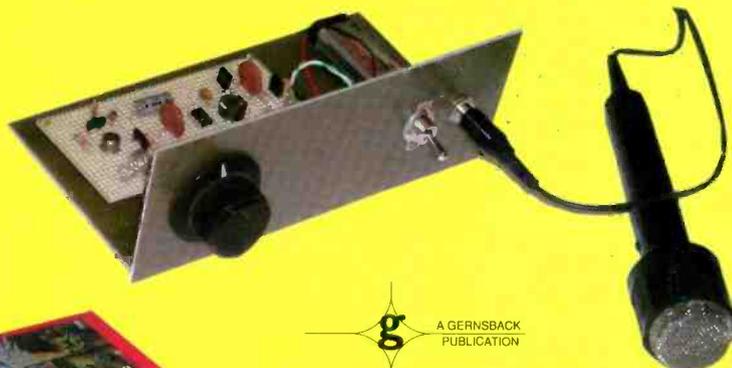


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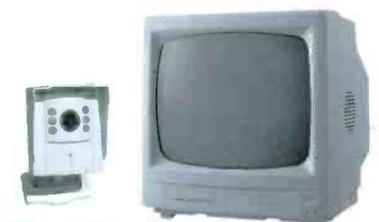
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82-8500	Pinhole lens	99.95	89.95



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SOLAR TO THE PEOPLE

Recently, I had the pleasure of thumbing through William L. Seavey's "The People's Guide to Basic Solar Power," and inside I found what appeared to be the key to unlocking the mystery of highly efficient and affordable energy. The author's guidebook was barely twenty pages long, but inside it was packed with info, diagrams, and prototypes for affordable solar-charged battery systems that start as low as \$100. Seavey explains that all one needs to take advantage of the sun's free energy is a solar panel, an inverter to convert DC to AC, and a deep-cycle battery. With an investment of around \$900, folks can build a system efficient enough to run a small fridge, a coffee pot, a microwave oven, a small console TV, and lights for several hours a day. Of course solar advocates know that living off the sun requires a bit of frugal electricity budgeting. Two boat batteries and a six-foot by seven-foot panel won't allow you to watch ten hours of football on your 52-inch TV, while you surf the Net on your computer basking in the light of halogen lamps. What do you expect? The sun's free. The solar movement is enjoying a lush following in mid-western North America and other sun-drenched zones. You can check out William L. Seavey's Web site at www.powerfromsun.com, or he can be reached via post at P.O. Box 311, Grover Beach, CA 93483. "The People's Guide to Basic Solar Power" is \$9.95. Now on to the show...

This month we have a wide variety of electronics for you, including: historical events in electronics, a biography of a current inventor, recent advances in technology, robots, crystal oscillators, lasers, and more. We are happy to report that all winners of the "Find Hugo's Head and Win!" contest have been notified and awarded. For those entrants who were not chosen this time, don't fret. Work is on the way for another contest later this year. Thanks again for the slew of readers from as far as Eastern Europe and as close as Long Island, New York.

Exciting projects are in the works at our labs (located in an undisclosed shed off the beaten path). Frequent guest, and one time associate editor, Marc Spiwak, has been seen tinkering nearby, and work is almost complete on a UHF Listening device that readers can build themselves. Even canines will envy the users of this device. We'll bring our readers this article soon, as well as many other practical circuits and prototypes. Would-be Edisons and Hoppers alike can always contact me with their own queries and ideas at editor@gernsback.com.

And now, it's time for a very special treat. Let's all go back together to a time when Hugo Gernsback himself held the helm. The year was 1952 and the magazine was **Radio Electronics**. The boss was waxing fantastic about a future where society will become fully integrated with machines referred to as "Electronic Brains." Read on, as Hugo Gernsback's words ring true, once again.

Enjoy,



Chris La Morte
Managing Editor

ELECTRONIC BRAINS

....An electronic computer boom is now in the making....

By HUGO GERNSBACK

SCIENTISTS are pretty well agreed now that most animal brain functions are partly electric, many wholly electric. It is known that the human brain has the equivalent of over ten billion neurons (nerve-cells), many of which act very much like vacuum tubes, or, to be more up-to-date, transistors. The human brain has the facility of storing many millions of impressions fed to it from the outside world. When required, these stored impressions act upon or solve various problems.

Some exceptional human beings have what are called computing brains. They can solve, in a few seconds, complicated mathematical problems merely by exercising certain not-too-well-understood functions in the brain.

Electronic computers as we know them today can duplicate many functions of the human or animal brain. Frequently electronic brains can do all this much faster and better and without chance of error.

No wonder then that the best electronic engineering minds have been busy for many years devising better and more efficient electronic computers. These machines started out originally as highly complex and cumbersome devices, and now are becoming even more complex, but are also constantly shrinking in size.

With the advent of the transistor, compact electronic desk computers of the highest order will be a reality in the not very distant future. Not all electronic computers and calculating machines are alike. They differ in various respects, depending upon the work they are called upon to do.

The vast quantity of intricate calculating done nowadays by humans takes a terrific amount of mind power and man-work hours. This valuable power will in the future be released and used for other more productive work. The reason is that one good computer can easily do the work of dozens of accountants in a fraction of the time it takes humans to do the same chore. Indeed in many instances the ratio is 1000 to 1, increasing in favor of the computers as they become more efficient.

How closely the human brain is now imitated is best illustrated by a recent invention of Dr. Howard Aiken, head of Harvard Computing Laboratory. He developed the new *Static Magnetic Memory*—a rapid storage device. The brain of the nation's most ambitious computer, the fabulous new Mark IV, now nearing completion, has 40,000 such Static Magnetic Memory Units.

No wonder then that one of the biggest branches of the electronic industry is now electronic computers. More and more firms are engaged in building these calculators for various purposes. It is quite certain that electronic computers will be one of the biggest, if not *the* biggest, division of electronic manufacturing in the foreseeable future. This estimate was recently made by Dr. Simon Ramo, chief of research of Hughes Aircraft Corporation, at the fifth annual convention of the Federated Financial Analysts Society in San Francisco.

At the present time, as is only natural, military establishments have first call on electronic computers, because of the importance of the military uses of these devices. In modern war, electronic computers are priceless. They literally spell the difference between victory and defeat. All guided missiles, whether modern cannon or long-distance guided rockets or

planes, must be directed by electronic computers. Even in World War II, the German robot long-distance V1 and V2 rockets were shot down with almost perfect regularity by electronic computing devices attached to anti-aircraft guns in England.

This, however, is only the beginning. The future general, before he goes into a battle, will have the possible results forecast by an electronic computer in such a manner that he will know for a certainty—given certain vital factors—if he can win or not.

There are today hundreds of special military electronic computer uses, and it may be safely stated that if and when World War III comes, it will be fought—and won—chiefly with military electronic computers.

On a more peaceful side, according to General David Sarnoff, chairman of the board of the Radio Corporation of America, "the nation's business operations will be revolutionized within a reasonably near future." In a recent talk, Sarnoff said: "These modern electronic robots promise to revolutionize and simplify the clerical operations of insurance companies, banks, tax bureaus, stock exchanges, and business in general. A single electronic computer can do the combined accounting of receivables, payables, purchases and stock controls."

He continued, "With some nine million persons—or 16% of the working population—engaged in clerical activities, present business systems are too slow and costly. The men responsible for making major decisions all too often find out that they must shape tomorrow's policy on the basis of statistics which are weeks or months out of date. It is now feasible to combine the automatic devices which have been developed for radio-television to form a complete electronic accounting system for even the largest business organization."

It was recently predicted by government scientists that new and simplified electronic computers will soon make their appearance for practical business uses, such as inventorying, accounting, market research, sales, mailing lists, and such business calculations as payroll amortization, prorating, various statistics, quality control, and other records.

Electronic computers will not only be used for future business systems, but for many other endeavors, chiefly for scientific and research purposes, which were the first to use the electronic computers in the past. They can also be used for such unusual purposes as sports. College football has already begun to use electronic computers. An eastern university has used electronic brains in analyzing opponents' plays. The best scientist of the university uses the usual punch-card system and electronic computers to plot in advance a coming game. It is also a fact that in the past several seasons the electronically-guided team remained undefeated!

From this it seems reasonable to deduce that organized baseball will use computers to give the team the right answers well in advance. Other sports, such as tennis, and horse racing, are in the same class.

Right here the thoughtful non-electronic mind may well calculate what is going to happen if the opposing team *also* uses electronic computers. For the answer we need no electronic computer—almost certainly *the better team will win*.



YESTERDAY'S NEWS

A PEEK INTO THE GERNSBACK ARCHIVES



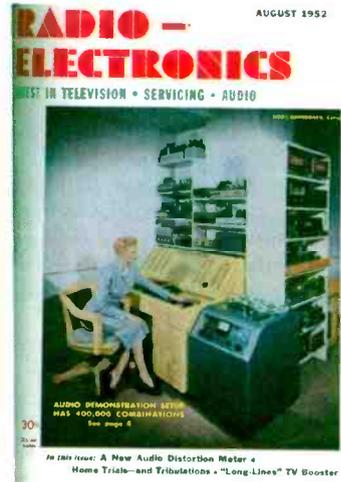
1900

1910

1930

1940

1952



Dateline: August 1952 (50 years ago)

Inside **Radio Electronics** readers found an Editorial written by Hugo Gernsback, which was entitled "Electronic Brains," that told of a future where computers would be integrated into virtually every aspect of our lives (check out the reprint in this issue). Within the pages there was also an article on the latest technology for audio—tape recording. The article described the techniques used to tape phonographs and live audio using the best in reel-to-reel systems.

