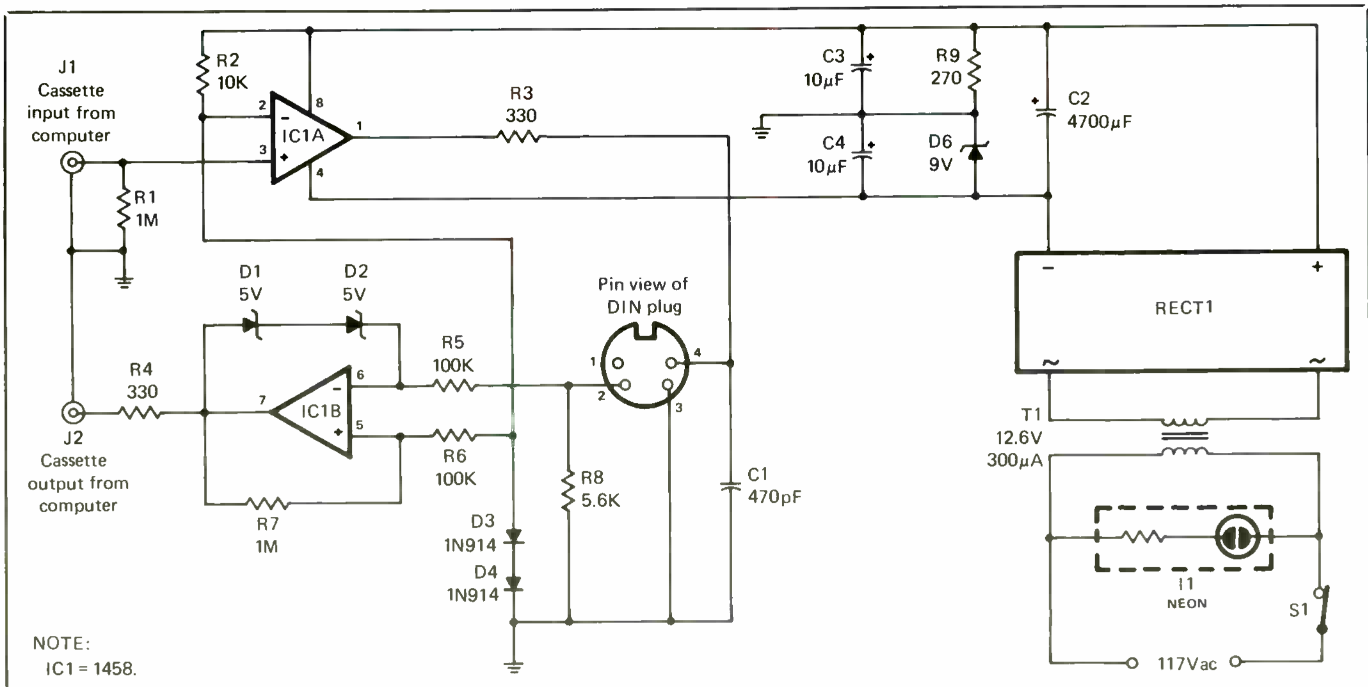


About the Circuit

The CoCo CASS/RS232 Adapter converts the cassette port's signal levels to and from the levels defined for the RC232C standard (loosely interpreted). The full schematic diagram of the Adapter, including its ac line-operated power supply, is shown in Fig. 1. In this circuit, *IC1A* and *IC1B* perform the conversion by comparing the input signal to a reference potential and switching the output positive or negative according to the result of the comparison.

Noninverting comparator *IC1A* is referenced to +1.3 volts. The maximum and minimum levels from the computer's cassette output, taken from the 6-bit DAC output, ranges well above and below this reference potential. Accordingly, the output, which is connected to the printer's data input line via the DIN connector, will switch between the supply rails. Capacitor *C1* limits the slew rate to conform to the RS232C standard.

Inverting comparator *IC1B* has hysteresis limits that are 0.5 volt above and below the 1.3-volt reference. The hysteresis prevents false output switching that could be caused by noise on the input line coming from the printer's status output. Since the lower hysteresis limit is above ground, the Adapter signals a "printer not ready" status if the printer isn't turned on or is busy. Diodes *D1* and *D2* limit the output voltage swings. The output voltage is attenuated by *R4* in series with the computer's cassette



PARTS LIST

Semiconductors
D1,D2—5-volt, 1-watt zener diode
D3,D4—1N914 small-signal diode
D5—9-volt, 1-watt zener diode
IC1—1458 dual operational amplifier
RECT1—VMO8 or similar bridge rectifier

Capacitors
C1—470-pF ceramic disc
C2—4,700-μF, 16-volt electrolytic
C3,C4—10-μF, tantalum electrolytic

Resistors (¼-watt, 5% tolerance)
R1,R7—1 megohm
R2—10,000 ohms
R3,R4—330 ohms
R5,R6—100,000 ohms
R8—5,600 ohms
R9—270 ohms (½-watt)

Miscellaneous
I1—Panel-mount neon-lamp assembly with built-in current-limiting resistor
J1,J2—⅛" mini-phone jack
S1—Spst miniature toggle switch
T1—12.6-volt, 300-mA power transformer (Radio Shack Cat. No. 273-1385A)

Printed-circuit board or perforated board with suitable Wire Wrap or solder hardware (see text); aluminum chassis box (Radio Shack Cat. No. 270-238 or similar); printer cable (Radio Shack Cat. No. 26-3020 or equivalent); ac line cord with plug; insulating tubing; labeling kit; clear acrylic spray; rubber grommets; machine hardware; stranded hookup wire; solder; etc.

Fig. 1. Complete schematic diagram of CoCo CASS/RS232 Adapter, including its ac-line operated power supply.

input resistance so that the input to the computer is limited to a safe level.

The power supply doesn't require regulation. Any split supply capable of delivering about +9 and −9 volts at 50 mA will do. You could even use two 9-volt transistor batteries to power the project if you wish. In the Fig. 1 circuit, a divider consisting of *R9* and *D6* establishes a midpoint ground reference to permit use of a power transformer that doesn't have a center-tapped secondary.

Construction

The Adapter's circuit can easily be assembled on a 5″ × 2½″ circuit board that neatly fits into a readily available aluminum chassis box. Printed-circuit wiring is recommended, though you can Wire Wrap or point-to-point wire the circuit if you wish, on perforated board, using suitable hardware. If you wish to use a pc board, fabricate it using the actual-size etching-and-drilling guide shown in Fig. 2. The pc board accommodates all components except POWER switch *S1*, INPUT and OUTPUT jacks *J1* and *J2* and neon-lamp indicator assembly *I1*.

After drilling the component mounting holes in the pc board, temporarily mount the transformer on the board and drill ³⁄₁₆″ holes for its mounting tabs. Drill another ³⁄₁₆″ hole about ¼″ in from and centered between the long edges at the other end of the board. Position the board in the bottom half of the box and drill ³⁄₁₆″ holes to match those you just drilled in the pc board.

Drill appropriate-size holes in the front panel of the box for *I1* and *S1*, centering them between top and bottom and spacing them at least 1½″ in from the sides. Drill holes in the back panel of the box for mini-phone

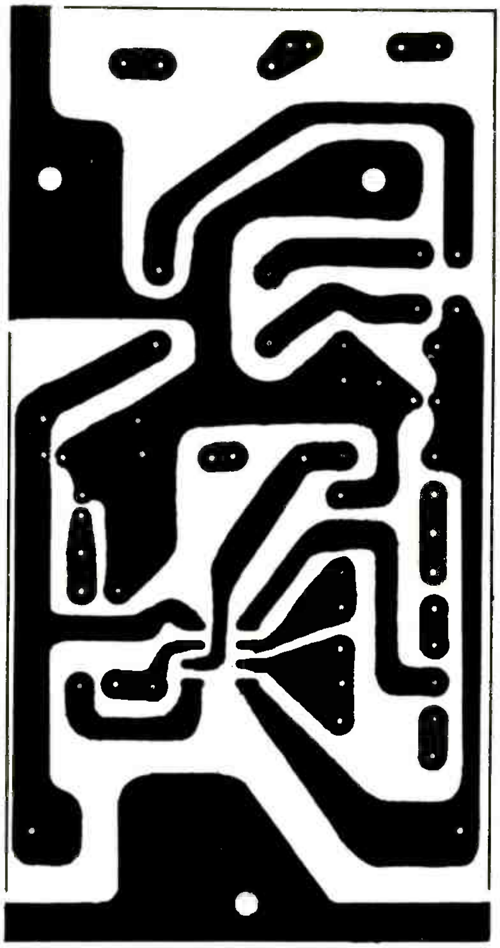


Fig. 2. Actual-size pc etching-and-drilling guide.

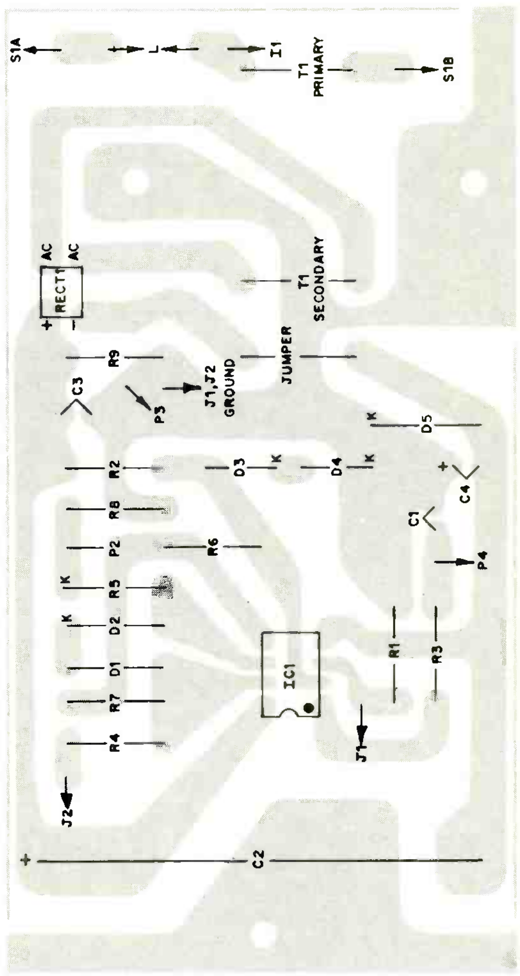


Fig. 3. Wiring diagram for board.

jacks *J1* and *J2* and the entry points for the printer cable and ac line cord, all centered between top and bottom and spaced 1" apart. Make the cable and line cord holes large enough to accommodate rubber grommets.

Deburr all holes and check component fit. Then clean all exterior surfaces of both halves of the aluminum box with water and a fine soapy steel wool pad. Wipe dry and label the two mini-phone jacks to indicate which plugs (INPUT and OUTPUT) they are to receive. You can use dry-transfer lettering at this stage or apply tape labels later. Spray all exterior surfaces with two or three *light* coats of clear acrylic, allowing each coat to dry before spraying on the next.

Mount and solder into place all components on the pc board exactly as shown in Fig. 3. Be sure to observe proper orientations for *IC1* and bridge rectifier assembly *RECT1* and the polarities of the diodes and electrolytic capacitors (*C1* can mount in either polarity).

Strip ¼" of insulation from both ends of three 5" and three 3" lengths of stranded hookup wire. Tightly twist together the fine conductors in each wire end and tin with solder. Plug one end of the 3" wires into the holes labeled J1, J2 and J1, J2 GROUND and one end of the 5" wires into the holes labeled S1A, S1B and I1. Solder all wires to their pads on the board. Slide a 2" length of insulating tubing over the I1 wire.

Install rubber grommets in the holes for the line cord and printer cable in the rear of the box. Cut the plug off one end of the printer cable and feed this end into the box through the left rubber grommet, viewing the box from the rear. Trim 2" of the outer plastic jacket from the cut end of the cable and ¼" of insulation from each conductor. Tightly twist together the fine wires of each conductor and tin with solder.

Use an ohmmeter or continuity tester to identify the wires with the pins on the plug by color and pin number. Clip off the lead that connects to pin 1. Tie a knot in the cable about 2″ up from where the outer plastic jacket ends. Then plug the identified conductors into the holes labeled P2, P3 and P4 in Fig. 3 and solder them into place.

Tightly twist together the fine wires in each conductor of the ac line cord and sparingly tin with solder. Feed the prepared end of the line cord into the box through the other rubber grommet and tie a knot in it 3″ from the prepared end. Plug the line cord's conductors into the holes labeled L and solder into place.

Mount the pc board assembly in the box with three ¾″ spacers and 6-32 × 1″ machine hardware. Then mount *I1* in its front panel hole. Mount *J1* and *J2* in their respective holes in the rear panel. Connect a 1½″ bare solid wire from the shell (ground) lug of *J1* to the shell lug of *J2*. connect the *J1* and *J2* wires coming from the circuit board to the tip (signal) lugs of *J1* and *J2*, respectively, and the J1, J2 GROUND wire to the shell lug on either *J1* or *J2*. Solder all connections.

Connect and solder one of *I1*'s leads and the wire coming from hole S1B to one lug of the switch and the wire coming from hole S1A to the other switch lug. Twist together the bare wires of the remaining *I1* lead and the wire coming from hole I1. Solder the connection and, when the solder has cooled, slide the insulating tubing over the connection to insulate it from the rest of the circuit.

Mount the switch in its hole in the front panel. Pull on the line cord and printer cable to seat their knots against the rubber grommets.

Testing the Adapter

Before putting the CoCo CASS/RS232 Adapter into service, it should be checked out. First check for cor-

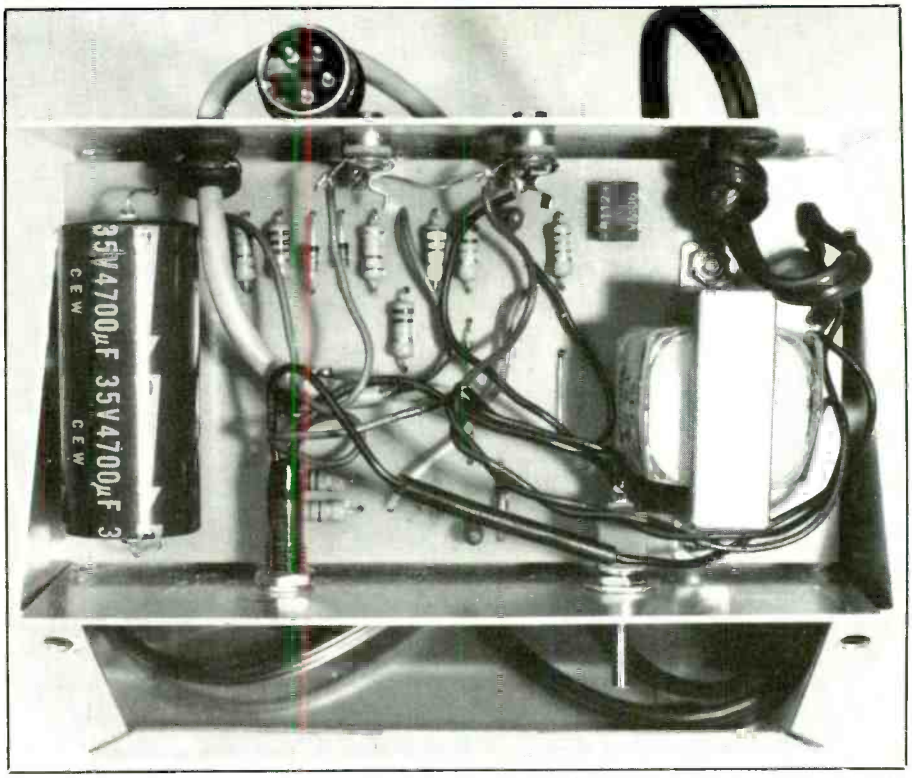


Fig. 4. Interior view of assembled CoCo CASS/RS232 Adapter with circuit board mounted inside commonly available aluminum utility box.

