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Vol. 67 No. 4

CONTENTS

APRIL 1996

ON THE COVER

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APRIL 1996

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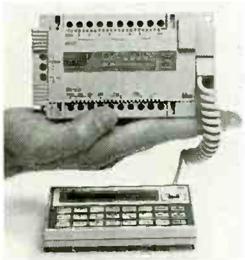
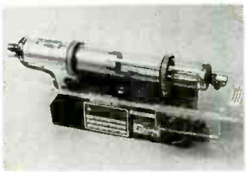


DEPARTMENTS



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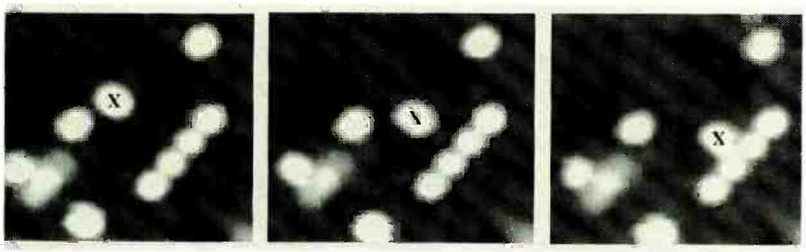
WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

"Atom-tracker" sensor observes moving atoms

For several years now, scientists have had the ability to observe atoms at rest on a crystalline lattice, allowing them to examine the structure and reliability of materials. Scientists at Sandia National Laboratories recently came with a way to observe atoms as they move about. Understanding how an atom moves at various temperatures, and how it is ultimately incorporated into surfaces, will play an important role in the manufacture of the smaller, faster, and smarter electronic structures of the future. It should also allow electrochemical researchers to see how corrosion occurs—one atom at a time.



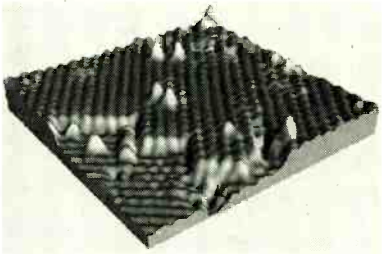
SANDIA ATOM TRACKER LOCKS ON TO A SILICON DIMER (marked with an "X") as it moves along a crystalline row of in-place silicon atoms.

Sandia physicist Brian S. Swartzentruber programmed a needle-like "atom-tracker" sensor of a scanning tunneling microscope (STM) to ride the atom's high point, anywhere that the atom moves. He used lateral electronic feedback from a surface's atomic topography to supplement the vertical feedback that is ordinarily provided by a scanning tunneling microscope. The additional information tells the sensor if it's sliding down the sloping sides of a moving atom, and provides directional guidance as to which way the sensor must move to regain the high ground.

The technique is sensitive enough to allow a scientist to see a pair of bonded atoms change their configuration at a single lattice point. Should the phenomenon of atom exchange on smooth surfaces—when an already embedded atom is displaced by the moving atom and continues on the moving atom's path—the sensor switches to follow the "evicted" atom.

The scanner reaches a speed of that is about 1000 times faster than the usual STM imaging time interval by tracking a single atom instead of scanning the entire image field. The technique can work at high temperatures where some materials begin to become unstable. It can potentially be used to watch corrosion and crystal growth—the leave-taking or addition of an atom—as it occurs.

"[The technique] will enable people to measure how often atoms attach to and detach from different parts of a surface at various temperatures—how much energy it takes to pull an atom off or stick it on," Swartzentruber said. "We'll be better able to create conditions so that an atom attaches to a desirable place on the surface rather than just clumping to another added-on atom. We'll also be able to quantify conditions in which an atom is more reluctant to leave a surface on which it wants to remain."


SCANNING TUNNELING MICROSCOPE VIEW of atoms in a silicon lattice with bumps on the surface showing deposited atoms.

HDTV system recommended to FCC

Late last November, the FCC Advisory Committee on Advanced Television Service (ACATS) recommended that the Federal Communications Commission adopt as the new US digital television broadcast standard the technology developed by the Digital HDTV Grand Alliance. The Grand Alliance was formed in 1993, at the urging of the Advisory Committee, when the developers of four competing digital HDTV systems merged their technologies and pooled their resources to develop a single HDTV system. The recommendation represents one of the final steps in the eight-year struggle to establish an advanced television (ATV) standard in the United States.

The Grand Alliance system will bring large-screen, high-resolution displays and a 19-megabit-per-second pipeline of data into American

continued on page 26

VIDEO NEWS

WHATS NEW IN THE FAST-CHANGING VIDEO INDUSTRY

BY DAVID LACHENBRUCH

DVD peace treaty

Final agreement between the proponents of two high-density optical disc systems for video and computer use now makes it possible that the first products will be available in quantity by the end of this year. The two camps Multimedia CD (MMCD), sparked by Sony and Philips, and Super Density (SD), led by Toshiba and Time Warner now have worked out complete specifications as a follow-up to their August, 1995, agreement to combine the systems.

A PROTOTYPE OF TOSHIBA'S SD-1006 DVD PLAYER. The company expects to have it and another model on the market this fall.

The principle parameters are unchanged from those reached in the earlier agreement. The basic disc is adapted from the SD proposal for CD-sized media composed of two layers, each 0.6-mm thick. Data capacity is 4.7 gigabytes per side, using the "PC-PC" error correction scheme adapted from the SD proposal and "8-16" modulation system from MMCD. The system operates at an average data transfer rate of 4.69 mbps. One participant in the discussions said that the unified format draws equally from the MMCD and SD proposals in its 11 main parameters.

The audio system represented an interesting compromise. For NTSC countries, the discs must have Dolby AC-3 audio, but can use MPEG as an option. For PAL and SECAM countries, the reverse is true. That split decision is as political as it is technical. The movie industry has proposed that discs be differentiated consistent with the disparity in TV standards as a means of controlling international distribution of home video titles for copyright purposes—particularly important from their standpoint because Hollywood product frequently is released in video in the U.S. while, or even before, it is shown in first-run theaters in Europe.

The two competing disc systems both have been known generically as "digital video disc" because they were proposed as a new high-quality carrier for video. However, the personal-computer industry saw the value of the system as a replacement for CD-ROM, and it was, in fact, an ultimatum from a group of major computer manufacturers that sparked the peace talks. Not the least of the problems in reconciling the two proposals was what to call the final result. The negotiators settled on the familiar initials "DVD." But the initials no longer stand only for "digital video disc." Because its usefulness will extend far beyond video to computer and audio storage and who knows what else DVD now stands for "digital versatile disc."

The first form of the new standard to be offered to the public is expected to be the DVD-ROM for computer storage, because its design will be simpler technically and legalistically. Unlike the video version, it won't require MPEG encoding. The drive is expected to fit into the standard CD-ROM drive space and the discs will have more than seven times the capacity of existing CD-ROMs. Already a handful of major manufacturers are promising DVD-ROM drives by this summer.

Although manufacturers are promising DVD video disc players for this fall, there are still some barriers to their practical debut and general use. DVD video players are expected to be marketed primarily as very high-quality movie machines. But the Hollywood studios are reluctant to put their films on digital discs without some form of electronic protection against

continued on page 81

Q & A

READERS QUESTIONS, EDITORS ANSWERS

Scope probe circuits

Q *My question is about oscilloscope probes. I'd like to know the difference between the circuits in Figure 1 and how they work. Also, is there anything that could be added to either circuit to protect the scope when measuring high voltages such as automotive ignition secondaries? — G. C., Houston, Tex.*

A Both circuits are essentially the same once you remember that the cable has some capacitance of its own. So the only difference is which of the two capacitances is variable — the one across the resistor or the one across the cable.

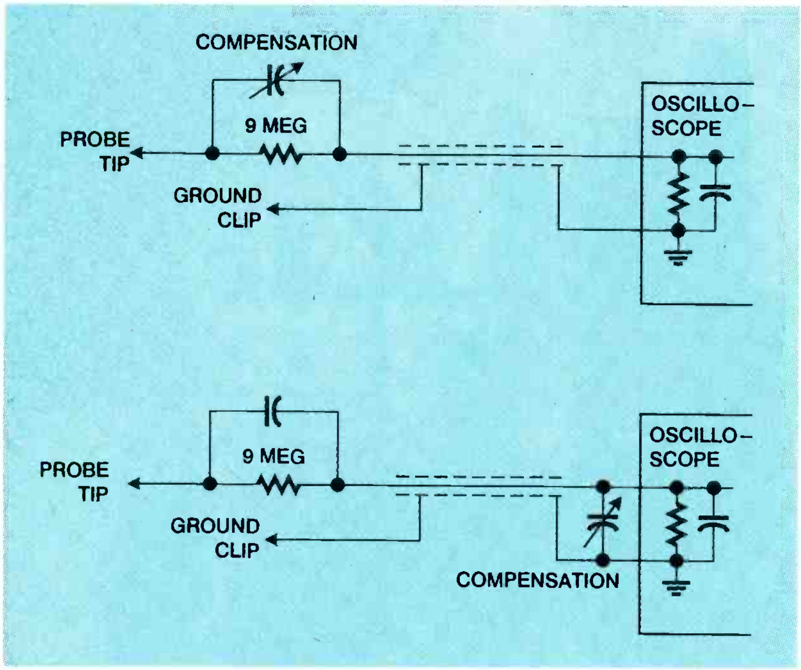


Fig. 1—TWO TYPES OF 10:1 low-capacitance oscilloscope probes.

Getting back to basics, here's how an oscilloscope probe works: The input of an oscilloscope has a resistance of 1 megohm. If you were to connect the scope directly to a circuit, it would be just like adding a 1-megohm resistor to ground, and the operation of the circuit might be disrupted. The 9-megohm resistor in the probe provides isolation. The oscilloscope gets only $^1/_{10}$ as much signal, but it also has only $^1/_{10}$ as much of an effect on the circuit to which it is connected.

If the probe had nothing but a 9-megohm resistor in it, high-frequency performance would be poor, and all waveforms would look rounded and blurred. The cable capacitance, plus the capacitance at the input of the scope itself, would tend to bypass the high frequencies to ground. So a capacitor is added across the resistor, to compensate for the cable capacitance and enable you to see the true waveform. Even then, the oscilloscope can disrupt the operation of a high-frequency circuit because the overall reactance at high frequencies is a lot less than 10 megohms.

High-voltage probes exist but are not easy to build for yourself; they contain special high-voltage resistors. A better way to couple an oscilloscope to an ignition secondary is to use a coil clamped alongside the wire, like the coil used by a timing light.

Finding transmitter frequencies

Q *What test instrument do I need to use to find the frequency of a garage door opener, and what is the procedure? — M. A. G., Dallas City, Ill.*

A Use a frequency counter. Hold the transmitter close to the frequency counter's antenna and transmit. The display will show the frequency. This works with all types of radio transmitters, not just garage door openers.

Power-hungry?

Q *I built a two-channel portable guitar amplifier with two TDA2006s based on a circuit in your April 1990 issue. I'm using four 9-volt alkaline batteries, but they get hot and run down fast. What can I change? Should I use car batteries? — W. E. B., Newport News, Va.*

A Four nine-volt batteries just don't contain enough energy to provide more than a few minutes of room-filling music, especially if the music includes lots of bass, which

continued on page 82

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

ALTERNATE 60-LED DEMULTIPLEXER

In the November 1995 "Q&A" column, W. Closs requested how to hook up 60 LEDs to count from 1 to 60 sequentially. I would like to submit an alternate diagram. It uses a 4022 counter-decoder that minimizes components and simplifies wiring.

JAMES J. BAYER
Winthrop Harbor, IL

AC HUM SOURCE

Your response to Mr. Pritchard's AC hum problem, ("Q&A," *Electronics Now*, January 1996) omitted one possible source—a ground loop.

I have encountered that type of problem both at home and when I was doing stage sound reinforcement. Ground-loop problems are caused by slight differences of AC line potential at each piece of equipment. Those differences cause 60-Hz current flow in the audio lead shields. That comes from voltage drops in each power run caused by differing current loads and length of conductors. Keep in mind that all conductors have resistance. (See Table 1.)

TABLE 1

AWG No.	OHMS/1000 FEET	OHMS/100 FEET
16	4.094	0.409
14	2.575	0.258
12	1.619	0.162

For example, a circuit that draws two amps through 100 feet of No. 12 two-conductor wire will have: E = IR, {E = [(2 × 0.162) × 2]}. That represents a 0.648-volt drop, as illustrated in Fig. 1.

Similarly, a circuit drawing one amp through 100 feet of No. 12 two-conductor wire will have a 0.324-volt drop. If the chassis of those components are connected to AC common, a voltage differential of 0.324 volts AC will exist between the equipment. Thus, when the audio connections are made, AC current will flow in the shield of the connecting leads, as shown in Fig. 2. Note that older house wiring, which uses No. 14 wire, will result in a worse hum problem.

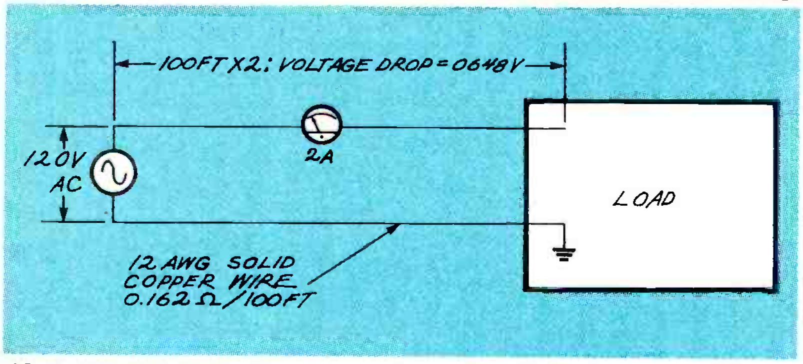


FIG. 1—POWER LINE voltage drop across a line 100-feet long.

The best remedy for that condition is to ensure that all the components are connected to the same outlet through a power strip (with circuit breaker). That cuts down the differential voltages. Be sure you do not overload the power strip and outlet's rated capacity (check the circuit breaker).

A more costly solution is to isolate a troublesome component from the AC main with a transformer.

Professional sound gear avoids the problem by using balanced pair with shield wire. In troublesome cases, the shield can be lifted at one end to break the loop, allowing the signal to pass while still shielding against RFI and noise.

Also, a ground loop caused by your local CATV system can be eliminated by fabricating a video isolation transformer: connecting two 75-ohm/300-ohm transformers back to back at the CATV cable before the first video component, as shown in Fig. 3.

The wire data mentioned above comes from *The Radio Amateur's Handbook 1991*, pages 35-36. The *Sound Reinforcement Handbook*, from Yamaha, has a very good chapter dealing with AC power sources and problems.

GREG SISKA
Topsham, ME

TRANSISTOR-SWITCHING CIRCUITS

I am writing in regard to your answer to the transistor-switching circuit question ("Q&A," *Electronics*

Now, December 1995).

Although an 800-mA transistor might seem capable of controlling a 125-mA incandescent lamp, that is a very unreliable practice because the usual 125-mA lamp will require a peak turn-on current of 1.25 to 1.5 amperes! Because of built-in design and test tolerances, operating duty cycles, and (normally unwanted) series resistancesflor dumb luckflthe transistor might survive for a short period of time, but then go "poof" for no apparent reason. By limiting the base current to 12 mA, the 2N2222 transistor may not saturate, which means that it will operate linearly (only 480 mA at minimum beta), will get very hot depending on duty cycle, and might go "poof." A low-beta transistor might also cause a noticeable delay in the lamp turn-on time. The Allegro application note, "A Primer on Essentials of Output Voltage Limitations," might help explain this problem.

Regarding the second part of your answer (inductive loads), a simple diode across the load will cheaply and effectively protect the drive transistor. Note, however, that this practice was banned in military operations because of the slowed release time of the relay and the attendant fast wear out of the relay contacts. A better method is a diode plus Zener, as shown in another Allegro applications note, "A Primer on Driving Incandescent Lamps." The Zener provides for a higher flyback voltage and much faster relay drop-out time.

RAYMOND DEWEY
Technical Information Coordinator
Allegro Microsystems, Inc.
Worcester, MA

EASY-PC DOES IT

I totally disagree with the negative comments made by TJ Byers about the EASY-PC CAD program in his article "So, You Want to Buy a Computer?" (*Electronics Now*, January 1996).

I have used EASY-PC for the past three years with much delight and success, and ease of use! Its command structure is very well thought out and, above all, easy to use. It is definitely not clumsy, as Mr. Byers states.

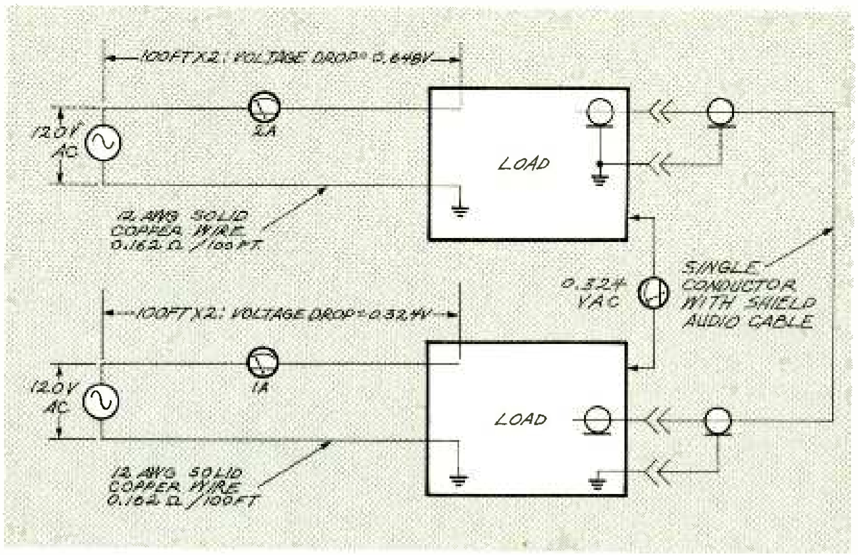


FIG. 2—VOLTAGE DIFFERENCE between two loads caused by different line voltage drops.

Obviously he has not done his homework. If he had, he would have discovered that "rubberbanding" is a feature on EASY-PC, invoked by just pressing "X." That's allflone keystroke. What could be simpler?

Readers interested in learning the truth about EASY-PC should read two articles appearing in *73* magazine. The first appeared on page 48 of the April 1992 issue; the second, on page 42 of the January 1994 issue.

Readers should try EASY-PC for themselves. (A demo disk is available.) I am sure that they will be very pleasantly surprised by its ease of use and well thought-out command structure.

B.M. AUGUSTE
Hamilton, Ontario, Canada

IF YOU DON'T HAVE ANYTHING NICE TO SAY...

I was reading an article in the January 1996 issue of *Electronics Now* and was amazed at the audacity of the author.

He was belittling, insulting, and ridiculing an individual who had used his help line to try to get information, just because that person was not aware of things that the author knew about.

It seems to me that if you don't know something exists, then you can't research it or even ask questions about it. When there are things a person needs to know, he should be informed without being humiliated for asking.

Who is this author? None other than Don Lancaster writing in his "Hardware Hacker" column. Can I see Don in "Grumpier Old Men II"?

J. RAMSEY
Belton, MO

TRANSISTOR HISTORY

I wonder if other *Electronics Now* readers share my interest/hobby. I collect early transistorsflI mean the components themselves, not transistorized radios. Most of your readers probably know *where* the transistor was invented: at Bell Laboratories (although "discovered" would be a more accurate term since they what they found was certainly not what they were looking for!). However, how many people know *when*? It was in December 1947, probably longer ago than many electronics enthusiasts would guess.

The importance of the transistor is obvious to anyone with any knowledge of electronics. It has transformed our lives, for better or worse, and made possible things that were unthinkable only a few decades ago. The repercussions of its invention are far from over, as the development of the digital integrated circuit, some packed with millions of transistors, is still continuing at an astonishing pace.

Despite this situation, few people are interested in the early history of transistor development and manufacturing. The earliest transistors were point-contact types. Nowadays, those are hardly ever mentioned in electronics books and, if they are, they are dismissed in a single sentence as some kind of inferior early aberration. That is unfair to a device that was never fully understood and that operated in a fundamentally different way from the junction transistor that superseded it.

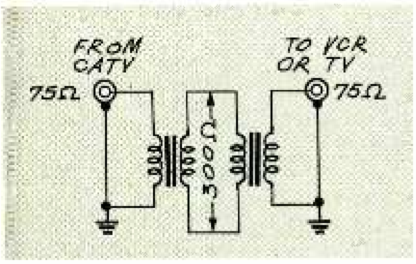


FIG. 3—USE TWO LINE-MATCHING video transformers to isolate CATV ground from home video components.

Point-contact transistors are very hard to find today, as are the earliest junction types. Almost any transistor from the 1950s is, in my opinion, worth preserving for its historical interest, as are data sheets and books from the same period. The people who were involved in the infant transistor industry are retired, and it is becoming urgent to record their memoirs if their memories and recollections are not to be tragically lost forever.

I collect 1950s transistors and other kinds of early semiconductor material, as well as data sheets and books, company histories, and other anecdotal material. I would like to hear from anyone who has material that might interest me, or who shares the same interest, or who has any connection with the early transistor industry.

ANDREW WYLIE
21 Brancaster Lane
Purley, Surrey CR8-1HJ
England

EN

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PC-BASED DIFFERENTIAL OSCILLOSCOPES

THE PCI-411 AND PCI-412 PC-based differential oscilloscopes from PC Instruments provide the measurement capability of a stand-alone oscilloscope with the convenience of the PC environment. Combining robust differential oscilloscope amplifiers with a powerful set of software features to capture many difficult-to-measure waveforms, the differential input oscilloscopes can handle many demanding situations.

For example, they can be used to eliminate unwanted 50/60-Hz when measuring the outputs of force sensors, bridges, accelerometers, and strain gauges. Sensing current on motor control lines, SCRs, audio signals, and power lines is easily accomplished using a shunt and the differential inputs of the oscilloscope board. Any waveform that is not referenced to ground can be measured using the differential inputs.

Rotational velocity measurements can be made by combining a pickup coil, the differential inputs, and the frequency-counting function provided by the included software. The input resistance and capacitance of the board are compatible with ×10 and ×100 probes, extending the common-mode measurement range.

Each single-channel board occupies one PC/AT expansion slot, and offers 1-MHz bandwidth and real-time sampling rate of 12.5 megasamples per second, an 80-dB common-mode rejection ratio at 100 Hz, ±200 volts input protection, input impedance of 1 megohm and 15 picoFarads, and AC/DC coupling and DC offset control. Each board has seven vertical ranges, the PCI-411 from 10 mV/div to 1 V/div, and the PCI-412 from 50 mV/div to 5 V/div. The PCI-412 also features a common mode, neasurement range of ±40 volts.

The BenchCom for Windows software bundle, included with both boards, contains the graphic user interface, drivers, programmer's libraries, DLLs, and utilities needed by test engineers to incorporate the PCI-411 and PCI-412 into a test system. The software includes the capability to control several oscilloscopes in a multi-channel test system.

The PCI-411 and PCI-412 each cost $1495.

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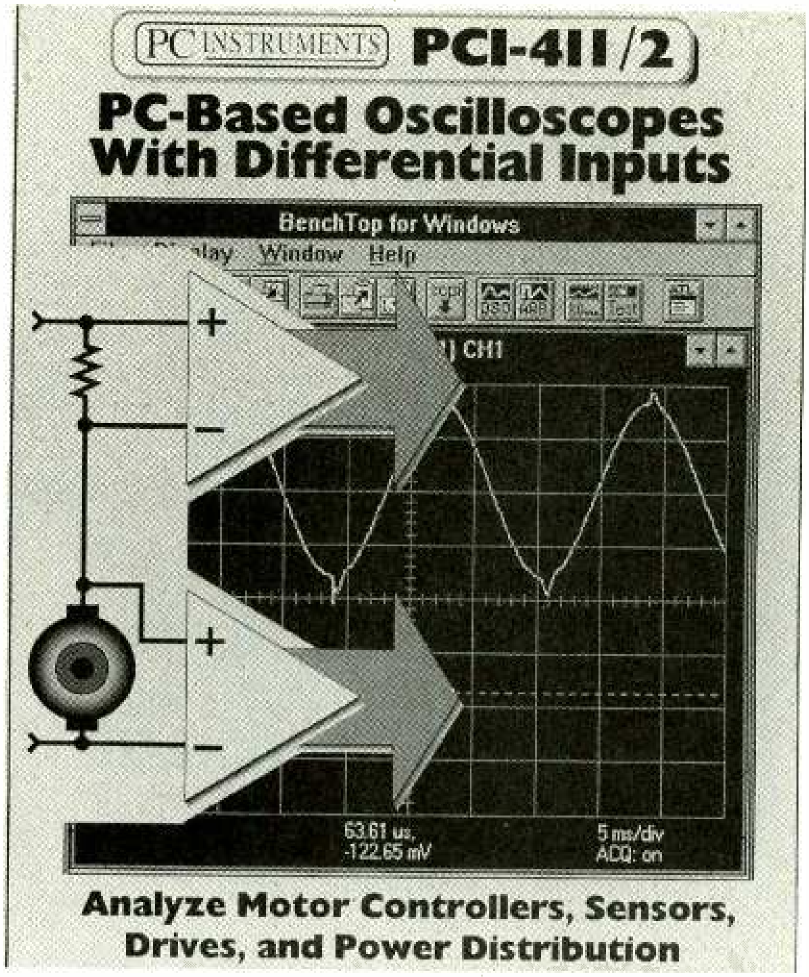
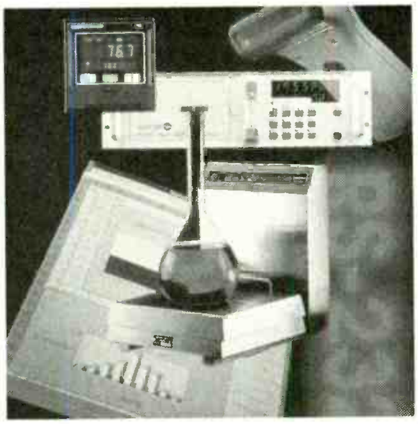


CIRCLE 20 ON FREE INFORMATION CARD

SOFTWARE WEDGE UPDATE

THE SOFTWARE WEDGE Pro/Windows is a data-acquisition tool that adds serial data input and output capability to other software programs. It allows the user to collect data from instruments like bar-code readers, electronic scales, measuring tools, telephone systems, and other industrial, medical, or laboratory equipment and store it directly into their favorite PC applications.

WinWedge Version 3.0, the first major upgrade, has many advanced features that enable the user to communicate between any Windows, DOS, NT, or Windows 95 application and his instruments, even if those instruments require sophisticated interfaces.



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The Wedge works by passing serial data either as keystrokes or by dynamic data exchange (DDE) to applications such as Excel, Lotus, Access, Quattro, LIMS, SPC, industrial software, or custom software. It supports complete two-way serial I/O and offers a range of features that ensure that only the data that you are interested in is input exactly where you want it to go.

In addition to advanced data parsing, filtering, and formatting features, Version 3.0 offers powerful math and string functions, hot-keys, and a "virtual instrument" mode. The program supports 30 different math functions, including multiplication, addition, subtraction, division, square roots, trigonometric functions, exponential and log functions, and absolute value functions, that can be applied to incoming serial data. Up to 50 hot keys perform any of 13 different actions, including transmitting data out of a serial port; sending prompts to instruments; toggling, raising, or lowering the DRT or RTS lines; and resetting, disabling, or enabling WinWedge. The virtual instrument mode is useful for testing WinWedge to see how it will collect data from various instruments that you might connect to it.

WinWedge Pro v3.0 costs $395, the upgrade from version 2.0 costs $129, and DOSWedge Pro version costs $295.

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FoamClean is easy to use. After peeling off as much of the label or sticker as possible, spray on the foam, wait for it to "collapse," and wipe the surface clean. Besides label adhesive, FoamClean will remove the residue left by chewing gum, wax, crayons, and lipstick.

A six-ounce can of FoamClean, which includes a label-lifter tool for removing the top layer of coated labels before application of the cleaner, has a suggested price of $7.40.

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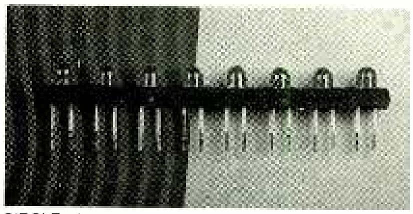
BOARD-LEVEL LED STRIPS

A NEW SERIES OF BOARD-level LED strips from Lumex Opto/Comp-onents is available in a



CIRCLE 23 ON FREE INFORMATION CARD

choice of five, six, or nine 3mm LED's on /-inch centers. The strips are aimed at end-product makers who need consistent placement of multiple LEDs and precise alignment of X and height positions. The strips can be used as ladder displays, or volume or multi-status indicators, typically for products such as industrial controls, audio equipment, medical instruments, and annunciator panels.

The strips, which can be flexed to match curved surfaces, can also be broken up into any combination of LED lengths, strung together to form longer strips, or attached side-by-side. Users could purchase 9-LED strips, for instance, and break them into 6- and 3-LED segments for assembly to their boards. The strips can be ordered in any combination of colors (red, super red, yellow, green, or amber), light intensities, or lens finishes. Additional options include bi-color, low-current, or fixed-voltage LEDs. Power requirement is 10 to 25 milliamperes (1 to 5 mA for low-current versions), with forward voltage of 1.6 to 2.6 volts (Vf).

Prices for the LED strips range from $1.90 to $3.00 in quantities of 1000 pieces or more, depending on exact specifications of the strips.

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TRIPP LITE'S SMART DATA-Center 3000XL and 5000XL intelligent line interactive UPS (Uninterruptible Power Supply) systems combine innovative features not found on other systems in their price range. They offer microprocessor control over a wide variety operating conditions while providing high levels of network power, communication, management, and reliability.

Exclusive to the SMART Series are four Db9 network ports to allow multiple server shutdown of different operating systems from the same UPS. The 3000XL and 5000XL each offer a total of 14 AC outletsfltwelve 120-volt and two 208/240-volt receptaclesflto facilitate the connection of multiple pieces of network equipment. Hot swap battery capability and expandable battery capability are also standard.

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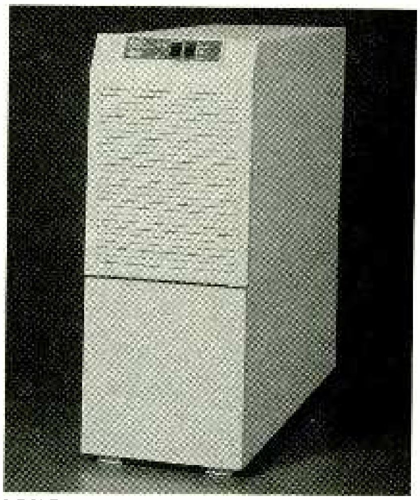

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tion with PowerAlert PLUS software to enable tracking and logging of network power operations with an easy-to-use menu system. Events such as incoming voltage, frequency, percent of battery power remaining, UPS temperature, and UPS load are just a few of the many parameters that can be displayed. Network management and control functions are further enhanced when the SMART DataCenter is coupled with Tripp Lite's SNMP-2 UPS adapter.

The SMART DataCenter models 3000XL and 5000XL have suggested retail prices of $2799 and $4199, respectively.

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continued on page 82

NEW LITERATURE

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The Low Budget Video Bible: Second Edition

by Cliff Roth
Desktop Video Systems
Box 668 Peck Slip Station
New York, NY 10272
Phone: 1-800-247-6553
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CIRCLE 40 ON FREE INFORMATION CARD

You don't have to spend a fortune to produce great videos. This book provides a practical guide to creating high-quality video on a shoestring budget. It shows readers how to get maximum performance from their camcorders and editing equipment fl at the minimum cost.

Aimed at students, hobbyists, artists, and semi-professional video producers, the book explains video terminology and jargon and answers the most commonly asked video questions. It provides pointers on buying video equipment as well as shooting and editing videos. It describes the differences between various types of camcorders and editing VCRs, helps readers decide what videocassette format to use, and discusses how the consumer formats compare to professional formats such as Betacam SP, D-2, and D-3.

The book describes the features to look for on camcorders and VCRs, and how to use them. It shows readers how to record the best sound and maximize the use of audio tracks, when it's best to edit in-camera, and when non-linear editing can help save money. It explains how RC, SMPTE, and VITC time codes are used; how to achieve accurate editing without using expensive equipment; and how personal computers and personal video are merging. Separate chapters are devoted to lighting, audio, and graphics.

The closing chapters deal with video opportunities for aspiring professionals, with a look at cable TV and public access TV, and advice on getting funding for video productions. New and emerging video technologies, including HDTV and direct broadcast satellites, are also discussed. Several useful appendixes provide low-budget video resources, including video editing services, manufacturers, and funding sources.

Real-Time Animation Toolkit in C11

by Rex E. Bradford
John Wiley & Sons, Inc.
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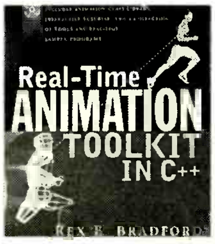

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If you've seen Jurassic Park or Toy Story, you've seen real-time animation. It's the latest technique used by movie and game producers to draw audiences to the box office and game players to the stores.

This book teaches graphics programmers how to develop and use real-time animation. It offers in-depth coverage of VGA, Super VGA, and Windows displays, including WinG; and takes a close-up look at the FLIC format, the most-widely used animation file format. The book describes a powerful "scene-and-actor" methodology for seamlessly overlapping multiple screen elements. It provides color look-up tables for fast shading, hazing, and translucency; viewers for popular graphics and animation file formats, and file conversion utilities.

The included CD-ROM includes animation in Real-Time Toolkit (ARTT); an interactive multimedia ARTT browser; source code for all classes, tools, and sample programs; and WinG runtime files. Together, the book and disk provide readers with everything needed to create sophisticated, high-quality animations using a PC.

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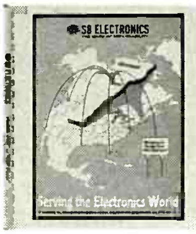

CIRCLE 38 ON FREE INFORMATION CARD

This comprehensive technical data book contains details on the SB Electronics' radial-lead Orange Drop and axial-lead 192P Pacer film/foil capacitor lines. It includes information on the High A-C Voltage

Orange Drop, rated up to 900 VAC with operating frequencies through 175 kHz. Applications include electronic lighting ballasts, CRT monitors and displays, switching power supplies, amplifiers, and control circuits. The catalog also provides complete technical data on polypropylene and polyester film dielectrics, including RMS voltage versus frequency curves, dv/dt, dissipation factor, corona start voltage, insulation resistance, ESR, current ratings, resonant frequency, and temperature characteristics.

UNIX Companion

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CIRCLE 37 ON FREE INFORMATION CARD

Created by top UNIX administrators, the *UNIX Companion* is a loose-leaf bound, updatable reference manual that contains everything you need to know to configure, manage, upgrade, and troubleshoot your UNIX system. It covers all UNIX features and commands, hardware components, networking and the Internet, security, installing upgrades, and using applications. Important technical issues, such as connecting networks, DES encryption, and writing shell scripts, are highlighted. The manual comes with a disk that contains shell scripts, diagnostic programs, and utilities.

The reference manual reveals fast and efficient ways to manage your UNIX system, and proven techniques to minimize downtime and system problems. It explains how to expand your system into a full-power network, customize your shell for maximum performance, and enhance your capabilities with X Window, laser printers, and CD-ROM drives. Throughout its 800 pages, flowcharts, diagrams, and checklists help system administrators troubleshoot hardware, speed up disk and file access, and maintain data integrity.

The comprehensive reference manual is updated five times a year to ensure accuracy and provide the very latest product developments and maintenance guidelines. The supplements give system administrators timely, authoritative operational and technical information on an ongoing basis. The updates cost $43 each on a fully-guaranteed trial basis.

Capacitor Data Book

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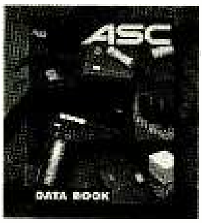

CIRCLE 36 ON FREE INFORMATION CARD

This data book summarizes ASC Capacitors' product offerings and provides useful information for anyone interested in capacitors. It contains general information about specifying the correct capacitor type and value. Topics range from the basic "What are Capacitors?" to the more advanced, such as "How Close is a Close Tolerance Capacitor?," "Capacitance vs. Temperature," "Insulation Resistance and Leakage Current," and Dielectric Absorption." For further reading, the book lists appropriate technical papers, which are also available from ASC.

The book includes a section on application-specific, custom solutions. The section discusses which capacitor parameters can be altered to produce solutions that are unavailable in standard configurations. Among the many solutions mentioned are extremely high-voltage or very-low E.S.R. capacitors, custom AC- and DC-based film formulations to enhance dielectric performance, and completed capacitor subassemblies to reduce manufacturing cycle time and inventory costs.