1960

Dateline: August 1972 (30 years ago)

Fiber optics was barely shaking the telecom industry when the folks at **Radio Electronics** were on the story, and giving their readers the latest facts on the exciting technology that merged the fields of optics and electronics. A reoccurring feature called "The State of Solid State" made its debut by keeping the readers abreast with the latest offerings of solid-state electronics. An installment of the popular column "New and Timely" told of doctors beginning to use low-amp electrical impulses to promote bone growth.



1972

1980



Dateline: August 1992 (10 years ago)

Holograms were the *soup du jour* in this issue of **Popular Electronic**. Readers learned how to set up their own hologram studio based around a HeNe laser tube. A "Hands-On Report" reviewed Elenco Electronic's *Micro-Master MM-8000 BASIC Systems Course*, which schooled users in the construction of personal computers and microcontroller programming. Also inside was a construction article that showed how to build a handy convenience light for your remote control

1992

2000

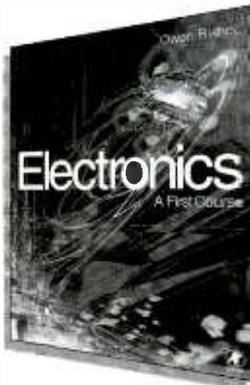
NEW LITERATURE

Electronics—A First Course

by Owen Bishop
Newnes Press,
Butterworth-
Heinemann
225 Wildwood Ave.
Woburn, MA 01801
781-904-2500
www.bb.com

\$29.99

Starting with the basics of electricity and component types, this text introduces students to practical work almost straight away. No prior knowledge of electronics is assumed. The approach is student-centered with Test Your Knowledge features to check understanding, as well as numerous activities suitable for practicals. Key facts, formulas, and definitions are highlighted to aid revision. This book is ideal for a wide range of introductory courses in electronics, technology, physics, and engineering.



Optoelectronics And Fiber Optic Technology

by Ray Tricker
Newnes Press,
Butterworth-
Heinemann
225 Wildwood Ave.
Woburn, MA 01801
781-904-2500
www.bb.com

\$29.99

An ideal introductory text for installation engineers and field service engineers, this is a unique practical guide to the technology and applications of fiber optics and the wider technologies of optoelectronics. Using a minimum of mathematics, the book describes key aspects of installation, test techniques, safety, cable TV systems, LANs and WANS, and the global fiber-optic highway. It is also genuinely useful for technicians, engineers, managers, and students.

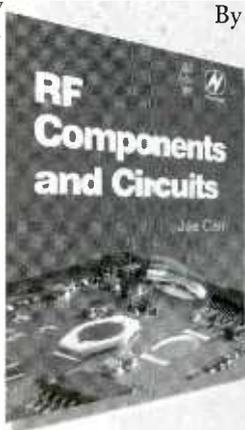


RF Components and Circuits

by Joseph F. Carr
Newnes Press, Butterworth-Heinemann
225 Wildwood Ave.
Woburn, MA 01801
781-904-2500
www.bb.com

\$37.99

By explaining how different circuit types work and how they can be modified, the author provides a master class in RF design that is essential reading for electronics engineers, hobbyists, and students. The RF circuits covered in this book are the heart of the electronic design of TV sets, personal mobile radio, remote control systems, mobile phones, and digital TV and radio. Some basic knowledge of electronics is assumed, but the important features of RF are fully described.

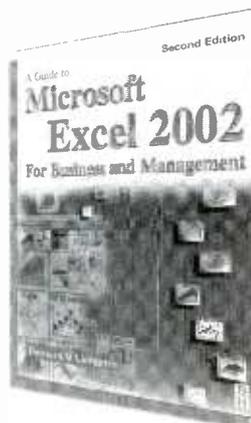


Guide To Microsoft Excel 2002 For Business And Management, Second Edition

by Bernard V. Liengme
Elsevier Science
225 Wildwood Ave.
Woburn, MA 01801
781-904-2500
www.elsevier.com

\$29.99

Written specifically for business students and professionals working with Excel, this text provides a practical guide to using its functions and exploring basic principles, as well as to more complex areas such as modelling, chart analysis, reporting, and automatic importing from the Web. The pages are illustrated throughout with screenshots, examples, and case studies based on real-world situations and readily adaptable to workplace circumstances.

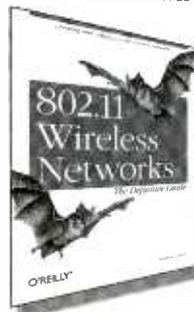


802.11 Wireless Networks: The Definitive Guide

by Matthew S. Gast
O'Reilly and Associates, Inc.
101 Morris St.
Sebastopol, CA 95472
800-998-9938 or 707-829-0515
www.oreilly.com

\$44.95

If you are a network administrator, architect, or security professional, you need to understand the capabilities, limitations, and risks involved with integrating wireless LAN technology into your current infrastructure. This practical book gives a general introduction to wireless networks and provides all the information needed to analyze, debug, troubleshoot, and deploy them. Also covered in detail are media access control, management operations, detailed framing, and point coordination function



Electronic Test Instruments: Analog And Digital Measurements

by Robert A. Witte

Prentice Hall

One Lake St.

Upper Saddle River, NJ 07458

800-282-0693

www.prenhall.com

\$55

Offering a thorough, unified, up-to-date survey of the entire field of electronic instrumentation, this practical guide to electronic test and measurement introduces essential theory and includes many circuit models and conceptual block diagrams. It covers all mainstream test instruments such as meters, signal sources, oscilloscopes, frequency counters, power supplies, spectrum analyzers, and more. In addition, the text illuminates important concepts such as loading effect, grounding, and bandwidth.



Electric Motor Maintenance And Troubleshooting

by Augie Hand

McGraw-Hill

2 Penn Plaza, 12th Floor

New York, NY 1012

800-2MCGRAW

www.books.mcgraw-hill.com

\$34.95

An ideal resource for anyone who has to purchase, install, troubleshoot, perform limited repairs on, or maintain industrial-size electric motors, here's everything you need to know to keep them running smoothly. The author uses easy-to-understand language and time-saving flow charts without complicated math, and provides a host of troubleshooting tricks and procedures and a thorough overview of motor types, components, and operation.



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Intended for the scientist, educator, and engineer enthusiasts, this catalog contains 100 pages with over 1500 hard-to-find science, laboratory, optical, and weather-related products. Some featured items include telescopes, magnets, binoculars, weather instruments, solar equipment, lasers, microscopes, and biomedical instruments.



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01845

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www.contacteast.com

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This 340-page catalog offers specialty products from leading manufacturers, including test and measurement instruments, tool kits and cases, measuring tools, and soldering and desoldering products. It also contains accessory and support products, such as static protection, contamination control, storage and handling products, magnification and lighting, adhesives, dispensers, gloves, cleaners and aerosols, product identification items, workbenches, chairs, and much more.



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A.R.C.

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Carlisle, MA 01741

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www.antiqueradio.com

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Published 12 times a year, this national publication for buyers and sellers of old radios and related items is chock full of informative articles, auction reports, meeting notices, event listings, and reviews. Probably of most interest are the classifieds offering old parts, restoration guides, radios, service manuals, and just about anything a radio enthusiast might be looking for.



GIZMO®

For more information go to page 80A

or e-mail: requests@berkshire-is.com

TRICK CD Wallets

Offering the latest in innovative audio storage, these trendy, rugged, innovative, clever, and kool **TRICK CD Wallets** (\$9.99) are targeted for young adults. The wallets, which come in attractive colors and are decorated with beading and designs, protect and store up to 24 CDs or 12 with liner notes. The Spring ensemble features a light purple suede-like material embroidered with tiny flowers and a metallic silver trimmed with a black leather-like Koskin material. A new line will be available for the Fall.



Case Logic, Inc., 6303 Dry Creek Parkway, Longmont, CO 80503-7294; 303-652-1000; www.caselogic.com.

CIRCLE 50 ON FREE INFORMATION CARD

Grand Cinema

Designed to deliver a cinematic experience, the **SIM2 HT300 DLP Projector** (\$14,995) offers remarkable color fidelity, sharp details, and superb picture quality. Boasting a resolution of 1280 x 720 pixels for support of native 720p HDTV resolutions, this projector delivers true High Definition capability. It also features a new sealed optical engine—the entire light path, from the lamp up to the lens, is sealed. Equipped with a 6-segment color wheel, double keystone adjustment with 16 degrees of optical correction, and a built-in interlacer, the projector is elegantly designed with smooth curves to make it attractive for any décor.

SIM2 Seleco USA; 10108 USA Today Way, Miramar, FL 32025; 954-442-2999; www.sim2selecousa.com.

CIRCLE 53 ON FREE INFORMATION CARD



Customized Sound

When you are watching a movie or listening to music, the room you are in can affect the quality of the sound.

The Bose **Lifestyle 28** (\$2499) and **35** (\$2999) *Home Entertainment Systems* feature the **ADAPTiQ** Audio Calibration System, which offers a solution to the problem.