Listing 1. BASIC Loader for Machine-Language Routine

```
10 'LOADER FOR MACHINE-LANGUAGE
20 'SUBROUTINE TO PRINT STRING
30 'USING CASSETTE PORT ADAPTER
100 N=0:READ P$:READ PE:READ PX
110 PRINT"VALIDATING"
120 READ H$:IF H$="X" THEN 180
130 N=N+1:IF LEN(H$)<>2 THEN 170
140 IF H$="00" THEN 120
150 V=VAL("&H"+H$):IF RIGHT$(H$,
1)<>"0" AND V<=VAL("&H"+LEFT$(H$
,1)+"0") THEN 170
160 IF V>0 THEN 120
170 PRINT"BYTE";N;"= "H$:PRINT"C
ORRECT AND TRY AGAIN":END
180 PS=PE-N+1
230 POKE 480,INT(PE/256):POKE 48
1,PE-PEEK(480)*256:POKE 482,INT(
N/256):POKE 483,N-PEEK(482)*256
240 PCLEAR1:CLEAR 200,256*PEEK(4
80)+PEEK(481)-256*PEEK(482)-PEEK
(483)
250 RESTORE:READ P$:READ PE:READ
 PX
260 N=256*PEEK(482)+PEEK(483):PS
=PE-N+1:PX=PS+PX
270 PRINT"LOADING"
280 FOR N=PS TO PE:READ H$
290 POKE N,VAL("&H"+H$):NEXT N
300 PRINT"HIT D(DISK), T(TAPE) O
R N(NONE) TO SAVE ";P$
310 H$=INKEY$:IF H$="" THEN 310
320 IF H$="N" THEN PRINT P$;" IN
 MEMORY":GOTO 370
330 IF H$="D" THEN SAVEM P$,PS,P
E,PX:GOTO 360
340 IF H$<>"T" THEN 300
350 CSAVEM P$,PS,PE,PX
360 PRINT P$;" SAVED"
370 PRINT"FROM";PS;"TO";PE
380 PRINT"EXECUTE AT";PX
390 END
400 DATA PRINTER2,32767,0
410 DATA BD,B3,ED,1F,02,E6,A4,2F
,0B,AE,22,A6,80,8D,06,25,FC,5A,2
6,F7,39
420 DATA 34,36,F6,FF,20,C4,01,27
,03,43,20,3C,8E,00,09,1A,32,20,0
7,44,24,04,C6,02,20,04,C6,FE,20,
00,F7,FF,20,10,AE,8D,00,24,31,3F
430 DATA 26,FC,C6,02,30,1F,26,E3
,5A,26,FD,C6,02,F7,FF,20,EC,8D,0
0,0E,E3,8D,00,0A,C3,00,28,83,00,
01,26,FB,35,B6
440 DATA 00,B5,X
```

Listing 2. Device Driver and Descriptor Modules Patch

```
OS-9 PATCH TO CREATE DEVICE DRIVER AND DESCRIPTOR MODULES

T
TMODE .1 -PAUSE
DEBUG
L P
. .+38
=D1
L P
. .+2E
=D1
L PRINTER
. .+AA
=02
=C6
=FE
=8D
=CE
=44
=6A
=61
=26
=F3
=E6
=C8
=1D
=27
=04
=C4
=FE
=8D
=C0
=C6
=02
=8D
=BC
=6D
=C8
=1F
=27
=03
=12
L PRINTER
. .+108
=20
L PRINTER
. .+158
=6F
=C8
=1E
=6F
=C8
=1F
=EC
=C8
=20
=5D
=2A
=03
=6C
=C8
=1F
=C5
=40
=26
=21
=C5
=20
=27
=03
=6C
=C8
=1E
=5F
=85
=20
=27
=0C
=85
=80
=27
=11
=C6
=FE
=85
=40
=26
=02
=C6
=02
=E7
L PRINTER
. .+18D
=C6
L PRINTER
. .+14
=D1
Q
* SECTION BELOW IS USED
* ONLY IF PRINTER READY
* GIVES HIGH (1) INPUT
DEBUG
L PRINTEQ
. .+33
=5F
=39
L PRINTEQ
. .+5A
=25
=D7
=16
=00
=A1
L PRINTEQ
. .+D5
=24
Q
* END OPTIONAL SECTION
SAVE /D0/TEMP PRINTEQ Q
VERIFY U </D0/TEMP >/D0/CMDS/Q
DEL /D0/TEMP
ATTR /D0/CMDS/Q E PE
TMODE .1 PAUSE
-T
```

rect voltages from the power supply with a dc voltmeter. Plug the project's line cord into an ac outlet and set the POWER switch to on. The panel lamp should light and there should be +9 volts or a bit more at the + end and −9 volts at the − end of *C2*, both with respect to the project's box (circuit ground). Next, the output voltages should measure about +5.6 volts at the tip lug of *J2* and about −8 volts at pin 4 of the printer cable.

Temporarily jumpering the tip lugs of *J1* and *J2* should cause the polarity of the voltage at pin 4 of the printer cable to reverse. Remove the jumper, plug the cable into and turn on your printer. There should now be about −5.6 volts at *J2*'s tip lug. Jumpering *J1* to the + end of *C2* should cause the printer to start printing and the polarity at *J2* to reverse. Removing the jumper should cause the printer to cease printing.

Connect the Adapter to the computer with a standard cassette cable. The gray AUX plug goes to *J1*, the black EAR plug goes to *J2*. Type in:

10 PRINT PEEK(65313):GOTO 10

and RUN the one-line program to display the value of the bits in the PIA at $FF20. The printer status signal is the low-order bit. Turning on and off the printer should cause the number displayed to switch between 2 and 3. Remember which number is displayed when the printer is on. If it's 3, the cassette input signal is being inverted. The original Color Computer may invert the signal, though the Color Computer 2 doesn't.

Stop the program by pressing the BREAK key. With the printer on, type POKE 65312,255. The printer should start printing. Typing POKE 65312,2 should cause the printer to stop. If you get these results, power down the Adapter, put together the two halves of the box and secure them with the supplied sheet metal screws.

The Software

With the CoCo CASS/RS232 Adapter connected between your Color Computer and printer, don't expect to be able to print through the cassette port with PRINT#-2, and CSAVE will just print garbage. If you're using BASIC, you need a machine-language subroutine to use the Adapter. The BASIC loader for one that works is given in Listing 1. After entering the loader and saving it, simply run it before loading and running a BASIC program. The subroutine ends at the highest RAM address, and the loader automatically reserves the 97 bytes it needs. If your CoCo has less than 32K of RAM, change the number in the first DATA statement from 32767 to your highest RAM address. If you save the subroutine on disk, type CLEAR 200,32670 (or a lower address if you changed the ending address) before executing the LOADM command.

If your computer inverts the status signal, change the eighth byte from 27 to 26 in line 420 of the loader. This changes the test from a low (0) input to a test for a high (1) input.

The following BASIC program illustrates how the subroutine is called:

```
10 DEF USR0=32671
20 S$="THIS IS A TEST"+CHR$(13)
30 X=USR0(VARPTR(S$))
```

You must define a user subroutine execution address of 32671 (or the address given by the loader if you changed the ending address). Thereafter, the subroutine will print any string whose VARPTR it's given as a parameter. The string can contain characters with any code from 0 to 255. The subroutine uses the CoCo printer standard of one start bit, an 8-bit word length, no parity and two stop bits.

Baud rate can be changed to suit your printer. The parameter is coded in the last DATA statement of the loader as follows:

300 baud: DATA 01,6A,X
600 baud: DATA 00,B5,X
1200 baud: DATA 00,58,X
2400 baud: DATA 00,2A,X

For OS-9 version 2.0 users, the patch in Listing 2 will create device driver and descriptor modules for device /Q. It simply makes appropriate changes to the modules in a file named Q. If your computer doesn't invert the cassette input signal ($FF20 reads 2 when the printer is ready), exclude the optional section in the patch listing.

The best way to apply the patch is to create a procedure file (using BUILD or EDIT) with the lines shown and then execute the procedure file. This gives you the opportunity to verify the lines before they are executed.

Reboot after applying the patch, whether it's successful or not, because the patch modifies the modules in memory. To use the new modules, execute LOAD Q, LINK Q and then LINK /Q as the device name to print through the cassette port. You might want to add these modules to the boot file using OS9GEN. The baud and parity bytes can be changed with XMODE.

Keep in mind that when you power up your CoCo or press the RESET button, the printer will print garbage if it's turned on. So always turn on the printer last and turn it off during a manual rest. ME

BOOKS

Now That You Know Assembly Language: What Can You Do With It? by Jules Gilder. (Redlig Co., 2068 79 St., Brooklyn, NY 11214. $19.95.)

If you have ever longed to have an expert explain the intricacies of assembly-language programming on the Apple II, this new book does just that. The book is for novice programmers who have learned the basics of 6502 assembly language but are encountering difficulties creating practical programs of their own for their Apple II computers.

The objective of the book is to elevate beginner programmers to a new level of sophistication, so the author immediately suggests that the reader acquire an Apple II assembler (if he has not already done so)—the same powerful tool the pros use to write their assembly-language programs.

Early chapters present simple assembly-language routines, such as sending text to a printer and reading a character from the keyboard. The programs are thoroughly analyzed, with the author explaining such concepts as the 6502 stack.

Once the author has developed short enough routines, he combines them to produce more interesting programs. The outstanding ones were a software-based numeric keypad, a keyboard clicker, a screen printing routine, an Applesoft shorthand utility, a keyboard clicker, a program to restore files lost in memory, and a program to define Applesoft function keys. Like the shorter programs, these are also thoroughly analyzed.

A particularly strong area of the book is the way it reveals to the reader how a good programmer takes advantage of the assembly-language programs built into the Apple II ROMs. For the audience this book is attempting to serve, this feature alone may well justify its cost.

One shortcoming is that some routines are outdated. For example, in one part of the book the author presents a program that teaches an Apple to recognize lowercase letters. Apple IIe and IIc owners will find this program irrelevant, and one can wonder how many Apple II Plus owners have not yet solved this problem to their satisfaction.

Some of the general programs are a bit "long in the tooth," too. For instance, the author includes a menu-generating program that is certainly functional, but it is too unimaginative. It just lists the choices on the screen line by line and the user selects an item by pressing a number or letter. However, most modern programs interact with the user in other ways. Readers would likely prefer routines for graphics-based menus or menus that simulate interfaces like those used by Appleworks or Lotus 1-2-3.

Another failing is, ironically, caused by one of the book's strong points. As mentioned, whenever the author presents a program, he thoroughly analyzes it for the reader. Though this pedagogical method has merit, the author neglects to give the reader a more generalized framework for developing programs on his own. He does emphasize that longer programs should consist of a number of shorter routines, but this may not be enough guidance for the type of reader this book addresses.

All programs in the book are intended to run on Apple's older operating system, DOS 3.3. For Apple ProDOS users, there is a four-page appendix entitled "Adapting Programs to Work With ProDOS." Missing from the book, however, is any mention of the features of the new 65C02 chip used in all current Apple IIe and IIc computers.

Two companion disks are available. One contains the source code for all programs in the book, the other the object code. The latter allows you to run any of the programs. The disks are $15 each.

For the most part, the author has selected programs that will fan the interest of a beginning programmer, if not set him on fire. But potential readers should be warned that even though the author has attempted to clear a path in the dense assembly-language programming jungle, a considerable amount of effort is still needed to master this difficult subject.

NEW LITERATURE

Tools & Test Equipment Catalog. A 160-page, full-color electronic tools and test equipment catalog is available from Jensen. Two new sections feature fiber optics and wire/cable supplies and equipment. Included in an expanded line of circuit board equipment are breadboarding kits, cutters and drill sets, antistatic carrying cases and racks, test cables, insertion/extraction tools and other production tools. Other categories cover lighting and optical aids; metric power and metalworking tools; work holding devices; drafting supplies; and more than 50 dedicated tool kits. For a free copy, write to: Jensen Tools Inc., 7815 S. 46 St., Phoenix, AZ 85044.

Switching IC Application Note. A 4-page application note titled "Switching Inductive Loads with Power Interface ICs" is available from Sprague. The bulletin presents the four basic rules that one must follow when using power interface devices to drive motors. For a free copy of Ap Note No. AN29349, write to: Technical Literature Service, Sprague Electric Co., P.O. Box 9102, Mansfield, MA 02048-9102.

Products for Impaired Catalog. Radio Shack's 32-page "Selected Products For People With Special Needs" catalog lists items specifically designed for the physically impaired. Among the devices listed are flashers that light up when the telephone rings and oversized number buttons on telephone instruments; tools for one-hand operation; an emergency message dialer; a portable FM monitor for the bedridden; digital fever thermometer and pillbox timer; etc. For a free copy, write to: Radio Shack Circulation Dept., 300 One Tandy Center, Ft. Worth, TX 76102.

Power-Meter Technical Note. Hewlett-Packard's 10-page "Four Steps in Buying an RF/Microwave Power Meter" brochure outlines the considerations that should be used in choosing r-f/microwave power meters and sensors. It includes a discussion on understanding the signal, various sources of measuring uncertainty, power sensor alternatives and application considerations. Photos and diagrams illustrate these points. The last page reviews HP's solutions and includes a selection table of HP power sensors. For a free copy of Technical Note No. 64-4, write to Inquiries Manager, Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, CA 94303.

Two-Way Radio Brochure. An 8-page, full-color brochure from Midland LMR summarizes recent developments in the company's professional two-way radio systems and equipment. It details the latest advances in the Midland Syn-Tech line of advanced programmable mobiles, portables and base stations and discusses repeaters and accessories and economical PLL-synthesized mobiles and portables. For a free copy, write to: Midland LMR, Marketing Dept., 1690 N. Topping, Kansas City, MO 64120.

Surge Suppressor Brochure. CPS Electronics' new four-color "Electra Guard Surge Suppressor Program" brochure lists and illustrates with photos a full line of consumer-grade power conditioners. Complete product specifications are listed on the last page in a table that is color-coded according to the level of power protection available with each device. For a free copy, write to: CPS Electronics Inc., 4152 112 Terrace N., Clearwater, FL 33520.

Custom/Stock Inductors Catalog. An illustrated 6-page catalog from Toltec Industries describes an extensive line of stock-value and custom-wound inductors. It lists the wide range of ferrite-bobbin and ferrite-rod inductors, toroids, transformers and specialty inductors and subassemblies made by the company. For a free copy, write to: Toltec Industries, Inc., 7024 Manya Circle, San Diego, CA 92154. **ME**

ELECTRONICS NOTEBOOK

Ultraminiature Radio Transmitters

By Forrest M. Mims III

In October of 1957, I arose early one clear morning to search the dawn sky for a view of the final stage of the rocket that propelled the first artificial earth satellite into earth orbit. Watching that tumbling booster flicker rapidly across the sky over Houston and hearing the sounds broadcast by its payload were thrills I'll never forget.

Another engineering triumph of 1957 might be considered, at least in engineering terms, the inverse of the Sputnik. It was the development of tiny radio transmitters that could be swallowed so researchers could measure the temperature and pressure along the gastrointestinal tract. For a teenaged electronics experimenter in 1957, the development of the "gutnik" was at least as significant as the orbiting Sputnik. Developing and launching earth satellites required a national space program. But building pill-sized transmitters to explore the human body seemed very much within reach.

Today building and experimenting with miniature radio transmitters remains both fun and educational. Even if your workbench is only sparsely equipped, you can assemble in an hour or so a basic radio beacon transmitter not much bigger than a sugar cube. I'll provide the construction details for this and two other miniature transmitters below. But first let's review a little of the fascinating history of biomedical telemetry.

Biomedical Telemetry

Television nature documentaries have recorded countless scenes in which a miniature beacon transmitter is attached to a captive animal. When the animal is released, biologists are able to pinpoint its location by means of sensitive receivers equipped with directional antennas.

Though tracking transmitters are a very common application of telemetry, the field of biomedical telemetry is amazingly diverse. For example, miniature transmitters have been used to monitor the heart rate of a roaming elk, the body temperature of a 400-pound tortoise, the migration of trout in Wyoming, the vital signs of sheep and dog fetuses, and the walking patterns of brain-damaged children.