The book also catalogs ASC's more than 40 standard capacitor lines. It describes physical and electrical characteristics, and includes drawings to clearly illustrate specifications. Types of capacitors described include those using polypropylene, polycarbonate, polyester, and polystyrene dielectrics, as well as polyester RC snubber networks. The book also describes IGBT snubber capacitors, high-performance speaker capacitors, round or flat upright capacitors, high-wattage (5-watt) RC snubbers in single packages, high-voltage capacitors, specialty oil-filled capacitors, and ballast capacitors. Other products include feed-through capacitors, plastic film capacitors to replace large canned aluminum electrolytics capacitance bands, and metallized polypropylene capacitors to replace aluminum electrolytic for cold-temperature operation.

Simplifying Power Supply Technology

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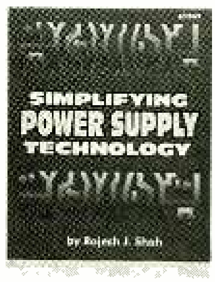

CIRCLE 35 ON FREE INFORMATION CARD

Power supply technology has made great strides in recent years, as many researchers have dedicated their careers to advancing the field of power electronics. The basic concepts presented in this book help the reader understand and appreciate today's power supply technology.

The book was written for readers from various backgrounds, including students, hobbyists, professional technicians, engineering assistants, and marketing and sales personnel. It provides an introduction to the field, simplifying the concepts of power-supply technology and giving the reader the background and knowledge to confidently enter the power-supply industry. Topics covered include input, regulators, converters, control, and specifications.

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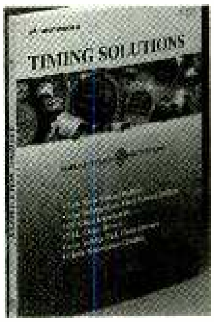

CIRCLE 35 ON FREE INFORMATION CARD

Aimed at designers seeking solutions for high-speed clocking requirements, this 335-page book describes the industry's broadest line of clock distribution circuits with timing solutions that include all logic technologies, including TTL, CMOS, ECL 10H, ECLinPS, PLL, and BiCMOS.

Revision 5 has been updated and expanded to include all the latest information on Motorola's low-voltage PLL clock drivers, 5-volt PLL clock drivers, low-voltage/low-skew fanout buffers, low-skew fanout buffers, and clock generation circuits. It features data sheets as well as application notes on system design considerations, clock distribution techniques, and details on designing with PECL.

Recent additions to Motorola's product line include a variety of low-voltage ECL/PECL fanout buffers, programmable ECL/PECL clock generators, and low-voltage clock drivers. LVECL/LVPECL clock distribution trees can be designed by combining various models of fanout buffers with the MC12429 of MC12439 LVECL/LVPECL clock generators (programmable to 800 MHz).

The MPC931 and MPC951 PLL devices provide a LVPECL reference lock to allow for "zero delay" translation to LVCMOS, thus easing the design of mixed-technology clocking trees. For single-chip solutions, the MPC 991 and MPC992 provide integrated LVPECL PLL clock generation as well as low-skew fanout buffering.

Vertical Antenna Classics: The Best Articles from ARRL Publications

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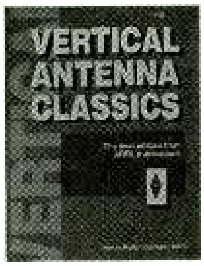
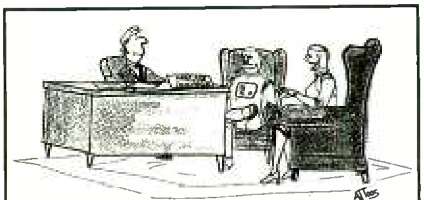


CIRCLE 33 ON FREE INFORMATION CARD

This book, aimed at anyone who is in the market to buy or build a vertical antenna, provides a wealth of advice on choosing the design that will work best for you. It also offers tips and techniques on improving the performance of existing verticals. The book is a collection of articles from *QST* and the *ARRL Antenna Compendium* series, spanning almost 20 years. Selections from *QST*'s "Hints & Kinks" column convey the insights of hams who have found solutions to annoying problems.

The book provides all the theory needed to provide a solid foundation for modeling verticals and all other ham antennas. It explains how a handheld's antenna works, and shows how to build a high-performance handheld antenna as well as a three-band antenna for your car. The book covers HF antennas, directional arrays, and radials and ground systems. An article that explores the factors that go into mobile antenna performance even offers computed radiation patterns for various vehicle shapes. Finally, the book lists the suppliers who sell verticals and the parts you need to build them. Plans, schematics, and instructions for building VHF, UHF, and HF antennas are included. EN



"We're having technical difficulties."

EQUIPMENT REPORTS

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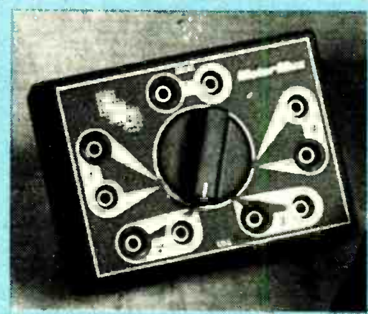

Any piece of test equipment that speeds up your troubleshooting time is a good investment. The faster you can complete a job, the more servicing volume you can handle during your work day. Equipment that makes this possible is even more valuable if it also reduces the chance of your making a measurement error. Human error wastes time and money, especially if parts are changed unnecessarily because of measurement errors.

One of the most commonly used instruments is the DMM. This vital device has countless applications, so it makes sense to invest in a good quality DMM. It can be a sizable investment, especially when it is intended for professional use.

Even the best DMM can only test one point in a circuit at a time. Troubleshooting usually involves moving the pair of test leads from point to point in a circuit until the information you are after reveals itself. It does not matter whether you are experimenting with some new circuit or if you are repairing something; test leads always have to be moved from place to place in the circuitry you are investigating.

Probing different points in a circuit can be frustrating at times, and it's easy to probe the wrong point especially if you are testing integrated circuits — counting IC pins can get tedious after a while.

To avoid moving test leads around you can either buy several DMMs or buy one *MeterMux*. This little instrument from Innovative Solutions (416 Stewart Hollow Road, Portsmouth, OH 45662, 614-574-4304) is a simple device that adds versatility to DMMs and other test equipment.

The MeterMux

The *MeterMux* is a test-lead switcher. On the front panel of this little $4^1/_4 \times 3$-inch unit are five pairs of shrouded banana jacks. One pair of banana jacks at the top of the unit, labeled "DMM," connects to the input jacks of a DMM or almost any other kind of test equipment. The other four pairs of jacks, labeled 1 to 4, are input jacks that can connect to as many as four pairs of test leads. Each pair of test leads can then be connected to different points in the circuit you are working.

A rotary switch on the front panel connects one of the four pairs of input jacks to the DMM jack which is, in turn, connected to the DMM's input. You can then easily switch between the four test points and read the DMM display. The *MeterMux* is completely passive and requires no power to operate. It can switch up to 1 ampere and handle as much as 15 amperes continuously.

The switch box is simple and appears to be well-made. It will easily stand up to professional use. It greatly increases the flexibility of any DMM and is a great convenience at the test bench. We don't think that many people would opt to use the *MeterMux* with inexpensive DMMs, as it costs $79.00

Put it to work

This handy instrument has many practical applications. For one, it eliminates the need to move test leads from point to point in a circuit.

The *MeterMux* can also be used to switch between different kinds of test leads. There are test leads with sharp probes, alligator clips, micro clips, insulation-piercing probes, and many other types. Hook up four different kinds and you can eliminate the hassle of changing the test leads and reduce wear and tear on the DMM input jacks.

To connect the *MeterMux* to your DMM you will need a pair of banana-plug-to-banana-plug leads. They can be made quite easily. Another option is to buy the one-piece 1-foot long double-banana-plug cable that Innovative Solutions sells for $17. If you need a longer cable, they offer a 3-foot cable with plugs for $18.50. They also offer a BNC-to-double-banana-plug cable for $23.50. It allows you to use the *MeterMux* with an oscilloscope or other with of test equipment that has a BNC input. The only requirement is that you supply the appropriate test leads to do it according to the application. A full line of test leads are available. EN

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Tektronix

WHAT'S NEWS

continued from page 4

homes—using the same amount of spectrum as today's analog, low-resolution TV. The new standard also places the United States in a leadership position in digital television technology.

The 25-member ACATS panel, which is made up of senior executives from the broadcast, cable, telephone, consumer-electronics, computer, and entertainment worlds, overwhelmingly approved the results of extensive laboratory and field testing of the digital high-definition TV technology. Their final technical report concluded that the Grand Alliance's system is superior to any known alternative system in the world, better than any of the four original proposed digital HDTV systems, and surpasses the performance objectives of the Committee.

The tests evaluated the Grand Alliance system's four principal subsystems: scanning formats, video and audio compression, transport, and transmission.

The proposed HDTV scanning formats include five progressive-scanning formats and one interlaced-scanning format—24-, 30-, and 60-frame-per-second progressive scan with 1280×720 pixels; 24- and 30-frame 1920×1080 progressive; and 60-frame 1920×1080 interlaced. The HDTV system uses MPEG 2 video compression and Dolby AC-3 six-channel digital surround sound. A packetized data transport subsystem performed well when tested to evaluate the switching between compressed data streams, the robustness of headers and descriptors, and interoperability between the compression and the transport layer.

Micromotor drives gears

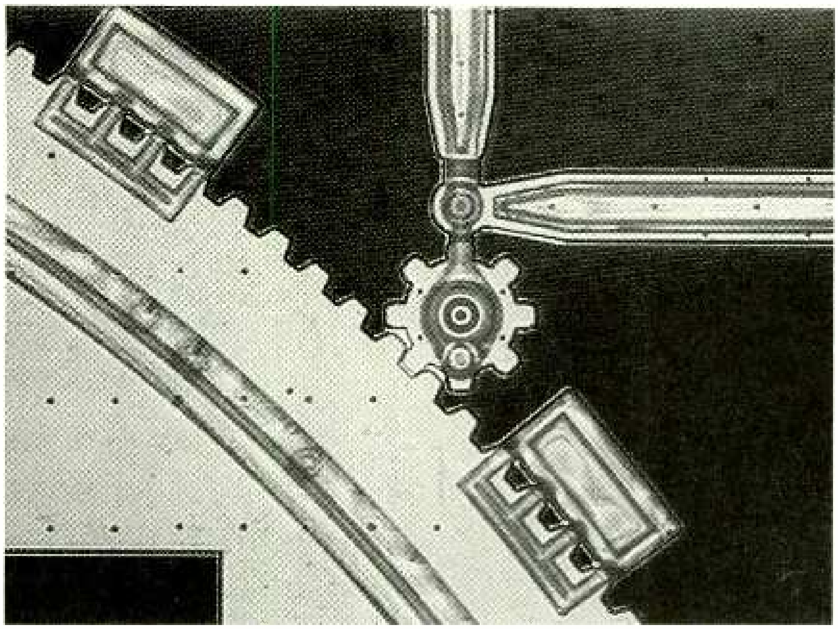
Researchers at Sandia National Laboratories have developed the first micromotor to drive external gearing and to be built entirely by microelectronic fabrication techniques. The pollen-sized gear has been shown to mesh with and drive a gear 30 times its size.

"We believe we are the first to demonstrate a really good silicon micromotor that can connect up with a variety of devices," said Sandia scientist Jeff Sniegowski, who, along with engineer Ernest Garcia and group leader Paul McWhorter, headed up the effort to build the millimeter-square engine and its even tinier gearing. "Our idea here was to develop a generic micromotor that has a gear output, so people can see there's a power source they can hook up an application to."

A videotape of the device in action shows a large wheel, which has two holes, being driven by a microgear. The large wheel function as an optical shutter, since a beam of light can pass through its openings in some positions but not in others. Other video footage shows the smaller gear—smaller than the diameter of a human hair—turning two similarly sized gears at the rate of 200,000 revolutions per minute.

The device is the first micromotor to be built with three levels of polycrystalline silicon—a jumbled version of ordinary silicon. The first level contains the engine, the second the gears that the engine drives, and the third the linkages that connect the engine to gears or other linkages.

The micromotor developed at Sandia differs from others micromotors in several ways. First, it is the only one to be made by simply etching silicon. Second, it is self-contained, without relying on any attached mechanisms to perform specific tasks. Third, other micromachines drive rods that function as pistons. Because those pistons are not directly linked to the motor, when a load is applied, they may fail to deliver steady, continuous power.



A MICROGEAR SMALLER THAN THE DIAMETER OF A HUMAN HAIR drives a gear 30 times larger than itself. Rectangular brackets stop the large gear, which acts as an optical shutter when light passes through the rectangular opening, from warping.

Sandia's micromotor, which develops 0.5 microwatts of power delivered through a gear 50 microns in diameter, could be used to operate tiny micromedical pumps that function as drug-delivery systems internal to the body, and to act as low-cost, high-performance gyroscopes that could have a dramatic impact on the design of future automobiles and military systems.

Because the researchers built the micromotor using etching processes and silicon materials already in use by the microelectronics industry, mass production of micromotors should be relatively easy. And because the tiny motor and gearing has much less mass than its standard-sized counterparts, it is better able to survive impact. EN

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Signalling System 7

The mystery of instant worldwide telephony is exposed.

JEFF HEWETT

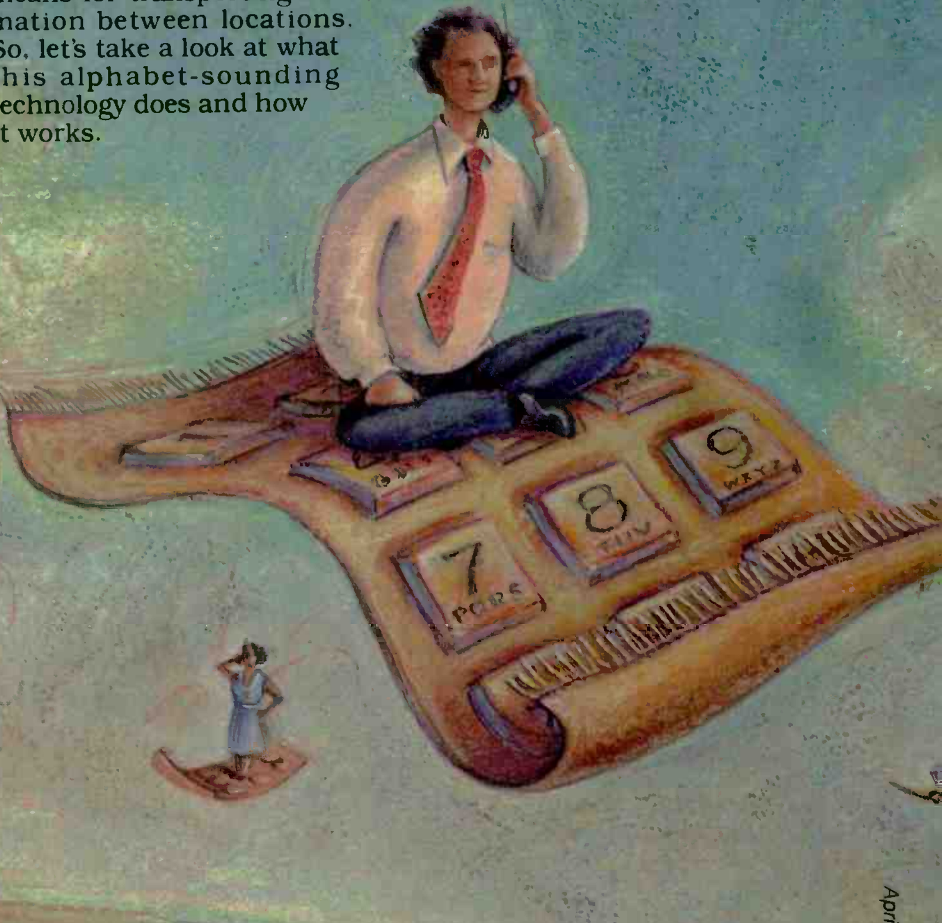
MOST OF US DON'T STOP TO CONSIDER the "magic" of instant worldwide communications that takes place when we pick up our phones. Whether we want to make a call to a phone in the house next door or on another continent, we just expect the magic to happen. When your call travels even a short distance, it becomes part of traffic on a network that's well known to only a relatively small number of people. The network is called Signaling System 7, or SS7. Over the past five to ten years, telephone operating companies have been upgrading their networks to use this standard communications protocol, providing them with faster call setup times and the ability to expand their service offerings.

You don't hear much about the SS7 communications network until it fails—but then it makes the headlines. Two incidents on the east coast a few years ago grabbed national news attention when large portions of the telephony network lost service due to SS7 outages. Staggering revenue loss was reported due to the loss of communications by businesses.

Electronics Now readers should be interested in understanding SS7 technology because communications is one of the fastest growing areas in the electronics arena today. Information is now a cornerstone of our society, and delivering that information readily from one point to another is of utmost importance. There is a proliferation of communications services ranging from caller ID to cellular service to ISDN and the forthcoming AIN or Advanced Intelligent Network. SS7 plays a major part in many of these services providing the means for transporting information between locations. So, let's take a look at what this alphabet-sounding technology does and how it works.

In-band vs. out-of-band

When a phone call is made, call-control information is sent to the local telephone office. The digits dialed are the main routing components that determine a call's destination. If the dialing is for a local call, the call may be connected from the same office from which the originating line terminates. Many times,



the telephone switch at the local office that services a phone line may have to route a call to another office connected by a trunk. Call-control signals such as the number dialed and the answer indication from the other end are information used for managing a call connection.

Using traditional signaling methods, the trunk between the two offices carries information down the same set of wires that the voice signal travels. This is called *in-band signaling* because the call-control signaling is sent down the same path as the voice signal. Signaling System 7 handles all these tasks on a separate facility known as a *signaling link*. The signaling link can handle the call-control information for many calls going on simultaneously. The actual voice path between the two offices is still over the trunks, while the call-control signaling is traveling on a separate communications channel. This is called *out-of-band* signaling. Figure 1 diagrams the in-band and out-of-band technique.

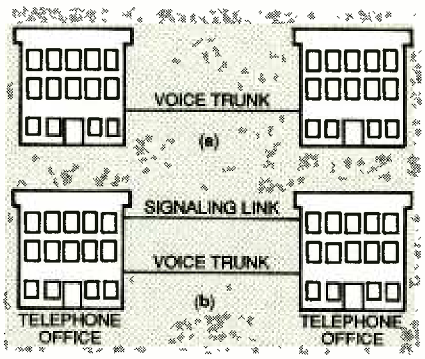


FIG. 1—SIMPLIFIED CONNECTIONS for In-Band (a) and Out-Of-Band (b) signaling between telephone offices.

SS7 is essentially a *packet switching network*. Signaling information is carried in data packets between the telephone offices in much the same manner as X.25 or other packet-switching protocols previously installed. This packet-switching network is overlaid on top of the existing telephony network, adding an entirely new dimension. This gives the telephony network a number of advantages over the traditional signaling system. The primary benefit is increased bandwidth for call signaling. The voice trunk is limited since its primary responsibility is to carry voice or data. SS7 provides additional bandwidth, a standardized protocol for sending information between different vendor equipment and increased data transmission speed.

Demand for network services

The greatest benefit for both the telephone operating companies and their subscribers is the increased capability to provide network services. Prior to using SS7, many telecommunications equipment vendors had proprietary means for sending feature-related signaling between offices. This prevented true networking of services. When Integrated Digital Services Network (ISDN) was introduced into the marketplace a few years ago, one complaint was its limited service across geographical locations. This created situations which came to be known as "ISDN islands." SS7 eliminates this problem by encapsulating the ISDN call information in packets and transporting them across the network, bridging the islands.

SS7 enables or enhances a number of services including:

- Enhanced 800 service
- Custom Local Area Signaling Services (CLASS)
- Advanced Intelligent Network Services (AIN)
- ISDN Connectivity
- Cellular Service

We will try to encapsulate a discussion on how SS7 works with each of above services by looking at just a few of them. Until recently, when you purchased 800 service, the number you were given actually belonged to the local company that was the service provider. FCC rulings in recent years have changed this scheme. Now with an enhanced form of 800 service, the 800 number can be retained by the subscriber even when he switches service providers. However, this means that the telephone company can no longer determine which service provider to route the call to just by the 800 number that's dialed. SS7 provides the capability to query a database to determine the service provider for routing the call to as well as other information associated with the call. Refer to Fig. 2.

Custom Local Area Signaling Services (CLASS) use SS7 capabilities to deliver services such as caller ID (identification), automatic redial, and call screening. Call screening allows the consumer to selectively accept or reject calls from selected numbers. The information for these services is transported between offices via SS7 packets.

The standards

The ability to provide information between phone offices without regard for which vendor's equipment is used requires global standards. Standards are developed at different levels by different organizations. Global SS7 standards are

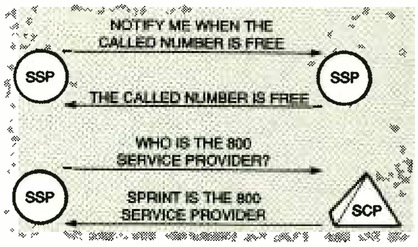


FIG. 2—CLASS (Custom Local Area Signaling Services) and Enhanced 800 services using TCAP (Transactions Capabilities Part) queries.

developed by the International Telecommunications Union Telecommunications Standardization Sector (ITU-TS), formerly known as CCITT. Different countries make their own refinements of the ITU standards as necessary. The discussion here is limited primarily to North American networks. The American National Standards Institute (ANSI) and Bellcore further refine the ITU standards for North American and Regional Bell Operating Companies (RBOCs) respectively.

Virtually anyone in the communications field today will recognize the Open Systems Interconnection (OSI) model. The OSI stack was developed by the

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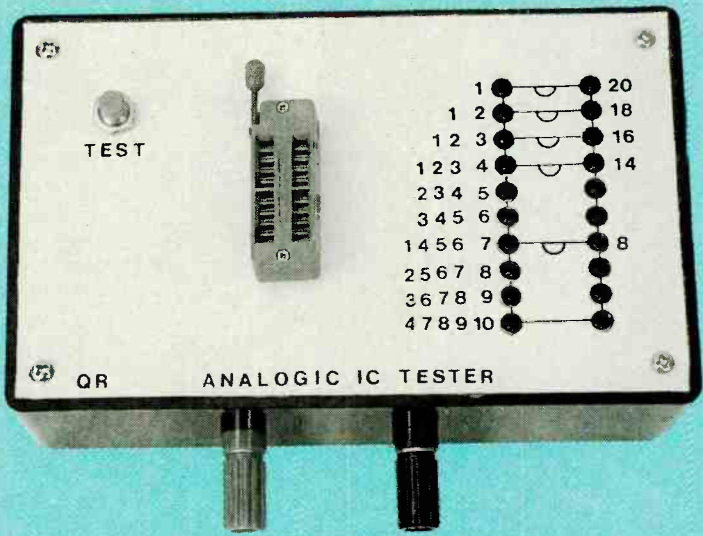
ANALOGIC IC TESTER



Check out digital and analog ICs with this inexpensive home-brew combo tester

RICK DUKER

THE ANALOGIC IC TESTER IS A DEVICE designed to test both analog and digital integrated circuits. Most IC testers will test digital ICs, but are unable to test analog or linear ICs. The few commercial IC testers that test linear devices cost thousands of dollars, which leaves the average electronics technician or hobbyist between a rock and a hard place. The Analogic IC Tester is designed to fill this void and to provide a reliable means to test all types of integrated circuits. Although the device does not boast 100 percent reliability, the Analogic IC Tester is a very good indicator of the condition of an integrated circuit.

The Analogic IC Tester checks out more than just ICs. It will test virtually all PN junction devices such as diodes and transistors, as well as passive devices such as capacitors and inductors, making it a very useful addition to any test bench.

The Analogic IC Tester is very easy to operate. There are no switches to program or time-consuming test procedures to follow. The Analogic IC Tester is a static tester, that does not actively test the function of the IC. The tester will check all ICs with as many as 20 pins. Devices with more than 20 pins can be tested as well, although the tests must be made off-board.

Theory of operation

The Analogic IC Tester tests for PN junction faults in an IC. Every IC is composed of diodes and transistors connected in many varied combinations. However, what all ICs have in common is the PN junction at each pin. In most cases when an IC fails, one or more PN junctions have failed. All it takes is one junction failure to alter or halt the normal operation of an integrated circuit.

Every IC has its very own semiconductive "fingerprint" unique to itself, in much the same way that every person has a unique fingerprint. The Analogic IC Tester provides a visual indication of that fingerprint. When the fingerprint of the device being tested matches that of a known good identical device, then the IC is considered good. If the fingerprints do not match, then the IC is considered defective. The Analogic IC Tester will give a relatively accurate analysis of the device being tested in most cases.

The IC fingerprint patterns are displayed on dual rows of ten LEDs. Each LED corresponds to an IC pin. The PN junctions of an IC are tested by first applying a positive potential to the ground pin and/or the +V pin. This positive voltage then turns on the forward biased PN junctions in the IC. This forward current then activates various LEDs on the pinout display via buffering circuitry. The brightness of the LEDs depends upon the number of PN junctions and resistances within the IC in the current path.

Circuit description

Figure 1 is a schematic diagram of the Analogic IC Tester. Each pin of the IC socket (SO1) is connected to a transistor buffer which drives a display LED. There are 20 LEDs (LED1 to LED20) for each pin connector in SO1. Transistors Q1 to Q20 provide buffering while resistors R1 to R20 and R21 to R40 provide current limiting, voltage division, and biasing for the transistors. Resistors R41 to R60 limit the current to the LEDs to a safe level.

Power is obtained from a standard 9-volt battery. Voltage regulator IC1 steps the battery voltage down to +5-volts regulated, a safe level for most ICs. Test switch S1, when it is pressed, passes the supply current. Binding posts BP1 and BP2 are standard five-way binding posts. The red post is +5-volt DC while the black post is the circuit's common ground.

Putting it together

Construction is simplified when a printed-circuit board is used. Hardwiring to a perfboard is an alternative if you have the

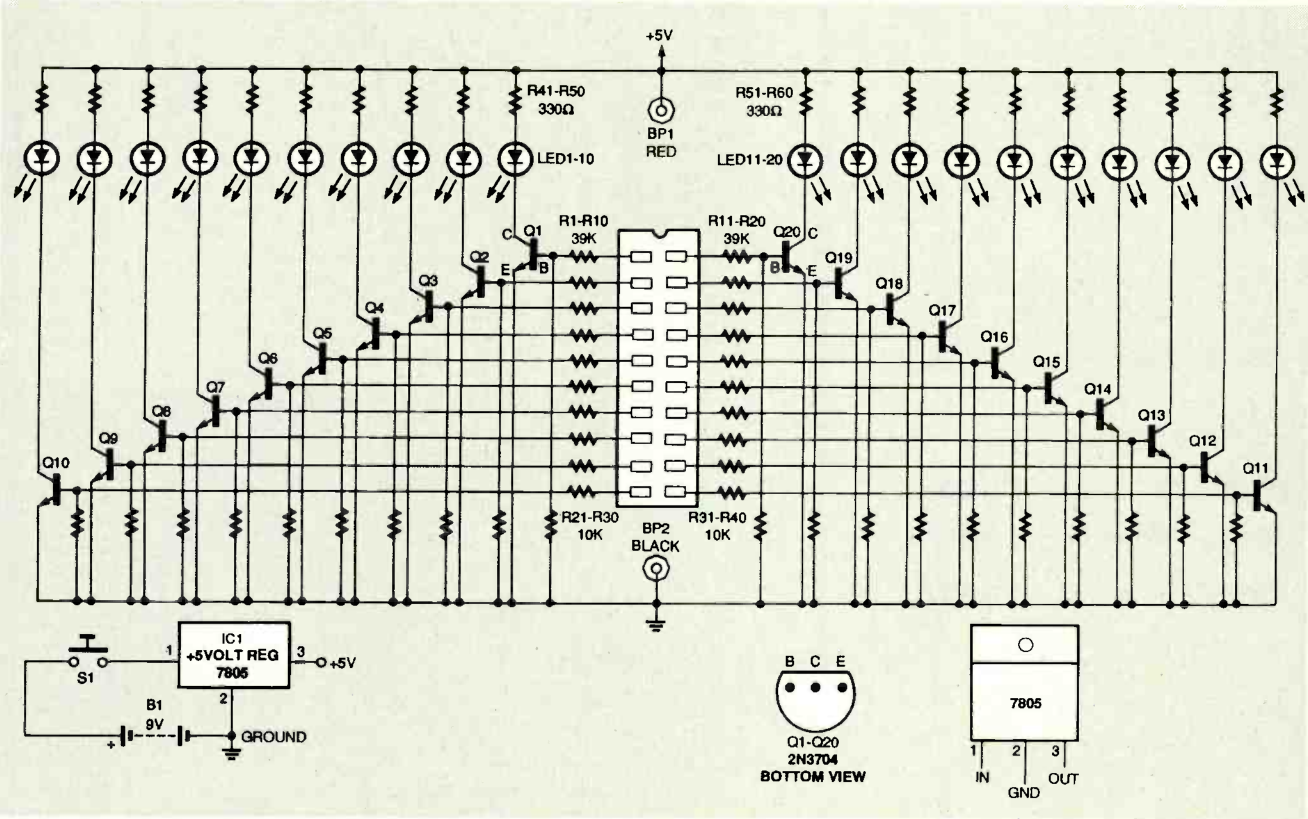


FIG. 1—SCHEMATIC DIAGRAM for the Analogic IC Tester reveals possible mirror-image layout on printed-circuit board.

PARTS LIST

All resistors are 1/4-watt, 5%.
R1-R20—39,000 ohms
R21-R40—10,000 ohms
R41-R60—330 ohms
Semiconductors
Q1-Q20—2N3704 NPN transistors
IC1—7805 5-volt DC regulator (TO-220 case)
LED1-LED20—Light-emitting diodes, standard red
Other Components
BP1—5-way binding post, red
BP2—5-way binding post, black
S1—SPST pushbutton switch, normally open
SO1—20-pin wirewrap IC socket
SO2—20-pin, Zero Insertion Force socket
Miscellaneous
Materials required to etch a single-side PC board (3 × 5-inch), 9-volt transistor-radio battery clip, plastic box (6-1/4 × 3-3/4 × 2-inch) with aluminum faceplate (6 × 3-1/2-in) (Radio Shack 270-627), spacers, screws, adhesive, wire, solder, etc. Patch cords—1 red, 1 black, banana plug to miniclip.

The following is available from Quantum Research, 17919 77th Avenue, Edmonton, Alberta, Canada T5T-2S1:

Etched and drilled PC board, $20.00
Partial kit—includes PC board and all board mounted components. Does not include ZIF socket, 5-way binding posts, box and hardware. Order #AIT1PK, $49.95
All prices in U. S. funds. Please include 10% for shipping and handling.

time and tenacity. A suitable PC foil pattern is illustrated. After you have etched the PC board, here's how you go about it.

Layout and identify all parts and become familiar with the construction steps.

Following the parts placement diagram, insert all the resistors onto the PC board in groups as illustrated in Fig. 2. Solder them in place. Be sure to use only rosin-core solder and do not overheat the pads or traces on the PC board. Insert all the transistors and solder in place. Check that they are inserted correctly. Heatsink the transistor body when soldering to prevent possible heat damage.

Insert the LEDs onto the PC board and solder them in position. Be sure they are installed correctly. It is important that they are mounted the correct distance from the board. The prototype was mounted to the faceplate with 1/2-inch spacers, so the LED height should also be 1/2 inch or slightly more, measured from the surface of the PC board to the top of the LED.

Insert the +5-volt DC regulator IC1 and solder in place. Gently force IC1 backward so that its leads bend and the device is horizontal to the PC board. Solder pushbutton switch S1 onto the PC board. The threaded portion of S1's shaft should be above the 1/2-inch plane so that the unit's faceplate and a flat washer can be secured with a nut. Solder

Continued on page 62

MINI METROLOGY LAB

Build a DC null detector/amplifier for your DVM as the second component of a mini metrology lab.

CONRAD R. HOFFMAN*

THIS THREE-PART SERIES BEGAN last month with a description and complete construction details for a precision voltage standard. To increase the utility of the standard, two additional pieces of equipment are required. First is a Kelvin-Varley voltage divider (KVD), to scale the value of the voltage standard to other voltages. Second is a null detector, to determine when the voltages are equal. However, because the null detector is required to build the KVD, it is this month's project.

A null detector—often called a null meter or a DC null voltmeter—is a very sensitive, center-zero voltmeter. When it is connected between two points, it indicates the magnitude and direction of any voltage difference by swinging its needle to the left or right. A good null detector can easily resolve one microvolt (one millionth of a volt), or less. Though generally calibrated and capable of making voltage measurements of either polarity, null detectors are usually used to determine equality between two points. As an example, a null detector is the ideal tool for measuring the voltage difference across a Wheatstone bridge. The more sensitive the null detector, the smaller the voltage difference that can be detected, and the more precisely the bridge can be balanced. See Fig. 1.

Design issues

At first glance, the design of a good null detector might appear trivial. After all, it's just a high-gain amplifier followed by a meter. But let's look a bit closer.

CMRR: The first issue is common-mode rejection ratio or CMRR. A null detector is often called upon to make comparisons at both high and low voltages. It is essential that the meter's zero point does not shift between these two conditions. Although a differential amplifier could be designed to do the job, its passive-component stability would have to be exceptional. The issue of CMRR is avoided in this design, which is based on a floating, single-ended amplifier.

Leakage and ground loops: At the microvolt level, any leakage or voltage generated by ground-loop current causes errors. Again, floating the amplifier eliminates that issue as a concern: With no ground, there can be no ground currents!

Drift: Chopper stabilization is *de rigueur* in all commercial null detectors. It prevents the zero point from drifting during

*Thanks to Jim Williams and Mark Gordon of Linear Technology Corporation for their assistance with the design of the Mini Metrology Lab.

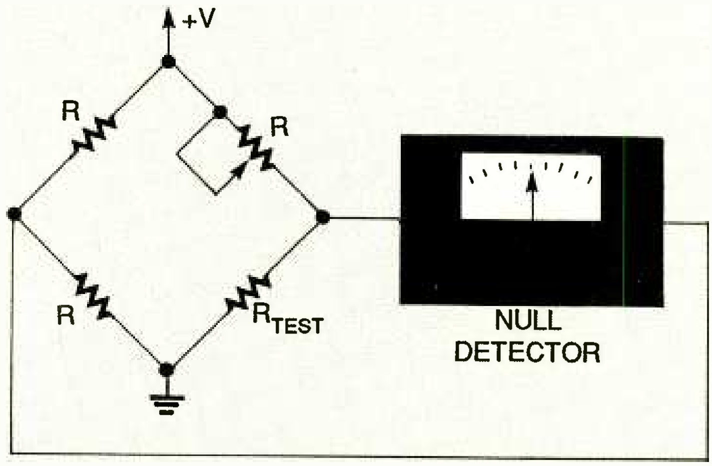


FIG. 1—A NULL DETECTOR can be used to verify that a bridge is in balance.

use, even on the lowest ranges. At one time, chopper stabilization required elaborate discrete designs. The classic Hewlett Packard 419A chopper circuit used flashing neon bulbs and photocells. Other designs used vibrating reed relays. Today a high performance chopper stabilized amplifier in an 8 pin mini DIP can be bought for less than five dollars, so there is no excuse for not using one. One caveat: These amplifiers have an absolute maximum power supply voltage of +9 volts.

Protection: Because null detectors have high sensitivity, and are used around, relatively speaking, large voltages, they are often severely overloaded. No damage should occur under any reasonable overload.

Input offsets: The null detector should indicate the same reading for both high- and low-impedance sources. Very low input offset current specifications, plus good circuit layout, will accomplish this.

A real-world design

To keep the cost low and the performance high, the null detector is designed as a "front end" for a battery-operated digital voltmeter or DVM. You might be skeptical that a digital display can be used easily in this application. However it has proved entirely satisfactory. Better yet, the digital display eliminates any worries about pivot friction or "sticky" needles—an all too common problem with older meters.

The null detector is based on the Linear Technology LTC1050 amplifier. Chopper stabilized, it provides performance that is almost drift-free. The low-frequency gain is guaranteed to be over 130 dB, so only one amplifier stage is needed. Input bias and offset currents are in the picoampere region and, finally, the sample-and-hold capacitors have been incorporated within the amplifier, further simplifying the null detector's design.

The circuit must be battery powered, but there are no cells that give us reasonable positive and negative supply values. The answer lies in the TI2426 "rail splitter" ground IC. Using this special divider/buffer, a standard nine-volt battery will provide 4.5 volt supplies—perfect for the CMOS chopper amplifier.