Its innovative technology analyzes and adjusts sound according to acoustics, speaker location, and even listener location. Both systems include an **ADAPTiQ** headset and the application software on a CD-ROM. Step by step, the software guides you to correctly perform the calibration.

Bose Corp., The Mountain, Framingham, MA 01701; 508-766-7781; www.bose.com.

CIRCLE 51 ON FREE INFORMATION CARD



Magic Cabinetry

Featuring hand-rubbed Honduras mahogany, this motorized rotating **Corner Cabinet** (\$17,500) is operated by remote control to transform a bar and display into a home theater with the press of a button. The lower corner section has two adjustable shelves. A radio remote control rotates the upper cabinet into three stop positions—raised panel doors, a lit mirrored display, and a television/DVD. The cabinet also provides storage for DVDs and video tapes and features attractive halogen lighting.

Lowell/Edwards, 979 Third Ave., Fifth Floor, New York, NY 10022; 212-980-2862; www.lowelledwards.com.

CIRCLE 52 ON FREE INFORMATION CARD



Superior Sound

The **QuikWave EM3018B** digital sound system (\$179) is a stand-alone sound repeater capable of reproducing more than a hundred different stereo/monaural CD-quality sounds stored on a tiny CompactFlash memory card. Directly compatible with industrial standard, in compressed Windows.wav files, it offers superior sound quality over other sound systems incorporating lossy compression schemes or proprietary file formats. The **EM3018B** can be powered by a single voltage supply and can output to speakers directly. The built-in 40-watt/channel power amplifier eliminates the need for an external amplifier in most cases.

Eletech Electronics, 16019 Kaplan Ave., Industry, CA 91744; 626-333-6394; www.eletech.com.

CIRCLE 54 ON FREE INFORMATION CARD



Home-Theater Processor

Offering all of today's processing schemes, the *Theater Grand III* (\$3495) includes a full 7.1 Dolby Digital Surround EX, an easy upgrade path, and holographic imaging. The connection suite can

accommodate all the latest digital gear with three buffered, high-definition component video inputs and an



8-channel direct path, analog input for DVD-Audio and SACD. It also provides stereo playback with down mixing from a multi-channel source, and a second zone has a fully independent volume control that can be controlled with infrared commands. The TGIII also intelligently monitors all input activity, switches to new sources, and selects the right surround mode for each input—automatically.

Sunfire Corp., P.O. Box 1589, Snohomish, WA 98291; 425-335-4746; www.sunfire.com.

CIRCLE 55 ON FREE INFORMATION CARD

RF Modulator

Easy to operate and install, the *Terk RF Modulator* (\$29.95) allows video components such as DVD players, video game systems, satellite receivers, VCRs, and camcorders to be viewed on televisions that are not equipped with an available audio/video jack. A perfect solution

for older television sets that have limited input capabilities, it is useful for newer sets as well that are using the maximum number of audio/video



inputs. The modulator is also furnished with stereo output capability, is Internet TV compatible, and has a 1K/75-ohm switch to improve impedance matching and enhance picture quality for low-output video sources.

Terk Technologies; 63 Mall Drive, Commack, NY 11725; 631-543-1900; www.terk.com.

CIRCLE 58 ON FREE INFORMATION CARD

Digital Voice Recorder



Intended for commercial and educational use, the *DW-90 Digital Voice Recorder* (\$99.95) has 8 MB of Flash memory that holds up to 90 minutes of information. It can be quickly and easily downloaded to your PC via the included

USB cable. The recorder comes with a built-in microphone, microphone stand, earphone, strap, and software.

SCIENTIFICS, Dept. A021-C999, 60 Pearce Ave., Tonawanda, NY 14150-6711; 716-874-9091; www.scientificsonline.com.

CIRCLE 57 ON FREE INFORMATION CARD

Amber Signals

Designed to be installed on virtually any vehicle, these *Wide Angle Signal Mirrors* (\$169) offer the expanded visibility of a convex mirror. They also have amber-colored

chevron signals, which provide the accident prevention of a fully-functional signal mirror. When a turn signal is activated, a flashing chevron appears in the corresponding mirror to alert drivers in the blind spots around and behind the vehicle. They are

mounted directly onto a vehicle's exterior rearview mirror; and each kit comes complete with two wide angle signal mirrors, a wiring kit, and installation instructions.

Muth Mirror Systems, P.O. Box 418, Sheboygan, WI 53082; www.kwmuth.com.

CIRCLE 56 ON FREE INFORMATION CARD



Mobile Phone Chargers

Designed to supply the power needed to charge a cell phone battery from a USB port on the notebook computer, the *USB Mobile Phone Charger* (\$19.95) will keep your cell phone up and running almost anywhere. While

the phone is charging, the user is able to make phone calls or use the modem feature. The charger will not affect the notebook's internal battery because of the low

amount of current needed to charge the cell phone. They are compatible with

Nokia, Ericsson, and Motorola phones, and feature a USB connector on one end and the vendor-specific adapter on the other.

American Power Conversion, P.O. Box 278, 132 Fairgrounds Rd., West Kensington, RI 02892; 800-788-2208; www.apcc.com.

CIRCLE 59 ON FREE INFORMATION CARD



Color Printer

Said to be the world's fastest CD color printer, the *SignaturePro* (\$1895) uses advanced inkjet technology to deliver 2400-dpi resolution. It prints a disc with full color, 100% coverage in just 16 seconds, using dual-cartridge print technology with separate black monochrome and three-color ink cartridges. Also featured is built-in PrimaColor color matching software and an exclusive, patent-pending early-warning ink-level monitoring system.

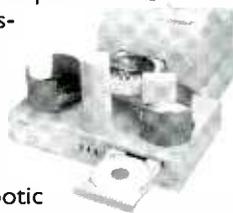
Primera Technology, www.primeratechnology.com.



Optical Disc Duplicator

Configured for either CD-R or DVD-R, the *Composer Optical Disc Duplicator* (\$2495) duplicates and optionally prints up to 50 discs per job from any Windows-based PC. After a duplication job has been started, the process is automatic and no further operator intervention is necessary. A robotic arm transports discs from an input tray to the integrated CD-R or DVD-R recorder. The disc is then moved to an optional ink-jet or thermal optical disc printer where it is printed and then stacked in a 50-disc output tray.

Primera Technology; www.primeratechnology.com



High-Speed Scanner

Reaching speeds of up to 480 megabits per second, the *Canoscan D1250U2F Scanner* (\$199) is USB 1.1 and 2.0 compatible. Four-button operation enables the user to copy, scan, or e-mail photos, text, or film. The Advanced Z-lid expansion top allows scanning of thick items such as books or magazines while maintaining low height of the scanner by hiding the expansion hinge in the design of the scanner. Archiving photos to a CD-R drive is easy using the *ArcSoft PhotoBase* software included with the *CanoScan D1250U2F*. The high-optical resolution of 1200 x 2400 dpi and 48-bit color depth provide for more than 281 trillion possible colors on photos or film scanning.

Canon U.S.A., Inc., www.usa.canon.com.



Digital Organizers

Combining a sleek appearance with practical everyday use, the *EXcelsior* (\$29.99) and the *EXtreme* (\$19.99) *Digital Organizers* have a silver-metallic finish, rubber grip, lottery number generator, stopwatch, and countdown timer. With memory upgrades from 384 KB to 768 KB, the *Excelsior* package includes a desktop cradle, flip-top cover, PC link cable, and software. The *Extreme* has 192 KB, allows information to be backed up to a PC, and features a touch screen for easy data entry.

Royal Consumer Information Products; www.royal.com.



PDA Keyboard and Case

This high-tech *PDA Keyboard and Case* (\$79.99) has a futuristic hard-silver and black case, and PDAs are held securely in place in the built-in docking port. There is a full QWERTY keyboard for easy text input, a calculator, and hot buttons for programming the alpha, numeric, and command keys. It supports the Palm III, Palm V, and Handspring Visor series.

Fellowes Manufacturing Company; www.fellowes.com.



Business Buzz

IBM THINKS SMALL AND WINS BIG
Heading into the teraflop region of processing power, IBM's new Cell chips are predicted to rock the microprocessor marketplace. Billed as a "supercomputer on a chip," the Cell is poised to take off. Talks are already underway to put the Cell into Sony's next-generation Playstation consoles due to the reportedly amazing level of graphic detail the chip can process. IBM's Cell and Intel's xScale are not in direct competition as of now, but future revisions of each manufacturer's chips would be vying for popularity among manufacturers of consumer electronics, namely game consoles.

FLAT TRANSFORMER TECHNOLOGY
Broadband Telcom Power (BTCPower) has released an industry first—the HQ series of synchronously rectified, highly efficient DC/DC converters that provide an impressive 50 Amps of output current at low voltages. The company's patented Flat Transformer technology incorporates multiple cores with single windings in the construction of step-down transformers. Engineers have found that Flat Transformers are better at heat dissipation. Typical high-efficiency converters show an efficiency drop as the output current increases in proportion to the square of the current; the HQ series has not exhibited this loss. More information can be found by visiting www.btcpower.com, or calling 714-259-4888.

SOUNDVU REVOLUTIONIZES CELL PHONES

NXT, creators of innovative flat-panel speakers, is working with Siemens to produce a new prototype cell phone—the S45—that incorporates SoundVu technology. Display panels made with SoundVu serve three distinct roles: visual display, speaker, and microphone. This technology will allow manufacturers to completely seal their cell phones, making them truly waterproof, as well as promote further miniaturization of products. Also, users will not have to hold their phones in close proximity of their heads—a practice still being studied to assess the risk of harmful radiation.

