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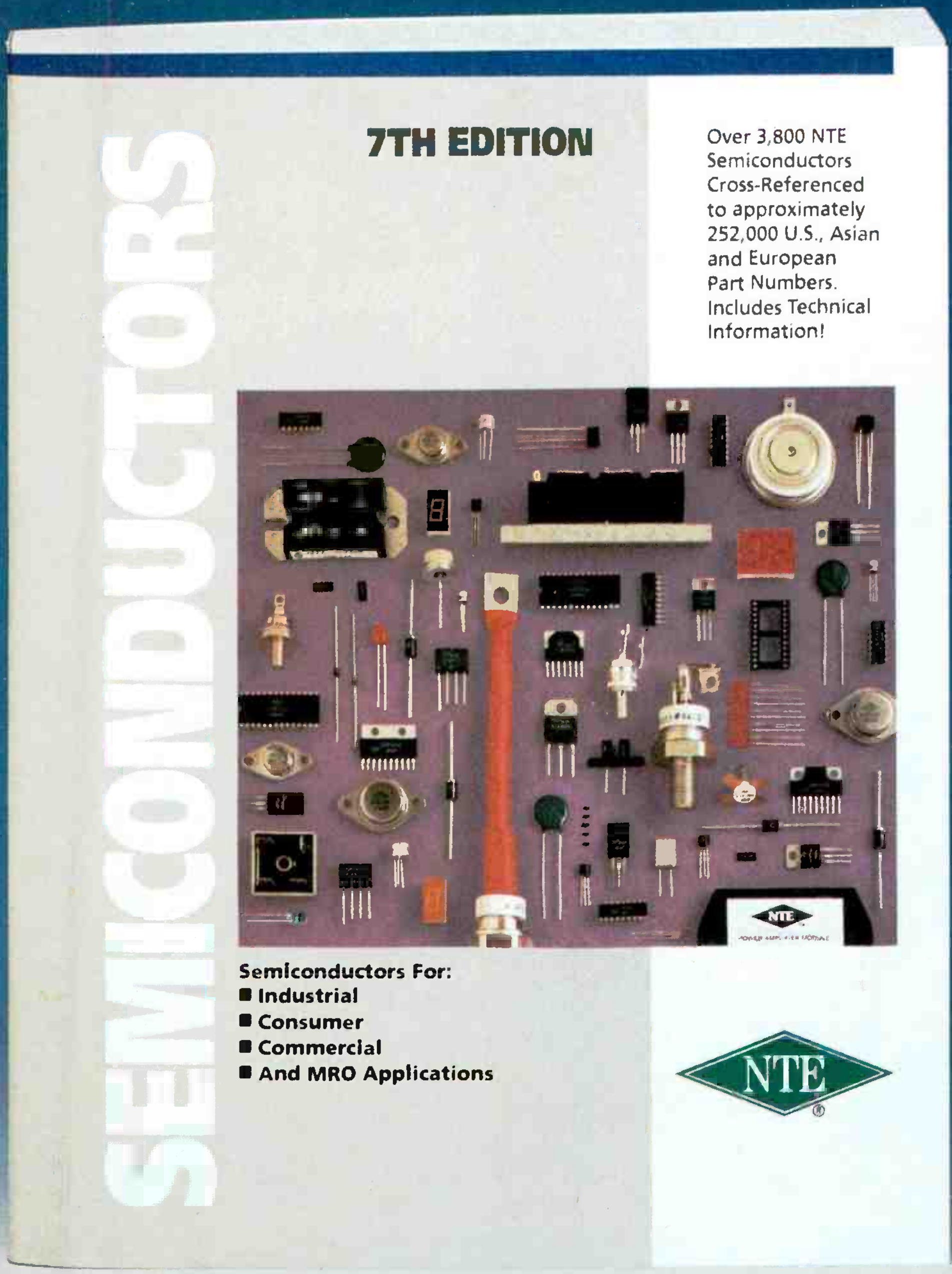

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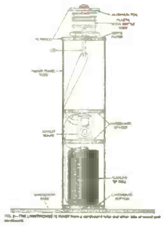

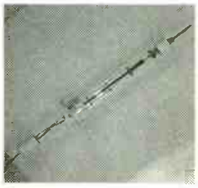

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WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

Smart radar detectors

Approximately 20 million drivers rely on radar detectors to warn them of speed traps. A new generation of radar detectors will also alert them to emergency vehicles, accidents, and road construction on the road ahead.

Researchers at the Georgia Tech Research Institute (GTRI), with support from a consortium of consumer-electronics companies, have developed a safety system that uses advanced radar detectors to warn drivers of highway hazards. The Safety Warning System™ will transmit detailed text messages to owners of specially equipped radar detectors, and will also provide a general warning to drivers using older radar detectors that are not capable of displaying text.

"Intelligent transportation systems planned for the future will improve highway safety by providing drivers with information about the hazards ahead of them, but it's going to be years before such systems are implemented," said Gene Greneker, a principal research associate at GTRI. "The Safety Warning System will provide a sophisticated warning system today and serve as a stepping-stone to the future."

To get the new technology on the road, four leading radar-detector manufacturers agreed to use a common technique for sending emergency information and a standard set of warning messages compatible with National Highway Traffic Safety Administration guidelines. The consortium, known as RADAR, includes B.E.L.-Tronics, Ltd., Sanyo Technica USA, Inc., Uniden America Corporation, and Whistler Corp-oration. RADAR has filed a patent application to protect the technology and is pursuing efforts to commercialize the transmitter system.

The "smart" radar detector features a built-in LCD readout that can display up to 64 characters. When it receives a safety message, it firsts sounds a tone, and then displays the message. A second message can be sent at the same time. For instance, a driver could be warned of a hazard and then advised that the speed limit had been reduced.

To warn users of older radar detectors, the transmitter also sends out microwave signals on the K band. Those drivers would be aware that they were approaching a hazard, but would not know its exact nature.

Transmitters will be located on police and other emergency vehicles, as well as on construction equipment, bridges, existing overhead sign warning systems, and other fixed sites. Portable transmitters could be moved to cover other locations whenever they are needed.

GTRI, which has built and tested one transmitter system and will be building others as part of larger-scale testing, predicts that one day the transmitters will be standard equipment on police cars. "When the police officer turns on the blue lights or siren to begin a pursuit or respond to an emergency, the transmitter would send out a message alerting motorists," said Greneker. "At an accident site, the

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EQUIPPED WITH THE SAFETY WARNING SYSTEM, the advanced radar detector on the car's dashboard receives traffic safety information broadcast by the transmitter on the side of the road. A warning notification tone is sounded, and then a text message appears on the detector's LCD.

VIDEO NEWS

WHATS NEW IN THE FAST-CHANGING VIDEO INDUSTRY

BY DAVID LACHENBRUCH

TVs and PCs

Although television sets and personal computers continue to sell at near-record or record rates, their manufacturers and dealers are dissatisfied with the profits and nervous about the future. As a result, manufacturers of both products are jealously eyeing each other's turf. PC manufacturers are adding TV cards, and TV makers are introducing models with computer features. We've detailed some of these developments previously in this column, but the TV/PC—or PC/TV merger has now reached feverish heights, long before anyone really knows whether the two products belong in one cabinet.

At one time, PC and accessory manufacturers offered TV cards so that computer enthusiasts could watch CNN while creating spreadsheets with Lotus 1-2-3, or doing computerized banking. That might have been a great idea, but it never reached landslide proportions, perhaps because very few people wanted to mind-process the news or a sitcom while processing words or figures. After all, a computer is a computer, and a TV set is a TV set.

Whether the twain shall meet is still a moot question. At a time when both the PC and TV industries were suffering from sagging profits, each decided to invade the other's turf. After all, both used cathode-ray tubes for a display. Why not a big-screen product that will both deliver TV pictures and display computer data, and do whatever computers do?

On the computer side, Gateway 2000 introduced its Destination series, based on the principle that computing was now a family enterprise and couldn't really be enjoyed with the family scrunched around a 14-inch display. So let's bring the computer into the living room.

Because the TV set was already king of the living room, Gateway equipped its PC with a 31-inch screen, a TV tuner, closed captioning, and an on-screen program guide. That's in addition to the now-standard CD-ROM, modem, and bundled software. So when the family's not sitting around watching E.R., it can enjoy a pleasant evening of netsurfing or CD-ROM gameplaying. The Destination line is priced at around $4000 and under, depending on the computer configuration and home-theater features desired (*Electronics Now*, June 1996).

Of course, it wasn't long before competitors came along. A Silicon Valley company, NetTV, announced a 27-inch "World Home Theater Computer," priced at $2995 with a quad-speed CD-ROM drive, a 1-gigabyte hard drive, a fax/modem, a wireless keyboard, a 125-channel TV tuner—the works. NetTV almost copied Gateway's pitch when it said "we tried to make a PC that would take the home computer out of the spare bedroom or home office and put it in the living room."

TV strikes back

The TV people, already suffering a mini-recession because people were spending disposable income on computers instead of big-screen TVs, got approximately the same idea. Keep the computer in the den, they said, and keep the TV in the living room, but add some of the

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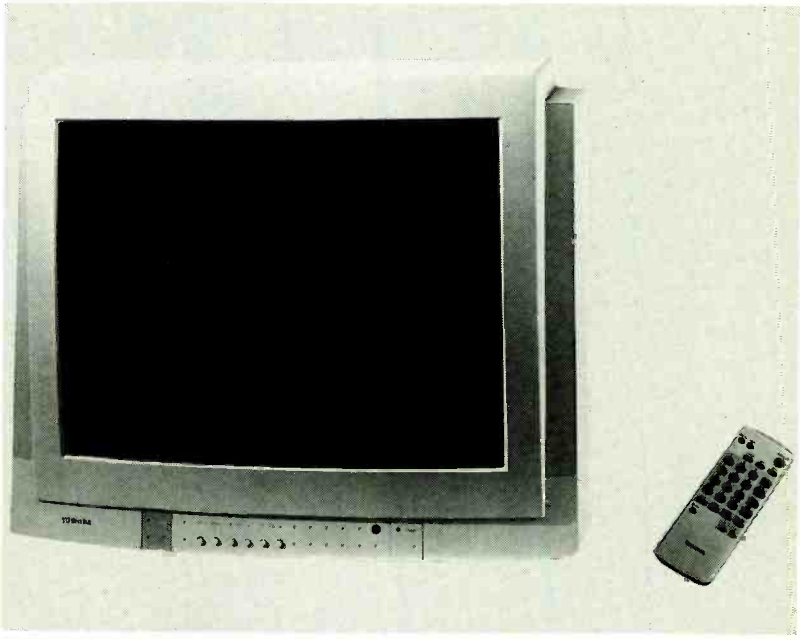

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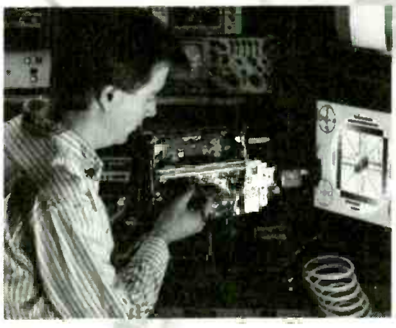

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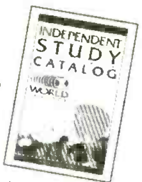

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Q & A

READERS QUESTIONS, EDITORS ANSWERS

Controlling stepper motors

Q *I have an STK6982 (ECG1736) stepping motor driver chip and a floppy drive stepping motor with five wires, black, red, white, brown, and green. Can you help me with the circuit? Thanks. — R. K.*

A Discarded floppy disk drives are a great place to get stepping motors (stepper motors); the motor you describe is a very common and useful one. It runs on 12 volts at 400 mA and provides generous torque. Unfortunately, the STK6982 (ECG1736) isn't a very good chip with which to drive this motor, for reasons we'll get to in a moment.

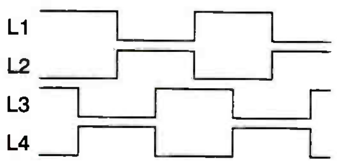

Fig. 1

To make a stepping motor rotate, you have to energize its four windings in the right sequence, as shown by the waveforms in Fig. 1. (Some other combinations will also work. A little trial-and-error is needed here.) The controller is usually used as the switch that applies voltage to the windings; on and off in this sequence.

Figure 2 shows a stepping motor controller built with ordinary, easy-to-find components. It accepts a square wave and advances the motor one step on each cycle. The square wave can come from either an external source or from an oscillator circuit, such as the one in Fig. 3.

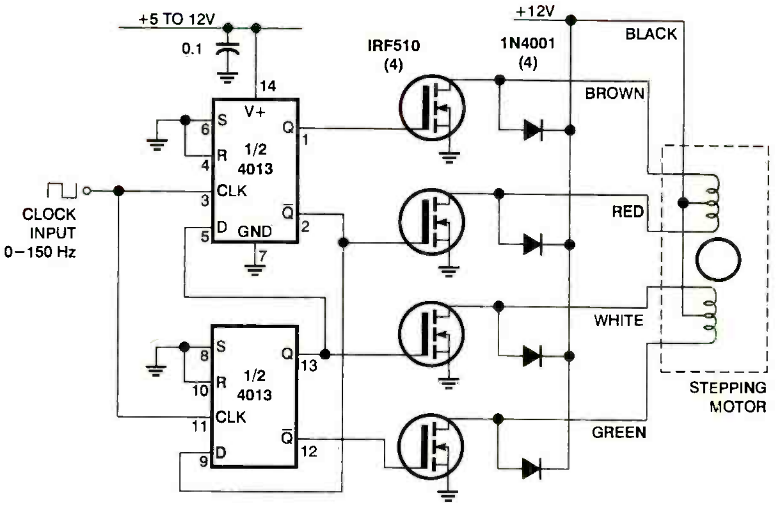

Fig. 2

Several popular ICs put this whole circuit, or something equivalent, on a single chip. Two chips of this type are the Allegro (formerly Sprague) UCN5804B and the Motorola SAA1042A.

The SAA1042A is especially versatile because it can drive both bipolar (4-wire) and unipolar (5- and 6-wire) stepper motors. Figure 4 shows how to hook it up; your motor is the one in the middle. Other motors may use different color codes. The connections are easy to figure out with an ohmmeter plus some trial and error.

Pin 10 of the SAA1042A controls which way the motor turns; connect it either to ground or to V_{CC}. Similarly, pin 8 controls whether the motor moves in full or half steps. For logic-level compatibility, use a 5-volt supply for V_{CC} while supplying the motor with a higher voltage (V_M). At higher voltages and currents the SAA1042A is likely to need a heat sink; with your 12-volt motor, it probably won't. Make sure the square-wave input doesn't swing below ground; if it does, the SAA1042A will skip steps and otherwise act erratic.

Now back to your STK6982 (ECG1736). That chip does the work of the power transistors in Fig. 2 but not the flip-flops that generate the waveform, so you'll have to generate the switching sequence externally. But a more serious problem is that the STK6982 contains a current limiter designed for 6-wire unipolar stepper motors — that is,

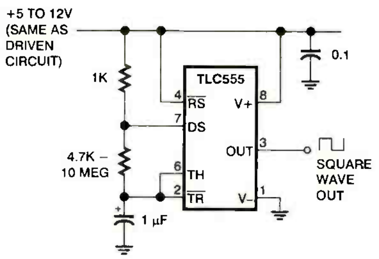

Fig. 3

HOW TO GET INFORMATION ABOUT ELECTRONICS

Books: Several good introductory electronics books, including *Building Power Supplies*, are available at Radio Shack.

Our favorite general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham radio equipment dealers.

Copies of past articles in *Electronics Now*, *Radio-Electronics*, *Popular Electronics*, and *Hands-On Electronics* are available from our Reprint Bookstore, 500-B Bi-County Road, Farmingdale, NY 11735 (1-516-293-3000).

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, Box 637, Spanaway, WA 98387.

Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including Radio Shack on special order). The ECG, NTE, and SK lines contain just a few hundred parts which substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations can be located by writing to the American Radio Relay League (Newington, CT 06111). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts both amateur and professional.

Writing to Q&A: We welcome your questions. The most interesting ones are answered in print, usually within 9 months. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* We regret that we cannot give personal replies.

motors in which the taps of the two windings are not connected together, as they are in yours. To use it, you'd have to open up the motor and separate the two connections that presently go to the black wire.

The SAA1042A costs about $17 from Motorola distributors. Data sheets are available from Motorola, P.O. Box 20912, Phoenix, AZ 85036. If you decide to stick with the STK6982 (ECG1736), you can get an ECG1736 data sheet from Philips ECG, P.O. Box 967, Greeneville, TN 37744.

Some useful World Wide Web

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LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Bench power supply correction

A couple of errors appeared in the schematic of the main power supply in my "Versatile Bench Power Supply" article (Electronics Now, December 1995). In Fig. 1 of the original article, the voltage divider was omitted. The problem can be corrected by adding resistors R17 and R18 used as a voltage-divider, as illustrated in Fig. 1.

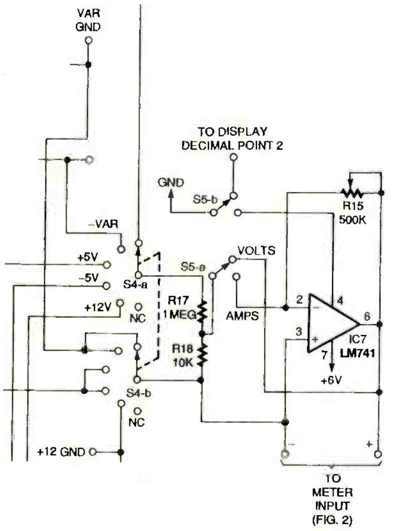

FIG. 1—Corrections to the schematic for the "Versatile Bench Power Supply."

Resistor R17 is rated at 1 megohm, while R18 is 10,000 ohms. That change allows the voltmeter to read the outputs of the power supply.

A second correction, also shown in Fig. 1, ties the "pole" of switch S5-b to ground, instead of +5V, and reverses the power connections of IC7. Now, the S5-b "throw" line goes to IC7 pin 4, and the bottom line, pin 7, goes to +5V. —Carl J. Berquist

Using the LM386

I just read Carl J. Berquist's article "Experiments with Laser Light" in the June 1996 issue of Electronics Now. I have not done much with lasers, but I was interested in Fig. 3, the "Simple IC Amplifier" using the LM386. I recently built three different circuits using the LM386, and while doing so I gained some information about using that IC. A number of circuits that use it have been published. Most of my information came from the LM386 data sheet in *RadioShack's Semiconductor Reference Guide*, and from the "Headphone Amplifier" circuit in *Electronic Projects for the Guitar*, by R. A. Penfold (PC publishing, distributed in the U.S. by *Electronic Technology Today Inc.*).

If Electronics Now readers build the circuit as shown in the article's Fig. 3, they might have some problems with instability, depending on the layout of the circuit and the differences between various LM386 ICs. When C1 is used between pins 1 and 8, the voltage gain of the LM386 is about 200, and a 100-uF bypass capacitor (C4) should be connected from pin 7 to the negative supply line (see revised schematic shown in Fig. 2). If C1 is omitted, the voltage gain is about 20, and C4 is not needed. Intermediate gains can be obtained by connecting a resistor in series with C1. About 1200 ohms gives a gain of about 50.

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Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

A series RC network (R2 and C5) should be connected across the output. According to Mr. Penfold, this is sometimes called a "Zobel Network." If there is still instability at certain output levels or certain settings of the volume control, R2 can be reduced. I have used values as low a 3.9 ohms. Mr. Penfold uses 1 ohm.

However, in the unit with which I had the most problems with instability, adding a 0.1-uF bypass (C3)

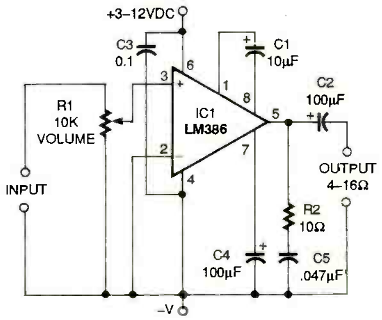

Fig. 2—R2, C3, C4, and C5 have been added to the Simple IC Amplifier circuit for improved stability.

at pin 6 (the positive power terminal) eiminated all instability while leaving R2 at 10 ohms. A 0.1-µF power-supply bypass capacitor is often used with digital ICs, but none of the LM386 schematics I looked at used one. I have since added it to my other LM386 circuits. I do not know if it needs to go directly to pin 4, as shown in Fig. 2, or if it can go to any point in the -V line. I connected it as close as I could to power supply pins 4 and 6, as that is considered good practice with digital ICs. I hope this information will be helpful to anyone who is having problems with the Simple IC Amplifier circuit.

BILL STILES, CET
Hillsboro, MO

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EQUIPMENT REPORTS

TELULEX SG-100 SIGNAL GENERATION AND PROCESSING ENGINE

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The Model SG-100 Signal Generation and Processing Engine is a signal source capable of generating many waveforms, including CW and wideband frequency sweeps from DC to 20 MHz in steps of 0.1 Hz. The signals are generated using direct digital waveform synthesis (DDS) techniques for high accuracy and precision. Modulation types are available include basic sinewave, AM, FM, PM, SSB, BPSK, and FSK modes. A digital signal processor (DSP) controls every aspect of the digital display system (DDS) system and is used internally for the precise generation and processing of all modulating waveforms. The use of DSP technology makes possible additional modes which process or analyze an externally applied signal such as DTMF detection and power-level measurement.

The SG-100 can supply an output level of 10.0-volts peak-to-peak with an offset voltage of +/-8.O volts (unloaded). The output impedance is 50 ohms, therefore the 50-ohm loaded output level is 5.0-volts peak-to-peak, with an offset voltage capability of ±4.O volts. The output level and offset voltages can be adjusted with a resolution of 1 mV. Output levels can also be specified in dBm with .1 dBm resolution. The unit is calibrated to produce accurate output levels and DC offset voltages.

Two front-panel connectors provide the SIG Out main signal and the SYNC Out signal. The latter is a TTL/CMOS compatible square-wave output that swings from 0 to +5-volts and is useful for driving digital circuitry.

Punching in the frequency

A numeric keypad on the front panel of the SG-100 is used to select a mode, and enter or edit all parameters applicable to that mode, and select a frequency. Frequencies from 0 to 20 MHz can be selected in steps as low as 0.1 Hz. A rotary knob allows quick frequency adjustment of any numeric value and gives the user the ability to manually adjust a value across a wide range without using the keypad. This feature was used by the reviewer to zero beat off-the-air broadcast-band carriers and detect the station's frequency drift from its assigned frequency. A few local stations were off by 200 Hertz.

The SG-100 visual LCD display has $^3/_{16}$-inch characters in a 2-line by 40-column format. The display shows all operating parameters simultaneously without tedious submenus.

The user can select a modulating waveform that is either internally generated or externally supplied. External modulation signals in the 80 Hz to 8.5 kHz range can be used.

An external digital input on the rear of the SG-100 serves several purposes. For most modes, it serves as a gate to switch the RF output signal on and off. In external FSK or BPSK mode, it is a high-speed data input for FSK or BPSK digital modulation of the output waveform at rates up to 3 MHz. In modes that have a trigger function (burst, one-shot sweep, etc.) this input serves as an external trigger which triggers a sweep or burst on the rising edge of the input.

Computer compatible

The SQ-100 has a RS232 DB9 female connector on the rear of the unit that permits the user to remotely control the unit's using ASCII characters. It is wired as a DCE (pin 2 = output, pin 3 = input). No special hardware or protocols are needed; any dumb terminal or computer serial port can be used. An on-line help menu is available that lists all remote-control commands to the terminal. The baud rate is fully programmable up to 57.6 kbaud, and defaults at power-up to 9600 baud. Software upgrades are also downloaded to the unit's internal flash memory using this port.

An interesting feature is the DTMF (dual-tine multi-frequency) detection mode that detects and displays inputted touch-tone dialing tones. Once a digit is detected, it is displayed on the LCD display and sent to the RS232 terminal port.

The unit sells for $795.00 direct from the manufacturer and other test equipment outlets. Telulex Inc. is located at 2455 Old Middlefield Way S, Mountain View, CA 94043; 415-938-0240; FAX 415-938-0241; Internet http://www.Telulex.com; E-mail: sales@Telulex.com. EN

WHAT'S NEWS
continued from page 4

officer would use the transmitter to warn oncoming cars."

Since 1991, the FCC has allowed the use of unattended radar transmitters—"drone systems"—to trigger hazard detectors to warn drivers of oncoming vehicles. RADAR has petitioned the FCC to allow higher transmitting power that would increase the range of the Safety Warning System and enhance the ability of moving emergency vehicles to broadcast warnings. At presently approved power levels, the system will provide a warning at least one mile ahead of a highway hazard.

The Safety Warning System was developed by GTRI researchers Greneker and Bruce Warren, with help from the engineering staffs of each participating industry member. A binary encoded modulation technique is used to broadcast the warning message to the new K-band detectors. Because the 64 standard warning messages are preprogrammed and stored in the detector's memory, the simple code is all the receiver needs to determine which message to display. For increased reliability, the seven-bit code can be repeated as often as ten times a second.

Customized messages can also be sent, using a keyboard and simple computer-based menu system. Messages on unattended systems could be changed remotely through a dial-up system. Programming functions allow the system to broadcast during certain times of the day, to operate only when vehicles are approaching, or to turn themselves on only after sensing a hazard such as a bridge failure or low visibility.

Greneker believes the technology developed for radar detectors could be applied to other wireless communications needs, expanding the market for both transmitter and receiver manufacturers.

"Every police car one day will have one of these," Greneker predicted. "When the police officer turns on the blue lights or siren to begin a pursuit or respond to an emergency, the transmitter would send out a message alerting motorists. At an accident site, the officer would use the transmitter to warn oncomming cars."

Of course, for such a system to be used nationwide, those states that currently ban the use of radar detectors would have to change their laws.

Hard Disc Drive Boosts Memory Capabilities

IBM has announced the first magnetic disk-drive products to exceed one-billion bits of data in a square inch of disk space. A billion bits is equivalent to 62,500 double-spaced, typewritten pages—enough paper to make a 21-foot-tall stack. The two 2.5-inch disk drives include the highest capacity low-profile drive available for notebook computers.

The two-disk, 12.5-millimeter Travelstar™ 3LP offers a choice of an industry-leading 1.44-gigabyte or 1.08-GB capacities. The companion Travelstar 2XP is a three-disk, 17-mm, 2.16-GB design with transfer rates ranging form 48.9 to 74.7 megabits per second. Each of the new drives boasts the industry's highest capacity per platter. EN

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Handheld Digital Multimeters

TEKTRONIX' DMM800 SERIES of handheld true-rms digital multimeters is designed to meet the accuracy and resolution requirements of electronic design engineers and technicians. At the heart of the series is the TC8129/8131 chip set from TelCom Semi-conductor, Inc. the industry's first full-featured, autoranging, autocalibrated DMM analog-to-digital converter. The chip set features complete DMM functions and offers the highest resolution and accuracy available on the market today—4¾ digits or 40,000 counts and 0.06% basic DC volts accuracy. For design troubleshooting and characterization work, the DMM800 Series provides up to twice the accuracy and up to 10 times the resolution of competing handheld DMMs.

The entry-level DMM830, the mid-range DMM850, and the high-end DMM870 provide a full range of industry-standard features—voltage, current, resistance, capacitance, frequency, and temperature. All three models are true rms meters that offer adjustable auto power-off, memory store/recall, a water- and dust-resistant casing, and the Tektronix three-year warranty.

CIRCLE 20 ON FREE INFORMATION CARD

Both the DMM850 and the DMM870 offer a dual numeric display that lets users clearly read two measurements at once. They can measure temperature in both Fahrenheit and Celsius, eliminating the need for a separate temperature meter. Both meters feature a time stamp that can label when minimum and maximum values have occurred during testing. In addition, the DMM870's 1-ms peak-hold function uses a time stamp to record the minimum and maximum readings for short-mode events, making it possible to detect anomalies that might otherwise go unnoticed. The DMM870 is also the first DMM to let engineers set high/low tolerances, sounding a beep when measurements exceed the user-set limits.

The DMM830, DMM850, and DMM870 have US list prices of $199, $249, and $289, respectively.

TEKTRONIX MEASUREMENT BUSINESS
Literature Distribution Center
P.O. Box 1520
Pittsfield, MA 01202
Phone: 1-800-479-4490, action code 715

HID Lamp Controller

UNITRODE'S UCC3305 FULLY integrates all the functions required to control and drive one High Intensity Discharge (HID) lamp. Well suited for any lighting application that requires high efficacy (lumens/watts), distinctive blue-white light color, and small physical lamp size, the controller allows the end user the advantage of using a lamp that has increased longevity.

CIRCLE 21 ON FREE INFORMATION CARD

Designed for the demanding,

fast turn-on and restart requirements of automotive headlamps, the UCC3305 also meets the needs of other HID-lamp applications, such as street lamps, stadium lighting, and theater lights. The UCC3305 compensates for variations in lamp temperature output during warm-up and restrikes with programmable circuitry. That is critical for automobile headlights because of the dramatic change in output from a cold lamp to one that is fully warmed.

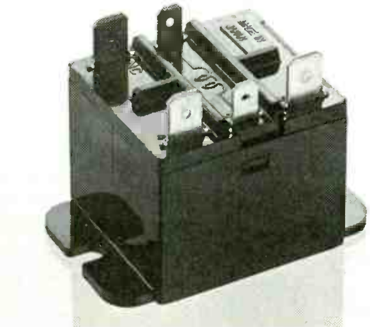
The UCC3305 is an integral part of a fully integrated electronic ballast controller that incorporates many of the discrete functions required to drive the HID lamp. Featuring a lamp-power regulator and a complete current-mode, pulse-width modulator, the device implements fixed frequency operation into the design, allowing for easy harmonic filtering. The UCC3305 also features overcurrent and overvoltage protection, operates over a wide input voltage range, is protected against lamp opens and shorts, and has a high current FET drive output. It is offered in 28-pin surface-mount SOIC and DIL packaging.

The UCC3305 is priced at $4.67 in 1000-piece quantities.

UNITRODE CORPORATION
7 Continental Boulevard
Merrimack, NH 03054-4334
Phone: 603-424-2410
Fax: 603-424-3480

Multi-purpose Relays

NTE ELECTRONICS' R47 SERIES relays are designed for a variety of applications, including HVAC, appliance control, and office equipment. The relays feature quick-connect ter-



CIRCLE 22 ON FREE INFORMATION CARD

minals on top for coil contacts. Additional coil connections can be accommodated with a PC-mount option on the bottom.

Operational in AC or DC, the R47 relays perform at a temperature range of −10°C to +55°C. Insulation resistance is 100 megohms minimum (at 500-volts DC), and the dielectric strength is 2000-volts AC, 50/60 Hz for one minute. The relays weigh approximately 1.55 ounces.

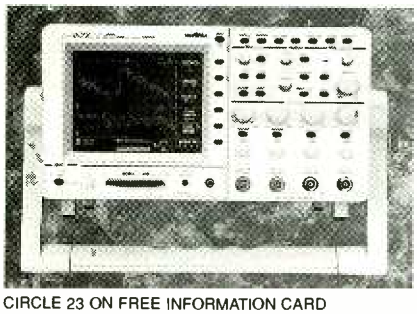
The 15-ampere relays are offered in either SPST-NO or SPDT configurations, and are available with coil voltages of 24 and 120-volts AC or 12, 24, and 110-volts DC.

Pricing in 1000-piece quantities is under $6.

NTE ELECTRONICS, INC.
4 Farrand Street
Bloomfield, NJ 07003
Phone: 1-800-631-1250 or
201-748-5089
Fax: 201-748-6224

Programmable Digital Storage Scope

THE METRIX OX2000 DIGITAL storage oscilloscope is capable of capturing data at speeds of up to 200MS/s in a single-shot mode and up to 60GS/s for repetitive waveforms. Its high sampling rates, together with its internal and external memory storage facilities, make the OX2000 a good choice for use in test and measurement, quality assurance and control, production testing, and research and development.


CIRCLE 23 ON FREE INFORMATION CARD

The OX2000 is fully programmable with SCPI (Standard Commands for Programmable Instruments), and test setups and waveforms can both be stored in the instrument's 40-KB internal memory. A built-in PCMCIA slot also allows long-term data storage via DOS-compatible, 1-megabyte external memory cards.

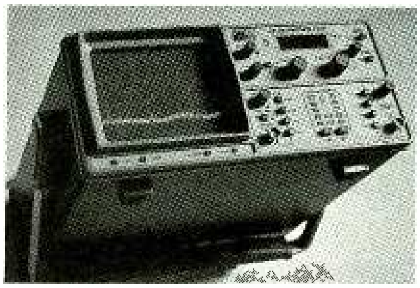
Because the OX2000 is full digital, stored signals can be compared, manipulated, displayed, and transmitted in a variety of formats. Up to eight traces can be displayed simultaneously on the screen, and specific portions of measured waveforms can be compared directly with reference waveforms stored in memory. Sophisticated trigger facilities include peak-to-peak, window, and event-counting or time-delayed options. Waveform analysis routines are built in. The OX2000 has a color VGA output port as well as RS-232 and IEEE 488.2 interfaces, and is compatible with LabVIEW and LabWindows software.

The OX2000 has a suggested retail price of $5995.

METRIX INSTRUMENTS
P.O. Box 332
Brea, CA 92622-0332
Phone: 714-992-1239

Spectrum Analyzers

FOUR SPECTRUM ANALYZERS from B+K Precision claim stable and relatively drift-free operation, offer wide dynamic range and generously large maximum signal input, and provide important features such as tracking generators and audio demodulation.


CIRCLE 24 ON FREE INFORMATION CARD

All four models have stability and dynamic range equal to those of more expensive spectrum analyzers. The B+K instruments can measure low-amplitude signals over a range of −100 dBm to +13 dBm; 80 dB is displayed on the screen at 10-dB/division. The maximum input level is +20 dBm. The spectrum analyzers drift less than 0.150 MHz per hour.

Models 2615 and 2620 are designed for applications up to 500 MHz. Both include a scanwidth selector that can adjust the frequency display width from 50 kHz to 50 MHz per division.

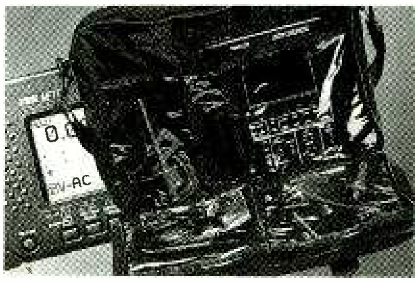
The Models 2615, 2620, 2625, 2630 cost $1795, $2195, $2595, and $3395, respectively.

B+K PRECISION
6470 West Cortland Street
Chicago, IL 60188
Phone: 1-800-462-9832

Test Companion Accessory Kit

THE MODEL 6119 TEST Companion™ Accessory Kit from ITT Pomona is designed specifically for use with the THM 500 Series TekMeter from Tektronix. It is part of a line of brand- and model-specific accessory kits that also include kits for use with Fluke and Hewlett-Packard instruments.

The test accessories are supplied in


CIRCLE 25 ON FREE INFORMATION CARD

a large, briefcase-style carrying case with shoulder strap. Accessories include an ×1, 30-MHz oscilloscope probe; a test lead set; probe bodies with banana plug tips; flexible Grabber test clips; a grip clip; large safety alligator clips; and adapter banana plugs to BNC female. The rugged case is tailored to hold and protect the meter and accessories in the office, plant, or field, also features a variety of zippered and Velcro-sealed pockets for holding service manuals, service forms, as well as other miscellaneous items.

The Model 6119 Test Companion™ Accessory Kit costs $270.

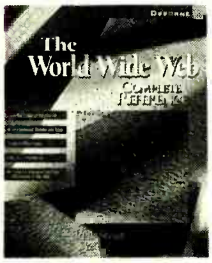
ITT POMONA ELECTRONICS
1500 East Ninth Street
Pomona, CA 91766-3835
Phone: 1-800-241-2060
Fax: 909-629-3317 EN

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

The World Wide Web Complete Reference

by Rick Stout
Osborne/McGraw-Hill
2600 Tenth Street
Berkeley, CA 94710
Phone: 1-800-822-8158
Fax: 614-759-3644
$29.95



CIRCLE 337 ON FREE INFORMATION CARD

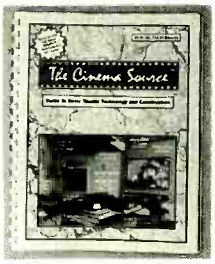
This comprehensive book helps novices avoid getting tangled up in technical jargon and experienced users take full advantage of the power of the World Wide Web. Illustrated fully and written in a fun, easy-to-understand style, it first shows Web basics, and then guides readers through the more advanced features of the most powerful information/communication interface in use today.

The book explains how to get connected to the Internet and how to choose and use a Web browser. Readers learn how to use the Web to its full potential, thanks to practical advice on such matters as creating your own Web pages, establishing a business or personal presence on the Web, creating interactive forms to collect information from other users, using images and color on Web pages, creating clickable imagemaps, integrating audio and video clips into Web presentations, accessing and using high-speed connections to the Internet, and using the exciting features of HTML 3.