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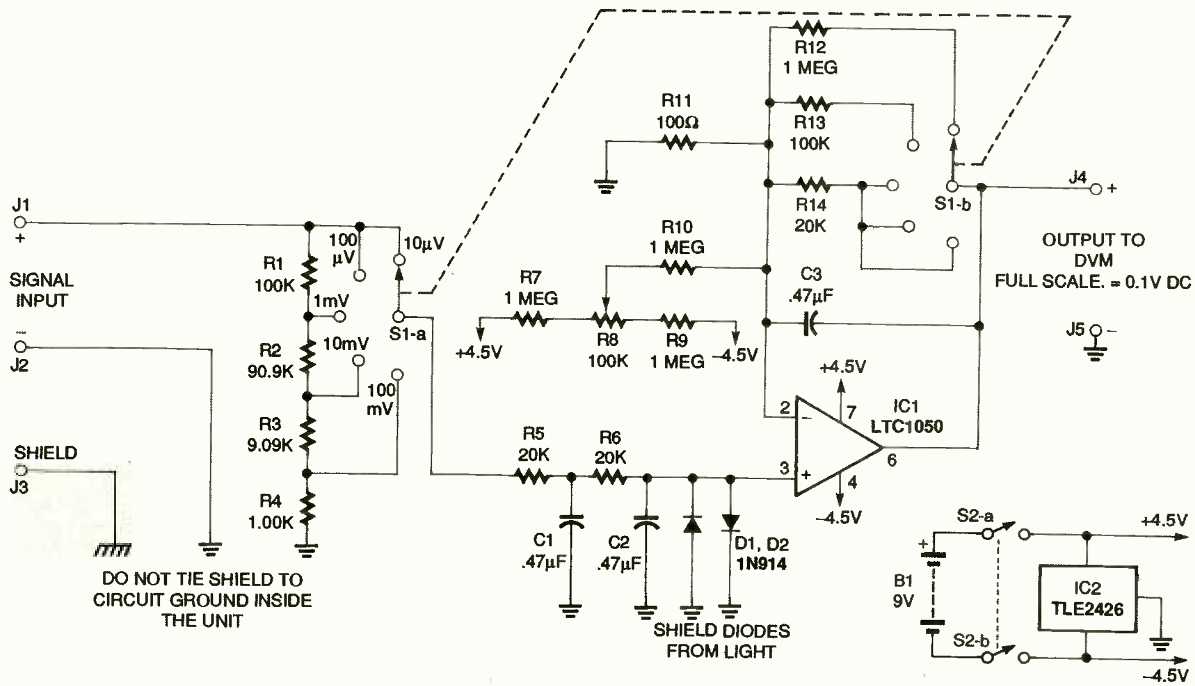
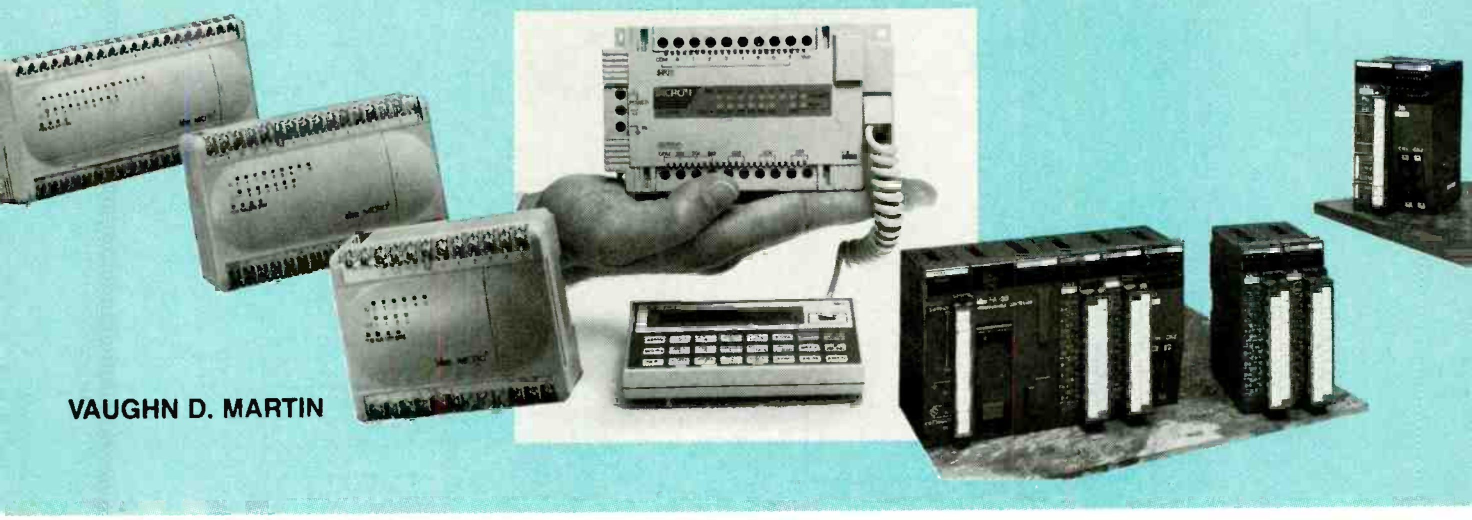


FIG. 2—NULL-DETECTOR SCHEMATIC. A 9-volt battery, in conjunction with rail- splitter IC2, forms the power supply.



VAUGHN D. MARTIN

PROGRAMMABLE LOGIC CONTROLLERS

Programmable logic controllers are the brains of modern industrial control systems. This article will show you what they are, how they work, and where they are used.

MODERN FACTORIES ARE EFFICIENT, output minimal pollution, very safe, and require far less manpower to perform very complex manufacturing operations. There is one technological advance that is largely responsible for most of these advances. It is the programmable logic controller or PLC. This microprocessor-based electronic device has replaced virtually all relay and electromechanical-based logic with solid-state programmed control devices. Best of all, PLC's can be reprogramed and reconfigured in just minutes whenever production requirements change.

PLCs are extremely reliable and provide fast reaction time. As a result, PLCs lower the costs of manufacturing and they can reduce factory down time. They also provide communication links to factory mainframe computers that govern process-control systems, and deliver the signals needed to make data logging possible. PLCs are usually located inside small wall- or rack-mountede enclosures. You can expect to find multiple PLCs placed close together so that wiring between them is kept as short as possible to speed process control reaction time.

Three different PLCs with different housing configurations are shown above. On the left is the IDEC Micro3, a small self-contained controller that has external communications links, analog input and output capabilities and needs only sensors and control relays to govern a factory process. The PLC on the right is a more advanced IDEC FA-3S in a rack-mount configuration. This design offers the flexibility of selecting custom input and output plug-ins when you need to create specialized process controller. A third variety of PLC, center above, is the IDEC Micro 1. It is shown with its program loader attached. Program loaders are used to create and load process-control programs into PLCs. In many instances, a standard PC can do this job through a compatible serial port link.

The microprocessor or CPU (central processing unit) that is the brain of a PLC might be a 8088, 80286, 80386, or 80486. While these are the most commonly used processors, some PLCs use custom logic or similar microprocessing units. But no matter which specific processor is used, its function is still the same: to monitor crucial process parameters and adjust process operations accordingly. Let's look at a real-word example; the operation of a fairly simple factory element, an annealing furnace.

PLCs at work

In the past, factory workers who were responsible for operating an annealing furnace were stationed at control consoles that were equipped with gages to indicate fire, crucible, conveyer belt or car (materials to be annealed are often carried through furnaces in towed cars), temperatures, gas or fuel flow rate, steam or exhaust pressure and any other relevant parameters. Air is fed to the furnace by natural convection or multiple-speed fans. These workers kept the furnace matched to the annealing load.

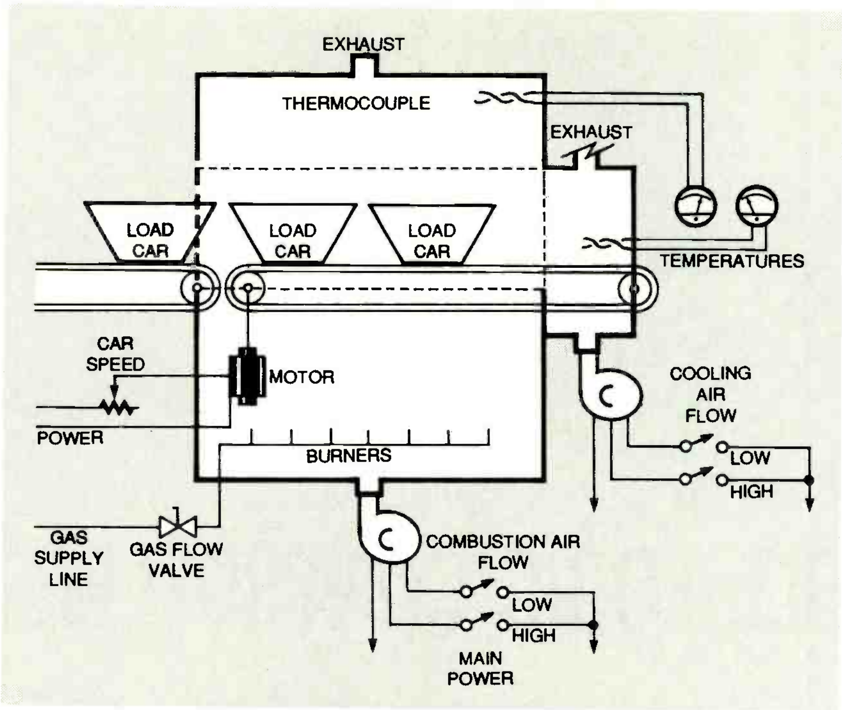


FIG. 1—SIMPLIFIED DIAGRAM OF A MANUAL FURNACE shows all the adjustments and measurements that must be controlled to insure proper operation.

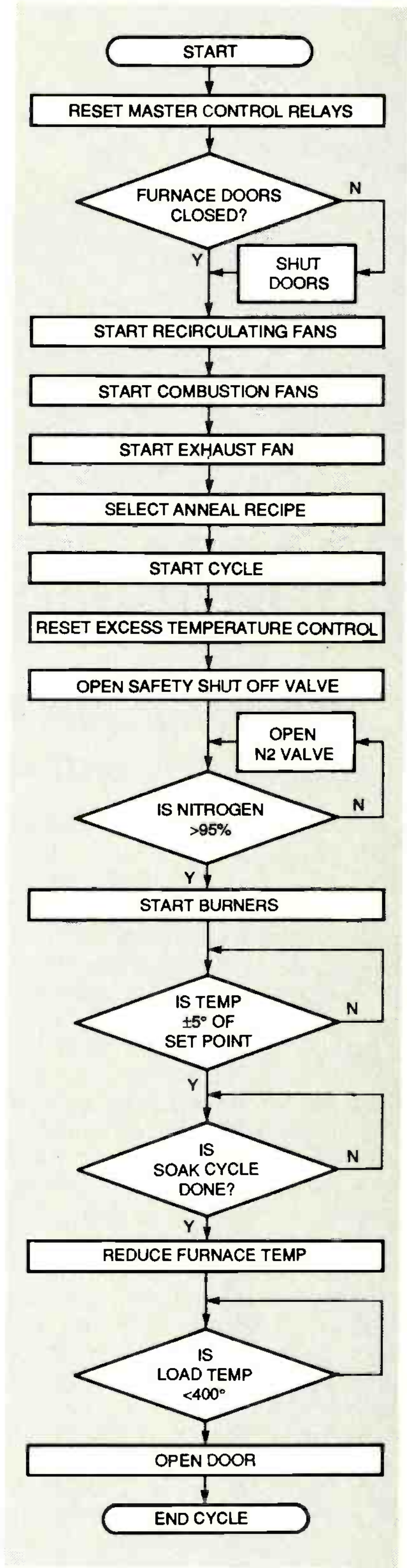


FIG. 2—FLOW CHART for a typical annealing furnace.

Figure 1 is a simplified diagram of such a furnace.

Now let's move ahead into today's world where we find multiple PLCs governing the modern furnace by regulating air, fuel and material flow rates. In addition they monitor and control chamber and exhaust oxygen and nitrogen content to minimize pollution. To ensure safe operation, barometric and chamber pressures as well as emergency temperature limits are also monitored. Other furnace monitor and control functions handled by PLCs include the comparison of blower speeds with air-flow rates (thus sensing blower malfunctions), continuous sensor self-testing, and even assuring the correct flame color by maintaining a proper air-fuel mixture. Even the most diligent floor-worker could not have kept up with all the furnace-control functions a single PLC performs today.

Figure 2 is a flow diagram for starting up a PLC-controlled annealing furnace. Remember that it can take several hours for some of the steps listed here to complete. In this specific example the furnace must be monitored and controlled throughout an 18-hour period. With a PLC in control, the entire process occurs automatically, without human intervention—unless there is an emergency shutdown. It is this simplification of factory processes that has made the PLC so important.

The typical PLC

Every PLC is composed of a processor and user-programmable memory that stores the program that the PLC executes. There are also a number of peripheral elements such as analog and digital input-output (I/O) interfaces, timing, counting and match units; and network communications controllers. Figure 3 shows some of the components that may be found in a typical PLC system. Using these system components, the PLC is directed to carry out the stored program based on real-time incoming data.

Each PLC bases all of its decisions on its stored program combined with data acquired from external sensors. A properly designed PLC initiates an emergency halt if any of the sensors fail. All emergency halts must be set up to stop any industrial processes associated with the sensor failure. This is when an industrial electronics troubleshooter must locate and repair the fault quickly to mini-

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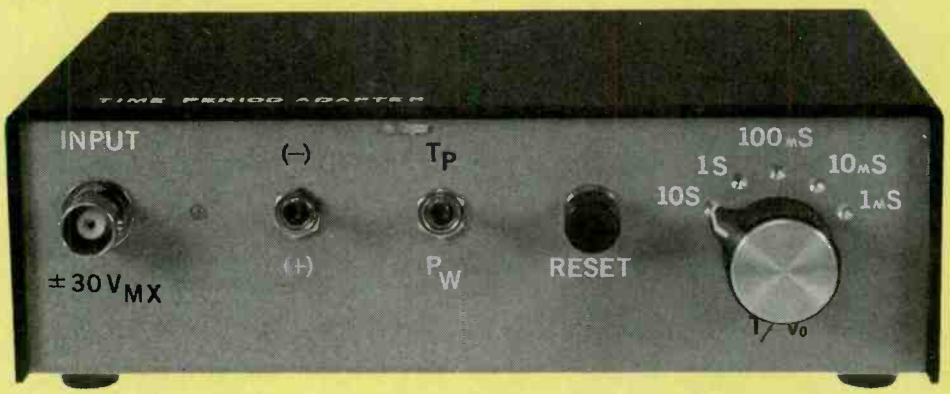


Time-Period Adapter

Expand the measuring capabilities of your digital multimeter with this easy to build and simple to operate accessory.

SKIP CAMPISI

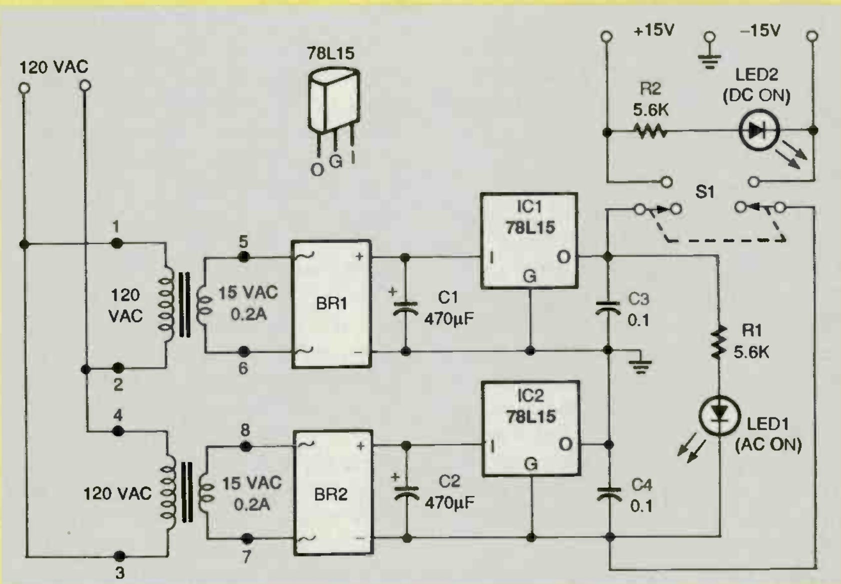
HAVE YOU EVER TRIED TO MEASURE a low frequency waveform accurately with a frequency counter? Have you been frustrated in trying to measure a pulse width accurately on your oscilloscope by counting graticule squares? If so, the Time Period Adapter can simplify these measurements by putting your digital multimeter (DMM) to work as the display.

Frequency counters typically include a local oscillator that provides precision gate pulses to counters which total the input pulse count over the duration of the gate pulse. This measurement technique works well unless the input frequency is below about 100 Hz, where the degradation of resolution begins.

The Time Period Adapter functions in an inverse mode to measure the period of the input pulses. This technique offers superior resolution at low frequencies by making use of the input pulse as the gate pulse, while the local oscillator supplies the precision pulse train to be counted.

The adapter's five ranges cover 10 seconds per volt (s/V) output to 1.0 millisecond per volt output (ms/V), with a resolution of 0.5 microseconds on its highest range. The adapter's full-scale output is –1.000 volt, with a full-scale accuracy of ±0.1% or better. Overflow (overrange) occurs automatically at –1.024 volts. The adapter is switch-selectable so that it can measure time period, pulse width, and either positive- or negative-going pulses.

The adapter accepts a wide variety of waveforms, including TTL logic, CMOS logic, and bipolar sine, square, and triangle waves in the range of ±1.0 volt



SCHEMATIC FOR OPTIONAL ±15-VOLT dual power supply

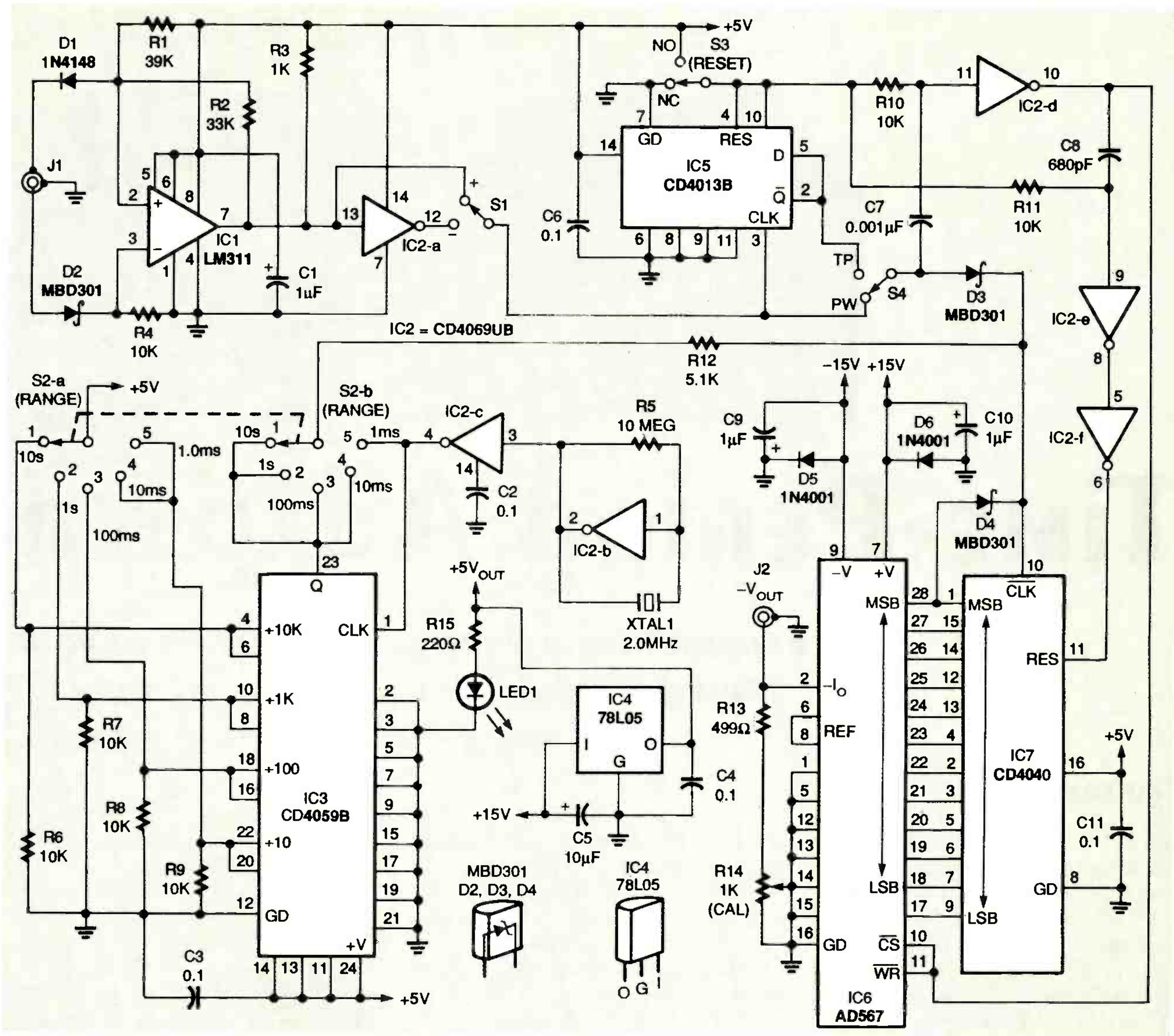


FIG. 1—SCHEMATIC FOR THE TIME PERIOD ADAPTER. Panel-mounted components are located on the front and back walls of the project case.

to ±30 volts. It will trigger on any input that passes through the reference level of 0.9 volts applied to the adapter's internal comparator.

Powering the adapter

The author's prototype was designed to be powered by an external ±15-volt, 100-milliampere supply. Power connections are made by a two-conductor shielded cable terminated by ⅛-inch, three-conductor phone jacks and plugs. This external power supply is optional and it is not critical for proper performance.

If you don't have a ±15-volt dual supply or would have difficulty purchasing one, a schematic for a suitable supply is included here. It can be built within the project case or made as a separate outlet-mounted module. If you elect to do it as an external power supply, be sure to make the changes in the circuitry specified later in this article.

How does it work?

Refer to the schematic diagram, Fig.1. Integrated circuit IC1, an LM311 comparator, conditions the input waveform for the 5-volt logic required by the circuit. The gate signal is applied to IC7, a CD4040B CMOS 12-stage binary counter, to measure pulse width or through IC5, a CD4013B CMOS dual flip-flop, to measure time period.

Integrated circuit IC2, a CD4069UB CMOS hex inverter, provides the precision 2.000 MHz crystal-controlled pulse train for IC3, a CMOS divide by "N" counter. It divides the pulse train by 1, 10, 100, 1000, or 10,000 to cover the five ranges selected by rotary selector switch S2.

The divider's output is gated by the input pulse at IC7 through a resistor-diode NOR gate. Integrated circuit IC4, a 78LO5 voltage regulator, supplies +5 volts to the circuit; IC2-d, IC2-e, and IC2-f provide the properly timed reset signal for IC7 and the latch enable signal for IC6, an AD567 digital-to-analog converter (DAC), the key

Continued on page 75

BY DON LANCASTER

PIC programming tricks, adressing modes, and an update for Adobe Acrobat

THERE SURE HAS BEEN QUITE A LOT OF INTEREST IN MICROCONTROLLERS BOTH ON MY TECH HELPLINE AND PSRT LATELY. THIS MONTH, I FIGGURED I WOULD LOOK AT THE SECRETS TO UNDERSTANDING AND using new low-end microcontrollers. This requires the learning and mastering of microcontroller...

Addressing Modes

Each company has different names for them, and each places different emphasis on how important each one is. Regardless, a computer *address mode* is some way that the CPU (central processing unit) has of accessing data or program memory locations both within and outside its *address space*.

As we have seen in some previous columns, the address space represents the total reach of the microprocessor. Those individual byte locations in an address space typically support ROM (which is memory that is more or less permanent); RAM (memory which is fast and easy to change); I/O (short for input/output); or nothing at all (unused). More on address space in MUSE92.PDF.

To understand any microcontroller or microprocessor, you *must* understand its underlying addressing modes. Use the wrong mode and you are *certain* to get into trouble. And not picking the "best" mode for your task may cause your program to need more memory or to run slower.

As I see it, there are seven basic addressing modes that are in popular use today. I have summarized them in Fig. 1. They are:

implied— With implied addressing, no further information is needed to complete the task. Such as a CLC instruction that clears a carry flag. Or does a similar housekeeping duty. Say you just got home, and there, sharpening its claws on your favorite speaker grill, is the cat.

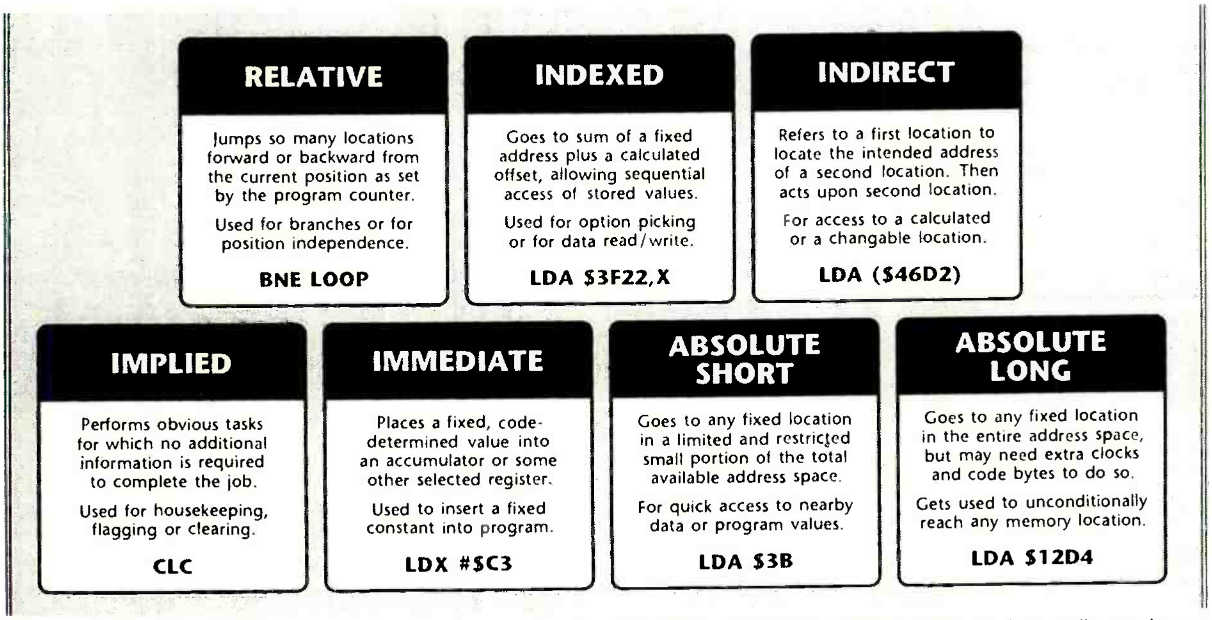


FIG. 1— THE KEY SECRETS to using and understanding microcontrollers and microprocessors lie in understanding and properly selecting addressing modes. Here are the seven most common addressing modes in use today.

INDEXED–

The PIC lets you modify the bottom 8 bits of the program counter, just like it was any other register. Here's how to select one of four options...

```
PICKONE  ADDWF PC,1    ;add selection 0-3 to PC
         GOTO  SEL0    ;selection 0 if chosen
         GOTO  SEL1    ;selection 1 if chosen
         GOTO  SEL2    ;selection 2 if chosen
         GOTO  SEL3    ;selection 3 if chosen
```

INDIRECT–

Indirect addressing works the same way, by modifying the program counter. Here's how to go to a calculated **NEWADD** address...

```
GOTOADD  MOVFW NEWADD ;calc address to W
         MOVWF PC     ;change program counter
                      ;continue at NEWADD.
```

RELATIVE–

It is unlikely you would want to go to a relative address, because it is just not a PIC thing to do. But, if you must...

```
BRANCH   MOVFW HOWFAR ;branch offset to W
         ADDWF PC,1   ;send PC there
                      ;continue at branch
```

Flag-specific opcodes are thankfully absent in the PIC. Instead, the superpower test-any-bit-and-skips do the job. Here's how to branch on carry clear...

```
TESTC    BTFSC S,C    ;test carry flag
         GOTO  CSET   ;move here if set
         GOTO  CCLR   ;move here if clear
```

It is often possible to avoid relative addressing entirely. By using a "if the left one don't get ya, the right one will" ploy. Such as this constant-time example to move any random bit into any arbitrary location...

```
MOVB     BTFSC AA,BB  ;test bit BB of register AA
         BSF   YY,ZZ  ;set bit ZZ of reg YY if 1
         BTFSS AA,BB  ;test bit BB of register AA
         BCF   YY,ZZ  ;set bit ZZ of reg YY if 0
```

PROGRAM DATA ACCESS–

The PIC's "non-Von" architecture separates program and data memory. But the RETLW command can return literal data stashed on the program memory side. Here's how to convert integers 0-15 to ASCII characters 0-F: Start by building up this table lookup data stash...

```
STASH    ADDWF PC,1   ;go to selected char
         RETLW #$30   ;ASCII 0 if hex 0
         RETLW #$31   ;ASCII 1 if hex 1
          . . .        . . . . .
         RETLW #$45   ;ASCII E if hex E
         RETLW #$46   ;ASCII F if hex F
```

When you need it, use this sub to convert hex in a mere five machine cycles. Begin with 0-15 in the W register...

```
         CALL STASH   ;returns ASCII to W
```

FIG. 2— THESE "MISSING" ADDRESS MODES are easily added to any PIC.

Exactly what you say probably won't be printable. But the chances are it will leave no doubt whatsoever *which* cat and *which* speaker grill you are referring to.

Implied addressing can do specific functions quickly, but its powers are otherwise limited. These are usually single-byte instructions.

immediate— By using immediate addressing, a fixed *value* is placed into an accumulator, a register, or in another location. Such fixed values are sometimes called *literals*. The fixed value is either built into the instruction opcode word (PIC) or can be the byte immediately following an opcode (everybody else).

You can think of a gas station as immediate addressing, where you place exactly an ordered quantity of gas into your vehicle.

Immediate addressing is the way of introducing fixed values into your programs. But when you need one of many possible values, a fancier mode will be required.

relative— With relative addressing, you'll jump so many steps forward or backward from *where you now are*. The score is usually kept by a *program counter*. Normally, the PC advances just one address location at a time, picking up as many bytes as may be required for any instruction and then going on to the next one. Exceptions occur whenever you jump to a chosen new location or go to a subroutine or accept an interrupt.

Relative addressing is commonly associated with *branches* and *loops*. Often, some test is made, such as a BNE (branch-if-not-equal). On branch not taken, the program counter goes on to the next instruction. On branch taken, a relative hop is made.

Relative addressing is the same as using a pogo stick. Go so many hops forward or backward from *where you now are*. One interesting property of relative addressing is that it is usually *position independent*.

absolute long— With absolute long addressing, you can reach anywhere in the entire address space. Just as on a town zoning map, any house can be located within your city limits. This mode typically takes several bytes. In a 64K address space, you might need one byte for the opcode, one byte for the lower 8-bits of your address and a final byte for the upper 8-bits. Thus, absolute long addressing can end up slow, long, and ungainly. It is also usually limited to going to one *fixed* and *known* location.

absolute short— With an absolute short addressing, you can quickly and conveniently get to some *assumed smaller portion* of the address space. Such as your lowest 256 locations in memory. Or the current memory page you were just working on. Say you are hanging a painting on your living room wall. You usually don't worry about *which* house on *which* block is involved. You'll just assume you are already in the right house.

Absolute short is normally faster than absolute long addressing and often requires fewerr program bytes. However, its reach is obviously limited, and turf fights can place high value on certain locations.

indexed— Things do get interesting should you want to rapidly access a bunch of *nearby* memory locations—like going into the donut store and ordering one of each. The clerk will take one from each tray as they go along. With indexed addressing, you reach the *sum* of a *fixed* base address and a *variable* offset. Reading a file message is one obvious use.

Indexing could get done by adding the contents of an *index register* to a base address in the operand. Or can be done by direct modification of the program counter.

indirect— Sometimes you'll want to *calculate* an address location. To do this, you use an indirect address. Where you first *refer* to one address to get a second one. It's just like asking the little old lady in some rural Post Office where somebody lives.

Indirect addressing is often used for *option picking* or *case* commands, where a menu selection can get you to several different locations. This is also useful for larger tables where the *start* of a message or a data sequence has to be predetermined. Depending on the microcontroller, indexing can be 8-bits or 16-bits wide.

Assembler Rules

Most often, you'll create all your machine language code by using an *editor* and an *assembler*.

Each assembler will have a certain rule set that lets you pick an address mode. The rules are often based upon the number of hex bytes involved and certain punctuation symbols in your operands. One of the possible sets of rules has been used in the assembler notation examples of Fig. 1.

Watch all assembler operands very carefully!

For instance, a hex location will either start with a "$" or end with an "H". A "#" usually selects a literal value. Absolute long addresses might be four hex bytes long. Instead, an absolute short might only be two hex bytes. Indexing is sometimes shown with a comma, while indirect address-

```
; Code module to multiply a BASE integer 0-21 by a factor
; of 12. Can be used for the access of tablular data.

X12         BCF S,C          ; clear carry flag
            RLF BASE,1       ; 2X BASE into BASE
            RLF BASE,1       ; 4X BASE into BASE
            RLF BASE,0       ; 8X BASE into W
            ADDWF BASE,1     ; 8X+4X = 12X into BASE
```

FIG. 3— PIC SOURCECODE can be amazingly short and fast. Such as this five-byte and five-cycle multiply by twelve.

```
; Code module to provide a time delay of n instruction
; cycles. n can vary from 4 to 255 and is destructively
; read from COUNTER. There are 2 or 3 cycles of overhead.

; The module is easily extended to 9 or 10 bits.

DELAY       BCF S,C          ; clear carry (if needed)
            RRF COUNTER,1    ; bit 0 into carry
            BTFSC S,C        ; stall one cycle?
            BCF S,C          ; yes, but MUST clear carry
            RRF COUNTER,1    ; bit 1 into carry
            BTFSC S,C        ; stall two cycles?
            GOTO LOOP        ; yes, by using extra GOTO

LOOP        BCF S,C          ; 4*n cycle delay loop
            DECFSZ COUNTER   ; round and round
            GOTO LOOP        ; till done
```

FIG. 4—THIS TIME DELAY GENERATOR offers a resolution of ONE single instruction cycle.

ing often requires parenthesis.

Needless to say, it's extremely important to know and understand the rules for the particular assembler you are working. The most common beginner mistake is mixing up hex and decimal location values.

Locations $09 and $10 are *not* beside each other! Another goof is to leave your "#" off a literal address, changing it over to absolute short addressing instead. In one case, you get value #$06. In the other, you get whatever location $06 may happen to feel like giving you at this particular time—with wildly different results.

PIC Addressing

Sometimes it takes a little extra time and effort to master the address modes which are *really* available on any micro. Two good ways to do this are to study existing code and to try out new things on your own.

We saw an example of how to pick up indirect indexed addressing on a 6805 a few columns back. Details in MUSE94.PDF on *GEnie* PSRT.

At first glance, those stupendously great PIC microcomputers seem to lack much in the way of addressing modes, especially the low-end chips. In fact, all you'll initially see is one plain old absolute short, fixed code GOTO command.

What tricks could you play here? Figure two summarizes some sneaky ways to multiply the flexibility of PIC addressing.

The absolute short addressing on the 16C5X accesses 512 bytes for a GOTO or 256 bytes for a CALL. Your other higher 512-byte memory pages can be reached by setting or clearing page bits in the status register. On fancier PIC's, modifying a register known as PCLATH gives you similar absolute long addressing.

A unique feature of the PIC family is that the lower 8 bits of the program counter might be written to just like writing any other register! As Fig. 2 shows, direct program-counter access gives you a method to do relative, indexed, and even indirect addressing, as well as to access program-side data. For instance, when you store some value to your program counter, it acts just like a GOTO. If, instead, you *add* something to PC, you can move so many steps forward (or backward) for indexing or branching.

One curious "gotcha," though: On low end 16C5X devices, either a sub CALL or a program counter PC write *forces* address line A8 to *zero*. This means you'll have to *carefully* plan what goes where. And that you are limited to only *one-half* of your total available memory for data or for PC based moves. But note that you can always "Get out of Dodge" on a plain old subroutine. Just call a GOTO. The fancier PIC chips do not have these restrictions.