Radio-Controlled Helicopter "Taught" to Fly



The first-ever autonomous acrobatic maneuver done by a remotely controlled helicopter was recently accomplished with a modified X-Cell 60 R/C model helicopter just like the ones flown by radio control enthusiasts.

Recently, a team of researchers in the Massachusetts Institute of Technology's Department of Aeronautics and Astronautics achieved an aeronautical "first"—the first-ever autonomous acrobatic maneuver done by a remotely controlled helicopter. The research, partially sponsored by the Office of Naval Research, is aimed at developing more maneuverable and less expensive military UAVs (Unmanned Air Vehicle). The feat was accomplished with a modified X-Cell 60 R/C model helicopter just like the ones flown by radio control enthusiasts.

AI Flight School

The MIT team developed the model's flight-control software in an interesting way by essentially "teaching" the control system how to fly maneuvers. This was done by first having a human UAV pilot fly the X-Cell 60 through the maneuver while the pilot's control inputs were recorded in detail. Then a computer simulation using this recorded information was used to develop the control software for flying the helicopter robotically. Finally, the model helicopter was flown autonomously using

the software loaded into the craft's on-board computer, basically a 266-MHz Pentium-like processor with 16 megabytes of random memory.

The maneuver—a high-speed, corkscrew-like 360-degree aileron roll—can be seen on a video at <http://gewurtz.mit.edu/research/beli.htm>. Now, the researchers are working on another equally complex maneuver, this time a split S that consists of a half roll followed immediately by a half twist. These feats are especially significant, because whether flown by human pilots or autonomously, helicopters are much more complicated and difficult to fly compared to even the most sophisticated, high-performance fixed-wing aircraft.

The idea behind the control system logic is to break down the complex set of pilot inputs during a maneuver into basic mathematical algorithms. Using these "building blocks," the computer can create almost any complex maneuver by recombining the right set of algorithms. In addition to providing a UAV with advanced aerial maneuvers, the algorithms could be used to create completely new maneuvers that could give UAVs a decided edge in hostile airspace.

Unlimited Possibilities

The researchers foresee small, agile, robotic helicopters that could fly in mountainous terrain, urban areas at low altitude between skyscrapers, or other challenging terrain that is off-limits to larger aircraft or too dangerous for manned aircraft. These small, unmanned helicopters could perform reconnaissance missions or even carry weapons.

The rotary UAV could also have non-military applications, such as surveying disaster sites too dangerous for manned operations or by moviemakers shooting aerial scenes that can cost as

TYPE

much as \$20,000 a day if a helicopter has to be rented and a pilot hired. The model being used by the MIT team is equipped with a vibration isolation system to protect the control box that could also allow blur-free footage from vantage points accessible only to very small aircraft. Indeed, a vibration isolation system like one in this MIT X-Cell 60 was installed in a small, pilot-operated helicopter to shoot an Emmy-winning 2000 National Geographic documentary about the life of pigeons in New York City from a falcon's-eye viewpoint.

An RC Air Force?

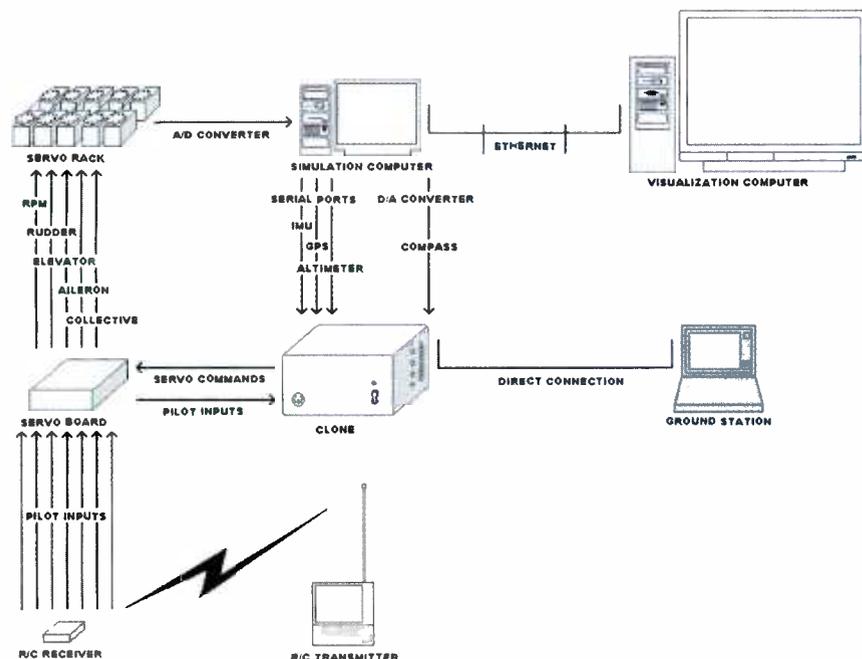
After years as an "almost ran" military systems, UAVs are now playing a key role in the Mid-East. Predator UAVs built by General Atomics are flying reconnaissance missions over Iraq. Predators as well as Global Hawks built by Northrup Ryan are playing a key reconnaissance role in the war on terrorism in Afghanistan. Other Predators flown by the CIA equipped with a cou-

ple of Hellfire anti-tank missiles can not only find al-Qaeda and Taliban leaders in hiding, but can also kill them after they are sighted.

While great for high-risk missions without endangering the lives of human pilots, fixed wing UAVs have drawbacks. First, they fly slowly and thus are quite vulnerable to hostile anti-aircraft fire. A few Predators have been downed over Iraq airspace. Secondly, now highly skilled and experienced pilots must fly them from the ground. Robotic helicopters could be flown by anyone. Finally, they are quite expensive—Predators cost about \$2 million each. The MIT researchers say a militarized rotary wing UAV could cost about \$500,000.—by Bill Siuru **CT**

Robot Developer Kit

Evolution Robotics, Inc., a robotics technology and professional services company, began shipping its Robot Developer Kit (RDK), in May. Each



A human UAV pilot flies the X-Cell 60 through the maneuver while the pilot's control inputs are recorded in detail. Then a computer simulation using this recorded information is used to develop the control software for flying the helicopter robotically.

Research Notes

MONITORING ELECTROCHEMICAL NOISE (EN)

Los Alamos Laboratory is developing technology to help monitor corrosion within large, subterranean stainless and carbon-steel radioactive liquid waste storage tanks. Standard corrosion monitoring uses strips of material formed from the same material as the storage tank, called coupons. These coupons are immersed in the waste and are periodically retrieved to note the degree of corrosion. The sampling can often cost nearly \$100,000 per sample each time. In an attempt to lower costs and provide real-time corrosion data, scientists are researching electrodes made with materials as similar as possible to the tanks, which are placed within the tanks themselves. The electrodes monitor Electrochemical Noise (EN) that is present during corrosion. The EN is measurable by noting the voltage fluctuations among the three submerged electrodes. Studying the magnitude and polarity of these signals provide indications of type and significance of corrosion.

NASA INCREASES PROPULSION RESEARCH

Tired of tooling around space at a slug's pace, NASA researchers are currently trying to develop faster and more efficient space propulsion. Robert Winglee, a scientist at the University of Washington in Seattle, has proposed a plasma balloon. Dubbed the Mini-Magnetosphere Plasma Propulsion (M2P2), Winglee's balloon creates an enormous magnetic bubble around a craft that interacts with high-speed ionized particles shed by the Sun. These particles push the vehicle through space.

BOEING'S X-45 ROLLED OUT

In May, Boeing successfully completed a fourteen-minute maiden flight of the X-45 remote-controlled combat plane. Developed for the United States Air Force and the Pentagon's Defense Advanced Research Project Agency (DARPA) by Boeing's Phantom Works, the tailless craft has a wingspan of 36 feet, weighs in at 8000 pounds, and can carry up to 3000 pounds of ordinance. Air Force officials foresee the X-45 as a tool used to surgically strike anti-aircraft batteries.

Prototype

industrial-strength kit is made up of the necessary software and hardware tools needed by developers and manufacturers to quickly create their own autonomous personal robots for the home and workplace. In bringing the kit to market, Evolution Robotics has added a servo motor option and a new personality software module.

Some Assembly Required

The RDK, built to support application development using the Evolution Robotics Software Platform, allows developers to create behaviors and applications for various prototypes. Inside are easy-to-assemble aluminum hardware, plug-and-play expandable electronics, stepper or servomotors, as well as a copy of the Evolution Robotics Software Platform, developer tools, APIs and documentation. The platform has a complete robot control architecture with ready-to-use behaviors, such as: following a target, obstacle avoidance, listening for voice commands and responding with speech, and exhibiting personality.

"The Apple II and the IBM PC launched and, in many respects, created the PC revolution by providing small inexpensive computers to end users and developers, who then invented the amazing set of applications we have



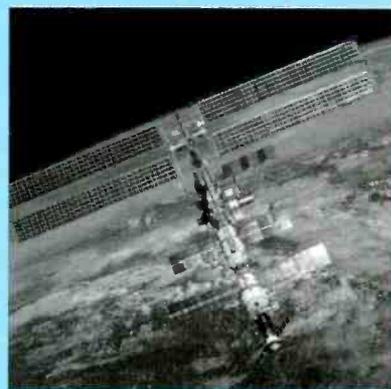
Each Robot Developer Kit is made up of the necessary software and hardware tools needed by developers and manufacturers to quickly create their own autonomous personal robots.