The book also describes many of the Web's varied offerings, including business opportunities and ways to provide services or sell products online. It provides a catalog of the diverse businesses and entrepreneurs found on the Web.

Guide to Home Theater Technology and Construction

The Cinema Source
2 Redmond Street
Burlington, MA 01803-2924
Phone: 1-800-483-9778
$9.95 ($12.95 in Canada)



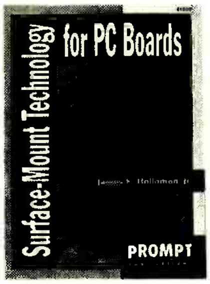
CIRCLE 338 ON FREE INFORMATION CARD

This 100-page book is much more than a catalog. Aimed at home-theater enthusiasts and do-it-yourselfers, it provides a wealth of practical information about home theater. It describes all the necessary components—large-screen picture, multi-channel audio, speakers, etc.—and what roles they play in the home-theater system. The book explains how line-doublers and THX and Dolby Pro Logic surround sound work. It explains how curved and flat screens differ, what tactile sound is, and what AC-3 digital sound is. Readers are shown how to mount a video projector, project video on different aspect ratio screens, set up a surround-sound system, and what types of cables and interconnects to use. A customer profile details one family's custom home-theater setup.

The catalog also presents home-theater products—primarily top-of-the-line goods at below-retail prices. Product categories include front video projectors, projection screens, audio systems, multichannel power amplifiers, audio processors, control systems, in-wall speakers, and even furniture and accessories designed to complement home-theater components.

Surface-Mount Technology for PC Boards

by James K. Hollomon, Jr.
Prompt Publications
2647 Waterfront Parkway East Drive
Indianapolis, IN 46214-2041
Phone: 1-800-428-7267
$26.95



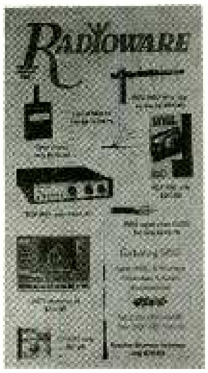
CIRCLE 339 ON FREE INFORMATION CARD

Manufacturers, managers, engineers, and others who work with printed circuit boards will find this book to be a useful source of information about surface-mount technology (SMT) and fine-pitch technology (FPT). Practical data and clear illustrations clearly present the details of design-for-manufacturability, environmental compliance, design-for-test, and quality/reliability for today's miniaturized electronics packaging.

The book includes information on the benefits and limitations of surface mount technology. It describes SMT and FPT components, land patterns, and manufacturing methods. The book addresses reliability and quality assurances as well as practical applications and standards. A glossary of SMT terms is included.

Radioware Catalog 952

Radioware Corporation
P.O. Box 1478
Westford, MA 01886
Phone: 1-800-950-WARE
Free



CIRCLE 340 ON FREE INFORMATION CARD

This 45-page catalog is filled with antennas and accessories for ham, SWL, and scanner enthusiasts. Product categories include slow-scan TV, counters and computer scanning, DSP audio filters and keyers, antenna baluns, antenna wire, coax cable and connectors, antenna components and accessories, SWR meters and analyzers, interference filters, transmit filters, VHF/UHF antennas, scanner antennas, HF antennas, HF/VHF antennas, VHF/UHF mobile antennas, antenna mounts, CD-ROMs and software, and scanner and ham kits.

Digital Panel Meter Data Book

Datel, Inc.
11 Cabot Blvd.
Mansfield, MA 02048
Phone: 508-339-3000
Fax: 508-339-6356
Free

CIRCLE 341 ON FREE INFORMATION CARD

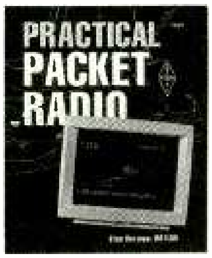
This data book describes more than 200 meters and instruments and provides 16 application notes. The 100-page guide is filled with design and applications information on $3^1/_2$- and $4^1/_2$-digit, LCD and LED display, miniature digital voltmeters. New products include ultra-low-power LED-display digital panel meters, self-powered AC and DC voltage monitors, 4–20-mA loop-powered displays, and self-contained $4^1/_2$-digit slave displays. Product descriptions include clearly written data sheets with electrical specifications, dimensional drawings, and ordering guides.

More than half the data book is devoted to applications information intended to simplify the task of specifying and using digital panel meters. The fully-illustrated application notes describe such popular panel meter applications as DC ammeters, battery/supply monitors, resistor scaling networks, thermometers, tachometers, and AC voltmeters. Detailed circuit schematics include component part numbers and values and model numbers. Other topics discussed include panel meter input connections, LCD versus LED displays, and troubleshooting procedures.

The catalog also describes a wide selection of useful accessories, such as plug-on boards, low-cost DC/DC converters, three-terminal linear regulators, and AC/DC power modules. Mating connectors and terminals, panel-cutout punches, crimp tools, and optional bezel assemblies are also offered.

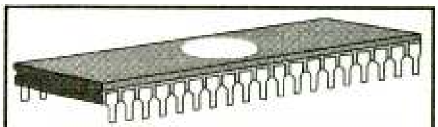
Practical Packet Radio

by Stan Horzepa, WA1LOU
The American Radio Relay League
225 Main Street
Newington, CT 06111-1494
Phone: 203-666-1541
Fax: 203-665-7531
$15.95



CIRCLE 342 ON FREE INFORMATION CARD

Packet radio has come a long way since the early days. Such developments as low-cost PCs, a new generation of terminal-node controllers (TNCs), and 9600-plus baud rates have created a world of new opportunities for packet enthusiasts. This book brings readers up to date on the very latest developments in the field, and provides all the practical information needed to select, install, and operate a packet station. It also



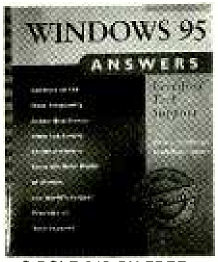
includes tables and lists of symbols and commands that serve as handy references.

The "Installation" section of the book deals with practicalities. It describes the necessary hardware—including TNCs, modems, computers, terminals, radios—and software. It then shows readers how to tie all those pieces together, with information on such topics as setting the switches and picking baud rates.

The "Applications" section lays a foundation with a thorough examination of the basics, and really takes off from there. Topics include networking, HF communications, bulletin boards, DX packet clusters, gateways, and packet in outer space.

Windows 95 Answers: Certified Tech Support

by Martin S. Matthews and Carole Boggs Matthews
Osborne/McGraw-Hill
2600 Tenth Street
Berkeley, CA 94710
Phone: 1-800-822-8158
Fax: 614-759-3644
$19.95



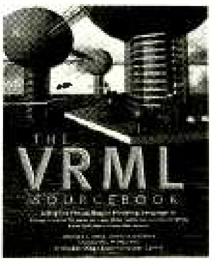
CIRCLE 343 ON FREE INFORMATION CARD

Osborne/McGraw-Hill has teamed up with Stream International Inc., the world's largest provider of technical support, to produce a series of "Certified Tech Support" books, including this one. The book is based on the most frequently asked Windows 95 questions taken from actual support calls fielded by Stream International, which answers more than 500,000 technical support calls each month. Rather than spending valuable time and money dialing Microsoft's technical hotline, readers can find the answers at their fingertips, whenever they need help—often in less time than they would have spent on hold.

The book is designed to ease the transition to Windows 95. Clearly written and logically organized, it helps readers take full advantage of all the powerful new features, commands, concepts, and components of the 32-bit multitasking operating system. The book opens with the "Top Ten Tech Terrors" associated with Windows 95, answering such questions as: How do I find my files and programs? Can I recover a file I've mistakenly deleted? How can I get to my previous version of MS-DOS? Do I have to reinstall my applications after installing Windows 95? The rest of the book is divided by topic, providing detailed coverage of installation; new features; setup, customizing, and optimizing Windows 95; using Windows 95; file management; printing; networking; communications; multimedia; and Windows 95 DOS.

The VRML Sourcebook

by Andrea L. Ames
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Phone: 1-800-CALL-WILEY
Web site: http://www.wiley.com/compbooks/
$29.95



CIRCLE 344 ON FREE INFORMATION CARD

Virtual Reality Modeling Language (VRML) was created to promote the use of interactive simulations on the World Wide Web. While both VRML and HTML are used to publish information over the Internet, VRML replaces the traditional two-dimensional, text-driven environment with three-dimensional, interactive data and virtual worlds.

This book teaches Web developers and HTML users how to take advantage of VRML. It explains how to design complex objects with VRML; link VRML objects to other Web resources; and use special lighting, camera angles, and professional graphics for realistic 3-D worlds on the Web. The book also shows readers where to find VRML resources.

Japanese Style LEDs Product Selection Guide 2004-10

Lumex Opto/Components Inc.
290 East Hellen Road
Palatine, IL 60067
Phone: 1-800-278-5666 or 847-259-2790
Fax: 1-800-944-2790 or 847-359-8904
E-mail: lumex@aol.com
Free

CIRCLE 345 ON FREE INFORMATION CARD

This second-source catalog presents 42 families of popular Japanese-style LED lamps made originally by Panasonic, Rohm, Stanley, and Toshiba. It includes line drawings of all 42 styles, plus seven pages of cross references from Japanese part numbers to those of US manufacturer Lumex Opto/Components. Although some of the Japanese-made part numbers have been phased out over the years and lead times for others exceed 20 weeks, all parts in this catalog are available immediately for sampling, and production quantities have lead times of two to six weeks. **EN**

BY JEFF HOLTZMAN

Web resources

I'VE BEEN LOOKING INTO WEB TECHNOLOGY IN A SERIOUS WAY LATELY, SO I THOUGHT I'D SHARE SOME OF WHAT I'VE LEARNED. A DISCLAIMER FIRST: EVERYTHING IN THIS AREA IS SUBJECT TO CHANGE. THE dv/dt (RATE OF change) of Internet technology is utterly insane. We'll start with a little Internet background, and then get into Web-specific technologies.

Everything in the Internet world is client/server based. Servers (e.g., Web sites, FTP sites) have stuff that Clients (e.g., Netscape Navigator) want. For the sake of this discussion, the details of how clients and servers communicate is magic. To use Internet software successfully, all we have to know are two addresses: That of the client, and (you guessed it) that of the server. Server addresses, especially of well-known public sites, tend to be static.

Client addresses can be static or dynamic. Dynamic addresses are assigned (and reassigned) on the fly as required. For example, a dial-up Internet Service Provider (ISP) assigns you an address when you call. When you hang up, that address goes back into a pool of free addresses. On the other hand, if you're on a network that uses TCP/IP as its native communications protocol, you probably have a static address.

Behind the address

Regardless of how you get it, your address has the form of four octets (an octet is the politically correct 90's term for byte): W.X.Y.Z, for example, 127.0.0.1. Remembering number sequences like that is not something most people are particularly good at, so it is possible to create a textual alias. Thus, a textual address like jkh@acm.org eventually gets resolved to a numeric address like 127.0.0.1.

If you send e-mail to that address, a bunch of packets spew out onto the Internet. Devices out there recognize the "acm.org" part of the address, associate it with the correct numeric address, and send those packets on their merry little way. When they arrive at acm.org, it likewise associates the jkh part of the address with the remaining part of the four-octet address, and at that point, they know it's intended for me. The associations are made by tables, typically simple ASCII files that include one text name and the corresponding numeric address per line.

As long as two machines that want to communicate can find each other's IP (Internet Protocol) addresses, all that works transparently, regardless of whether the machines are two feet or two thousand miles apart.

So that, in simplistic terms, is how the low-level plumbing works. So how do we get Web pages and file transfers?

Protocols

A protocol is simply an orderly way of having a conversation: "If you say this, then I'll say that, then you'll say something else, and I'll hang up." Different protocols are used at different levels of the communications chain. At low levels, we have things like TCP, IP, NetBIOS, NetBEUI, and IPX/SPX. Those protocols allow raw packets of data to move across a network with varying levels of reliability and efficiency.

Higher level protocols put the raw packet-transfer ability of the low-level protocols to use. The Internet has spawned numerous protocols over the years to handle different kinds of client-server transactions, including Gopher, FTP, HTTP, Finger, Ping, WAIS, Telnet, News, and more.

Gopher is similar to what we now think of as the Web; it allows menu-based navigation and file transfer. FTP is a file-transfer protocol. HTTP is the hypertext transfer protocol that is the basis of the Web. Ping and Finger allow net resources to be located. WAIS is a full-text indexing service and protocol. Telnet allows a computer to emulate a remote terminal, log on to a server, and run programs on it. There are other protocols for handling e-mail (POP, SMTP, and others). There are protocols that help manage network resources (SNMP).

Servers

So far we've only talked about how messages pass back and forth between clients and servers; we haven't said a word about the endpoints themselves.

In general, anybody who can talk the talk and walk the walk can be an endpoint; underlying computer architecture is irrelevant. Thus a UNIX server can talk equally well to clients running PCs, Macs, or other UNIX boxes. A client can run a graphical or a character-based environment; the server doesn't know and couldn't care less. It's really up to the client how it wants to present the information it receives from the server. Thus, you'll probably never see anything but a GUI interface on a Mac, but PCs and PDAs may use character-based interfaces. If you have a PC, you can try this out for yourself using LYNX, a public-domain Web browser developed by the University of Kansas.

The hottest area of development is in Web servers and clients. They communicate using the HTTP protocol, which works like this: Client initiates transfer by establishing connection to server. Server acknowledges connection. Client requests data item. Server responds with status followed by data. Connection closes.

HTTP defines seven methods for data transfer: GET retrieves file specified by a URL. HEAD gets meta information (things like author, title, etc.) from a file specified by a URL. PUT saves a file to a specified URL. POST sends information related to a specified URL. DELETE requests that server delete specified URL. LINK and UNLINK establish and remove links from specified URL.

Those seven commands are all it takes to build a Web server. In fact, I've seen a functional Web server built in about 100 lines of code. Of course, that's not something you'd want to run in a production environment, but it does serve to illustrate the underlying simplicity of the HTTP protocol.

One neat thing a Web server can do is to launch an external program in response to a Web client request (submitted via POST). Using yet another protocol called CGI (common gateway interface), a Web server can launch an external program, get results from it, reformat that information on the fly, and return it to the Web client—the browser.

Much CGI programming is done using a public-domain language called PERL. PERL is available on nearly every platform. It's a neat language for parsing text files, as it has built-in text-

Web Resources

Following are some books and Web sites I've found useful in learning about Internet communications protocols and applications. First the books.

WebMaster Windows ($?), Bob LeVitus and Jeff Evans, AP Professional, 1996, ISBN: 0-12-445572-7. Provides a basic, painless introduction to setting up a Web server. Includes a CD-ROM with a 30-day trial version of QuarterDeck's WebServer, along with HTML editors and numerous utilities. The web server will run on Win31 or Win95.

Internet Server Construction Kit for Windows ($39.95), Greg Bean, John Wiley & Sons, Inc., 1995, ISBN: 0-471-12696-9. A more technical introduction to web servers. Includes material comparing various public-domain and commercial servers. Comes with CD-ROM containing public-domain servers for HTTP, WAIS, FTP, and others. Also has pointers to web sites where most recent versions can be obtained.

The Webmaster's Handbook ($29.95), Christian Neuss and Johan Vromans, International Thomson Computer Press, ISBN: 1-85032-253-8. This is a thin but dense book that provides a concise introduction to HTTP, and then goes on to show how to use PERL to accomplish various tasks. A CD-ROM contains tons of PERL code; the CD is accessible by DOS, UNIX, and Mac systems. Appendices present a 100-line web browser and a 100-line web server, both written in PERL. Studying that code will teach you a lot about the details of HTTP. Other appendices provide quick references for HTML tags and PERL code.

World Wide Web Programming With HTML and CGI ($39.99), Ed Tittle, Mark Gaither, Sebastian Hassinger, and Mike Erwin, IDG Books, ISBN: 1-56884-703-3. Of the books I've had a chance to examine, this one provides the best overall introduction that I've seen to SGML, HTML, CGI, various servers, and so forth. The CD-ROM includes all kinds of interesting stuff, such as source code for an HTTP server, a Telnet server, a WAIS server, an ANSI.SYS driver that provides VT-102 terminal emulation, and all sorts of other weird stuff. If you want to learn the guts of Internet programming, this disk will keep you busy for a long time.

The Web Page Design Cookbook ($34.95), William Horton, Lee Taylor, Arthur Ignacio, and Nancy L. Hoft, John Wiley and Sons, ISBN: 0-471-13039-7. Covers aesthetic design of Web pages; lots of good HTML tricks. CD-ROM contains lots of usable HTML code.

URLs

http://www.sandia.gov/sci_compute/elements.html: Excellent ongoing effort to track HTML evolution and extensions by Microsoft, Netscape, and others.

http://www.microsoft.com/intdev: Resources for HTML specs and beta copies of MS Internet tools (Front Page, Internet Studio).

http://www.w3.org: This is where you can find current specs and links to many web-related resources. For example, you can obtain RFC1866, the HTML 2.0 spec, here.

http://www.webreference.com: Useful HTML-related information.

http://www.hal-pc.org: Useful HTML-related information.

http://www.metronet.com/1h/perlinfo: Useful PERL-related information.

matching and regular-expression functions. It's also good (under UNIX) for doing shell and system-control programs.

CGI is an awkward hack that depends on the use of environment variables to pass file names back and forth—but it works. However, Microsoft and Netscape (and probably all the other server vendors) are defining their own proprietary interfaces that will allow more efficient server-to-external program communication. The current CGI-based system requires external processes to be spawned; the new API-based systems will allow continually executing applications to communicate directly.

Clients

Mostly what's transferred from server to client using the GET method are ASCII files in a format called HTML (hypertext mark-up language). HTML is closely related to SGML (standard generalized mark-up language), an ISO standard for encoding document structure and format. SGML defines entities called DTDs (document type definitions), which define how the markup tags in a given document are to be interpreted. If you're familiar with the concept of style sheets in modern word processors, a DTD is similar to a style sheet. One difference is that with SGML, you never encode formatting directly in a document. For example, you don't mark a word bold or italic. There must be a tag or style (e.g., <EM> or <STRONG>) that a run-time display engine interprets as italic or bold.

HTML is nothing more than an SGML DTD. It has a bunch of tags that define various structural and stylistic characteristics of a document. It's the job of the Web browser to interpret those tags, and to apply the corresponding formatting. In a text-only browser like LYNX you'll see one representation. In a GUI browser like Netscape, you'll see another. Unfortunately, at the current state of HTML evolution, the displays produced by different GUI browsers differ.

HTML began life as a valid SGML DTD. Whether it still conforms is unclear. The problem has been what might be called distributed evolution. There is no one organization responsible for defining HTML. At one point, the W3C (World Wide Web Consortium) at MIT created a well-documented HTML 2.0 spec, which was valid as of about two years ago. W3C began an HTML 3.0 spec, but pretty much abandoned the effort in the spring of 1995. Now various extensions to HTML 2.0 are being promoted by Microsoft, Netscape, the W3C, and others.

Early HTML was very loose in its specification as to how document layout was to be interpreted. For example, even things as basic as fonts and font sizes were left completely up to the local browser to interpret. That made HTML web-page development difficult, because something that looked OK in Netscape might look poor in some other browser.

One W3C-proposed extension involves the use of word-processor like style sheets, which provide a hierarchical style system that conforming browsers would interpret similarly.

Going beyond format issues, there is the question of interactivity. This is where technologies like Java and Visual Basic Script come in. We'll leave discussion of them to another time.

Hardware watch

If you insist on having the absolute latest and greatest, skip this paragraph. Otherwise . . . A company called Bason Hard Drive Warehouse has some great deals. For example, recently I picked up a 3-GB SCSI drive for less than $500.The drive is a Seagate 43400N with the following critical specs: 5400 RPM, 10 ms avg. seek, 512K buffer, Fast SCSI-II interface. The catch? It's a 5¼-inch full-height unit. Bason shipped only the bare drive, but a quick GO SEAGATE on CompuServe turned up the required setup information. If you're interested in maximizing bang-for-buck re-disk and tape storage, check out Bason. Everything the company sells comes with the original factory warranty. For more information, contact Bason Hard Drive Warehouse, 20130 Plummer Street., Chatsworth, CA 91311. (800) 238-4453. (818) 727-9054.

Stay in touch: jkh@acm.org. EN

VIDEO NEWS

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computer's features to the TV. Almost simultaneously, virtually all the major and minor TV brands began exploring various TV/PC combinations.

RCA announced that it was test-marketing the "Genius Theater," a 35-inch TV equipped with a CD-ROM player and a modem for access to the Internet. RCA's top two rivals—Zenith and Magnavox—came along quickly.

Zenith, proclaiming that it probably wasn't too bright to add all computer features to its TVs, announced that it would market a line of net-browsing TVs later this year, based on a technology developed by former members of an Oracle team that had been developing a low-cost "network computer." Zenith's NetVision TVs, in screen sizes 27 inches and larger, will support Internet services including the World Wide Web and e-mail, and will have the capacity to support JAVA terminal applications, Zenith says. The company's trackball remote control or an optional wireless keyboard can be used for navigation.

Magnavox's parent, Philips, was a little more mysterious, revealing that it planned something called MAT—which stands for "multimedia access terminal." It won't exactly be a TV set, but neither will it be a computer. As described, it will be a TV accessory with software for browsing the Internet, and will serve as a video-phone and telephone with Caller ID. It will also have jacks to connect it to other products.

Toshiba actually was first in the TV/computer-combo race—it has been marketing "TIMM," which stands for "Toshiba Integrated Multimedia Monitor," for a year or more in limited quantities. With a 20-inch screen, it is priced at $899, and sales so far have been slow, the company concedes. Its parent company in Japan has introduced a 27-inch version, but for the time being Toshiba has no plans to market it here.

Hitachi plans to top everybody so far with a 60-inch projection TV/combo at the rather breathtaking price

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BY FRANKLIN J. MILLER

Audio system integration

A knowledge of impedance matching and an understanding of component spec sheets will help you integrate a high-quality public address system

YOU CAN INTEGRATE A TRULY SATISFACTORY PROFESSIONAL-LEVEL PUBLIC ADDRESS SYSTEM FROM DISCRETE COMPONENTS IF YOU TAKE THE TIME TO UNDERSTAND THE PRINCIPLES OF IMPEDANCE MATCHing and learn the meaning and shortcomings of the manufacturer's specifications data. That information is published in the manufacturers' data sheets and user's manuals.

A knowledge of how to interpret performance ratings and an awareness of what information is not in this data will help you to avoid pitfalls when you purchase or build your own components. This holds true regardless of the amount of money you intend to spend on those components.

The design concept behind a professional public address system is, not surprisingly, very important to achieving the desired results. The system integrator usually assumes that all of the components that will be included in the system have been tested and will function correctly if all of the manufacturer's stated operating conditions have been met. Unfortunately, even when all of those conditions have been met, your system might not give you the performance you expected.

Figure 1 is a simplified block diagram for a public address system consisting of seven discrete components. If you are doing the systems integration, and are about to install one or more new components, consider all of the possible inputs and outputs . Also take note of all locations where other signals will enter. Prepare a clear plan for achieving the desired performance, and carefully consider all the tradeoffs between cost and quality when purchasing or building your own equipment.

Figure 2 is a block diagram of a multi-component public address system that includes typical values of gains and losses from the microphone or input end to the speaker or output end. This will give you an overall view of the signal gains and losses to be expected.

You can learn a lot about public address systems and how to inte-

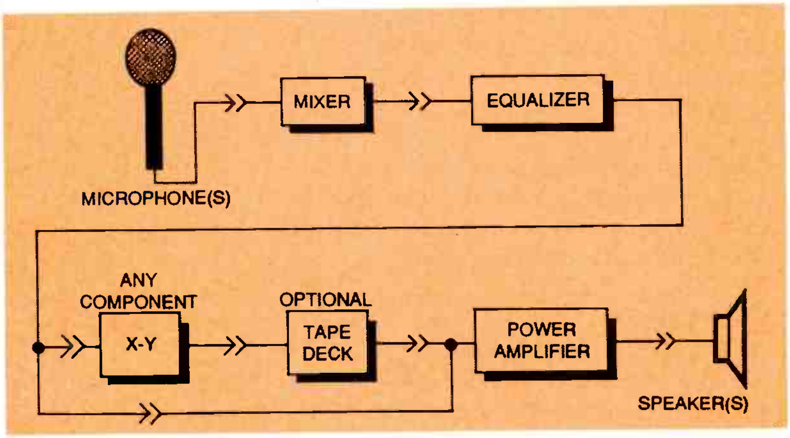

FIG. 1—Generalized block diagram for a professional public address system

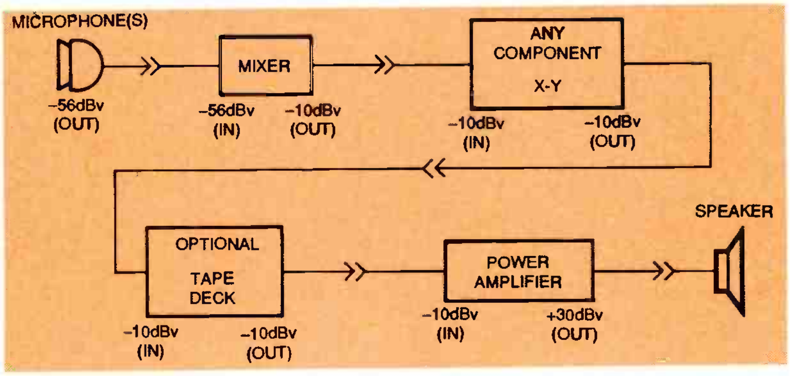

FIG. 2—Block diagram for a public address system showing typical signal levels at each stage.

Table 1. Typical Audio Component Specifications

Input level	-10 dBV
Input impedance	10K ohms
Gain (Input to output)	Unity (no gain)
Output level	-10 dBV
Output impedance	will drive inputs of > 1K ohms
Jacks (inputs and output)	Unbalanced RCA type

grate them successfully by studying the faults or shortcomings of other people's systems. Then you will have a better idea about how to avoid repeating those mistakes in new or updated systems. What causes some public address systems to hum? Why are they noisy? Why is the microphone too soft? What is causing the distortion? These are questions you should ask and attempt to answer. A good place to begin planning any public address system is to start at the individual component level and understand the characteristics and specifications data for those components.

Microphone characteristics

Most of the microphones suitable for professional public address systems are either dynamic or electret-condenser microphones. Dynamic microphones do not require external power. However, electret-condenser microphones must be powered by an internal battery or a "phantom" power supply. The term phantom power supply refers to a technique for supplying power to a system component over wires. In this case, it refers to the transmission of power to the microphone through audio cable.

This can be done if the positive voltage from the power supply is connected to both pin numbers 2 and 3 of an XLR connector through a pair of matched resistors, and the shield is used as the ground connection. The tolerance of the resistors can be as wide as ±20%, but the difference between their values must be less than 0.4% for adequate symmetry as well as preventing unwanted DC from flowing between the two signal leads.

This phantom supply can be fed from the mixer or a separate power supply. A phantom supply can provide a voltage for the field-effect transistor (FET) amplifier typically located in the microphone head. The integration of dynamic microphones can be difficult for the following reasons:

- Dynamic microphones typically have lower output voltages than electret-condenser microphones.
- Dynamic lavaliere microphones typically produce lower output voltages than the standard-size units, and electret-condenser lavaliere microphones produce higher voltages than the standard versions. The difference between the output levels of these two different kinds of microphones could be as much as 20 dB between their lowest and highest outputs.

Therefore, it is important that the system mixer be capable of handling those voltage differences without causing audible noise, because the preamplifier's gain is being pushed to its limit.

Another serious concern in public address systems is audio noise that can be caused by an impedance mismatch between the microphone and the mixer. Simply stated, a high-impedance microphone should not be connected to a low-impedance input, or the converse of that arrangement. This form of mismatch is called a "global mismatch." In the United States 150 ohms is considered to be low impedance, but in Japan, for example, 600 ohms is considered to be low impedance.

In public address systems, the optimum solution is to have the output impedance of the microphone match the input impedance of the mixer. It often turns out that the closeness of that match becomes a matter of the time and cost you are willing to invest to obtain the exact match. Bear in mind, however, that some microphones are unbalanced and some are balanced. A balanced microphone is equipped with a three-pin XLR connector and an unbalanced microphone is connected with a two-conductor phone plug. Balanced connectors help to reduce audio noise and pickup.

Make the connection between the microphones and the mixer with two-conductor shielded cable and XLR connectors for the best results.

Table 2. Attenuation Values for The Pad in Fig. 4 (Resistance in ohms)

Loss (dB)	R_a	R_b
0.5	270	180K
1.0	560	82K
2.0	1.1K	43K
4.0	2.2K	22K
8.0	4.3K	10K
16.0	7.5K	3.3K
32.0	9.1K	510K

The next step is to examine the mixer's input stages. Ask yourself these questions:

- Are the inputs balanced?
- What is the impedance of the inputs?
- What input level will the mixer be

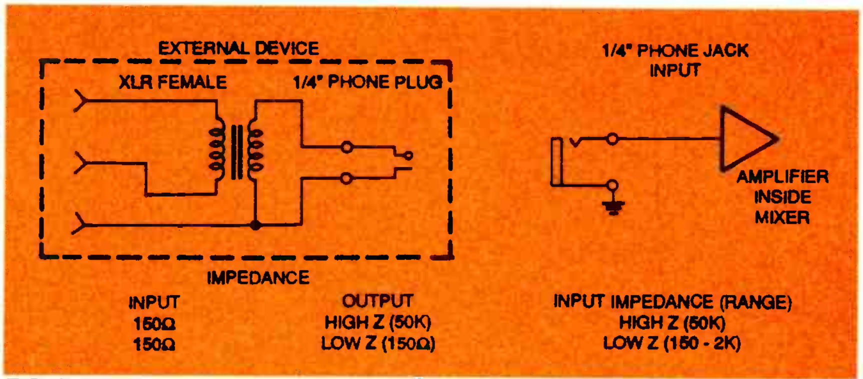

FIG. 3—Examples of unbalanced inputs.

able to handle without overloading ?

- What is the maximum gain before audible noise or hiss is heard?

A quality mixer from a reputable manufacturer will perform satisfactorily and you will get satisfactory answers to all of those questions. Figure 3 is a simplified diagram of an external circuit that can compensate for the shortcomings of mixers due to unbalanced inputs. Late model public address systems might include 3.5mm connectors in the same locations where earlier models had 1/4-inch phone connectors. (This substitution was made to save space and cost.)

If you are satisfied that all the shortcomings of the mixer have been corrected, examine the output of the mixer that will feed the next component in the signal processing chain. Because of the many possibilities for components that could be here, it is best to generalize about them rather than to go into specific details about these components.

Table 3. Gain Vs. Resistance for the Gain Circuit in Fig. 6 (Resistance in ohms)

Gain (dB)	Rx
6	100K
9	56K
12	33K
15	22K
18	15K
21	10K

Most consumer or nonprofessional mixer outputs are rated at -10 dBV, and they will drive 1K loads or greater. The output connectors on these mixers are generally RCA-style or 1/4-inch phone jacks. Verify that the jack is one or the other of these. You should know this before you proceed to the next step.

Now you want to know the characteristics of the inputs and outputs of the next component in the chain. The characteristics of the connectors should be determined. If the equipment is designed for consumer audio or semiprofessional applications, it would have specifications that match or are close to those given in Table 1.

If these specifications closely approximate those of your components, your system should work well, but if there are significant differences you might encounter problems. Two-to-three decibel differences should not be significant, but five- to 15-decibel differences call for remedial action. At the input, the gain must be boosted either by the component itself or an external device.

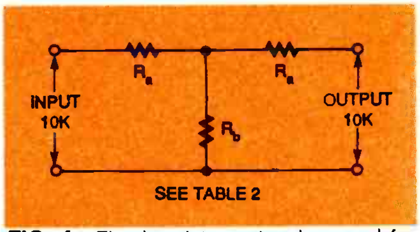

FIG. 4—Fixed resistor network or pad for unbalanced circuits.

Some public address system components such as tape decks, microphone preamplifiers, and wireless transmitters for musical instruments have input gain controls. These controls boost or attenuate signal levels, depending on their design. If the audio level is excessive, the values of a network of fixed resistors (pad) or an attenuator can be calculated and the pad or attenuator can be inserted across the input terminals, as in Fig. 4.

Table 2 relates loss in decibels to the values of resistors R_a and R_b. Remember that pads can be put in series to obtain exact attenuation values. Figure 5 is the schematic for a simple variable pad consisting of a 10K audio-tapered potentiometer. This potentiometer will permit you to adjust attenuation to suit your listening requirements.

On the other hand, if you want to boost the input level, gain is needed. This is not as easy to do because a gain circuit is required. Figure 6 is a schematic diagram for a suitable gain circuit based on a low-cost, general purpose operational amplifier. It can be an industry-standard 741, a National Semiconductor LF351 or a Texas Instruments TL071, for example. Table 3 lists the values of gain obtainable with different settings on potentiometer R2's wiper.

To obtain maximum performance from your public address system, all signal levels should be equal. If the signal level is too low, you are likely to hear noise and hiss, but if the signal level is excessive, the result will be overdriving and distortion. If hiss and noise are so low that you can't hear them, it might not be worth your time and money to make any improvements. But if you or those with more acute hearing can hear the hiss and noise, you must eliminate the cause.

Simple test equipment that you could build such as signal generators, AC voltmeters, and distortion analyzers, will permit you to make the diagnostic measurements on your system. The output of these instruments will be fed to the power amplifier at the end of the equipment chain just before the speaker or speakers. The steps that were taken with the components will also be necessary with any of these instruments in place.

Table 4. Typical Public Address System Component Specification

1. Frequency response:	±20 dB, 20Hz-20 kHz
2. Distortion:	< 0.001%
3. Input level (nominal):	-10 dBV
4. Maximum input level (before clipping):	+10 dBV
5. Input connector(s):	1/4-inch phone jack & female XLR
6. Input impedance:	10 kilohms (line)
7. Gain:	20 dB
8. Noise:	-90 dB below rated output
9. Output level (nominal):	+4 dBm
10. Output load:	>600 ohms
11. Output connector:	Male XLR
12. Power requirements:	120 or 220 VAC, 50/60 Hz
13. Power Consumption:	< 4 watts
14. Dimensions:	13.25 X 7.25 X 3.50 inches

Getting what you pay for

If you have purchased quality audio components from a reputable manufacturer, you can assume that they include high quality circuitry. You can also expect that a lot of attention was given to signal-to-noise ratio, total harmonic distortion, (THD) frequency response, "headroom,' input clipping level, and other performance parameters.

This data is generally published in the manufacturers' data sheets or owner's manuals. You can find many references that will help you to understand the meaning of the published data. To familiarize yourself with what to expect, refer to Table 4, a generalized specification for many typical audio components.

Be warned! Not all data sheets are organized the same way. The organization of these sheets might have been set up years ago when audio products contained vacuum-tubes and they have been carried over to the solid-state era. The following comments will help you to understand the significance and importance of each of the specification values listed:

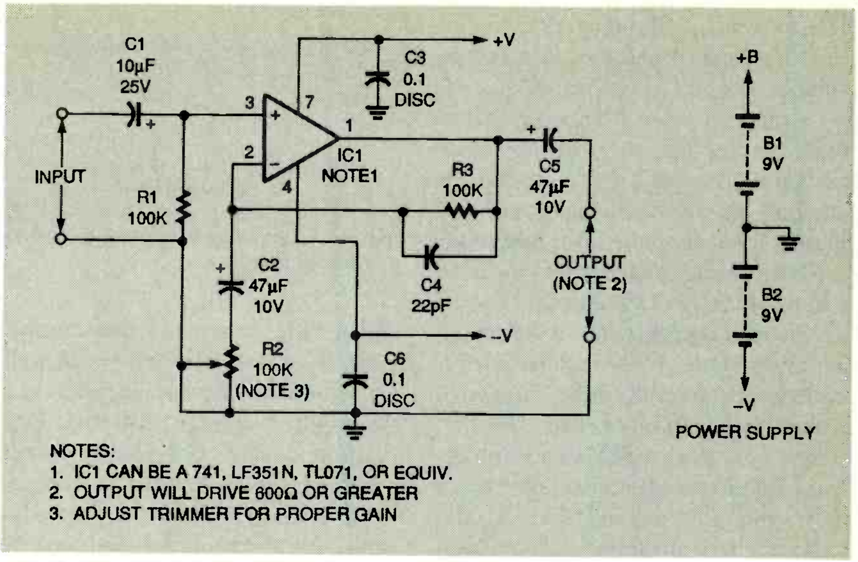

FIG. 6—Signal boost circuit based on an operational amplifier.

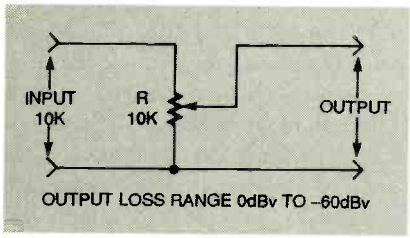

FIG. 5—Variable pad for a public address system.