Two Examples

The PIC is rapidly becoming *the* chip of the decade. No matter what your electronic project, you can make it better, faster, and cheaper if you add one or more PIC chips to it.

Those PIC's *completely* blow the competition away with 3(speed and 3(code-length advantages. But even more by its ultra-clean elegant simplicity. Nearly all instructions are a single byte long and execute in a single machine cycle.

Let us look at an example or two that might give you the flavor of PIC programming. We've already looked at a *six* byte and *six* clock sinewave generator in MUSE85.PDF.

In my magic sinewaves, I needed to multiply by twelve to calculate the table base addresses. As Fig. 3 shows, a PIC does this in five bytes and five cycles. Four bits and four cycles, actually, if you have a known clear carry flag on entry.

Note that most PIC instructions are *dual mode*. An assembly command ending in ",0" places the result back into your "W" *accumulator*. But one ending in ",1" places the result into the target register instead.

One urgent need common to many microcontroller programs is a high resolution delay generator. These are handy for everything from electronic music up to baud rate generation to timing circuits. Your obvious starting point with any microcontroller is a countdown *loop*. The trouble is that any loop will take several machine cycles to execute its decrement-and-branch instruction.

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Organizations
http://www.sbe.org (Society of Broadcast Engineers)
http://www.smpte.org (Society of Motion Picture & TV Engineers)

Can we do better?

Your key secret appears in Fig. 4. Purposely slow down your loop so it takes exctly *four* cycles. Before using your loop, first shift the LSB of the count value into the carry. Then add *one* cycle of delay if carry is set. Next, shift the next count value bit into the carry, and selectively add *two* cycles of delay if the carry is set again. Finally, use the main loop for multiples of four cycles.

Presto. A delay generator having a one cycle resolution, done in nine or ten bytes of code, with a mere two or three cycles of overhead!

Uh, that strange BCF S,C in the loop serves two purposes. First, it acts as a NOP to burn up one cycle of delay. And second, it acts as a "good neighbor" to leave a cleared carry for later use elsewhere.

That first BCF S,C clearing can be omitted if it is never needed.

A free *Incredible Secret Money Machine* if you can show me *any* way to shorten or otherwise improve this code. On *any* micro.

To get yourself PIC literate, start with that *Microchip Data Book* and the new *Microcontroller Applications Manual* from *Microchip Technology*. Then go to the *Basic Stamp* products from *Parallax*. Finally, step up to the *Scott Edwards PIC Tools*. I've got scads of PIC support up on my *GEnie* PSRT. Including all of the *Basic Stamp* manuals and bunches of my own tutorials, code, and applications.

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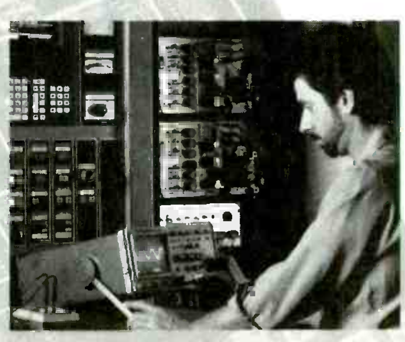

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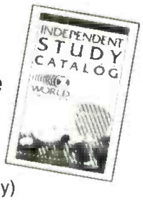

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Engineering Resources

TV Technology is a great trade mag from those same people who publish *Radio World* and *Computer Video*. In a recent issue, they included a handy rundown of the major internet sites of interest to television engineers. I've excerpted part of their listing as this month's resource sidebar.

Acrobat Update

The folks at *Adobe Systems* have dramatically improved and upgraded the fine device-independent *Acrobat* document distribution system. They even provide a free new *Acrobat CD Sampler* available on request. Well, sometimes it is free and sometimes there is a modest shipping charge. Their sampler includes free Acrobat readers for Mac, Windows, DOS and UNIX. Plus lots of other goodies.

The key to Acrobat is a more or less ordinary textfile called a .PDF file. This file format preserves the *exact* layout and typography of any document. Technical or otherwise. Compared to grubby old fax, you get *camera-ready* copy much faster and cheaper. Compared to HTML, you get infinite more flexibility and *exact* control of what your user sees.

Anyone can print or view a .PDF file by booting one of the free and widely available readers. The .PDF files can be generated by any major application that uses *PDF Writer*.

You can make your own files from any PostScript input by using the *Acrobat Distiller*. You modify your files for distribution using *Acrobat Exchange*. More in MUSE94.PDF, in ACROCAT.PDF, and in my reprints.

Let's see. The neat new stuff. One is a *Weblink* plug-in, which makes Acrobat online-compatible with *Netscape* and other surfing software. You can now *directly* view all downloaded Acrobat documents while online. The ability to navigate through any document is also improved.

There's now a new *article* feature made up of *threads* and *beads*. These literally let you string together bits and pieces of text. There's also a new *movie* feature lets you do animation, *Quicktime* movies, or even quality sound bytes.

But the greatest new features seem to be *Acrobat Search* and *Acrobat Catalog*. I guess I have now written some 1800+ technical articles. It's getting real hard to remember when I last wrote on paleomagnetism, steam calliopes, synthetic kale, or flying car labor-of-love newsletters.

Acrobat Catalog is exceptionally good at taking a humongous pile of related documents and letting you *rapidly* and *globally* search *all* of them for keywords. Not only does Search give you keyword locations, but it even guesses how "relevant" the hits are on each found document! And there is *no limit* to how many keywords you can use! You can even search for *numbers* or text buried in your illustrations! There are full synoymn and "sounds like" features, too. with logic.

Here's how it's done: Acrobat Catalog first "insides out" the *entire* library, alphabetizing *all* the words, along with numbers for *each* page of *each* document in which that word appears. A special .PDX file is then created holding this information.

Acrobat Search then can quickly go through this single new .PDX file looking for hits. Only the few single pages including the selected hits get exhaustively searched.

Since searching on keywords such as "an" or "the" is singularly useless, you'll usually strip down the file by removing *excluded words*. You have a choice here of a very tight and fast .PDX file with only a few keywords. Or else a larger and slower one that includes vastly more choices.

I am in the process of making all my stories globally searchable. I do hope to place the whole works on CD ROM someday soon. This should also speed up how fast I can release hard-copy reprints. Search features will be added to PSRT shortly.

Several Acrobat hints: Always be sure to work with a Mac or Windows

continued on page 53

BY CARL J. BERGQUIST

In the beginning there was coherent light

Build a basic experimenter's laser. You'll put it to work performing a variety of experiments we will present in future columns.

THIS NEW ONGOING COLUMN BEGINS BY PRESENTING A BRIEF HISTORY OF LASERS, SOME BASIC THEORY, AND DETAILS OF HOW TO BUILD A LASER YOU CAN USE TO CONDUCT A WIDE VARIETY OF EXPERIMENTS THAT will be presented in future columns.

In the early 1900's, Albert Einstein published a paper addressing the properties of what he called stimulated emission of radiation or SER. His theory explored the principals of photon production through inner atomic activity. It solidly laid the groundwork for what is obviously one of the most important inventions of this century; the "LASER" the anacronom for light amplification by stimulated emission of radiation.

It wasn't until the 1950's that Bell Laboratories began to search for laser applications. Earlier research was hampered by financial restrictions, the demanding needs of the military during two world wars, and the perception by many that the final result would amount to little more than a fancy flashlight. In the end, however, all the development frustration, time, and money expended to produce that first blast of laser red light, from a rod of synthetic ruby crystal, was worth the wait.

In the forty years since its introduction, lasers of all types and varieties have become an important part of our lives. They are used by surveyors to measure distances accurately, in manufacturing plants to control the smoothness of surfaces with great precision, and they even show up in such everyday places such as automobile speed traps, CD and videodisc players, and electronic pointers used by lecturers.

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Laser light theory and properties

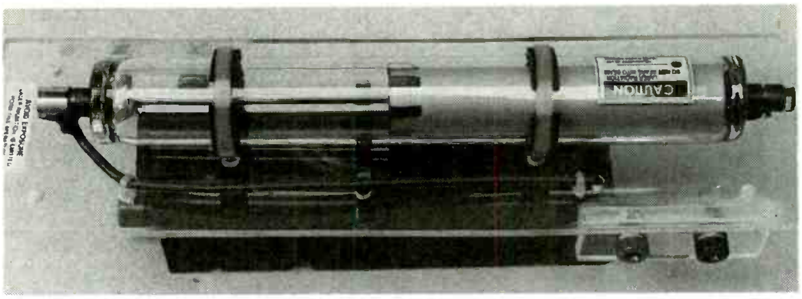

FIG. 1— LASER TUBE CLOSE UP. This one is the Spectra-Physics model No. 088. It is shown mounted on a Plexiglass platform with the high-voltage power supply directly below it.

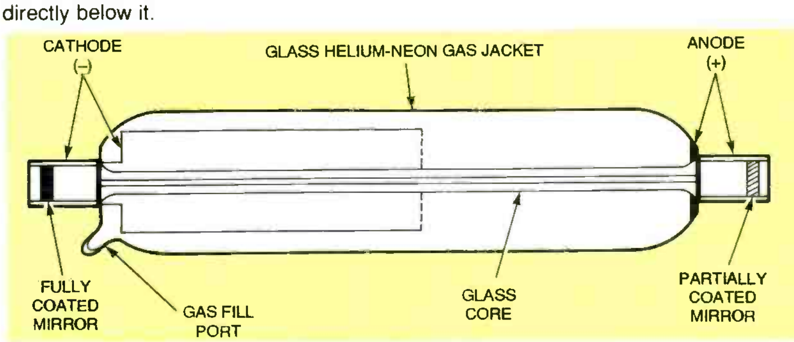

FIG. 2— BASIC DIAGRAM OF AN He-Ne laser tube. Some tubes have metal ends instead of the solid glass envelope. The glass fill port is used during manufacturing to charge the tube.

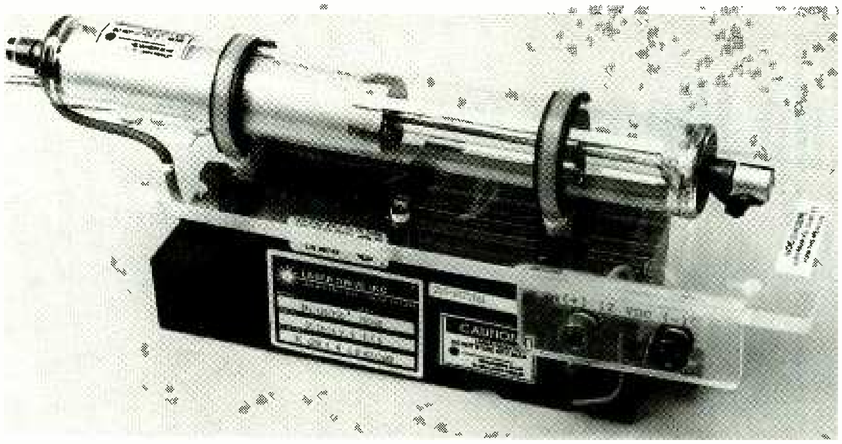

FIG. 3— LASER TUBE MOUNTED ON ITS PLATFORM. This side view shows details of the mounting techniques that are used.

In theory many substances can be made to lase if the proper energy level of stimulation is applied. There are three major categories of lasers (those made from solid, liquid, and gaseous materials. There are also four other lesser-known groups (diode lasers such as the ones used in your compact disc player; tunable dye lasers that can emit laser light at more than one wavelength; X-ray lasers that do not produce a visible light; and a device known as a free-electron laser that uses a beam of free electrons (electrons not associated with any atom) as the active material.

The energy source that activates a laser can be light, heat, electricity, or even atomic energy. Solid lasers are built around rods of ruby, or other, synthetic gem materials. Other solid lasers use materials such as Nd-YAG (YAG stands for yttrium-aluminum-garnet. Nd-YAG is a YAG rod doped with neodymium) and Nd-glass (glass doped with neodymium) materials. Semiconductor lasers also use solid materials but work in an entirely different manner. We will not look at these devices in this series.

Liquid-based lasers use both dyes and chemicals, that are usually pumped through the lasing chamber where they are exposed to the energy source. Perhaps the most commonly used medium is gas, if we don't count the tens of millions of relatively low-power lasers used in everyday consumer products such as CD players, CD-ROM drives and other devices of this kind. Helium, neon, argon, krypton, carbon dioxide, and even some vaporized metals, such as cadmium or arsenic, are also used in conjunction with other gases as laser materials.

Whether solid, liquid, or gas, a material will lase if more of its atoms are in a high-energy state than in a rest state. This doesn't normally occur in nature, but must be forced, or in the terminology of lasers, pumped.

Until Einstein proposed his idea of SER, scientists believed that a photon could only be absorbed by an atom (and raise that atom to a higher energy level) or be emitted by the atom (as it dropped to a lower energy level). Einstein was most interested in what would happen if a photon hit an atom that already was at a higher energy level. He theorized that a photon with energy corresponding to that of an energy-level transition could stimulate the release of a photon that would be identical to the first. If enough atoms could be excited, the chance of photons hitting them would be increased. That would lead to a chain reaction where photons would hit excited atoms and make new photons, with the process continuing until the energy source was removed.

Normally, stimulated emission is unlikely because when a material is in equilibrium, more atoms are in low-energy states than are excited, and the population at a particular energy state decreases as the energy of the state increases. In other words, atoms tend to drop to the lowest available energy level by spontaneously emitting a photon.

For stimulated emission to occur, a population inversion is required. In other words the population of atoms at a higher-level energy level must be higher than that at a lower-energy level. When that happens, photons that are emitted spontaneously are more likely to collide with an atom in an excited state than to be absorbed by the atom with a lower energy level. The result is laser gain or light ampli-

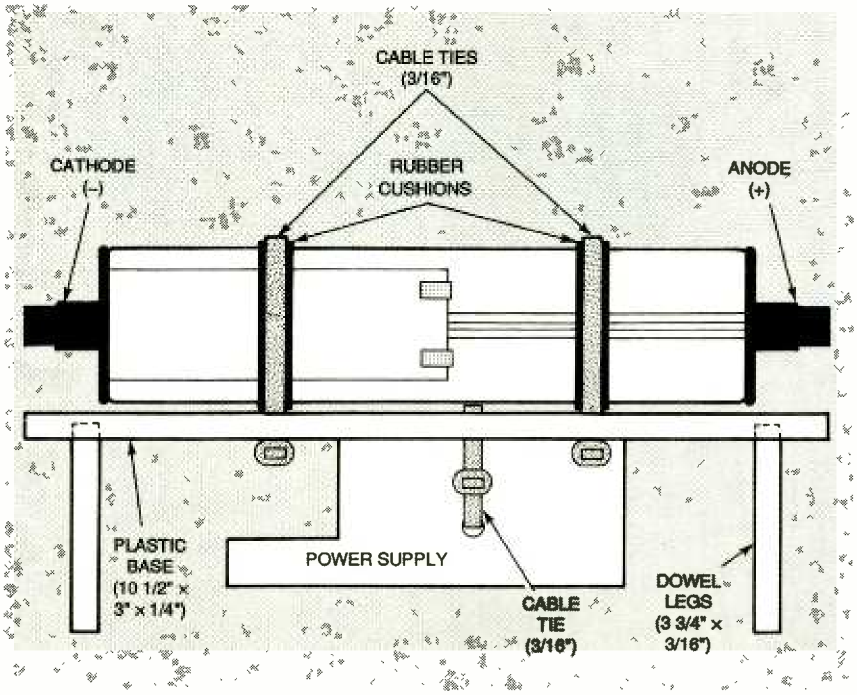

FIG. 4— ANOTHER VIEW OF HOW THE LASER TUBE is fastened to its platform. For safety reasons, it is best to place the laser tube inside a plastic or metal housing.

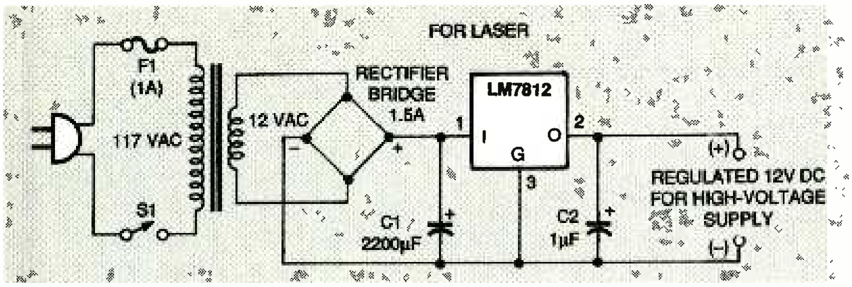

FIG. 5— REGULATED POWER SUPPLY DELIVERS 12 volts DC to drive the laser's high-voltage supply.

fications as the chain reaction creates more atoms with higher energy levels.

Stimulated emission has a couple of special properties that make laser light unique(it has the same wavelength as the original photon (monochromatic), and it is in-phase (or coherent) with the original light. A third special property of laser light is collimation(the laser emits a narrow beam of light that exhibits very little spreading, even over long distances. Collimation occurs without using any optics, and is responsible for the high intensity of the reflected laser light or "spot". Semiconductor lasers emit beams with a divergence angle much higher than those of gas or solid lasers. Optics are used to shape the beam to make it narrower.

The most commonly used laser energy sources are light and electricity. With solid and liquid lasers, light,(in the form of high-power xenon flash tubes or carbon arc lamps arranged to surround the laser tube(is a practical and effective choice. This type of laser is usually a pulsed emitter that sends out short, high-power bursts of light rather than a continuous beam. The high-intensity flashes of light provide the energy to create the population inversion. With gaseous lasers, an envelope, often made of glass, contains the gas, or combination of gases, to be lased. A core running the length of the envelope, through its center, terminates into a mirror-electrode assembly at each end. One end is the anode. The other is the cathode. A DC voltage is connected; positive to the anode and negative to the cathode. This voltage, usually between 300 and 10,000 volts, depending on the size and type of laser, provides the energy for the population inversion. While its efficiency is a mere 2 to 5 %, the value and versatility of device far outweighs the cost of operation.

The power supplies used are also special. Most of the time a very high "starter" voltage, about 10,000 volts, is required to initiate the population inversion. Then the supply drops back to somewhere between 1000 and 4000 volts DC, to maintain that state.

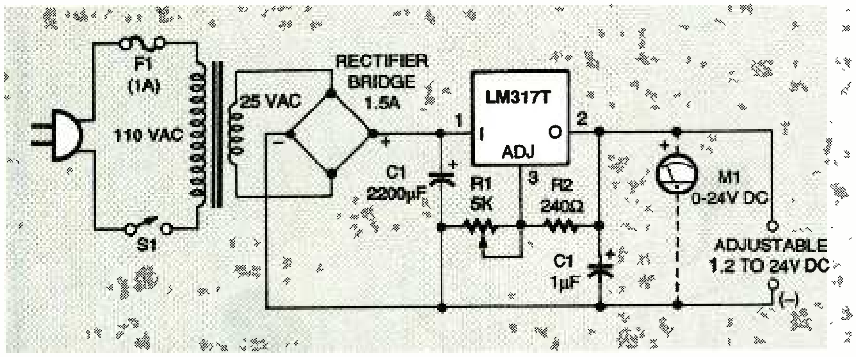

FIG. 6— A MORE ELABORATE VARIABLE POWER SUPPLY is shown here. The meter, which can be an analog or a digital type, is optional.

Up to this point, most of the information has been directed at the stimulated emission of radiation (SER) aspect of the laser. But the light amplification (LA) part is equally important. Let's take a look at how lasers go about this procedure. Whether solid, liquid, or gaseous; the ends of the rod or the liquid/gas envelope must be precisely parallel to each other, and at a 90-degree angle to the sides of the device. Each end is fitted with a mirror that reflects the photons back and forth, and produces the amplification. As more photons are emitted, they combine with the ones already present.

If the system was completely light tight, the amplification process would continue to saturation and there would be no laser beam output. To permit the laser to emit its beam, the mirror on one end, usually the anode, is only a partial mirror. This allows some light to escape. The quantity of light that escapes varies to some degree among various manufacturers, but the rule of thumb is about 10%. The escaping light is what becomes the intense laser beam.

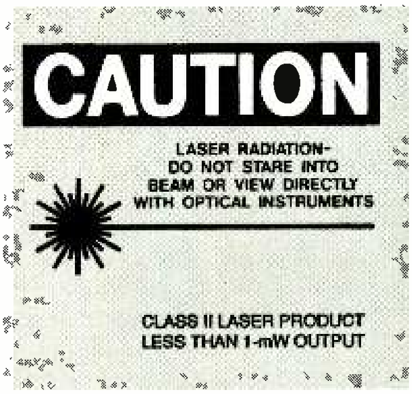

FIG. 7— THIS IS A WARNING NOTICE THAT MUST be attached to all low-power lasers. Make sure you attach one to your unit.

Build your own laser

With the technical stuff out of the way, it's time to get down to the fun. There are numerous sources of laser parts, power supplies, equipment and support items, such as front surface mirrors, motors, and optical elements. Table 1 lists some of these suppliers. Many of these companies carry a wide variety of types in all three states. We are going to show you how to build a small low-power helium-neon, He-Ne gas laser. Helium-neon tubes are relatively inexpensive and they are readily available, along with power supplies from surplus-equipment suppliers.

He-Ne lasers are remarkably reliable. It is rare to find a sub-performing tube that works only partially.

The tubes almost always either work very well or not at all. Most suppliers are quite good about testing used equipment and offer limited warranties to protect their customers. Surplus lasers can provide excellent savings for the experimenter. The average He-Ne laser has a life expectancy that exceeds 5,000 hours.

The second and very important consideration is ***SAFETY!*** This is a good time to mention the hazards of working with lasers and the precautions that must be followed. Remember, the light emitted is very intense. *Take no chances. Never look directly* into the beam of *any* laser. *Never allow the beam to reflect back* into your, or anybody else's eyes. *Permanent damage to the retina can easily occur.*

The high-voltage supply for the tube is the next consideration. Keep the leads as short as possible, and well insulated. Keep the connections, on

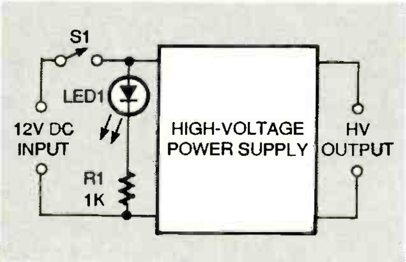

FIG. 8— DETAILS OF THE PROTECTIVE HOUSING for the laser tube.

both ends, out of easy touch. The average supply will have a "kicker" voltage of between 6,000 and 15,000 volts, and will run continuously at 1,000 to 3,000 volts DC, depending on its power. Even at the low current in the 4 to 10-mA range, contacting a hot He-Ne power supply can be dangerous. With this in mind, let's take a first look at the unit we will build.

The laser tube we used is a Spectra-Physics No.088, 1-mW helium-neon device that measures 9 $^3/_4$ inches long by 1 $^1/_4$ inches in diameter. Its electrodes are at each end; the cathode is attached to the long metal sleeve that surrounds the glass core. You can clearly see the details in the photo in Fig. 1 and the diagram in Fig. 2. The power supply's negative output (Laser Drive Inc. No. 006-1012158) is connected to the cathode, while the positive side goes to the anode at the opposite end. The ballast resistor is built into the power supply, so an external one is not needed. Use only high-voltage dielectric cable to make these connections.

TABLE 1—LASER SUPPLIERS

American Science and Surplus
3605 Howard Street
Skokie, IL 60076
(708) 982-0870

Electronics & Computers Surplus City
1490 West Artesia Blvd.
Gardena, CA 90248
(310) 217-1922

Electronic Rainbow, Inc.
6254 LaPas Trail
Indianapolis, IN 46268
(317) 291-7262

Information Unlimited
Box 716
Amherst, NH 03031
(603) 673-4730

Midwest Laser Products
Box 2187
Bridgeview, IL 60455
(708) 460-9595

MKW Industries
1269 Pomona Road
Corona, CA 91720
(800) 356-7714

Timeline, Inc.
23605 Telco Avenue
Torrance, CA 90505
(301) 784-5488

When making the connections to the anode and cathode, do not attempt to solder the wire to the electrodes. The heat of soldering is likely to cause the glass envelope to crack and ruin the laser tube. Instead, use one half of a fuse holder, or wrap and twist the wire securely around the metal electrodes. It is a good idea to keep these leads short, no more than 24 inches long, for both safety and efficiency. If you follow the recommended assembly methods, long leads to the tube are not needed. Mount the laser together with the high-voltage power supply as shown in Fig. 3. This method works well, as it keeps everything together, in one easily handled package.

The power-supply assembly is an epoxy encapsulated, portable unit, that measures 5 inches x 1 $^1/_8$ x 1 inches, in a plastic case. At one end, a length of color coded (red for positive, and black/yellow for negative) small-gauge wire protrudes for connection to the 12-volt DC, 1 ampere, standard power supply. On top, there are two spring-clip quick connection terminals(one each for the anode and cathode. The positive terminal is at the open end of the package (see Fig. 4).

Here, the high-voltage leads can be soldered. As an alternative, well insulated spade connectors also make good choices for this hook-up. Since the input to the high-voltage supply is 12 volts DC at 1 ampere, the laser can be made portable by using a battery pack

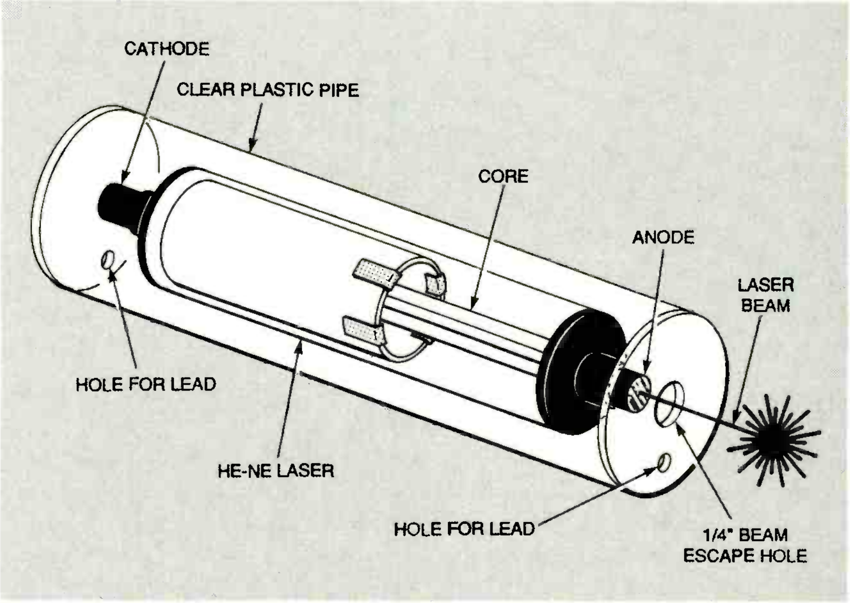

FIG. 9— ON-OFF WCH AND INDICATOR LIGHT CIRCUIT. You can add it to the laser's high-voltage power supply.

for power. However, for most of the experiments this column will describe, the 12-volt regulated power supply (see Fig. 5), is all you will need. Once you have the wiring ready, connect the three components together temporarily and apply AC power to the 12-volt supply for a systems check. If all is well, the tube will energize and emit a red beam of light. To protect yourself from any electrical shock, do not contact the laser while it is operating and exposed like this.

If the test run is successful, disassemble the components and start reassembling the laser and power supply in a more permanent arrangement. Figure 5 shows one layout, but is not the only way to go. Here, a piece of Plexiglas, 1/4 inch thick by 10 1/2- by 3 inches is cut to form a platform to hold the laser and its power supply. Drill the necessary mounting holes and use cable ties as shown together with soft rubber strips as cushions to secure the tube to the board. Next, drill 3/16-inch holes half way down the platform, 3/4-inch in from the sides..

Now make the anode and cathode connections. Secure the power supply to the underside of the Plexiglas board with cable ties. Feed the anode and cathode leads to the tube through 1/8-inch holes in the board. Connect them to the laser tube to complete assembly (see Fig. 6). To comply with the regulations of the US Center for Devices and Radiological Health (C.D.R.H.), a warning label must be placed prominently on the completed assembly. Figure 6 is a facsimile of the needed label.

For added safety you can place the laser tube into a housing. There are several ways to do this. One favorite method is to use an appropriate length of clear plastic pipe with ends (see Fig. 7). This method leaves you with clear view of the laser tube and allows you to observe the lasing action (glowing of the glass core) when the unit is operating. The clear pipe can easily be masked with black paper to block the light, when you do not want the extraneous light. Whatever type of housing you choose, you need to drill a 1/4-inch hole in the cap at the emitting end to provide an unobstructed exit for the beam. Also, don't forget to drill holes for the high voltage leads that go to the anode and cathode. These can be located at the ends of the housing. The wires can be brought back and secured with cable ties at the point where they enter the power supply. In most applications the ballast, if used, remains outside the tube housing, for heat protection.

Now that the laser assembly is complete, cement 2 1/2- by 1-inch Plexiglas strips to each side of the board. Use 1/4-inch holes to accommodate banana jacks for the 12-volt DC power supply connection and anode lead access. These will be used later during the electronic modulation experiments (see Fig. 8).

The next installment show you how to put your newly assembled laser to work. You'll learn how to modulate the beam both mechanically and electronically. You will transmit sound signals over the beam and perform other fascinating laser experiments. EN

HARDWARE HACKER

continued from page 48

reader. The DOS and UNIX versions apparently are not being upgraded, at least not so far. Also, the Acrobat "security" levels seem to have serious problems.

Certain uploading protocols, especially XMODEM, can distort the file just enough to prevent valid users from ever gaining access. And, if you give your user the ability to print his file, he can subvert *all* other security levels, any time he wants to. More details have been posted in the file INSECURE.TXT.

I do not personally use any of the Acrobat security features.

If you want to jump into Acrobat, their *Adobe Developer's Association* has a $500 yearly developer program. This gives you the latest insider CD's with all of their latest software.

I've posted scads more info, tech docs, and great heaping bunches of Acrobat support to *GEnie* PSRT. I stock the Acrobat "pewter" reference manual here at *Synergetics.*

New Tech Lit

From *Texas Instruments*, a CD on *MOS Memory Specifications*. Plus a new *Power Semiconductors Product Digest* from *International Rectifier.*

The full text of all of the FCC regs are now available on the internet as http://www.pls.com:8001/his/cfr.html Actually, the *entire* CFR or *Code of Federal Regulations* is stashed here. With powerful search features.

Those miniature melody generators as used in greeting cards and such are distributed in quantity by *Dicker.* A melody chip source is LSI/CSI.

Some backgrounder info on those VCR *Plus* codes has been posted to PSRT as file VCRPLUS.TXT.

Industrial Market Place is a great surplus trade journal. This is mostly mechanical stuff, but there's lots of computers and electronics as well.

WebWeek is a new net magazine by the *PCWeek* and *MACWeek* folks. Free to qualified subscribers.

Samples of porous plastics are now offered by *Porex Technologies.* The specs on low melting point alloys are in an *Indium Corporation* flyer.

A major improvement in polymer solar cells is described in *Science* for December 15, 95. Pages 1789-91.

A free coaxial cable handbook is available through *Times Microwave.* Included are detailed specifications and full application notes on most cables.

Magic sinewaves are creating a revolutionary new power electronics development. They greatly improve the efficiency and can dramatically reduce the costs of such products as induction motor speed controls, home energy efficiency improvers, electric autos, and solar inverters. This is a *billion* dollar new opportunity that's largely up for grabs.

Quite a bit has happened on the magic sinewave front in the last few weeks. I'll be happy to send a free tutorial reprint to anyone who wants one. Formal proposals and a rather detailed tutorial library are also now available to serious inquirers only. These are also found on PSRT as files MAGSINT.PDF and MSPROP1. PDF.

Seminars, my PIC source code, and codeveloper programs are also newly available. Seminars are done in-plant or in a wilderness resort lodge. EN

SIGNALLING SYSTEM 7

continued from page 30

International Standards Organization (ISO) and contains seven layers identifying communications functions between two nodes such as the physical medium used for the connection, the error correction method, addressing scheme and so on. SS7 is also a protocol and is based on the OSI protocol stack.

The Protocol

The SS7 protocol (refer to Fig. 3) is composed of:

- Message-transfer part
- Signaling connection control part
- ISDN user part
- Transaction capability application part

The MTP (message-transfer part) provides the basic transport system for all SS7 messages. It is somewhat like a delivery truck. It is responsible for getting information from one network node to another in a reliable fashion. It makes up the first three levels of the protocol stack; the physical, link and network layers.

Layer 1, the physical level, specifies the actual medium used for transmission. It uses a four-wire connection and typically a bit-rate transfer of 64 kilobits per second (kb/s) or 56 kb/s. V.35 connections may also be used with incremental transmission rates up to 64 kb/s.

Layer 2, the link level, provides a number of functions to ensure that there is a good connection between two nodes for communicating. Error detection, error correction, signaling unit alignment and signaling link alignment are all part of the link layer's responsibility. It is at this layer that the actual signaling unit is formed. Signaling units are simply SS7's version of packets. Signaling units are transmitted across the signaling link continuously whether there is any information to transmit or not. When there is actually a message to be sent, it is sent in an MSU (message signaling unit). During periods when there is no information to send, FISUs (fill-in signaling units) are sent. This continuous stream of packets ensures that link problems are detected immediately. There is a third type of signaling unit, an LSSU (link-status signaling unit) which is used to convey changes in the status of the link between the two ends.

Layer 3, the network layer, has two basic responsibilities: address routing and network management. The first of these involves looking at the address of each packet to determine its destination. This also requires that alternate routing and recovery procedures are implemented when a network failure occurs.

The SCCP (signaling-connection control part), which is part of Layer 4, provides additional routing and network management functions to the MTP. It allows applications to talk to each other at different nodes, and it provides network management capabilities at the application level. For example, an application may want to reroute a message in the event of an application failure. You'll note from the SS7 protocol model (Fig. 3) that there is a connection between the ISUP and SCCP layers. SCCP contains connection-oriented procedures that may be used by ISUP; however ISUP doesn't use them today. It can communicate directly with MTP which suffices for current ISUP needs. New services may however make use of the SCCP connection-oriented capabilities.

The ISUP (ISDN user part) of Layer 4 provides connection-oriented signaling between nodes. This type of signaling relates to setting up, taking down and monitoring the connection of the actual voice path between offices. ISUP is what provides the capability for phone calls to be completed. It also provides services such as Caller ID. The name ISDN User Part can be a bit misleading, however, because you don't need to have ISDN to use this capability. It was however designed with ISDN capabilities in mind.

TCAP (transaction capabilities application part), also part of Layer 4, allows connectionless communications between two applications using a generic language. It provides query and response capabilities allowing nodes to request and respond to network and service information regardless of whether there is an actual call established between offices. This opens up an entire world of database interaction allowing centralized network intelligence in handling calls.

Now that you have an idea of how the protocol works, let's move to a network viewpoint. As mentioned earlier, SS7 is essentially overlaid on the existing telephony network. This introduces some new network elements as well as giving additional capabilities to previously existing ones. The network is

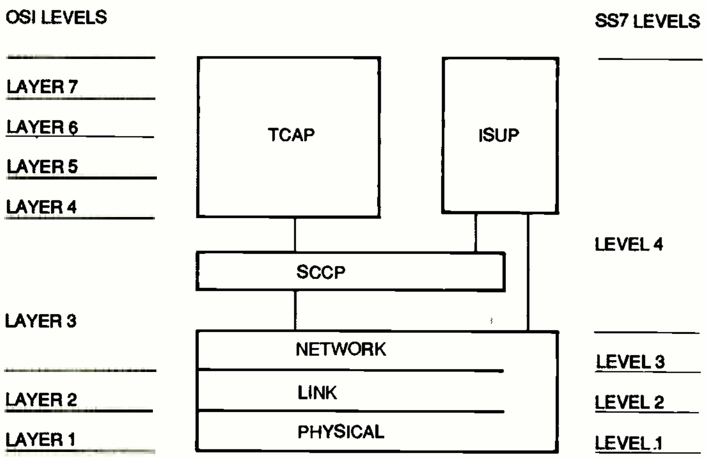

FIG. 3—OPEN SYSTEMS INTERCONNECTION (OSI) and Signaling System 7 (SS7) protocol models.

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Accredited Member, Distance Education and Training Council made up of a number of nodes called signaling points. Figure 4 shows a network example consisting of connected nodes.

The SSP (service-switching point) is the telephone office with SS7 capabilities. It can originate and terminate messages but cannot transfer them. The STP (signaling-transfer point) takes care of the transfer part. It is the message-switching hub of the network, essentially a big packet switch. Many of the routing decisions are made at the STP. Without this node, every SSP would need to have a connection to every other SSP it was required to send messages to. This would quickly grow into a complicated scheme. STP's are usually deployed in mated pairs to provide redundancy.