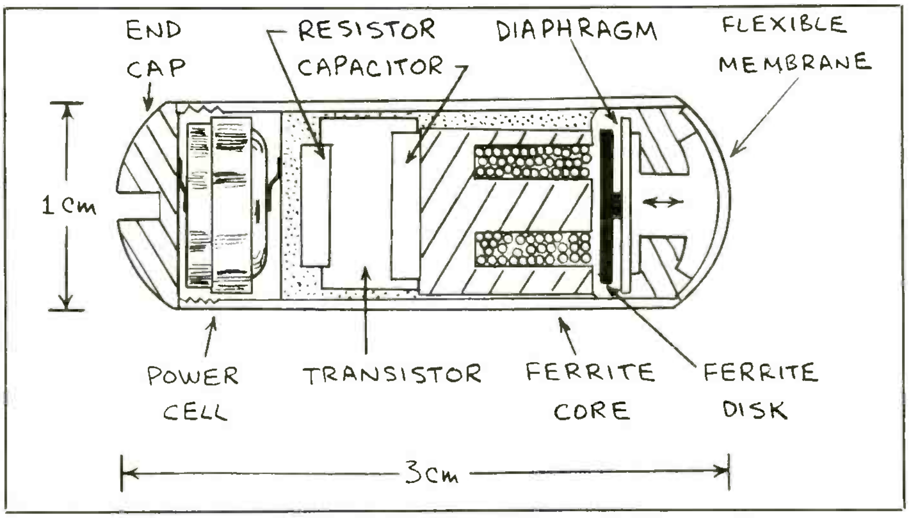


Fig. 1. Cross-section of early pressure-sensing "pill" transmitter.

The most compact biomedical transmitters are those designed to be swallowed or surgically implanted. One of the the pioneers behind the development of these tiny transmitters, and the field of biomedical telemetry itself, is R. Stuart Mackay. In 1957, Dr. Mackay and Bertil Jacobson at the Karolinska Institute in Sweden published two technical papers that described a simple radio-frequency transmitter that could be safely swallowed and used to monitor the gastrointestinal tract. Later in 1957, a group of researchers from the Veterans Administration Hospital in New York and Cornell University Medical College announced a similar device that transmitted the pressure inside the intestinal tract.

Figure 1 is an outline view of one of the so-called pill transmitters developed by the latter group. The tiny transmitters were also called endoradiosondes, radio pills, gutniks, and transensors. Whatever the name, the basic circuit for these transmitters, which are still used by medical researchers, is a modified Hartley oscillator powered by a miniature mercury- or silver-oxide button cell.

In operation, the oscillator generates an r-f carrier signal which is periodically extinguished or blocked by a capacitor. Since the blocking rate is controlled by a resistor, the transmitter can transmit a temperature signal by substituting a thermistor for the resistor. It can simultaneously transmit a pressure signal. This is accomplished by attaching a ferrite disk to a flexible diaphragm installed over one

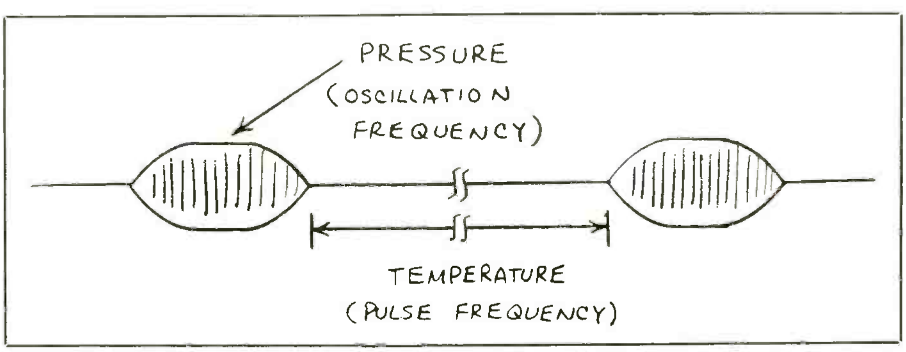


Fig. 2. Transmitting temperature and pressure simultaneously.

end of the transmitter's coil. Movements of the diaphragm in response to pressure variations alter the inductance of the coil, hence the frequency of the signal (but not that of the bursts). Figure 2 illustrates how both temperature and pressure are transmitted in this fashion.

The range of these transmitters is measured in feet. Therefore, the animal or person being monitored must stay within range of a nearby receiving antenna or antenna array. If the gastrointestinal tract or some other organ of a free-ranging animal is to be monitored, a receiver connected to a more-powerful transmitter is attached to a collar worn by the animal. The external receiver intercepts the weak signal from inside the animal and passes it to the external transmitter for rebroadcast.

Assembling a pill-sized transmitter might at first seem beyond the capabilities of the average electronics experimenter. Not so. From 1965 to 1972, Dr. Mackay presented a series of four-day courses on biotelemetry. As a special hands-on exercise, participants in these courses were given a soldering iron, several small electronic components, and instructions on how to assemble a temperature-transmitting transmitter.

As Dr. Mackay later reported, "It was interesting to see a group of dentist, obstetricians, physiologists, etc., without previous relevant experience, produce in one evening a functioning transmitter. The transmitter was encapsulated in a 1-centimeter long piece of soda straw, which the participant could then swallow if he wished. The reliability was absolute; there were no failures among a thousand participants (if one ignores wiring errors that were corrected.)" (Taken from "Biomedical Telemetry: The Formative Years," *Engineering in Medicine and Biology*, March 1983.)

If people with the diverse backgrounds described by Dr. Mackay can successfully assemble pill-sized transmitters, it goes without saying that electronics experimenters can do the same with one hand tied behind their backs. Anyway, I hope this discussion of the background of miniature biotelemetry transmitters has challenged you to assemble and experiment with one or more such devices. Their serious applications include science fair projects, biomedical research, secret identification beacons, wireless outdoor/indoor temperature beacons, and so forth. They can also be used in hidden transmitter games and as teaching tools.

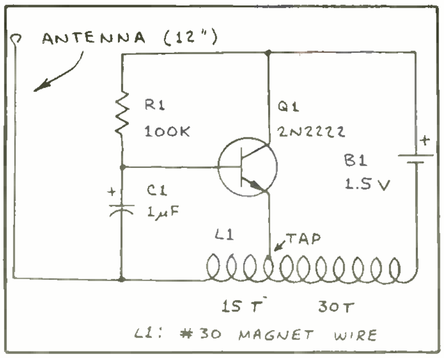


Fig. 3. A miniature r-f transmitter.

A Tiny Beacon Transmitter

Shown in Fig. 3 is the circuit for a miniature beacon transmitter. In most ways, the circuit is essentially identical to the one used by Dr. Mackay in the course described above. In operation, the circuit transmits a pulsating r-f signal that can be received at the low end of the 88-to-108-MHz FM band and across a wide swath of the shortwave spectrum, particularly the 16-meter band and beyond. When the transmitter antenna is 12" long, maximum usable range is around 6 to 8 feet.

Figure 4 is a sketch of a single r-f pulse radiated by the Fig. 3 transmitter. This view of the pulse was obtained by connecting an oscilloscope probe to the transmitter's antenna lead. The pulse is actually an envelope of broad-spectrum r-f oscillations containing many high-frequency harmonics. Note that while the transmitter is powered by a 1.5-volt cell, the peak amplitude of the r-f signal is −30 volts. This voltage jump occurs because of the autotransformer action of the coil.

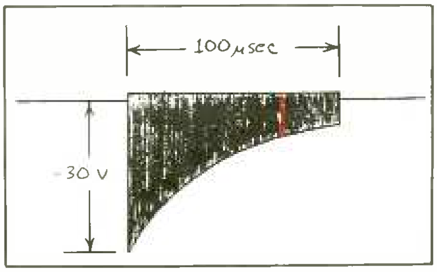


Fig. 4. A typical r-f pulse envelope from a transmitter that is not crystal controlled.

The only significant difference between the Fig. 3 circuit and the one specified by Dr. Mackay is the coil. Dr. Mackay specified 150 turns of the #40 enameled magnet wire tapped at 50 turns. I have used many different wire sizes and numbers of turns and have found that 45 turns of #30 or #40 magnet wire works well in the 16-meter shortwave band. The transmission frequency, which is very broad, can be lowered, but not necessarily narrowed, by increasing the number of turns.

Figure 5 shows a typical coil of the kind I have made. Coils like this can be wound in a few minutes with little difficulty, particularly if you punch holes in the form with a needle to receive the end and tap leads. Incidentally, the coil can be made using wrapping wire, but considerably more space will be required.

Dr. Mackay specified that the coil be wound on a 1-centimeter length of soda straw. The components of the transmitter could then be stuffed inside the coil for the utmost in miniaturization. I have found that the coil can be wound on forms much smaller and much larger than a soda straw. Therefore, I have not specified a form size in Fig. 3.

Figure 6 is a pictorial view of a transmitter I assembled that's smaller than a dime. A 2N2222 or any other npn silicon switching transistor can be used for *Q1*, *R1* is a miniature ¼-watt resistor, and *C1* is a miniature tantalum capacitor. All are readily available.

A piece of tough but flexible clear plastic found stashed away in my supplies drawer served as the circuit board for my prototype. Mylar and other materials can also be used. Holes for the component leads were punched through the board with a needle. The transmitter can be built without a circuit board if you prefer. So few components are used that they can be wired directly together. This is the method used by Dr. Mackay to permit the circuit to be installed inside the coil.

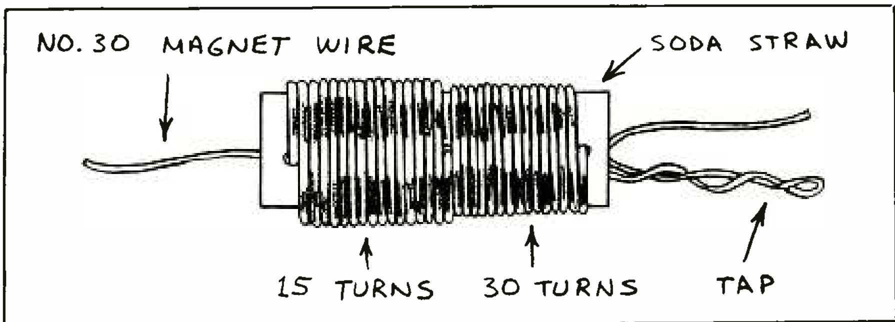


Fig. 5. A homemade air-core r-f coil.

This basic transmitter radiates a fixed-frequency pulse train that produces a clicking sound from a receiver. To transmit such information as temperature or light intensity, *R1* can be replaced by a thermistor or photoresistor. The value of *C1* can be altered to give any desired frequency output. The simplest approach is to use a value for *C1* that gives a series of "pocks" that are slow enough to be easily counted. With the help of a digital timer or watch, you can then calibrate the system (for example, pulse rate versus temperature). A slow pulse rate will allow you to make surprisingly accurate measurements without resorting to an oscilloscope or frequency counter.

This transmitter can be powered by a mercury (1.3 volts) or silver-oxide (1.5 volts) primary cell or a nickel-cadmium (1.2 volts) storage cell. When powered by a Ni-Cd button cell, the prototype transmitter I built consumed 0.2 milliampere.

Keep in mind that the power source for the transmitter can greatly influence size. One of the smallest power sources is a No. 312 mercury button cell. However, unless you can find a version of this cell with solder tabs, it must be installed in a holder or leads must be spot-welded to it. I used Ni-Cd button cells equipped with solder tabs to power the prototype transmitters I built. (Warning! Never attempt to solder leads to a button cell which does not have solder tabs! The heat from a soldering iron can will probably cause the cell to explode!)

Crystal-Controlled Mini-Transmitters

The range of the circuit in Fig. 3 is limited because it oscillates over a wide band of frequencies. Range can be increased if radiated power is concentrated at a single frequency by regulating the oscillator with a quartz crystal.

Figure 7 shows the circuit for a simple crystal-controlled r-f oscillator. This circuit is not the blocking-oscillator type shown in Fig. 3. Instead, it generates a steady, unmodulated r-f carrier signal. It consumes 0.1 milliampere when powered by a 1.2-volt Ni-Cd button cell.

Inductor *L1* is a standard 100-microhenry choke rather than a hand-wound coil. Better results, however, can possibly be achieved with hand-wound coils; so you might wish to experiment with *L1*.

I have used a 27-MHz Citizens Band crystal with this circuit without altering the value of *C1* or *L1*. No doubt the performance of the circuit can be improved by tailoring *C1* and *L1* to the oscillation frequency. In any event, the oscillator gave relatively strong signals over a range of up to 50 feet.

Operation of this circuit can be controlled in part by the setting of potentiometer *R1*. Before power is applied to the transmitter, set *R1* to its midpoint an tune a receiver to the crystal frequency. After applying power, adjust *R1* while listening to the effect it has on the radiated signal.

Remember that this transmitter radiates an unmodulated carrier wave. Therefore, it does not produce a characteristic audio signal from a receiver. Instead, it may make its presence known by blanking out a competing signal and by producing high-pitched whistling sounds. For example, when a 10-MHz crystal is used, the transmitter blanks the time-of-day signals being received by a nearby shortwave receiver tuned to National Bureau of Standards station WWV. That's why the relevant FCC regulations, some of which are given below, should be consulted before selecting a crystal frequency.

Modulated Transmitter With Crystal Control

The basic crystal-controlled carrier transmitter in Fig. 7 can be modulated by applying a signal to the base of *Q1*. The problem here is to design a modulating circuit that can be powered by a supply that provides as little as 1.2 volts. One of the simplest solutions is to use an LM3909. Though designed primarily to flash an LED, this versatile chip can be used as an audio-frequency oscillator.

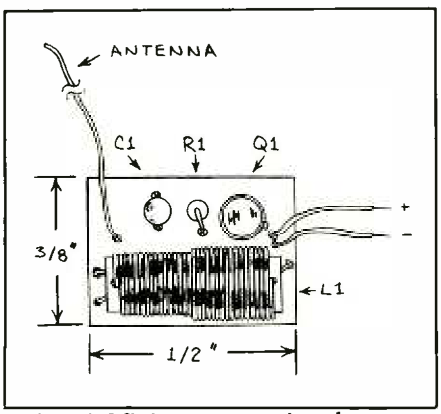


Fig. 6. Miniature transmitter layout.

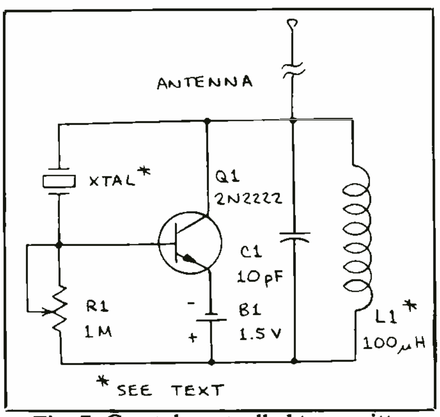


Fig. 7. Crystal-controlled transmitter.

ELECTRONICS NOTEBOOK ...

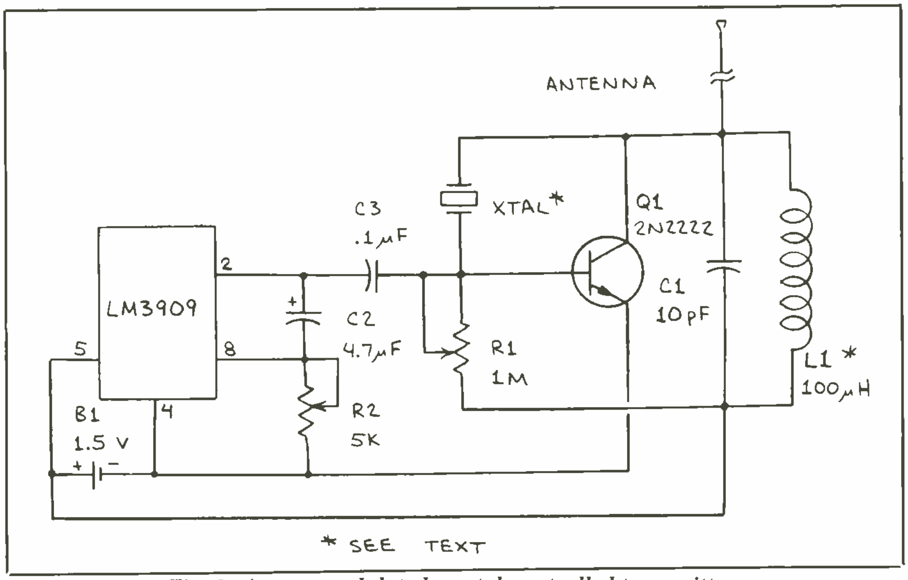


Fig. 8. A tone-modulated crystal-controlled transmitter.