1. A frequency response is stated, but no indication is given that filters were in place during the test procedure. This information can be very important in your end-use application because if the filters were not included in your system, the frequency response can differ significantly from that of a system with filters.

2. The distortion percentage is given, but it is not accompanied by the frequency at which this measurement was made. If the equipment contains transformers, this frequency would be very important because distortion varies with frequency.

3. The input level specification states the signal input level that the device is designed to accept. You should know this value so that you do not overdrive the unit. The modifier "nominal" refers to the unit's normal operating level. Do not exceed this value if you expect the unit to function properly.

4. The maximum input level is a limiting value beyond which the unit will not perform properly. The output could be distorted or even fail if this limit is exceeded.

5. Before purchasing an audio component, it is helpful to know what connectors have been installed. If these are not compatible with connectors on the other components that you own, you will probably have to purchase adapters or new cables.

6. The value of input impedance is important because it tells you about the conditions that must be met to drive the component properly. If this value is not given you might have to measure it with a test instrument.

7. The value of gain given gives you an indication of the units amplification capability. It will indicate the gain available for the next component in the chain, of if it will overdrive the next unit.

8. The noise rating is particularly important if you will be recording with your system. Too much noise will result in a poor recording. Moreover, if you plan to listen to music with a wide tonal range or voice, the presence of noise will detract from the performance. Were filters in place when the measurements were made?

9. The output level is an indication

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BY CARL J. BERGQUIST

Optics and optical experiments

Use lenses, defraction gratings and mirrors to discover new ways to have fun and learn more about lasers and their properties.

THE SINGLE MOST FASCINATING AND USEFUL CHARACTERISTIC OF LASER LIGHT IS PROBABLY COLLIMATION—THE CONCENTRATION OF ITS MONOCHROMATIC LIGHT INTO A TIGHT PENCIL BEAM. FREQUENTLY, however, this is the very characteristic that needs to be enhanced or defeated to make an experiment or device work. This is where various optical elements come into play. Let's take a look at some of these components individually and examine their capabilities.

Lenses are vital

There are two basic varieties of lenses that are used in laser applications; convex or positive, and concave or negative. They can be either single sided or double sided, (see Fig. 1). Each type has its own special purpose and a particular effect when used as a part of an optical system. Whether single or double, all convex lenses condense light. Concave lenses, on the other hand, spread or diffuse, a beam of light, increasing its area of coverage, but decreasing its intensity.

These properties are important. Especially so, in future columns, when we get to holograms or 3-D pictures. Combinations of both types of lenses are needed to control the light in a variety of experiments. For example, you might start out by using a concave lens to spread the laser beam. Following this a convex lens might be introduced to limit the amount of spread. All in all, an optical lens is one of the most important optical components you will use with lasers. It is a good idea keep several of each type on hand. The source list provides names and addresses of companies that handle optics. The lenses you buy can be either plastic or glass. Some surplus dealers sell individual elements by the bag. Each bag usually holds a number of lenses of both types.

Surplus lenses are generally seconds, but, a few edge chips, or surface blemishes, rarely affect their performance at for our applications. Another good source for lenses is old or damaged cameras. Their lenses can usually be disassembled, and will often provide four or five elements of different styles.

WARNING! ! !

This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter, materials and substances. Neither the publisher nor the author make any representations as for the completeness or the accuracy of the information contained herein and disclaim any liability for damages or injuries, whether caused by or arising from the lack of completeness, inaccuracies of the information, misinterpretations of the directions, misapplication of the information or otherwise.

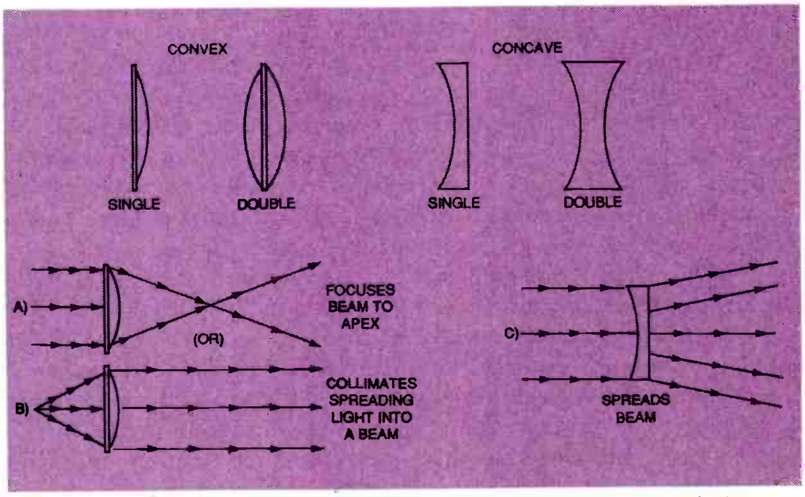


FIG. 1—CONVEX AND CONCAVE LENSES come in both single and double configurations. a—Collimated laser beam into a convex lens produces a focused beam at the focal point of the lens. b—A spreading beam into a convex lens collimates the light. c—Collimated laser beam into a concave lens causes the beam to spread.

Specialized lenses

Fresnels and diffraction gratings are specialized lenses, or more accurately, a composite of specialized lenses. The Fresnel consists of a series of concentric convex elements, eventually terminating in the center. They are readily available in everything from full-page magnifiers, found in the office supply section of discount stores, to laboratory-grade devices. The price is probably the best guide to their quality. Five dollars will usually buy you a good quality specimen for experimenting.

Diffraction gratings are made from either glass or plastic, and are a composite of very small parallel prisms, usually numbering 1500 to 2000 lines per millimeter. When a beam of light strikes their surface it is broken up into a spectrum by each of the mini prisms, which produces a stunning effect. While there are some very valid scientific applications for diffraction gratings, their cost, around $100 for a 2 inch square, makes them extravagant items for the experimenter. Edmund Scientific sells experimenter-grade replica gratings for a little as $10.75. Refer to their catalog for details. If available, however, working with them can be a highly entertaining experience.

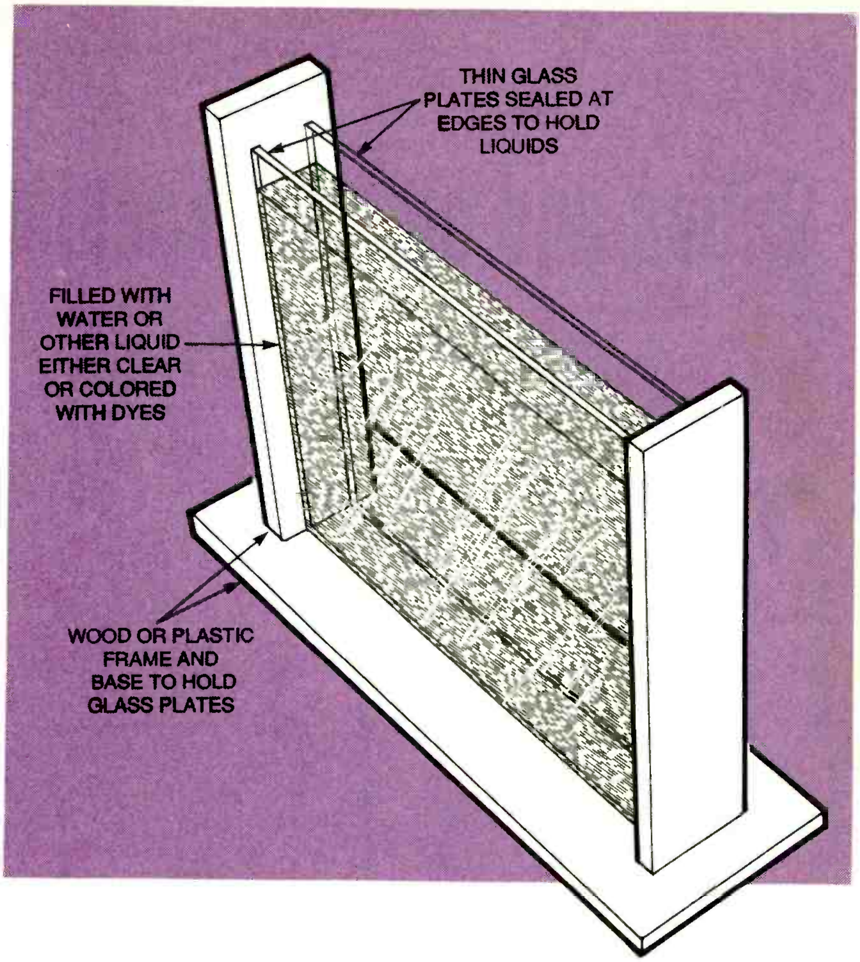


FIG. 2—HOME-MADE LIQUID FILTERS are easy to make. Follow this illustration carefully. Silicon aquarium cement forms a good liquid-proof seal.

Mirrors and reflective surfaces

Mirrors come in two varieties; rear surface, where the metallic coating is placed on the back of the glass, and front or first surface, where the coating is on the front of the glass. Rear surface mirrors are the most common as they are the most durable of the two. The metal reflective coating is quite fragile and when it is on the front, is easily scratched or rubbed off.

While ordinary rear-coated mirrors are very useful in many experiments, they do have a major drawback—they are going to reflect two separate laser beams. The metalized back surface of the glass sheet will return the most powerful beam, but a weaker secondary beam will emanate from the front glass of the mirror. Often, this is not a problem, but when it is, the only solution is to use a front-surface mirror that reflects only one image.

Mirrors are easy to find. Ordinary rear-surface mirrors are found in discount stores, drug stores, home decorating centers, as well as building and construction supply outlets. The thinner ones are easily cut with a glass cutter. This does take some practice, especially if you have no previous experience working with glass. Go slow, work carefully, and remember that glass edges can result in some nasty cuts. Wear goggles and gloves when working with glass.

Front surface mirrors are harder to find. Many of the companies in the source list, especially surplus dealers, carry them regularly. Hobby shops, toy stores, photographic parts suppliers, old cameras, slide, movie, or overhead projectors can all be fruitful sources of front-surface mirrors. Metalized mylar, and chrome plated or polished sheet metal, while not of exceptional quality, are readily available, inexpensive, and useful substitutes for glass front-surface mirrors.

Once you have the mirrors you need it's time to put them to work. The primary purpose of mirrors and other reflective surfaces is to maneuver the laser beam in a direction other than where it is aimed—to change the direction of the laser beam. In addition to being valuable for the demonstrations and experiments you might set up on an "optical bench", it is easy to see how this principle would be vital in fence perimeter alarms, or bouncing the beam back and forth across a room.

If you add an electric motor to move your mirrors, you'll discover some interesting effects. Try aiming the laser beam first into one revolving mirror and then another. Mirror balls make a really entertaining target.

Prisms and beam splitters

When a beam of white light is

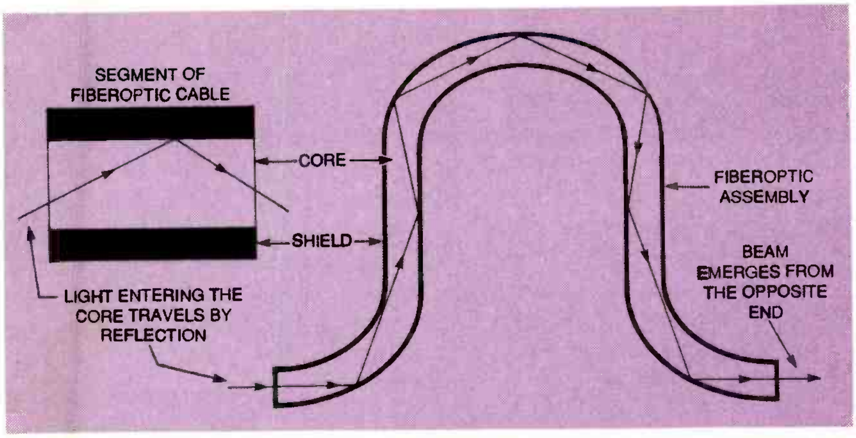


FIG. 3—LIGHT TRAVELS THROUGH A FIBEROPTIC CABLE in a series of straight lines. As each line reaches a surface of the cable it reflects inward and down the cable until the beam finally emerges from the opposite end.

directed at a triangular prism, the light that exits is segmented into all of the individual visible light colors between infrared and ultraviolet. In theory, and by nature, laser light is coherent and monochromatic. In reality, lasers also do emit the entire spectrum, even though one color, or frequency is predominant. Therefore a laser beam directed into a prism will also segment into the full visible light spectrum, with the strongest section being at the spectral location of the primary color. With most He-Ne lasers this will obviously be a section of the red division.

Prisms have many applications when you are conducting optical experiments. Beam splitters are devices that direct part of the light one way, and the rest another. The ratio of this division depends on the type of splitter used and how it is constructed. One simple variety uses the partial mirror principle in which the rear surface is not fully coated. Another method is to place two triangular prisms hypotenuse to hypotenuse. If a right angle or penta-prism is introduced, the beam can be redirected in much the same way as with a mirror, but with virtually no distortion.

The ratio here will depend on the size and shape of the individual prisms. If they are identical the split will be 50 percent each way. If they are different, more light will go in one direction than the other. The most significant benefit of being able to split the beam in two is that you can conduct two different demonstrations or experiments at the same time.

Filters and polarizers

Another optical method for controlling the laser beam calls for using filters. These devices come in a multitude of varieties and purposes. The two most useful filters are single color and white-light inhibitors. The first group are made as red, green, blue, yellow, orange, etc. Generally, they pass only light of their own color and reject all other light. As you saw while building your receivers, this rejection property helps eliminate background noise produced by ambient light. Other dedicated filters control infrared and ultraviolet. Neutral-density have no effect on the color of the light but do regulate the amount of light that passes through them. Diachronic filters allow only one specific frequency of the spectrum through while rejecting all others. Polarizers or polar screens, are marvels in themselves.

If we align the light waves in only one direction by passing the beam through a polarizer the beam is polarized. When a second polarizing element is placed in front of the first and its polarization is aligned with the first element, both filters are passing light on the same predetermined plane. As long as those planes remain aligned, all of the light will pass through both filters. If you rotate one of the polar screens, the planes fall out of phase and light transmission decreases. When the planes are at 90 degrees to each other, all light is blocked by the second filter. This is theoretical and some tiny fraction of the beam will always pass through, but it is easy to see how effective the polarizer is as a light intensity control. Again, refer to the source list, visit photo suppliers and hobby shops, to locate sources of filters.

Another quite satisfactory resource is clear packaging material or colored gels that come with children's' toys and art kits. They are made of glass, plastic, gel stock. You can make your own from a thin waterproof tank and food coloring dyes. Figure 2 shows all the details of a filter you can make.

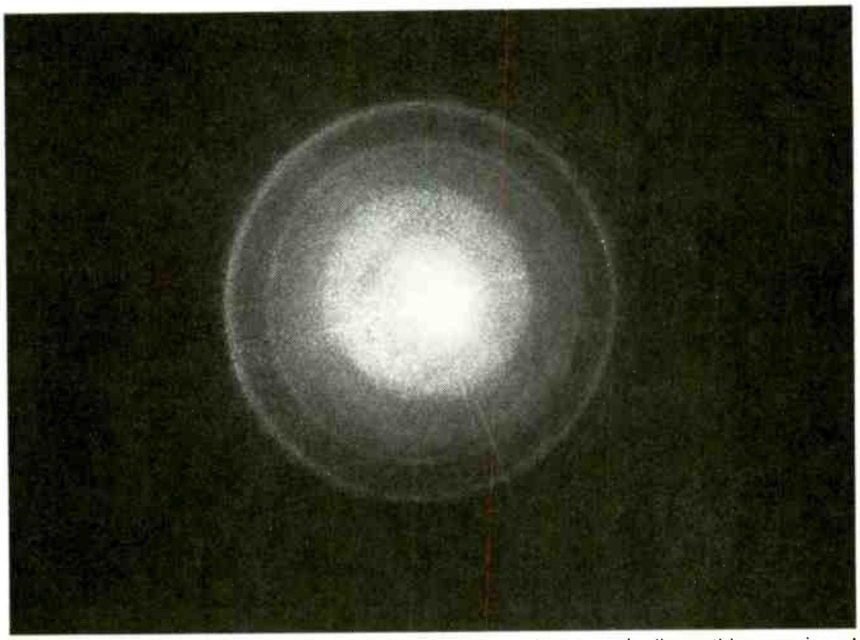


FIG. 4—THIS IS THE HALO EFFECT of laser light. When you duplicate this experiment you will see that each of the bands is a different color.

Light guides and fiber optics

One property of light that all laser experimenters must remember is that light waves or rays or beams do not curve. They only travel in a straight line. This characteristic is the reason why light is easy to redirect. You can change the direction of a laser beam by simply reflecting it off some surface. Also, it contributes to the crisp focusing of light that is not nearly as pronounced in other forms of electromagnetic energy, such as radio or sound. When it is necessary to bend a beam of light, a light guide or fiber optics can handle this task.

Many materials have the ability, through internal reflection, to bend light rays (see Fig. 3). These materials include glass, plastic, and even water. They appear to be function most efficiently when they are formed into round shapes (rods or thin fibers). Again, referring to Fig. 3, the most common type of fiber optic devices uses internal reflection to bounce the light from side to side, down the length of the cable. The solid core, sometimes in actuality a bundle of small fibers, is surrounded by a jacket or shield that keeps external light from entering the fibers. The exposed ends are polished, and sometimes fitted with connectors.

When a laser beam is fed into one end of the assembly, it will follow the shape of the cable, and emerge from the other end, with very little intensity loss. You can make your own home-brew devices from glass and plastic rods that you wrap with black plastic tape, as a shield to keep the light from escaping from the sides. Both materials can be shaped with the aid of diffused heat, but once set, neither one is flexible.

To demonstrate the principle using water as the light conductor, fill a length of rubber tubing or a piece of ordinary garden hose with water. Then aim the laser beam into one end. The light will pass through the water and emerge from the opposite end.

Another method used to obtain the same result revolves around a core that is, for lack of a better description, "spun" into a composite of convex lenses. In this arrangement, the light is constantly being focused towards the center of the core, and follows the shape in that fashion. While useful, and entertaining on the optical bench, the practical applications of light guides are astounding. They have been used by doctors to illuminate areas hard to reach places, to act as extended lenses to explore internally without surgery , to treat heart and eye diseases when used in conjunction with high-power lasers, that pinpoint laser light for use as optical scalpels. New ideas emerge every day.

The communications industry has put them to use in ultra quiet data links that carry, not only voice conversations, but, also, television and computer signals. Commercially, fiber optics have appeared as everything from "gooseneck" flashlights to decorative lamps that shimmer when touched. But, to date, one of the most efficient, and practical partnerships has been between the fiber optic and the laser.

The best bet for finding fiber-optic materials is to check through the source list. Surplus suppliers will be especially valuable. Occasionally, suitable experimental stock can be found in hobby shops or optical or physics kits sold for children and students.

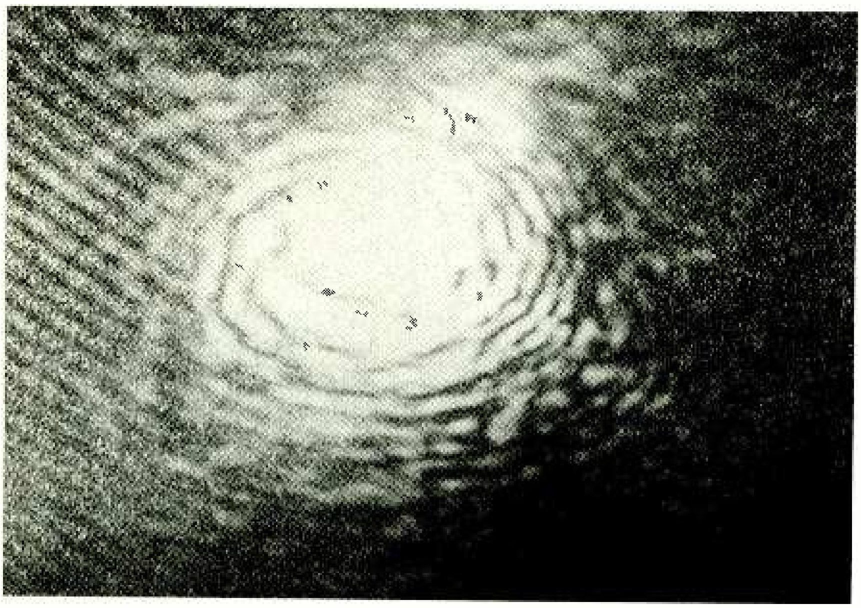


FIG. 5—SPECKLING EFFECT OF LASER LIGHT results when you project the beam an a non-reflective surface. Note the flecks of light around the center. This also reveals the surface terrain of the illuminated object.

Non-reflective surfaces

A few quick notes regarding the properties of non-reflective surfaces. Any material that tends to absorb, or diffuse the beam is considered non-reflective, and can reveal some unique characteristics of laser light. As previously mentioned, although the laser beam is coherent, it still contains all the other colors in the visible light spectrum, in very small quantities. This can be illustrated by observing the "halo" effect that surrounds the pin point spot of light (see photo in Fig. 4). Note, the circular bands of weak light that ripple out from the center; each is a different color as you will see when you try this experiment.

To set up for this demonstration use a sheet of frosted plastic as the non-reflective surface. Arrange the sheet in a "rear projection" position so the laser points at one side and you are able to look at the other side.

Another interesting property of laser light is speckling. Due to the extreme precision of the beam, and the unevenness of most surfaces, especially those made of non-reflective or semi-reflective materials, what appears to be speckles of light surround the spot (see the photo in Fig. 5). In actuality, this is a sub-reflection of the beam. This type of surface absorbes and stops the light at the end of an optical bench or other experiment or demonstration. It limits the laser beam to its intended are. EN

BUILD THIS Stereo Compressor

Designed to lower the audio blasting that goes with TV-commercials, the unit also serves as a studio sound manipulator!

JULES RYCKEBUSCH

AN AUDIO COMPRESSOR IS AN ESsential tool for audio processing and it is commonly found in recording studios. Most recording studios have a selection of compressors, each chosen for some specialized feature or nuance. Your home may not be a professional recording studio, but you do need our Stereo Compressor, so read on.

As the device's name implies, the Stereo Compressor compresses or limits the dynamic range of an audio signal. (Make sure you read the sidebar How Compressors Work.) In a recording studio, compressed audio prevents tape-recorder overload during loud passages without losing quiet passages in the noise floor (hiss). Before compressors were invented, the recording engineer would ride the gain by manually adjusting the signal level. Compressors are commonly used to record vocalists and acoustic instruments, especially those that have large dynamic ranges. Compressed audio can also be used to create artificial effects while recording, such as increasing the apparent sustain of an instrument or completely squashing the level of a signal. We will learn how to accomplish these audio effects later.

Compressors can also be abused. Have you ever wondered why TV commercials sound louder than regular TV programming? Well, the producer of the offending TV commercial has used a large amount of compression on the audio tracks and then boosts the gain to just below distortion level. The end result is an apparent increase in loudness to the listener. This works because modern TVs and home theaters have a large dynamic range for the audio signal.

Film and TV producers take advantage of the dynamic range available to them by recording normal conversation and background sounds 6 to 12 dB below the maximum signal level. Then for dramatic effect, music and sound effects such as explosions can be that much louder than the dialogue track. This is very noticeable when watching a movie on a high-fidelity video tape recorder. In fact, for late-night viewing, when you are *trying* to be quiet, you have to turn the TV up just to hear the dialogue and then quickly turn it down when the car chase scene comes crashing into your living room. But, with the Stereo Compressor, you don't need to constantly ride the gain. It will automatically do that for you!

When you patch the Stereo Compressor between your hi-fi VCR and your stereo sound system, you can enjoy listening to movies late at night in full fidelity, at low volume, without being blasted out of your chair when Rambo raids your living room. You can also use the unit to prevent tape (recording) overload while making home audio recordings.

How it is done

The block diagram of the Stereo Compressor is shown in Fig 1. The input signal is fed to a voltage-controlled amplifier

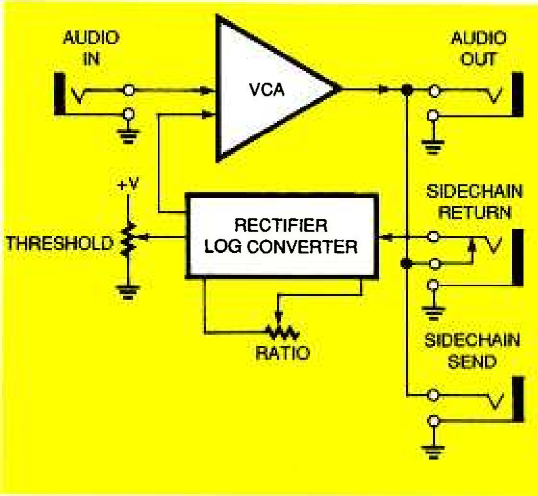


FIG. 1—FUNCTIONAL BLOCK DIAGRAM of the Stereo Compressor. Side-chain portions of the diagram may be omitted from the unit's construction.

(VCA) that has a nominal gain of unity. Some of the output signal is fed to a precision rectifier followed by a logarithmic converter circuit. The output of this block is a DC voltage proportional to the log of the average level of the input signal. By sending some of this DC control voltage to the VCA we automatically reduce the gain of the VCA when the input signal exceeds a user-determined threshold level. It is important to note that we determine the signal level after the VCA and not before. This allows the output level to increase and sound normal, but not increase as much as the input signal does. By varying the amount of feedback we adjust the compression ratio, which in conjunction with the THRESH control, determines the operating characteristics of the compressor.

The optional *sidechain* jacks permit external processing of the audio signal or substituting a completely different audio signal as the control signal. This add-on circuitry lets the user experiment and achieve some useful audio effects.

How it works

Figure 2 is the schematic diagram of the Stereo Compressor. The device has two independent channels of compression, right and left. The heart of the circuit is the SSM2120 dual dynamic range processor integrated circuit IC3. The SSM2120 features two complete dynamic range processors. Each one consists of a voltage-control amplifier, a logarithmic converter, and a precision rectifier. The chip also features a dynamic range of 100 dB at only .01-percent total harmonic distortion at +10 dB input. The remainder of the Stereo Compressor circuit consists of input and output buffers, the control circuitry and the comparator.

Since the electronics for both channels is identical, we will look at the right channel in detail. The input audio signal from J1 goes to an inverting buffer circuit consisting of R40 and R44 and IC1-b. Its output signal (IC1-b, pin 7) is coupled to the signal input on IC3, pin 8, via C4, which blocks any DC component of the input signal. The SSM2120 chip is actually looking for a current input source, and R43 provides the proper amount of current to the chip. The RC filter formed by C8 and R18 eliminates any stray RF interference.

The output signal from the internal VCA of IC3 (pin 4) is actually a current signal. It is restored to a voltage signal by current-to-voltage converter IC1-a and its feedback resistor R46. The signal from IC1-a, pin 1 is routed to output stage amplifier IC5-a via R34. The output signal from IC5-a, pin 1, is coupled via R35 and C9 to jack J3. OUTPUT potentiometer R55 lets you adjust the unit's gain.

The output signal is also sent to the rectifier input (IC3, pin 9) via R36 and C7 either directly, or via the optional side-chain jack circuitry including R50. The side-chain jacks consist of a standard 1/4-inch open-circuit OUT phone jack (J7) and a 1/4-inch IN phone jack (J8) with a normally-closed switch built into them. These jacks form a normalized patch point for additional audio processing. With nothing plugged into J8, the signal path is uninterrupted. By inserting a phone plug into the side-chain IN jack (J8), the normal signal path is broken and either the processed original signal is sent to the rectifier input, or a completely different (new) signal is sent to the rectifier input. We will later see how to use this feature for some really powerful audio processing.

But first, the control side of the house. Resistor R22 provides a reference current to the log-averaging circuit within IC3 via pin 2. It also forms an RC timing circuit with C5. This RC circuit determines the response time for the compressor. The time constant is set so that the compressor will respond rapidly without distorting.

Potentiometer R51 along with other resistors, develops the threshold level signal. The voltage from the wiper of R51 is sent to the threshold input of IC3 (pin 1) via R42. Another resistor R41 across the threshold pin 1 and the control output pin 3 establishes the internal gain of the control stage. The control output signal from pin 3 goes to a voltage-divider network centered around potentiometer R53 then to the inverting VCA input of IC3 (pin 7). A positive voltage on this input reduces the VCA gain, which is what we need to make the compressor work. Note that both the inverting and non-inverting control inputs (pins 5 and 7) are tied to ground via R5 and R7. The control inputs must remain close to ground potential for proper operation. A 6-millivolt change in voltage at these control pins causes a 1 dB change in VCA output. Diodes D6 and D7 ensure a unipolar control voltage. Potentiometer R53 is the compression RATIO control. It gives

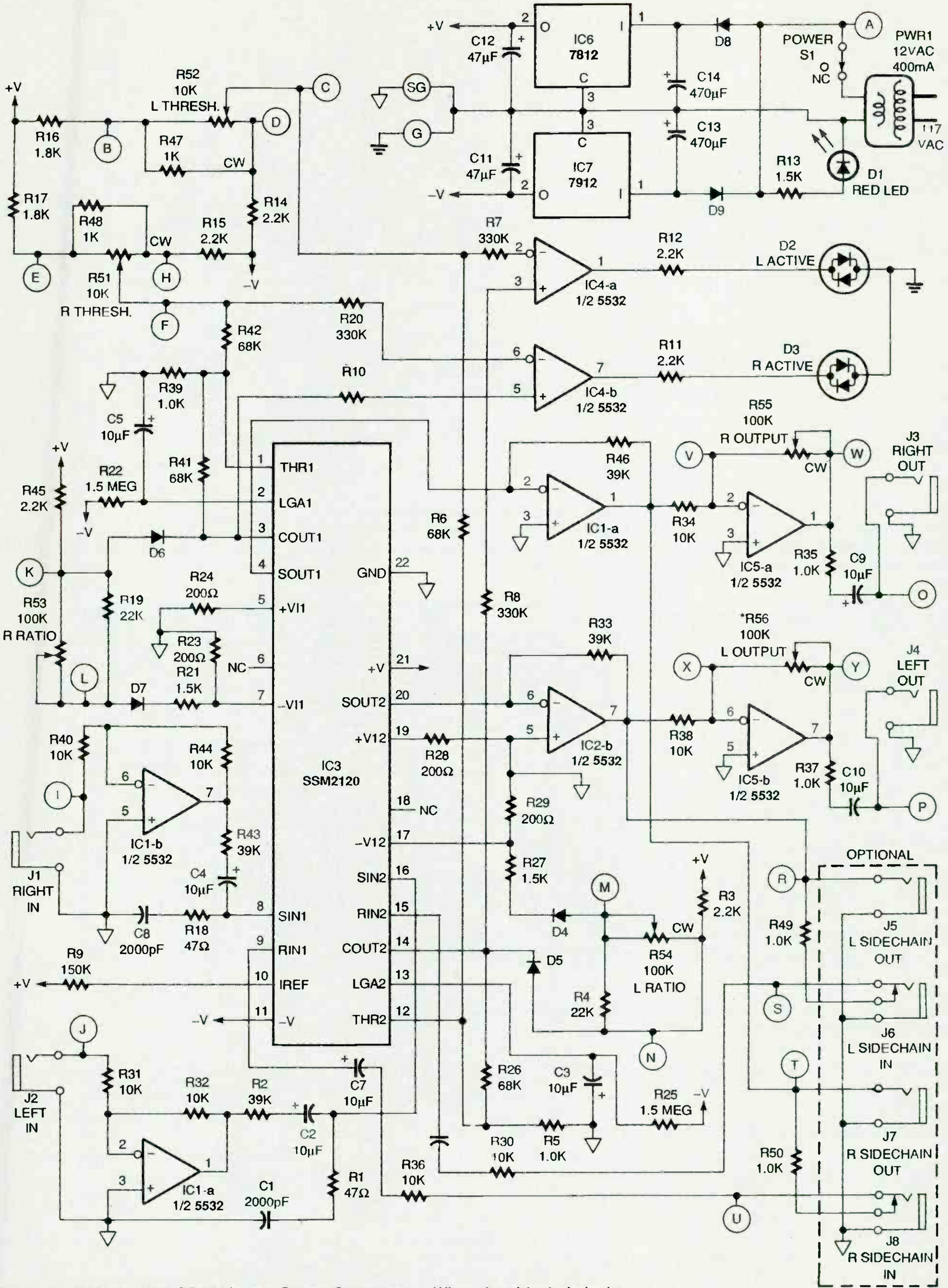


FIG. 2—SCHEMATIC DIAGRAM for the Stereo Compressor. When the sidechain jacks are included, the unit is designated as the Stereo version by PAiA. The Home Theatre version eliminates the jacks.

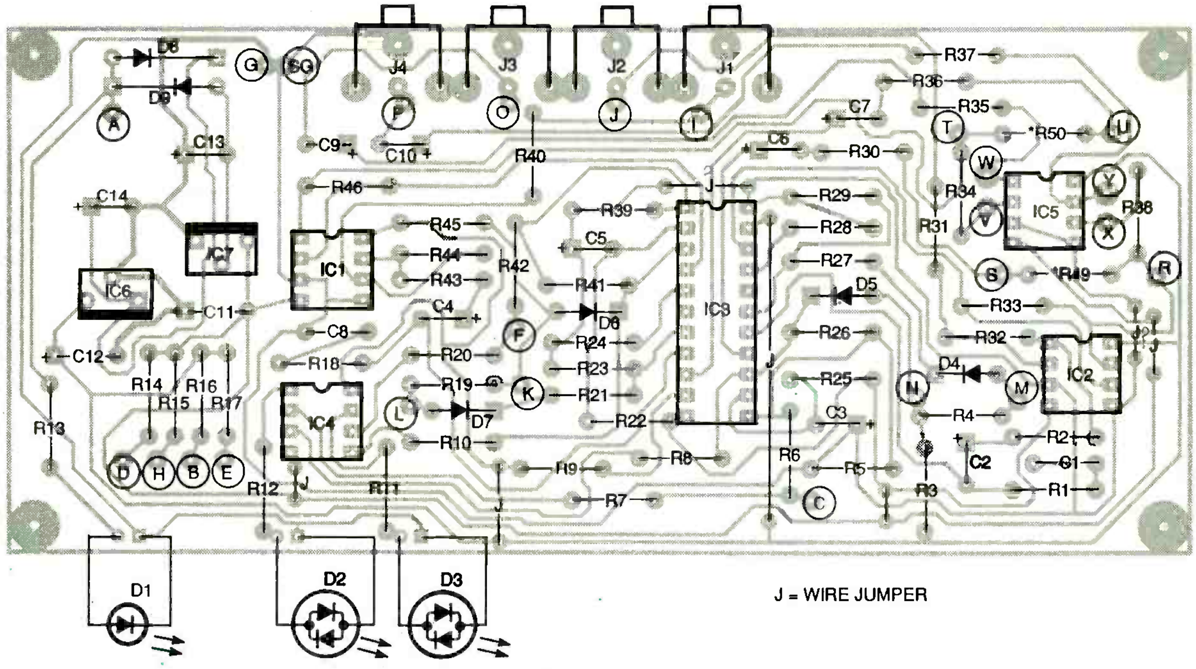
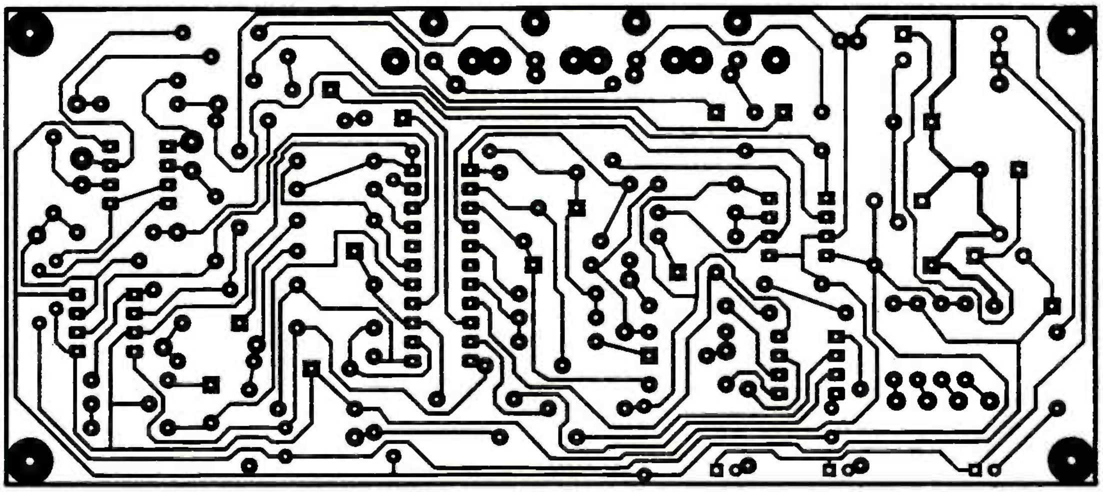


FIG. 3—PARTS PLACEMENT on the PAiA PC board. The silk-screen markings on the board provide an additional assist for the assembler. Resistors R49 and R50 are shown in place for the Home Theatre version. The studio version of the Stereo Compressor has these resistors mounted on jack terminals.