The SCP (service-control point) provides database services. Telephone offices can send queries to the database requesting information regarding 800 numbers, Private Virtual Network numbers and calling-card numbers, to name a few.

Network routing

We have seen that the physical connection between offices that provides the signaling communications is called a signaling link. This link is actually a part of a linkset. A linkset is simply a set of signaling links connecting two offices. ANSI specifies that a linkset may contain up to 16 links. Many offices might be able to handle all of their traffic on a single link per linkset. However, the desire for additional traffic capacity or just alternate facilities in the case of a facility failure often merits additional links. There can only be one linkset defined between two offices. While links define physical connections between offices, a *route* describes the path between a node and a destination.

A route may consist of multiple linksets. There may be several routes from one node to another. Each route follows one or more linksets to its destination. Just as there may be several links in a linkset, a routeset is a set of routes which describes alternate paths from a node to a destination. When a node needs to send a message to another node, it chooses a routeset which is associated with a destination, then chooses a route within the routeset (remember that a route really just describes a linkset), then chooses a link within the linkset.

That brings us to the next topic of routing: how to determine which node to send a message to. Every office is assigned a point code. This is the address of the office, simply a number to uniquely identify it. Point codes vary in format depending on the country and the standards they use. The ANSI standards used by North America designate a 9-digit point code to identify each node in the network. Each message contains both a destination point code to identify the office to send the message to and an origination point code to identify the office sending the message. Within each office, translations are done to map this address to a routeset for which outgoing messages are to be sent. This means that each node must designate routesets for each point code it wishes to directly send messages to.

The decisions about how routing will be done can vary from company to company and are made by administrators of the network. This type of routing based on the point codes is done at the network level of the MTP and its primary responsibility is getting messages from one node to another.

The next level of routing to consider is routing to an application, or in SS7 terms, a subsystem. Subsystem routing is also based on a number designated for a specific application. This number must be agreed on by different companies so that a subsystem number identifying a particular subsystem can be interpreted correctly. These are usually not defined in the more general standards, but are usually defined by those involved in network administration. For instance, Bellcore, the research and development organization for the regional Bell operating companies has defined a number of subsystems for their clients in the US. One example is Custom Local-Area Signaling Services (CLASS), which has been defined as subsystem 251. Therefore, two offices sending CLASS related messages would designate a subsystem of 251 in the message. Subsystem routing is the responsibility of the SCCP level of the protocol. At the beginning, we determined that the digits of the telephone number played a major part in determining how your call is routed through the network.

One of the popular buzzwords in SS7 terminology is something called *global title translations*. A global title is simply a set of digits. These may be digits dialed by a subscriber or provided by an application by some means. Global title translations is the process of mapping those digits to an SS7 address, namely a point code and a subsystem. We've determined that a point code can route a message to an

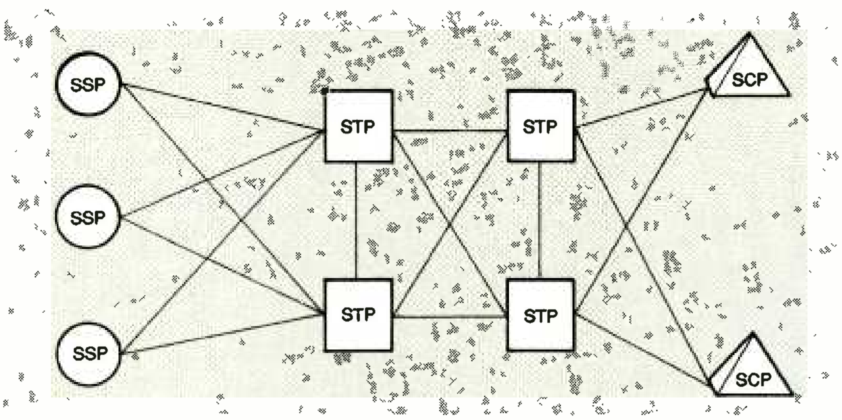


FIG. 4—AN SS7 SIMPLIFIED NETWORK showing Service Switching Points (SSP) interconnected to Service Control Point (SCP) via a network of Service Switching Points (STP). SSP, SCP and STP are nodes providing specialized services.

office and a subsystem number can route to an application. Once these two pieces of information are determined, we have the means to get a message from our application to an application somewhere else in the network. Traditional routing in the telephony network is based on digits. You realize that fact every time you pick up the phone. However, the SS7 network routes its messages based on point code and subsystem. Therefore global title translations are needed, which is also a function of the SCCP layer of the protocol.

Let's summarize how messages are routed across the SS7 network. When a call begins its routing process, the dialed digits are examined. For connection-oriented calls using the ISUP layer of the protocol, the digits are mapped internally to the appropriate point code by the office sending the message to the next node. The ISUP message also contains a circuit-identification code to identify which trunk the message relates to. This is necessary because it will be traveling on a different facility from the actual voice or data call. If level 2 has determined that both ends of the signaling link are at a suitable level of service, level 3, the network level routes the message to the next office based on the point code.

Now, assume that you're sending a TCAP message to a database to determine information related to an 800 number. (Refer to Fig. 5.) The point code to send the message to would still have to be determined, but a subsystem number would be needed also. The protocol model shows that a TCAP message must ride on top of the services of SCCP. Since TCAP is a connectionless message that's normally related to an application, the subsystem routing services of SCCP are needed. This is where global title translations comes into play. From the SSP, the message might be sent to the STP to let it perform the translation on the 800 number and determine how to route it to the database. In fact, this is what's normally done.

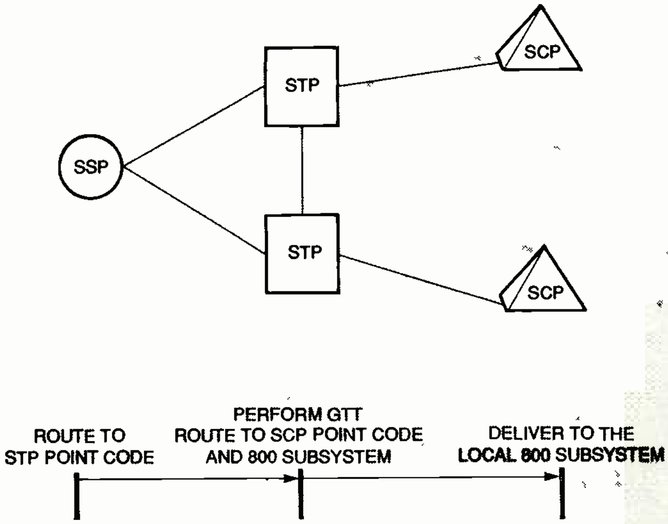


FIG. 5—AN EXAMPLE OF SS7 routing to determine information related to an 800 number. From the SSP a message goes to the STP and it performs the translation on the 800 number and determines how to route it to the correct 800 database.

It is not necessary for all of the offices to have knowledge of the database locations. This can be taken care of at a centralized point, the STP. Routing might occur through multiple STPs before reaching the SCP, but by the time it arrives, the final point code and subsystem have been determined so that the 800 application software at the appropriate database can handle the message.

The self-healing network

The headlines citing major SS7 outages give insight into the importance of the signaling network. If an office uses SS7 signaling, its loss means that the office can't communicate with the rest of the world. It becomes isolated. The network and protocol design take this into account, providing alternate routing, compulsive restoration where possible, and internodal communications to coordinate activities concerning degradation or loss of service. The network management implemented by the MTP can be divided into three categories: signaling-link management, signaling-route management, and signaling-traffic management.

Together, these management procedures attempt to maintain service by re-routing or controlling traffic when there is congestion or a failure in the network. Built-in recovery procedures attempt to restore network components to service if possible.

Signaling-link management is responsible for maintaining the path between nodes. If excessive errors are detected by the link layer, the link may be deactivated. Signaling link management will attempt to restore the link through a process known as signaling link alignment. This involves an exchange of signaling units (LSSUs) to bring the link back to the proper state. Each end of the link uses a signaling-unit error-rate monitor to monitor the number of errors at the link level and determine the stability of the link. When signaling-link management has determined that the link is suitable for use, it will report it to level 3 as being available.

Signaling-route management maintains and distributes information between nodes on the availability of signaling routes. Much like a traffic reporter, it sends out messages about the loss or degradation of routes causing other nodes to choose alternate routing or take appropriate actions.

In Fig. 6, for example, assume that the link between SSP A and STP 1 failed. The STP would send a transfer-restricted (TFR) message to the other SSPs informing them that it has limited routing capabilities to access node A. The TFR message would contain the point code identifying node A as the subject of the message. As long as the other nodes are able to route messages by another route, they will not try to access node A through this STP. This helps to minimize the traffic between the two STPs unless it is absolutely necessary, since STP 1 would have to route any messages it received destined for A through STP 2. The other network nodes can still route through STP 2 with no problem.

Since STP 2 will not be able to send messages to SSP A via STP 1 at all, STP 1 sends a transfer-prohibited (TFP) message to STP 2. This message contains the point code for SSP A marking its route as unavailable for messages coming from STP 2 in this direction. As you can see, the only way STP 1 can get a message to SSP A would be to route it through STP 2. It would have to send the message right back, causing double traffic over the link joining the two STP's. The TFP will prevent that situation.

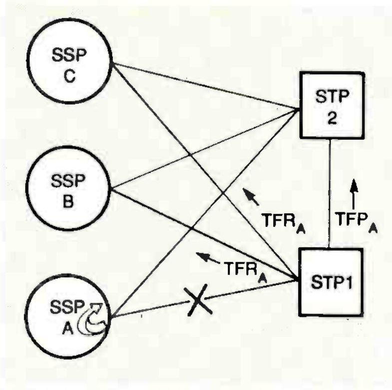


FIG. 6—NETWORK MANAGEMENT automatically re-routes messages in the event of failures.

When the route between STP 1 and SSP A is restored, STP 1 will send out transfer-allowed (TFA) messages to its adjacent nodes, informing them that routing is again available to SSP A. There are additional messages that are used to accomplish all the tasks that need to be handled by routeset management but this scenario gives you an idea of how nodes communicate the availability of routes between each other.

GLOSSARY OF TELEPHONE NETWORK TERMS

AIN—Advanced Intelligent Network. A network concept in which services are created and managed in a centralized location. This moves the service intelligence from the telephone office to a service control point.

ANSI—American National Standards Institute. Refines the Global SS7 standards specified by the ITU-TS for North American and regional Bell operating companies.

Associated mode—Signaling mode in which a node is directly connected to the destination node by a linkset.

CLASS—Custom Local Area Signaling Services. A set of services usually targeted for residential and small business which provides the equivalent of many business features such as caller identification and automatic recall.

Connection-oriented signaling—Signaling used to set up, monitor and take down calls or pass information related to a call connection.

Connectionless signaling—Signaling used to transfer information not associated to a particular connection. Often referred to as a Query/Response method.

FISU—Fill-in signaling units. An SS7 packet sent when there are no MSUs to be sent. Since SS7 links transmit a continuous stream of packets, these are used as filler when there are no messages which need to be sent.

Global title translations—The process of converting digits to an SS7 address. SS7 uses point codes and subsystems to deliver messages.

ISDN—Integrated Services Digital Network. A network concept which provides multiple integrated services from a single point of access. ISDN provides access to voice, circuit-switched data and packet-switched data as well as enhanced call control signaling from the end user to the telephone office.

ISUP—ISDN user part. Part of the SS7 protocol which provides connection-oriented signaling used for setting up, monitoring and taking down trunks.

ITU-TS—International Telecommunications Union–Telecomunications Standardization (Sector). Organization that determines Global SS7 Standards.

Link—A communication channel between two adjacent signaling points which provides a path for messages to travel.

Linkset—A set of links between two adjacent signaling points

LSSU—Link-status signaling unit. An SS7 packet used to convey changes in the link state between nodes.

MSU—Message-signaling unit. An SS7 packet used to send information across the network.

MTP—Message-transfer part. Levels one through three of the SS7 protocol. MTP provides reliable transfer of signaling units between network nodes. Its responsibilities include point code routing and network management.

NSP—Network-service part. Refers to the combined services of MTP and SCCP. Together, these provide end-to-end application routing.

OSI—Open System Interconnection. The telephone hook-up system commonly used throughout the world.

Point code—An address for an SS7 network node.

Quasi-associated mode— Signaling mode in which a message must travel over two or more linksets to reach its destination. It is not directly connected to the destination point.

Route—A path from a signaling point to a destination.

Routeset—A collection of routes used to access a destination.

SCCP—Signaling-connection control part. Part of the SS7 protocol which provides additional routing capabilities to the MTP, including subsystem routing and global title translations.

SCP—Service control point. A database used to access information about calls such as routing, billing and the selection of the service provider. The SCP provides a centralized form of intelligence for handling calls.

SP—A signaling point that can originate and terminate SS7 messages but does not have TCAP capability. The term signaling point is sometimes used to refer to any network node with signaling capability; however this should not be confused with the specific "Signaling Point" node type.

SSP—Service-switching point. A node that can originate and terminate messages but does not have the capability to transfer them. It also has the ability to send TCAP messages.

SS7—Signaling System 7. A system that specifies the signaling protocol for the telephone network.

STP—Signaling-transfer part. A node used to transfer messages between other switching nodes. Acts as a message switching center.

subsystem—An application at a node which uses the routing capabilities of SCCP.

TCAP—Transaction Capabilities Part. Part of the SS7 protocol which provides a generic format for transferring application-related information.

Trunk—Facility which carries voice or data traffic between two telephone offices.

The third area of network management is signaling-traffic management, which is responsible for routing the traffic in the network as the availability of routes change. Let's take our previous example and look at how traffic management handles this situation. At SSP A, all traffic destined for STP 1 must be stopped and re-routed to STP 2. Link-layer procedures exist to attempt to account for all messages which might have been in transit between the nodes when the failure occurred to ensure that messages are not lost. This communication is done using the route through STP 2. This coordination between the two nodes terminating the faulty route is called a changeover and is one example of how traffic management works in the SS7 network. Traffic which was destined for the linkset to STP 1 will now be changed over to the linkset for STP 2.

Again, there are a number of such procedures that make up signaling-traffic management. Congestion procedures were not even mentioned. But network management is a big subject—it's hard to predict the future, especially with the rate of change that's taking place in communications today. However, as you read, a great deal of development is being done in the area of centralized services such as the Advanced Intelligent Network (AIN). These services rely heavily upon the SS7 protocol to communicate.

We have only scratched the surface of all the inner workings of the SS7 network, but I hope it's enough to spark your interest in some further reading. I spoke with Travis Russell, the author of the only book I've seen to date that's totally dedicated to the subject and asked, "Why did you decide to write the book?". He replied, "Because there simply wasn't anything out there that was comprehensive." Russell writes from a wealth of practical experience and discusses a number of the network services which use the SS7 protocol. The book is titled "Signaling System 7", McGraw-Hill publisher. Ω

ANALOGIC IC TESTER

continued from page 32

the battery clip to the board noting that the red lead goes to the battery's positive terminal and the black lead to the negative terminal.

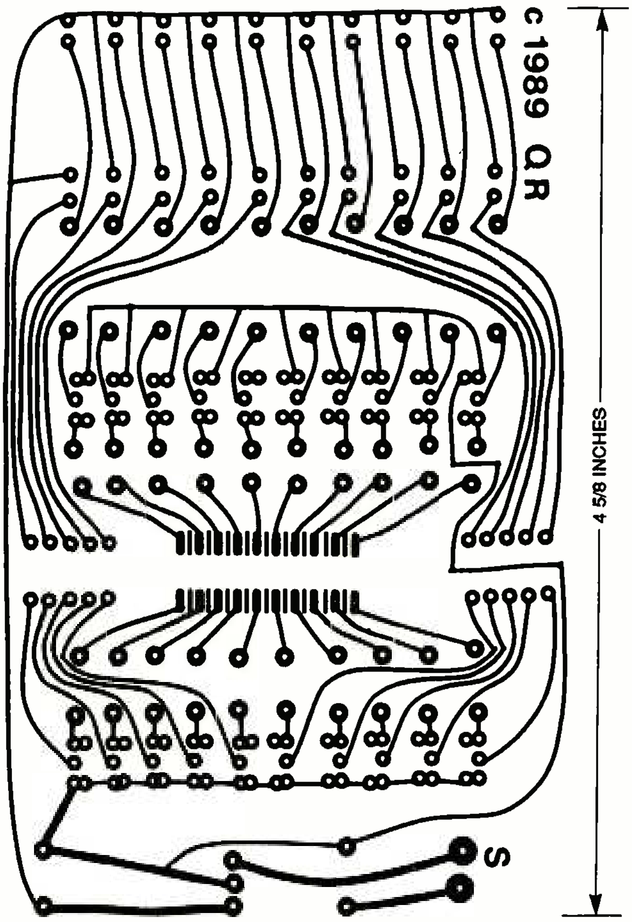
Mount a 20-terminal, wire-wrap socket (SO1) to the PC board. It too should be mounted slightly more than 1/2 inch off the PC board so that it is approximately flush with the unit's faceplate on assembly. When SO1 is in position, solder it in place. Solder to the board two lengths of wire about four inches long. Use a red wire for connection to BP1; black for BP2. This completes the required soldering on the PC board. Inspect your work carefully and re-work any bad connections or cold solder joints. Remove accidental solder bridges. Check that all the traces are continuous without breaks.

The next procedure is to fabricate the faceplate of the enclosing plastic box with the aluminum faceplate purchased with the plastic box. Use the template shown in Fig. 3 to mark the holes to be drilled on the faceplate. (Make a copy or two and use them.) Use a center punch to locate hole centers for the LEDs and switch S1, then drill the holes. Check that the switch shaft passes through its hole. The LEDs' rounded lenses should fit in the holes without passing through. Cut out the rectangular opening for the socket SO1. Use a nibbling tool or small saw and file to cut out the opening for SO1.

Deburr all the drill openings and file the edges smooth. Glue the template (copied from Fig. 3) onto the faceplate with common paper glue. Apply a sheet of clear, self-adhesive vinyl over the template to protect the paper's surface.

Drill two holes in the side of the plastic box (refer to photos) and mount BP1 and BP2.

Drill four holes in the circuit board and attach the standoffs



FOIL PATTERN for non-parts side of the printed-circuit board.

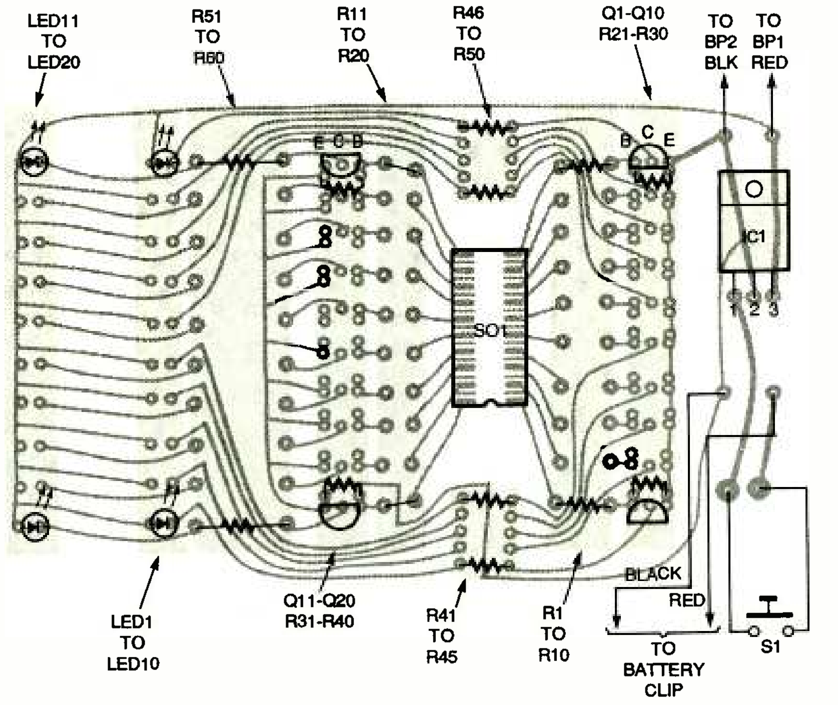


FIG. 2—PARTS LOCATION for the Analogic IC Tester. Limited numbers of parts are illustrated because similar-function parts (transistors, LEDs and resistors) mount in apparent columns in the diagram.

using the screws that came with the standoffs. Apply a small amount of silicone adhesive on the unmounted ends of the standoffs. Align the board with the prepared metal faceplate and then press the standoffs to the backside of the plate. Allow the adhesive to set overnight.

Solder the binding-post leads to BP1 and BP2 and attach a 9-volt battery to the bottom of the enclosure with double-sided tape. Do not use silicone adhesive or epoxy cement—the battery has to be replaced from time to time. Insert the ZIF IC socket SO2 into SO1. Snap the battery clip onto the 9-volt battery and position the faceplate on the box opening. Fasten the faceplate in place with four small self-tapping screws. Construction is now complete.

Testing and operation

In order to use the Analogic IC Tester it is necessary to build or purchase a 12-inch long test cable with a standard banana plug at one end and a microclip at the opposite end. A pair of one red and one black test cables is good to have, although for standard testing, only one red cable is required.

Plug the banana plug of the red cable into BP1, the red binding post. That puts +5- volts DC on the micro-clip every time TEST pushbutton S1 is pressed. With S1 pressed, touch the end of the microclip (metal hook) to each contact of the ZIF socket in succession. If the unit is functioning correctly, each LED will light when its corresponding socket contact is touched. This simple test confirms that the Analogic IC Tester is functioning and ready to test ICs.

To operate the tester, insert a known good IC into the ZIF socket. You can use the pin-orientation guide on the top panel although it doesn't really matter to the tester what position the IC is inserted. Once the IC is in place, push the lever on the ZIF socket to lock the IC in place. Now clip the microclip onto the ground or −V pin of the IC. If you do not know which pin that is, you will have to consult a data book to find out. With the microclip in place, push the TEST button and observe the device's fingerprint on the LED display. If the IC is a digital device then all the LEDs should be lit to some degree of brightness. As a general rule, TTL and CMOS digital ICs should light all the pin LEDs. We have not yet discovered an exception, although you may. Of course, pins designated as *not connected* (NC) will never affect the operation of the LEDs. If a connected pin of a digital IC does *not* light, there is a fault at that pin and the IC should be discarded or marked accordingly.

If the IC under test is a linear IC then the rules change somewhat. LEDs of a good device may or may not be lit. There may even be differences in the fingerprints of the same device from different manufacturers. For example, if you compare schematic diagrams of the 555 timer IC from various manufacturers you will notice that they are not all identical. These differences can change the device's fingerprint.

With analog or linear ICs, two tests are necessary. Attach the microclip to the −V pin and then push the TEST button. Note which LEDs are lit, dim or unlit. Then remove the test-lead microclip and attach it to the +V pin. Push the TEST button

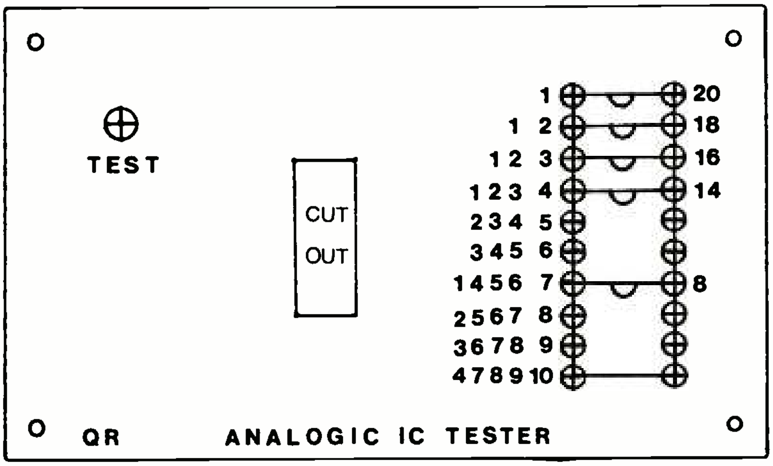
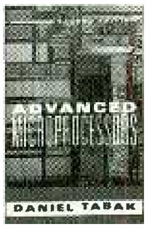


FIG. 3—FACEPLATE TEMPLATE is illustrated two-thirds original size. Zero-insertion-force socket SO2 connects to 20-pin IC wire-wrap socket that is positioned under the "CUT OUT" rectangle in diagram.

TABLE 1 - TYPICAL LIBRARY LISTING FOR TESTED IC's

Part No.	Make	Test No	Pin No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1741	MOT	1		U	U					U												
1741	MOT	2	D	U	U	D	D															
1458	MOT	1		U	U		U	U														
1458	MOT	2		U	U		U	U														
555	SGS	1						U														
555	SGS	2	V	D	D		U	D														
324	NAT	1																				
324	NAT	2	U	U			U	U			U	U		U	U							

LED status: *U* indicates unlit. *D* indicates dimly lit. *V* indicates very dimly lit. *No marking* indicates LED is at maximum brightness where pin exists.



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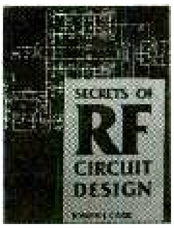

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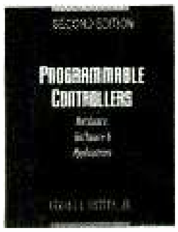

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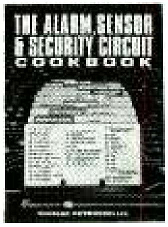

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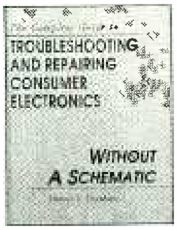

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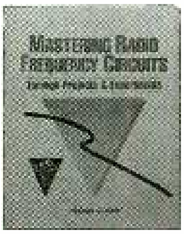

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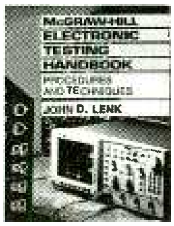

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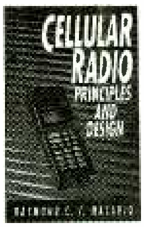

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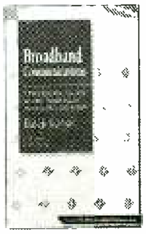

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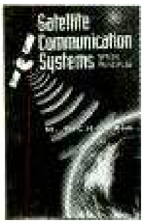

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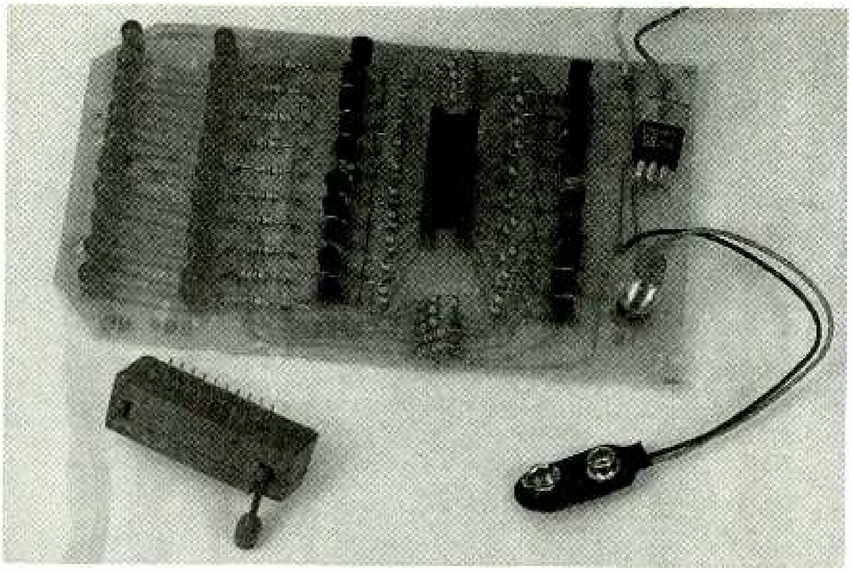


ALL THE PARTS are shown correctly soldered onto the Printed-circuit board. The Zero-insertion-force socket (SO2) is inserted into SO1 after the faceplate is secured to the printed-circuit board.

and note again which LEDs are lit, dim, or unlit. Both these tests should be done on a known, good device. Record the manufacturer, part number and LED states as noted above. When testing any questionable device, compare the above record with the test results of this device. If the LEDs show a different pattern for the same IC then it should be considered defective and discarded. If the LED pattern matches, then in most cases the device is good.

When testing linear ICs, the second test is usually the most informative. Often a bad device will pass the first test, but fail the second test.

Some general guidelines are helpful when testing linear or analog ICs. They are:

1. Output pins of good devices typically have lit LEDs.
2. Output pins of defective devices may be very dim or unlit.
3. Input pins may be lit or unlit depending on the device.
4. Corresponding input and output pins of dual, triple, quad, etc., function ICs should be identical. (e.g.: If one input pin of a dual op-amp has a lit LED, the other input pin should have a lit LED.)

It is an excellent idea to record all your findings in a reference library. As your library grows you will have to rely less on having a known good IC for comparison testing. Rather you can simply look up the device in your library and note what the output display should look like if the IC is good. Table 1 is an example of a typical library listing. The above serves only as a possible type of setup. You can record your results anyway you wish as long as you are consistent in how you do it!

There's more

The Analogic IC Tester will test more than integrated circuits. You will also find it useful for testing diodes, transistors, inductors and capacitors.

Testing Diodes:

1. Insert diode leads into any two contacts of SO2.
2. Connect the positive microclip to the anode lead. Push the TEST button. Both LEDs should light if the diode is good.
3. Connect the microclip to the cathode lead. Push the TEST button. If the diode is good only the cathode LED should light.

Testing NPN Transistors:

1. Insert the transistor leads into any three contacts of SO2.
2. Attach the microclip to the base lead. The base, emitter, and collector LEDs should light if the device is good.
3. Attach the microclip to the emitter lead. the collector and base leads should *not* light when the TEST button is pushed.
4. Attach the microclip to the collector lead. Push the TEST button. The base and emitter LEDs should *not* light if the device is good.

Testing PNP Transistors:

1. Insert the transistor leads into any three contacts of SO2.
2. Attach the microclip to the base lead. Push the TEST button. The emitter and collector LEDs should *not* light.
3. Attach the microclip to the collector lead. The emitter LED should *not* light when the TEST button is pushed.
4. Attach the microclip to the emitter lead. Push the TEST button. The collector LED should *not* light.

Testing Inductors:

1. Insert inductor leads into any two contacts of SO2.
2. Attach microclip to any lead. Push the TEST button. Both LEDs should light, one possibly brighter than the other. If one of the LEDs is unlit, the inductor is open, or has an extremely high resistance.

Testing Capacitors:

This test will only determine a capacitors approximate condition and works best with values greater than 1 µF.

1. Discharge capacitor completely. Insert capacitor leads into any two contacts of SO2.
2. Attach microclip to positive lead of the capacitor if it is polarized. Watch the LED of the negative lead very closely and push the TEST button. For small value capacitors, the LED will blink once. For larger values, the LED will light, then slowly fade out as the capacitor charges up.
3. If the capacitor is open, the LED will not flash or light at all.
4. If the capacitor is shorted the LED will remain lit as long as the TEST button is pressed.

Conclusion

The Analogic IC Tester can be an extremely useful piece of equipment for the technician or hobbyist. Although its indications are sometimes not perfectly accurate, it will successfully determine the condition of many parts. The Analogic IC Tester is very easy to use and requires only minimum training time. Ω

METROLOGY LAB

continued from page 34

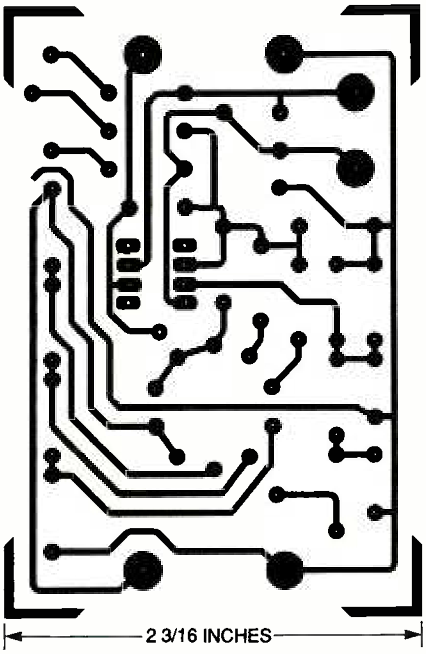
Commercial null detectors usually cover a voltage range of 1 microvolt to 1000 volts. This makes the range-switching circuit quite complex because both the input attenuation and amplifier gain must be switched. In practice, the higher voltage ranges of a null detector are rarely used, so the input of this detector is limited to a maximum of 100 millivolts. That not only reduces the circuit complexity, but also the parts cost. Above 100 millivolts, your DVM alone is all you need.

The most sensitive range is 10 microvolts, full scale. This allows the detector to resolve 1-microvolt differences with no difficulty. The input impedance will be 200 kilohms for normal "in-range" signals, falling to a minimum of 40 kilohms under overload conditions.

The limiting factor is the voltage rating of the first input-filter capacitor, which runs at about 1/2 the input voltage, under overload conditions. Figure 2 shows the schematic for the null detector

Assembly

The circuit is quite forgiving of construction and layout, since it only responds to very low frequencies. Still, using a circuit board helps to reduce wiring errors, and will result in the most stable and reliable null detector. A circuit-board layout is provided here. Figure 3 is its parts-placement diagram.



You will need a two-pole, five-position, rotary switch for S2, the range control. Almost any two-pole wafer type switch will work, because most of them allow you to set a hardware stop to limit the number of positions.

Note that the two pads for the switch wipers are not in line with the switch terminals. They must be wired around the switch to the correct terminal. The circuit board is supported entirely by the switch wiring. Install the circuit board on the switch last, to allow for positioning and alignment. Check your switch with an ohmmeter to be sure that your wiring matches the schematic.

Install the components as shown in Fig. 3, taking the usual precautions to protect against electrostatic discharge (ESD)—the LTC1050 is a CMOS device, and can be damaged by ESD. Do not use sockets, because they will contribute to thermal-EMF errors. When all the components have been mounted on the PC board—including the connecting wires—clean off all flux residue with a suitable remover. Also scrub the solder side of the board with soap and water, rinse it, then dry it with warm air. After cleaning, handle the board by the edges to avoid fingerprints.

Use a metal chassis, and wire the input and output connections as shown in the schematic. Do not make any connection from the null detector circuitry to the chassis. The null detector should be floated independent of its chassis, and a chassis ground connector should be provided at the input. This allows you to tie the null detector's chassis to the shield of the circuit being measured, if required.

The protection diodes on the amplifier input are slightly photosensitive at these high gains, so a light-tight chassis is also

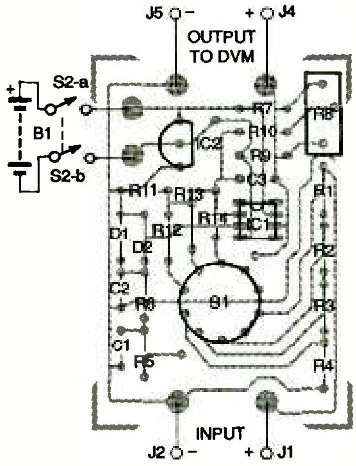


FIG. 3—PARTS-PLACEMENT DIAGRAM. Be sure to verify that your rotary switch confirms to the schematic.

PARTS LIST

All fixed resistors are RN55D or better 1%, metal film.
R1, R13—100,000 ohms
R2—90,900 ohms
R3—9090 ohms
R4—1000 ohms
R5, R6, R14—20,000 ohms
R7, R9, R10, R12—1,000,000 ohms
R8—100,000 ohm multi-turn trimmer potentiometer

Capacitors
C1, C2, C3—0.47 µF, 50 volts, metallized film

Semiconductors
IC1—LTC1050CN8 op-amp
IC2—TLE2426 "railsplitter" virtual ground
D1, D2—1N914 or similar

Other components
J1, J4—5-way binding posts, red, gold flashed brass preferred
J2, J3, J5—5-way binding posts, black gold flashed brass preferred
S1 2-pole, 5-position rotary switch
S2 SPST or DPST switch
Miscellaneous:PC board, 9V battery snap w/ leads, 9V battery clip 9V battery, case, solder, hookup wire

Note:The following are availble from Conrad Hoffman, 4391 County Road #1, Canandaigua, NY 14424-9611; E-mail: 73260.2255 @compuserve.com:
- **Printed circuit board, $15 plus $4 shipping and handling. Checks and money orders accepted only.**

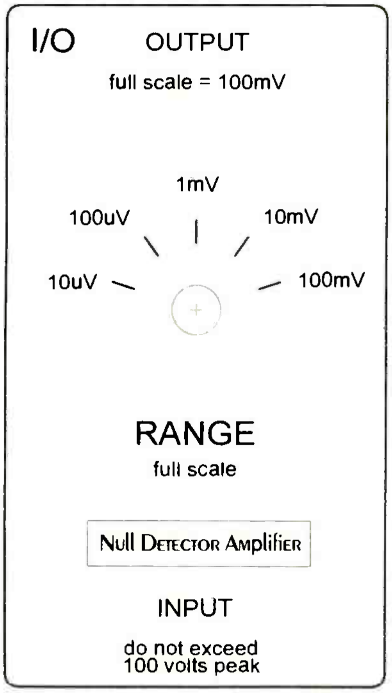


FIG. 4—FRONT PANEL suggested layout.

required. Follow the general layout of Fig. 4 to create a cover decal.