Figure 8 shows an LM3909 audio-frequency oscillator connected to the carrier transmitter in Fig. 7. Here, *C2* and *R2* control the frequency at which the LM3909 "keys" the carrier oscillator. The circuit transmits a clear audio signal to a shortwave receiver up to 100 feet away. With the values shown and depending on the setting of *R1*, the signal is a train of pocks or a buzz. Total current consumption from a 1.2-volt Ni-Cd cell is 0.7 milliampere.

Figure 9 is a sketch of the waveform that appears on an oscilloscope connected to the antenna terminal of the transmitter. What's shown is a single pulse in a series, each of which forms a burst of r-f oscillations at the frequency of the crystal. The r-f signal contained in each burst is much purer than that depicted in Fig. 4.

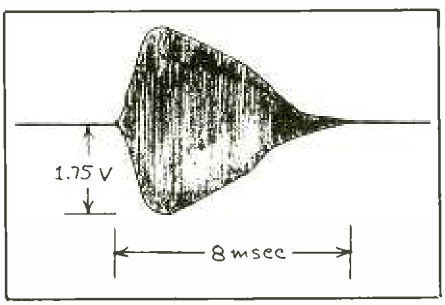


Fig. 9. Typical r-f pulse envelope from crystal-controlled transmitter.

The Fig. 8 circuit can transmit temperature or light intensity if *R1* is replaced by an appropriate sensor. For best results it may be necessary to alter the value of *C1*.

FCC Regulations

The Federal Communications Commission regulates devices that emit radio-frequency signals. The rules and regulations published by the FCC are highly detailed and complicated, which is why I am particularly fond of the largely unregulated world of free-space lightwave communications. (Many lasers are subject to various regulation.) Part 15 of the FCC regulations ("Radio Frequency Devices") governs low-power communications devices such as experimental transmitters, wireless microphones, garage door openers, security alarms, and cordless telephones. Some of the key provisions of Part 15 that pertain to experimenters, all of which are subject to change, include the following:

15.1 (a) An incidental and restricted radiation device may be operated under the restrictions and provisions set forth in this part without an individual license.

15.3 Persons operating restricted or incidental radiation devices . . . shall not be deemed to have any vested or recognizable right to the continued use of any given frequency . . . operation of these devices is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by other incidental or restricted radiation devices . . . .

15.104 . . . the use of a low power communication device for eavesdropping is prohibited.

15.113 . . . a low power communication device may operate on any frequency in the band 510-1600 kHz provided . . . (a) The power input to the final radio stage . . . does not exceed 100 milliwatts . . . (c) The total length of the transmission line plus the antenna, plus the ground lead (if used) does not exceed 3 meters . . . .

15.116 A low power communication device may be operated in the band 26.99-27.26 MHz provided . . . (a) The device may not be used for voice communications . . . or for CW communications . . . (b) The device shall operate on one or more of the following frequencies:

26.995 MHz	27.145 MHz
27.045 MHz	27.195 MHz
27.095 MHz	27.255 MHz . . . .

15.117 (a) A low power communication device may be operated on one or more of the permitted frequencies . . . :

49.830 MHz	49.875 MHz
49.845 MHz	49.890 MHz
49.860 MHz	

15.118 A low power communication device which is home built in a quantity of 5 or less and which is not marketed may be operated in the band 49.82-49 MHz provided . . . (b) The power input to the device measured at the battery or the power line terminals shall not exceed 100 milliwatts under any condition of modulation. (c) The antenna shall be a single element 1 meter or less in length permanently mounted on the enclosure containing the device . . . .

15.152 . . . the operator of a low power communication device . . . which causes harmful interference to an authorized radio service, shall promptly stop operating the device until the harmful interference has been eliminated.

Some provisions of Part 15 are impractical when applied to ultraminiature transmitters. For instance:

15.133 A person who constructs not more than five low power communication devices for his own use, and not for sale . . . shall attach to each device a signed and dated label that reads as follows: I have constructed this device for my own use. I have tested it and certify that it complies with the applicable regulations of FCC Rules Part 15. A copy of my measurements is in my possession and is available for inspection.

In spite of idiosyncrasies like this, Part 15 contains many other provisions that will prove helpful to low-power transmitter builders. For instance, requirements for operation of wireless microphones and biotelemetry devices in the 88-to-108-MHz FM band are given. Also covered are provisions that permit the FCC to inspect transmitters and measurement records of builders.

You can find the full text of the FCC regulations at a library that has a government documents section. Look for "Code of Federal Regulations," Telecommunication, Parts 0 to 19.

Going Further

Must reading for constructors of pill-size radios is "Little Radio Transmitters for Short-Range Telemetry" (C.L. Stong, *Scientific American*, March 1968, pp. 128 through 134).

I included details on a simple r-f transmitter in *Engineer's Mini-Notebook: Basic Semiconductor Circuits* (1986), a new Radio Shack book that should be available by the time this column appears in print. This book also describes a one-transistor audio-frequency Hartley oscillator.

A special issue of *Engineering in Medicine and Biology Magazine* (March 1983) covered virtually every aspect of biotelemetry. Topics covered include history, transmitter design, hybrid transmitters, packaging, and power sources.

An excellent reference for those who want to design optimized r-f oscillators is *RF Circuit Design* (Chris Bowick, Howard W. Sams & Co., 1982).

Finally, if you want to explore the world of licensed amateur radio, be sure to read *Tune in the World with Ham Radio* by the American Radio Relay League (send $7 plus $1 postage to ARRL, 225 Main Street, Newington, CT 06111). ME

HARDWARE HACKER

Stroke graphics, temperature-measurement circuits & stunning new graphics materials

By Don Lancaster

We will start off with our usual reminder that this is your column and that you can get technical help on most any topic per the "Need Help?" box.

Many of our newer readers have been asking about the artwork you see here. Everything, including *all* schematics, isometric sketches, tech illustrations, etc. is done *solely* with the AppleWriter word processor running on an Apple IIe and then printed camera-ready and slightly oversize on a Laserwriter printer.

An exciting new language called *Postscript* makes it all happen, helped along by some utilities I put together on my own. No digitizers or scanners of any type are used.

I've got a free demo pack on all this that I'll be most happy to send to you when you call or write. Some of it is now even in *full color*, straight out of a stock Laserwriter!

And now . . . .

What are the differences between stroke and raster scan video?

There have been several calls from *Modern Electronics* hackers who have picked up bargain priced surplus "XY" color RGB video monitors and have asked if I would please show them a simple interface circuit usable for personal computer text input. Well, yew jest caint get there from here, no way, nosiree, nohow.

Why?

At one time, long ago and far away, there were two fundamentally different ways of presenting data on a video screen.

The method you probably know about is called "raster scan" graphics, and is shown in Fig. 1. With raster scan graphics, the video screen is constantly "painted," going rapidly to the right and slowly downward, creating a *raster* of *scan* lines. When a particular dot on the screen is to be lit a particular color, the guns in the CRT display tube are activated, producing a spot. Sequential spot

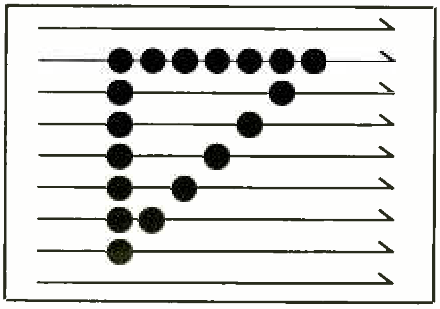


Fig. 1. Raster scan graphics.

patterns then produce dot-matrix text characters or graphic video images.

Raster scanning, or course, is used in all newer video games, in all television broadcasts, and in all personal computers.

The alternative to raster scanning is called "stoke graphics," and is shown in Fig. 2. With stroke graphics, each and every object to be put on the screen is drawn one at a time, in sequence. Instead of the horizonatal and vertical oscillators used in raster scanning, there is just a pair of deflection amplifiers. Data from a "display list" is D/A converted and routed to the deflection amplifiers. Each object on the screen is drawn one line at a time.

Stroke graphics is particularly good at showing diagonal lines of open and chunky objects, such as various sized asteroids, tumbling in different directions all at once on a predominantly black background.

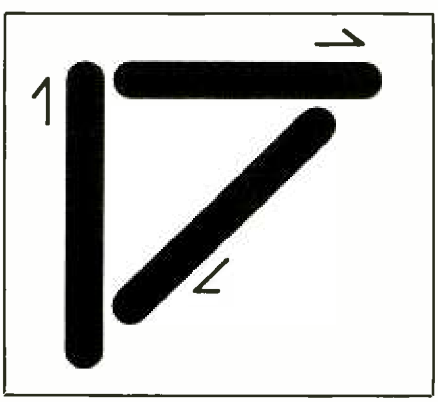


Fig. 2. Stroke graphics.

The early advantages of stroke graphics were that you needed incredibly little digital memory and you never put the CRT electron beam any place you did not really want an image.

But there were some overwhelming gotchas that killed stroke graphics a decade ago, except in plotters, military stuff and certain arcade video games that were able to uniquely exploit this type of display.

The first major disadvantage is that text is extremely difficult to show, especially in nice-looking fonts. The second is that flicker can get ridiculously bad if you try to put too many objects on the screen at once. The third is that large solid-color objects, or colored backgrounds are just not feasible.

So why not just throw a couple of horizontal and vertical oscillators on a stroke system and pretend it is a raster scan display? After all, a couple of 555 timers shouldn't be all that complex, should it? This sounds simple enough, but there is a problem in the comparative writing rates between raster and stroke systems. A normal resolution raster scan graphics system has to sweep from left to right across the screen in something like 60 microseconds. On a 10" raster, this converts to a 6-microsecond-per-inch sweep rate. The surplus arcade monitors being sold today have a sweep rate around 0.04 microseconds per inch, which is 150 times too slow! The flicker would be unbelievably bad, as the screen would get updated a maximum of once every 2 seconds or so, rather than the 60 fields per second needed for a flicker-free display.

Well you say, why not just soup up the stroke monitor's XY deflection amplifiers and give them a little better frequency response? Would that work?

Once again, the answer is: no way! Raster scan sweeping is extremely energy efficient, since the deflection current used to sweep from center to right is saved, reversed, and then used again to sweep from left to center. Unless you get very tricky, the high-frequency linear deflection amplifiers you would need for fast-raster-rate stroke graphics would

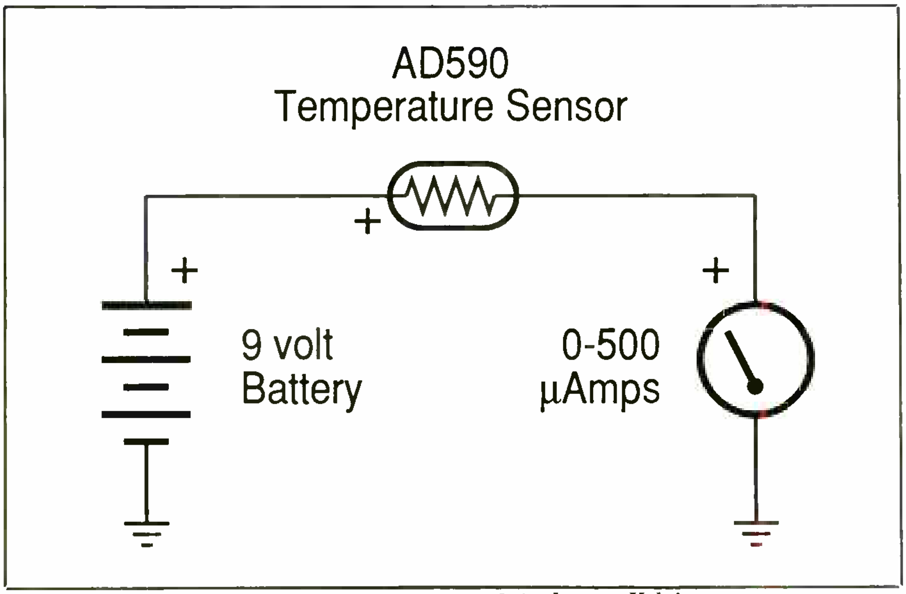


Fig. 3. Simple thermometer reads in degrees Kelvin.

have to handle several kilowatts of power for a large color display!

The bottom line? Thse surplus XY monitors are real parts bargains and they let you do all sorts of interesting but highly specialized video game simulations. But they are absolutely and totally unsuitable for displaying stock text and video from any personal computers.

How can I electronically measure temperature

There are lots of different ways to measure temperature, depending on the range being measured, the type of output wanted, and the accuracy needed.

Traditional thermometers are based upon the thermal expansion of some material. Liquid columns of mercury or alcohol are used in everyday thermometers. A very thin capillary tube is used to "amplify" the apparent expansion.

Another important temperature transducer is the bimetallic strip. In a bimetallic strip, two metals or alloys with different expansion coefficients are bonded together. As the temperature changes, one metal or alloy expands faster than the other, and the strip will bend or coil. This is how your usual home heating thermostat works. Alternatively, you can form a snap-action disk out of bimetallic material, giving you the switching thermostat you will find in an electric skillet or a coffee maker.

Measurement of extremely high temperatures takes special techniques. An older way to measure the temperature of a furnace or a kiln is with an "optical pyrometer." This is simply a wire that is heated. You visually compare the wire color against the furnace color, and adjust a dial until they match. You then read the equivalent temperature off the calibrated dial.

A more modern way to measure high temperatures is with an infrared sensor. These are sort of like photocells, except they respond in the infrared region to radiation from any hot body. They have the big advantage of being able to remotely measure any hot source. Unfortunately, infrared sensors become quite expensive and cumbersome when you try to accurately measure lower temperatures with them.

Today, there are at least six popular ways of measuring everyday temperatures electronically. These include the crystal oscillator, the thermocouple, the thermistor, the p-n junction, the silicon transducer, and the bulk silicon resistor. Of these, the crystal oscillator method is by far the most precise and has by far the best resolution. It can resolve down to 0.001 degree or better. On the other hand, this method is very expensive.

Most quartz crystals are carefully cut at just the right angle to minimize frequency variations over temperature. You can instead carefully pick your crystal cut to purposely get a strong and linear frequency variation. By hetrodyning the output frequency against a stable source, you get an audio tone that can be measured. *Hewlett-Packard* is one source of instruments of this type.

Any two dissimilar metals that contact each other will generate a voltage that is proportional to temperature. This is the principle behind the thermocouple.

Thermocouples are used in industry to measure a wide range of temperatures. One popular thermocouple is called a "type J" and is made from copper contacting the alloy constantan. The output from this arrangement is only 50 microvolts per degree C or so. Thus, you have to use precision differential instrument amplifiers to get useful results. You also have to figure out where to connect the other end of the constantan wire, for this connection will also generate a voltage that is in series with the one you are trying to measure. Traditionally, the other connection was made in an ice bath, so you would get the relative temperature difference between the two thermocouple junctions. These days, however, a precision voltage reference is often used to replace the ice bath.

You have to be very careful when connecting thermocouples, for even solder to copper has a 3-microvolt per degree C thermal voltage.

Many different thermocouple systems are available from *Omega Engineering*. They also have a fat and free *Temperature Measurement Handbook and Encyclopedia* that you can send for.