BOTTOM VIEW of the PC board, shown same size, details the foil pattern home-brew experimenters must assemble.

an adjustable compression ratio of 2 to 1, all the way to about 25 to 1.

The last portion of the circuit is the comparator formed by IC4-b, two input resistors R10 and R20, a bicolor light-emitting diode LED3, and current limiting R11 for the light-emitting diode D1. Notice that op-amp IC4-b is a comparator. Normally it is unwise to use an op-amp for this purpose because the output stage saturates, which will slow down the comparator's response time. (Note: D1 through D3 are light-emitting diodes or LEDs. This symbol identification code was used in this story in order to agree with PAiAs kit symbolism.) In this instance, we need to get an output that changes from one supply rail to the other. This makes dual-LED interfacing very simple. Along with being an excellent audio op-amp, the NE5532 functions well as a comparator in this application.

The power supply circuit consists of an externally connected Wall-Wart 12-volt AC transformer PWR1 and associated diodes and capacitors. (See top-right corner of Fig. 2.) One side of the 12-volt AC line is tied to ground and the hot side goes to half-wave rectifiers D8 and D9. These diodes deliver bipolar, unfiltered DC, and each supply is filtered by electrolytic capaci-

Continued on page 72

NEW WINDOWS 95 KEYBOARD

Does your new keyboard have three keys too many? Find out what they're for!

TJ BYERS

MOST OF US EXPECTED WINDOWS 95 to make changes in the way we work, but how many knew just how far these changes would take us. In addition to wrestling with a new desktop interface and 32-bit applications that don't look anything like their Windows 3.1 counterparts, there's Windows 95-specific hardware to learn about, too.

One of the latest, and most interesting, peripherals is the Windows 95 keyboard. Sometimes called a 104-key enhanced keyboard, this new keyboard has three keys dedicated to faster Windows 95 operations. For example, pressing one of these new keys can launch an application or bring up the Start menu. Even if you're not a Widows 95 user, you can program these new keys to jiggle your Windows 3.1 and DOS applications.

The new keys

The three new keys are two "Windows" keys located between the Alt and Ctrl keys on both sides of the space bar and an "Application" key sandwiched between the new right Windows key and its companion Ctrl key (Fig. 1).

A major complaint about Windows 95 is that it requires a fair amount of "mousing around" before you can start even the simplest task. Sure, you can use the Explorer or create a Shortcut group, but they still require a mouse. By the end of the day your fingers will probably ache and maybe your wrist will swell.

Fortunately, the Windows 95 keyboard can put all that behind you. When used in combination with other keys, the Windows keys can lighten your workload in two ways. First, and foremost, you can use the Windows keys in conjunction with other keys to cut through a lot of Windows 95 red tape (See Table 1). Alternatively, you can use the Windows keys to open the Start menu, from which you can either mouse around to your heart's content, or let your fingers do the walking with the cursor keys.

In addition to the two Windows shortcut keys, there is a new Application key. Calling the third key an Application key is something of a misnomer, though, because it doesn't really start any application. Instead, it's a special key that's programmable by an application to do application-specific tasks, such as opening a spreadsheet. However, programs that use the Application key don't really exist as yet, which is why this key is reserved for future use. If you're like me, though, you can't resist pressing it. Well, help yourself. You'll soon discover that the only thing it does is display the current application's context menu—maybe. This is definitely a key in search of a job. Fortunately, you can download

TABLE 1—WINDOWS-KEY COMBINATIONS

Key Combination	Action Taken
Windows	Clicks Start Button
Windows + R	Run dialog box
Windows + TAB	Activates the next Taskbar button
Windows + F	Find document
Windows + Ctrl + F	Find computer
Windows + E	Exploring - My Computer
Windows + F1	Displays the popup menu of selected object
Windows + Pause (Break)	Displays System Properties
Windows + Cursor (arrow) key	Moves cursor halfway to edge of screen
Windows + M	Minimize all
Shift + Windows + M	Undo minimize all

FIG. 1—AT FIRST GLANCE, a Windows 95 keyboard looks like any other. Maxi Switch's Nova 9500W, pictured here, is a Windows 95 keyboard that lists for $49.95 — which means you should be able to buy it for about $35 on the street.

shareware from the *Electronics Now* BBS (516-293-2283) that puts this key to good use.

Advancing the technology

You'd be surprised what a difference three little keys make. While the Windows shortcuts may be reason enough to entice you to buy a new Windows 95 keyboard, you should know by now that most vendors are never content with plain vanilla if they can sell you mocha fudge ripple. Consequently, several keyboard manufacturers are using these extra keys as an excuse to promote their new keyboard technologies—technologies that will reap benefits for users and vendors, alike, but heretofore have found little acceptance except in a few niche markets.

An improvement that many users find valuable is the addition of a large, Backspace key. Located on the left side of a split spacebar (Fig. 2), this new key makes corrections and backspacing faster and easier because accessing it requires less hand movement. Even though this key is found only on 105-key Windows 95 keyboards, it isn't Windows 95 specific. It will work with any Windows or any DOS program just like your conventional backspace key now does.

Custom programming

Shortcuts for Windows 95 aside, a few clever keyboard vendors have discovered a way to make the new Windows and Application keys useful for the Windows 3.1 and DOS user. Using special software drivers, you can program these keys to create custom macros or launch applications.

I first saw these features in an Alps GlidePoint Keyboard. The software included with the keyboard lets you define the function of the split spacebar. It also

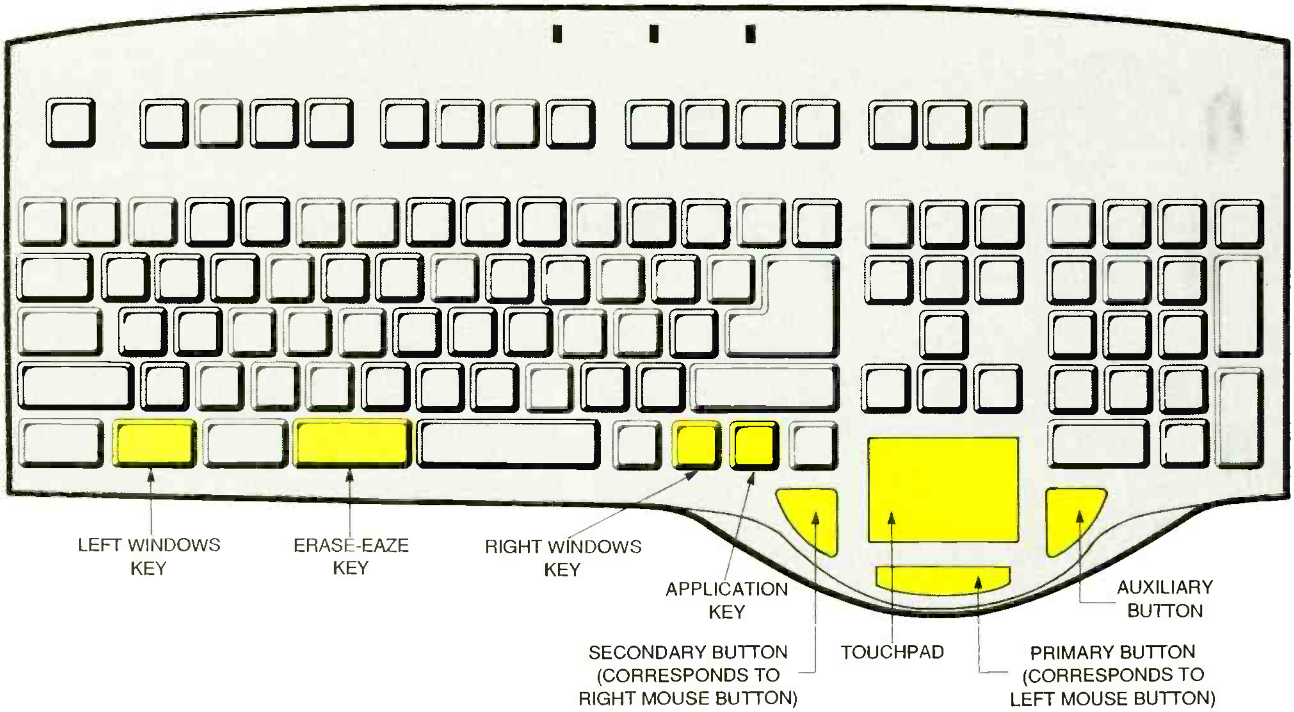


FIG. 2—THE WINDOWS 95 KEYBOARD has three new keys: two Windows keys, one left and one right, located between the space bar and the Ctrl keys, and an Application key seen on the right. Some Windows 95 keyboards have a split space bar that doubles as an oversized backspace key. A few feature a GlidePoint touchpad pointing device.

lets you reprogram the Windows and Application keys to do just about anything you want (Fig. 3). Unfortunately, remapping the Windows and Application keys works only with Windows 3.1, not with Windows 95, Windows NT, or OS/2. Fortunately, I discovered a freeware OS/2 driver on the Web, called WINKEY01.ZIP, that reprograms these keys to work with all flavors of DOS, WinOS/2, and OS/2. You can find it at ftp.leo.org//pub/comp/os/os2/drivers/misc. The Alps program, which is also free for the asking, can be downloaded from their Web site at http://www.alpsusa.com.

Ergonomic improvements

Another area where keyboard vendors are taking poetic license to advance the technology is keyboard ergonomics.

The first thing you'll notice about enhanced Windows 95 keyboards is their size and shape. Most boast a small 18-by-7-inch footprint and a low profile. The lines are rounded, the keys are full travel with tactile feedback, and many are spill proof. The Alps GlidePoint keyboard comes with a contoured wrist rest. And the Nova 9500W from Maxi Switch uses conductive rubber-dome technology, which has a light, tactile touch to reduce fatigue and yield higher data-entry productivity.

Of all the new ergonomic innovations, the "wave" keyboard is undoubtedly the head turner of this century. A major cause of tendinitis and carpal tunnel syndrome in the office place is the way we're forced to use the keyboard—with our palms face down. This is in direct contrast to their natural position of facing each other, as in applause. Exacerbating the situation is that they have to be twisted outward at the same time so that the fingers line up with the keys. This puts a lot of stress on your wrists.

While it's pretty hard to make a practical keyboard that you could clasp between your hands concertina style, the outward twist can be eliminated if the keyboard is split down the middle and hinged at the top. This lets you swivel the two halves until you find an angle that lets you keep your hands and wrist in a straight line with your forearms.

That's the basic principle behind the wave keyboard. Instead of having the halves swing

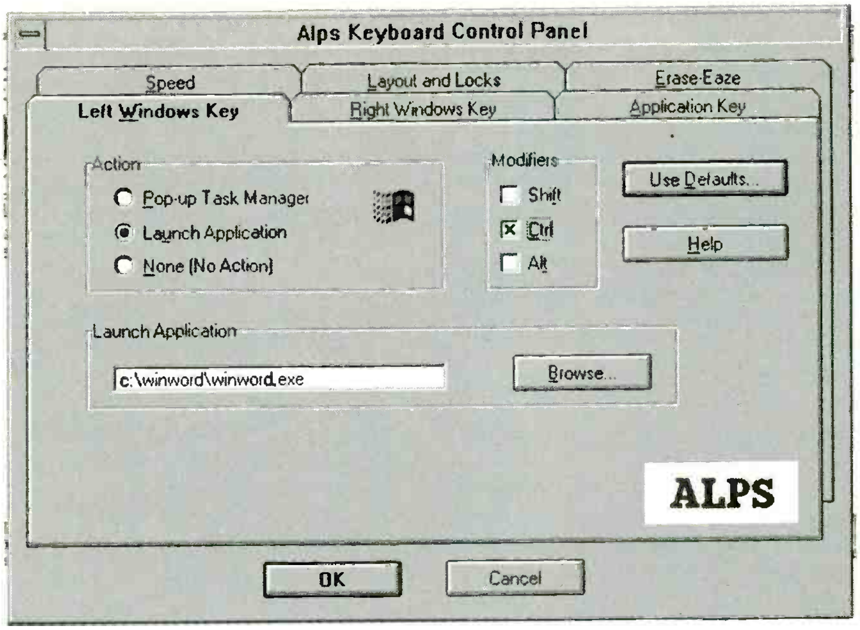


FIG. 3—KEYBOARD SOFTWARE, like that from Alps Electric (http://www.alpsusa.com) and the one located on the Electronics Now BBS at 516-293-2283, lets you remap the Windows and Application keys.

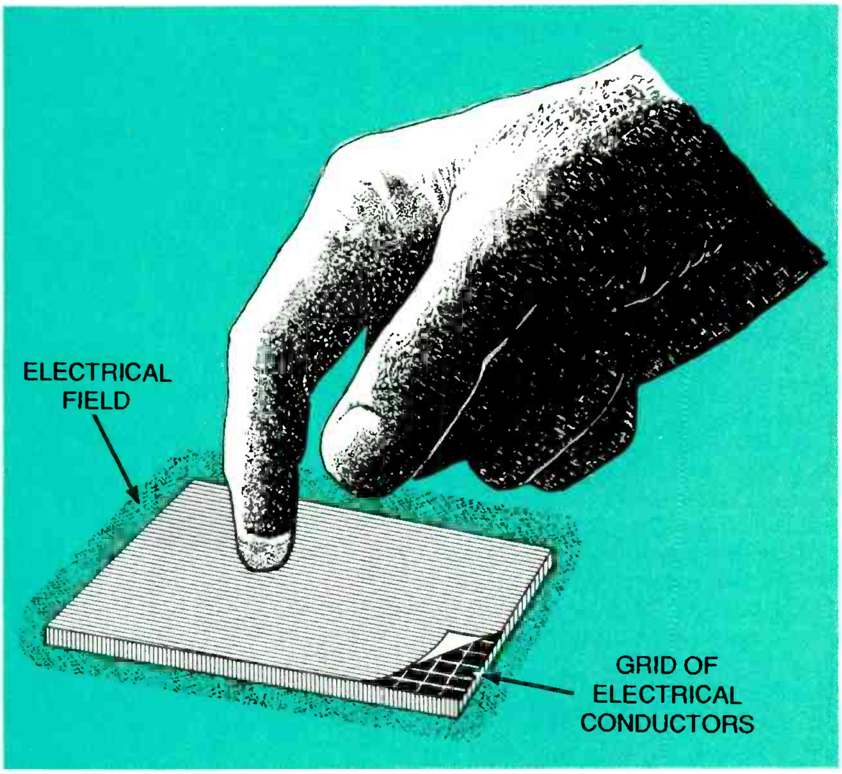


FIG. 4—THE GLIDEPOINT TOUCHPAD POINTING DEVICE works on the principle of field distortion sensing, a form of capacitance-sensing technology. When you come in contact with the touchpad, the capacitance in your finger distorts the electric field at that spot. Because the technology depends on body capacitance, GlidePoint requires no contact pressure and is immune to other types of stylus, like a pencil.

through an infinite range of angles, though, the Microsoft's wave keyboard, shown on the first page of this article, permanently sets the angle for you.

Directly to the right of the keyboard are the quick-access keys, which consist of the word processing keys (insert, delete, etc.) and the inverted-T cursor keys. Here is where the wave keyboard has an advantage over a hinged keyboard. Notice that these keys are angled slightly clockwise of the vertical. This is done so that a slight twist of your wrist lets you access them without having to move the position of your hand. Finally, there's a standard 17-key keypad. Basically, this is your standard 10-key numeric keypad plus a smidgen of computer command keys, like Enter and NumLock. The orientation of this keypad is straight ahead, simply because it's the most comfortable way to use these keys.

When all four elements are viewed from afar, the keyboard looks like a flag waving in the breeze — hence the name, wave keyboard.

The GlidePoint

At least two keyboard makers, Alps Electric and Cirque Corp., embed the unique GlidePoint touchpad pointing device into some of their Windows 95 keyboard designs. Invented by Cirque Corp., the GlidePoint touchpad does everything your mouse does—only better. Instead of chasing a rodent across your desktop, you use your fingertip to control the movement of the pointer and launch applications. With GlidePoint, you don't need a mouse—your finger is the mouse.

Unlike most mouse-alternative pointing devices, GlidePoint doesn't need special software to work. It behaves exactly like a Microsoft serial mouse right from the box. When the optional software is installed, GlidePoint leaves the mouse eating dust. For example, a single tap on the touchpad is the same as clicking the left mouse button, and double tapping is the same as a double click. You can even drag and drop without using the "mouse" button.

The only problem is it takes some getting used to. At first I though that pounding harder on the keypad would produce faster results. It's just the opposite. The lighter the touch, the more responsive the keypad. The GlidePoint touchpad works its magic through a technique known as field-distortion sensing, a form of capacitance-sensing technology. Under the touchpad's surface are two layers of parallel wires, separated by an insulator, arranged in a matrix pattern (Fig. 4). When power is applied to the grid, an electrical field is generated.

When you place your fingertip on the touchpad, the capacitance between your finger and ground distorts the electrical field. By scanning the grid and measuring the strength of the distortion on each conductor, the touchpad can precisely pinpoint the location of your finger. If you move your finger, the location of the electrical distortion moves, too. The touchpad tracks this motion, and translates it into on-screen pointer movement. A mistake that I made was pressing too hard. As it turns out, the lighter the pressure, the more responsive the GlidePoint pad.

From Windows keys to wavy keyboards to GlidePoint mice, the new Windows 95 keyboards are right on key. So much so, in fact, that it's almost a given that the next keyboard you buy will be a Windows 95 keyboard. The days of the Enhanced 101-key keyboard, like Windows 3.1, are numbered. Ω

KEYBOARD SOURCES

Alps Electric (USA), Inc.
3553 N. First St.
San Jose, CA 95134-1898
(800) 825-2577
http://www.alpsusa.com

Cirque Corp.
2850 E 3300 S
Salt Lake City, UT 84109
(801) 467-1100
http://www.xmission.com/kurtisv/cirque.html

Fellowes
1789 Norwood Ave.
Itusca, IL 60143
(708) 893-1600
http://www.slonet.org/hwright/fellowes.html

Fujitsu Microelectronics, Inc.
Electronic Components Div.
3545 N. First St.
San Jose, CA 95134
(800) 642-7616
http://www.fujitsu.com/FCPA/

Gateway 2000
610 Gatewat Dr.
North Sioux City, SD 57049
(800) 846-2000
http://www.gw2k.com/

KeyTronic Corp.
PO Box 14687
Spokane, WA 99214
(800) 262-6006

Maxi Switch, Inc.
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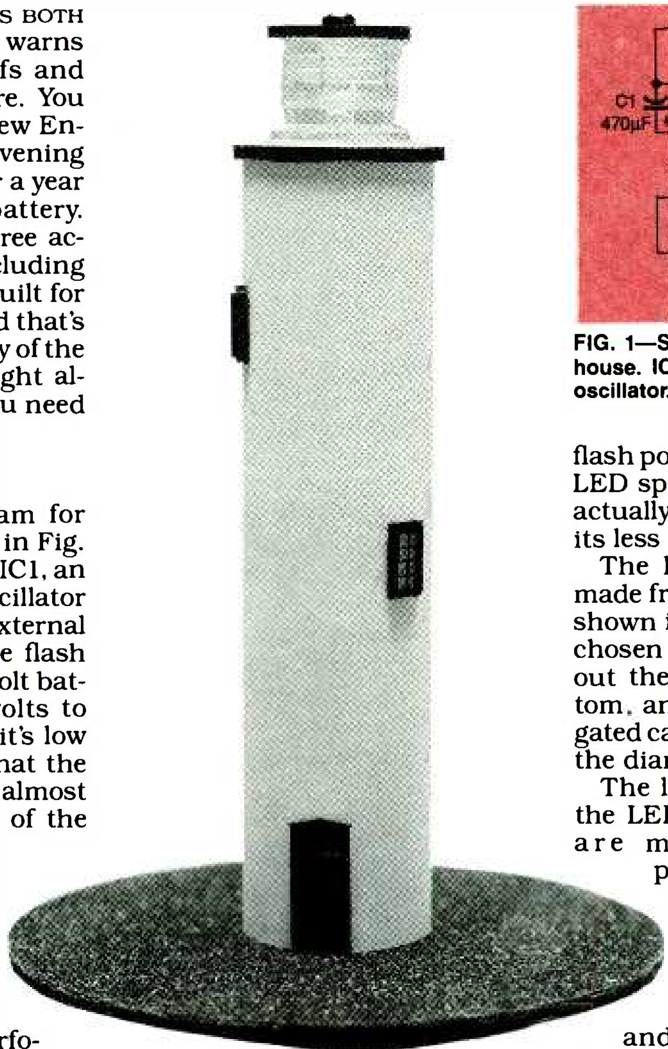
All right! Who gave me this laser pointer?

ELECTRONIC LIGHTHOUSE

This one evening project will run for over a year on a single battery!

DEAN F. POETH, II K8TM

THE LIGHTHOUSE COMBINES BOTH beauty and utility as it warns ships of dangerous reefs and other hazards near shore. You can build a model of a New England lighthouse in one evening that will run for well over a year on a single flashlight battery. The circuit uses only three active components (not including the battery) and can be built for less than five dollars. And that's only if you have to buy any of the necessary parts. You might already have everything you need in your junkbox.



How it works

The schematic diagram for the lighthouse is shown in Fig. 1. The circuit is based on IC1, an LM3909 LED flasher/oscillator integrated circuit. An external capacitor determines the flash rate and boosts the 1.5-volt battery voltage to over 2 volts to light an LED. The circuit's low current drain ensures that the lighthouse will operate almost as long as the shelf life of the battery.

Construction

Construction is straightforward and the parts layout is non-critical. Because there are so few parts, perforated construction board is the preferred construction method. A super-bright LED is recommended for the most brilliant flash possible. The super-bright LED specified in the Parts List actually draws less current than its less efficient cousins.

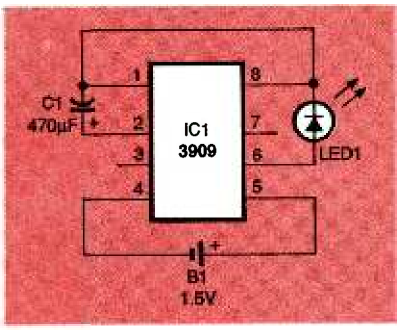


FIG. 1—SCHEMATIC FOR THE LIGHTHOUSE. IC1 is an LM3909 LED flasher/oscillator.

The lighthouse is basically made from a cardboard tube, as shown in Fig. 2. Once you have chosen the tube you'll use, cut out the spacer disks, the bottom, and the base from corrugated cardboard. Cut them to fit the diameter of the tube.

The lighthouse floor (where the LED is mounted) and roof are made from 3/16-inch plywood. White card stock, cardboard, or balsa wood can be substituted, however. Cut out the parts with a band saw and drill two holes in the floor for the LED leads. Paint both discs black or color them with a large felt-tip marker.

Glue aluminum foil to the underside of the roof and white paper to the top of the floor. Trim away any excess foil and paper. The bump, or bubble, on top of the roof is a ceramic transistor with its leads cut off. Any similar "bump" could be used here, or you don't have to install one at all. The lighthouse details are merely suggestions, and you are certainly free to design your own lighthouse and add your own details if you so desire.

PARTS LIST

- IC1—LM3909 LED flasher (Radio Shack No. 276-1705)
- LED1—Super-bright 2000 mcd LED (Radio Shack No. 276-087)
- C1—470 µF, 35-volts, electrolytic
- B1—1.5-volt alkaline D cell
- Perforated construction board, cardboard tube, 2-liter plastic soda bottle, grass paper, wire, cardboard, plywood, burned out transistor (see text), and decorations such as doors, windows, and paint.

The dome lens is made from the threaded top part of a clear plastic 2-liter soda bottle. First cut the bottle near the top with a utility knife or scissors, and then finish the edges by sanding them smooth. A stationary belt sander works great for this. Then glue the roof to the top of the lens.

Pass the LED leads through the holes that you drilled in the lighthouse floor and glue the LED in place. Next glue the LED floor to the lighthouse lens. Once the glue has dried, you can wire the LED and battery to the circuit board.

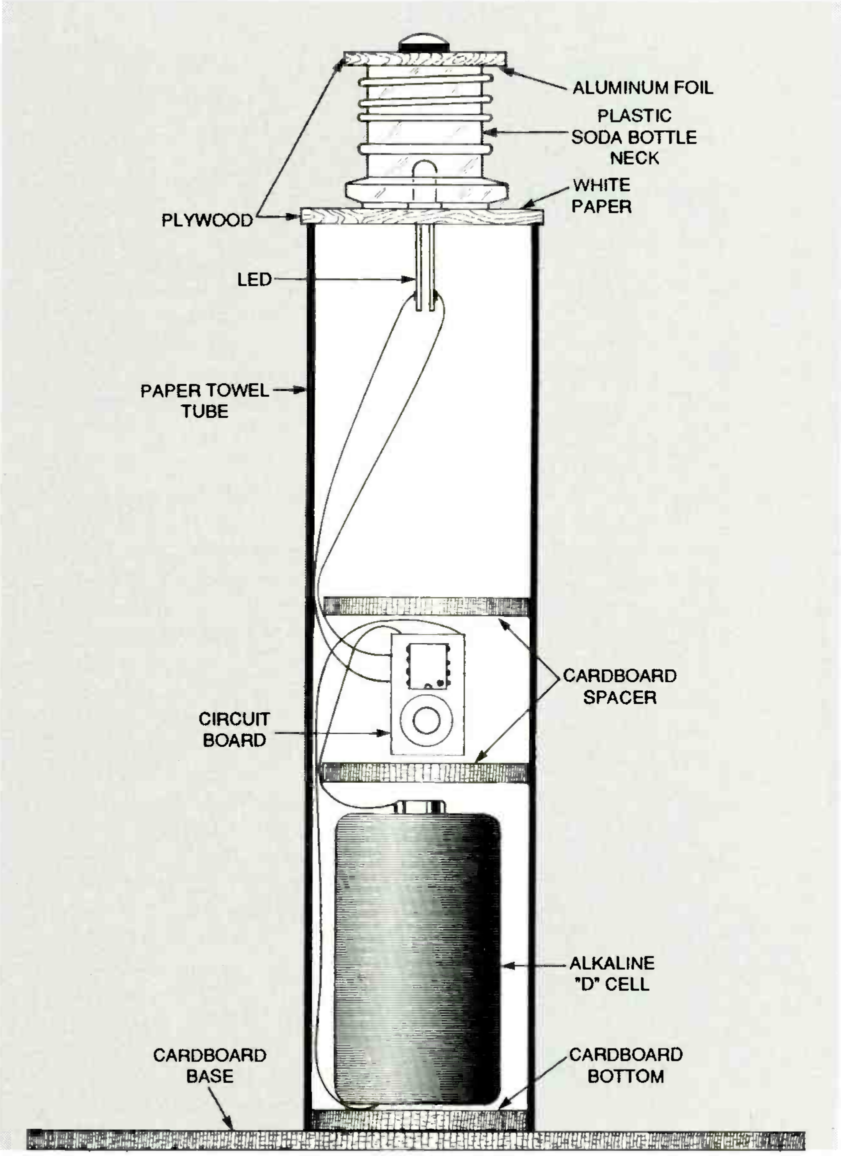


FIG. 2—THE LIGHTHOUSE IS MADE from a cardboard tube and other bits of wood and cardboard.

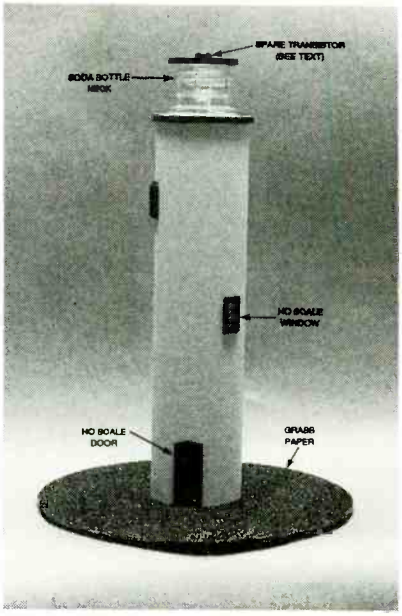


FIG. 3—THE BUMP ON TOP of the roof is an old ceramic transistor with its leads cut off. The dome lens is made from the threaded top part of a clear plastic 2-liter soda bottle. An HO-scale door and windows complete the look.

The body of the lighthouse should be about 7 inches long. After gluing the cardboard bottom to the tube, either wrap the tube with plain white paper glued in place or paint the tube white. Trim off any excess paper hanging over the ends of the tube. Next glue some grass paper (used on model railroad layouts) to the top of the cardboard base and then glue the lighthouse to the base (see Fig. 3).

Insert the battery, circuit board, and spacer disks into the tube as shown in Fig. 2, and then glue the dome assembly to the top. You can add a few finishing touches to the lighthouse to give it that custom look by gluing an HO-scale door and some windows to it. You can also make your own doors and windows, if you like.

The lighthouse is now ready to be placed in a dimly light corner of an office or room. There it will sit, warning people of the "dangers" around it. Ω

BUILD THIS DISCONE VHF-UHF ANTENNA

THE DISCONE ANTENNA DESCRIBED here was designed to operate over a frequency range of 700 to 2000 MHz. It is a very small antenna, but very effective. It is vertically polarized, and has an omni-directional radiation pattern.

The antenna's principle elements are a flat conducting disc mounted horizontally atop but insulated from a conducting cone. The disc diameter is about 0.17 wavelength at the lowest desired operational frequency, and the cone has a length of 0.25 wavelength on the side. The discone's impedance is 50 ohms, so it can be fed by a 50-ohm coaxial cable. The outer (shield) conductor is connected to the cone, the center conductor is connected to the disc. The antenna's actual impedance varies depending on the cone's angle, frequency, and disc-to-cone spacing. Nevertheless, discone dimensions are not very critical for optimum performance.

Figure 1-a is an idealized sketch of a true discone antenna and its basic dimensions. It was determined that the disc diameter should be 3 inches and the length of a side element of the cone should be 4¼-inches. The angle θ (Fig. 1-b) could be any angle between 25 to 40 degrees, so 30 degrees was selected for a practical reason. The space created by the insulating washer (S) will be ⅕ of the inside diameter of the brass tube (Fig. 2) or about ⅛ inch (thickness is not critical).

Construction

A piece of ⅝-inch brass tube is used to support the discone and is the outer conductor of the feedline (Figs. 1-b and 2). This tube has an inside diameter of 19/32 inch. With commonly available ¼-inch brass rod used for an inner conductor, the section of coaxial line that results has a 52-ohm impedance.

The exact impedance is not too critical and less than 10% variation in impedance should not cause reception problems. The length of the brass tube is up to the discretion of the builder. The loss the added length in-

The discone is a popular wide-band antenna for VHF and UHF. This article shows you how to build a very efficient one for your UHF scanner.

WILLIAM SHEETS, K2MQJ and RUDOLF F GRAF, KA2CWL

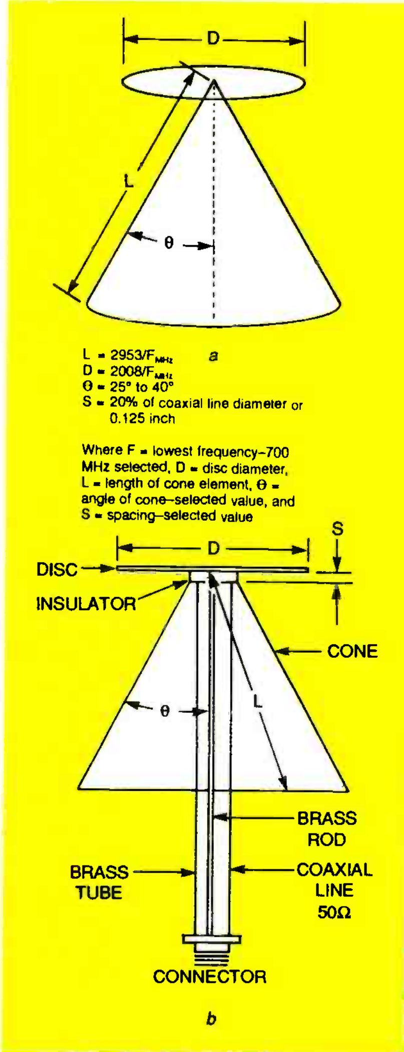


FIG. 1—DISCONE ANTENNA DIMENSIONS: a–view of idealized discone antenna and, b–view of assembled antenna specified in this article. Equations can be used for assembled antenna and provide excellent reception results.

troduces is negligible. A 5½-inch length of brass tube was used in the discone illustrated here, but up to about two feet of tubing should present no problems. Longer lengths will require some mechanical modifications in order to ensure that the line geometry remains concentric and reasonably rigid. This becomes a construction problem and should be avoided.

Theoretically the cone of the discone should come to a point. However, it can be truncated to allow the brass tube to be soldered to it. The disc is fastened to the brass rod (Fig. 3) by a screw which fits into a tapped hole in the center conductor. A shoulder insulator made from plastic faucet washers keeps the brass rod concentric with the inner wall of the brass tube and provides a spacing between the disc and cone of about 0.125 inch. The bottom end of the line section is soldered to a type N UHF connector. A small clamp or U bolt can be used to mount the antenna to a mast.

Sheet metal work

The disc and cone were cut from .019 gauge copper flashing stock (Fig. 2) purchased from a local plumbing supply house. Since the angle selected is 30 degrees, a half-circle pattern is needed to form the cone. Cut the cone and disc according to pattern. Allow a little overlap tab as shown in Fig. 2 to allow for soldering. Use shears and wear heavy gloves as copper tends to cut with sharp razor-like edges. File all edges smooth.

The cone is formed by first drawing radial lines on the inside surface, bending the pattern a little at each line around a block of wood or steel, and repeating the process until the pattern edges meet. The cone should be a fairly good, even, circular shape. Make sure the hole at the top will fit the ⅝-inch brass tube snugly. Clean the edges and soldering surfaces with fine (No. 0) steel wool. Clamp the edges of the cone together with the tab underneath and solder using 60/40 solid-core solder and a liquid flux. Next, clean the brass tube with fine

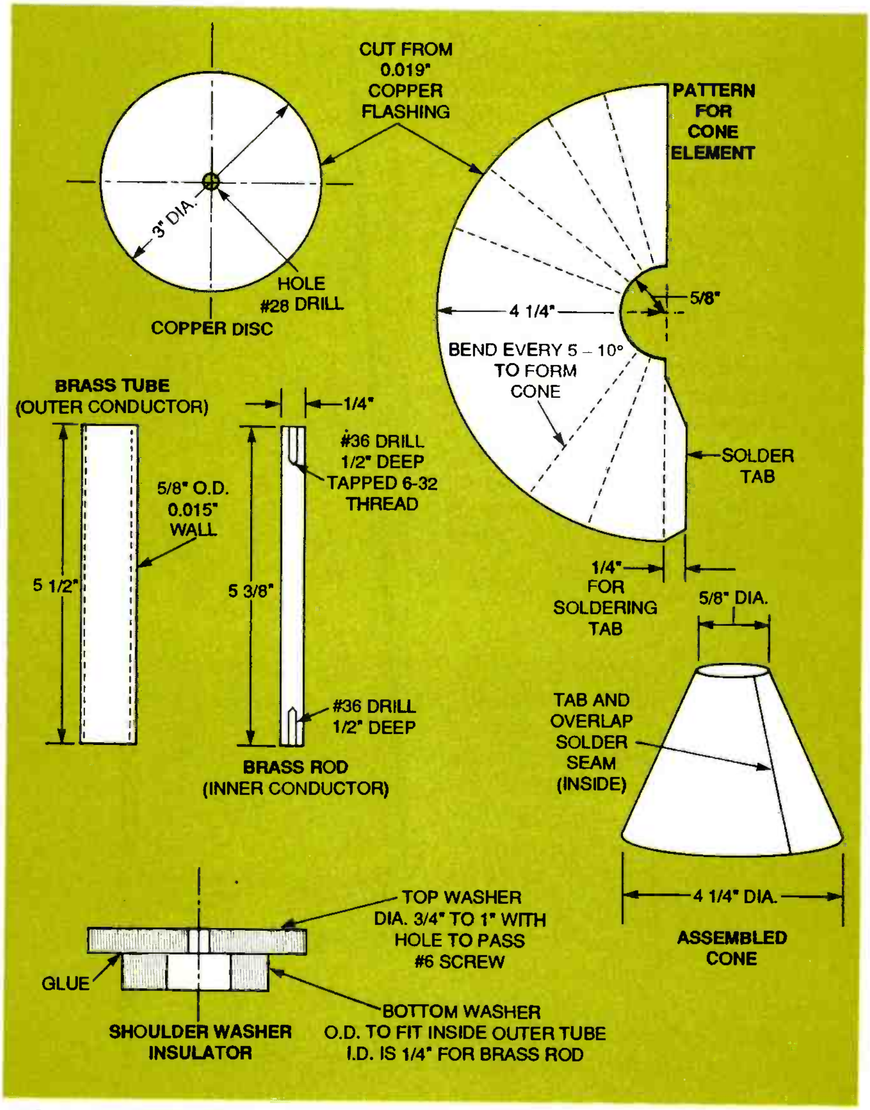


FIG. 2—CONSTRUCTION DETAILS for a 700-2000-MHz UHF discone antenna.

steel wool and solder the cone to the brass tube as shown in Fig. 3. Make sure the brass tube is symmetrical and concentric in the cone. Carefully clean all flux residues using hot water and baking soda, followed by a final rinse in hot water.