Mount the five binding posts, the power switch, and battery clip, and then install the completed PC board and rotary switch as shown in Fig. 5. Finish the job by wiring the input and output binding posts, power switch, and battery snap.

Install a fresh 9-volt battery in the null detector and connect the detector to your DVM. Turn on the power, and set the null detector range to 10 microvolts. Short circuit the input, and adjust the zero trimmer for minimum output on the DVM. Don't use plated plugs to short circuit the input because they will cause offset errors. Instead, use copper wire. Full-scale output on each range is 0.1 volt, so the correct range for most DVMs is the 200-millivolt scale. For 3¾-digit, 4½- digit, or other DVMs, simply use the most sensitive scale that still includes 0.1 volt. You may prefer to lock your autoranging DVM in the appropriate range, because automatic range switching can be somewhat confusing if used with the null detector.

You can make a quick check of each range of the null detector with the 10-volt standard that presented last month along with the voltage divider shown in Fig. 6. This should produce a full scale reading on each range of the null detector.

Continued on page 78

THE GALVANOMETER

From the mid 1800s, galvanometers were used for null detection. They were basically d'Arsonval meter movements with very delicate suspensions, often a finely drawn quartz fiber. Since there were no amplifiers at the time, the making of sensitive galvanometers was raised to a high art.

Typically, a small mirror was used instead of a pointer. A focused beam of light was then reflected off the mirror to a paper target several feet away. This optical lever amplified the slightest motion of the mirror to the point where it was visible.

Naturally, a mechanism this delicate was easily damaged. Rough handling, or even a brief over-voltage condition was usually fatal. Galvanometers were awkward, they had to be carefully leveled, and had fairly low impedances. The coil resistance varied from less than twenty ohms to a few thousand ohms at best.

Electronic null detectors relegated the galvanometers to history because they have far better sensitivity, higher impedance, and they are better suited to the rigors of daily use.

Today, however, few null detectors remain on the market. High resolution DVMs can do the same job for all but the most specialized needs.

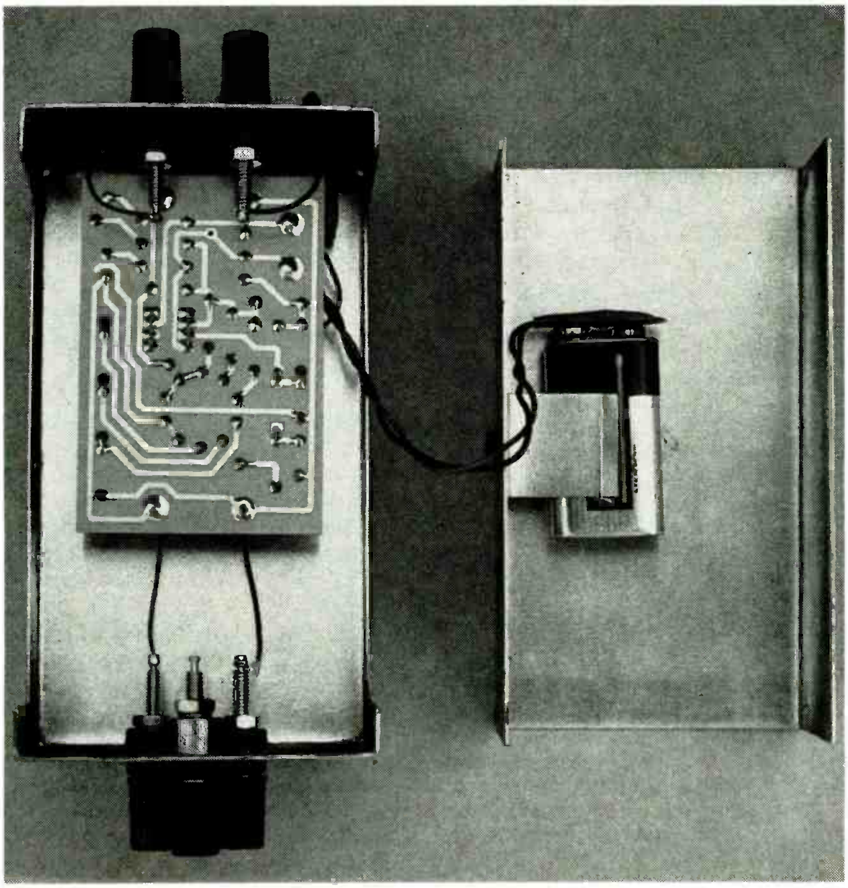


FIG. 5—ASSEMBLED CIRCUIT BOARD is mounted in its case.

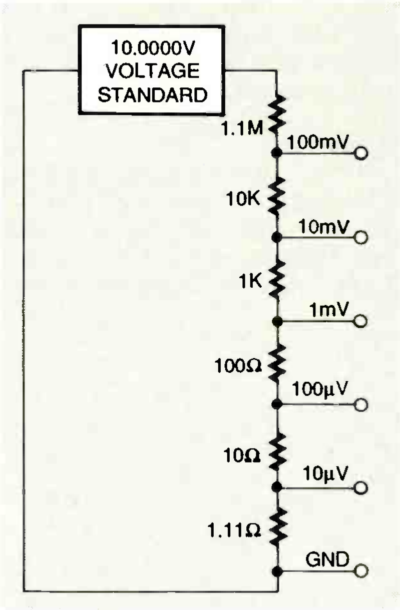


FIG. 6—TEST EACH RANGE of the null detector with this simple divider.

PLCs

continued from page 38

mize down time. Troubleshooting techniques will be described in another article.

All industrial process instructions must be converted to a language that the PLC can understand. A standard represen-

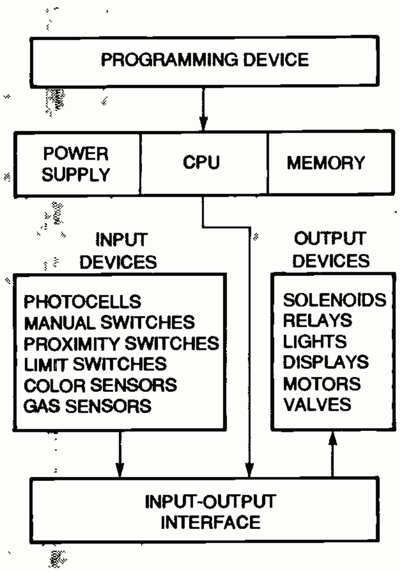


FIG. 3—TYPICAL SYSTEM COMPONENTS that are used in PLC industrial control systems.

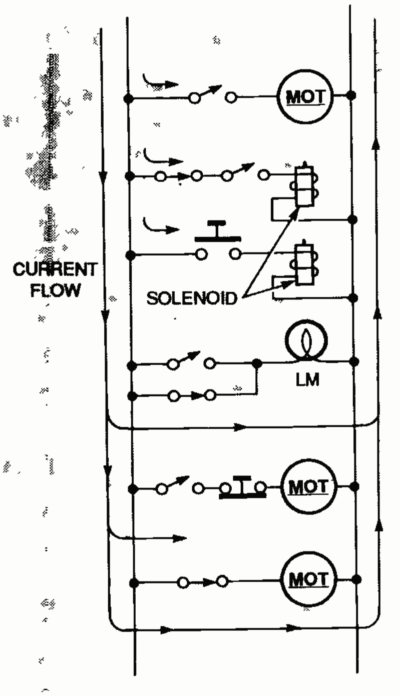


FIG. 4—CONVENTIONAL ELECTRONIC DIAGRAM of a ladder-logic diagram.

tation of process control has evolved. It is called a ladder logic diagram and is named for its resemblance to a ladder. It was derived from its predecessor diagram, called a relay logic diagram. Figure 4 is a typical relay logic diagram. If you follow the ladder from the top down (the normal direction of control flow), you can see how the various switches and relay contacts are evaluated (are they closed?). At the same time the corresponding controlled items, such as motors (M), lights (L), or solenoids (S), are commanded accordingly.

The PLC relay logic diagram (Fig. 4) translates into the PLC ladder logic diagram of Fig. 5. In both diagrams, the left-hand elements correspond to electrical contacts or switches. Normally closed switches, such as limit switches, are converted to parallel lines with a slash through them. Also, the rightmost elements in both illustrations represent the controlled items. When looking at the diagrams, you can see a series of sequential events occurring. It starts at the top left of the ladder. If the first ladder-rung switch on the left is closed, the motor starts. If not, the motor remains idle and you go on to the next rung down. When the system is operating, the PLC checks through the entire ladder from top to bottom. When it is done it simply starts all over again until it gets a stop-process command.

Logical-control rungs

Some logic control requires more than a simple on or off. An example of this is shown in Fig. 6, which is a single rung of a typical logic ladder. The four switches; S1, S2, S3, and S4, together control the operation of motor M. Just how they do their job is easily explained in standard logic terms. For example, if S3 AND S4 are both closed, the motor will start. OR the motor will start if S1 is closed AND S2 is NOT opened AND S4 is closed.

For the previous example we have placed the gate-like logic conditions in small caps. Since S1 and S2 are connected in se-

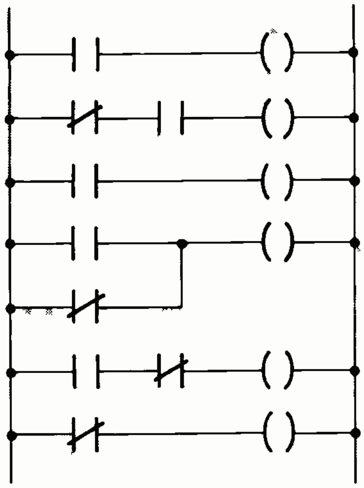


FIG. 5—LADDER LOGIC DIAGRAM representation of Figure 4.

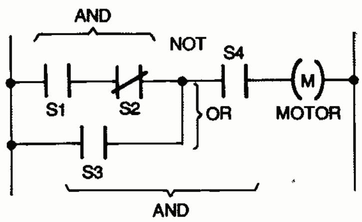


FIG. 6—CLOSE-UP OF A SINGLE LADDER RUNG in a ladder-logic diagram.

ries, both must be on for the motor to start. This means that a series connection of two or more switches is a logic AND condition. Multiple switches in parallel, such as S1, S2 and S3, means that either S1 and NOT S2, or S3 alone can start the motor if S4 is closed. This defines the logic OR condition, a parallel connection of controls. Finally, S3, the normally-closed switch, will start the motor if it is NOT operated. This logic function makes it possible for limit switches, that may open when a motor reaches a preset mechanical limit, to control an operation. This is often used to prevent mechanical damage to gears and drives. Some PLCs have other, more complex logic operations. However, the three logic functions listed here are the most powerful and commonly used in industrial applications.

One advantage of PLCs is their ability to change program flow based on operating conditions. This feature permits control programs to be restarted, bypassed or terminated, as necessary, by switch conditions found while the PLC executes its instructions. This is done by placing a program control function on the right side of a ladder rung, where motors, solenoids and other operating devices are normally drawn. In most PLCs the minimum control functions can be represented by the commands CONTROL SET, CONTROL RESET, JUMP TO RUNG, AND JUMP END LADDER. Figure 7 shows how such control elements

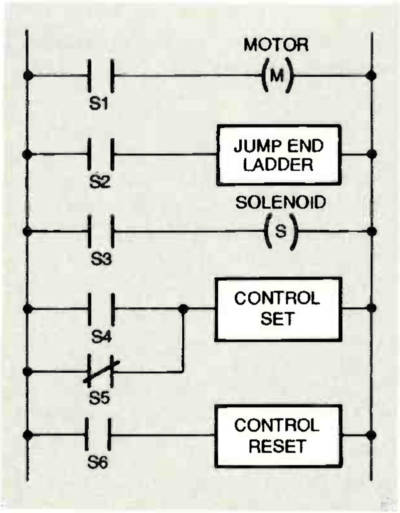


FIG. 7—THESE LOGIC-LADDER ELEMENTS include programmable control functions.

might be included in a typical ladder logic diagram. When S2 closes, the program control jumps past the entire ladder diagram and restarts at the top. If S4 closes, a SETcommand is executed. It sets some selected output to activate. If S5 is closed, it resets the output to off.

Until now we have assumed that there are switches opening and closing in response to discrete stimuli. This works well for starting and stopping processes and provides limit controls when ON or OFF conditions are met. Many industrial control decisions, however, are based upon linear, or what are called "gray area" input data. These call for switching decisions when a furnace temperature rises above 1200 degrees, or the pressure in a vessel exceeds 30 psi. To provide this kind of control, analog sensors such as thermocouples and strain gages are used to produce a proportional output voltage or current in response to temperature or pressure differentials.

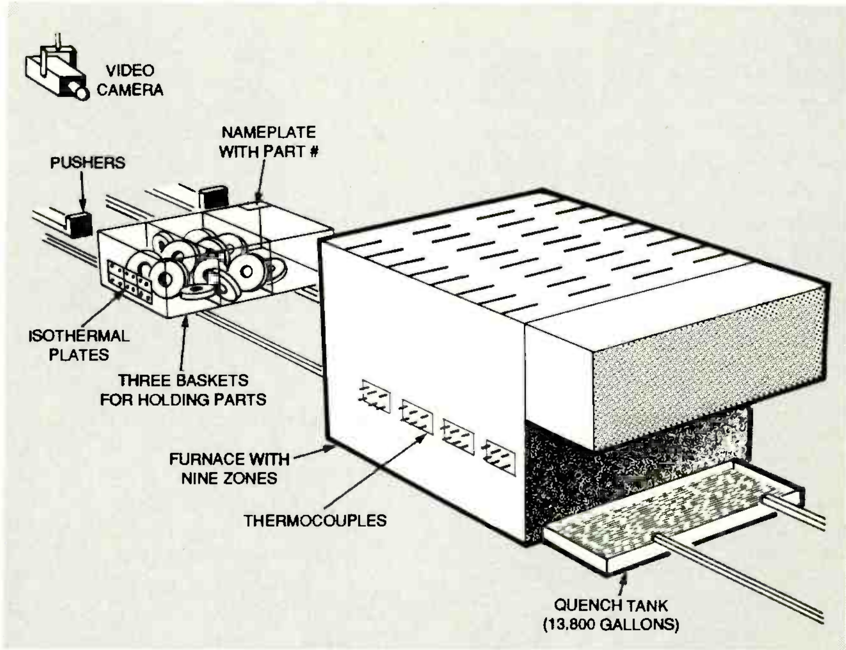


FIG. 8—THERMOCOUPLES MONITORING FURNACE TEMPERATURE. This is typical of how sensors are used to monitor industrial systems run by PLCs.

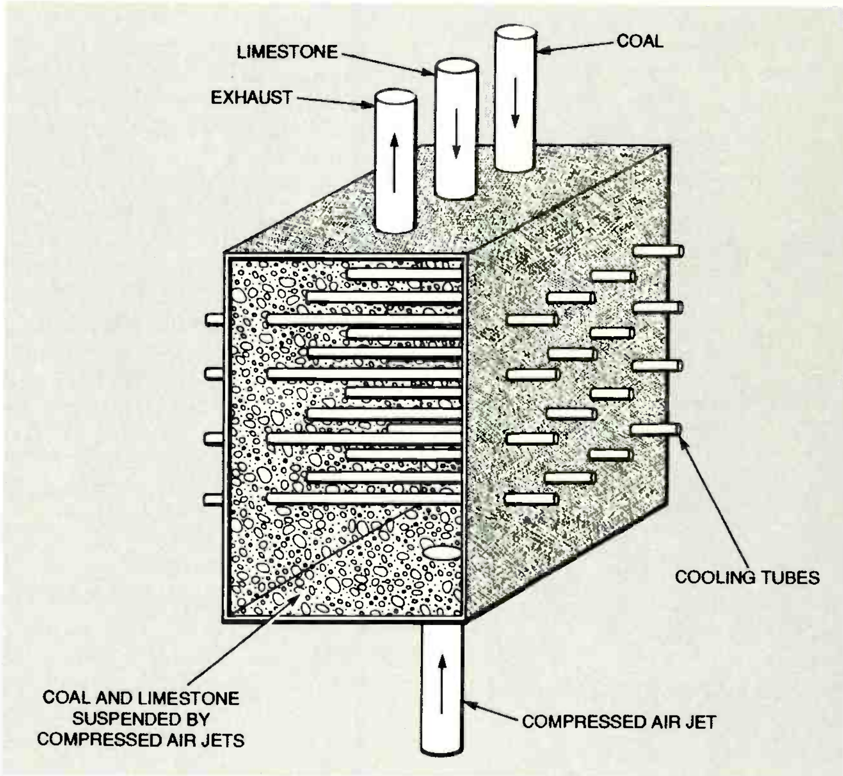


FIG. 9—CONSTRUCTION OF A FLUIDIZED BED COAL FURNACE. Thermocouples are positioned to monitor and control temperatures in the system.

Thermocouples at work

Thermocouples are self-powered, simple, inexpensive, rugged devices that are simply two conductors made of dissimilar metals, which are fused or bonded together to form a junction. Heating a thermocouple junction causes current flow in the conductors. Thomas Seebeck made this discovery in 1821 and the effect is named after him. Figure 8 shows how thermocouples with whiskers (exposed couplings for connections) are mounted in a typical industrial furnace. Figure 9 is a simplified diagram of a fluidized bed coal power plant. These installations can produce electric power from low grades of coal at high efficiency. The major advantage of these plants is that they can meet sulfur-dioxide emission standards without expensive pollution controls. Keeping these plants operating at proper temperature levels to minimize polluting exhausts is another application for thermocouple sensors linked to PLCs.

Aother place where thermocouples are used to monitor an industrial process is in the injection molding of plastic parts. Modern molds (see Fig. 10) use heaters and thermocouples in each runner to insure that the plastic in this area stays molten so the finished product has a smooth surface. PLCs often use thermocouple signals to monitor industrial processes.

Strain gages in industry

Product liability has made it vital for manufacturers to test products extensively, looking for dangerous weaknesses. Strain gages are common devices used for testing the mechanical qualities of products. In use they provide a measurable variation in resistance that is proportional to the applied mechanical stress. There are four basic types of strain gages: piezoresistive or semiconductor; carbon resistive; bonded metallic wire; and foil resistive. The most popular strain gage is the bonded metallic-wire device. It consists of very fine wire or foil bonded to a backing carrier. Figure 11 shows what some of the devices look like. The resistance of the gage varies linearly with applied force.

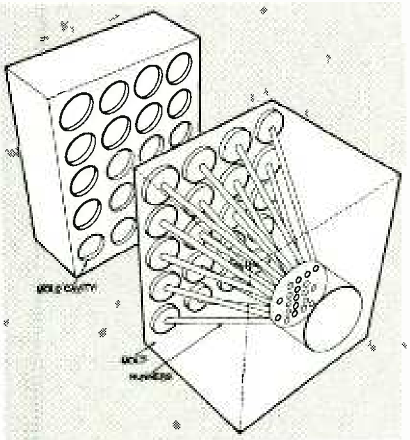


FIG. 10—PLASTIC INJECTION MOLDING SYSTEM. Thermocouples are installed in the injection tubes to monitor and control material temperatures.

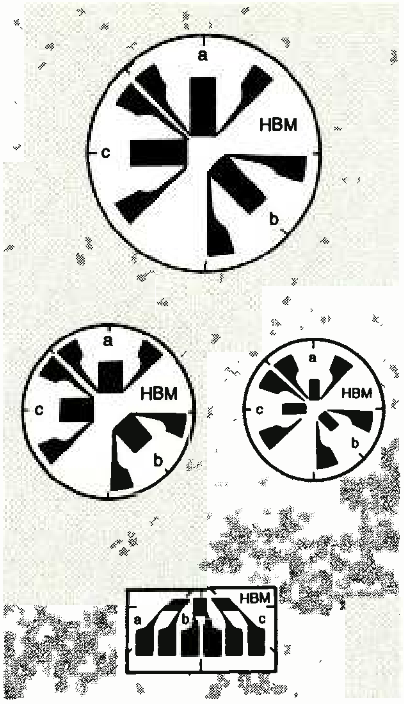


FIG. 11—FOUR DIFFERENT VARIETIES of bonded metallic-wire strain gages.

How PLCs handle sensor data

The processor in the PLC understands only digital signals. That's why some kind of data conditioner must be used to convert continuously variable inputs from a variety of sensors into two-state GO or NO-GO signals. An analog-to-digital A/D converter is commonly used to do this job. When used as an I/O device for the PLC, it compares a fixed operator-set voltage against some incoming variable voltage from an analog sensor. If the variable voltage rises above or drops below the preset comparison value, the A/D converter changes state. Figure 12 shows how it works. Whenever the input sensor signal rises above the operator-set threshold of 6 volts, the A/D output changes states from a logic 1 to a logic 0. Similarly, if the sensor input falls below 6 volts, the A/D again changes states.

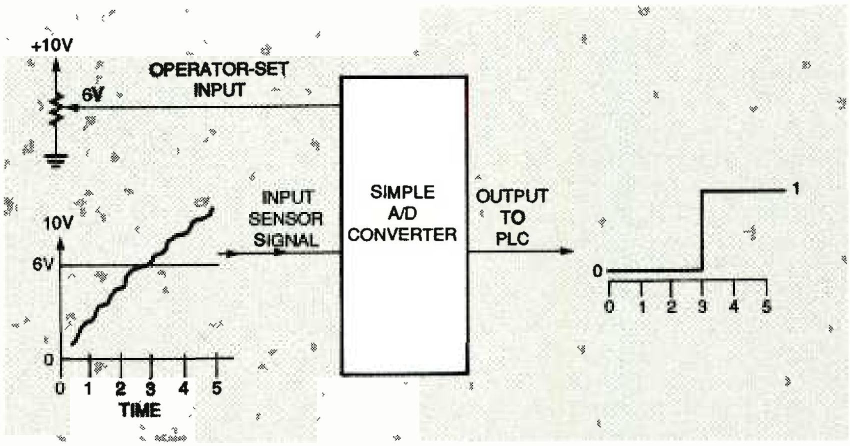


FIG. 12—BASIC EXAMPLE OF A/D CONVERSION as it might be used in an industrial application.

A newer form of A/D converter changes the variable input voltage into a digital value that corresponds to the applied voltage level. When the converted signal is fed to the PLC, the controller initiates a mathematical comparison to determine if the value is over or under the preset threshold. Programmable thresholds are what makes it possible to make measurements during a process that controls length, weight, or physical size.

One example is shown in Fig. 13. This is a sketch of a PLC controlling the filling of containers of various sizes. A series of containers in a variety of sizes makes its way down a conveyer belt. An optical sensor determines the size of the next container and tells the PLC to fill it to capacity. Let's assume that the cylinders hold 1 pound, the cones hold 1.5 pounds and the boxes hold 2 pounds of material. When the optical sensor tells the PLC that a conical container is ready to be filled, an internal PLC weight threshold is set to 1.5 pounds. Next the PLC energizes the solenoid to open the hopper until the A/D output reaches 1.5 pounds. At that point the PLC closes the hopper solenoid and the conveyor motor is turned on long enough to move the next container to be filled into place. This procedure continues until the system is shut down.

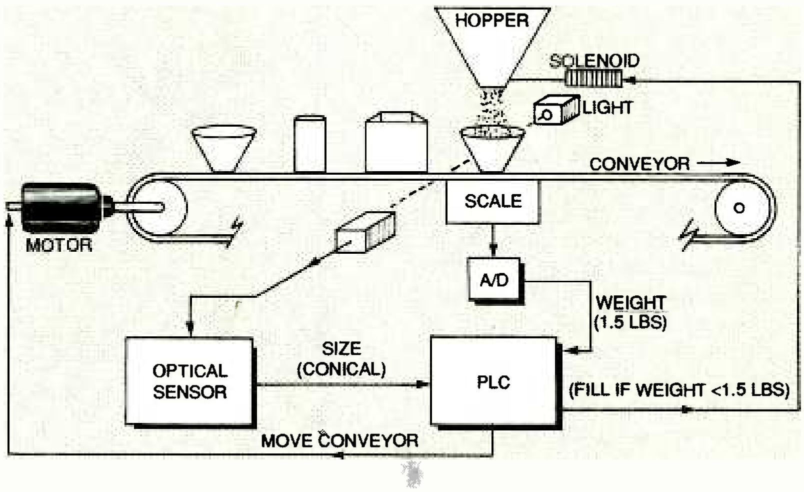


FIG. 13—VARIETY OF CONTAINERS are automatically filled. PLC is connected to an optical sensor and an A/D converter to be able to do this automated task.

Optical sensors

In Fig. 13, we introduced an optical sensor. These devices are used to count, determine color and consistency, and to also determine position and size of a variety of objects. They can provide digital ON/OFF outputs or linearly variable values, depending upon how they are set up. In Fig. 13, the optical sensor (often called an optosensor) produces three outputs, one for each shape of container.

Two types of optosensors are shown in Fig. 14. These are sophisticated light sensors that have built-in electronics. The first one, Fig. 14-a, is a fiber-optic through-beam sensor. It transmits light from the projector to the receiver. This type of sensor provides reliable detection of opaque objects. Another sensor, a diffuse-reflected light sensor, again with a built-in light source and receiver, is shown in Fig. 14-b. This sensor type detects scattered light reflected from an object. It works well for detecting transparent objects. Since it does not need a separate receiver or reflective backplane, wiring and installation are simplified.

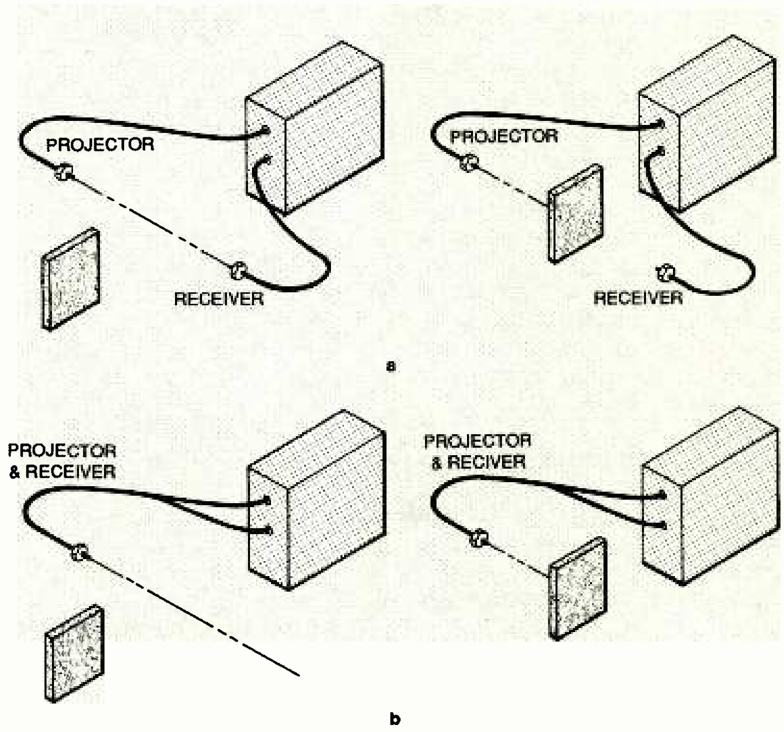


FIG. 14—TWO KINDS OF OPTICAL SENSORS. Through-beam sensor uses separate projector and receiver (a). Diffuse-reflected light sensor combines projector and receiver into one unit (b).

By this time you should have a good picture of how PLCs together with appropriate sensors are used to control industrial processes. In our next article we will show you some simple potential problems that can crop up when PLC's are part of a manufacturing operation. When a problem shuts down a factory line with a programmable controller, industrial technicians are under tremendous pressure to isolate the problem and fix it so that the system can get up and running again. Fortunately, there are some tried-and-true troubleshooting techniques that can help you speed through a PLC shutdown so that you can track down and repair the problem to get the industrial process back on line.

Our next article will show you those techniques with the aid of some real-world examples of PLC problems and how they are solved. Ω

TIME-PERIOD ADAPTER

continued from page 40

component in this adapter.

DAC IC6 converts the 12-bit count stored in IC7 to a negative output current. That current is converted to a negative voltage by the combination of R13 and R14. The voltage is sent to a DMM at jack J2 over a twisted-wire pair terminated with a phono plug at one end and a suitable matching plug for the DMM at the other end.

Most microprocessor-compatible 12-bit DACs with on-board latches and references will work in this adapter. Either the AD667, DAC667, DAC811, DAC813, or AD3860 can be substituted for the AD567 specified. All of these DACs have pin-out schemes that differ from that of the AD567, but they all have the same power requirements. Refer to the appropriate manufacturer's specification sheet or data book if you wish to make a substitution for the AD567.

Building the adapter

Refer to the parts placement diagram, Fig. 2. The author built the entire circuit on a rectangle of standard perforated board that measured 3 by 4 inches. The holes are 0.10-inch apart on centers, and the board had foil pads and power buses. Point-to-point wiring of components on a perforated board is preferred to printed-circuit board construction in this project because it permits components whose spacing is critical to be placed closer together. This eliminates long signal traces that would be susceptible to noise and coupling.

Before beginning any assembly work, drill the mounting holes in the four corners of the circuit board, and make a paper template of the hole spacing for later transfer to the base of the project case as a hole-drilling pattern or template.

Begin circuit construction by inserting and soldering the six DIP sockets in the positions shown on Fig. 2. Insert and solder IC4, the 78L05 voltage reg-

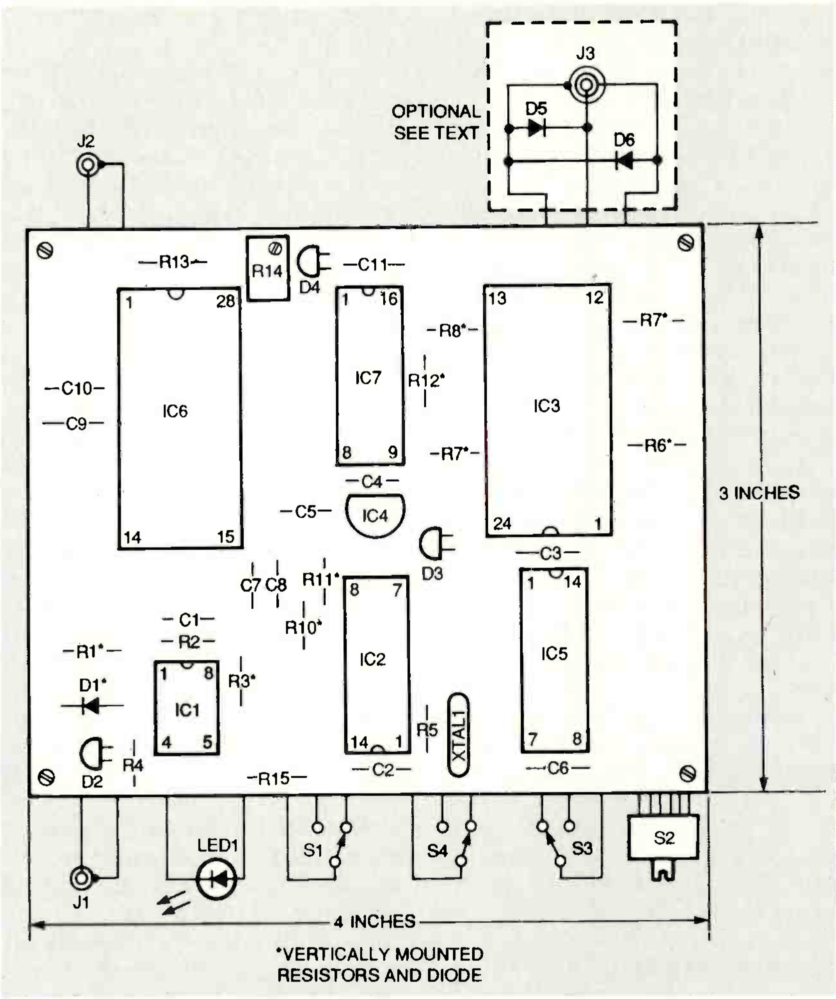


FIG. 2—PARTS PLACEMENT DIAGRAM. Panel-mounted components are shown schematically outside of the circuit board outline.

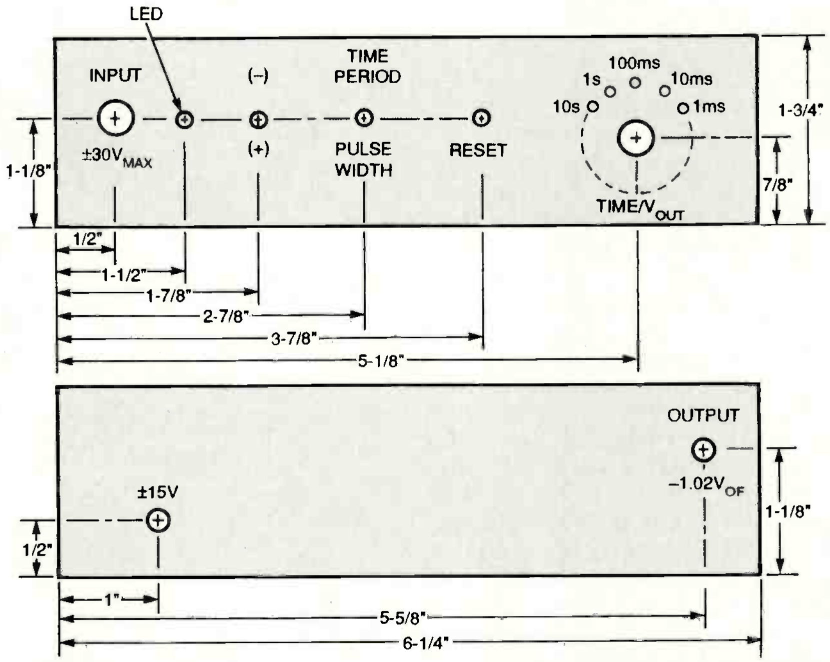


FIG. 3—HOLE DRILLING AND LABEL location diagram for the specified project case.

ulator at the center of the board. Fan-out the ground and +5-volt buses to the other IC sockets in a star-shaped pattern.

Insert and solder all resistors, capacitors and TO-92-packaged diodes. (You might want to mount some resistors vertically to conserve circuit board space and keep interconnections as short as possible. Asterisks have been placed on parts placement diagram Fig. 2 to indicate the resistors and one axial-leaded diode that the author mounted vertically.)

Make all wired connections with No. 22 AWG insulated solid hookup wire. Keep all leads as short and direct as possible. Also, isolate the AC signal leads from each other. The suggested component layout in Fig. 2 effectively accomplishes this for you.

To obtain the best adapter performance, make up an input feed cable from a 2-foot length of RG-174 or RG-58 coaxial cable terminated with a BNC male plug on one end and two suitable clip-on connectors at the other end.

Mechanical work

A standard, off-the-shelf, or catalog two-piece aluminum project case was selected for this project. It measures $6\frac{1}{4} \times 3\frac{3}{4} \times 1\frac{7}{8}$ inches. (Note: If you intend to put the power supply inside the case, select a larger case than the one specified to contain the additional circuitry without crowding.) Refer to the hole-drilling and label diagram, Fig. 3. Carefully lay out, centerpunch, and drill or form all the holes in the front and back walls of the project case base for the panel-mounted switches, jacks and LED.

Drill the hole for the LED carefully to a diameter so that the T-1 lens can be press-fit from the back side of the panel and will remain securely in place. All other hole diameters will be determined by the outside diameters of the bushings of the threaded, panel-mounted components. Tape the paper circuit board hole-drilling template to the bottom of the case and centerpunch and drill the four holes in locations as shown in Fig. 4.

When you have drilled or formed all of the mounting holes, you might want to label the functions of the switches with transfer letters or another suitable marking technique. Refer to hole -drilling and label guide Fig. 3 for suggested labels and locations.

Final assembly

Refer to assembly diagram Fig. 4. Insert and fasten all panel-mounted switches, jacks, and LED. (The author selected a blue-light-emitting diode because of its pleasing appearance, but a LED of any other color will work just as well.) Fasten ¾-inch standoffs to the underside of the circuit board at all four corners with screws. Solder all wired interconnections at the component end that will connect between the switches, jacks, and LED and the circuit board.