Thermistors are compounds of silicon carbide and other materials that exhibit a very strong change of resistance versus temperature. By first calibrating a thermistor and then measuring its resistance you can measure temperature.

While you get something that is very easy to measure as an output, thermistors tend to be be nonlinear. Sometimes, several thermistors and resistors are placed in a single package to give more linearity and accuracy. Self-heating effects must be carefully watched in thermistors, or they will mask the real temperature.

Yellow Springs Instruments is a leading source of thermistors and probes. In general, thermistors are an older technology that is being rapidly replaced by the silicon transducers and silicon resistors.

For quick and dirty temperature measurement, just use the base-emitter junction of any old silicon transistor—or stack a bunch of them up. Each junction changes by 2.2 millivolts per degree centigrade over a fairly wide temperature range. Diodes should also work just fine. Unfortunately, this output voltage sits on top of a 0.6-volt device-dependent offset; so it is best used for limited accuracy or for "set-point" uses where you want to turn a switch on or off at a fixed and easily calibrated temperature.

This silicon junction effect is carefully linearized and calibrated in the silicon temperature transducer. What you have is a miniature integrated circuit that uses a current mirror to route the internal current between a pair of carefully matched silicon junctions. The differential mirroring is adjusted so that an extremely linear and reproducible output current of 10 microvolts per degree Kelvin results.

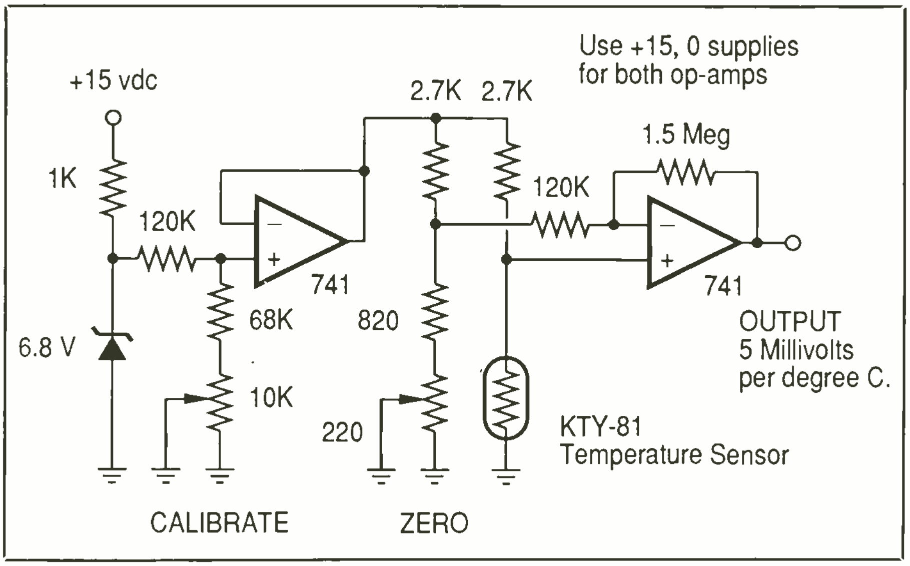


Fig. 4. This circuit gives 0-to-5-volt output for 0-to-100-degree C input.

The *Analog Devices* AD-590 is typical, and costs under $2.00. A similar part is available carded at *Radio Shack*. Since these devices produce a current output, they can be used over long distances. With a current output, all thermocouple effects in your wiring, plugs, and connectors magically go bye-bye.

The only little gotcha is that the output current is referenced to absolute zero, rather than zero degree centrigrade or to zero degree Fahrenheit. The typical output current is 273 microamperes at 0°C and 373 microamperes at 100°C. A pair of op amps usually have to be added to get a large output that is proportional to these everyday temperature scales. One op amp eliminates the 273-microvolt offset; the other amplifies and scales for either Fahrenheit or centrigrade use.

Finally, bulk silicon itself has a strong 0.7-percent per degree centrigrade temperature coefficient. You can just take a block of silicon, measure its resistance, and you are home free. The brand new *Amperex* KTY-81 sensors sell for as little as 21 cents each, are easily linearized with one resistor, and are accurate to a fraction of a degree.

These also need a pair of op amps to get linear operation over the Fahrenheit or centigrade scales. Free samples of the KTY81 series are available to letterhead requests.

In general, if you want to know a lot more about temperature sensors and sens-

NAMES AND NUMBERS

Amperex
Providence Pike
Slatersville, RI 02876
(401) 762-3800

Analog Devices
2 Technology Way
Norwood, MA 02062
(617) 329-4700

Control Engineering
1301 South Grove Avenue
Barrington, IL 60010
(312) 381-1840

Hewlett Packard
1820 Embarcadero Road
Palo Alto, CA 94303
(415) 857-8000

Measurement and Control
2994 West Liberty Avenue
Pittsburgh, PA 15216
(412) 343-9666

Omega Engineering
Box 4047
Stamford, CT 06907
(203) 359-1660

Omnicrom Systems
26111 Brush Avenue
Cleveland, OH 44132
(216) 289-6688

Yellow Springs Insts.
Box 279
Yellow Springs, OH 45387
(513) 767-7241

ing, check out *Measurements and Data* or *Control Engineering* magazines.

Show me some simple thermometer circuits

Figure 3 shows the AD 590 temperature transducer in a very simple circuit. The output meter directly measures degrees Kelvin, so 0 degree centrigrade will read as 273 microamperes, while 100 degrees centrigrade will read as 373 microamperes. To get to Fahrenheit, just relabel the meter scale.

Figure 4 shows how to use a KTY-81 silicon resistor to produce a 0-to-5-volt output for a 0-to-100-degree centigrade input. This dual op-amp circuit is typical of what you need to get from a sensor that is based on absolute zero to output everyday temperature scale values.

The 250-ohm pot is used to zero the 0-degree output. Then the 10k pot is used to set the 100-degree output to +5 volts. Most any old dual op amp could be substituted, as could a regulator for the zener diode. You might be able to cheat and use a 9-volt battery as well. Total cost should be well under $5.

For more details on these two circuits, check out the "Silicon Temperature Sensors" ap note from *Amperex* and "Use of the AD590 Temperature Transducer in Remote Sensing" ap note from *Analog Devices*.

What is the new Omnicrom process?

I've just discovered a little-known graphic arts material called "Omnicrom." It has incredible hacker potential. What this material does is instantly convert *any* toner image from a copier or a laser printer into "real" printing in "real" ink, in any of 60 colors.

Figure 5 shows the details of this exciting new process. Toner basically consists of a mixture of black stuff and hot glue. When most people use toner, they are after the black image. But you can instead think of toner as a hot glue image that has been applied exactly when and where you want it.

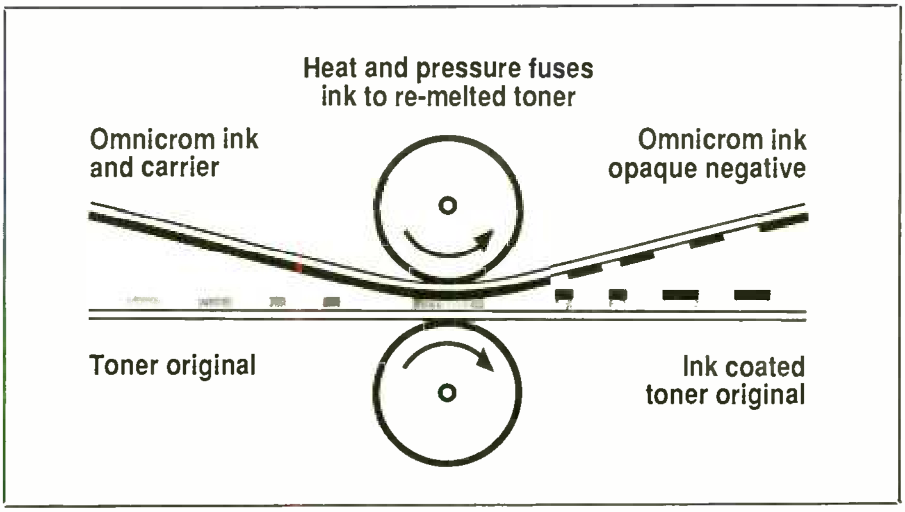


Fig. 5. How the Omnicrom color process works.

An Omnicrom sheet consists of real ink in stunning colors applied to a carrier. You place this sheet in contact with any toner original and apply heat and pressure. The heat and pressure remelts the toner and sticks the ink to it. At the same time, an opaque negative is produced on what remains of the Omnicrom sheet.

There are at least four ways to fuse the ink to your toner. The simplest is to use a laser printer, such as Apple's Laserwriter, and run the material through a second time while hand feeding a blank page.

You can experiment with most any copier that has a short and straight paper path that will accept heavier stock. Word has it that the next generation of copiers, particularly those by Minolta, will be set up to reliably handle this process.

If you do lots and lots of this sort of thing, you can buy a ridiculously overpriced $1300 fusion system directly from *Omnicrom*. Finally, you can easily build your own machine out of old copier parts or replacement components.

The sheets cost around 35 cents each, and their unimaged areas can be reused as often as you care to. Besides bright colors and metallics, there are golds, silvers, a pearl, black, and even a clear gloss.

What good is all this? First and foremost, laser printer users gain full color capability right here, right now, and at reasonable cost.

You can easily do many printed circuits from 2:1 artwork without needing a camera or a darkroom, at one-tenth the usual cost and hassle. All you need is a reducing copy machine. Same goes for panels, dialplates and the callouts for printed circuits. Any old copy from any old copy machine can now be made totally and truly black, any time you need a camera-ready image.

Several colors can go on one page by taping small pieces of Omnicrom over each color area. The best tape to use is *3M* Post-It Cover Up Tape from your local office supply.

Write or call, and I'll be most happy to send you some free Omnicrom samples to play with. This stuff is utterly and absolutely amazing. Let me know what new and mind-blowing uses you can come up with for this exciting new material. **ME**

NEED HELP?
Phone or write your **Hardware Hacker** questions directly to:

Don Lancaster
Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073

Looking Back at 1986's Best

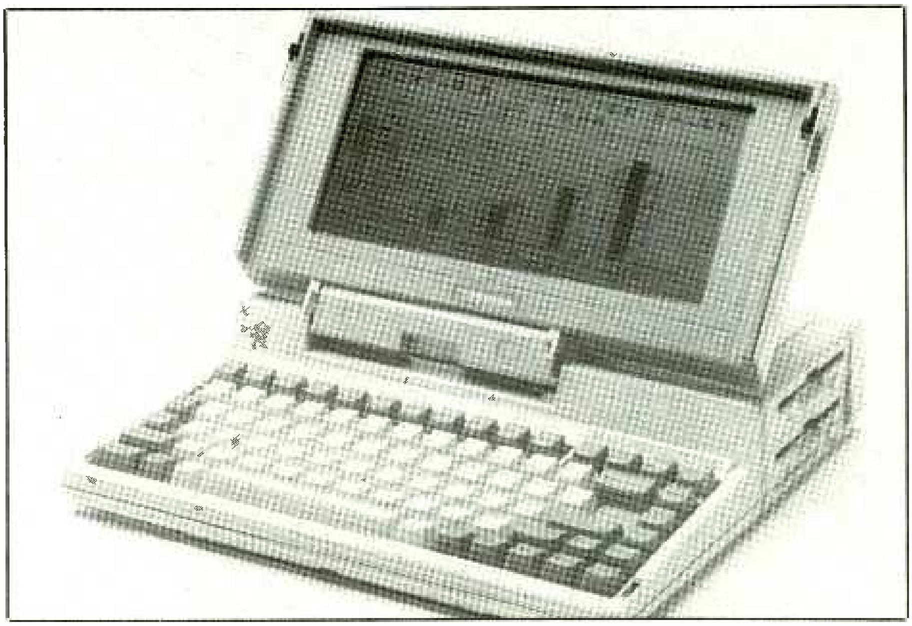
By Eric Grevstad

The December issue's here again, but how can I write a review of the year in MS-DOS computing when I've already declared that desktop publishing is overrated for a small market niche dependent on high-powered processors? The page-layout craze overshadowed two more important trends in the PC market—one being increased stability and a muting of last year's incessant "Shakeout! The sky is falling!" refrain, and the other being a welcome continuation of the downward price spiral for hardware. Computers and printers are getting more affordable every day; maybe 1987 will see the same finally happen for software.

But these are generalities. There are more specific things to say about the past year, so I'll list a few highlights from this column's product-oriented point of view. (I'll get back to reviews next month, but one product didn't arrive in time and another—SPI's Open Access II, perhaps the most ambitious integrated package yet—demanded more time than this month's deadline allowed. It was either a year-end roundup or a Christmas gift guide, and if I wrote a gift guide I'd spend it all plugging the word processor I just adopted, which I'll talk about later.)

• *What I Want for Christmas:* Readers have noticed that I continue to cheer for cheap 8088 PC clones; I've been leery of 80286-based machines, first because the PC AT seemed overpriced and unreliable and later because folks told me the 80286 was only a stopgap, that I should wait for computing nirvana with the awesome 80386. That may be true and there should be 80386 machines for sale by the time you read this, but they'll cost a ton and won't have much full-powered, specially written software until 1988.

Meanwhile, though, I'm not sure how much longer I can resist AT clones' plunging prices and soaring speeds. PC's Limited has jolted the market with the 286-16: almost triple the original AT's 6-MHz speed, a smaller footprint, and a megabyte of exotic high-speed RAM chips on the motherboard for $2,995. Tandy, taking the gloves off even as its sales force dons blue suits and "sincere" ties (actual quote from company dress-code memo) to challenge IBM for corporate sales, offers a trim-sized, 8-MHz machine for $1,699.



Toshiba's T1100 Plus—one of Grevstad's favorite 1986 products even before major improvements were made to the original model.

• *Best New Entry:* It's traditional for IBM products to fade after a year as compatible makers introduce machines that cost less, do more, or both, but Toshiba is the first to trash a brand-new IBM. Other reviewers and I agreed the Toshiba T1100 was the best MS-DOS laptop yet, except for a poor keyboard layout and one 3.5-inch disk drive compared to the PC Convertible's two. The reviews and Convertibles had barely hit the streets when Toshiba trotted out the T1100 Plus, with a better keyboard, a second microfloppy drive, a faster 80C86 chip, a boost to 640K, and both serial and parallel ports for $2,399. Come to think of it, maybe I could live without an 80286 desktop for Christmas.

The T1100 Plus deserves to pound the uninspired IBM to pieces in the marketplace; along with the T3100 (an AT-compatible portable with plasma screen and hard disk) and a line of high-quality matrix and laser printers, it marks Toshiba as the most hustling, heads-up hardware company today.

• *Hardware Disappointment of the Year:* Tandy 600, a sleek laptop design with reasonably powerful (if not overly friendly) ROM-based software, but no other software. It had about a two-month sales window before fully PC-compatible portables appeared, but was so overpriced it sank without a trace almost immediately.

• *Software Disappointment of the Year:* Except for the widely advertised sex game, Interlude II, my vote for the year's worst software would probably go to Able One, a dreadful integrated package I reviewed in the October column. Dac Software, which scored a hit with its low-cost Dac-Easy Accounting program, bombed badly with a $50 word processor, Dac-Easy Word; I was halfway done with a ripping review (among other charms, it saved your letter to Grandma by overwriting whatever filename was first in the directory, such as COMMAND.COM) when Dac called to say the program was being pulled in favor of an improved version 2.0, but I haven't received a copy.