Cut the brass rod to the same length as the brass tube. Drill a #36 hole in each end ½-inch deep. Use a drill press if possible, and center punch each end to prevent the drill from "walking". The rod has to be held by a vise or clamp to do this. Tap one end of the brass rod for a 6-32 screw thread.

Make a shoulder-washer insulator as shown in Fig. 2 from two plastic washers. The top larger washer should be ¾- inch diameter by ⅛-inch thick and the center hole should be large enough to pass a 6-32 screw (#28 drill hole), but not larger than 3/16 inch. The bottom washer should be press fit into the brass tube whose inside diameter is 19/32-inch. The center hole should be ¼-inch diameter to pass the ¼-inch brass rod. Glue the washers together to form a shoulder washer. Now trial fit the entire discone assembly together. Trim the length of the center conductor so the top of the shoulder washer rests on the end of the brass tube. When the parts fit properly, you are ready to solder.

Clean the brass rod and the rear of connector flange with fine steel wool. The surfaces should be shiny. Using 60/40 rosin core solder, solder the untapped end of the brass rod to the N type UHF connector's center pin. Use at least a 100-watt soldering iron. Next, insert this assembly into the lower end of the ⅝-inch brass tube. Insert a 6-32 by ½-inch long, brass, roundhead screw through the center of the copper disc, the insulator, and into the tapped hole in the end of the brass rod. Tighten the screw enough to hold the parts together and hold them in place for soldering. Make sure the brass tube is centered on the flange of the connector. Now, solder the connector's flange to the brass tube all around the seam. Use only enough solder to do the job.

Check for shorts with an ohmmeter. There should be an infinite resistance between the disc and cone, and the center terminal and flange of the type N connector. Next, check that zero

PARTS LIST

LIST OF MATERIALS

1—Brass tube, ⅝-in. (0.015-in. wall), 5½-in. long
1—Brass rod, ¼-in., 5⅜-in. long
1—Copper or brass sheet, .019 to .030-in. thick, approximately 5 × 12 in.
1—Type N UHF connector, UG58A/U, preferably silver plated
2—Plastic faucet washers (¾ to 1-in. dia.) with hole for #6 screw or smaller (drill and file to sizes in drawing)
1—6-32 × ½-in. brass machine screw, Philips or slotted head
2—Pipe clamps to fit ⅝-inch O.D. tube (plastic preferred) for mounting antenna.

Parts and materials not normally stocked by electronic parts stores can be obtained at hobby shops specializing in model aircraft and/or cars, plumbing supply outlets and hardware stores.

A catalog describing kits for ATV transmitters, ATV receiving converters and other projects usable with the antennas described in this article is available from North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804. Please include a #10 SASE and $1.00 to cover handling and postage.

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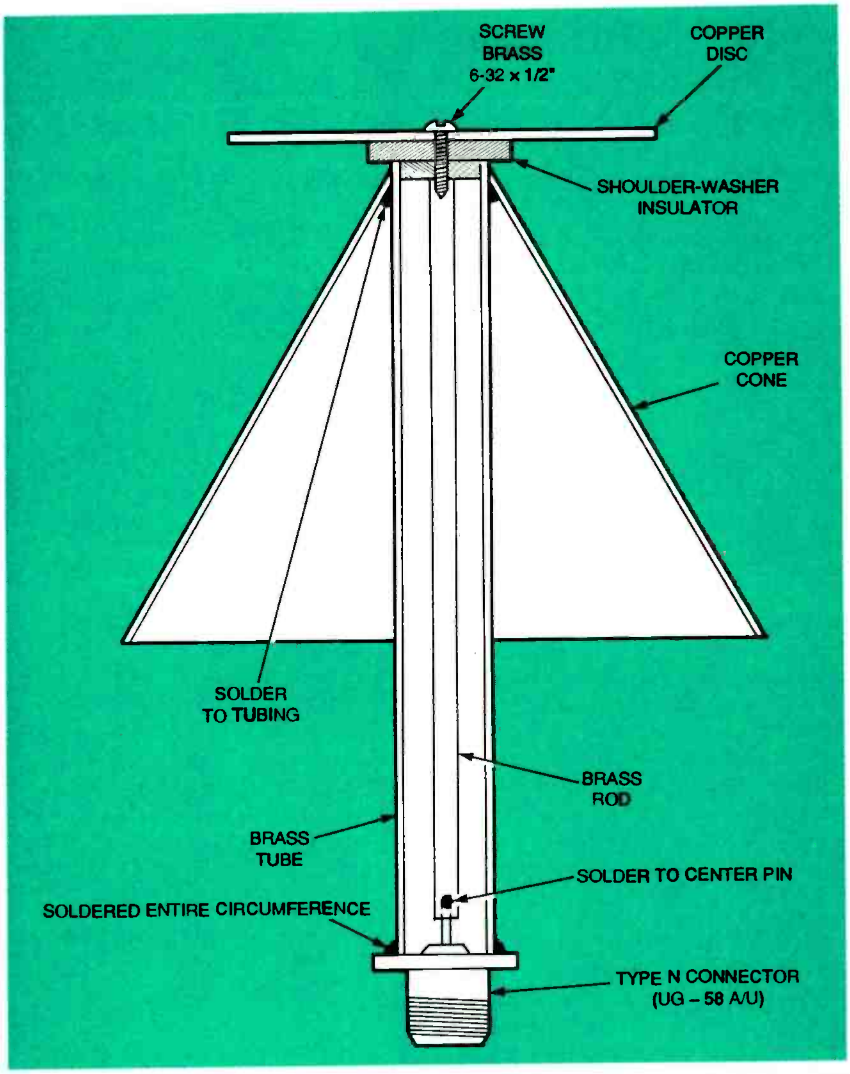


FIG. 3—ASSEMBLY VIEW of the discone antenna. Parts should fit firmly together before soldering is attempted. Clean surfaces to be soldered to a bright shine with #0 steel wool.

resistance (short circuit) exists between the disc and the center terminal of the connector.

Clean all flux residues and the discone construction is done. Alcohol is good for removing rosin flux. Clean with alcohol only outdoors and away from fire as alcohol can be toxic and is highly flammable.

If you have suitable equipment, check the antenna's VSWR at the frequencies of interest. The prototype's measured VSWR was found to be better than 1.5 to 1 at 910 and 1289 MHz. Use type N connectors preferably.

Mount it

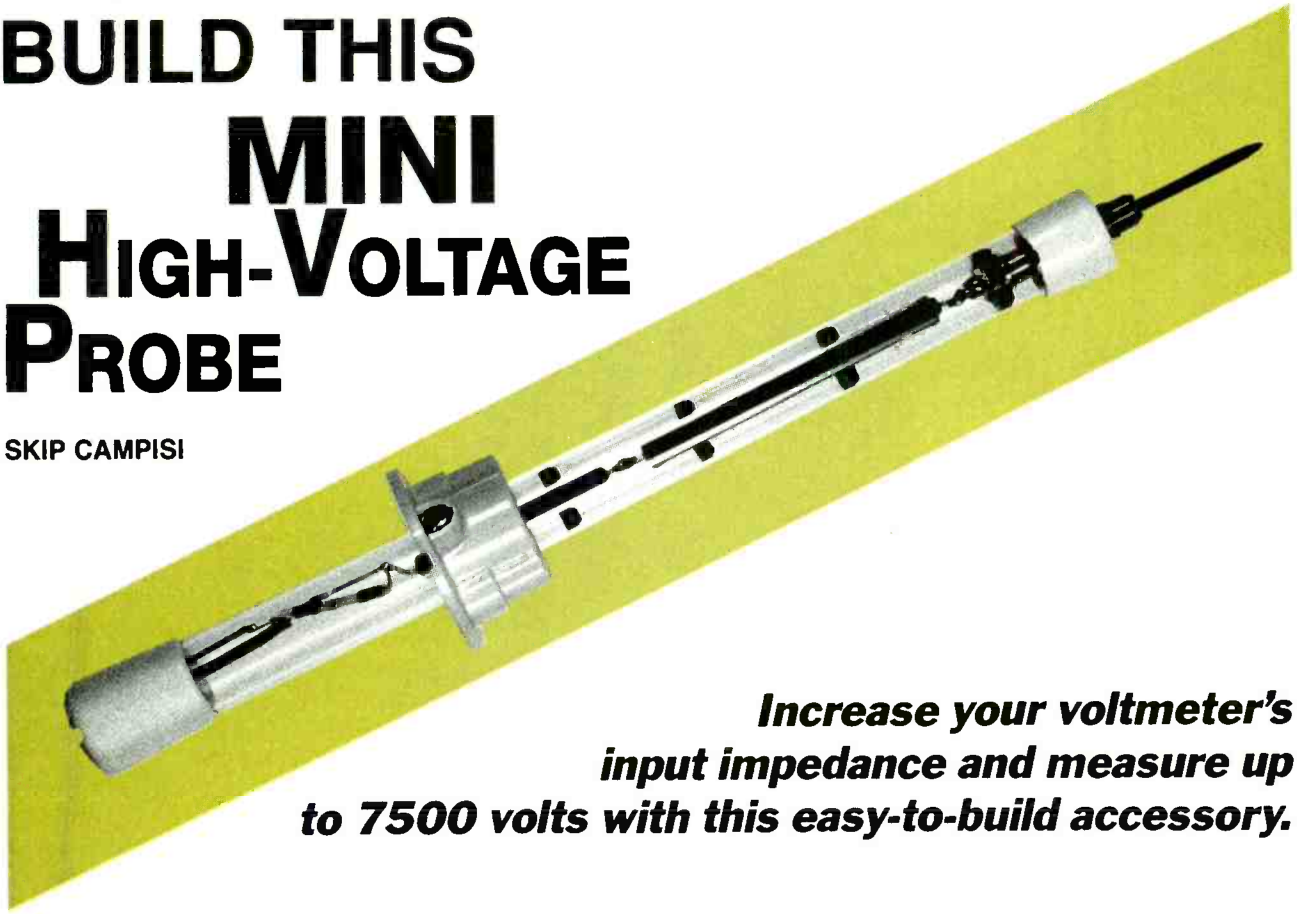
The discone can be mounted to a mast with clamps. Fasten clamps around lower end of brass tube, being careful not to dent or crush it. You can use small metal or plastic cable clamps as the antenna is very light, or it can be plugged directly into the scanner antenna jack. Use a right-angle adapter.

When the antenna was used with a pocket scanner, excellent reception results were obtained on 860 and 935 MHz commercial signals, much better than the 8-inch "rubber ducky" original equipment. Also, a marked reduction in intermodulation and cross modulation effects was noted. Although below the cutoff frequency, satisfactory 450-MHz reception was also obtained. For optimum 450 MHz performance, increase the cone and disk dimensions 75 percent.

In field tests, the discone assembled by the authors outperformed a 24-inch commercial discone sold for scanner reception at 900 MHz. This is probably because the home-built discone has a lower wave angle and because it is constructed of solid copper elements, with resulting lower losses. Improvement on reception and transmission was about 3 dB. The discone was actually used as a transmitting antenna for some experimental amateur TV transmissions at 900 and 1300 MHz frequencies. (See ATV Transmitter, page 31, May, 1996 issue.) Ω

BUILD THIS MINI HIGH-VOLTAGE PROBE

SKIP CAMPISI



Increase your voltmeter's input impedance and measure up to 7500 volts with this easy-to-build accessory.

THE MAXIMUM ALLOWABLE VOLTAGE specification on the typical digital voltmeter (DVM) usually never exceeds 1000 volts. Even the DVM's 10-megohm input impedance every so often loads down a high-impedance circuit giving false readings. That's why you either need a $100-plus, store-bought, high-voltage probe or the Mini High-Voltage Probe that you can build in one weekend for about $10 to $20. So save the money and read on.

The Mini High-Voltage Probe has an input impedance of 110 megohms, or 11 times that of a standard DVM, and it can handle 5000-volts AC or 7500-volts DC peak. The prototype illustrated in this article and a common, service-type DVM were used to test a 5500-volts AC transformer, and the probe performed perfectly. Its accuracy is within 1 percent, which is typical considering the components used in the probe's construction.

About the circuit

The schematic diagram of the probe (Fig. 1) reveals its simple circuit. It is a standard voltage divider made up of resistors with a 1-percent tolerance. Resistors R1 and R2 are the key elements here. They are rated at 15,000 volts and 10,000 volts, respectively. The 7500-volt DC peak specification for the assembled probe **must not be exceeded under any circumstances!** Play it safe and purchase a factory-built unit if you require higher voltage measurements, especially if you wish to do TV servicing.

The values for series resistors R3 and R4 are in parallel with the 10-megohm resistance of the DVM, thus providing a 1000 to 1 voltage divider. Voltage measurements made by the probe should be multiplied by a factor of 1000. If your DVM uses a different input impedance than the standard 10 megohms, you can adjust the R3-R4 series combination as needed.

Construction

The body of the probe is made from an antenna wall feed-through tube available from Radio Shack. The tube is made of clear plastic with an outside diameter of ¾ inch, and a bore of ⅝ inch. It has two flanged end plates, one of which is glued in position. Remove the other end plate by loosening the Phillips

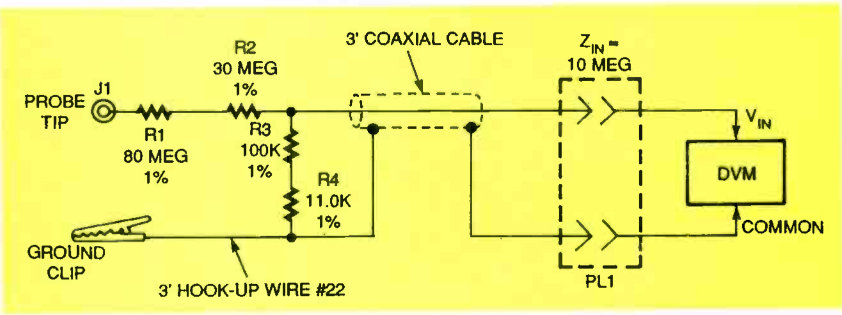


FIG. 1—SCHEMATIC DIAGRAM for the Mini High-Voltage Probe.

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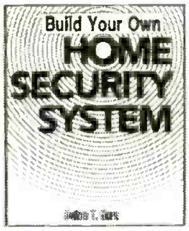

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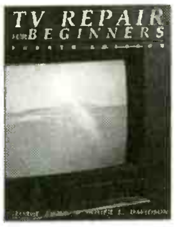

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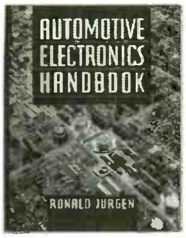

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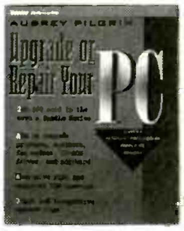

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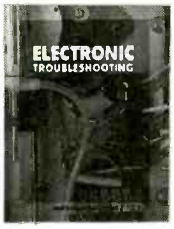

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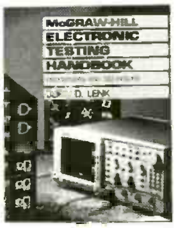

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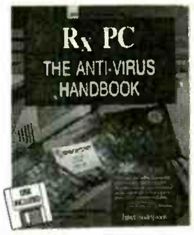

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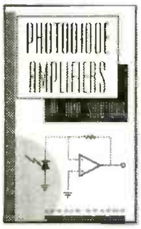

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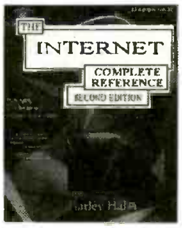

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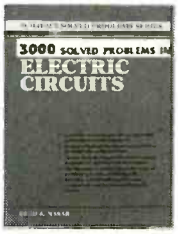

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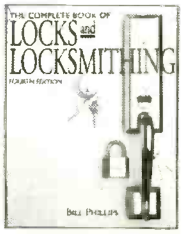

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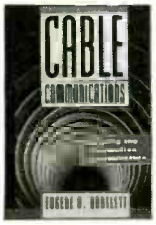

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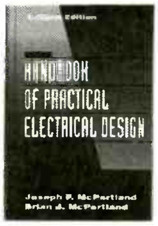

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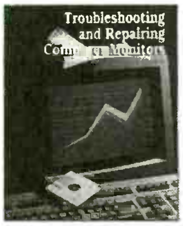

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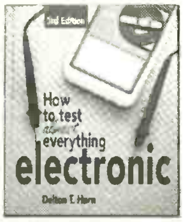

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head set screw and slide it off the tube. Measure from the open end of the tube and cut off (with a hacksaw or razor saw) an 11-inch length of tube. Discard the short piece with the glued-on end plate.

Take the end plate containing the set screw and note the lip inside the bore. Use a ¼ to ⅜-inch diameter rat-tail file to smooth down the lip so that the end plate can be slid easily along the tube. This end plate serves as the hilt on your probe and keeps your hand safely away from the high-voltage business end of the probe.

WARNING: ***Do not be tempted to paint the clear plastic tube—insulation integrity could be compromised!***

Now prepare five ⅜-inch rubber faucet washers (obtainable at plumbing supply stores or hardware outlets) by enlarging their center bores. The standard ⅜-inch washers have an outside diameter of ⅝ inch with a flat outside edge. Check to be sure that they slide easily into the probe body before drilling. Using drill bits twisted with your fingers (no power tools), you can do a neat and quick job by "stepping up" drill bit sizes in increments of 1/64 inch or 1/32 inch to attain the final sizes. Drill two washers to a bore of 7/32 inch, one washer to ¼ inch, and two washers to 9/32 inch. Install J1, a panel-mount RCA phono jack, in the washer drilled with a ¼-inch bore. Do not overtighten the nut, or the washer will spread out and bind in the probe's body—a nice slide fit is desirable. Secure the nut on J1 with a dab of silicone sealant.

Drill a ¼-inch hole dead center in the end of a ¾- inch, plastic, chair-leg end cap. Install J2 (panel-mount RCA phono jack) in this hole and tighten securely. Drill an appropriate sized clearance hole in the center of another ¾-inch end cap to pass both the coaxial cable and ground lead you plan to use, allowing about 1/16-inch clearance.

Fabricate a probe needle from a 3-inch length of ⅛-inch diameter brass or steel rod (the prototype used a section of brass welding rod). Round off one end of the rod for easy insertion into the jacks, and file the other end to a blunt needle shape, rather than a sharp point, to suppress arcing and corona discharge. This work can be done by hand, or, more rapidly, chucked in a lathe or power drill. Finish up with fine steel wool and metal polishing paste for a nice finish. Tooth paste works fine in a pinch!

Insert the rounded end of the probe needle into J2, mounted on the ¾-inch cap. Leave about 1¼-inch protruding from the front of J2. The probe needle should be a tight fit to keep it from sliding when used. If the fit is too loose, remove the needle and flow solder into the jack's center conductor pin for a better fit. If necessary, you can solder the needle directly to the pin. Install the assembly of J1 (mounted in its washer) on the rounded end of the needle, leaving J1's center-conductor lug accessible. No connections are to be made to J2's center conductor, or either jack's ground lug.

Refer to the parts location diagram (Fig. 2), then install the two 9/32-inch-bore rubber washers on R1, and the two 7/32-inch bore rubber washers on R2, in the approximate positions shown. Trim the leads on R1 and R2 to ½-inch long. Solder R1 to J1's center conductor eyelet. With a long-nose pliers, make wire hooks of the leads on one end of R1 and R2. Connect R2 to R1's other lead by interlocking their wire-hook leads and solder. Slip the assembly into the probe's body to check for a smooth slide fit. Bend the leads of R1 and R2 carefully to accomplish this.

Series connect R3 and R4, and put a slight offset bend in R2's free lead as shown in Fig. 2. Solder the free end of R3 to R2 near the bend and arrange the leads as shown. Cover R3-R4 with a piece of heat-shrink tubing. Likewise, cover R2's lead with heat-shrink and leave about ½-inch of exposed wire at the end. Select a 3-foot length of flexible coaxial cable such as RG-174 or audio cable, and solder its center conductor to the junction of R2-R3. Solder the braided shield to R4's free end, along with a 3- foot length of insulated #22 stranded hookup wire.

Feed the two cables through the probe body followed by the entire resistor/probe tip assembly. If the ¾-inch cap containing the probe tip is not a tight fit on the tube, secure it with a dab of silicone sealant.

Install a cable tie on the two cables right before they exit the tube, and slide a plastic washer up the cables to the tie thus providing strain relief for the cable and wire. Slip the previously completed "hilt" over the cables and onto the tube and position it so that the end of R2's body can just be seen at the junction of R2-R3 (Fig. 2). Tighten the set screw snugly, using care not to crack the tubing. Slip the remaining ¾-inch plastic cap

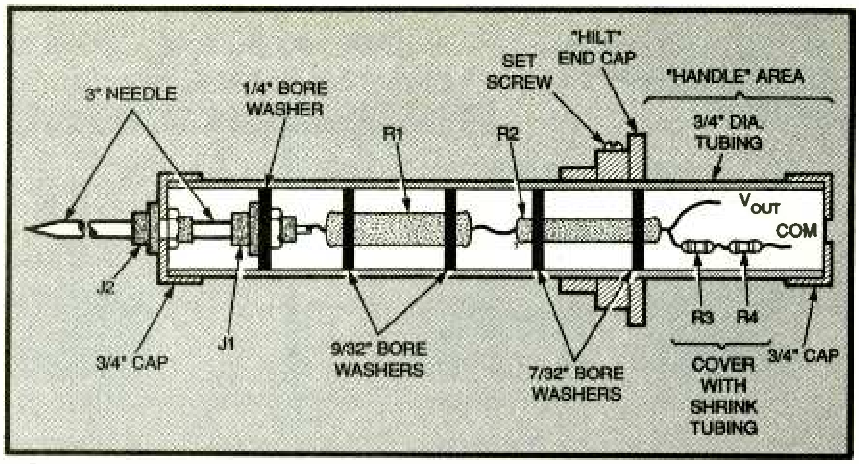

FIG. 2—DETAILED ASSEMBLY VIEW of the Mini High-Voltage Probe. The neoprene faucet washers are identified as ⅜-inch; however, their actual outside diameter is ⅝ inch.

over the cables and onto the probe's body.

Solder an alligator clip to the end of the 3-foot hook-up wire, which is the probe's ground lead. Select the connector which mates to your DVM (a dual banana plug is typical) and connect it to the end of the 3-foot coaxial cable, the braided shield going to the ground, or common terminal. This completes construction of the probe, which is now ready for testing.

PARTS LIST

Resistors
R1—80 megohms, 1%, 7.5-watt, 15,000-volts, metal-film Caddock #MG780 (Johnson #160-CAD-80M)
R2—30 megohms, 1%, 3.5-watt, 10,000-volts, metal-film Caddock #MG735 (Johnson #160-CAD-30M)
R3—100,000 ohms, 1%, ¼-watt, metal-film (Johnson #151-100K)
R4—11,000 ohms, 1%, ¼-watt, metal-film (Johnson #151- 11.0K)
Connectors
J1, J2—Jack, RCA phono, panel mount
PL1—Dual banana plug
Miscellaneous
1—Tube, antenna through-wall lead-in (Radio Shack 15-1200)
2—Cap, plastic chair leg, ¾-in.
5—Washer, neoprene, faucet (sink) ⅜-in. (⅝-in. O.D.)
3-ft.—Coaxial cable, flexible, any impedance
3-ft.—Wire, #22 stranded, insulated, hook-up
1—Alligator clip

All four resistors are available from: Johnson Shop Products, P.O. Box 2843, Cupertino, CA 95015; Tel: 408-257- 8614.

Testing and operation

Check for proper operation of the divider circuit on a low-voltage DC source. Plug the probe into your DVM, making sure that the braided shield is connected to the DVM common or ground terminal. Connect the probe ground clip to the negative terminal of a nine-volt battery and touch the probe needle to the positive terminal. The DVM should indicate about 9.0 millivolts as a satisfactory reading. Now measure the battery voltage directly (without the probe) using your DVM and ordinary test leads.

Multiply the probe's reading by 1000, and compare it to the battery voltage direct reading (without the probe). The two readings should match within about ±2% or better. If not, go no further before finding and correcting your problem! When the readings agree, you may check the high-voltage performance of your probe.

WARNING: *To avoid the risk of electrical shock and possible damage to the probe or other equipment, follow these instructions exactly!*

As a general precaution before proceeding with any high-voltage check with any high-voltage probe, always inspect the insulation integrity of your probe and cables first. Make sure there are good connections to the plug and ground clip. Check that the wire to the ground clip is not worn or frayed. Plug the probe into the DVM, observing proper polarity (ground to ground), and turn on the DVM.

Begin by using a high-voltage AC transformer rated less than 5000-volts AC, with the power OFF. Connect the probe ground clip to one of the transformer's terminals, and by means of a short clip lead, connect the probe needle to the other terminal, keeping the leads separated to avoid drawing an arc. Without touching the probe's body, apply power to the transformer and look and listen for any arcs or "sizzling" at any points in your set-up.

If you have a problem, repair it *before* attempting to handle the probe during actual use. If everything looks satisfactory, note the actual reading on your DVM, and if this reading appears correct, you are ready to make high-voltage measurements with your home-brew probe!

To measure high-voltage DC, first connect the ground clip to chassis ground, then touch the probe needle to the high voltage terminal. If possible, make the high-voltage connection before turning on the high-voltage supply: This will prevent arcing to the probe needle, which could damage the probe or the equipment under test. Remember to multiply all of your readings by 1000, and hold the probe by the handle behind the hilt.

Be cautious

Never grasp the probe ahead of the hilt near the divider section! *Never* connect the ground clip to a voltage referenced above or below earth ground—serious electrical shock and instrument damage could result. The clip has to be either transformer isolated from ground, or at ground potential for safe operation. Of course the probe can be used for a low-voltage, high-impedance measurements by DVM, also—just remember to use the 1000 multiplication factor. Ω

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Sacramento, CA 95824

HSC Electronics
4837 Amber Lane
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Colorado

Gateway Electronics of CO
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Denver, CO 80211

Centennial Electronics
2324 E. Bijou
Colorado Sps., CO 80909

Connecticut

Signal Electronics Supply
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W. Hartford, CT 06110

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437 Washington Avenue
North Haven, CT 06473

Georgia

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5159 Glenwood
Boise, ID 83714

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Tri State Elex
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Maryland

Mark Elec. Supply Inc.
5015 Herzel Place
Beltsville, MD 20705

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1117 West 36th Street
Baltimore, MD 21211

Massachusetts

U-Do-It Electronics
40 Franklin Street
Needham, MA 02194

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Purchase Radio Supply
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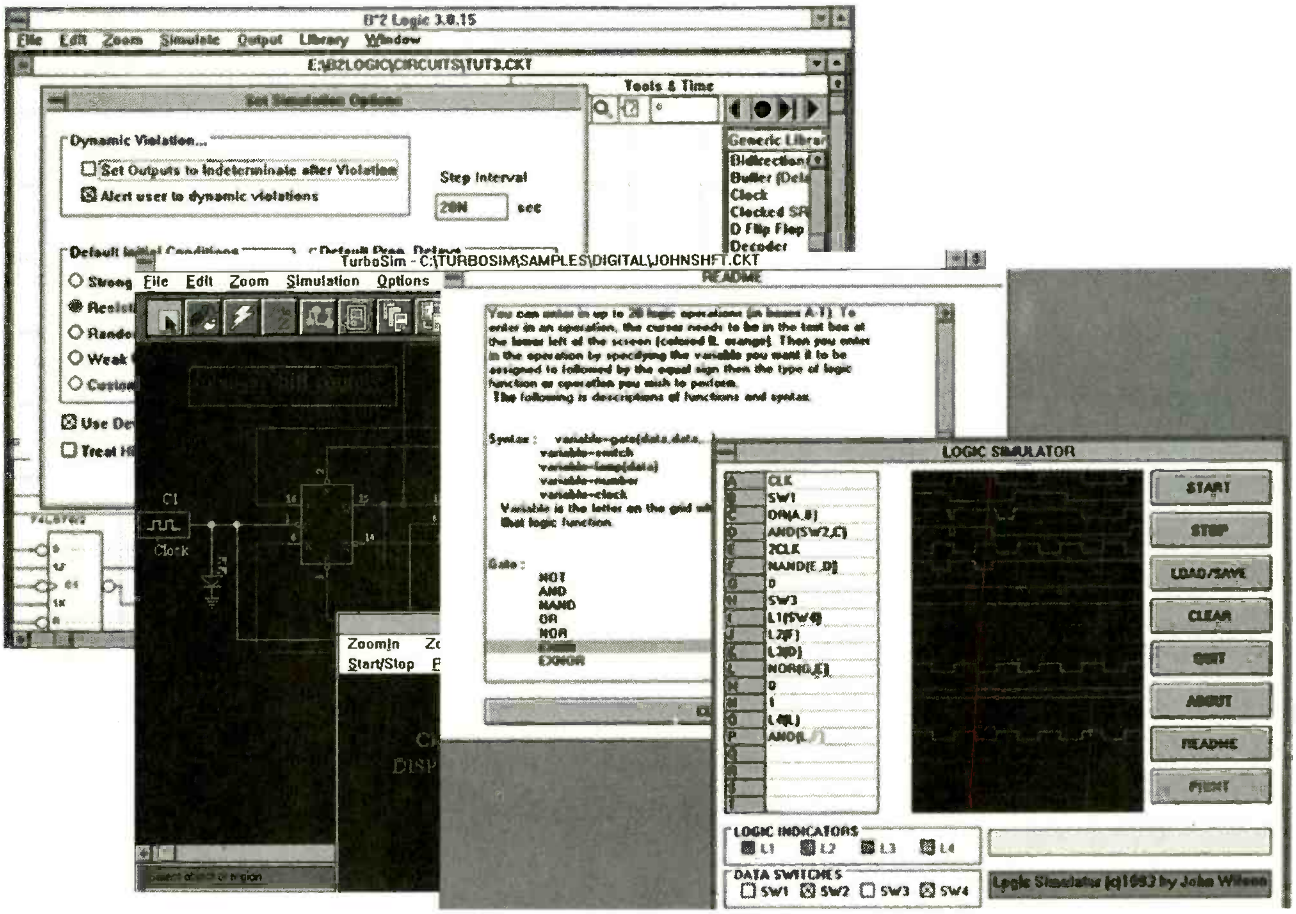

Are you stalled without a clue as to why your TTL design doesn't work? Use a logic simulator to tell you why it's stalled and how to get it up and running.

TJ BYERS

IN THIS INSTALLMENT OF LOW-COST circuit design software, the last in our series, we look at logic simulators. It's been said that logic simulators are the life blood of the computer industry. Without them, the Pentium PC undoubtedly wouldn't exist. While this may be true, those simulators are way beyond the means of your pocketbook and ours. Fortunately, the logic simulators described in this article aren't so costly—all of them check in under $350. Nonetheless, they are based on the same principles as the big boys, and have the ability to tell you if your home-brew digital project will fly—or not.

Digital simulation differs considerably from analog simulation in that the software disregards any reference to voltage or current. Instead, the simulators deal with the Boolean logic states of true and false. Typical applications serviced by logic simulators include counters, sequencers, computer interface devices, computer adapter boards, and motherboards

Basically, logic simulators let you simulate any design built with logic gates, flip-flops, and microcontrollers—which covers a lot of ground.

Logic simulators fall into two categories: state analyzers and timing simulators. A state analyzer uses a Boolean engine that calculates the output status of a design under given input conditions. It doesn't take into account setup times or bandwidth limitations; in a Boolean simulation, all gates and components are deemed perfect. Timing simulators, on the other hand, take into account the effects of time delays caused by loading, stray capacitance, temperature, and a host of other variables. These simulators can accurately predict the performance of a design for any clock rate and any given range of stress factors.

In this article we look at five

logic simulation programs that cost between $7 to $298. Only one of the five, Logic Simulator, is a state analyzer. The others are timing simulators. There are no winners or losers here. Even if we wanted to pick a best buy out of the bunch, the programs are diverse enough that it's like comparing apples to oranges.

How logic simulators work

At the root of all logic simulators is a Boolean engine that grinds through the mathematics of the design to determine the logic states of the nodes. While some logic simulators are satisfied with state analysis only, most add timing analysis, which takes into consideration timing parameters.

Logic levels. Even though logic simulators disregard voltage and current levels, they aren't oblivious to them, simply because voltages are an important part of the simulation process. But rather than follow the voltage excursions, like analog simulators do, logic simulators use voltage trigger points that tell the program when the signal has crossed the threshold from one logic state to another.

Most designs are based on TTL devices, which define logic high at 5 volts, and logic low at zero volts. However, these are ideal values used by the Boolean calculator—values that would never work in real life. Because of factors intrinsic to semiconductor fabrication, you must take saturation voltage, gate loading, stray capacitance, and temperature into account. Consequently, the TTL voltage levels are set at 2.0 for logic high and 0.8 volts for logic low. Of course, the voltage of a logic high will eventually settle at 5 volts (or close to it), but the state change is recognized when the voltage exceeds 2.0 volts. Beyond that, the logic gate could care less how high the voltage goes—well, kinda. There's always the trip back down.

Switching times. Ideally, the transition from one state to another should be instantaneous. In reality, it takes time for the voltage to change from one value to another. In analog designs this is called the slew rate; in digital designs it's called switching time (Fig. 1).

There are two types of switching times: rise time and fall time. Rise time is the time it takes for the voltage to go from logic low (typically 0.4 volts) to logic high (2.0 volts). Rise time is determined by the stray capacitance across the input of the logic device coupled with the resistance of the connecting wires. Together they form a series RC circuit, where the charging current to the capacitor is limited by the input resistance. The formula is $t = RC$. The smaller the capacitance and resistance, the faster the switching time. Fall time is the

TABLE 1—LOGIC SIMULATORS

	B²Logic	Logic Simulator	Pulsar	SuperSIM	TurboSIM
Price	$199	Shareware	$149	$149	$149
Format	Windows	Windows	DOS	Windows	Windows
RAM required	2MB	4MB	640K	4MB	4MB
BBS file	b2logic.zip	logic.zip	pulsar.zip	supercad.zip	turbosim.zip
Schematic capture	Y	N	N	Y(1)	Y
Compoment library	Y	N	Y	Y	Y
Step operation	Y	N	Y	Y	Y
Hierarchical circuits	Y	N	Y	Y	Y
Bus support	Y	N	N	Y	N
Zoom	Y	N	Y	Y	Y
Timing violations alert	Y	N	Y	N	Y
Glitch trapping	N	Y	Y	Y	Y
Power dissipation	Y	N	N	N	N
Pattern matching	N	N	Y	N	Y
Strong low/high	Y	Y	Y	Y	Y
Weak low/high	Y	N	Y	Y	Y
Resistive	Y	N	N	Y	N
High impedance	Y	N	Y	Y	Y
Undefined	Y	N	Y	Y	Y

1) Extra cost

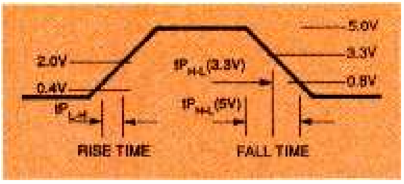

FIG. 1—THERE ARE TWO TYPES OF SWITCHING TIMES: rise time and fall time. Both are shown here.

time it takes for the voltage to go from logic high (typically 4.6 volts) to logic low (0.8 volts). Fall time is almost exclusively determined by the output load capacitance, which has to discharge through a parallel resistor; e.g., the low-level (off) resistance of the gate's output. Again the formula is t = RC, but this time the voltage excursion is much greater than that of the rise time: 3.8 volts versus 1.6 volts. Consequently, the fall time is often greater than the rise time.

That's why the new 3.3-volt logic is so hot. With a voltage swing of just 2.1 volts from logic high (typically 2.9 volts) to logic low (0.8 volts), the fall time is much faster and more in line with the rise time.

Propagation delay. What the preceding text is leading to is the critical simulation parameter called propagation delay, which is the time it takes for a state change on the input of a logic device to appear at the output. Propagation delay is the sum of the rise and fall times added to the internal setup time of the gate. Propagation delays are important because they determine the maximum operating speed of a circuit.

As you can guess, propagation delay isn't a fixed value. Both the rise and fall times are influenced by external forces. For example, the fall time of a gate with a 100 pF load is twice as long as one with a 50 pF load. Worse, you have little control over the loading capacitance. It's determined by the number of gates hanging on the output, and the length of the traces connecting them together. Temperature affects propagation times, too. Most logic simulators let you adjust the propagation delays of the various components, or the overall design, to discover the impact of different propagation delays on your design.