►ISS Update

The *International Space Station (ISS)* has suffered some minor mechanical flaws, but so far the multi-national maintenance teams are doing a credible job of troubleshooting and repairing the various bugs that arise. One such repair involved the Russian-made Elektron generator, which creates oxygen from water through electrolysis. An intermittent fault caused a complete generator failure back in May, forcing the crew to rely on oxygen reserves for three days. The crew used highly flammable, solid-fuel canisters to produce oxygen while the generator was down. In a slightly similar scenario to NASA's suspenseful Apollo 13 Mission, flight controllers in Moscow troubleshot the circuit from Earth and successfully narrowed the problem to a broken sensor in the oxygen generator. Luckily the generator job only took three days, well within the limits of the backup supply of oxygen, which would have been enough for three months. A workaround software-patch was quickly developed in order to rig the system into repair.

Sweden, Finland, and Russia have joined forces to launch the *Submillimetron Project* in order to produce an orbital telescope. The main objective of the telescope is to complete a submillimeter wave, full-sky survey; or, in layman's terms; the most detailed map of the Universe known to mankind. The entire project is expected to cost the three investing nations less than \$150 million. Home base for the telescope would be a dock located on the Russian module of the ISS. The telescope will periodically return to the dock for repairs and general calibration, before returning to its monotonous task of scanning the sky piece by piece. The telescope is also to be equipped with a super-sensitive receiver operating in the border region of IR and microwave—the tetrahertz range. Fans of SETI will be happy to know that this advanced listening post will be searching for any signals present on this band. Those involved say, "Probably, they will hear the voice of an extraterrestrial civilization. Or perhaps they will discover something absolutely new, for instance, a type of substance previously unknown." The United States, among other nations, is expected to contribute greatly in advanced technology development that will be incorporated into this multi-functional telescope.

By the time you read this, the Expedition Five Crew should be well on their way to accomplishing their task at hand—the installation of the first left-side truss rod (*1TSP1*), as well as the Crew and Equipment Translation Aid (*CETA*). These pieces continue to build on to the primary work platform that when complete will consist of a long truss-rod with a robotic arm mounted onto it. Crewmembers will attach themselves to the truss via the *CETA* in order to manipulate the robotic arm, which will then be used to construct the remainder of the station. Expedition Five Commander Valery Kozun, along with Flight Engineers Peggy Whiston and Sergei Treschev, are all due back to Earth in October 2002.



Crews onboard the *International Space Station* are continuously at work completing the joint-national science platform. Auxiliary equipment planned for the station include a robotic arm for help in construction, as well as a roving telescope.

today," said Professor Don Norman, who is a Professor of Computer Science at Northwestern University. "Evolution Robotics has done the same thing by facilitating the first affordable home robot for the right set of users and developers to give us the amazing applications of the future. Today, the personal robot

has taken its first step toward becoming a standard member of society."

And It Has...Personality

Evolution Robotics has also created a customizable personality module for developing unique personalities and digital characters. The personality module

comes with three predefined "faces" that tie directly into the software architecture of the robot and display emotions. "Revealing and demonstrating the inner workings of the robot will greatly enhance the experience of owning and working with a robot," said Bill Gross, Executive Chairman and Visionary Leader of Evolution Robotics. "When robots begin to enter our daily lives, it will be critical that they are designed to help their human owners understand how they work and when they might need assistance—that is what our personality module is designed to do."

"The Robot Developer Kit we have developed is a clear sign of Evolution Robotics' commitment and passion to bring to market the next wave of personal robot products for the home and workplace," said Bernard Louvat, President and COO of Evolution Robotics. "By providing the Evolution Robotics open software platform as the fundamental building blocks for the Robot Developer Kit, we have created a standard upon which all future personal robots can be built and developers can depend."

What's Inside

Evolution Robotics offers the Robot Developer Kit in two configurations—one configured for lab or team use, and the other configured for individual use—at three price levels, ranging from \$1495 to \$9995. Specifically, the standard Robot Developer Kit will include:

- Robot control module—control up to two stepper motors or two servos
- Motors with separate encoder inputs
- Sensors—nine infrared IR sensors, one USB camera, and bump sensors
- Microphone
- Drive and power—two stepper or servo motors, and differential steering
- 12-V battery
- Variable modular aluminum chassis components and plastic connectors for quick and flexible construction of hundreds of different designs
- World-class technical support, developer tools, and documentation
- Application Program Interface (API) for the Behavior modules—speech, vision, and personality
- Behavior layer

- Hardware layer
- Application utilities

Twelve months of free upgrades, including an upcoming object recognition module that will be available later this year, are also part of the package. Also available from Evolution Robotics is their ER1 personal robot for less than \$600. Our readers might prefer the ER1-K, which is an identical, but unassembled kit that costs less (\$499), and you get to put it

together yourself. The ER1 requires a laptop (not included) that must be at least a 800-MHz PII. The laptop is fully integrated into the chassis; and it acts as the brain for controlling the stepper motors, web camera, audio capture device, and other auxiliary equipment. The two-foot tall ER1 is controlled through a software control module over any 802.11 wireless network. For more details about Evolution Robotics' products, visit www.evolution.com. **PT**

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- Minimum Autorouter grid: 0.02 mm
- SMD pads can be rounded or round
- Different pad shapes for Top, Bottom, or Inner layers

EAGLE 4.0 Light is Freeware!

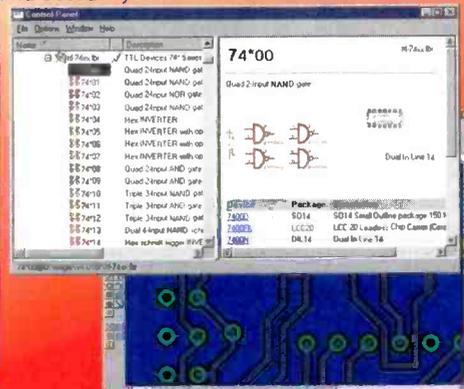
You can use EAGLE Light for testing and for non-commercial applications without charge. The Freeware Version is restricted to boards up to half Eurocard format, with a maximum of two signal layers and one schematic sheet. All other features correspond to those of the Professional Version. Download it from our Internet Site or order our free CD.

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INTERNET DisCRETION

How are you at resisting temptation? Imagine a scenario where you can lie, cheat, and steal virtually carte blanche, where a sucker and his money are always being parted, where your actions are limited only by your ethics or lack of them.

This is one side of the world of online auctions. It's the Wild West out there, huge and still largely ungoverned. Online auctions are the playing field of the conscience. How far will you go in promoting your interests? How dark will you tint the gray as you traverse the expanse that separate and meld truth and falsity into one another?

The good news is that, according to my experience and that of many others, there's far, far more good than evil out there. The bad news is that there's evil out there. This truth may be as old as the hills, but it's a truth you need to keep in mind if you venture into the always fascinating and frequently rewarding realm of online auctions.

CYBER FRAUD: THE REAL DEAL

The big three online auction houses are eBay (www.ebay.com), Yahoo Auctions (<http://auctions.yahoo.com>), and Amazon.com Auctions (<http://auctions.amazon.com>), with eBay being far larger than Yahoo Auctions and Amazon.com Auctions combined. eBay contends that the rate of auction fraud on its service is very low. It says that only one "confirmed" fraud occurs per 40,000 eBay listings. That is indeed a low rate—0.0025 percent.

The FBI, on the other hand, contends that the figure is much higher. As a part of its "Operation Cyber Loss" project, it determined that the rate of online auction fraud is about one in a hundred, or 1 percent. This is a very high rate of fraud, a whopping 400 times higher than what eBay contends.



AuctionWatch

The screenshot shows the AuctionWatch website interface. At the top, there are navigation tabs: HOME, SELL, MANAGE, UNIVERSAL SEARCH, STORES, RESUME CENTER, HOME HISTORY, and MY ACCOUNT. Below these are links for Services, Products, Pricing, and Company. The main content area is titled 'TIPS & TACTICS' and is divided into two columns: 'buyers' and 'sellers'. The 'buyers' column lists various tips such as 'Addressing Regulatory Questions', 'Analyzing Bid Patterns', and 'Avoiding Excessive Shipping Costs'. The 'sellers' column lists tips like 'Accepting Credit Cards', 'Addressing Bounced Checks', and 'Attracting a Clientele'. There is also a 'Customer Mgt' section on the left side of the page.

Auction Watch's Web site includes tips on avoiding auction fraud, as well as other related subjects. Government organizations, such as the FBI and the Federal Trade Commission, also maintain Web sites to help protect consumers from fraud.

The FBI's figure is the one to believe. eBay, whose earnings soared again in its latest quarter, to \$47.6 million, is very reluctant to intervene in individual auctions, describing its service as merely a venue that brings buyers and sellers together. Its policy is that it won't interfere with the auction of a blatantly counterfeit collectible, for instance, unless it's contacted first by law enforcement authorities.