Another software disappointment: business buyers' inertia and unwillingness to break out of the Lotus position,

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- Model 5161.....................................$88.95
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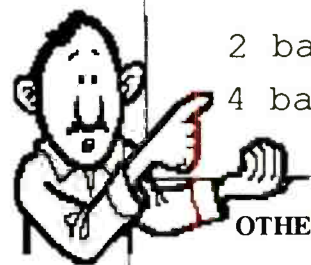
2 battery pack $1.79

4 battery pack $2.79



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Parallel switch box x 4.............$44.95
Serial switch box x 2...............$39.95
Serial switch box x 4...............$44.95
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20 MEG hard drive - Seagate ST225 & controller card...........................$389.95
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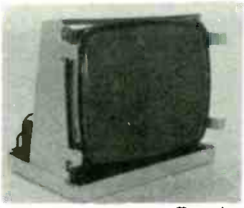
Oscilloscope probes-switch selectable to 1x or 10x. In 10x, freq. response is DC to 100MHz.................................$29.95
150 Watt power supply-direct bolt in replacement. Has four drive connectors & motherboard connectors. 1 year warranty, FCC type accepted......................$89.95

MONITOR CHASSIS



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PC PAPERS ...

as seen in the cool reception given the innovative Javelin package (Javelin, short of funds, laid off its sales staff in August). Still, corporate computing is not entirely immune to progress; WordPerfect climbed the sales chart as the outdated, Wang-like Multimate and antique WordStar fell.

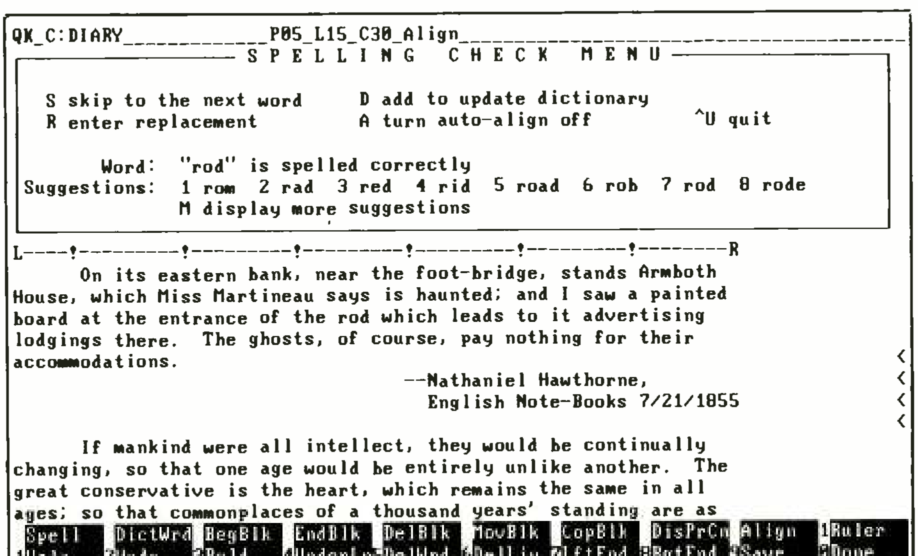
• *Not the Consumer Price Index:* While a glut or shakeout trims the ranks of mail-order hardware and software sellers, one discount outlet continues a practice that deserves nothing but blame and boycott. Members claim that PC Network of Chicago delivers good service, but when will the firm quit filling computer magazines with splashy ads full of false prices? Every figure has an asterisk; every ad's fine print confesses, "Members pay 8 percent above this wholesale price plus shipping." Counting $8 for a year's membership, that kicks a copy of 1-2-3 from the advertised $280 to $312.90.

• *Late But Good Move:* Hercules Computer Technology slashed its price from $499 to $299 and added high-speed, multi-font capacity to its monochrome graphics card. If the sale had come a month earlier, I wouldn't have blown $122 on a semifunctional mail-order clone I recently purchased.

Industry and press pundits shrug that Hercules and I are both too late, but I'll shout it again: I don't want to buy an Enhanced Graphics Adapter and expensive color monitor; I don't believe that umpteen pretty colors add significant value to my word processing and spreadsheet files; I think high-res monochrome shades are fine for all but artistic graphics, at least until Microsoft Windows really takes over (which won't happen for a year or so at the earliest, when software companies rewrite everything for the 80386 and DOS 5.0 as I said above). Meanwhile, stand up and fight for your green screens!

• *Late But Great Move:* Some software vendors are still dragging their feet, but 1986 will be remembered as the year the people spoke and copy protection died. Not only did the trade association ADAPSO finally withdraw the hardware-based protection scheme it had been promoting for a few years (gee, I was looking forward to having a lock on the back of my PC and inserting a different key every time I ran a program), but the big three—Microsoft, Lotus, and Ashton-Tate—yielded and, at least to some extent, unprotected their best-selling software.

Naturally, the publishers still have profit margins at heart; Aston-Tate charged owners $45 to unlock their copies of Framework II or dBase III



NewWord 3 combines a WordStar-like screen with built-in spelling.

Plus, while Lotus agreed to unlock 1-2-3 only for corporations buying 100 copies at list price. Did you ever notice that the publisher that's been most paranoid about copy protection is the one that's never shaken the tag of "one-product company"? In a just world, everyone would abandon Lotus to buy Computer Associates' equally powerful, graphically superior, unprotected SuperCalc4.

• *Update of the Year:* It's not surprising that, in a year in which I tested the two word-processing superpowers, Microsoft Word 3.0 and WordPerfect 4.1, I found a new word processor for my own use. But it may surprise a few trendy types that the program I chose, and rave about every chance I get, is a clone of MicroPro's obsolete WordStar, using identical control-key commands to produce identically formatted files: NewWord 3 from Newstar Software Inc. (3351 Vincent Road, Pleasant Hill, CA 94523; 415-930-9400).

NewWord 3 costs $349; the WordStar Professional bundle costs $495, takes more disk-swapping, and has roughly half the power. Like the earlier NewWord which I reviewed in the July 1985 issue, NW3 has priceless improvements to WordStar such as better cursor handling, less frequent disk access, and an undelete command; it still suffers from WordStar's need to reformat edited paragraphs one at a time, but shows spacing, justification, and page breaks on-screen as some brand-new programs can't. There are dozens of printer drivers, plus documentation enough for everyone from novices to hackers who want to see source code.

Past that, NewWord 3 adds the stuff of WordStar users' dreams: automatic index and table of contents generation; 36 custom macro plus 40 definable function keys; a built-in calculator, which automatically adds numbers in a block or column or figures individual calculations for mail-merge letters; the ability to run DOS commands from within a document; and both built-in and separate spelling checkers (the former is a little limited in suggesting corrections, but nicely integrated with the MicroPro-style command and menu interface). I must admit that it's better suited to WordStar veterans than computer novices, but for them NewWord 3 is sheer rapture.

• *Best Nasty Remark:* Quadram/Datavue's slogan, "The IBM PC Convertible—Solving the Mystery of 'Whatever Happened to the PCjr Design Team?'" There were modest price cuts, an 8-MHz AT with a funny keyboard, and a costly 6-MHz XT-286 with "stopgap" written all over it, but for most of this year Big Blue seemed to hold its leadership position as effectively as Ferdinand Marcos—helpless in the face of the cheap clone invasion, the Convertible a dud, talk of abandoning "commodity-like" parts of the computer market even as rivals race to beat it to the 80386 arena. IBM may have an ace up its sleeve (as I write, the rumors are shifting from a low-cost clonebuster to a deluxe high-speed, high-resolution workstation), but it's waiting a long time to play it. ME

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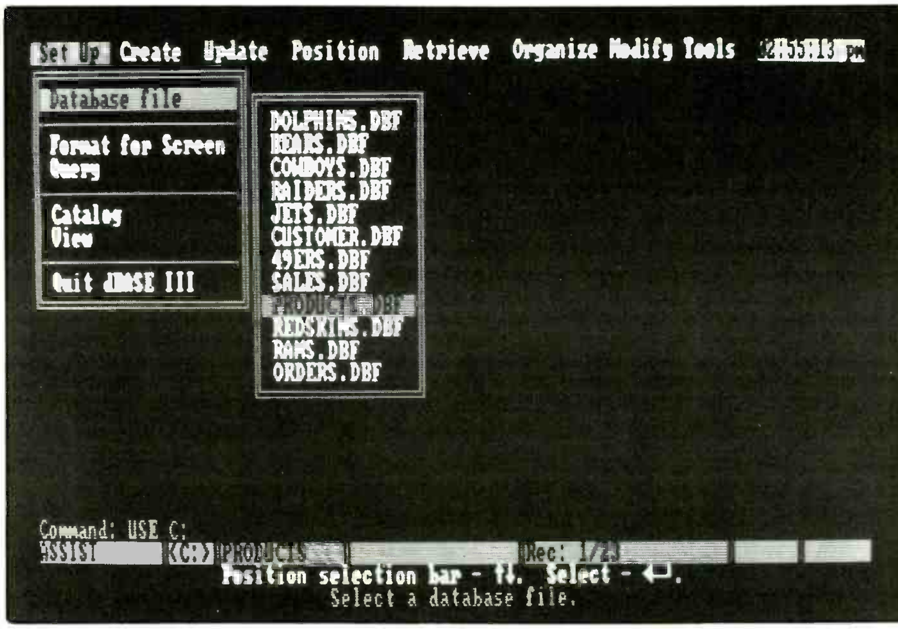
SOFTWARE FOCUS

dBase III Plus: The New Heavyweight Data Manager Walks the Tightrope Between Ease of Use and Power

By Joseph Desposito



The new "Assistant" in dBase III Plus features a Framework-like user interface, including pull-down menus. Users can create files, add or edit data and create reports and labels without programming.

Any organized collection of information can be called a data base. The most powerful microcomputer software programs for organizing, retrieving and updating records is the data base manager or relational database. It is popularly used for mailing lists, inventory management, customer records, and a host of similar applications where multiple files with different information are needed. Ashton-Tate database software, namely dBase II, set the standard for this software breed for early 8-bit computers just as WordStar did for word processing and VisiCalc for spreadsheets.

With the advent of IBM's 16-bit computer and similar machines, dBase II was rewritten to perform with them. Competitive software freshly designed for 16-bit machines challenged dBase II, though, and Ashton-Tate responded with dBase III, a database manager that retained much of the earlier program's flavor while providing many functional and speed advances. This was followed by dBase III Plus, Ashton-Tate's latest and the subject of this review, that addressed an ease-of-use problem and further enhanced power and speed for the IBM-PC, XT, AT and compatibles.

On the power side, dBase III Plus includes many new commands and functions and can be used in a local-area-network (LAN) environment. For this review, however, it will be examined from a single-user perspective.

Accompanying dBase III Plus's multiple floppy disks are two handsome, thick three-ring binders for Programming and Learning And Using information. You need a minimum of 256K of user memory, but you really can't do anything with so little memory. If you don't have at least double this amount of RAM, and preferably more, forget it. You'll need PC-DOS 2.0 or higher or the equivalent MS-DOS and either two 360K floppy disk drives or one floppy drive and a hard disk drive. The program supports monochrome and color monitors, and any printer (including laser) with 80 or more columns.

Originally, dBase III Plus was copy-protected by Superlok, but copy protection was recently dropped, happily. The new data manager has a suggested selling price of $695, though we've seen mail-order prices with more than a $300 discount. We don't know if this is for a copy-protected version or not, so check this out if you go this buying route. For $45, Ashton-Tate will exchange unprotected programs for those registered owners of copy-protected versions.

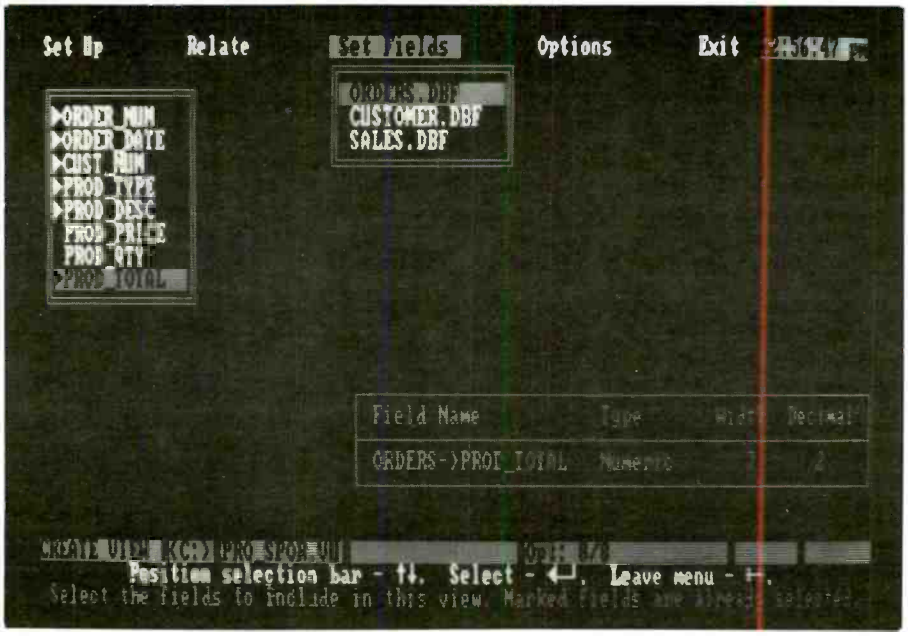
A Database Assistant

Prior versions of dBase started with a dot prompt, awaiting user key input to make things happen. dBase III Plus, however, has tackled this challenge to users unfamiliar with dBase conventions by incorporating its Assistant. With this new interface, which makes extensive use of pulldown menus and moving bars to make a selection, both simple and relatively complex database tasks can be done without resorting to dBase commands or its programming language. The latter option is retained, of course.

To give you a better idea of the capabilities of the Assistant, we will examine a typical relational database. The personnel department of a company has three related files: the employee file (107 entries), the department file (5 entries), and the salary file (107 entries). We'll assume that the three database files already exist as text files and that they will be imported to dBase III Plus.

To begin dBase III Plus, you type dBase at the A > prompt. After a copyright notice, the Assistant's main display appears. Along the top of the screen is a menu bar with eight choices: *Set Up, Create, Update, Position, Retrieve, Organize, Modify* and *Tools*. The first choice, *Set Up*, has its pulldown menu showing. If you tap the right arrow key a few times, you see that for each choice on the menu bar there is an associated pulldown menu with as many as eight choices.

Besides the menus, the Assistant allots the bottom three lines of the screen dis-



The new dBase III Plus software can visually relate up to 10 files without programming. Related files can be displayed, saved and retrieved. Screen format and query files can also be used with "View."

play for the following: a status bar that displays the drive and file in use, a message line that describes current menu options, and a navigation line that describes the keys that can be used to make choices, get help, exit, etc. One other line of the screen becomes active as you make choices from the menus. It is called an action line, and it shows the dBase command that is being constructed with the menu choices. The action line is particularly interesting since it serves as a bridge between the latest way to use dBase and the way it was done prior to this version. Any of these displays can be turned on or off by the user.

Creating a Database File

The normal procedure for beginning operations with dBase III is to choose *Database file* from the *Create* pulldown menu. When you do this, a submenu appears that lets you select the current drive; then you are prompted to enter the name of the file. The next step is to create the fields of a record. This is done by filling in the field name, type (which includes logical Yes or No), width, and number of decimal places (for numeric fields) for each field. You may input up to 128 fields per record. Control-End ends this process and you are then prompted to enter data. The next time you open the file, you do it by selecting *Database file* under the *Set Up* menu. After indicating the drive, a question appears: Is this file indexed? (Y/N). A yes answer will make the index file(s) active.

To import database files into dBase III, such as our personnel files, you move to *Tools* on the menu bar. A pulldown menu shows *Import* and *Export* as two of the choices. The Assistant only allows import and export of *PFS: File* files. To import text, DIF, SYLK, or WKS files from other programs, you must leave Assistant and work with the dBase III Plus dot prompt. This procedure is not difficult, but new users should not expect to work only with the Assistant. To leave the Assistant, you simply press the ESCape key. This brings up a new screen with a dot prompt. You import text files with the following command: APPEND FROM < filename > TYPE < file type >. In our case, Employee.txt is the filename and SDF is the file type. To import 107 records took 9 seconds for the employee file (8 fields/92 characters per record) and 5 seconds for the salary file (10 fields/34 characters per record).

Creating an Index File

To sort or index a database file, you move to *Organize* on the menu bar. The pulldown menu contains these two options. When you sort, you create a new file whose records are in a different order than in the original file—they have been physically moved around. When you index, you create a file that points to records in the original file containing certain data. Index is faster.