Note: If you intend to use an external power supply, mount diodes D5 and D6 directly on the power input jack J3, as shown in parts placement diagram Fig. 4. However, if you plan to put the power supply in the project case, those diodes will not be needed.

Switches S1, S3, and S4 can be connected to the circuit board with No. 22 AWG solid, tinned hookup wire. Connect rotary switch S2 with No. 22 AWG stranded copper wire twisted into pairs to resistors R6, R7, R8, R9 (all were mounted vertically in the prototype) and a short length of RG-174 or RG-58 coaxial cable (shield grounded at one end) to resistor R12.

Keep the leads from the circuit board to the switches and jacks as short as possible. Solder all leads to the circuit board before fastening the board to the base of the case with screws Attach the knob to the shaft of rotary switch S2.

After the wiring is complete, carefully check all wiring and soldering to verify that there are no inadvertent solder bridges or cold solder joints. Verify that all polarized components are oriented correctly, as shown on the schematic, Fig. 1.

When you are satisfied that your wiring is correct, install the DIP-packaged integrated circuits in their designated sockets. Caution: IC2, IC3, IC5, and

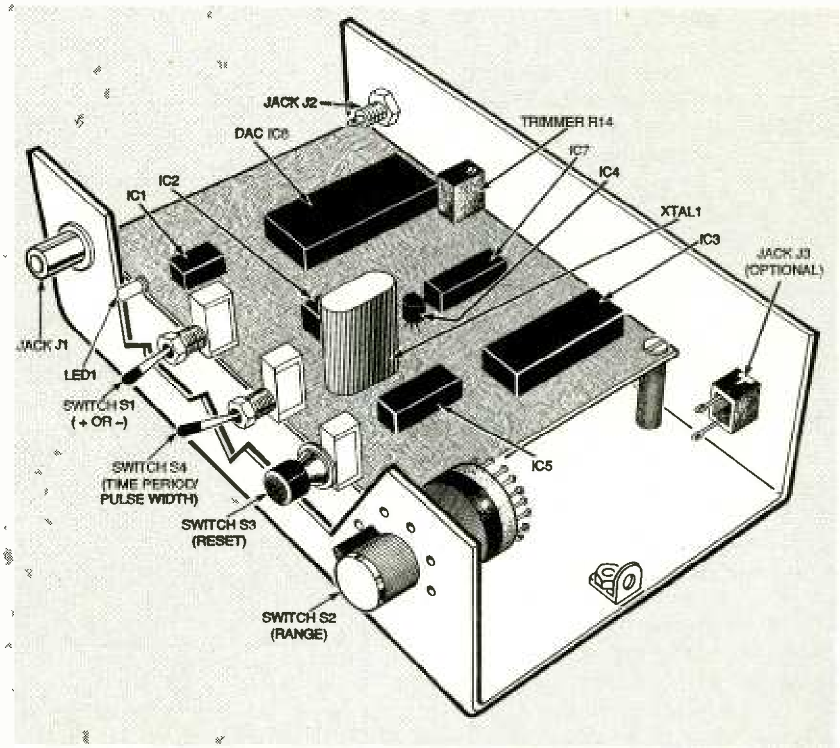


FIG. 4—ASSEMBLY DIAGRAM showing the location of principal components.

IC7 are CMOS devices subject to damage or destruction by electrostatic discharge (ESD). Wear a grounded wrist strap when removing these devices from their containers and placing them in the appropriate DIP sockets.

Calibrating the adapter

Turn on the ±15-volt dual power supply. Set switch S4 to TIME PERIOD. Turn the knob of switch S2 to 10 ms/volt. Introduce a 6.3- to 12.6-volt 60-Hz signal to jack J1 from a low-voltage filament transformer or a signal generator. Set the selector switch of your digital multimeter to the 2-volt range, and plug the DMM into the adapter.

The period of a 60-Hz signal is 16.7 milliseconds, so the output of the DMM will be in an overrange condition. Adjust calibration trimmer potentiometer R14 on the adapter circuit board so that display of your DMM shows −1.0240 volts. This procedure sets the output for exactly −0.5 millivolts per step of digital to analog converter IC6.

Select the 100 millisecond per volt (ms/V) setting on rotary selector switch S2. A reading of −0.167 volts should appear. This equals 16.7 milliseconds, the period of the waveform. Note: If you still get an overrange reading, temporarily attach (with clip leads) a capacitor with a value between 100 and 500 pF in parallel with 680-pF capacitor C8 to see if the desired reading appears. It might take a few trials to find just the right value. When the right value is found, solder it in place.

If the DMM reading scrolls, follow the same procedure described for capacitor C8 to the 0.001 μF capacitor C7. When the scrolling condition is corrected, solder that corrective capacitor in place. (This procedure should not be necessary if IC2 is a high-quality device.) If either condition cannot be corrected, replace the CD4096UB with another one made by another manufacturer.

Putting the adapter to work

You will find the Time Period Adapter is easy to use. Simply introduce any waveform you want to measure, select TIME PERIOD or PULSE WIDTH with panel-mounted toggle switch S4 and select positive (+) or negative (−) (for pulse direction) on panel-mounted toggle switch S1. Then set rotary range selection switch S2 to the highest range obtainable before an overrange at −1.024 volts. The adapter will reset automatically after every cycle, but RESET switch S3 overrides all other functions.

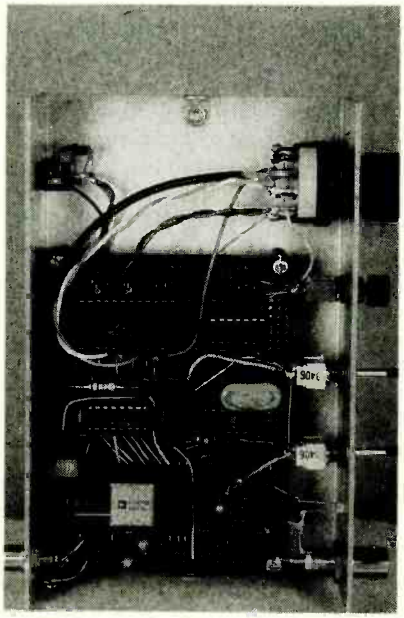
The RESET function is handy for long-time-period or single-event measurements. Push the RESET switch before introducing the input signal. The PULSE

PARTS LIST

All resistors are ¼-watt, 5 %, unless otherwise specified.
R1—39,000 ohms
R2—33,00 ohms
R3—1000 ohms
R4, R6, R7, R8, R9, R10, R11—10,000 ohms
R5—10,000,000 ohms
R12—5100 ohm
R13—499 ohms, ¼-watt, 1%, metal film
R14—1000 ohms trimmer potentiometer, cermet, multiturn, Bourns No. 3299 or equiv.
R15—220 ohms
Capacitors
C1, C9, C10—1μF, solid tantalum electrolytic
C2, C3, C4, C6, C11—0.1 μF, monolithic ceramic
C5—10 μF, solid tantalum electrolytic
C7—0.001 μF, ceramic disc, 10%
C8—680 pF, ceramic disc, 10%
Semiconductors
ICI—LM311, comparator, National or equiv.
IC2—CD4069UB, CMOS hex inverter, Harris or equiv.
IC3—CD4059A, CMOS programmable divide by "N" counter, Harris or equiv.
IC4—78L05, 5 volts, 100 mA voltage regulator
IC5—CD4013B CMOS dual D-type flip flop, Harris or equiv.
IC6—AD567 12-bit digital-to-analog converter, Analog Devices or equiv.
IC7—CD4040B CMOS 12-stage binary counter, Harris or equiv.
D1—1N4148 silicon switching diode
D2, D3, D4—MBD301 Schottky hot-carrier diode, Motorola, NTE583, or equiv.
D5, D6—1N4001 50 volts, 1 amp, silicon rectifier (optional, see text)
LED1—light-emitting diode, blue, silicon-carbide (see text)
Other components
XTAL1—2.000-MHz quartz crystal in a metal case
S1, S4—toggle switch, SPDT, 1 amp miniature, panel mount
S2—rotary switch, 2-pole, 5-position, miniature, non-shorting, panel mount
S3—pushbutton switch, SPDT, 1 amp momentary, panel mount
J1—jack, BNC panel mount w/ plug
J2—jack, RCA phono, panel mount w/ plug
J3—jack, ⅛-inch phono, 3, conductor, panel mount w/ plug.
Miscellaneous: perforated circuit board w/ foil pads (see text); aluminum project case, Ten-Tec TG-26 or equiv. (see text); DIP sockets: one 28-pin, one 24-pin, one 16-pin, two 14-pin, one 8-pin; insulated solid copper hookup wire, No. 22 AWG; insulated stranded hookup wire No. 22 AWG; 50-ohm coaxial cable (RG-174/RG-58) (see text); standoffs, ¾-inch; screws and nuts, knob for rotary switch, solder.

Optional power supply
Resistors
R1, R2—5600 ohms ¼-watt, 5 %
Capacitors
C1, C2—470μF, 35 volts, aluminum electrolytic
C3, C4,—0.1 μF, 25 volts, monolithic ceramic
Semiconductors
IC1, IC2—78L15 15 volts, 0.1 amp voltage regulator, National or equiv.
BR1, BR2—bridge rectifier, 1 amp, 50 PIV, DF01M or equiiv.
LED1—light-emitting diode, red, T-1 case
LED2—light-emitting diode, yellow, T-1 case
Other components
S1—DPDT toggle switch, 1 amp, miniature, panel mount
J1—phone jack, ⅛-inch, 3-conductor w/plug (optional)
T1—transformer, dual 15-VAC, 0.2-amp secondary, split bobbin, PC mount Prem No. SPW-111 or Triad No. FP30-200 or equiv.
Miscellaneous: perforated circuit board (see text); aluminum project case (see text); panel mount AC line plug; hookup wire No. 22 AWG; screws and nuts, solder.

WIDTH option on switch S4 is intended only for rectangular pulses because the 0.9-volt reference will not permit accurate measurements of sine, triangular, or similar waveforms unless the TIME PERIOD function is toggled on S4.



THE PROTOTYPE ADAPTER was built using point-to-point wiring.

Dual power supply

If you do not have a suitable ±15-volt power source, you can build the circuit whose schematic is included in this article. This supply can be built by point-to-point wiring on a 2×3-inch piece of perforated circuit board following accepted practice. It can be mounted within the project case on appropriate standoffs, or it can be packaged in a small project case for AC-line outlet mounting.

The author packaged the completed circuit board in a two-part aluminum project case that measured 1½₂×4 inches with an external, two-prong AC line plug mounted on the outside. Ventilate the case by drilling a series of holes in the top cover of the case. A pattern of holes ⅛-inch in diameter covering about 1 square inch in the center of the cover will be satisfactory. Alternatively, place a factory-made perforated or screen cap about 1-inch in diameter over a 1-inch diameter hole formed in the cover. Ω

METROLOGY LAB

continued from page 70

A bit of practice

There are many uses for your new null detector, but as a warm up for Part 3 of this series, you might like to investigate resistor stability. Build the Wheatstone bridge shown in Fig. 7 on a scrap piece of perfboard. Use a multi-turn potentiometer, or the bridge will be impossible to zero. This is a comparison bridge for resistors of close value—10 kilohms in this case.

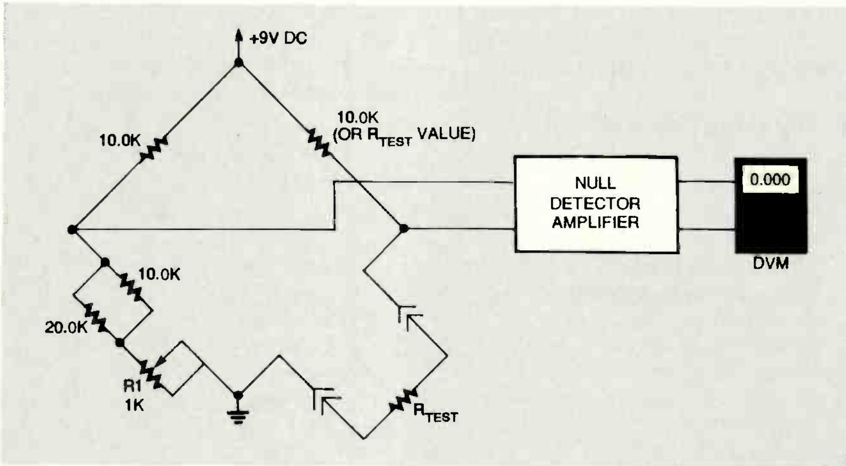


FIG. 7—THIS COMPARISON BRIDGE will let you get started with your null detector.

Now, find as many different kinds of 10-kilohm resistors as you can. be able to compare resistors of the same type, but made by different manufacturers.

One by one, install them in the bridge and zero it. Notice the change in value as you warm them slightly with your fingers, or a hot air gun. Don't warm the bridge, because we don't know anything about the components used to build it. Also, try to detect the difference between thermal EMF errors caused by heating one end of the resistor, vs. the whole body. Try soldering a piece of wire near the resistor body and see if there is a permanent change in value.

You can also test the stability of a trimmer potentiometer compared with a fixed resistor.

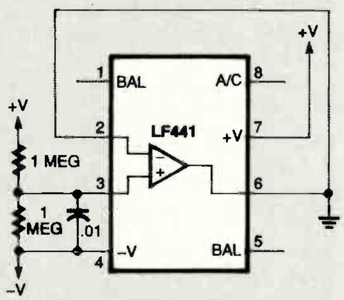
You will quickly learn that all resistors are not the same, and you will have a better understanding of how to choose from the various types. You may even conclude that passive components aren't all that passive!

This little resistor exercise should get you ready for the next project, which is a Kelvin-Varley voltage divider. Ω

MAKING YOUR OWN RAIL SPLITTER

The TI2426 "rail splitter" virtual-ground IC makes it possible to run the null detector from a standard 9-volt battery. Although it would be possible to use a voltage divider built from passive components to create a dual power supply, any practical resistor values would cut battery life dramatically.

The Texas Instruments "rail splitter" is just a high value voltage divider with an op-amp follower to provide a low impedance ground. It is possible to do the same thing with discrete parts, but you'll sacrifice board space because you won't be able to fit it all in a nice TO-92 transistor case!



The circuit shown here should work fine. You must use a low-power op-amp, of which there are many to choose from. The National LF441 is a good, inexpensive choice (don't confuse it with the 411). Pin 6 is the virtual ground "output".

This circuit will work correctly down to a battery voltage of about six volts. The current consumption is about 160 microamperes.

BY JEFF HOLTZMAN

The spinal column of civilization

SUPPOSE YOU WERE 25 YEARS OLD IN THE YEAR 4 BC. AT THAT TIME, YOU COULD NOT KNOW THAT BY THE TIME YOU WERE THIRTY, SOMETHING WOULD HAPPEN THAT WOULD CHANGE THE WORLD. By the time you were 40 (or 50 or 60) you would know that something had happened back then, something big, something important. Maybe you'd wish you had paid a bit more attention to what was going on, that you had taken notes or kept a diary. The world changed right under your nose, and you hardly even noticed.

Some people believe we are living in another such era, undergoing the same type of momentous change. If so, what is the critical event? The invention of the microprocessor? Semiconductor memory? Semiconductors in general? Information theory? The personal computer? Broadcast television? Hypertext? Photolithography? Phototypesetting? Ethernet? Xerox PARC? MIT's Media Lab? The Internet? Perhaps something that hasn't even happened yet?

In that light, what year is it? Is it –4 or 0 or +50 or something altogether different?

Have the biggest changes occurred already? Or is what we've seen until now only a prelude for the real event?

No one can answer those questions yet. But according to some people, "it" is the Internet. And there are compelling reasons to accept the conclusion, if not the reasoning. For example, if you view civilization as a living organism, you could view the Internet as the spinal column of that organism, enabling communications among the sensory functions, the motor functions, the food processing and waste-disposal units, and so on.

However, the Internet is undergoing rapid evolution. What we know and understand about it today differs radically from what we will know and understand about it tomorrow.

At one end of the spectrum lies the view that the Internet, and a simple "thin client," which is like a miniature solid-state dumb terminal using a TV for display, will completely replace today's current computing infrastructure. The thin client will provide just-in-time computing, delivering both program code and data on an as-needed basis. The thin client will have no persistent storage (hard disk). Everything will be stored on the net. The thin client hardware will require no configuration or maintenance. You'll just plug it in and use it. No RAM upgrades, no CPU upgrades, no operating system upgrades, no running out of hard disk space.

The software, on the other hand, will automatically be upgraded every time you log on or run another application. Egghead Software, along with all the other distributors and middleman in the supply chain, will go out of business. And Microsoft? With millions of socially responsible and politically correct Netizens out there doing development on the net, there won't be a need for Microsoft or any other commercial vendor.

Money will be made by selling client hardware, by providing physical connections (like the phone company) and "air time" (like CompuServe, but in new ways, priced perhaps by bit or by packet or by transaction), by selling advertisements, by selling traditional goods and services, and in other still-undefined ways.

Virus writers will have a field day finding new ways to infiltrate the upload/download process. That in turn will spur business for anti-virus writers.

Consumers will use thin clients and the Internet for E-mail, shopping (maybe), game-playing, and perhaps the occasional on-line search for hot vacation spots or homework help for the kids.

Business will adopt the technology even faster than consumers. That way it can dispense with information service departments, programmers, technicians, and so on. About all they'll need will be the equivalent of telephone-repair personnel to keep the net pathways operational. Businesses won't have to agonize over upgrading to Windows 95 or NT. They won't have to worry about three-year hardware obsolescence cycles, RAM upgrades, CPU wars, or anything else of the sort. At long last, the computer infrastructure will become transparent, like plumbing and wiring. Its absence will be noticed, but under normal circumstances, most people won't think twice about it.

On the other hand . . .

That's one vision. It's an only slightly hyperbolized description of what the anti-Wintel coalition (the Microsoft/Intel haters) wants to see. Some parts of it are appealing; others, it seems to me, ridiculous.

The real problem I have with that vision is its lack of regard for momentum. As Newton taught, momentum is what causes a body to continue moving in one direction at a constant rate unless it is disturbed by some force. And the momentum of the personal part of the computer industry up till now is incongruent with the direction forecast by the anti-Wintel crowd. In these terms, the question is whether the combined forces represented by 1) the anti-Wintel crowd, and 2) popular interest in the Internet is sufficient to significantly alter the trajectory of the PC industry.

I think not. I think that there will be a jolt as the gravitational fields of these two masses interact, and that the courses of both will be changed. But there are many other forces at work that serve to cloud the issue and make the outcome less than certain. For example, the video game industry could easily co-opt the hypothetical thin-client market.

There is also a high degree of functional overlap between thin-client, cellular, and PDA technologies, none of which has begun to seriously consider convergence among voice, video, fax, E-mail, and general binary data communications. In this context, thin-client technology may be a stopover on the way to a more general solution to a communications problem, not a data-processing problem.

Perhaps there is no general solution. Look at how pagers, beepers, cellular phones, cellular modems, portable phones, IR and RF-based computer networking equipment all meet separate needs, even though they have much in common functionally and technologically. Perhaps we're doomed to a future in which everyone will have to tote a briefcase full of devices for sending and receiving data in various formats to and from various systems.

That might not necessarily be bad, if those devices were designed in an integrated, cooperative manner, such that they used the same user interface, operating procedures, power connector, database format, etc.

Bottom line: Is there room for a low-tech quasi-computer quasi-communicator? Probably. Will it displace existing infrastructure? Only at the very low end. Don't sell your PC yet.

Bookshelf

If you're interested in using computer graphics for the purpose of visualizing data, spend 20 minutes with *Visualization*, subtitled *Using Computer Graphics to Explore Data and Present Information*. The book is full of full-color illustrations that may spark ideas about ways to represent the data that is important to you. The illustrations cover many fields, ranging from medicine to finance to CAD to weather to topography to visual programming. The text is simple-minded. For example, page 151 of the book summarizes the origin and history of GUI's in four loosely written paragraphs. There is nothing on semi-structured data visualization, a topic I am particularly interested in. The book includes a CD with additional images and QuickTime animations. At about $50, this is an expensive book with a guaranteed short shelf life. Save your money and browse it at the bookstore or library.

If you don't "get" user interface design, get out your checkbook and buy a copy of *About Face*. The author is Alan Cooper, who is credited with the design of Visual Basic. In some 550 pages of very readable yet hard-hitting text, Cooper presents numerous user-interface design axioms, critiques existing software programs, and offers advice on everything from menu and dialog-box design to a consideration of explicit vs. implicit file save mechanisms. Cooper codifies and explicates many concepts and practices that I have believed and used intuitively over the years, so I have a special fondness for the book. In fact, it's the kind of book I wish I could say I had written. One interesting concept is that of the software designer. Cooper says,

Most artifacts of the mechanical age are designed by professionals. Our cars are designed by trained, professional automobile designers, not by mechanical engineers. Our houses are designed by professionally trained and certified building designers—architects—not by structural engineers. . . . Programmers, deep in their thoughts of algorithms and coding arcana, design user interfaces the way miners design the landscape with their cavernous pits and enormous tailing piles. The software design process alternates between the accidental and the nonexistent. . . . There is a conflict of interest in the world of software development because the people who build it are also the people who design it. If carpenters designed houses, they would certainly be easier or more interesting to build, but not necessarily better to live in. The architect, besides being trained in the art of what works and what doesn't, is an advocate for the client, for the user. An equivalent role in the world of software has not fully developed yet. (pp. 22-3).

If your job involves software that interacts with users in any way, *About Face* can help you increase the quality of that interaction by orders of magnitude. Highly recommended.

Visio Technical Version 4

Visio is a stencil-based drag-and-drop "drawing" program for inartistic people who nonetheless need to create computer graphics. I have loved the *design* (in the sense used above) of Visio ever since Version 1, and the latest version is even better. Visio is sold in several levels, with Visio Technical at the high-end. The program includes literally thousands of what the company calls *SmartShapes*, which are like CAD symbols with intelligence. Visio Technical can also read, write, and annotate AutoCAD files.

This version also includes extensive support for OLE Automation, which allows you to control the program from your own programs written in C/C++, Visual Basic, Delphi, or what-have-you. Thus, although Visio still has no autorouter, it's conceivable that you could write one yourself by extracting net list information from a Visio file, crunching it, and then using the Visio drawing engine to create multi-layer board layouts.

Even for run-of-the-mill design specs, block diagrams, and conceptual documentation, as well as network layouts, space planning, and electrical/electronic schematic capture, Visio is a fantastic value. Also highly recommended.

E-mail

Jim Brain uses "obsolete" Commodore machines for varied functions, and says that a Commodore "is an ideal computer to experiment with, since an engineer can 'know' it, unlike new technologies. Sitting next to me now is a robot with a CBM brain . . ." Jim maintains a wealth of free info for Commodore owners at http://www.msen.com/~brain/cbmhome.html. (Note that there is a tilde after the slash and before "brain.")

Send your comments to me at jkh@acm.org. EN

VIDEO NEWS

continued from page 6

copying. Several groups are now studying various approaches, and most studios won't feel comfortable about any releases in the new medium until Congress acts to make digital video copy protection the law of the land.

That hasn't stopped manufacturers from making promises. Philips is promising DVD players under Philips and Magnavox brands in the U.S. before year-end. Toshiba was the first to announce products with actual model numbers and pricesfl$599 and $699. Thomson Consumer Electronics reiterated its promise to price one RCA-brand player at $499. (The player initially will be made for Thomson by Japan's Matsushita, and in exchange Thomson will supply Matsushita with Digital Satellite System receivers.) Sony, Pioneer, and others also have expressed plans to offer video players before the end of this year, but have not given proposed prices.

Warner Home Video, one of the prime movers in the DVD push, has promised to release digital discs day and date with VHS product, and, in addition, to release large backlogs of its older films. Columbia Tristar Home Video, owned by Sony, says it has earmarked 150 pictures for DVD release. Most other Hollywood studios have kept silent, several of them taking a wait-and-see attitude toward the system, pending development of anti-copy protection.

In the more distant future is a new music disc. The audio industry is reacting slowly, anxious not to damage sales of CDs with a lot of talk about a new system on the horizon. .

That extra link

The fastest growing—and most lucrative—segment of the direct-view TV market has been the 35-inch set, an area that was pioneered by Mitsubishi but has been increasingly dominated by Thomson Consumer Electronics, which makes RCA picture tubes and RCA, GE, and ProScan TVs. Thomson also sells TVs to other brands and retail outlets—for example, Sears' 35-inch model. The 35-inch tube is currently the biggest direct-view picture tube in general use. Mitsubishi does make a 40-inch tube, but it is quite expensive and bulky. Sony, known for its large-screen Trinitron TVs and a major competitor of Thomson, has suffered in the largest size categories because its biggest tube is 32 inches.

In response to demands from dealers to plug the hole in its line and block Thomson's dominance, Sony now has built a combination tube and TV set plant at its Pittsburgh-area manufacturing complex. The plant will turn out 35-inch product only for the time being. The unique plant will combine both TV and tube production in one assembly operation. In addition, it eventually will be able to call on the glass and the aperture grill for its tube from the same manufacturing complex.

Less than two weeks after Sony's announcement that it was graduating to the new size Trinitron, Thomson upped the ante by an inch, announcing that the 35-inch sets in its high-end ProScan line (which competes directly with Sony's high end) would switch from 35-inch to 36-inch tubes around midyear. What's more, Thomson said, the new tubes would have a finer pitch than conventional TV picture tubes, making them capable of displaying SVGA graphics.

Dual-deck VCRs

Almost all audio cassette recorders for home use now have double decks, so a dual-deck VCR would seem like a logical extension. But somehow the concept has never lived up to its advance billing. When the concept was first proposed almost a decade ago, the motion-picture industry was up in arms, fearing that it would lead to widespread piracy and violation of copyrights.

Then along came Go-Video, a small Arizona video software-production company, which tried to get Japanese manufacturers to make dual VCR decks for sale under its own brand. When there was widespread refusal, it filed antitrust suits against them. Eventually, Go-Video reached an agreement with Samsung to supply it with dual VHS decks. Those have gone through several generations of product, never being overwhelmingly successful. In 1994, Samsung's principal Korean competitor, LG Electronics, introduced its own GoldStar brand double deck, combining an 8mm deck with a VHS version—seemingly ideal for people who want to copy their camcorder tapes to VHS. That deck is being quietly closed out at $499.

Now Go-Video has a second supplier—Japan's Shintom, which will produce a low-end double deck for it starting around midyear. It will combine a two-head VHS videocassette player with a four-head mono VHS VCR, making possible the $399 price point that has eluded Go-Video to date. Go-Video's current three-model line sells at $499 to $799. EN

NEW PRODUCTS

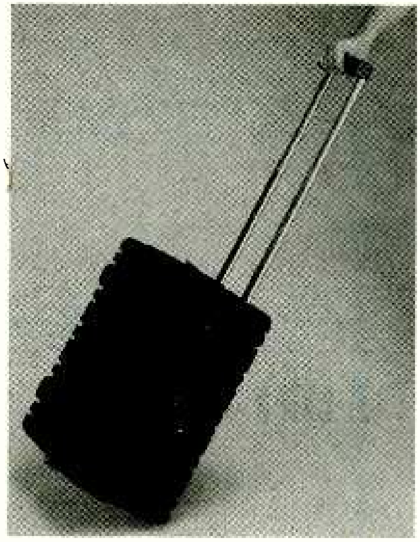
continued from page 16

TOOL KIT ON WHEELS

JENSEN TOOLS HAS PUT one of its best-selling tool kits into a case with wheels. The JTK-87WW, featuring a comprehensive selection of 109 quality tools for general electronic field service, is a welcome alternative to toting a 27-pound tool kit by hand.

The JTK-87WW features Jensen's unique "Roto-Rugged Tote Case." Four ball-bearing rubber wheels are recessed into its bottom. In addition, two "stair riders" make it easy to transport up and down steps. A telescoping handle extends to 41-$^1/_2$ inches for pulling. D-rings attached to the sides of the case accommodate a 72-inch bungee cord (included) for attaching extra luggage or equipment.

The Roto-Rugged case's shell is rotationally molded of virtually inde-



CIRCLE 26 ON FREE INFORMATION CARD

structible polyethylene. The seamless construction of rotational molding gives it great integrity, with uniform thickness in the walls and impact-resistant corners. The case has raised, reinforced ribs for added strength and a scratch-resistant, black pebble-grain finish. Other features include a full-width piano hinge on the lid, a padded steel-core handle, and two key-locking latches.

Inside, the case measures $17^3/_4 \times 14^1/_2 \times 8$ inches at its deepest point. It accommodates two removable pallets that hold most of the 109 tools, while leaving plenty of room for optional test equipment and spare parts. Outside dimensions fall within the carry-on limits of most airlines.

Tools include pliers, screwdrivers, soldering iron, hex key sets, alignment tools, punch tools, wire cutters, crimpers and strippers, a DIP/IC extractor, a feeler gauge, a file kit, and more. The tool complement is offered in a choice of inch or metric measures.

The JTK-87WW tool kit on wheels costs $659; in quantities of three or more, the price is $606 each.

JENSEN TOOLS INC.
7815 South 46th Street
Phoenix, AZ 85044-5399
Phone: 1-800-426-1194
Fax: 602-438-1690

EN

Q&A

continued from page 8

requires a lot of the energy to reproduce. (Little transistor radios get decent battery life because their audio contains very little bass.)

All of the power delivered to the speakers has to come from the batteries. Each TDA2006 can deliver as much as 10 watts. When it's doing that, your battery pack has to supply *at least* 20 watts, five watts from each of the four batteries. To deliver five watts, a 9-volt battery has to produce a current of 555 milliamperes . That's enough to run it down in a matter of minutes.

There *is* something you should check. With no audio input, how much current does the amplifier draw? It shouldn't be much more than 60 milliamperes per channel. If it is, you have an oscillation problem. To counteract oscillation, make sure that you've included a 1-ohm resistor in series with a 0.22-µF capacitor across the output of each TDA2006, and a 0.1-µF capacitor across the power supply pins; these components should be as close to the chip as possible.

Rather than use bigger batteries, you might want to build a line power supply. For guidance, see Radio Shack's book, *Building Power Supplies*

Complicated timer/controller

Q *I am trying to design and build a timer/controller with a programmable timer to allow it to activate at 4 or more selected times of day. I would also like the controller to respond to light (sunrise and sunset), and I'd like to remotely activate it from a distance of 500 yards. Can you recommend a set of ICs and a schematic that will produce these results? — D. R., Houston, Tex.*

A You don't need a *circuit*, you need a *computer*. That is, the way to build your timer/controller is to write a suitable program for a microcontroller.

A microcontroller is a one-chip computer which you program by connecting to your PC. Once programmed, the microcontroller runs on battery power with just a few support components. Many microcontrollers include analog-to-digital converters (to which you could connect a photocell); all of them have digital output ports that can control relays, motors, and the like.

The easiest microcontroller to get started with is probably the Parallax "BASIC Stamp," described in Don Lancaster's column in this magazine in several recent issues (starting May 1995). It costs $29 and is programmed in BASIC. The manufacturer is Parallax, Inc., 3805 Atherton Road, Rocklin, CA 95765. If you can handle assembly language, you may prefer a PIC from Microchip Technology or a Philips 87C750, each of which costs only a few dollars.

Your 500-yard remote-control requirement is tougher. Can you use a long cable? If so, an RS-232 link to a PC, at a low baud rate, should work fine. (You may prefer to do *all* the controlling this way so that your device doesn't need a keypad or display.) Radio control is not so easy; nobody has come up with cheap and easy homebrew radio modems yet, but we can always hope.

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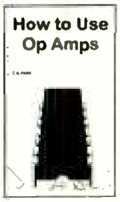
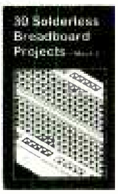
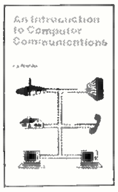
Electronics Paperback Books



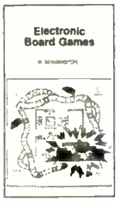
☐ **BP88—How to Use OpAmps...$5.95.** A designer's guide that covers operational amplifiers. Serving as both a source book of circuits and a reference book for design calculations. The text is non-mathematical and easy to understand by most readers.



☐ **BP113—30 Solderless Breadboard Projects-Book 2...$5.95.** Companion to BP107. Presented in exactly the same style using "Verobloc" breadboards. All the breadboard projects in this book are based on CMOS logic integrated circuits.

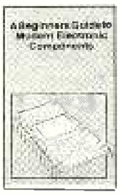


☐ **BP177—Introduction to Computer Communications...$5.95.** Details on types of modems and their suitability for specific application, plus details of connecting various computers to modems, and modems to the telephone system.

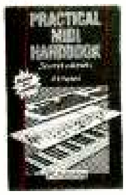


☐ **BP350—Electronic Board Games...$6.00.** Twenty novel electronic board games that you can build from the plans in this book. Some games are motor racing, searching for buried treasure or for gold in Fort Knox, — there is something for you to build and enjoy!

☐ **BP61—Beginners Guide to Digital Techniques...$5.00.** Covers the basics of digital techniques—decimal, binary, octal and hexadecimal numbering systems are covered plus insights on weighted and non-weighted binary-coded-decimal codes and alphanumeric codes. The basic building blocks of circuit logic, the common AND, OR, NAND, NOR and EXCLUSIVE-OR gates and bi-stables are thoroughly covered.

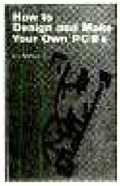


☐ **BP285—A Beginners Guide to Modern Electronics Components... $6.50.** It is easy for newcomers to electronics to become confused. There are a great many different types of components available often with numerous variations of each type. This book presents the reader with a vast amount of invaluable parts information to enable the right component to be selected every time for repairs and projects.



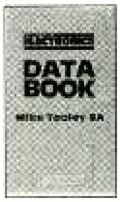
☐ **PCP103—Practical MIDI Handbook...$9.95.** The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding. This book is aimed at musicians and technicians who want to explore the vast capabilities of MIDI. It covers MIDI-based equipment you can use: keyboards, drum machines, sequencers, effects units, mixers, drum pads guitars. There's also a section on computer music.

☐ **PCP119—Electronic Music and MIDI Projects...$14.95.** Save cash by building the MIDI gadgets you need. Want a MIDI Thru box, program change pedal, Metronome, analog echo unit? Over 16 practical and very useful music and MIDI projects.

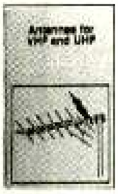


☐ **BP121—How to Design and Make Your Own PCBs...$5.75.** Simple methods for copying printed-circuit board designs from magazines and books on to copper. Covers all aspects of simple PCB construction as comprehensively as possible.

☐ **BP44—IC 555 Projects...$5.95.** Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer integrated-circuit chip is one such device. Included are basic and general circuits used by most hobbyists.

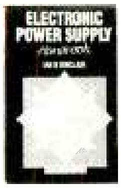


☐ **PCP109—Everyday Electronics Data Book ... $10.00.** An invaluable source of electronics information—the text contains sections that deal with the underlying theory of electronic circuits and a wide range of practical electronic uses for everyone.

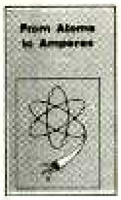


☐ **BP301—Antennas for VHF and UHF...$6.00.** From installing a TV or FM antenna to setting up a multi-antenna array for shortwave listening or amateur radio, this book explains the basics of VHF and UHF antenna operation and installation. The text describes in easy-to-understand terms the essential information about how antennas work, the advantages of different antenna types, and how to get the best performance.

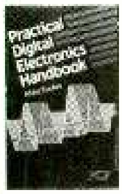
☐ **BP297—Loudspeakers for Musicians...$6.25.** Contains all the information that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, available fittings, finishing and how to connect multi-speaker arrays, etc. Includes ten enclosure designs with plans.



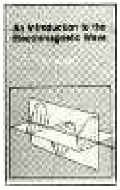
☐ **PCP110—Electronic Power Supply Handbook...$10.95.** All types of power supplies used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilizers to modern switch-mode systems, IC switch-mode regulators, DC-converters and inverters. The devices, their operating principles and typical circuits, are dealt with in detail.



☐ **BP254—From Atoms to Amperes... $6.50.** Explains in crystal-clear terms the fundamentals behind the whole of electricity and electronics. Really helps you to understand the basis of the complex subject perhaps for the first time ever.



☐ **PCP101—Practical Digital Electronics Handbook...$9.95.** An introduction to digital circuits, logic gates, bi-stables, timers, microprocessors, memory and I/O devices. A special feature of the book is the section on digital test gear projects.