THE BEST DEFENSES

All the online-auction services provide buyers and sellers with some protection against fraud. The most powerful is "feedback"—a way for participants in a transaction to rate one another and for others to see those ratings. But the ratings are always skewed positively, since leaving someone with negative feedback opens you up to receiving retaliatory negative feedback in return, and most people are reluctant to risk tarnishing their feedback record this way. Still, a large

percentage of negative feedback is a clear signal to stay away from a particular buyer or seller.

You should also avoid buying a big-ticket item from a seller with little feedback. Buying a more expensive item from a seller with a lot of feedback can also be risky, depending. One trick that scammers use is to sell a number of low-cost items to build up positive feedback, and then auction off a big-ticket item and skip town, virtually or otherwise, without sending it. It's always best when buying an expensive item to make sure that the seller has sold similar items in the past.

Mike Woodard Sr. of East Hampton, MA, recently paid \$300 for a set of old silver dollars through an eBay auction, only to have the seller nondeliver. Too often victims in these situations chalk it up as a learning experience—most online auction frauds go unreported—but Woodard took action. He contacted his local police department, who unlike most has a new Internet fraud

department. After Woodard presented his evidence, his police department contacted the police department local to the seller, who was from out of state. The seller was arrested and pleaded guilty, and Woodard is now awaiting restitution.

ARM YOURSELF WITH INFORMATION

More frequently, abuses arise when sellers mis-describe their items, exaggerating positives and ignoring negatives. The over-positive spin has always been a part of advertising practices, and it's easy for sellers to get caught up in this even when they're not intending to deceive. You should ask the seller for clarification beforehand if you have any doubts and refuse to bid if you don't get a satisfactory answer. Ultimately, with online auctions, knowledge is power. Arm yourself with information like this, and you'll greatly lessen your chances of getting duped. You can find more at the following Web sites:

Auction Watch's Tips and Tactics
www.auctionwatch.com/awdaily/tipsand tactics/index2.html

Internet Fraud Complaint Center's Fraud Tips
www1.ifccfbi.gov/strategy/fraudtips.asp

The Federal Trade Commission's "Internet Auctions: A Guide for Buyers and Sellers."
www.ftc.gov/bcp/menu-internet.htm

BREAKING THE INFORMATION LOGJAM

"Knowledge is power" is a profound phrase. However, there are cases where too much information can be overwhelming. Today, in the Information Age, we typically think of ourselves as being uniquely inundated with information. However, nearly two millennia ago, the Roman Stoic philosopher Seneca wrote, "What is the use of having countless books and libraries, whose titles their owners can scarcely read through in a whole lifetime? The learner is, not instructed, but burdened by the mass of them, and it is much better to surrender yourself to a few authors than to wander through many."

Still, technology does make the pace of life faster today than in bygone days, and information technology has

a way of forcing more data on us that we can handle. To be truly useful, information must be converted to knowledge and knowledge to wisdom. Fortunately, information technology can ameliorate the problem of information overload—often called "infoglut"—as well as aggravate it. It's how we use the technology that counts.

SIFT THROUGH THE INFO

Filter the info-wheat from the info-chaff. Who reading this right now isn't flooded with a gazillion e-mail messages each week, even each day. In response, some people have taken the draconian measure of not responding to or even reading e-mail, feeling that if the message is really important, the sender will follow-up with a phone call or fax.

Much is inevitably lost this way. A better approach is to set up "bozo filters" or rules in your e-mail program. Modern e-mail programs let you automatically direct junk messages into the trash as well as important messages into specific folders or mailboxes where they'll get your immediate attention. You typically instruct the program to look for keywords in the incoming messages' "From" or "Subject" fields or body of the message and tell it what to do next. With unsolicited mass mailings, or "spam," don't ask to be taken off the list or you may increase the spam you receive from unscrupulous senders.

If you follow Internet discussion groups—and much valuable inside information can be gleaned by doing so—you can also use technology to better manage your time. If one or more individuals habitually leaves belligerent, off-topic, overly-chatty, or otherwise time-wasting messages, you can set up a "kill file" or "kill filter" so that you'll be spared seeing that person's messages in the future.

Similarly, you can set up a "watch filter" that alerts you to any messages that contain keywords you choose. If you're pressed for time, you can ignore all other messages. Alternately, with Usenet discussion groups, you can avoid reading irrelevant messages by searching for keywords using Google Groups, at <http://groups.google.com>.

If you're searching for information on the Web using a search engine, you can save time by taking time to learn the site's advanced search proce-

POINT AND CLICK

Amazon.com Auctions
<http://auctions.amazon.com>

Auction Watch's Tips and Tactics
www.auctionwatch.com/awdaily/tipsand tactics/index2.html

DialogWeb's Alerts
www.dialogweb.com

Ebay
www.ebay.com

Google Groups
<http://groups.google.com>

Internet Fraud Complaint Center's Fraud Tips
www1.ifccfbi.gov/strategy/fraudtips.asp

Moreover Technologies
www.moreover.com

My Yahoo
<http://my.yahoo.com>

The Federal Trade Commission's "Internet Auctions: A Guide for Buyers and Sellers"
www.ftc.gov/bcp/menu-internet.htm

Yahoo Auctions
<http://auctions.yahoo.com>

dures. Another option is to use a Web clipping service that automatically searches for and delivers news and other information about topics you specify. A number of the free clipping services fell victim to the dot-com implosion, though My Yahoo, at <http://my.yahoo.com>, and Moreover Technologies, at www.moreover.com, are still going strong (Moreover provides pay services for businesses as well). Industrial-strength tools such as DialogWeb's Alerts, at www.dialogweb.com can be worth their price for critical information needs.

THE IMPORTANCE OF GOOD HYGIENE

Practice good information hygiene. Don't add to others' infoglut, and ultimately your own, by forwarding jokes or other irrelevant messages to those who may not have the time for them. Cc your own messages thoughtfully, not indiscriminately. Keep your e-mail messages to one screen whenever possible and use an informative subject line. Use other technologies

(Continued on page 18)

The Magic Of HTML

Are you interested in creating your own Web site? HTML is a programming language that lets you create a Web site with images, links, special effects, and more. Using tags, you can personalize the information and make your site look however you want to—you are in complete control. It really isn't too difficult, either. You just need a computer and a little patience—you don't need to be a Web or programming wiz to learn HTML. Some recommended reading is listed in the sidebar.

THE BASICS

HTML stands for *HyperText Markup Language* and is similar to SGML, the *Standard Generalized Markup Language*. Although it sounds complex, it really is a simple program you use to design Web pages. An HTML file consists of text, which is displayed to the reader of your HTML document, as well as tags that tell the browser how to format the text.

Invented by Tim Berners-Lee at the European Laboratory for Particle Physics in Geneva, HTML is a collection of platform-independent styles that define the different components of World Wide Web documents.

HTML lets you create links to another Web page, to a different location on the same Web page, or to any page anywhere on the Web. You can display your text in different styles, with different added effects, to enhance the appearance of your Web page. To really put the finishing touch on your site, you can add images and graphics, inserted from any graphics file.

HTML DOCUMENTS

HTML documents are plain-text, also known as ASCII files, that can be

```
Source of: http://www.gardenquest.com/planet_club_bronze.htm - Netscape
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=windows-1252">
<title>Bronze</title>
<meta name="GENERATOR" content="Microsoft FrontPage 4.0">
<meta name="ProgId" content="FrontPage.Editor.Document">
<meta name="Microsoft Theme" content="copy-of-citrus-punch 011, default">
<meta name="Microsoft Border" content="none, default">
</head>
<body background="_themes/copy-of-citrus-punch/j0143753.gif" bgcolor="#FFFFFF" link=
<div align="center">
<center>
<!--ms theme--><font><table border="1" width="77%" background="Prt01012.jpg" height="136" bordercol=
<tr>
<td width="100%" height="130"><!--ms theme--><font face="Arial, Helvetica"><h1 align="center">
M</font><font face="Berlin Sans FB Demi" size="6">embership</font></b></td><!--ms theme-->
</tr>
</table><!--ms theme--><font face="Arial, Helvetica">
</center>
</div>
<div align="center"><!--ms theme--><font face="Verdana, Arial, Helvetica" color="#FF6600"><font face=
receive the items listed below for 3 months.<br>
</font><font face="CG Times" color="#000080" size="3"><i>The specific plant
depends on the month you begin the membership</i></font><!--ms theme--></font></div>
<div align="center">
<center><!--ms theme--><font><table border="1" width="100%" height="27" bordercolordark="#FF6633"
<tr>
<td width="100%" height="31" background="Prt01005.jpg" align="center"><!--ms theme--><font face="
Membership</font><!--ms theme--></font></td>
<td width="15%" height="31" background="Prt01005.jpg" align="center"><!--ms theme--><font face="
Delivery</font><!--ms theme--></font></td>
<td width="17%" height="31" background="Prt01005.jpg" align="center"><!--ms theme--><font face="
Delivery</font><!--ms theme--></font></td>
</tr>
</center>
</div>
```

Fig. 1. Here is a screen shot of the source code written for Fig. 2.