To index a file, you select *Index* from the *Organize* menu. You are then prompted for a key expression, which is usually a field name. Pressing F10 will give you a list of fields in the current database file. Once this is done, you select the destination drive and type in a file name. This file becomes your index file. Indexing the Employee file (107 records) by Last Name took only 6 seconds.

Creating a Format File

Once a file is created, a corresponding input screen or form can be constructed by "painting" on the screen. Painting means moving database fields with the cursor keys to appropriate places on the screen. To construct an input screen you choose *Format* from the *Create* menu, select a drive, and type in a file name. A submenu bar appears with four headings: *Set Up, Modify, Options,* and *Exit.* Under *Set Up*, you choose *Select Database File.* A list of files created under dBase III Plus appears, such as the Employee file. You choose the file that needs an input form, and then choose *Load Fields* from the *Set Up* menu. A list of fields appears and you choose the ones that you want to appear on the input form. Then you press F10 and a screen called the blackboard appears with the selected field names and fields (shown by inverse X's) arranged in a vertical row.

Fields, but not field names, can be moved around the screen with the cursor keys. Thus, anytime you move a field to a different line, you must retype the field name and delete the old one. This is a cumbersome way of producing an input screen.

Although it is not suggested in the dBase III Plus manual, you may create an input screen (Format file) and its associated database file simultaneously by choosing *Format* from the *Create* menu first, instead of *Database file*. You are then prompted to enter the format file name for the input screen. This leads to the Format submenu bar, which has four choices, *Set Up, Modify, Options,* and *Exit.* If you choose an option under *Set Up,* called *Create New Database File,* you are prompted for the name of the database file.

Once you enter this, you press F10 to get to the blackboard. Once in the blackboard, you can "paint" your input screen. Whenever you need a field, however, you must exit the blackboard with F10 and input the characteristics of the field through the *Modify* menu. Besides the usual field characteristics of type (character, numeric, date, etc.), width, and number of decimal places, this menu lets you add other characteristics. For example, you can specify the range (upper and lower limit) of a numeric field. Once all characteristics of a field are chosen, you press F10 to return to the blackboard again.

Typical Screen Dumps

```
ASSIST              |<C:>|                       |Opt: 1/6
  Select  - ─┘.  Leave menu - ─  Help - F1. Exit - Esc.
                              Select a database file.

 Set Up  Create  Update  Position  Retrieve  Organize Modify Tools  10:47:46 am

                 | Append  |
                 | Edit    |
                 | Display |
                 | Browse  |
                 | Replace |
                 | Delete  |
                 | Recall  |
                 | Pack    |
```

```
 Set Up  Create  Update  Position  Retrieve  Organize Modify Tools  00:00:00 am

                                              | Index |
  WHAT                                        | Sort  |
  COMPLETED                                   | Copy  |
  WHO
  PHONE
  WHEN
  WHERE          |Field Name        Type       Width   Decimal|
  ACTIVITY       |WHEN              Date         8            |


                 Press ─┘ to select WHEN

                                                         Press  F5  to exit
Command: SORT ON
ASSIST          |<A:>|TODOLIST                  Rec: 10/10
```

```
 Set Up  Create  Update  Position  Retrieve  Organize Modify Tools  00:00:00 am

                                       | List    | | Execute the command       |
          Press ─┘                     | Display | | Specify scope             |
                                       | Report  | | Construct a field list    |
          to Execute the command       | Label   | | Build a search condition  |
                                       | Sum     | | Build a scope condition   |
                                       | Average |
                                       | Count   |

                                                         Press  F5  to exit
Command: LIST
ASSIST          |<A:>|TODOLIST                  |Rec: 3/3
```

Creating a View File

To perform relational functions with the dBase II Plus Assistant, you must create a view file. You do this by selecting *View* from the *Create* menu (main menu bar). As usual, you are prompted for the file name. Once you enter it, a View submenu bar appears with five choices: *Set Up, Relate, Set Fields, Options,* and *Exit.* Under the *Set Up* menu are all the database files on the disk. For our example, there are three files, Employee, Salary, and Department. You choose a database file for the View file by moving to it with the cursor key and pressing return. As soon as you do this, all index files on the disk appear. If you want to use an index file rather than the actual file, you select it. Once all the files you are interested in relating are set up (opened), you move to the *Relate* menu.

On the *Relate* menu are the names of the files chosen with *Set Up.* When you select one file, the others appear in a separate menu box. When you select one of these other files, dBase II Plus asks you to enter an expression (usually a field name), and suggests pressing F10 to list the fields in the file. Files can be related by record number or by a common field. In our example, both the Employee file

Menus of the dBASE III PLUS Assistant

TASK	MENU
select files to work with	Set Up
make new files	Create
change content of file	Update
locate records	Position
get back information	Retrieve
rearrange order of records	Organize
change structure of file	Modify
miscellaneous	Tools

and Salary file have a common field, Employee number, and the Employee file and Department file have a common field, Department Number. To relate the three together, you relate Salary to Employee by Employee Number and Employee to Department by Department Number. Once this is done, you move on to the *Set Fields* menu.

Under *Set Fields* is a list of the database files in the current View file. If you select a file, all of its fields appear. Now you must select the fields that you want to appear in the View file, from each of the database files. Once this is done, you move to *Options*. Under *Options* are the choices called *Filter* and *Format*. If you select filter, you must enter an expression that will filter, or only allow certain records to appear in, the View file. A typical filter is "SALARY $40,000." The option option, Format, lets you choose a Format (input screen) file to use with this View file. Once this is done, you exit the View file submenu by moving to the *Exit* menu and selecting *Save*.

With View, you can relate two or more files (up to ten) together. A restriction is that files related through the Assistant's View feature must have an identical number of records. Thus, files such as the Employee and Salary files can be related. However, a file such as the Department file, which has just five records cannot be related to either of those two. Relating files of different sizes is normally accomplished with a dBase III Plus program. When you leave the View submenu, you are returned to the main menu of the Assistant.

Creating Queries, Reports, and Labels

Next under the *Create* menu after *View* is *Query*. The Query feature allows you to create complex queries of the database and to save those queries by filling in boxes on the screen with choices from pulldown menus.

The final choices under the *Create* menu are *Report* and *Label*. These let you generate printed reports and mailing labels, respectively. Like the other choices on the *Create* menu, both *Report* and *Label* have submenus and both produce their own types of files.

Organizing dBase III Plus Files

To help organize your database files, a feature called *Catalog* is available from the Assistant's *Set Up* menu. A Catalog file groups related database files and support files. Support files include Index, Format, View, Report and Label. Thus, as you work with a database, only those files that pertain to it are brought up on the Assistant's submenus. You cannot create a Catalog file with the *Create* menu, however. You must do it by leaving the Assistant and entering the appropriate command at the dot prompt.

As mentioned, the Assistant may be disabled manually in favor of the dot prompt by pressing ESCape. If you do not want to have it appear at all, you can modify a config.db file so that the dot prompt appears upon startup. Even when using the dot prompt, you are often returned to the Assistant's submenus to complete an operation.

Power to the Programmer

Prior to the release of dBase III Plus, there were two versions of dBase III, one for the general public and another for developers. All the features of the Developer's release, including a program called RunTime+, are contained in dBase III Plus. There are over 50 enhancements to the dBase programming language, eight new commands, 32 additional functions, a new command editing capability, as well as support for LAN functions.

Some of the new features include dBCode, which encrypts and condenses application source code, and dBLinker, which consolidates files, saves disk space and creates a more efficient program.

Programmers can now do in-line commenting and make assembly language calls from the program. In-line commenting allows comments to be placed on the same line as source code; assembly language calls allow custom assembly language routines to be combined with a dBase III Plus program.

To assist programmers in creating smaller and faster programs, there are new character and mathematical functions. These functions no longer need to be created by the programmer.

Documentation

The program contains three major pieces of documentation in two binders: Learn-

SOFTWARE FOCUS...

dBase III Plus In a Nutshell

Name: dBase III Plus
Company: Ashton-Tate, 20101 Hamilton Ave., Torrance, CA 90502-1319
Phone: (213) 329-8000
List Price: $695
System Requirements: 256K RAM minimum, two disk drives, PC-DOS 2.0 or higher

ing dBase III Plus, Using dBase III Plus, and Programming with dBase III Plus. Additionally there are pamphlets for Getting Started, using the Applications Generator, a Quick Reference Guide, and a Customer Support Guide. In general, the documentation is very well done and slickly presented. However, there are a number of errors in the documentation, which indicates that it does not match exactly with the final release version of the product.

The program includes both on-disk and written tutorials. The disk tutorial concentrates mainly on an introduction to database terminology and the Assistant. The written tutorial includes these subjects and also introductory material about working from the dot prompt and programming. The written tutorial makes use of sample files included on a separate disk. Though the tutorials are informative and easy to follow, one may be left with the sense of how much more there is to be learned about the program, which has so many facits that make it so flexible.

dBase III Plus Specifications & System Requirements

An unlimited number of files can be created with dBase III Plus. The program accommodates up to one billion records per file, 128 fields per record on as many as 16 screens, and 4K bytes per record. dBase III Plus can handle both structured fields, such as numbers and data, and unstructured fields such as memos. It can import and export ASCII files and files from PFS:File, Lotus 1-2-3 (Wks), VisiCalc (DIF), and MultiPlan (SYLK).

Additionally, dBase III Plus can import files from dBase III and dBase II. Transferring data from dBase III is an easy task, but doing the same from dBase II can be a formidable job.

Many of dBase II's shortcomings have been corrected. With this pioneer data manager you could not modify the original structure set for a data base—field name, type, etc.—without destroying it and starting from scratch. This was corrected with dBase III and, naturally, carried over to dBase III Plus.

Among other improvements made to dBase III/dBase III Plus as compared to dBase II are the following:

	dBase III Plus	dBase II
Fields per Record	128	32
Characters per Record	4000	1000
Number of Records	1-Billion	65535
Open Data Files	10	2

Probably the most important of all the above functional improvements is dBase III/dBase III Plus's ability to open more than two data files at a time, thereby linking a bevy of files. For the remainder, they're nice cushions to have, though most micro users won't need them. For example, if you've got a billion records to handle, you would want the speedier mini or mainframe and a corresponding DBMS, not a microcomputer system.

dBase III Plus adds a host of new commands to expand the utility of the program, as well as some commands with changed syntax. Overall, though, if one is familiar with dBase II or III, it's an easy changeover.

dBase III Plus offers three levels of security, too, including passwords and encryption protection. And among its other welcome amenities are date, memo provisions, and better access to DOS.

Raw performance is a most important measure of a data base manager's worth, of course. dBase III Plus is an impressive upgrade of dBase III in this respect, and leaves dBase II far behind. It can index up to 10 times as fast as dBase III and sort up to two times faster, says Ashton-Tate. Various tests verify this potential. Naturally, this type of performance will come to the fore if, say, you're rebuilding a bunch of indexed data bases. It doesn't mean much if you're adding a record to a file with, perhaps, only one index open.

Conclusions

The dBase standard has certainly been raised by the introduction of dBase III Plus. A user gets a fast learning curve start by the use of the Assistant's pulldown menus, which is a very welcome addition for those new to dBase. A host of additional commands, significant functional improvements, and faster performance in many key areas adds to the luster of this new data base manager.

Further, the ability to work with this package by multiple users who can share it and peripherals, as well as having fine developer tools, sets Ashton-Tate in place as one of the leaders in the impor-

The Two (Inter)Faces of Ashton-Tate

Those who are familiar with Ashton-Tate's other popular software product, Framework II, will notice the similarity of the user interface to that of dBase III Plus. Strangely enough, the interfaces work differently, which might be a source of annoyance to those who use both products. With dBase III's Assistant, you move from choice to choice on the horizontal menu bar with the right-left arrows or by pressing a key that corresponds to the first letter of the menu choice. Pulldown menu choices can only be selected with the up-down arrows. Framework II, on the other hand, uses different conventions. Moving horizontally along the menu bar is done with right-left arrows or by pressing control plus the key that corresponds to the initial letter of the menu choice. With the pulldown menus, you can select a choice either by using the up-down arrows or by pressing a key that corresponds to the first letter of the pulldown menu choice.

tant programmable database manager program field for microcomputers.

Don't think that dBase III Plus is "perfect," however. Its Report Generator, though improved, is still rather weak, for example. I had expected creating forms, a crushing limitation on previous dBase versions, to have been improved to a greater extent.

Getting a taste of the nice Assistant that gives novices a headstart makes me yearn for an Assistant II to allow one to experience the fuller power of dBase. After all, programming with dBase's special language is what dBase is all about, isn't it? Otherwise, there are many non-programmable relational data bases to choose from. For a new single-user, this is a challenge, though to many not an uninviting one. Many buyers, in truth, have computer staffs or consultants to handle this sort of thing anyway.

Who are the prospects for such a powerful data base management program? Obviously, present users of an older dBase program are—and there are said to be 300,000 licensees for plain old dBase III and 325,000 users of old, old dBase II, all on familiar ground with dBase syntax and all with loads of files already in place and waiting to be transferred. What a base to draw on!

What about the rest of the world who require a data base for use with microcomputers? If you need the most powerful data base manager you can get your hands on, then dBase III Plus should be one of the leading candidates of choice. What it doesn't have or do best, third-party developers sell to strengthen the program even further. In fact, dBase add-ons are an industry unto themselves. Moreover, there are dBase clubs, newsletters, telecommunication special-interest groups, et al, to bolster use of dBase programs. All this combines to make it a more difficult hurdle for equally good, perhaps better data base managers to battle Ashton-Tate. Nonetheless, there are some, like MicroRim, who do battle well against odds. The pool of potential buyers is certainly big enough.

Then there are prospective users who now need to set up and manage a data base, but don't need all that power and accompanying complexity, as well as users of flat-file data base programs who want to move up to a more powerful product. For the former, it might be worthwhile to look at less powerful (and less expensive) products. If all you want is the ability to maintain basic data storage and retrieval and your data-handling requirements will likely not grow much, then perhaps you should look at some of the better "flat filers" such as PFS:File. Present users of filers who want to manipulate data in all sorts of ways, perhaps for comparison purposes or for automatic format style or for wrapping lines that extend beyond 80 columns, and so on, would likely consider a dBase III Plus as a possible trade up. Ashton-Tate, at least, must feel this way since simple file transfer provisions have been incorporated into dBase III Plus for existing PFS:File records.

In sum, dBase III Plus is an impressive data base manager that will appeal to "heavy hitters" among prospective users. Just keep in mind that this type of program offers cerebral challenges to squeeze the full power it has into productive form. **ME**

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board. Temporarily install *LED1* at E5 and E8 on the amplifier board.

With the output of both channels left open, apply power. You should *not* hear a sound from the power supply; if you do, this indicates a short circuit or excessive load. If your dc power supply has an ammeter, it should initially indicate between 3 and 3.5 amperes and then swing slightly up-scale as the output stages turn on and *LED1* lights.

Using a standard VOM—*not* a digital multimeter—to check the amplifier's output stage, you should obtain a dc reading of 1 volt or less. If you measure more than 1 volt positive or negative, there is a problem. If this occurs, shut off the power and correct the problem before proceeding. If it is a short circuit, continued operation of the amplifier board can destroy expensive components!

When both amplifier channels are oscillating properly, connect a small 4- or 8-ohm speaker to the left-channel output. When you turn on the power, there should be no noise coming from the speaker with no signal going into the amplifier's left input. Check for audio amplification by carefully touching (buzzing) pin 3 of *U3*. Repeat this check for the right channel.

After checking for basic operation, apply an audio signal from the speaker—*not* the earphone—output of a portable radio to each input. Connect the test speaker to the appropriate output and verify that each channel is functioning properly.

Bench Testing the Amplifier

In order to bench test your amplifier to full output, you will need a good-quality dc power supply capable of providing at least 20 amperes at 13.8 volts. During tests, keep all unshielded leads as short as possible and all inputs away from the speaker outputs.