So far we've discussed only two types of logic states, strong high and strong low, which assume that a totem-pole circuit drives (Fig. 2) the gate's output. In real life, there are other possible scenarios. For example, there are weak high and weak low states that reflect outputs controlled by pull-up and pull-down resistors, respectively.

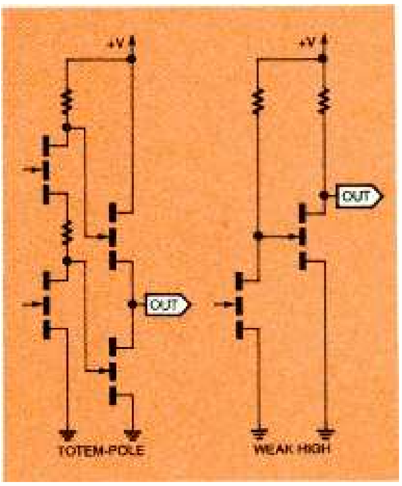

FIG. 2—MOST LOGIC SIMULATORS recognize several different types of logic states. A strong state is hard driven with lots of force, like the totem design you see above.

These states are called weak because they add another time element to our t = RC timing equation. A high impedance, or open-circuit, output is a weak-state output sans the pull-up or pull-down resistor. They are commonly used in wired-OR designs. Finally, there's an undefined state, which occurs on the outputs of initialized D-type flip-flops, or when the preset and clear signals of a J-K flip-flop are applied simultaneously. Two of the simulators in this review, B²Logic and Pulsar, can simulate all six states.

How circuits are defined

You don't just pluck rise and fall times out of the sky. They're forever carved in silicon at the time of the chip's conception, and are defined by the technology originally used to fabricate the chip. From that time forward, any chip bearing that number—74LS00, for example—must adhere to these timing parameters, even if it's built using a different manufacturing process or technology. If you use the same gate architecture but change the timing rules on purpose via a new technology, the part is assigned a new name, like 74ACT00.

Rather than defining these values each time you simulate a design, the logic simulator stores the values in a components library under the part's name for quick retrieval—just as schematic capture programs store component outlines. For example, the library timing sheet for a 74F241 would look something like the one you see in Fig. 3. The library contains a similar data sheet for every device in its inventory.

Notice that the data sheet in Fig. 3 contains minimum, max-

SN54F241, SN74F241
OCTAL BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

[illegible]

switching characteristics (see Note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 5 V, C_L = 50 pF, R_L = 500 Ω, T_A = 25°C: 'F241 MIN	TYP	MAX	V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX†: SN54F241 MIN	MAX	SN74F241 MIN	MAX	UNIT
t_{PLH}	Any A	Y	1.7	3.6	5.2	1.2	6.5	1.7	6.2	ns
t_{PHL}			1.7	3.6	5.2	1.2	7	1.7	6.5	
t_{PZH}	$\overline{OE}$ or OE	Y	1.2	3.9	5.7	1.2	7	1.2	6.7	ns
t_{PZL}			1.2	5	7	1.2	8.5	1.2	8	
t_{PHZ}	$\overline{OE}$ or OE	Y	1.2	4.1	6	1.2	7	1.2	7	ns
t_{PLZ}			1.2	4.1	6	1.2	7.5	1.2	7	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
NOTE 2: Load circuits and waveforms are shown in Section 1.

FIG. 3—THE CHARACTERISTICS OF A DIGITAL DEVICE are determined by propagation delay, which is the sum of rise time, fall time, and setup time. Armed with this information, the library can easily accommodate a wide range of parts using just one model by simply changing the rise and fall times.

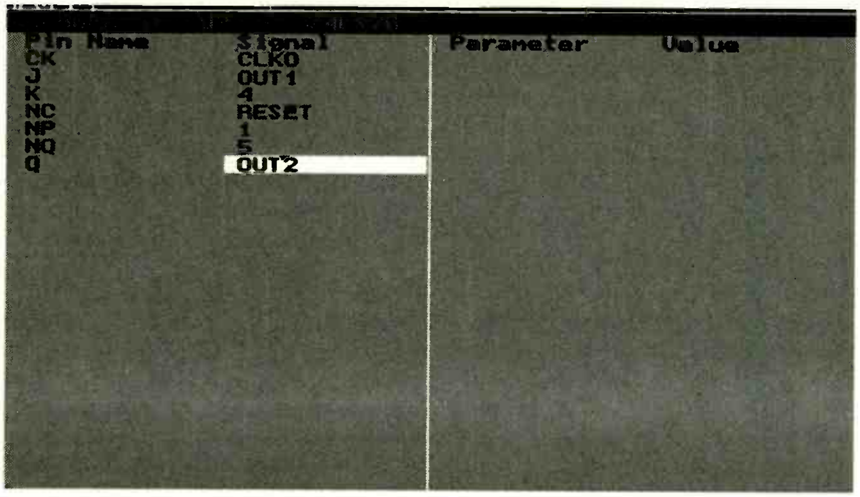

FIG. 4—THERE ARE TWO WAYS TO DEFINE a digital circuit for simulation. The above method, used by Pulsar, uses a logic table.

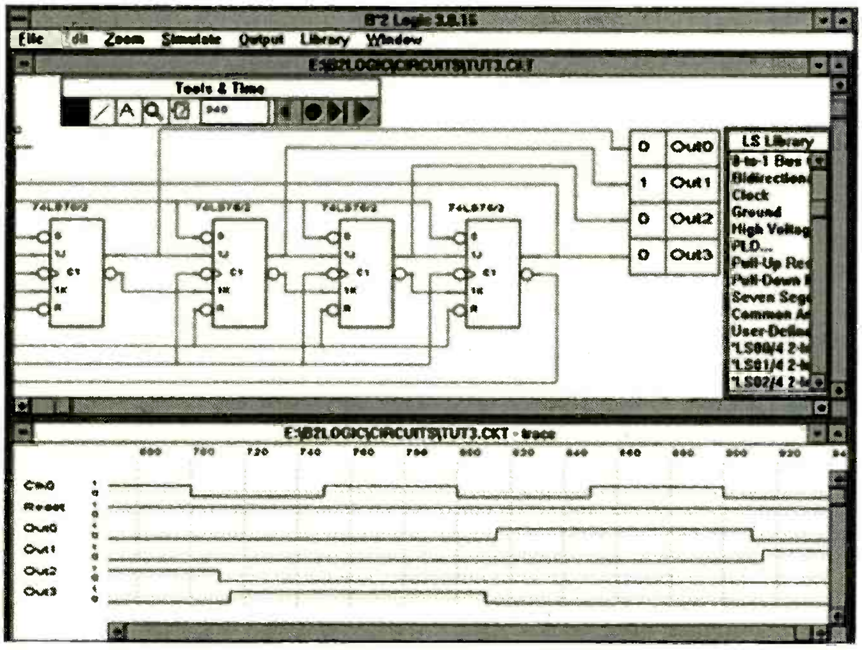

FIG. 5—THE OTHER WAY TO ENTER A CIRCUIT design into a logic simulator is via schematic capture. Sometimes the schematic program is a part of the logic simulator, like B²Logic above, while other logic simulators, like SuperSIM, read their information from an independent schematic capture netlist.

imum, and nominal values. During the manufacturing process, the semiconductor device is tested for electrical compliance. If it fails to fall within the range set by the minimum and maximum limits, it's rejected, never to see the light of day. A good logic simulator uses these limits to thoroughly shake out a design. Be aware, though, that not all logic simulators go into this much detail—especially those at the low end of the price scale. Sometimes all you have is a typical value to work with.

The typical value is the median (not the average) value of the parts coming off the assembly line. That is, these are the performance values you can expect from the device you hold in your hand. It's also the value used by the logic simulator unless you say otherwise.

To reduce the size of the library, many logic simulators use technology lookup tables. To understand how they work, consider the popular 74LS241, a 20-pin octal buffer. In addition to the 74LS241, which has a nominal propagation delay of 12 ns, this buffer is also available in 74AS241, 74F241, and 74LVC241 versions. Basically, the different versions are electrically identical, but each is built using a different technology with different timing parameters. The 74F274, for example, has a nominal propagation delay of 3.6 ns and the 74LVC241 (the 3.3-volt version) clocks in at 2.2 ns. Armed with this information, the library can easily accommodate a wide range of parts using just one model by simply changing the rise and fall times.

Building the circuit

Logic simulators have to work from a design, obviously. There are two way to accomplish this. The traditional way is to pencil in the design elements using a logic table, as is seen in Fig. 4. The modern method is to either attach the logic simulator to a schematic capture program, or to add a schematic capture program to the simulator itself (Fig. 5).

Each method has its merits. For simple designs, it's a lot easier to fill out a form than it is to fuss with schematic capture. As the size of the design increases, though, so does the number of labels needed to define the circuit. That's when it's wise to switch to a logic analyzer with a schematic capture connection.

Running a simulation

After the mechanics of building a circuit are under your belt, it's time to display what the circuit does, and when it does it. Does a glitch occur during the switching? Is there a timing violation? Does the design work as planned?

When working with a real breadboard design, such questions are answered using a logic analyzer. This is a piece of test equipment with centipede-like fingers, called pods, that attach to any part of your digital design that you wish. Triggering off the main clock, this oscilloscope-like device displays everything from rise and fall times to the most minute glitch.

Continued on page 76

BY DON LANCASTER

"Colorizer" for PostScript, using binomial coeffecients, laser printer repairs, and more . . .

FOR THIS MONTH, I THOUGHT WE'D LOOK INTO A FEW APPLIED MATH TOPICS. I WAS RATHER POOR AT MATH THROUGH MUCH OF HIGH SCHOOL AND COLLEGE. IT TOOK A GRADUATE LEVEL PARTIAL DIFF course for me to at last finally see the light.

There's a lot to be learned and big bucks to be made by playing around with numbers in one way or another. The one book that has done by far the most good for me over all the years is Mathematical Tables from the Handbook of Chemistry and Physics, from CRC Publishing.

The plot development is somewhat weak, but it's sure got a really great cast of characters. Alas, the book's ending is totally predictable.

My favorite current tool to explore math stuff is a Hewlett-Packard 4M+ printer. I use it as a general purpose PostScript Language computer. This route is rapid, easy, intuitive, highly graphic, and elegantly simple.

Let's look at a math topic or two...

Colorizing PostScript

I've got these great heaping piles of my column reprints that often use lighter grays for emphasis. It looks great in hard copy, but kind of awful when on-line or on any color display. I needed some sneaky trick to let me easily "colorize" these files, to automatically provide both gray and color at the same time.

A PostScript DeviceGray black has a value of 0. White is 1. My preferred very light gray is 0.96. Set through PostScript's setgray operator. On a 106 line, 600 DPI screen.

There are many PS color rendering options. One is called DeviceRGB. If a PostScript or Acrobat program uses DeviceRGB color, a black-and-white printer should automatically convert everything back to gray. Using this rule shared with the NTSC color TV people:

```
% A PostScript "colorizer" that causes black, white, and grey code to print
% normally but converts all grays to on-screen or on-line color tints.

% Insert colorizer near beginning of ps file where it can redefine -setgray-.

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/tintmat [
  {dup 0.842 ge {dup .7 mul .59 sub .11 div 1 exch setrgbcolor}
    {0.89 div dup 1.123 div exch 1.123 mul 0 setrgbcolor} ifelse} % lime 0
  {dup 0.59 ge {0.59 sub 0.41 div dup 1 exch setrgbcolor}
    {0.59 div 0 exch 0 setrgbcolor} ifelse}  % green 1
  {dup 0.11 ge {0.11 sub 0.89 div dup 1 setrgbcolor}
    {0.11 div 0 exch 0 exch setrgbcolor} ifelse}  % blue 2
  {dup 0.3 ge {0.3 sub 0.7 div 1 exch dup setrgbcolor}
    {0.3 div 0 0 setrgbcolor} ifelse}   % pink 3
  {dup 0.7 ge {0.7 sub 0.3 div 1 1 setrgbcolor}
    {0.7 div 0 exch dup setrgbcolor} ifelse} % turquoise 4
  {dup 0.41 ge {0.41 sub 0.59 div 1 exch 1 setrgbcolor}
    {0.41 div dup 0 exch setrgbcolor} ifelse}   % magenta 5
  {dup 0.89 ge {0.89 sub 0.11 div 1 exch 1 exch setrgbcolor}
    {0.89 div dup 0 setrgbcolor} ifelse}  % bright yellow 6
  {dup 0.731 ge {1 exch dup .41 mul .30 sub .11 div setrgbcolor}
    {0.856 div dup 1.155 mul exch 1.155 div 0 setrgbcolor} ifelse} % beige 7
      ] bind def

/tint 0 def                                        % sets the next tint proc

/setgray {tintmat tint get cvx exec} bind def      % redefines all grays

% Certain applications will require a print to disk first. Files already
% in Acrobat will also need redefinitions of -setcolor- and -setrgbcolor-.

% Additional details in COLORIZE.PS on www.tinaja.com
```

FIG. 1—A "COLORIZER" for black-and-white PostScript or Acrobat files.

NUMBER OF BITS IN WORD	NUMBER OF ONES IN WORD											
	0	1	2	3	4	5	6	7	8	9	10	11
1	1	1	-	-	-	-	-	-	-	-	-	-
2	1	2	1	-	-	-	-	-	-	-	-	-
3	1	3	3	1	-	-	-	-	-	-	-	-
4	1	4	6	4	1	-	-	-	-	-	-	-
5	1	5	10	10	5	1	-	-	-	-	-	-
6	1	6	15	20	15	6	1	-	-	-	-	-
7	1	7	21	35	35	21	7	1	-	-	-	-
8	1	8	28	56	70	56	28	8	1	-	-	-
9	1	9	36	84	126	126	84	36	9	1	-	-
10	1	10	45	120	210	252	210	120	45	10	1	-
11	1	11	55	165	330	462	462	330	165	55	11	1
12	1	12	66	220	495	792	924	792	495	220	66	12
13	1	13	78	286	715	1287	1716	1716	1287	715	286	78
14	1	14	91	364	1001	2002	3003	3432	3003	2002	1001	364
15	1	15	105	455	1365	3003	5005	6435	6435	5005	3003	1365
16	1	16	120	560	1820	4368	8008	11440	12870	11440	8008	4368
17	1	17	136	680	2380	6188	12376	19448	24310	24310	19448	12376
18	1	18	153	816	3060	8568	18564	31824	43758	48620	43758	31824
19	1	19	171	969	3876	11628	27132	50388	75582	92378	92378	75582
20	1	20	190	1140	4845	15504	38760	77520	125970	167960	184756	167960
21	1	21	210	1330	5985	20349	54264	116280	203490	293930	352716	352716
22	1	22	231	1540	7315	26334	74613	170544	319770	497420	646646	705432

FIG. 2—THIS BINOMIAL COEFFICIENTS TABLE quickly answers such questions as "how many binary words of length "n" have "k" ones in them? Any rightmost "missing" values can be found by symmetry.

$$gray=0.3red+0.59green+0.11blue$$

The "funny numbers" come about because the eye is the most sensitive to green and least sensitive to blue. More on this in my MUSE98.PDF at tinaja.com. At any rate, any 0.96 gray is quite light. So light that we might end up with uselessly weak pastels if we are not careful.

We can see that our color choices might end up restricted. No matter. One tint (used in various saturations) is good enough to make each column look much better.

The trick is to automatically define carefully chosen red, blue, and green values from the given gray. That will, in turn, return that same gray back to the black and white printer.

A branch of mathematics known as partial differential calculus can give us a hint of which way to go.

Say you only change red. The gray will shift by 0.3 times as much as the red does. Thus, any one percent gray shift requires a 3.33 percent shift in red. Similarly, a one percent shift in gray needs only a 1.69 percent green change. But takes a whopping 9.09 percent shift in blue.

Thus, if you want nice colors in place of lighter grays that are not washed out, you need to back off on your blue first!

For example, if you let red = 1 and let green = 1, our light gray equation can solve to:

$$blue = (gray - 0.89)/0.11$$

Which only works down to an 0.89 gray. So you need a different formula for darker grays. Say letting blue = 0 and red = green. Colorwise, as your gray gets darker, you start here with white. Then merge white and yellow, and finally go a full bright yellow at 0.89 gray. Below that, you drop down into the "darker" unsaturated yellows through brown to black.

Figure 1 shows us some possible shiftings. Uh, whoops. Backing off totally on the blue can leave you with a color which is best described as an infirmary yellow. The two I like the best are the pastel green and the somewhat brighter lime green.

To use these routines, just prepend them to your existing file. But do so in a position where they can redefine setgray. If you are in some application

```
% A PostScript utility to generate all possible binary words of length "n" having "k"
% ones in them. Send to any PostScript device using recordable two-way com.

% Copyright c 1996 by Don Lancaster and Synergetics, Box 809, Thatcher, AZ
% 85552. (520) 428-4073. synergetics@tinaja.com All commercial rights and all
% electronic media rights are *fully* reserved. Reposting is expersslv forbidden.

/bitsinword  10 def                % set the number of bits in the word

/ws0 bitsinword string def         % generate a workstring
/kproc0 {ws0 == flush} def         % define a proc that uses the string.

/0k0{kproc0} def
/1k0{false exch 1 ws0 length 1 sub{dup 3 -1 roll{1 sub ws0 exch 48 put}{pop ws0
   dup length 1 sub 48 put}ifelse ws0 exch 49 put kproc0 true} for pop} bind def
/2k0{false exch 1 ws0 length 2 sub{dup dup 4 -1 roll{1 sub ws0 exch 48 put} {pop ws0
   dup length 2 sub 48 put}ifelse ws0 exch 49 put 1 add 1k0 true} for pop} bind def
/3k0{false exch 1 ws0 length 3 sub{dup dup 4 -1 roll{1 sub ws0 exch 48 put}{pop ws0
   dup length 3 sub 48 put}ifelse ws0 exch 49 put 1 add 2k0 true} for pop} bind def
/4k0{false exch 1 ws0 length 4 sub{dup dup 4 -1 roll{1 sub ws0 exch 48 put} {pop ws0
   dup length 4 sub 48 put}ifelse ws0 exch 49 put 1 add 3k0 true} for pop} bind def
/5k0{false exch 1 ws0 length 5 sub{dup dup 4 -1 roll{1 sub ws0 exch 48 put} {pop ws0
   dup length 5 sub 48 put}ifelse ws0 exch 49 put 1 add 4k0 true} for pop} bind def
/6k0{false exch 1 ws0 length 6 sub{dup dup 4 -1 roll{1 sub ws0 exch 48 put} {pop ws0
   dup length 6 sub 48 put}ifelse ws0 exch 49 put 1 add 5k0 true} for pop} bind def
/7k0{false exch 1 ws0 length 7 sub{dup dup 4 -1 roll{1 sub ws0 exch 48 put} {pop ws0
   dup length 7 sub 48 put}ifelse ws0 exch 49 put 1 add 6k0 true}  for pop} bind def
/8k0{false exch 1 ws0 length 8 sub{dup dup 4 -1 roll{1 sub ws0 exch 48 put} {pop ws0
   dup length 8 sub 48 put}ifelse ws0 exch 49 put 1 add 7k0 true} for pop} bind def

%     (higher numbers ones or additional strings can be added here if needed. )

% //// demo - remove or alter before reuse. ////

% to generate all TEN bit words having FIVE ones in them...

0 5k0                              % call five ones entry point, preceeded by zero
quit
```

FIG. 3—A UTILITY TO GENERATE n-of-k binary bit sequences.

that prevents you from messing with the code, simply do a print to disk first.

Should your files already be in an Acrobat format, you may also have to print to disk, redefine setcolor and setrgbcolor, and then re-distill. More details on this in COLORIZE.PDF on tinaja.com

Binomial coefficients

Now that I have made you an expert in applying partial differential equations, let us go on to something tougher. What totally amazes me is how many times over the years that I've ended up right back on the very same page in the book. One that lists binomial coefficients.

These are intended for use by the statistics folks. They are used to answer questions such as "how many combinations of six coins are there that will have two heads and four tails?"

That same problem restated has become quite important in my magic sinewave work: "Generate all binary words of length n with k ones."

Well, let's see here. Say you have four bits. There's 2^4 = 16 possible words. There will be one word of no ones (0000). Plus four words having single ones (0001), (0010), (0100), (1000). There will be six words of two ones, namely (0011), (0101), (1001), (0110), (1010), and (1100).

Similarly, there will be four words that have three ones (0111), (1011), (1101), (1110); and a remaining word (1111) of four ones.

Go to six bits and we start to get messy with 64 combinations. But we can cheat. Of these 64 combinations, there will be a word with no ones and a word with six ones. There will be six having a single one and six with five ones. Taken together, these add up to 14 cases.

There will apparently be 5 + 4 + 3 + 2 + 1= 15 cases with two ones. Plus 15 similar cases of four ones. Which, by default, leaves us with 20 ones for the cases of three ones.

As you can imagine, exhaustive listings get old as the number of bits in the word go up. But we can clearly see a pattern emerging. There always will be one word with no ones and one word with all ones. There always will be n words having a single one in all bit positions. There will always be n words lacking a single one in all bit positions.

For the complementary "two ones" and "all-but-two-ones" cases, there will be the sum of (k-1)+(k-2) +...+ 2 + 1 combinations. These inner results will seem more ugly. But they end up rather simple to find.

Figure 2 shows us the table of binomial coefficients. Note how the combinations rapidly get out of hand. The key rule to generate this table is simple enough: To produce any new value in any given column, add your previous value to the value to its left. Substitute zeros for blanks on any "empty" column positions.

Restating it geographically, each "here" value equals the total of its "north" and "northwest" neighbors. Continued to extremes, we could find that there are 2,704,156 possible 24 bit words with 12 ones in them.

While you can easily write a trivial computer program that exhaustively searches for the - k of-n combinations, this approach rapidly gets inefficient. In the 3-of-18 case, you'd have to search out 262,144 combinations for a mere 816 final results.

Figure 3 shows some efficient PostScript code that I use to generate sequential strings for ones and zeros of length n. Sequences which do have precisely k ones in them. This is one example of reentrant code. Well, sort of, anyway. To find higher values of k, just continue the expansion in the obvious direction. Bunches more on magic sinewave opportunities in my MSINPROP.PDF on tinaja.com.

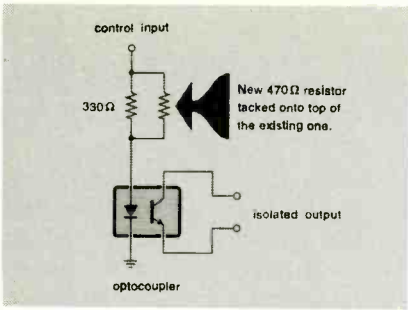

FIG. 4—CERTAIN OPTOCOUPLERS MAY 'run down" after 10,000 or so hours of operation. Sometimes, boosting the LED current by adding a parallel resistor can inexpensively and simply restore proper performance.

LASER PRINTER REPAIR RESOURCES

Advanced Recharging
4938 Sharp Street
Dallas TX 75247
(800) 437-2296

Apple Computer
20525 Mariani Ave
Cupertino CA 95014
(408) 996-1010

Hewlett-Packard Manuals
19310 Pruneridge Ave
Cupertino CA 94014
(800) 752-0900

Jensen Tools
7815 S 46th St
Phoenix AZ 85044
(602) 968-6231

LaserLand
2655 Orchard Lake Rd #119
Sylvan Lake MI 48320
(800) 60-TONER

National Parts Depot
31 Elkay Drive
Chester NY 10918
(800) 524-8338

Oasis Imaging Products
23220 Del Lago
Laguna Hills CA 92653
(800) 822-7661

PBTI Electronic Imaging
7195 30th Avenue N
St. Petersburg FL 33710
(813) 345-0010

QMS/Laser Connection
PO Box 81250
Mobile AL 36689
(205) 633-4300

Quality Laser Charge
1117 N. Equestrian Way
Prescott AZ 86303
(800) 828-6649

Recharger
4218 W Charleston Blvd
Las Vegas NV 89102
(702) 438-5557

Static Control Comps
3115 H Siler Dr
Sanford NC 27331
(800) 488-2424

Don Thompson
6 Morgan #112
Irvine CA 92718
(714) 855-3838

TonerPlus
8222 N Lamar Blvd #E44
Austin TX 78753
(800) 383-5564

Total System 2000
47-00 33rd Street
Long Island City NY 11101
(800) 682-7371

World Recharging Expo
4218 W Charleston Blvd.
Las Vegas NV 89102
(702) 438-5557

Laser printer repairs

Don Thompson just mailed me a revised copy of his superb Mastering Laser Printer Service manual. While pricey, this is by far the most useful servicing resource. Don also has first-quality repair seminars. Plus lots of repair parts. And has special pricing for readers of this column.

I've listed some other laser printer resources in this month's sidebar. *Recharger* magazine is the place to go for info on rebuilding procedures and toner supplies. I currently do use Static Control Components.

Getting machine specific service info can be tricky. Most laser printers use Canon engines. Hewlett Packard Manuals has costly but outstanding repair manuals for all their LaserJets that use Canon engines.

These same manuals can be highly useful for servicing Apple, QMS, and other brands. HP also carries most modules and has instant delivery. But they charge full list price and limit themselves to entire modules, rather than individual component parts.

A number of firms offer rebuilding and replacement modules at far lower prices. Some as "pre-exchanges". I have also listed a few of these in our resource sidebar.

Your most common laser printers likely to need repairs are still those that use the older Canon SX engines. Although getting a tad long in the tooth, there sure are a lot of these 300 DPI workhorses out there. Having high copy counts and low street resale prices. Typical models were the older Apple NTX and newer LaserWriter G, the Hewlett Packard LaserJet 3 or 3D. Or the PS820 from QMS. The HP manual 33440-90904 is a "must have" resource for working on any of these machines.

Don T. has a nice SX maintenance video. Along with a whole bunch of others for most of the newer engines. While the comments that follow are SX specific, similar attacks ought to work on most laser printers.

The first step on any laser printer repair is to make a careful visual inspection. Then get the problem to show up or otherwise become obvious. Often a simple cable check and a rebooting (host, network, and printer!) will get you back running properly. At other times, operator stupidity will turn out to be the real problem. Little things such as forgetting to pull the cartridge sealing strip.

Yet other times, hidden paper jams may be the culprit. One "tool" I've found rather handy here is a seven inch wide sheet of parchment cover stock. By gently sawing this through various points in the paper path, jam problems can often be cleared.

The second step is to substitute the toner cartridge and see if the problem goes away. Some cartridge problems are easily fixed; others are either fatal or not worth the effort. More on toner cartridge refilling can be found in HACK40.PDF, HACK78.PDF, or in TONERTRX.PDF.

The third big check is to place the printer in a darkened room and look into the paper exit area. On startup, an intermittent and dull yellow glow should tell you when the fuser lamp is cycling properly. Note that the lid has to be closed or all the interlocks bypassed for this lamp to light.

The fusion assembly accounts for a lot of your remaining problems. These include toner caking or a roller cracking; stripping of that notorious 14-tooth gear; a burned out fuser lamp; a bent or a broken paper exit sensor; or a coated or defective thermoprotector.

NAMES AND ADDRESSES

Adobe Acrobat System
1585 Charleston Rd
Mountain View CA 94039
(800) 833-6687

Alfa Products
P.O. Box 8247
Ward Hill MA 01835
(800) 343-0660

CRC Publishing
2000 Corporate Blvd NW
Boca Raton FL 33487
(407) 994-0555

Digital Magic
10 Tara Blvd 5th Floor
Nashua NH 03062
(603) 891-9168

Fisher Scientific
711 Forbes Ave
Pittsburgh PA 15219
(412) 562-8300

Fluke
PO Box 9090
Everett WA 98206
(800) 443-5853

Hewlett-Packard
PO Box 10301
Palo Alto CA 94303
(415) 857-1501

Home Theater
29160 Heathercliff Rd Ste 200
Malibu CA 90265
(301) 589-3100

Lindsay Publications
PO Box 538
Bradley IL 60915
(815) 935-5353

Magnet Sales
11248 Playa Court
Culver City CA 90230
(800) 421-6692

Maxim
120 San Gabriel Dr
Sunnyvale CA 94086
(800) 998-8800

Mitel
2321 Morena Blvd #M
San Diego CA 92110
(619) 276-3421

New Wireless Pioneers
Box 398
Elma NY 14059
(716) 681-3186

PC AI
3310 W Bell Road Ste 119
Phoenix AZ 85023
(602) 971-1869

Rutgers University Press
7 College Avenue
New Brunswick NJ 08903
(908) 932-1766

Synergetics
Box 809
Thatcher AZ 85552
(520) 428-4073

Texas Instruments
PO Box 809066
Dallas TX 75380
(800) 336-5236

Visual Developer
7339 E Acoma Drive Ste 7
Scottsdale AZ 85260
(602) 483-0192

A fuser substitution is the best way to test for all of these problems. A fuser exchange only costs $50 or so. If you want to do the repairs yourself, Don Thompson has an elaborate kit for fuser rebuilding.

There are only four screws holding your fuser in place. To reach these, get yourself a hard-to-find extra long Phillips screwdriver. Jensen Tools is one place that carries them.

Then put a tiny dab of beeswax on the tip. The fuser pulls straight up after these screws are removed. Be careful with the connector pins! A big warning: Never touch that fuser lamp! Fingerprint oil on that quartz bulb causes a local hot spot that can destroy the lamp. Handle this one gently by the extreme ends. Or else wear cotton gloves.

If the fuser lamp seems ok but still doesn't light, the problem may lie in that expensive ac power supply. The typical cure is to swap out the triac, two resistors, and the optoisolator. Again, Don Thompson has a nice kit for this. It can save you big bucks. But you do need to do a careful job of soldering.

The corona charging assembly is immediately in front of the cartridge area. A delicate wire here may need Q-tip cleaning or replacement. Also, the right end of this wire fits in an insulated block. Toner buildup here can cause imaging problems.

Clean corona charging assemblies are particularly important on duplex printers, such as the HP 3D. Images with "rain" or "bunches of grapes" on one page side only are often caused by a dirty corona charging assembly. This assembly has to work much harder on the back side, since it is dealing with a heated sheet.

Paper pickup problems can often be cured by replacing the pickup rollers or the registration assembly. Both of these are simple and cheap to do. Be extra careful of the fiber optic laser link when doing any service work.

One SX problem which I seem to have seen way more than my share of: Those path-sensing optocouplers may "run down" after 10,000 hours of operation. This sounds like a lot of hours but is real easy to rack up on any machine that gets left on continuously. The usual symptom is that the paper jam lights lie—either always or intermittently. You might blast the suspect opto with some spray cooler and watch for changes. Cleaning also helps.

One trick I have used is shown in Fig.4. If the optocoupler is just barely intermittent, you could easily add a new resistor in parallel with the existing one that sets the current to the LED. This runs the LED brighter and may cure your problem. It is far easier to tack on a new resistor than it is to replace an optocoupler.

Here are some more SX tips:

There is a hidden mirror located above the toner cartridge. A piece of cathair here can cause vertical stripes down the page. It is a front surface mirror, so clean it very carefully using a Q-tip. A metal gate has to be slid sideways to access this hidden mirror.

The vertical spacing between page defects can usually tell you whether you have a cartridge drum, magnetic roller, or fusion roller problem.

Gear noise can often be cured by a careful cleaning that totally removes any toner.

SX connectors are rather flakey. Sometimes reseating them or gently closing their contacts can cure maddeningly infuriating intermittents. Especially on the main motor.

Squeaks are not a serious problem. Except for their driving the user up the wall. A tiny amount of grease in the right place is the usual cure.

A continuous growling can usually be traced to that hidden and "secret" lower fan. Usually vacuuming off the clumped dust and adding a drop of oil is all that is required.

A similar drop of oil can also free the upper fan bearings as well. When working on the upper fan, be certain to clean or replace the ozone filter. Note that a slow upper fan can cause overheating that, in turn, leads to more serious problems. A "roasted toner" smell is usually caused by a slow or jammed fan.

Finally, of course, an intermittent muffled yowling might sometimes be cured by opening up your SX lid and letting the cat out.

A superb new printer

I've long been seeking a "perfect" laser printer for my book-on-demand publishing. The goals here include genuine Adobe PostScript level 2 or higher, a two sided printing duplexer, a companion hard disk, a Canon or better engine; recharging economics better than 0.1 cents per page.

In addition all manuals and all parts must be readily available; 600 DPI enhanced resolution; superb grays; photo enhancements; big trays; 16 pages per minute; and a street price under $1900. And perhaps an optional 11 × 17 capability.

That Hewlett-Packard 4M+ sure comes close. It more or less has all of these features except for an essential hard disk. The hard disk lets you do unattended BOD production, besides stashing all your files and fonts. And it dramatically reduces the amount of communications needed.

The 4M+ street price is $1590 or so. The print quality (especially on photos) is a quantum leap over anything previous. You can shortly expect a 5M+ at the same price that should include an optional hard disk.

But meanwhile, there is a brand new "big brudder" machine called the 5SiMX. I've got one of these, and it is absolutely ideal for most serious self-publishing. Yeah, this one seems expensive. But four or five of these $4000 class machines used in parallel can utterly and totally blow away a $225,000 Xerox Docutec!

Let's see, 24 pages per minute. A full 11×17. A well designed slide-in duplexer and hard disk; both present. Big trays, with even bigger ones as an option. Real PostScript. High wear items (fuser, pickup rollers, etc.) easily snap out for easy maintenance.

Problems so far have been minor. Their factory assembly misaligned a plastic duplexer tab that caused jams. Loosening two screws and placing tab A into slot B where it obviously belonged fixed this.

While there's Ethernet, Appletalk, and high speed bidirectional parallel interfaces, I sorely lacked a plain old serial input. Some external adapter should fix this. And you can't really fault HP for leaving a lesser used and slow interface off a fast machine.

Hewlett Packard has a free demo CD ROM on the SiMX. Two of them actually. But the second one is tricky to scan without the printer. Ask for their LaserJet 5SiMX Test Drive. And their Personal Trainer. You'll find more on BOD in my Book-on-demand Publishing Kit. For other self-publishing options, check PUB-ALTS.PDF on tinaja.com.

New tech lit

From Mitel, a fat new data book on Analog and Digital Telecomm Data. From Maxim, the 1996 New Product Selector Guide. Maxim is generous on free evaluation samples.

From Fluke, a free new video on Managing Electrical Power Systems.

From Texas Instruments, some free samples on their TSL240 series of light to frequency converters.

From Lindsay Publications, a reprint of a classic 1920 book on How to Make and Use a Small Chemical Laboratory.

One crucial danger in homebrew chemistry, though: Certain of those unknown bargain priced direct mail chem lab supply ads might in fact be DEA sting operations. It may be best to stick with the name brand biggies such as Fisher or Alpha.

Type MRI-G Magnetic paper which can show you field intensity patterns is sold by Magnet Sales.

Rare early radio publications are offered by New Wireless Pioneers. One fascinating book is American Plastic, A Cultural History. Since the author is an architect, the book has an interesting slant. From the Rutgers University Press.

There seem to be zillions of new trade journals and other mags coming out of the woodwork. This morning's collection included *Home Theater* on premium consumer audio and video; *Visual Developer* for Visual Basic users, *PC AI* for artificial intelligence and fuzzy logic; and *Digital Magic*. The latter is on animation for digital entertainment.

For all the fundamentals of digital integrated circuits, check into my classic CMOS Cookbook or else my TTL Cookbook. Also bargain priced in my Lancaster Classics Library. Per my nearby Synergetics ad. I've got my http://www.tinaja.com web site up and working. EN

VIDEO NEWS

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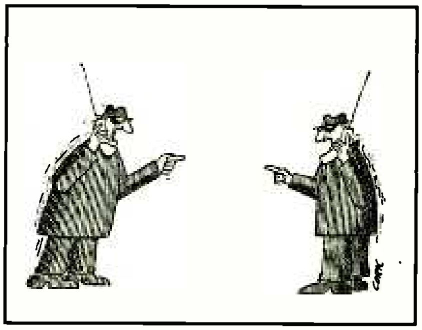
of $6900, but has offered few details. Curtis Mathes says that it has its own proprietary technology to build "Interview" TV sets with Web-browsing capability, and promises large-screen direct-view and projection models this year. It also plans a set-top box to add speakerphone and Caller ID features to those sets.

Cable surfing

The hottest product at the 1996 National Cable TV Association convention was the cable modem, already undergoing widespread in-home testing. Capable of extremely high speeds—up to 30 or 40 megabytes per second—they are now or will soon be supplied by at least a half-dozen companies. Cable systems without two-way capability can install modems that use a telephone line for the return link. Approximately 100,000 homes are expected to be equipped with cable modems by the end of this year. The cost will be added to your cable bill, of course. EN



BY K.L. YEUNG*

Four essential test instruments

DC power supplies, function generators, bench didigtal multimeters and frequency counters are essential in every lab or service center. Here we examine their applications and key features

THE MYRIAD OF TEST INSTRUMENTS AVAILABLE TODAY IS EXCEEDED ONLY BY THE NUMBER OF DEVICES AND COMPONENTS THSES OINSTRUMENTS TEST.. YET, OVER THE YEARS, A RELATIVELY SMALL NUMBER OF these tools have withstood the test of time and become the test tools of choice for service technicians, designers, educators and engineers.