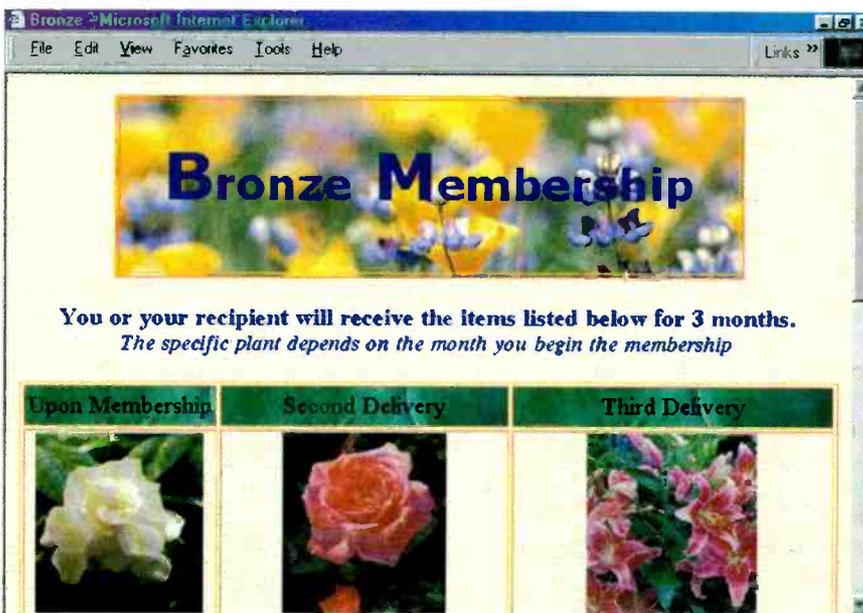


Fig. 2. This Web page was created from the source code shown in Fig. 1.

created using any simple text editor like Notepad or WordPad on Windows. It is best to create your code with these simple text editors as opposed to Word or WordPerfect, which may reformat your code as you create it. You are probably wondering how any lowly text editor could design such sophisticated-looking Web sites. Well, it's the Web browser that determines how the page actually looks. The browser reads the text, looks for HTML markings, then visually displays the page according to the instructions.

The only drawback to this is that it is impossible to know what your page will look like when it is done. Fortunately, you can do a test run on a browser before you actually publish your page. It's not a perfect scenario, but it works.

You will also need access to a Web server to get your files on to the Web. Contact your local internet provider to see if you can post your files free of charge.

TAGS

The tag is a code that describes how the images and texts are going to appear on your site. For example, if you want a certain word or block of text bold, you would type it as follows: (the tag for bold is ``)

```
<B>Welcome To My Web Page</B>
```

The first `` instructs the browser to make anything after it appear bold. The second `` (notice the backslash to denote an ending bracket) tells the browser to stop the bold instructions.

Tags denote the various elements in an HTML document. An element is a basic component in the structure of a text document. Elements can be heads, tables, paragraphs, and lists; and they may contain plain text, other elements, or a combination of both.

An HTML tag is made up of a left angle bracket (`<`), a tag name, and a right angle bracket (`>`). They are usually paired to begin and end the tag instruction. For example, `<H1>` and `</H1>`. The end tag is similar to the start tag except that a slash "/" precedes the text within the brackets.

Some elements may include an attribute, or additional information inside the start tag. For example, if we wanted to create a table using HTML,

we would use the table tag, `<table>`. We could add attributes to the tag to define the border and width of the table, as in: `<table border=2 width=100%>`.

Mark-Up Tags

- **HTML**—This announces to your browser that the file contains HTML coded information. The file extension `.html` also indicates that this is an HTML document and must be coded. The final tag in your document will be `</HTML>`.

- **Head**—The head element identifies the first part of your HTML-coded document that contains the title. The title is shown as part of your browser's window.

```
<head>
<title> my web page </title>
</head>
```

- **Title**—The title element contains your document title and identifies its content in a global context. The title is usually displayed in the title bar at the top of the browser window, but not inside the window itself. The title is also what is displayed on someone's hotlist or bookmark list, so choose something descriptive, unique, and relatively short.

- **Body**—The second and largest part of your HTML document is the body, which contains the content of your document (displayed within the text area of your browser window).

- **Headings**—HTML has six levels of headings numbered one through six, with one being the largest. Headings are usually displayed in larger and/or bolder fonts. The first heading in each document could be tagged `<H1>`.

```
<body>
<H1> This displays a large font </H>
Additional code here
</body>
```

- **Paragraphs**—You must indicate paragraphs with `<P>` elements. Without them, the document becomes one large paragraph. Your browser doesn't acknowledge carriage returns, so when it comes

RECOMMENDED TEXTS

HTML 4 For the World Wide Web, Fourth Edition: Visual Quickstart Guide

by Elizabeth Castro

HTML & XHTML: The Definitive Guide

by Chuck Musciano

HTML For Dummies

by Ed Tittel, et al.

across a spot where you pressed Enter, it will just keep reading the text until it comes to `<P>`. You can also use break tags (`
`) to identify a line break.

- **Lists**—Sometimes you'll want to present your information in the form of a list. HTML lets you create unnumbered, numbered, bulleted, and definition lists.

- **Tables**—You can also set up data into tables. HTML reduces multiple spaces to a single space, and doesn't pay attention to tabs. You can use rows and columns, however, and that will work in most situations. Refer to your selected text for more information.

ADDING IMAGES TO YOUR WEB PAGE

When you display images on your Web page, they don't actually appear on your text editor. All you do is add a tag to the document that basically says "add image here."

Use the image tag and define the source, which is the location of where the image is located.

```
<IMG SRC="A:\myimage.gif">
```

This HTML tag will display the image named `myimage.gif`, which is located on the A: drive.

CREATING A HYPERLINK

This is the backbone of all Web pages—creating the ability for your user to link to other locations, whether it be relative (within your own Web site) or absolute (to some other Web site). Here is an example.

```
<A HREF="HTTP://www.aol.com">GO TO AOL</A>
```

This bit of HTML code will display the words "Go to AOL" on your page, and will be linked to the AOL Web site. The user can click on these words to complete the link.

YOU'RE ON YOUR WAY

Although there is much more to know about "decorating" and designing your page for optimum beauty and presentation, hopefully you understand what HTML is about and how to go about making use of it. The concept isn't too far out—once you grasp it you should zip through the basics in no time. **P**

DIGITAL DOMAIN

(continued from page 15)

instead of e-mail, such as the telephone, when you expect a lot of back-and-forth communication—it will be a lot quicker.

If you're involved in creating Web pages, try to keep each page to a screen or two, and put the most important information up front. Break up pages with informative subheads so readers can get the gist of what you're saying with a quick scan.

When creating business documents, use executive summaries whenever possible. Wield clear, concise language to communicate, not bureaucratic to impress (and often confound).

Avoid time-wasting temptations. Surfing the Web can be the ultimate information time-sink, with ever more intriguing but ever less relevant links beckoning you on. Using an instant messaging or chat program can bring greater efficiency to collaboration, or it can degenerate into mere chat.

To manage e-mail discussions, selectively respond to e-mail, and match the length of your response to how eager you are to converse. A short, polite response indicates you've received the other person's message but need to move on.

Reid Goldsborough is a syndicated columnist and author of the book *Straight Talk About the Information Superhighway*. He can be reached at reidgold@netaxs.com or <http://www.netaxs.com/~reidgold/column>. **P**

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| <input type="checkbox"/> HH94S Hobbyists Handbook Spring Edition (1994) \$5.00 | |
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| <input type="checkbox"/> XTAL Crystal Set Handbook \$10.95 | |
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| | <input type="checkbox"/> 165 How to Repair CD Disc Players \$2.99 |
| | <input type="checkbox"/> 164 Modern Electrics (April 1908) \$1.99 |
| | <input type="checkbox"/> 160 New Ideas - 42 Circuits \$1.99 |
| | <input type="checkbox"/> 159 Low Frequency Receiving Techniques Building and Using VLF Antennas \$2.99 |
| | <input type="checkbox"/> 158 Electro Importing Co. Catalog (Circa 1918) \$2.99 |
| | <input type="checkbox"/> 157 All About Kits \$1.99 |
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BUY BONDS

MORE CHOICES in Optical Drives

Over the last several years, optical disc drives have become a standard and expected system component. What does change, almost from year to year, is exactly what kind of optical drive is expected. The most basic type of optical disc drive is the CD-ROM. Yes, these still show up, mainly in very low-cost entry-level PCs and laptops. Read speeds on these drives vary. When used on laptops, CD-ROM drives tend to top out at 24x. Those on desktops are generally faster, up to 52x. Keep in mind that those speeds are the maximum achievable speed, not the sustained average. Depending upon the technology used in the drive, CLV or CAV, read speeds can vary greatly depending upon what section of the disc is being read. With CLV (constant linear velocity), the drive motor spins the CD-ROM at a constant speed. This causes the outside tracks to pass by a fixed point faster than the inside tracks, so that those tracks are also passing by the read head more rapidly. With CAV, or constant angular velocity drives, the drive speed is adjusted so that the speed of the disc changes to maintain a consistent speed underneath the read head.

For most users, however, read-only optical drives are passé. Given that there is very little price difference between a CD-ROM drive and the less expensive CD-RW models, there is little reason to settle any more for just a CD-ROM.

FASTER, FASTER!

The big news is that in the last year you have some really terrific choices in



Pioneer embraced the DVD-RW and DVD-R format with its first generation drive, and it remained with this format with the DVR-A04—priced at just about \$500. The author was impressed with this device's performance.

optical drives if you want to upgrade your PC's capabilities in this area. Both write and rewrite speeds have taken a big jump just in the last year. It was less than six months ago when we received our first few drives capable of writing a CD-R at 24x. Within two months of testing those, vendors informed us of the availability of 32x write speed CD-RW drives. Most recently, we received a quartet of 40x CD-RW drives. These drives were provided by CenDyne, IO Magic, TDK, and TEAC.