You can use any 4-ohm load you wish. However, as the inductance of the test load increases, so does the r-f across the load. I have used automative tail lamps with their filaments in parallel. The type 1157 draws about 2.5 amperes at 12 volts (30 watts). This lamp can take quite a bit of abuse for a brief period. If you are going to monitor the amplifier's outputs with an oscilloscope, be prepared to see some unusual waveforms!

Looking at the output section ahead of the inductor will reveal a 64-volt peak-to-peak square wave. As the signal to the amplifier's input increases, the square wave's duty cycle will change at the frequency of the input signal. This effect will become immediately visible at input signal frequencies below 10 Hz. To test for full power output be sure that there is at least 13.8 volts reaching the power supply's input at *C1*.

Installation

The power supply and amplifier boards are best housed inside a well-vented heavy-duty metal enclosure like that shown in the lead photo. For maximum circuit protection, a fan is recommended to draw out the heat generated by the project. Mount the power supply and amplifier circuit boards so that their heat sinks will receive good air flow from the cooling fan.

Ordinary phono jacks serve for the audio input connectors to the amplifier. Since the input power is high-level, stranded heavy-duty hookup wire can be used between the input jacks and left (E3) and right (E1) input points on the amplifier board. (Reference both outputs to circuit—*not* chassis—ground.) Before plugging these wires into the board, slide ferrite beads *L7* and *L8* over them at the ends that plug into E1 and E3 on the board.

You can mount light-emitting diode *LED1* on the front panel with a lens clip or small rubber grommet. Alternatively, it can mount directly on the amplifier circuit board.

Provide good quality terminals for the 13.8-volt power input and the speaker outputs. Allow some method of terminating the shield from the speaker leads, which will be connected to a common ground point at the amplifier.

Install your amplifier in a location as close to the battery and main electrical system as possible. Use heavy stranded wire to provide dc power from your vehicle's electrical system to your amplifier. Keep in mind that any voltage drop in the primary side of the amplifier's power supply is multiplied almost six times after voltage step-up. Therefore, use at least 12-gauge wire. If you decide to mount the amplifier in your trunk or rear storage compartment, use 10-gauge or larger wire.

After installation, you can verify that adequate power is being delivered to the amplifier by cranking up the volume and measuring the voltage across *C1* in the power supply. With the engine running, you should measure not less than 12.5 volts. If you measure less than this, you need larger-gauge wiring.

Install a 20- or 25-ampere automotive-type fuse in the +12-volt line going into the amplifier's power supply. As mentioned, power to the amplifier can be automatically turned on and off at the right times via the relay that controls the electrically operated antenna in your vehicles. It can also be turned on and off via a heavy-duty switch or automotive accessory relay.

If you do not have the automatic switching capability, always turn on the amplifier at the same time as or after you turn on your car radio, and turn it off at the same time as or before you turn off your radio.

Use 14-gauge shielded cable to wire your speakers to the amplifier. Ground the shield only at the amplifier end to provide the best shield against radio-frequency interference.

The power amplifier is designed to be driven from standard speaker output stages of a typical car stereo radio. These radios often use full bridge output stages that do not have one side of the speaker grounded. To accommodate this arrangement, ac coupling and loading are provided on each amplifier input. To connect your radio to the amplifier, connect the positive (+) output of each channel to the amplifier's inputs and the radio's grounds to the amplifier's input grounds—*not* the power ground. The amplifier has isolated power and amplifier circuitry. Do *not* connect the amplifier power and input grounds together except through the connection physically located at the car radio. If you note interference from the vehicle's ignition and alternator, the two grounds are probably connected at more than one point.

Speaker Selection

Careful selection of good-quality speakers with satisfactory high-power-handling capacities and properly mounting them will give you sound levels and quality that you never experienced before in your vehicle. An automotive vehicle can provide a listening environment unlike anything you normally encounter in a home. With 200 watts of audio power inside a small, relatively nonresonant vehicle, you will be amazed at what you hear.

Always use the best baffle or enclosure you can afford and can fit into your vehicle. Never use a speaker without some type of enclosure. If you do, most of the sound coming from the front of the speaker will be canceled by the out-of-phase sound coming from the rear of the speaker. If you have piezoelectric tweeters, install a 50-ohm, 2-watt resistor in series with each to remove any remaining r-f from the amplified signal. These tweeters are very capacitive in nature and can drastically affect the performance of your amplifier. (Any remaining r-f not removed by the amplifier's filter inductor is averaged into dc power by any normal permanent-magnet speaker.)

Keep in mind that the digital stereo amplifier will not reduce any distortion produced by your radio's amplifier. It will maintain the same distortion level beautifully, which other boosters do not. The better the radio amplifier, the better the booster's output quality. To fully appreciate the booster's capability, a very clean program source—in particular, that from a CD player—is desirable. Note, too, that cheap car radios do not generally produce the needed 5 watts/channel output. You would not want to match this digital power booster to it anyway. **ME**

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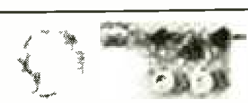

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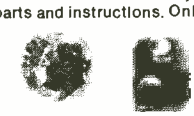

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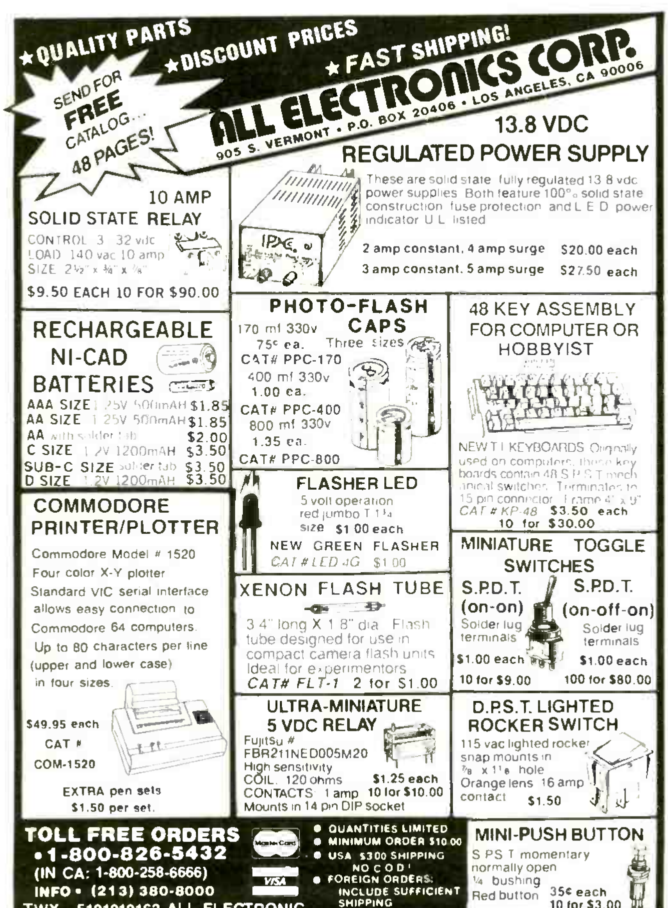

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Say You Saw It In Modern Electronics

Apple IIGS *(from page 40)*

ier and swifter, such as separate function keys, multi-key rollover, and more.

In the software arena, Styleware announced a Mac-like word processing package called MultiScribe GS and a mouse-based graphics tools program, TopDrawer. A Lotus 1-2-3 type of spreadsheet that can use up to 4.25 megabytes of memory and features icons and pull-down menus, the VIP Professional, was announced. It comes on 3.5″ diskettes. WordPerfect offers its version 1.1 on 3.5″ disk for the IIGS, claiming it provides three times the speed effected for other Apple IIs and an expander speller. Broderbund announced a new page layout program for the IIGS, its Newsmaker on 3.5″ disk for $89.95. MECA's Managing Your Money, Megahaus' PageWorks desktop publishing program, PBI Software's Visualizer business graphics program, and a host of educational and entertainment software programs were also announced for use with the new Apple IIGS.

Apple Computer claims more than 90 percent compatibility with the best-selling Apple II software packages and observes that many run faster on the IIGS due to its increased clock speed. Programs that don't operate properly are said to be ones that were developed outside of Apple's programming guidelines and communications software that require an Apple II Super Serial Card. Apple says that the IIGS is also compatible with nearly all printers, modems, and disk drives that work with earlier Apple II computers, and most peripheral cards, excluding ones such as multifunction cards that plug into a IIe's auxiliary slot.

Apple itself has not ignored new software for the IIGS, if only indirectly through enhancing its super-selling AppleWorks integrated software with a $250 version 2.0. It now has a mail merge function as well as word processing, spreadsheet and database, loads automatically into Apple expansion cards, and works with larger files.

Parting Remarks

Apple Computer has staked out a long life for the Apple II family of personal computers with the introduction of the Apple IIGS. It does seem as if the company looked over the shoulders of what Commodore and Atari introduced in terms of their graphics-oriented Amiga and 520ST models. Apple's financial and distribution muscle, plus an immense software library already in place and the confidence of so many third-part developers and retail dealers, however, places them and the Model IIGS in a much better position to succeed.

IBM and clone makers may have the corporate world to their own, but Apple Computer is certainly a strong challenger to them in education, home, and small-business areas. On a unit-share sales basis, in fact, Apple is the leader, I believe. According to the respected market research company, Info Corp., for example, Apple accounted for 31% of unit share in the month of July compared to IBM's 25%, though IBM was first with dollar sales (33% share vs. Apple Computer's 20% share). Apple's IIe sold at a 9% unit share, while Apple IIc hit 10% and Macintosh led with 12%.

The Apple IIGS is no "bargain-price" machine, as observed earlier. Nor does it feature a professional keyboard. Nonetheless, it offers a fine growth path, to quote Apple Computer. This should appeal to those who might wish to avoid Big Blue and its followers for whatever emotional reasons, though this attitude will likely diminish as Apple Computer's big-corporation image becomes entrenched. In any event, it's nice to have another major player with a different path to follow. ME open. Check pin 9 of *IC5* for four discrete pulses that repeat every second or so. Close *S3* and then *S2* (leaving the other switches open in each case) and check for three and two pulses, respectively. With no sensor switches closed, there should be just one pulse every second or so.

If you don't get the proper response, check the counter chain by temporarily removing *IC7* from its socket and shorting pin 11 of *IC5* to ground. (*Caution:* Always power down before removing or replacing any IC.) This will enable *IC5* to count continuously as it's clocked by *IC8*. You can then follow the waveforms produced by *IC5* through the AND gates in *IC2* and *IC3* to the trigger input at pin 2 of *IC7*.

Momentarily shorting pin 2 of *IC7* to ground and examining the 1-second pulse at pin 3 lets you manually check the one-shot action of this IC. This pulse should go to about 9 volts for a second and then to zero.

Temporarily removing *IC3* and connecting pins 4 and 8 of *IC9* together lets you check for a 2-kHz square wave at pin 3 of this IC.

When TattleTale passes all the above tests, it's ready to be put into service. Disconnect ac power, allow *C1* to fully discharge and replace the ICs in their sockets. Then connect TattleTale to the telephone line via its modular connector. Turn on power to the project and note once again that the LED lights.

To make an operational test, call your number from a telephone not on the same line. You should obtain an immediate answer in the form of a beep every second. Stay on the line until TattleTale disconnects about a minute later.

You can further check operation by closing one of the sensor switches and verifying that the proper number of pulses are being transmitted.

For protection against break-in, you can use any of the readily available magnetically or mechanically operated door and window switches. It's also possible to use a continuous closed-circuit foil loop on window panes, but remember to treat this as a normally closed sensor and make the circuit modification shown in Fig. 2.

To detect fire, heating/cooling system and refrigeration failure, it's easiest to use a suitable thermostat. For heating system failure, use a thermostat whose contacts close when the temperature falls. For fire and refrigeration and cooling failure, use a thermostat whose contacts close on a rise in temperature.

To detect flooding, you can buy or build a float switch that closes when the water level rises. For extra early warning, it's prudent to locate the float switch in a well or depression, such as the bottom of the sump where the pump is located. Be sure, however, that water never touches the electrical connections of your switch.

In Closing

With TattleTale standing duty as your security sentry while you're away from your home or office, you can relax. Any time you want to know what's happening, all you have to do is pick up the telephone, dial the number of the phone in the monitored location and listen for TattleTale's report. **ME**

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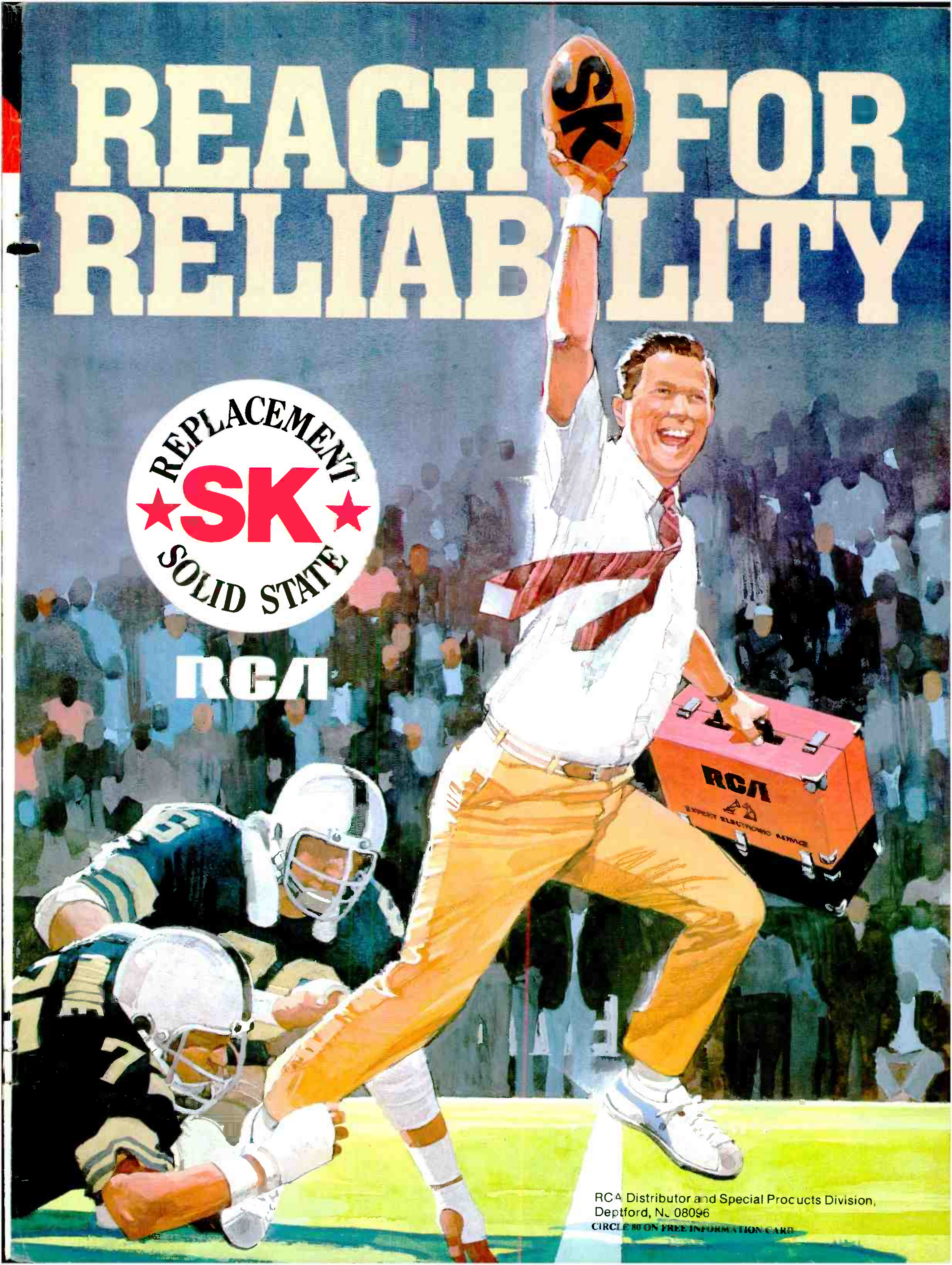
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