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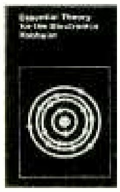

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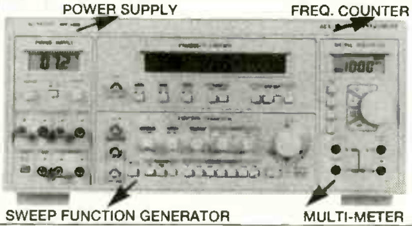

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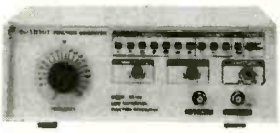

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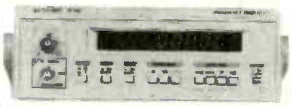

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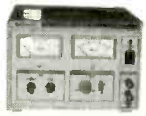

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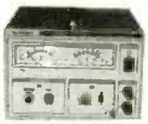

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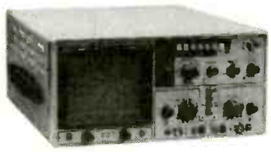

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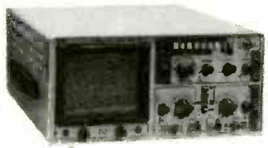

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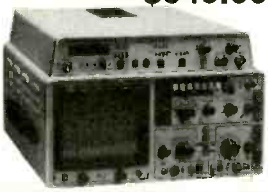

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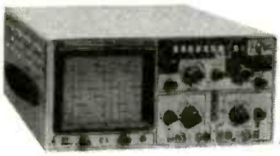

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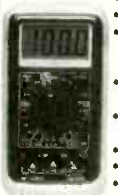

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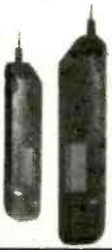

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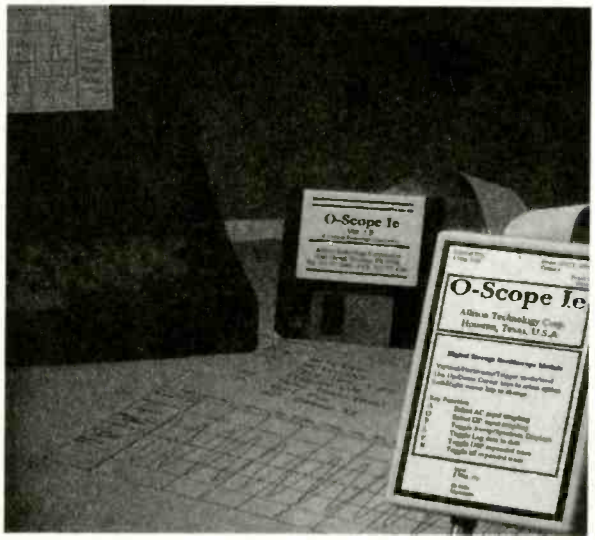

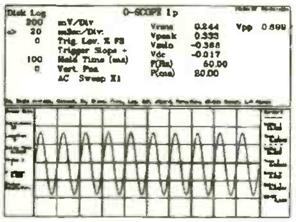

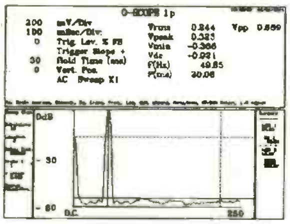

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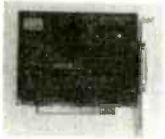

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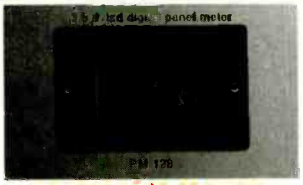

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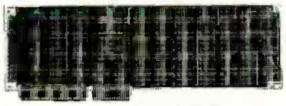

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Vector Cross Ref. #4617

CAT NO	PRICE EACH 1	5
PC218902	$25.66	$20.25

PC218904 (AT-BUS)

- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for: 1 D-Type Connector, 25-pin

Vector Cross Ref. #4617-3

CAT NO	PRICE EACH 1	5
PC218904	$25.42	$20.06

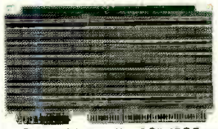
PC218903 (XT-BUS)

- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

Vector Cross Ref. #4613-3

CAT NO	PRICE EACH 1	5
PC218903	$23.51	$18.63

PC232904 (Multi-BUS)

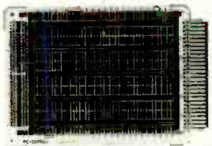


- Board Length: 12" (305mm)
- Board Width: 6-3/4" (171mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 Header, 100x2, 0.1" Spacing

Vector Cross Ref. #4608

CAT NO	PRICE EACH 1	5
PC232904	$38.40	$29.80

PC207905 (STD-BUS)



- Board Length: 6-1/2" (165mm)
- Board Width: 4-7/16" (113mm)
- Double Sided, 3-hole Solder Pads, Ground Plane and Power Bus
- Space Reserved for 1 Header, 34x3, 0.1" Spacing

Vector Cross Ref. #4610

CAT NO	PRICE EACH 1	5
PC207905	$13.66	$11.25

PC412902 (VME-BUS)

- Board Length: 6-5/16" (160mm)
- Board Width: 3-15/16" (100mm)
- Single Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

Vector Cross Ref. #4614-3

CAT NO	PRICE EACH 1	5
PC412902	$7.06	$6.00

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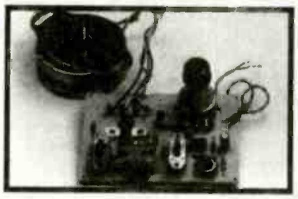
Features: 200mV full scale input 9VDC operation. Decimal point selectable. 13mm digit height, auto polarity indication, zero reading for 0 volt input. Measures 2.67" x 1.73" x 0.28" above panel thickness, 0.57" overall thickness. LCD size: 1.83" x 0.8". Has many useful applications and is easy to install.
CAT# PM-1 **$9.95 each**

Stepper Motor Controller Kit



This kit allows you to adjust the speed and direction of a stepper motor. You can move the motor in one step increments or rotate it at a constant speed. Visual indicators show the sequence of motion. Includes stepper motor, pc board, parts and instructions. (12vdc power source not included.)
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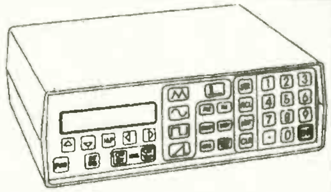

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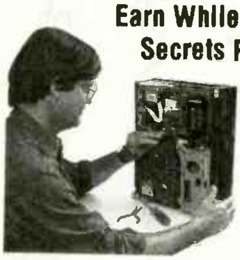

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20 character x 16 line **$79.00 or 2 for $149.00**
Mfr.: Toshiba TLX-1013-EO.
Unit is EL back-lit. Dim: 5 1/16"L x 4 1/16"H.
The built-in controller allows you to do text and graphics.

240x64 dot LCD with built-in controller. $79.00
Mfr: AND 4021ST-EO. *Unit is EL back-lit.* or 2 for $149.00

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16x1 ....3 for $25.00	20x2 ....$12.00	40x1 ....$8.00
16x1 (lg. char.)....$12.00	20x4 ....$25.00	40x2 ....2 for $25.00
16x2 ....$8.00	20x4 (lg. char.)....$25.00	40x4 ....$25.00
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5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • *Certain modules are backlit, call for more info.*

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size	Mfr.	price	size	Mfr.	price
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640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$15.00	160x128	Optrex	$15.00

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HeNe Laser Head (10Mw max. output) TEMOO, 15.5" long MFG: NEC **$99.00**
Laser Power Supply (for HeNe tube) **$89.00**

LASER SCANNER ASSEMBLY $29.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

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index guided. Threshold current 40 ma typical.

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Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. **(MFR: JAPAN ELECTRONICS)**

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Proteon ProNet-4 Model p1347 Token Ring Board $79.00
16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • interoperable with IBM Token Ring network

POS & BAR CODE

MAGNETIC CARD READER $25.00
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

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Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.

5 inch Amber	**$35.00**
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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

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CELL SITE TRANSCEIVER $99.00

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.

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Flip up LCD display (9-16 VDC) • Can communicate with any computer having RS 232 port • Can communicate with another Microterminal • Use by itself as electronic notebook • Onboard microprocessor, data RAM (32K) and Video RAM (64K) • Complex built in diagnostics and set up capabilities. • Original intention for POS applications. • display size 40x16 (256 x 128 pixels.) Dimensions: 6.3" W, 11"L, 2"H. (With LCD up height is 7.1")

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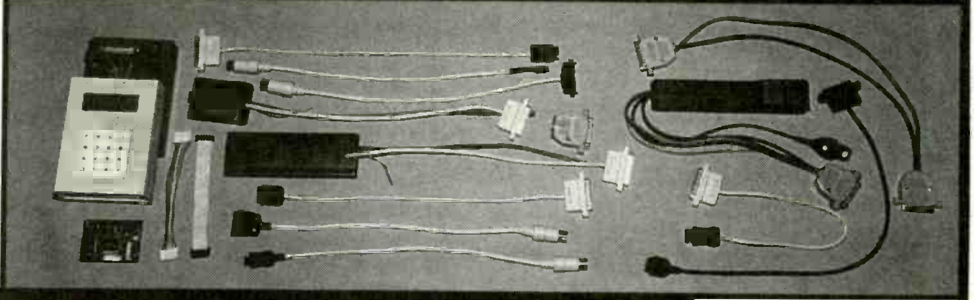

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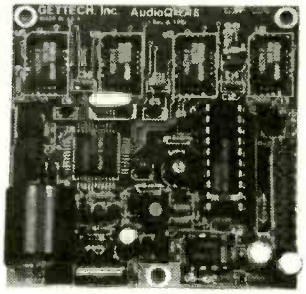

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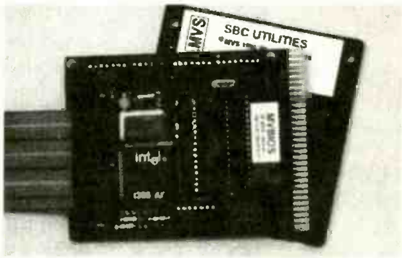

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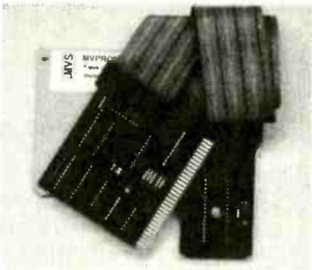

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8088 SINGLE BOARD COMPUTER	OEM $27	*95
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CAT# SMS-133

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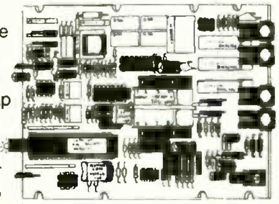


This pc board was atelephone line-sharing switch. A great source of cheap parts. On it you will find 3 LM317T voltage regulators, 1 LM340T-5 regulator with heatsink, 2 crystals, seven relays, a power transformer, a 600 ohm coupling transformer and at least 50 other parts. The voltage regulators alone are worth $ 5.00. Check it out!

CAT # EX-1218 **$3.50 each**

REED SWITCH

Single pole, normally open, hermetically sealed reed switch. Rated 1A @ 50 Vdc or 250 Vac. Glass enclosure is 1.4" long x 0.2" diameter. Lead length is 0.47".

CAT # RSW-14 **2 for $1.00**

MINI 12 VDC SOLENOID

12vdc, 54 ohm miniature solenoid. Coil mounted on U bracket. Bracket size: 0.36" x 0.43" x 0.81" long. 1.65" long plunger extends from both sides of coil. Spring return. Can be used for both push and pull action.

$1.25 each

10 for $10.00

CAT # SOL-23

RECHARGEABLE GEL CELL 12 VOLTS 9 A/H

Here's a great deal on new 12 volt 9 amp/hour rechargeable gel cell batteries. These batteries were recently manufactured and prepped for use in a product which hasn't yet come to market. The OEM didn't want to hold them in stock, so we got them at a greatly reduced price. They are 5.9" x 2.55" x 4.42" high and have a strip of foam padding stuck to one side. They have standard 1/4" quick-connect/ solder terminals. Weight: 8 lbs. Sealed gel cell batteries can be used in any position and can be recharged or trickle charged for long periods.

Lots of back-up power for your buck.

$28.50 each **CAT # GC-129**

8 for $208.00

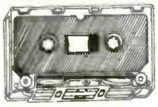
PHOTOVOLTAIC DETECTOR

Miniature silicon solar cell converts light impulses directly into electrical charges which can easily be amplified, using a transistor for example, to activate a control mechanism. Unlike a conventional photo diode or transistor, it generates its own power and does not require any external bias. Generates 0.4 vdc in moderate light. Silicon cell is mounted on a 0.31" x 0.23" x 0.07" thick plastic carrier and has pc leads on 0.2" centers. Large quantity available.

75¢ each **CAT # PVD-2**

10 for $6.50 • 100 for $50.00

C-30 AUDIO CASSETTE



Brand-new, good-quality 30 minute (15 min. per side) audio cassettes. Excellent for demos or instruction tapes. Manufactured without record-prevent knockout tabs, so the indentations must be taped over before use.

CAT # C-30 **3 for $1.00**

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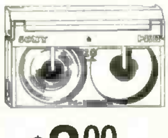
"HI-8" VIDEO CASSETTE (USED)

8 mm Video Camcorder Users!.



SONY Hi-8
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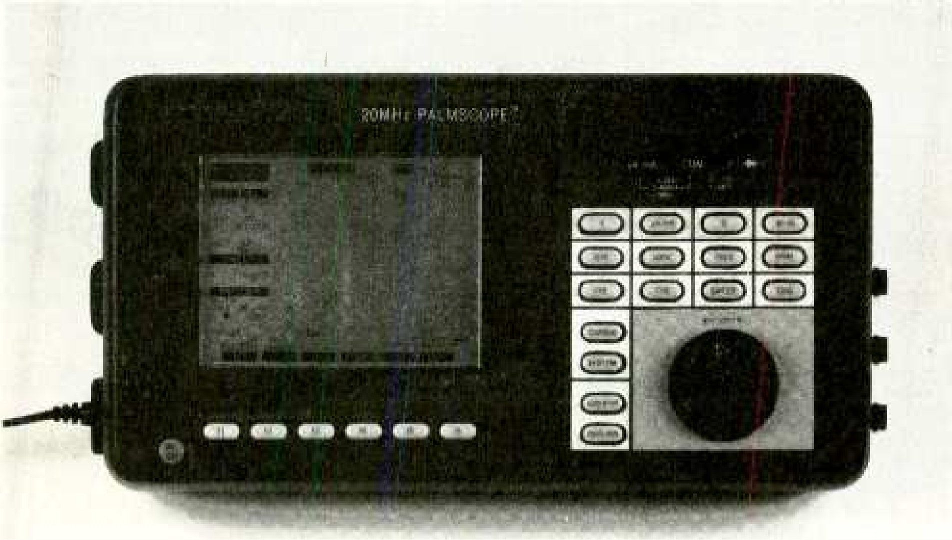
CIRCLE 214 ON FREE INFORMATION CARD

PALMSCOPE™ 320

ALL IN ONE DSO+DMM+LOGIC+COUNTER



Palmscope-320 features a 20Mhz DSO, 7 digit frequency counter, multimeter and logic scope. It can be operated with built-in battery for 3-4 hours typically. Built in RS-232 port and printer port extend your application. Optional software package is available.

PalmScope 320
$1695

DSO *• Dual channel digital storage oscilloscope (20 MS/sec) • Sensitivity range: 5mV / DIV - 20V / DIV • Sweep time: 50ns / DVI - 20s / DIV*

DMM *• Auto-range digital multimeter (4000 counts) • True RMS • DCV, ACV, DCA, ACA, Ohm Diode & continuity measurements*

LOGIC *• Logic Scope (8 channels, 50ns sample clock) • Selectable level: TTL/CMOS • Timing/State observation of logic signals*

COUNTER *•7 digit frequency counter (1 Hz to 20 MHz) • Selectable trigger level and FREQ/PER mode • Basic Accuracy ±10ppM*

General:
- Dual Channel Digital Storage Oscilloscope (20MS/s)
- Auto Range Digital Multimeter (3 3/4 digits, 4000 count)
- Frequency Counter (7 digits, 20 MHz)
- Logic Scope (8 channels, 50ns sample clock)

Display
- Number of Dots: 320(W)x240(H)
- Dot Pitch: 0.30 x 0.30 m/m
- Backlight: LED
- Data Out (RS-232C)
- Print Out: Portable Centronix and Epson Printer
- DC jack for AC adapter input
- LOW BATT Indicator

- Operating Temperature: 0°C to 40°C
- Operating Humidity: 0% to 70% R.H.
- Storage Temperature: -20°C to 70°C (0% to 80% R.H.)
- Dimension (LxWxH): 287x152x82 mm
- Weight: 2.0Kg
- Safety Compliance: it is designed to meet Class II per UL-1244, IEC 348 and VDE-0411

Introducing the Model #EDM-89S 5000 Count AUTO Range Digital Multimeter

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CIRCLE 264 ON FREE INFORMATION CARD

Parts Express™

Cellular Phone Battery For Motorola

6V, 700 mAH replacement battery for Motorola flip phones. Dark grey color.

#EN-140-860 .... **$23.50**(1-5) **$21.25**(6-UP)

Flip Phone Saver/Charger

Plug-in saver/charger for Motorola flip phones. Lifetime manufacturer warranty.

#EN-141-400 .... **$19.95**(1-5) **$16.95**(6-UP)

201 PanaVise Jr.

This mini vise is a invaluable bench top companion for the home hobbyist. PV Jr. uses the famous PanaVise design that turns, tilts, and rotates for a full range of movement. Ideal for soldering, gluing, and general work. Features jaws that open to 2-7/8", both vertical and horizontal grooves to hold work, and a fine adjustment knob. Net weight: 1 lb. 4 ozs.

#EN-365-300 .... **$19.95**EACH

Drive Belt Kit

We've selected 18 of our most popular VCR, cassette and turntable belts to include in this kit. 87 belts total, five each of 17 square belts from 2.3" to 13.2" for VCRs and cassettes, and 2 each of the 23.6" turntable belt. Have the belt you need in stock when you need it. A $50.00 value. Net weight: 1/4 lb.

#EN-400-910 .... **$29.95**KIT

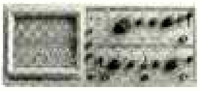
Pioneer 8" Woofer with Butyl Surround

PIONEER

8" paper cone woofer with a butyl rubber surround. Butyl rubber is extremely flexible and resists moisture better than foam. Half roll suspends the outside edge of the cone to allow distortion free sound. ◆Power handling: 80 watts RMS/150 watts max. ◆Voice coil diameter: 2 inches ◆Impedance: 8 ohms ◆Frequency response: 31-7000 Hz ◆Magnet weight: 30 ozs. ◆SPL: 91 dB 1W/1m ◆Vas: 2.44 ◆Qts: .26 ◆Xmax: .110 ◆Qes: .27 ◆Qms: 6.51 ◆Fs: 31 Hz ◆Net weight: 7 lbs. ◆Manufacturer model number: B20GR30-51F-Q. ◆Hole to hole: 7-3/4".

#EN-290-042 .... **$34.50**(1-3) **$29.95**(4-11) **$28.45**(12-UP)

Goldstar 20MHz Oscilloscope



GoldStar

The OS9020A combines both high quality and low cost, making it ideal for educational, industrial, and hobbyist applications. Features include: DC-20MHz analog bandwidth ◆6" high luminance CRT ◆Dual channel, dual trace ◆Max sweep time of 20nS/div ◆Trigger level control ◆Separate circuit for TV sync ◆Variable hold-off function.

SPECIFICATIONS: Vertical: Deflection factor: 5mV/div to 5V/div in 10 calibrated steps. Rise time: 17.5nS or less. Max input voltage: 250V (DC/peak AC). Modes: CH1, CH2, ADD, DUAL.
Horizontal: Sweep time: 0.2uS/div to 0.2S/div in 19 calibrated steps. Modes: X1, X10, X-Y.
Trigger: Modes: Auto, Norm, TV-V, TV-H. Source: CH1, CH2, LINE, EXT.
GENERAL: Dimensions: 12-1/2"W x 5-1/2"H x 16-3/4"D. Net weight: 16-1/2 lbs. Acceleration potential: 2KV. Power requirements: 100V/120V/220V/240V, 50/60 Hz. Comes complete with power cord, (2) 10:1 probes, and manual.

#EN-394-100 .... **$385.00**EACH

Audax 1" Titanium Composite Dome Tweeter

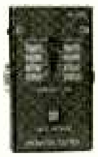
LA PASSION DU HAUT-PARLEUR AUDAX

Composed of pure titanium deposited on a polymer diaphragm, this composite offers the exceptional detail of metal domes while retaining the smoothness of soft domes. The result is outstanding clarity, low distortion and very high efficiency. ◆Power handling: 70 watts RMS/100 watts max. ◆Voice coil diameter: 1 inch ◆Impedance: 8 ohms ◆Frequency response: 2500-20,000 Hz ◆Magnet weight: 8-1/2 ozs. ◆Fs: 1500 Hz ◆SPL: 93 dB 1W/1m ◆Net weight: 1 lb. ◆Manufacturer model number: TW025M3 ◆Hole to hole: 3-3/8".

#EN-276-070 .... **$37.90**(1-3) **$34.75**(4-11) **$31.80**(12-UP)

Computer Monitor Testers

Peak Instrument Co.



These compact devices can quickly and easily troubleshoot, test, and align computer monitors, without the need for a separate computer. The #390-705 is used to test EGA, VGA, SVGA, VGA-8514A and VESA monitors. The #390-700 is used to test MDA, CGA, EGA, VGA, SVGA, and VGA-8514A monitors. Generates the following video test patterns: color bars, cross hatch, dots, color raster (white, red, green, blue), and windows. Two video connectors are provided: a digital/TTL 9 pin and an analog 15 pin. The testers may be powered by either a 9V battery or an external AC adaptor (not included). Dimensions: 1-1/2" x 3-5/16" x 5-5/8". Net weight: 3/4 lb.

#EN-390-700 (Standard Monitor Tester) **$149.00**EACH
#EN-390-705 (Monitor Tester w/High Res. VESA) **$149.00**EACH

The Wet Look™

The Wet Look™ is a new generation of high gloss polymers formulated especially for the speaker industry. This superior coating provides a protective "coat of armor" for your paper cone speakers. A special U/V inhibitor has been added to reduce the decaying effects of the sun's ultraviolet rays. The Wet Look™ makes paper cones resistant to water, humidity, sun, and salt. Best of all, it's easy to apply and cleans up with soap and water. 1 pint can.

#EN-340-510 (Clear) **$8.95**EACH
#EN-340-512 (Black) **$8.95**EACH

Profile A400 XL 2 Channel, 100 Watt Amplifier

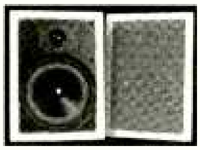
This nice sounding MOSFET stereo amplifier gives you plenty of output power for the money. Includes built-in subwoofer boost, class AB operation, power light strip, bridgeable to 200W mono, thermal protection, variable input sensitivity, gold plated RCA and speaker level inputs. Dimensions: 8-1/4"(W) x 2-1/4"(W) x 8-1/2"(D). Net weight: 6-1/2 lbs.

PROFILE

Specifications: ◆2 Channel: 100W x 100W RMS (4 ohm load/.05% THD) ◆Mono: 200W (4 ohm load/.05% THD) ◆Subwoofer boost frequency: 80 Hz ◆Signal to noise: 100 dB ◆Channel separation: 60 dB ◆Damping factor: 200 ◆Output current: 10 amps per channel max.

#EN-265-136 .... **$143.50**EACH **$132.80**(2-UP)

6-1/2" Two Way System

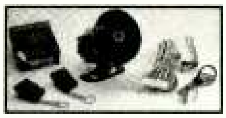


This is our most popular in-wall. The 6-1/2" polypropylene woofer and 1" textile dome tweeter were specially designed with home theater in mind. 3 piece design make installation in new or existing walls a snap. Textured ABS frame and steel mesh grill are spray paintable to match (or blend into) any decor. System comes with speaker assembly, removable metal grill, heavy steel backer plates, screws and hardware, hole cut-out template, paint mask, and detailed installation instructions.

Specifications: ◆6-1/2" polypropylene cone woofer with poly foam surround. ◆1" textile dome tweeter/midrange. ◆8 ohm impedance. ◆3 component L/C crossover network. ◆Frequency response: 50-20,000 Hz. ◆Power handling capability: 60 watts RMS/100 watts max. ◆Sensitivity: 89 dB 1W/1M. ◆Overall dimensions: 8-1/2" W x 12" L x 3-1/2" D. ◆Hole size: 7-1/4" x 10-3/4". ◆Fits into standard 2" x 4" wall. ◆Net weight: 12 lbs. per pair.

#EN-300-036 .. **$104.95**(1-3 PRS) **$96.50**(4-11 PRS) **$85.50**(12 PRS-UP)

Bulldog Model 7002PRO Alarm



BULLDOG
CAR & PERSONAL SECURITY SYSTEM

The 7002 Pro utilizes a sophisticated microprocessor to offer these technologically advanced features: (2) two remote controls, 6 tone 127 dB siren, keyless entry, active arming, programmable passive arming with doors locking, programmable 30 second chirp, anti-car jacking feature, valet mode, dual stage shock sensor, instant panic, negative and positive door pin trigger inputs, automatic 35 second alarm reset, starter kill relay and socket, 6 function LED status, remote car finder, 2 negative outputs, 30 second last door arming, silent arming/disarming, and arm/disarm confirmation chirp. Lifetime limited factory warranty. Made in the U.S.A. Net weight: 2 lbs.

#EN-330-312 .... **$99.95**EACH

12 Ga. Sound King Speaker Wire

Super flex, extra soft 60°C clear PVC insulation. Transfers music signals from the source to the speakers with high definition and clarity. Oxygen free, bare copper rope lay construction. Made in the U.S.A. ◆AWG: 12 ◆Construction: 259 x 36 Ga.

SOUND KING

#EN-100-155 (100 ft. spool) .... **$39.90**(1-3) **$34.90**(4-UP)

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150MHz 60MS/s	VC-5460	$3695
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20MHz 15MS/s	VC-5410	$1795

100MHz

- VC-6145 - Storage 4 Channel 100MS/s . . . $4795
- VC-6155 - Storage 100MS/s $3995
- VC-6545 - Storage 40MS/s $2995
- V-1585 - 4 Channel $2095
- V-1565 w/ Cursors $1795
- V-1560 . . . . $1595

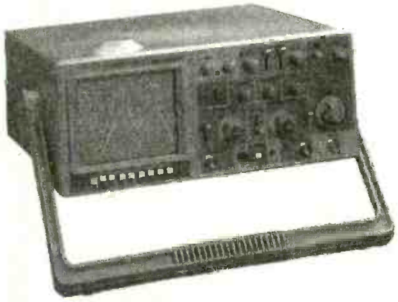
50/60MHz

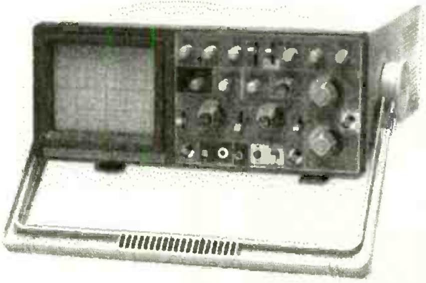
- VC-6525 - Storage 20MS/s $2795
- VC-6524 - Storage 20MS/s $2295
- V-695 - 60MHz w/ Cursors $1549
- V-555 - w/ Cursors $1095
- V-552 . . . . $949
- V-509 - Battery Operated . $1795

20MHz

- VC-5025A - 20MS/s DSO w/ DMM $1160
- VC-5025 - 20MS/s DSO w/ DMM $935
- VC-6523 - Storage 20MS/s $1995
- V-252 . . . . $449
- V-209 - Battery Operated . $1425

Quality Scopes by Elenco





60MHz

DS-603 $1350

- Analog / Digital Storage
- 20MS/s Sampling Rate

S-1365 $795

- Analog w/ Cursors

S-1360 $759

- Analog with Delayed Sweep

40MHz

S-1345 $569

- Analog with Delayed Sweep

S-1340 $489

- Analog

2 Year Warranty

25/30MHz

DS-303 $1095

- Analog / Digital Storage

S-1330 $439

- 25MHz Analog
- Delayed Sweep

S-1325 $335

- 25MHz Analog

OSCILLOSCOPE SELECTION CHART

ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1365	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232

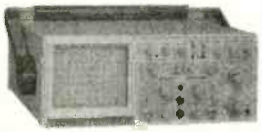
B&K Precision at Discount Prices

20MHz Analog

2120 - $389.95

2125 - $539.95

Delayed Sweep



Model 1541C

40MHz

$695

Dual Trace

60MHz with Cursors readouts and Dual Time Base

Model 2260

$1225

Model 2160

60MHz Dual Trace

$949

Dual Time Base • Delayed Sweep

Model 2190A

100MHz 3 Channel

$1379

Dual Time Base • Delayed Sweep

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- 91 . . . . . . $1225
- 92 . . . . . . $1525
- 96 . . . . . . $1795
- 97 . . . . . . $1795
- 97A $2945
- 99 . . . . . . $2095

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CIRCLE 333 ON FREE INFORMATION CARD

Use ELECTRONICS NOW Classifieds

READ BY ELECTRONIC BUYERS AND SELLERS AND TRADERS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues.**Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word, Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 -- Antique Electronics	270 -- Computer Equipment Wanted	450 -- Ham Gear Wanted	630 -- Repairs-Services
130 -- Audio-Video Lasers	300 -- Computer Hardware	480 -- Miscellaneous Electronics For Sale	660 -- Satellite Equipment
160 -- Business Opportunities	330 -- Computer Software	510 -- Miscellaneous Electronics Wanted	690 -- Security
190 -- Cable TV	360 -- Education	540 -- Music & Accessories	710 -- Telephone
210 -- CB-Scanners	390 -- FAX	570 -- Plans-Kits-Schematics	720 -- Test Equipment
240 -- Components	420 -- Ham Gear For Sale	600 -- Publications	730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #__________ **Special Category $30.00 Additional** __________

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00
17 - $42.50	18 - $45.00	19 - $ 47.50	20 - $50.00
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00
25 - $ 62.50	26 - $65.00	27 - $67.50	28 - $70.00

29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00

Total words ________ $2.50 per word = $________

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Card # _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Expiration Date _ _/_ _

Signature________________________

Name ________________________ Phone ________________________

Address________________________City State Zip ________________________

CLASSIFIED

CABLE TV

ATTN, cable box owners. Order your ID signal and bullet stopper before it's too late. Send $23.00 to **R.R. ENTERPRISE,** Box 3532, Easton, PA 18043.

SECRET Cable Descramblers Build your own descrambler for **Less** than $12.00 **in seven easy steps! Radio Shack** parts list and **Free** descrambling methods that **cost nothing** to try, included. Send $10.00 to: **INFORMATION FACTORY, PO Box 669,** Seabrook, TX 77586. For VISA/MC, COD's, (713) 922-3512 Anytime!

DESCRAMBLE Cable with simple circuit added to Radio Shack RF modulator and using VCR as tuner. Instructions $10.00. **TELECOM,** Box 832 E4, Brusly, LA 70719.

CABLE Descrambling New secret manual. Build your own descramblers for cable and subscription TV. Instructions, schematics for SSAVI, Gated Sync, Sinewave, (HBO, Cinemax, Showtime, UHF, Adult) $12.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

CABLE TV Equipment & Accessories Wholesalers welcome! 30 day moneyback guarantee! Free catalog! **PERFORMANCE ELECTRONICS INC., 1 (800) 815-1512.**

CABLE descrambler! Build with 7 Radio Shack parts costing $12. Instructions. $8. **F.A.S.T.,** Box 369-E4, Pt. Salerno, FL 34992-0369.

CABLE TV Test Chips for Jerrold, Tocom, Pioneer, Scientific Atlanta, etc...**Quick Installation!** New Multi-Mode modules available. Prices from $5.00 each. **1 (800) 786-9025.**

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"DESCRAMBLER Schematics Revealed" A powerful guide to descrambling schemes. $10.00. VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

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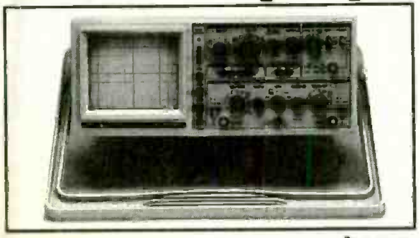

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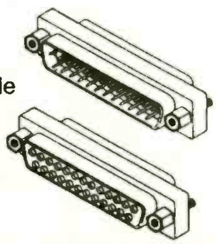

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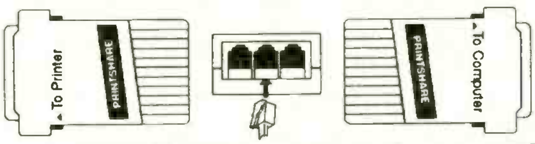

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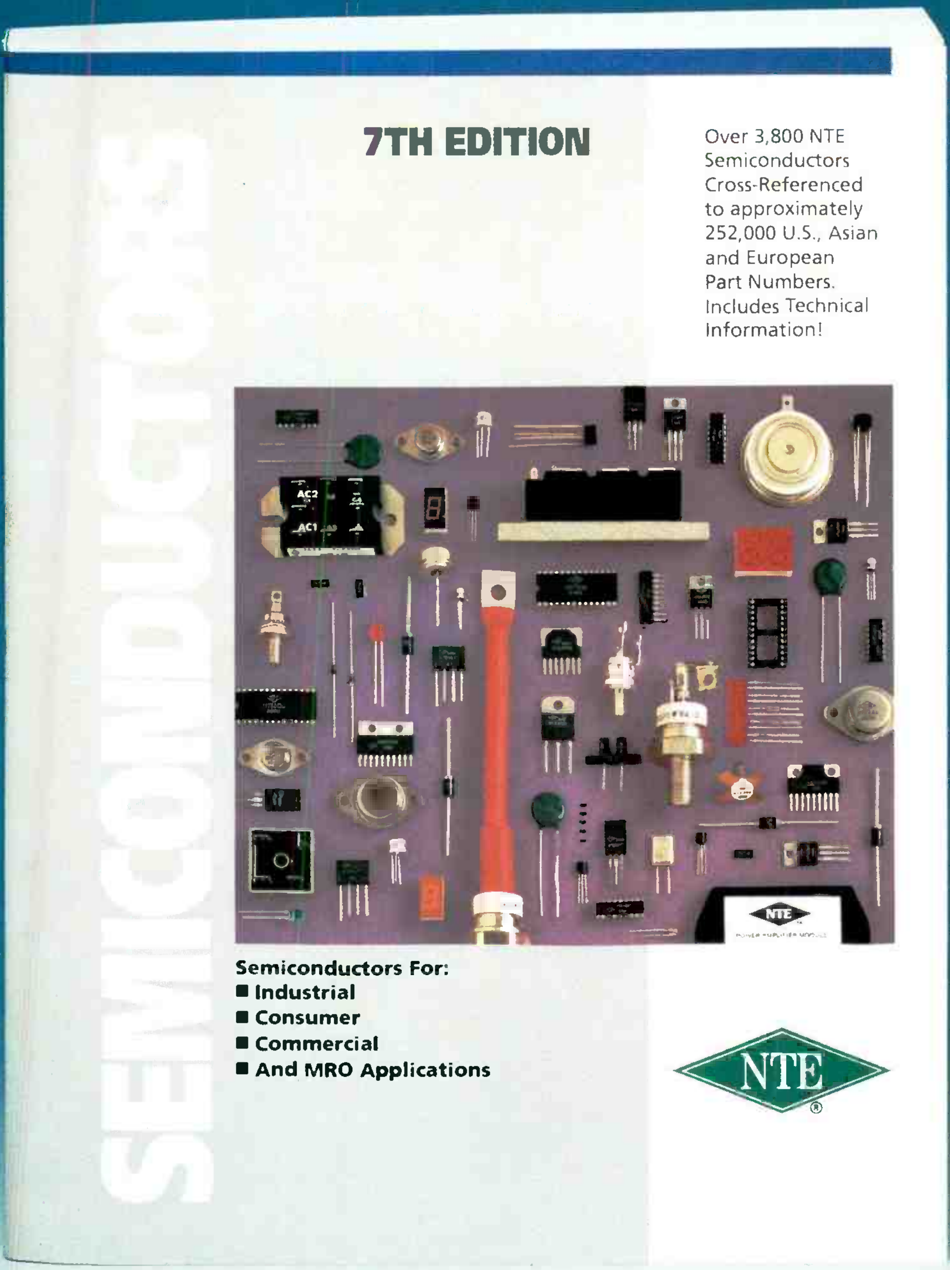

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