Many would nominate the oscilloscope as the foremost test instrument, and there would be few arguments. However there are at least four other essential test instruments that are found in almost every service center and laboratory—power supplies, function generators, bench digital multimeters and frequency counters. Here, we examine each of these tools and look at how they are used in their four primary application areas — service, manufacturing, education and design. We will also discuss important selection criteria for each and key features that have made them essential components of the test instrument toolbox.

DC power supplies

DC power supplies provide power to the device or unit under test (DUT/UUT). That's what makes them so indispensable. In the service industry, for example, they are used when repairing electronic products such as consumer electronics and office machines. They are also valuable when working on computer and telecommunications products. DC power supplies also are used to calibrate electronics products, process equipment and machinery.

In the manufacturing plant, DC power supplies are often a key component of in-house automatic test equipment (ATE) systems and are used in all manner of production and burn-in testing. Here, they are often found at troubleshooting repair stations and in the incoming inspection area for components and circuit boards.

Education laboratories provide DC power supplies so students can supply power to their experimental designs—whether they be electronics, telecommunications or electromechanical. These tools are also highly useful in the lab for teaching ATE concepts. Finally, when used for product design, power supplies provide the power for prototype boards.

What are some of the key features that you should consider when selecting a DC power supply? Certainly third-party safety approval, such as UL, CSA, ETL and VDE, should be high on your list. These certifications typically require the following safety features for approval: a fire-retardant case, fuse protection at both the primary

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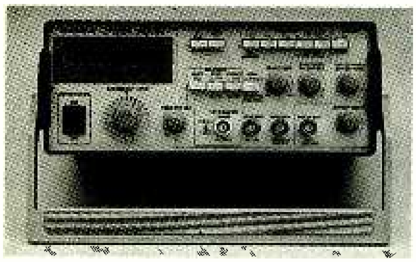
and secondary circuits, a power switch at the OFF position to cut both live and neutral leads, and an output post shielded from the user's body. Look for DC power supplies that deliver maximum temperature rise at full load. Compliance with current EMI/EMC regulations is a related requirement.

In addition to the mentioned safety features, you'll want your power supply to provide over-voltage and over-current protection and display warnings. Also important are enough output voltage and current range, plus high resolution for voltage and current settings. Be sure to check the number of voltage outputs to be assured they are adequate for your applications, and, if necessary, whether the unit comes with both a front and rear output terminal.

Availability of both parallel and serial modes will give you additional operational flexibility (e.g., for as voltage tracking), while programmability (on-line and off-line) grants you a wider range of functionality. Finally, floating outputs are an essential feature of many DC power supplies.

Function generators

Whether you need a sine wave, triangle or square wave, a TTL or other signal, function generators generate and provide signals to the device



under test (DUT). Like the DC power supply, function generators are used extensively in our four application areas: service, design, education and manufacturing.

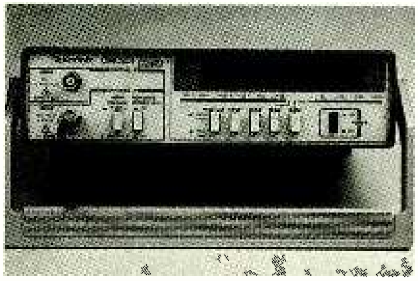
When used for depot service, function generators are typically employed to repair and calibrate electronic products and equipment of all types. In product design, function generators provide the source of a predefined signal and are used to test prototype circuit boards. Manufacturing engineers and technicians use function generators for production testing and troubleshooting repair stations. Like DC power supplies, function generators are an intrinsic component of many in-house ATE systems. And in the education lab, these indispensable tools provide signal sources to experimental designs of electronics, telecom and electromechanical projects.

In terms of selection criteria, many of the same safety considerations you consider when purchasing a DC power supply also apply to functions generators—third-party safety approval, fuse protection at both primary and secondary circuits and a power switch to cut power to live and neutral leads. You'll also want to ascertain whether the unit provides maximum temperature rise at the maximum output amplitude.

In addition to checking for maximum output frequency, amplitude and offset voltage, it's a good idea to determine the output frequency stability of the instrument you are considering. Here are some other useful functions or features to look for—adjustable duty, sweep function, modulation, frequency readout, output impedance, external frequency control and a built-in counter.

Frequency counters

Frequency counters are used to acquire and measure the frequency characteristics of a signal. Students use them to measure frequency, period and other timing related measurements. Product designers measure and debug timing signals with these tools. Service technicians employ them in the service center to help repair electronic products and calibrate electronics equipment. And manufacturing engineers and technicians utilize them for production test, in-process control and audit. You will



also find frequency counters in incoming quality control where they are used to test frequency-related components such as crystal oscillators.

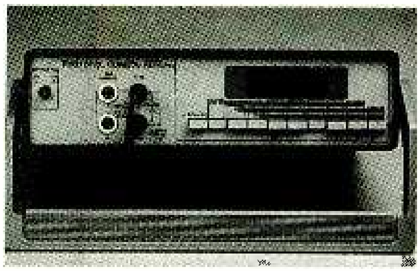
When choosing a frequency counter, make certain they carry third-party safety approval. Beyond that, useful capabilities include maximum input frequency, input voltage sensitivity, time base accuracy and the highest number of digits resolution for your application. Programmability and the ability to identify frequency overrange conditions are also desired functionality in these instruments. Check the number of digits to make sure it is sufficient for your application's needs. Finally, you may find it useful if your frequency counter provides such capabilities as time interval, period and totalize measurements.

Bench-type digital multimeters (DMMs)

When you need to show measurement results on a digital display for a variety of electrical parameters, you turn to your digital multimeter (DMM). It's a handy tool to have whether you are a manufacturing engineer, student, serviceperson or designer. The DMM is used in many of the same ways in all of the four application areas. Here are some additional uses for the DMM—in design, for verification of voltage and other electrical parameters during prototype stage; in the education lab, for measuring and recording the value of such electrical signals as voltage, current, dB and (during experiments; in the manufacturing arena, DMMs are used in quality audit and in-process QC, as well as for incoming inspection of components and boards.

When looking for a bench-type DMM, you'll need to examine the number of digits, along with the percentage accuracy. Both of these specifications should match in order to provide the best measurement resolution for your application. The measurement speed (number of measurements per second) should also be taken into account.

Autoranging capability is a common and useful DMM feature to have, and DMMs are increasingly offering programmability (both online and off-



line) to enhance their measurement flexibility. Protection against double-fault conditions caused by human error is an important safety issue with DMMs. Beyond that, the same safety features found in the other test instruments discussed warrant your careful consideration.

In summary...

Whether your job is in electronic service, manufacturing, education or design, we hope the preceding guidelines and suggestions will help you negotiate the sometimes confusing maze of test instrumentation. To make your job a little easier, we offer the following summary in table form of the four essential test instruments, their respective uses and key features you'll want to keep in mind as you make your decision.

Readers can contact Tektronix by calling 1-800-479-4490, Action Code 300. Additionally, Tektronix maintains a home page at:
http://www.tek.com/Measurement.

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TABLE—1

Instrument	Use	Key Features
DC Power Supply	Supply power to DUT/UUT	3rd-Party safety approval Compliance w/EMI/EMC regulations Output voltage/currant range Over-voltage/over-current indications Parallel/serial modes Floating outputs Programmability
Function Generator	Generate/provide signals to DUT	3rd-Party safety approval Compliance w/EMI/EMC regulations Max output frequency, amplitude, max offset voltage, programmability, additional features as needed
Frequency Counter	Acquire/measure the frequency characteristics of a signal	3rd-Party safety approval Max input frequency Input voltage sensitivity Time base accuracy Resolution Ability to identify overrange conditions Number of digits Programmability Other functions as needed
Bench-Type DMM	Show measurement results for a variety of electrical parameters	3rd-Party safety approval Over-voltage, over-current settings Accuracy specifications Number of digits Measurement speed Autoranging feature Programmability

LETTERS

continued from page 10

The application shown in my article is the basic "bare bones" configuration for the LM386, and should provide adequate performance for the intended purpose. However, Mr. Stiles point concerning possible stability difficulties is both accurate and well taken. Like most integrated circuits, the LM386 is very flexible, but it does exhibit some limitations.

Considering all that is packed into on of those little chips, it's surprising how "limited" those limitations are but stability, especially under taxing conditions, is definitely a problem. Thus, for any application other than a very basic one, I too would recommend a more complex arrangement, something similar to Fig. 2. Fig. 3 in my article provides a gain of 200 and, as Mr. Stiles pointed out, an electrolytic capacitor between pin 7 and ground would be helpful. That disables the internal input bias network and will improve stability.

Adding a series capacitor and resistor, from the output (pin 5) to ground, compensates for the speaker inductance and will help prevent distortion.

As for the use of a bypass capacitor across the power connections, it rarely hurts anything and is often an asset. That applies more to logic chips than linear devices, but still represents a pragmatic supplement. Mr. Stiles would surely be interested in an article that appeared in Gernsback Publications' Fall 1994 issue of the Electronic Hobbyist's Handbook. *"Test Bench Amplifier," by Luther M. Stroud, is an excellent piece on the construction of a general-purpose LM386 amplifier. There is a marked similarity between Mr. Stroud's circuit and that of Mr. Stiles.*

I appreciate Mr. Stiles' contribution, and the information will be of aid to fellow readers. I have found over my years of experimenting with electronics that any and all information is valuable. You never know when those "morsels of knowledge" will come in handy for solving problems.—Carl J. Berquist

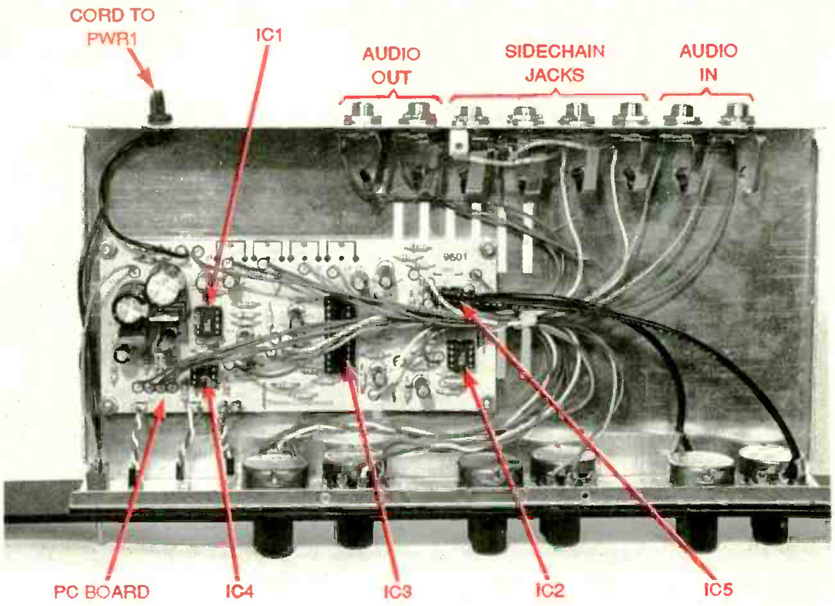
EN

STEREO COMPRESSOR

continued from page 40

tors C13 and C14. Even though PWR1 is rated at 12-volts AC, the filter capacitors charge closer to the peak value of the 12-volt AC, and just about 15-volts DC is delivered to the +12-volt DC regulator IC6 and –12-volt DC regulator IC7. The output of each voltage regulator section is filtered for decoupling purposes by electrolytic capacitors C11 and C12.

Two ground systems are used in the Stereo Compressor, one for power return and the other for signal return. This design practice reduces the possibilities of ground loops that introduce unwanted AC hum to the audio signals.



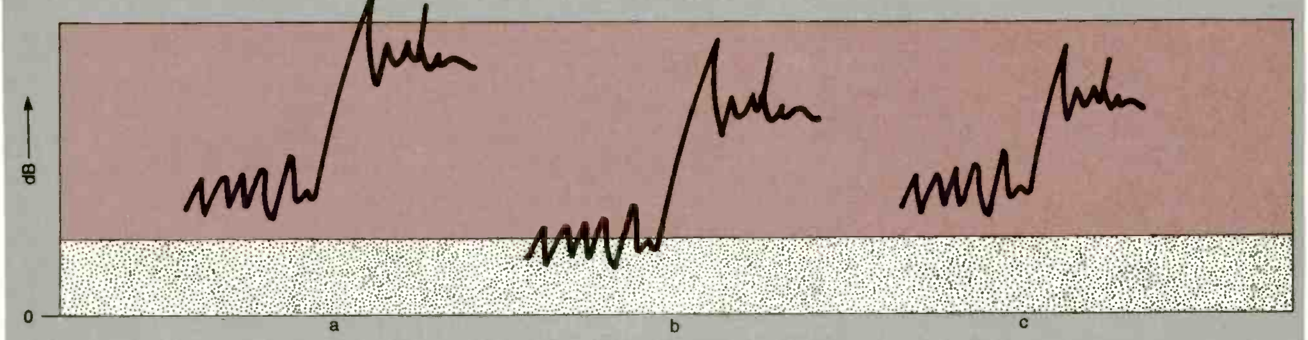
BIRD'S EYE VIEW of the Stereo Compressor before the chassis cover is secured in place. Note the neat interconnection between the PC board and front and rear panels.

Construction

Assembly of the Stereo Compressor is relatively straightforward. PAiA Electronics has complete kit of parts available for the Home Theatre version (no sidechain jacks) and the Studio version (includes sidechain jacks). If you want to roll your own, the circuit can be built on a Radio Shack experimenter's PC board or you could copy the same-size drawing of the circuit board provided in these pages and make your own board. The SSM2120 chip (IC3) is available from several sources including PAiA, Newark and Allied. The other parts are common garden variety types available from local and mail-order parts suppliers. If you do breadboard the circuit, make certain you use good grounding techniques. Return all signal and power grounds to one common point to eliminate any ground loops. Should you elect to use the PAiA circuit board, the circled letters in Fig. 2 are termination-point identifiers for hookup wires that run from the front and rear panel-mounted parts to the PC board. These interconnections are shown in Figs. 3 and 4.

The three light-emitting diodes D1 through D3 require lead extensions made from #22 insulated hookup wire. Mark the leads so that you can readily identify the anode and cathode terminals. Twist the leads of the LEDs and cut their length so that the LEDs will fit into the

HOW COMPRESSORS WORK



The gray band is the usable dynamic range of a quality audio tape. The dotted band below the gray band is the inherent tape noise (hiss) common to all tapes. The range (height) of these bands varies with tape quality. The audio signal in (a) shows a loud passage that is too loud for the listener, so the volume was turned down (b) to lower the loud passage in the tape's dynamic range. However, the quiet passage was lowered into the noise band common to all tapes. The quiet passage is either lost in the hiss or will sound appalling when played back. A compressed audio signal of the same passage (c) permits the quiet passages to be recorded above the hiss in the tape's usable dynamic range while the loud passage is reduced in volume for the listener's pleasure.

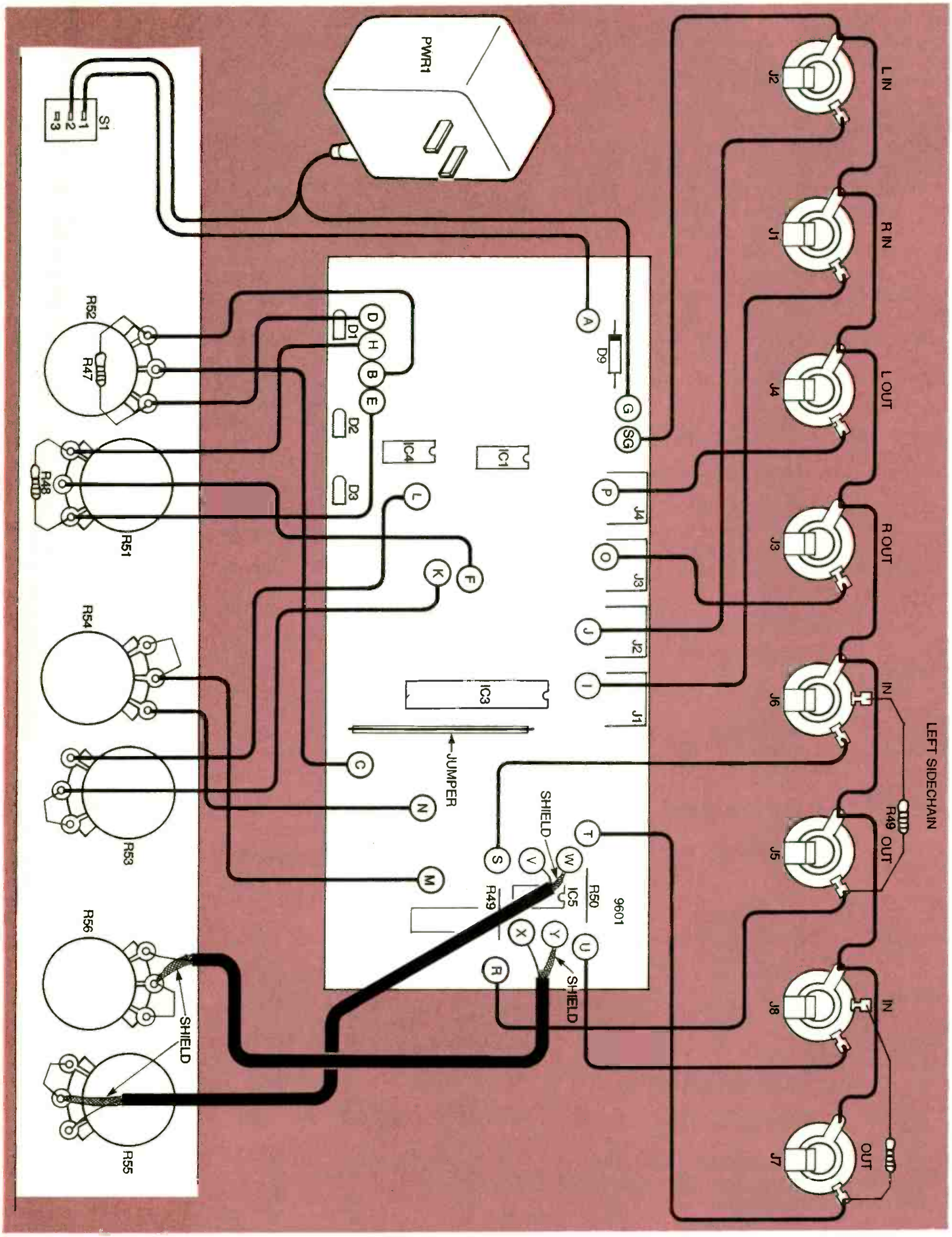


FIG. 4—INTERCONNECTING THE PC BOARD with the front and rear panel parts is simplified by PC board circled markings. The long cable runs from the board's output stage to two front-panel controls, which requires using thin, flexible, audio, coaxial cables such as the RG-174/U type. The unit's step-down power transformer PWR1 is contained in a wall-plug casing that plugs into a power outlet.

three holes provided for them on the front panel. These holes are between the POWER switch S1 and the THRESH potentiometer R52 (See Fig. 4).

If you choose to omit the sidechain option (*A big mistake*—Editor), eliminate jacks J5 through J8. Resistors R49 and R50 normally mount on the terminals of jacks J5 and J7. When the sidechain jacks are omitted, these 1000-ohm resistors are connected to terminals R and S and S and T, respectively, on the PC board.

The light-emitting diodes (D2 and D 3) combined ground path must return straight to the power supply common. The LED's comparatively high current that is switching on and off in this ground return could cause popping sounds in the audio output when connected to signal or even power grounds.

Testing

After you have wired the Stereo Compressor, check for solder bridges, cold-solder joints, incorrect component polarities and all the other nasty errors that prevent a circuit from functioning normally and sometimes result in self-destruction. Do this before applying power!

PARTS LIST

All fixed resistors are ¼-watt, 5%.
R1. R8—47-ohms
R2, R33, R43, R46—39,000-ohms
R3, R11, R12, R14, R15, R45—2200-ohms
R4, R9—150,000-ohms
R5, R35, R37, R39, R47-R50—1000-ohms
R6, R26, R41, R42—68,000-ohms
R7, R8, R10, R20—330,000-ohms
R9—150,000-ohms
R13, R21, R27—1500-ohms
R16, R17—1800-ohms
R22, R25—1.5-Megohm
R23, R24, R28, R29—200-ohms
R30-R34, R36, R38, R40, R44—10,000-ohms
R51, R52—10,000-ohm panel-mount potentiometrer
R53-R56—100,000-ohm, panel-mount potentiometer

Capacitors
C1, C8—2000-pF, ceramic disk
C2-C7, C9, C10—10-µF, 16-volt, electrolytic
C11, C12—47-µF, 16-volt, electrolytic
C13, C14—470-µF, 25-volt, electrolytic

Semiconductors
IC1, IC2, IC4, IC5—5532 dual low-noise op-amp
IC3—SSM2120 dynamic range processor
IC6—7812 +12-volt regulator
IC7—7912 −12-volt regulator
D1—Light-emitting diode, red
D2, D3— Light-emitting diode, bicolor, red and green
D4-D7—1N4148 silicon signal diode
D8, D9—1N4001 silicon power diode

Miscellaneous
J1-J4—Jack, RCA-phono, PC-mount (Home Theatre version only)
J1-J5, J7— Jack, ¼-in., mono-phone, panel-mount (Studio version only)
J6, J8—Jack, ¼-in., mono-phone, closed-circuit, panel-mount (Studio version only)
PWR1—Wall-Wart 12-volt AC transformer
PC board, wire, audio coaxial cable (see text), knobs, hardware, case, solder, etc.

The following are available from PAiA Electronics, 3200 Teakwood Lane, Edmond, OK 73013. Tel: 405-340-6300. FAX: 405-340-6378. Email: http://www.paia.com.

Complete kit of electronic components including circuit board, knobs, wall-plug transformer, phone jacks, etc., but less case—US$74.75 #9601K

Home Theatre desk-top case, punched, anodized, legended, with wood end caps and hardware—US$19.25 #9601DTC

Studio rack-mount case, standard 19-in. wide, 1-¾-in. high, punched, anodized, legended front panel. Includes 1/4-in. jacks and all hardware—US$29.50 #9601RMC

Please add US$7.00 for shipping and handling for kit orders in the USA.

PC board only—$22.50 #9601PC (shipping prepaid)

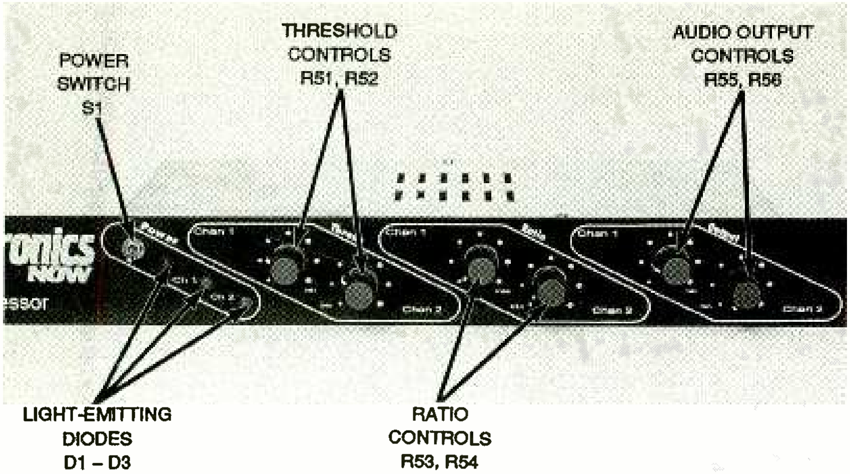
The best way to test the Stereo Compressor is to connect it between a CD or cassette deck and your hi-fi audio system. Set the RATIO control (R53) fully counter clockwise and the THRESH control fully clockwise. Set the OUTPUT control to about ten o'clock. These are the minimum settings. You should hear undistorted, noise-free audio. Both LEDs (D2 and D3) should be green. If there is distortion or noise, you need to go back and check your wiring and component polarities. If everything sounds good and you have green LEDs, then everything should be working fine. Note: with no input signal the LEDs may drift slightly and not track the THRESH control.

Once everything is working, slowly rotate the THRESH control. At some point around mid-rotation, the LEDs should start to indicate red. This means compression is starting to occur. Rotate the RATIO control clockwise. You should hear a decrease in volume as the compressor squashes the signal. At full counterclockwise rotation there might be some distortion. This is to be expected.

Using the compressor

The main use for a compressor is to keep levels from getting out of control while recording vocals and acoustic instruments. This takes a little experimentation. For a vocalist I usually start out around a 4-to-1 compression ratio with the THRESH set so the LED indicates red when the singers reach their nominal level. This way if they hit a note 20 dB higher than nominal (which would definitely clip most tape decks) the signal out of the compressor only increases by about 5 dB.

The Stereo Compressor can increase the apparent sustain of a sound. By using a large amount of compression and restoring the level with the OUTPUT control, the compressor will initially reduce the output signal by a large amount. As the input signal level decreases, the amount of compression will decrease and the output level will



FRONT PANEL view of the Stereo Compressor. Since the unit can be used in the recording studio, channel reference is made to 1 and 2 instead of LEFT and RIGHT, respectively.

remain relatively constant. The Beatles used this on the final piano chord in A Day In The Life to make the sound linger on.

To use the compressor as a limiter while recording, set the RATIO to about 20 to 1 and set the THRESH control so that the LEDs momentarily change from green to red on peak signals. This will preserve as much dynamic range as possible.

When the Stereo Compressor is connected to a hi-fi VCR for late night viewing, set the RATIO control as high as possible without distorting and set the THRESH control to change the LED's color during quiet spoken passages. This will allow you to preserve the fidelity and stereo spread of the movie sound track, hear all the dialog, but not get blown out of your seat when the F-114 does a strafing run in your living room. The above settings are intended to be starting points, so feel free to experiment.

Using the sidechain jacks

Along with regaining control of your hi-fi VCR, there are all sorts of useful functions available via the side chain jacks. By patching an audio processor in the sidechain jacks, all sorts of cool thing are possible. One of the most useful is creating a *de-esser*. This is a device used to remove sibilance from vocals. Sibilance is that nasty Shhhh sound that occurs when S words are spoken or sung, because of the way S sounds are formed in the human vocal track.

When we form an S sound, air passes between the teeth and tongue forming a burst of white noise and a short blast of air. If the speaker or vocalist is close to the microphone, this is picked up as a brief overload and noise burst. This burst of sound mostly contains high frequencies. By setting an equalizer to boost high frequencies and patching it into the side chain, the compressor will drastically compress the signal when the high frequencies are present, but act normally when they are not.

You cannot eliminate sibilance, but it can be minimized with a de-esser. Any equalizer will work. The best way to figure out what frequencies to boost is to listen to the audio through the equalizer. Start boosting until you have noticeably increased the sibilance. Anything above 3 kHz usually works; you may have to experiment. A similar problem, although at the other end of the audio spectrum, relates to P and B thump sounds. These can be minimized the same way by boosting the offending bass frequencies (less than 300 Hz) via the sidechain.

Another abuse of a compressor is to totally squash an individual instrument signal, then restore its level. This is done with vocals, snare drums, kick drums, etc. U2 does this on a lot of their recordings. By squashing instruments that have a percussive quality (such as drums or slap bass) the amount of percussive attack is increased. This occurs because the compressor does not respond instantly. The initial attack transient portion of the signal gets through the compressor unaffected while the remainder of the signal is compressed normally. The end result is overall increase in the percussive quality of the processed sound.

The Stereo Compressor can also be used as a *ducker*. A ducker is a device that reduces one signal's level based on a different signal. This effect gets used a lot on radio commercials. In this case, a different audio signal is fed into the side chain such as an announcer's voice. When the announcer speaks, the output of the compressor is reduced. This is useful for keeping background music at maximum volume, but letting the announcer's voice cut through the background music by reducing the music level when the announcer speaks. Listen closely to any radio commercial and you will notice this effect. Duckers are also great for DJs or a presentation with background music.

This ducker effect is also used in the studio to allow one instrument to cut through on a mix. If you want a particular instrument to be more noticeable, such as a snare drum, send the snare signal into the sidechain and have the rest of the mix feeding the compressor normally. When ever the snare drum plays, it will reduce the level of the main mix, increasing the presence of the snare drum without increasing its level. Just by adding a few jacks, we have increased the power of an already useful tool.

The Stereo Compressor is a state-of-the-art audio processor. It can be used to upgrade your home recordings, as an addition to a professional recording studio, or it can just allow you to enjoy late-night movies without riding the gain. Enjoy! Ω

LOGIC SIMULATORS

continued from page 62

There are three ways to run a logic simulation. The first is to press the start button and watch what happens. Sometimes the simulation runs through a user-defined number of cycles, then stops. Other times it keeps on going until you run out of patience or memory. If you're looking for a certain event to happen at a given time, many simulators have a step function that lets you walk through the simulation one step at a time. Which you choose depends on what you're looking for.

Timing violations and glitches

Basically, you use a logic simulator to see whether your design will fly or flop—another reflection of the logic simulator's all-or-nothing attitude that the analog simulator paints in shades of gray.

There are two types of problems that plague digital designs. The first is timing violations. Let's put this scenario into football terms, where the two sides aren't in position before the football is snapped. Examples of a violation are too many players on the field, players in the wrong position, and just general mayhem. Generally, the play is called dead, and everybody tries again. Another logic design flaw is the glitch. This time, something is happening too slowly rather than too fast. Let's say the quarterback has the football in hand, looks left then right, sees no open receiver in sight, and stands there helplessly waiting for a receiver to get free as he becomes a part of the turf under a hoard of 300-pound ogres. In both examples, the result is a loss of yardage — in other words, you lose.

Ideally, the logic simulator warns you when there's a timing violation or glitch problem. This can be done in several ways. The most basic is to show timing violations and glitches in different colors on the timing diagram. The problem with this is that a glitch can scroll past you during the simulation and go unnoticed. The better logic simulators have pop-up dialog boxes that tell you when a problem has occurred. Sometimes you can proceed with the simulation, and sometimes you have to fix the problem before continuing. In most cases, tweaking the clock rate and/or propagation time (as in changing technologies) does the trick. This is exactly why you bought the logic simulator to begin with.

Now let's see how the following five logic simulators do their tricks.

Product:	B²Logic
Version:	3.0
Price:	$199
Platform:	Windows
Publisher:	Beige Bag Software

B²Logic logic simulator is the companion program to Beige Bag's B²Spice analog simulator. By itself, B²Logic sells for $199. If you buy it bundled with B²Spice, though, the package price is $299, a savings of $99. This Windows program is extremely easy to use, and has features not found in other logic simulators—like the ability to estimate the power dissipation of the circuit under test.

B²Logic uses a built-in schematic capture program to define its circuits. The schematic capture program is quite versatile—and a lot easier to use than some of the schematic capture programs we've reviewed in the past. B²Logic comes with four logic families: standard 7400 TTL, low-power Schottky 74LS, Fast FCT CMOS, and Advanced ACT CMOS. You can toggle between the technologies with a pull-down menu. The parts are listed in a menu located on the left side of the screen; you place them on the screen by simply highlighting the device's name and dragging it into place. Wiring the circuit is a snap, too.

The simulation can be monitored in two ways, using output probes and via timing diagrams (Fig. 5). The output probe simply shows the state of the gate, not its timing. That's the job of the timing diagram, which is displayed as a split screen below the schematic. Like all Windows programs, the size of either screen can be adjusted to occupy any percentage of the display, or all of it. Along

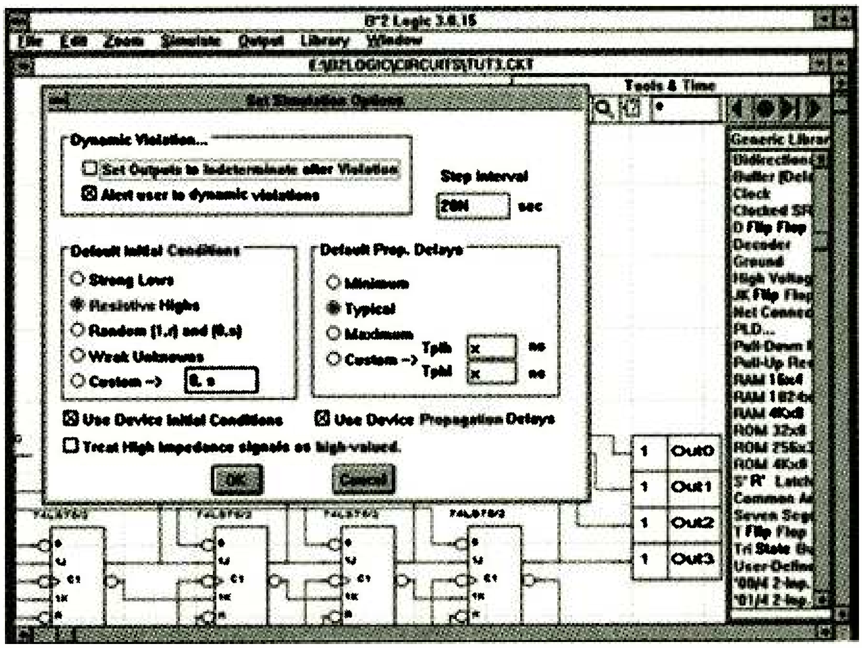


FIG. 6—B²LOGIC LETS YOU EASILY RUN the propagation delay gambit from minimum to maximum with a single mouse click. State conditions can be set to strong, resistive, or weak. There's also a random state, with a strong low and resistive high, and a custom option.

the bottom of the trace screen is a scroll bar that lets you move the timing traces backward and forward in time to view events. The time scale is set automatically by the clock rate of the pattern generator. Unfortunately, this sometimes causes a problem because B²Logic is a memory hog that tenaciously latches on to every byte of RAM available. On long simulations, B²Logic can use up all the free RAM, and more. Once the free RAM is gone, the program locks up.

Changing the propagation delay parameters and device states couldn't be easier. Both are adjusted from a common pull-down menu (Fig. 6). In addition to preset values for minimum, maximum, and typical, B²Logic lets you customize the rise and fall times globally or by the device. State conditions can be set to strong, resistive, or weak. There's also a random state, with a strong low and resistive high, and a custom option.

B²Logic is an excellent logic analyzer with several good features. It's easy to use, has plenty of analyzing options, and supports a wide range of technologies. Except for the occasional lock up, we have no complaints, only praise for B²Logic.

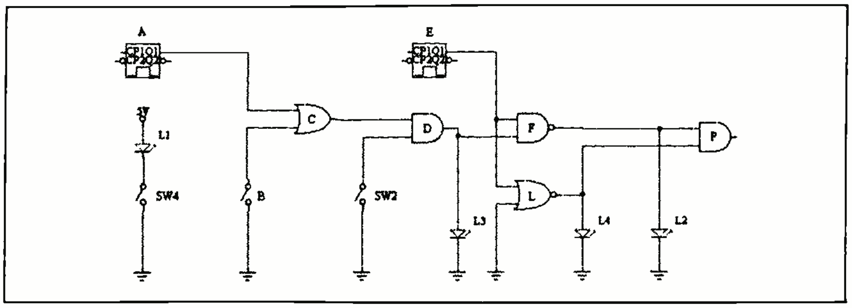


FIG. 7—LOGIC SIMULATOR IS A BOOLEAN-ONLY engine without a component library. Consequently, we couldn't build the Electronics Now benchmark circuit. Instead, this is the circuit we tested, as described in the table of Fig. 8.

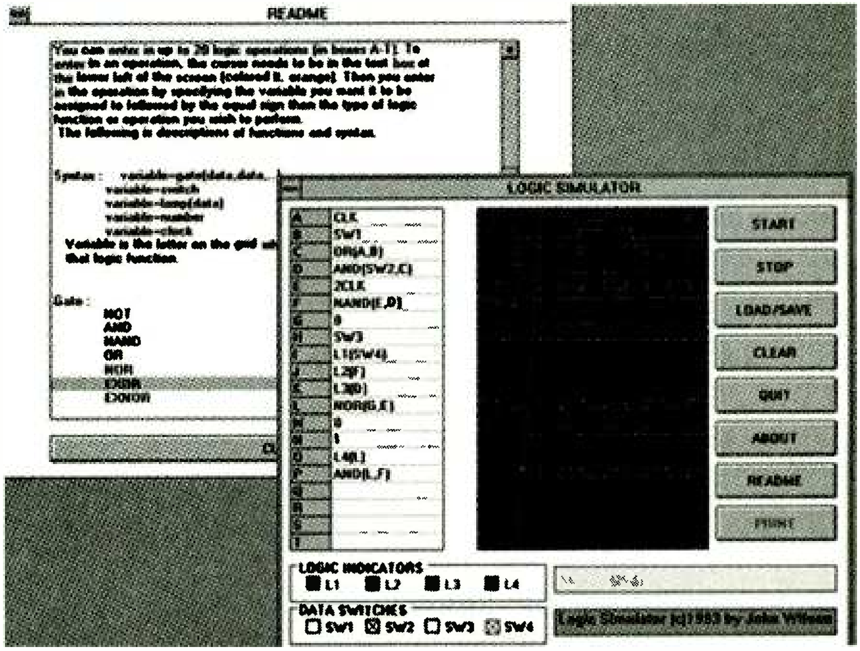


FIG. 8—FOR SIMPLE DESIGNS, Logic Simulator, a shareware program that you can download from the Electronics Now BBS, is an excellent choice. You must break flip flops (and the like) down to their Boolean components of basic gates.

Product:	Logic Simulator
Version:	1.0
Price:	Shareware
Platform:	Windows
Distributor:	John R. Wilson, Jr.

Suppose you don't need a full-blown logic simulator? What if all you want is a Boolean analyzer that will simply display the logic states of a design without the hassle of having to set up pattern generators, consider propagation delay, or select technologies? Then what you're looking for is Logic Simulator, a shareware program from John Wilson.

Logic Simulator is a Windows program that can handle up to 20 logic operations at a time. The operations can be any mixture of logic gates (including NOT and exclusive NOR), clocks, switches, and logic indicators, like the circuit shown in Fig. 7. Because of its simplicity, Logic Simulator can't handle complex designs like R-S flip-flops or multivibrators unless you break them down to their Boolean components of basic gates, which prevented us from loading and running the Electronics Now benchmark.

As expected, the circuit is built using a table, which consists of 20 lines. Each line holds an operation, like the output of an OR gate, or a logic state. The logic state may be created by a pulse generator, toggle switch, or a fixed high/low value. The simulation proceeds without stop for five clock cycles, during which time you can manually toggle the four data input switches.

The results of the circuit simulation are shown in a timing diagram sandwiched between the circuit table and control buttons (Fig. 8). The logic indicators (lower left) behave like an LED, showing bright when the line is high.

Logic Simulator is simple, streamlined, and a great teaching tool. And it's the perfect choice for digital designs that are too complex to work out in your head, but not big enough to warrant spending $150 on. Logic Simulator can be found in America Online's Computing Software forum or on the Electronics Now BBS. You can reach it by having your computer dial (516-293-2283).

Product:	Pulsar
Version:	N0304B
Price:	$149
Platform:	DOS
Publisher:	BSOFT Software, Ohio Automation

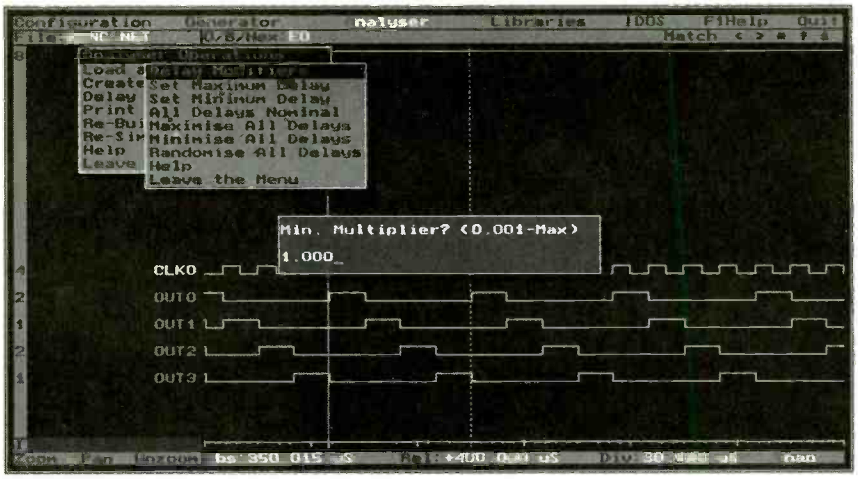


FIG. 9—B^2LOGIC USES A MULTIPLIER to globally change propagation time.

From the same people who brought you Easy-PC and Analyzer III comes Pulsar, a DOS-based logic simulator. The program has a long list of simulation features, like glitch trapping and pattern matching, and is easy to use. Like all Number One circuit design products, Pulsar can read netlists created by Easy-PC Professional schematic capture program.

Pulsar uses tables to build its circuits, not schematics. Which is a good argument for the purchase of Easy-PC Professional, otherwise you'll spend a lot of time translating wires into netlist labels. Fortunately, it's fairly easy to create the circuit right from Pulsar's interactive netlist editor. However, it's somewhat slow and tedious to use. Node connections that are identified by name, like OUT1, are displayed on the screen; numerically labeled connections aren't displayed.

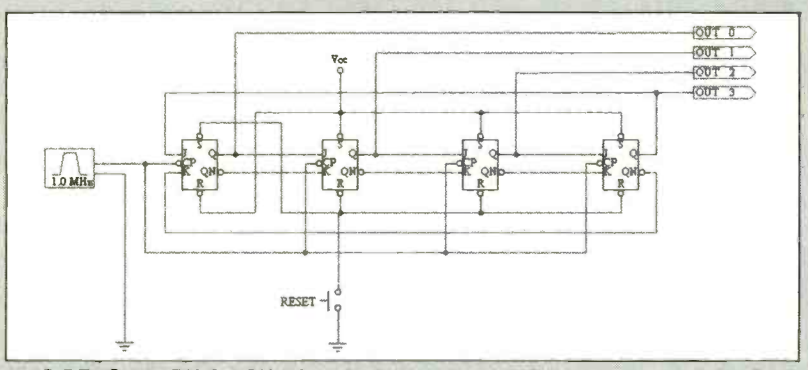
Displayed traces can be stacked in any order you wish, with adjustable spacing between them, using a simple click and drop routine. The X-scale timing parameters are easily changed by clicking on the bottom tool bar. Two movable vertical cursor lines, one absolute and one relative, accurately measure and display the time between any two events on the screen.

The component library is supplied with over 200 devices divided more or less evenly between 74LS TTL and 4000 series CMOS chips. The propagation delay times are fixed at typical, but can be globally changed from a pull-down menu using a multiplication factor (Fig. 9). Like B^2Logic, Pulsar recognizes more than just two logic states. In addition to the usual strong high and strong low, there's support for weak high, weak low, high impedance, and undefined.

Because it's DOS based, Pulsar has to work within the confines of DOS's 640-kilobyte memory constraints. Consequently, you have to balance between the number of nodes monitored and the length of the simulations to avoid running out of memory. Fortunately, Pulsar doesn't know how vast your resources are, so it chugs along until there's no more memory available, then displays the out-of-memory statement. You now have the choice of reviewing the simulation up to this point, or purging the memory and giving it another go. If your pockets are deep enough, there's Pulsar Professional ($349), which can simulate over a million state changes by using up to 16 megabytes of extended memory. From what we've seen of Pulsar Professional, it never runs out of steam.

Pulsar is a stable, easy-to-use logic simulator with lots of great features that should serve the average hobbyist quite well. For

THE ELECTRONICS NOW BENCHMARK



THIS BENCHMARK CIRCUIT is a 4-bit ring counter that uses four J-K flip-flops driven by a pulse or pattern generator.

To test the performance of the logic simulators, we loaded each program with the same benchmark, then put the simulator through its paces. The Electronics Now benchmark is a 4-bit ring counter. The circuit is built using four J-K flip-flops driven by a pulse or pattern generator as shown in the figure.

This design was selected for several reasons. For one, the simulation begins in an indeterminate state where the outputs have no idea of the state of the set and reset inputs. To get out of the indeterminate state, you have to press the reset button, which tests the manual input features of the simulator. In some cases, you can push buttons or throw switches prior to or during simulation. However, not all simulators have push buttons. In one case, the Pulsar, we had to simulate a pushbutton by customizing a pattern generator.

Another reason for choosing this particular ring counter design is because at clock rates faster than 33 MHz, timing violations occur. This design also lets us force glitches under certain conditions. Thus we had the opportunity to check out the error monitoring features of the logic simulator under test.

more ambitious designs, though, you'll want to invest in a copy of Easy-PC Professional, or plan on spending more time than you want creating and debugging designs.

Product:	SuperSIM
Version:	1.1
Price:	$149
Platform:	Windows
Publisher:	Mental Automation

SuperSIM is the logic simulator extension of Mental Automation's family of circuit design software, which includes SuperCAD schematic capture, SuperPCB PCB layout, and SuperSPICE analog simulator.

Like all of Mental Automation's Windows products, SuperSIM is built around SuperCAD. In other words, it's not a stand-alone program; it needs SuperCAD to work. In fact, the only way to get SuperSIM up and running is to launch it from a SuperCAD menu. The reason for this dependence on SuperCAD is Mental Automation's concept of providing quality circuit design software at a low cost. As we've seen in the past, a lot of circuit design software packages contains separate programs that, although similar, aren't interactive. Which means the circuits you draw in the schematic-capture program can't be transferred to the PCB layout or circuit simulation programs. Each time you enter a new phase of the design process you have to reenter the information from scratch. This is both time consuming and prone to error. SuperCAD solves the problem by being the ring master. This approach eliminates errors and saves time—which saves money.

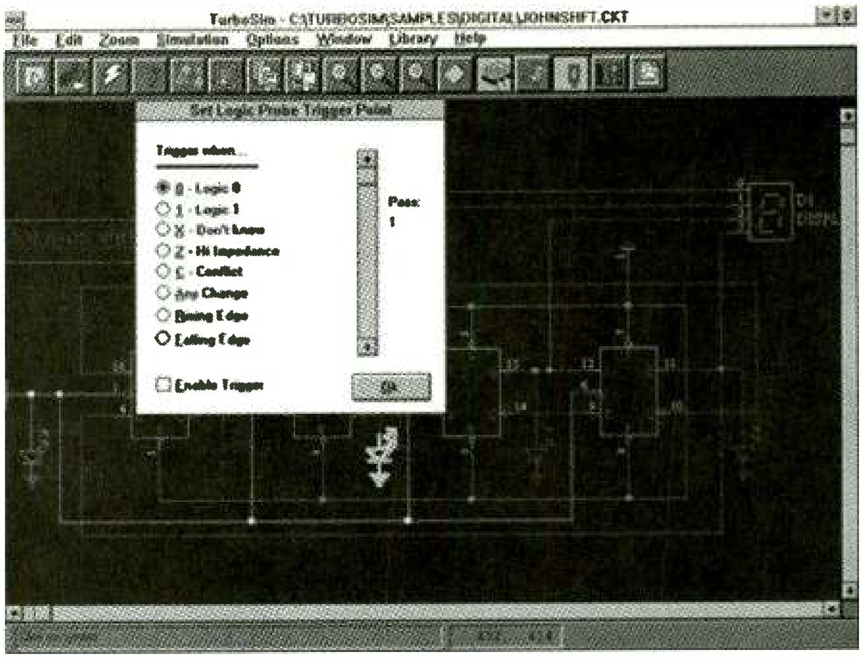


FIG. 11—TURBOSIM HAS THE WIDEST RANGE of logic states of the logic simulators in this review. The first two, Logic 0 and Logic 1, are strong logic and Any Change is weak pull-up or pull-down logic.

It's obvious that SuperSIM uses schematic capture, not a table, to define the circuit. However, the propagation delays and technologies are set by SuperSIM, not SuperCAD. When you load SuperSIM, it updates SuperCAD's component library with new devices—digital components with rise, fall, and other timing parameters defined. Altogether, 25 series 4000 CMOS and 125 TTL (7400 and 74LS) devices are added. Different technologies can be added either by modifying existing components, or as a blanket change using the global delay time option from a pull-down menu. SuperSIM recognizes nine state states, including resistive, weak, and undetermined.

The logic diagram emulates the screen of a benchtop logic analyzer. Traces that you want displayed are marked on the SuperCAD schematic by an asterisk. For example, the output of U2 in Fig. 10 is labeled CNX* and displayed as CNX.

We found SuperSIM to be the most interactive of all the logic simulators reviewed here. It instantly responds to changes made in the schematic, and vice versa. The only complaint is that it's more costly than the rest because you need to buy SuperCAD first. Demos of both SuperCAD and SuperSIM can be downloaded from the Electronics Now BBS.

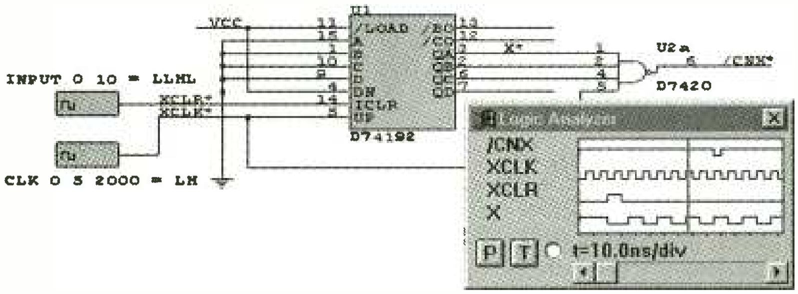


FIG. 10—SUPERSIM'S LOGIC DIAGRAM emulates the screen of a benchtop logic analyzer. Traces that you want displayed are marked with an asterisk (*).

Product:	TurboSIM
Version:	TK
Price:	$149
Platform:	Windows
Publisher:	Island LogiX

TurboSIM contains a separate analog and digital simulator in one package. The two programs aren't connected or interactive, and coexist only as roommates. Last month we looked at the analog simulator; this month

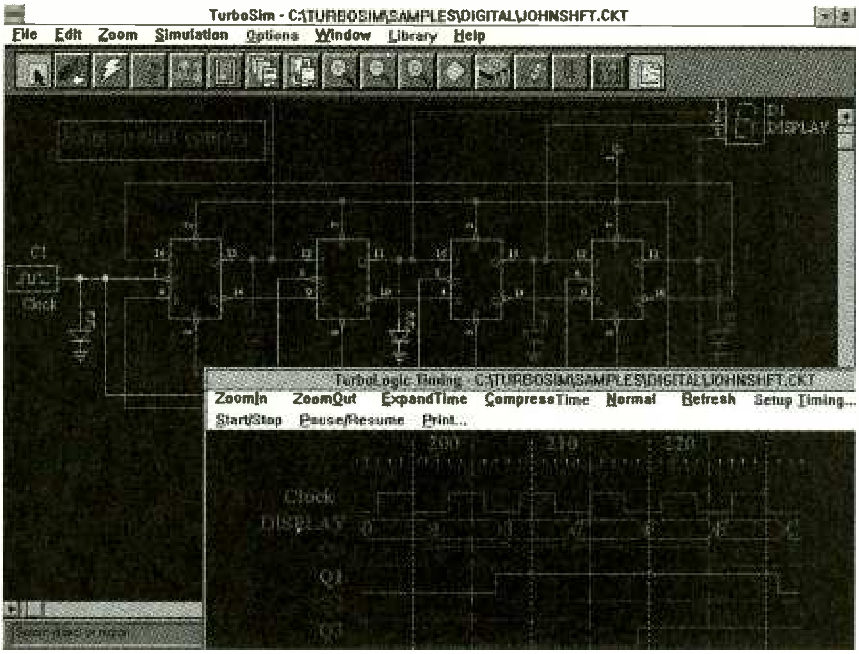


FIG. 12—TURBOSIM DISPLAYS THOSE WAVEFORMS that are earmarked with an "LED" scope probe.

we see how the logic simulator stacks up against the rest.

In case you missed our last episode, TurboSIM consists of three components: a schematic-capture module, a SPICE simulator, and a digital logic simulator. The logic simulator can link to the built-in schematic capture program for simulation input, or it can read a design directly from a netlist file.

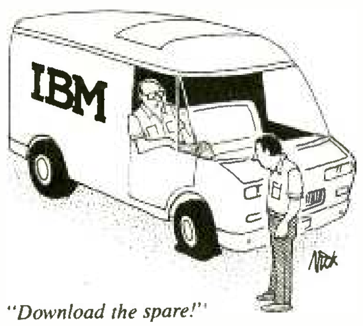
The schematic capture program draws from a library of 125 components, mostly of the 7400 TTL and series 4000 CMOS variety. Of course, there's a hefty helping of generic gates that can be programmed to represent any technology you wish. The propagation time is globally set from a pull-down menu (Fig. 11).

The timing diagram displays those waveforms earmarked with an "LED" scope probe (Fig. 12). There are five states recognized by TurboSIM: strong, weak, high impedance, undefined, and a unique state called don't know—which simply means that we don't know what it does. It appears to be a version of a weak low. TurboSIM has dialog box flags for both timing violation and glitch trapping.

There's little doubt that TurboSIM is a class act. It combines a quality schematic capture program with the dynamic duo of analog and logic simulation. About the only thing we could wish for is that the two be combined into one mixed-mode simulator. But that's in the works, and a demo should be posted on the Electronics Now BBS by the time you read this.

Closing Thoughts

Over the last year, we have shown you how to diagram, build, and test any circuit design you can think of without ever having to inhale the acrid aroma of melting solder or nick your finger with a hobby knife. Whether you want a schematic, printed circuit board, or breadboard testing, you know now that it can be done using your desktop computer and a printer. Better yet, you can do it for under $350. Ω



"Download the spare!"

Q & A

continued from page 9

pages about stepping motors are maintained by Doug Jones at "http://www.cs.uiowa.edu/~djones/step/".

Delay relays

Q ***My home heating system is the hot water boiler type. Presently, the thermostat turns the boiler and the circulating pump on and off at the same time. I'd like for the pump to continue running for about one minute after the boiler is turned off. The boiler and pump are controlled by the same 24-volt (AC) relay. Can you suggest some add-on circuit that I can hook up to the present circuit to delay the pump shut-off? — S. V., Hillside, Ill.***

A What you propose is called "run-on" and is a good way to save energy. Some air-conditioner thermostats do the same thing, running the fan for a few minutes after the compressor shuts off.

Because of the high level of safety and reliability needed in your application, we suggest that you use a commercial time-delay relay rather than building your own circuit. For example, the Amperite 24APR1-120C has a 24-volt primary and 10-amp DPDT contacts. It actuates instantly and provides an adjustable delay of 1 to 120 seconds before releasing.

This relay costs about $40 from Amperite distributors such as Newark Electronics (1-800-298-3133). Delay relays of various kinds are also available from dealers who carry the NTE line of replacement semiconductors. And you might check with the heating industry to see if a ready-made solution is available.

Giant, bright bargraph

Q ***I want to replace an analog panel meter with a giant bargraph for demonstrations during lectures — like an LED bargraph, but with 40-watt or brighter incandescent lamps. What components should I use? — W. D. R., Rio de Janeiro, Brazil.***

A You can use a conventional LED bargraph chip such as the National Semiconductor LM3914, but instead of LEDs, use solid-state relays (SSRs) that switch your light bulbs on and off. The "primary" of a solid-state relay is not a coil but rather an infrared LED with some protective resistance; thus, the SSRs can be wired directly in place of LEDs in your circuit. Instead of a pair of switch contacts, a solid-state relay has a triac or pair of SCRs as its switching element. You can use that to control your 40-watt lights. Most solid-state relays control only AC loads because the triac would latch if you tried to use it to switch direct current.

One suitable SSR is the C. P. Clare PM1204, which will switch 0.5 ampere at 240 volts AC and is triggered by 2 mA of current through its LED. Similar products are made by other relay manufacturers.

Some of the other requirements that you mention in your letter, such as a flashing LED to indicate the maximum value, are not provided by standard LED bargraph chips; the best way to implement them might be a suitably programmed microcontroller with an analog-to-digital converter on the input.

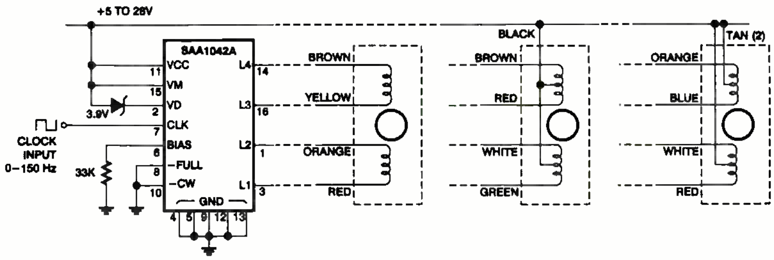


Fig. 4

Do they make...?

Q *In designing low power battery operated circuits, I use CMOS and LCD technology to save power. But when only one or two digits are to be displayed, I have to use LED 7-segment displays, which are real battery killers. Does anybody offer a 1- or 2-digit LCD that fits in a DIP socket?*

Speaking of sockets, 15 or 20 years ago it was possible to purchase low-loss Teflon-insulated DIP sockets, which were very handy in picoamp bias-current circuits. Are these available nowadays? Placing "guard" rings around PC board pads is an obnoxious routine!

Speaking of sockets again, I recently read someplace that "machined-pin" DIP sockets have less stray capacitance than standard DIP sockets. Is this true? I don't see much difference between round conductors and flat ones aligned edge-on, but I'm not a math whiz. — S. C., South Bound Brook, N. J.

A Your first question was the easiest. The Varitronix LCD001VT is a 2-digit LCD display that fits in an 18-pin DIP. You have to supply the drive oscillator, which may not be hard in a clocked digital circuit. According to its specifications, the display can be driven by two 4543's or an ICL7106. Varitronix displays are available from Digi-Key (P.O. Box 677, Thief River Falls, MN 56701, phone 1-800-DIGIKEY).

We couldn't find Teflon IC sockets. Teflon is an excellent low-loss insulator for high frequencies, but it won't do much about picoampere DC leakage, because the leakage is the dirt and moisture on the surface. Maybe the slippery surface helps.

The lowest-loss socket is no socket at all. An old trick to eliminate picoampere leakages is to bend the affected lead so it doesn't plug in; instead, run it through the air to the next component.

As for the last question, we looked at a few IC sockets in our junk box and found that machined-pin ones have a lot more space between metal contacts. That probably accounts for the reduced capacitance. EN

AUDIO UPDATE

continued from page 30

of the component's ability, and it should be evaluated with a knowledge of the performance characteristics of the next unit in the audio chain. This is important in overall system analysis because it determines whether you must add either attenuation or gain stages.

10. In total system design, it is important know how the next stage will load the previous stage to help to avoid system compatibility problems.

11. As in item 5, it is helpful to know what output connectors have been installed. If these are not compatible with the connectors on the other components that you own, you will probably have to purchase adapters or new cables.

12. A knowledge of power requirements is necessary to determine if the branch circuit at the location where the system will be installed has sufficient capacity to handle the system. It will also tell you if the component can be operated in foreign countries where 220-volt, 50 Hz power is the standard.

(You will need line cord plug adapters that will be compatible with the standards of the countries you visit, unless you plan to remove the North American standard plug and replace it. Remember that the linecord plugs specified on the European continent differ from those specified in Great Britain, and that there are other standards for the Middle East, South America, and Japan.)

13. Watts are a measure of power, and this value will give you an indication of current consumption. You will want to be sure that the addition of the component will not exceed the rating for the branch circuit fuse or breaker. Power amplifiers consume more power than signal-processing components. You might decide to run a separate branch circuit for your system so will not share the same circuit with motors or noisy appliances.

14. The dimensions of the unit are useful in planning the audio installation. Will it fit in a designated cabinet or rack, or will separate housing be required? Will it require forced-air cooling or will natural conduction and convection be sufficient? EN

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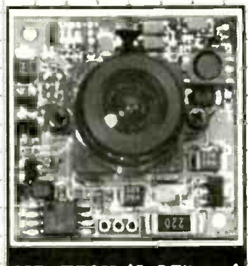
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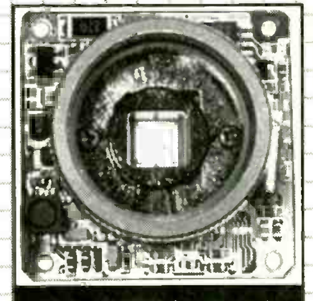
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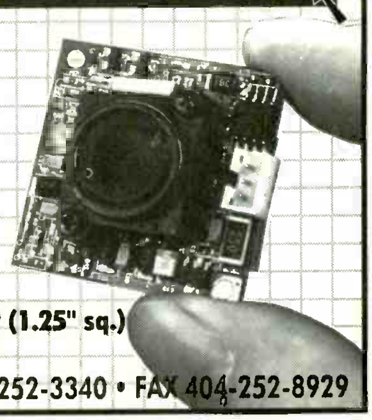
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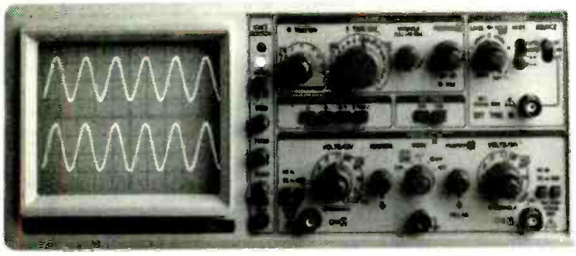

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EN-341-210	DeoxIT Pen Applicator	100%	9.95	8.95	8.05
EN-341-215	DeoxIT Vial w/brush, 7.4 ml.	100%	6.95	6.25	5.65
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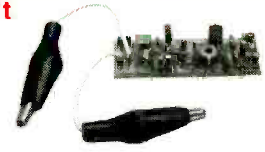

This small circuit, when connected to a phone line, transmits both sides of a telephone conversation into the FM radio band in the 90-95MHz area. The phone line itself is used as an antenna. Includes all components and instructions.

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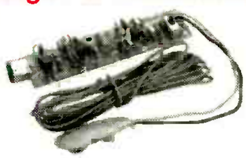

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7 inch Amber	$39.00
9 inch Amber or Green	$29.95

5" COLOR MONITOR $49.00

- Flat Faceplate • 320 x 200 Dot Resolution
- CGA & Hercules Compatible
- 12 VDC Operation • 15.75 KHz Horiz. Freq.
- 60 Hz Vert. Sync. Freq.
- Open Frame Construction • Standard Interface Connector
- Degaussing Coil included • *Mfr. Samtron*

CHARGE COUPLED DEVICES

MATRIX TYPE

"The Spy In The Sky" $29.00

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V)
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².
Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

LINEAR TYPE

4096 element CCD $19.00
1024 element CCD $15.00
2048 element CCD $15.00 • 1728 element CCD $15.00

HACKER CORNER

CELL SITE TRANSCEIVER $79.00 2 for $149.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

Portable Micro Terminal $99.00 or 2 for $149.00

Flip up LCD display (9-16 VDC) • Can communicate with any computer having RS 232 port • Can communicate with another Micro Terminal • Use by itself as electronic notebook • Onboard mic[illegible] RAM (32K) and Video RAM (64K) • Complex built in diagnostics [illegible] capabilities • Original intention for POS applications. • display size 40x16 (256 x [illegible] pixels.) Dimensions: 6.3" W, 11"L, 2"H. (With LCD up height is 7.1")

SOLD OUT

BAREBONES 286-12 COMPUTER $49.00 (2 FOR $79.00)
Slimline desktop case, 100 watt supply, math co-processor support. On board IDE & Floppy controllers. 2 COM ports and 1 parallel port with software setup. Supports up to 8 Megs using standard 30 PIN SIMMs. Internal room for (1) 3 1/2 inch IDE hard drive and (2) 3 1/2 inch floppies. Four 16 BIT ISA slots, accepts full length AT size cards. Keyboard can be set to no test at boot. Case size is 15.5'W x 16'D x 4"H.
(Motherboard can be purchased separately: $29.00 or 2 for $49.00)

.6" COMPOSITE MINIATURE COLOR DISPLAY $149.00
Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal. 250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over $600.00

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Our Best Offer Ever on a High Quality Full Sized DMM

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

$19.00 any qty

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	
20V	10mV	±(1%rdg+2dgts)
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	
20mA	10µA	±(1.2%rdg+2dgts)
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input. 2A/250V fuse.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

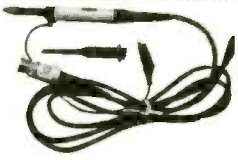
Maximum Open Circuit Voltage: 2.8V

Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

hFE Test
Measures transistor hFE.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Switchable Scope Probe Sets



(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe Set DC~150MHz	24.95	21.95	18.62

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 185mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 185mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

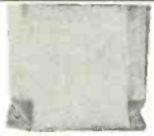
CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 185mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Developer



This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Tank

This handy etching system will handle PC boards up to 8"x9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

Desoldering Pumps

These powerful plastic body desoldering pumps are designed for easy one hand operation for fast, efficient desoldering. Double O-ring piston seals for maximum suction.

CAT NO	DESCRIPTION	PRICE EACH 1	5	10
08-366S	Large Desoldering Pump	$15.89	$13.49	$11.95
08-366E	Regular Desoldering Pump	10.89	8.59	7.39
08-366TIP	Replacement Tip	1.95	1.95	1.95

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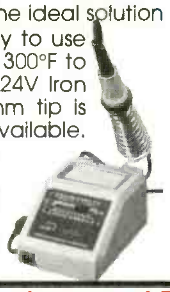
Electronic Soldering System

Here's the ideal solution when **Temperature Control** is required. Easy to use slide control allows user to set system from 300°F to 840°F. Voltage to iron from control unit is 24V Iron heating power is 48W. Replaceable 5.3mm tip is standard. Replacement irons and tips are available.



AS LOW AS $50.00

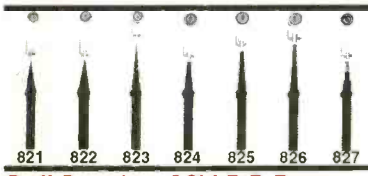
CAT NO	DESCRIPTION	PRICE EACH 1	5
SL10	Temp Controlled Soldering Iron	$56.00	$50.00
SL24V	Spare 24V Soldering Iron	10.50	7.50

Electronic Soldering System with LED Display

Deluxe temperature controlled system with LED display for maximum accuracy. Temperature is adjustable from 160°-480°C (320°-900°F). Iron heating power is 48 Watts. Runs on 24V from controller unit. Replacement irons and tips are available. Tip size is 5.3mm.

CAT NO	DESCRIPTION	PRICE EACH 1	5
SL30	Deluxe Soldering System w/LED	$86.00	$75.00
SL24V	Spare 24V Soldering Iron for SL10 or SL30	10.50	7.50

AS LOW AS $75



Replacement Tips for SL10/SL30

We now offer a variety of replacement tips for the SL10/SL30 soldering stations.

CAT NO	DESCRIPTION	PRICE EACH 1	5
821	1/32" Pencil Tip	$1.39	$1.19
822	1/32" Pencil Tip	1.39	1.19
823	1/64" Pencil Tip	1.39	1.19
824	1/16" Chisel Tip	1.49	1.29
825	1/8" Chisel Tip	$1.49	$1.29
826	3/64" Chisel Tip	1.49	1.29
827	3/64" Pencil Tip	1.59	1.39

Ball Bearing 12V DC Fans

These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4,49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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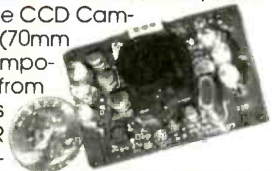
We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.

Tired of Paying Inflated Prices for Solder?

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
RH60-1	1-lb. Spool, .031", 60/40	$ 6.90	$ 5.96	$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CCD Camera - IR Responsive

As Low As $109!!



This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connecting three wires: red to 12V, black to ground (power & video) and brown to video signal output.

CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$125.00	$109.00

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MODEL	DESCRIPTION	PRICE
3400A	True RMS Volmeter	$275
141T	Spectrum Analyzer Display Section *Including 8552B-IF Section and 8553B-RF Section*	$995
6111A	DC Power Supply 0-20 V, 0-1 A	$400
3320B	Frequency Synthesizer	$525
6824A	Power Supply & Amp, 50 V, 1 A	$450
3586B	Selective Level Meter	$1,375

Keithley

225	Current Source	$625
240A	High Voltage Supply	$200

Kepco

OPS55-20M	Power Supply 0-55V, 0-20A	$1,450

Sensres

ESH	Electro Static Voltmeter *5, 10, 20, 30 KV, DC or AC RMS*	$750

Tektronix

MODEL	DESCRIPTION	PRICE
TM503	Power Supply for Tek Plug-Ins	$125
TM504	Power Supply for Tek Plug-Ins	$225
TM506	Power Supply for Tek Plug-Ins	$275
7B92	Time Base	$195
7B87	Time Base w/Retrigger Acquire Clock	$375
7B85	Delaying Time Base	$325
7B80	Time Base	$275
7B71	Delaying Time Base	$140
7B53A	Dual Time Base	$225
7834	Storage Oscilloscope	$1,350
7904	Main Frame	$725
7A12	Dual Trace Amp	$195
7D11	Digital Delay	$375
7A11	Amplifier	$225
7704A	Main Frame	$795
Type611	Storage Display Unit	$100

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Internal/External FM	Burst
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Internal/External SSB	DTMF Detection
Internal/External BPSK	Power Level Measmt

$795 (quantity 1)

The SG-100 gives you .1 Hz synthesized precision and a wide diversity of modulation functions all of which can be performed using an internally generated or externally applied signal. You also get signal analysis functions that are just not offered on any other signal source such as DTMF Detection and Power Level Measurement. And because you can download new instrument functions to Flash memory, you can ensure that your SG-100 will never become obsolete.

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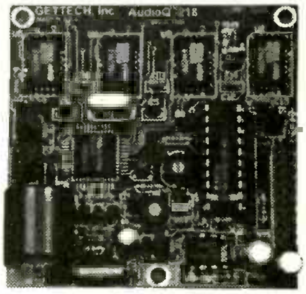

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- Data/Peak hold
- Audible contiuity
- Auto power off
- Unit indicator
- Diode Test

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$99.95

TK-3000

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NEW!

Tools Included:
- SR-2 - Deluxe Soldering Iron
- SH-1 - Soldering Iron Stand
- ST-1 - Diagonal Pliers
- ST-2 - Long Nose Pliers
- ST-30 - Deluxe Wire Stripper
- SE-1 - Solder Ease Kit
- ND-3 - 3 pc. Nut Driver Set
- TL-8 - Precision Screw Drivers
- ST-5 - Screw Driver Slotted 3/16"
- ST-6 - Screw Driver #1 Phillips
- ET-10 - IC Puller
- SP-2 - Solder Pump
- ST-20 - Safety Goggles
- ST-9 - Pocket Screw Driver
- ST-4 - Solder Tube
- SW-3 - Solder Wick

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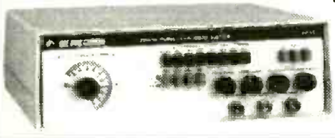

MX-9300 Four Functions In One

- One instrument with four test and measuring systems:
1.3GHz Frequency Counter • 2MHz Sweep Function Generator
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(0-30V @ 3A, 15V @ 1A, 5V @ 2A)

$479.95

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Model XP-581

4 Fully Regulated DC Power Supplies in One Unit
4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A
1 Variable - 2.5 - 20V @ 2A

$85

Digital Multimeter Model EDM-83B

$169

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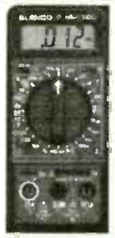

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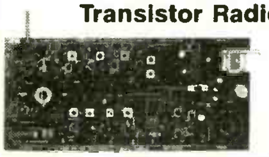

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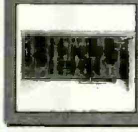

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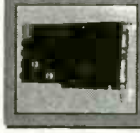

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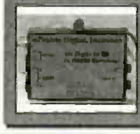

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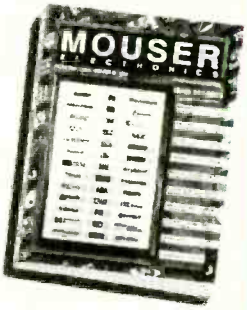

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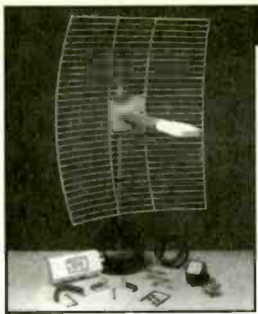

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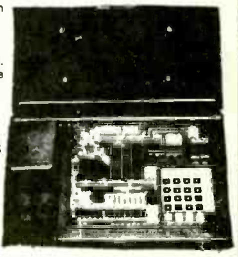

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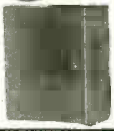

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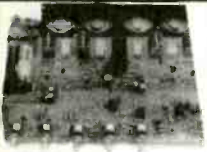

Kit:$ 67.92
Asmb.$ 86.95

Power Output:120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response:10-20KHZ. THD: <0.01%. Tone Control: Bass ±12dB, Mid & Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40VDC @ 6A. Suggested Mark V model 001 or 008 transformer. Recommended Metal Cabinet LG-1924.

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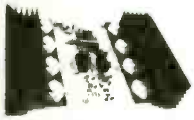

Kit:$ 165.00 Asmb.$ 195.00

Power Output: 300W into 4 ohms RMS. 200W into 8 ohms RMS. Frequency Response: 10HZ-20KHZ. THD: <0.03%. Signal to noise ratio: 91dB. Input Sensitivity & Impedance at 1KHZ, 1V 47K. Load Impedance 4-16 ohms. Power Requirement: ±55 to ±65VDC 8A. Suggested Mark V model 009 Transformer. Capacitor 10,000uf 80-100V model 016 or 019. Recommended Metal Cabinet LG-1925 for each channel.

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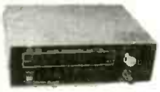

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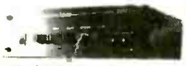

Kit:$ 77.00
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