In our initial tests, with media provided by the vendors, we were hard pressed to get record speeds as fast as 32x. This proved to be a function of early media. At 40x capability, all four of these drives are extremely sensitive to media and will not perform at the rated speed with media that doesn't meet specification. Verbatim was kind enough to send us a couple dozen of its new 40x CD-Rs, and that did the trick. All four drives loved the Verbatim discs, and we were able to burn a full 650-MB CD in just about three-and-a-half minutes with all four drives. The actual burn time varied by a few sec-

onds from drive to drive, largely as a result of the different mastering software that was provided by the vendor.

WHEN 700 MB IS NOT ENOUGH

While the newest generation of CD-RW drives is terrific, if your budget can handle it, an even better type of optical drive is now available. This is the DVD burner. These DVD drives can read standard DVD movies, read CD-ROM discs and read and write CD-R and CD-RW discs. But wait, there's more!

A DVD burner can also create write-once DVDs and rewritable DVDs. Why would you want to do this? One reason that comes to mind is the creation of DVD from your own home video that can play on almost any recently manufactured stand-alone DVD player. Another is the incredible 4.7-GB capacity of a DVD disc.

DVD burners are available in three different formats. The discs created in different formats are usually not readable in a DVD burner that uses a format different from the drive in which the disc was created. All three formats, however, can create a write-once disc that can be read in a standard DVD player or PC DVD-ROM drive. And two of the three formats create DVD rewritable discs that also have wide read compatibility.

The hold-out is the oldest of the three formats—DVD-RAM. With a DVD-RAM drive, you can store 4.7 GB if the media is single sided, or 9.4 GB of data and files if the media is double-sided. Most DVD-RAM discs come in a plastic cartridge, though you can remove the disc from the cartridge.

We tested the RS-111 DVD-RAM

SOURCE INFORMATION

CenDyne
714-556-1020
www.cendyne.com

Hewlett-Packard Co.
800-752-0900
www.hp.com

IO Magic Corp.
714-953-3000
www.iomagic.com

Pioneer Electronics, Inc.
310-952-2000
www.pioneerelectronics.com

TDK Electronics Corp.
516-535-2600
www.tdk.com

TEAC America, Inc.
323-726-0303
www.teac.com

VivaStar
510-699-1740
www.vivastar.com

drive from VivaStar. You can probably find this drive for considerably less than its list price of \$400, which makes it one of the less expensive DVD burners available. It includes five blank DVD-R discs, which makes it an even better deal. The VivaStar comes with its own recording software for recording on DVD-RAM and DVD-R discs. You can use a DVD creation application, such as Sonic's MyDVD with the DVD-R discs to make DVDs that will play on a stand-alone DVD player. Unlike the other DVD burners we tested, the VivaStar RS-111 doesn't record CD-R or CD-RWs, so you should consider keeping your current drive if you have one. The RS-111 will, however, play back DVD movies.

We also tested two of the second generation of DVD recordable drives using the other two formats. Pioneer embraced the DVD-RW and DVD-R format with its first generation drive, and it remained with this format with the DVR-A04. Hewlett-Packard was one of the many vendors that adopted the DVD+RW format. The first generation of these drives did not have write-once capability, though the dvd200i drive we tested added DVD+R capability. Both drives perform well, though

the HP is a bit faster when recording both write-once and rewritable discs. Both drives come with a terrific (though different) collection of applications, and both can play back standard DVD-ROMs as well as record standard CD-R and CD-RW discs. Pricing, at about \$500, is the same for both drives, so your choice will probably be made on which drive you are able to get for less.

THE BEST OF BOTH WORLDS?

If we had to choose only a single drive, we would probably go with either the HP dvd200i or Pioneer A04. In actuality, we think having both a DVD recordable and very fast CD-RW is the best path to take. We burn a lot of different kinds of discs here. Sometimes it will be a copy of a licensed application, so we have a backup if a disc gets scratched; other times it will be a copy of an audio CD to play in the car. That way, when the disc gets banged up, as it always does in the car, we have the original in good condition. We also make up a lot of compilation CDs, with specific tracks in MP3 or WMA format.

The DVD burners have also been getting a workout. We use the rewritables to make backup copies of important files and subdirectories. With most of our drives here containing 15 GB or more of data, files, and applications, it's still not possible to back up a hard disk onto a single 4.7-GB rewritable DVD. We also use write-once DVDs to burn long videos for other family members and friends.

One last caveat is that while you can copy CDs with a CD-R/RW drive, you can't copy commercial DVD movies with a DVD burner. At least not with the software that's provided. If you are willing to download software from the Internet, and experiment a bit, you will find that it is possible to make a copy, though with DVD write-once discs priced at about \$6 or \$7, it's probably not worth the time and effort to do so in most cases. **P**

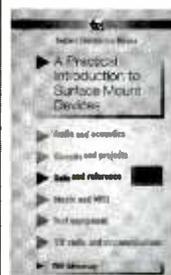
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5 GREAT PROJECT BOOKS

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To order one of these Books send amount indicated plus \$3.00 for shipping in the U.S. and Canada only to Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery. MA09

The FM Broadcaster

CLARKE HOMOLY

Here is a project that will amuse every electronics experimenter. Just a few dollars in parts lets you transmit your voice and music to any nearby FM radio! You have all seen various ads selling "wireless microphones" or "miniature FM transmitters." Well, here is one you can build yourself in the console of your choice. Use a little care and discretion in how and where you use it, since no one wants to interfere with anyone else's FM listening pleasure. Find a blank spot on the FM band and start broadcasting your own voice to a nearby FM receiver. This unit will give you surprising range and audio quality.

Circuit Construction. Find a box or cabinet about 8 inches long, 4 inches wide, and 3 inches deep. Once you take this important first step, the rest of the parts just seem to fly into place by themselves. Having a large supply of single-sided PC boards on hand, I soldered together a couple of scraps to make a no-cost chassis for this project (the walnut box cover comes later).

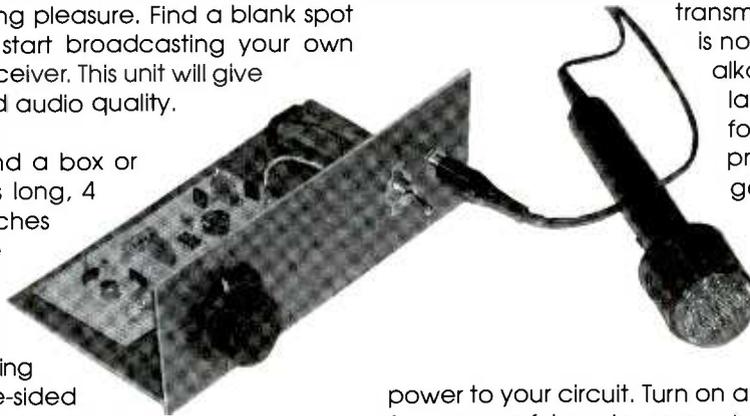
A piece of 2- × 4-inch perf board was the fastest way to fabricate the experimental circuit. Most of the items on the Parts List are easy to find, and none of the values are critical. The most difficult-to-find component is the variable capacitor. A search of several electronics catalogs did not turn up any. Small screwdriver-adjusted trimmer capacitors are plentiful, but not the 1/4-inch shaft variable capacitors that give you the luxury of adjusting with a big tuning knob. Unless you like to visit electronics ham-fest flea markets, you will probably have to settle for some 3–40 pF trimmer. Once all those parts have been gathered, you are ready to warm up that solder pencil.

It is a good idea to run a heavy bare-ground buss wire the full length along one edge of the perf board. This setup will give you a handy ground termination for the several parts that need to connect there. Along the opposite edge of the perf board, run a second buss wire for the +9 volts. Form your coil by wrapping the three turns around a 1/4-inch drill bit, and then slide it off.

When mounting the variable capacitor, be sure that you do not ground the rotor when mounting to your cabinet. The stator (the part that does not turn) should

connect to the collector of Q1. The rotor will have the shaft and knob attached to it. Doing things in this manner will help prevent your hand from causing frequency shifts when tuning. If a tiny trimmer capacitor is used, it will simply be mounted on the perf board. Although not evident in the photo, the battery holder was a low-tech dab of silicone sealer.

If you remember to turn the transmitter off after use, there is no reason why your 9-volt alkaline battery should not last three years. Finally, for home-construction projects, it is always a good idea to use IC sockets for easy part substitution.



Testing and Operation.

Once all components are in place, apply power to your circuit. Turn on an FM receiver and listen for a powerful carrier somewhere near the bottom of the 88–108-MHz band. After the carrier is located, you will find that it will overwhelm any FM station that you happen to place it on top of. No antenna is necessary to broadcast in a 50-foot radius. Do not expect your tuning range to cover the entire FM band; you may need to adjust the size of the coil to cover different portions of the FM band. Slightly compressing the coil, or adding one turn, will lower the frequency of the resonant circuit. In most cases, you will find that your frequency range will be over at least half the FM band.

Once you are satisfied that your transmitter is radiating a good carrier, you are ready to plug in the microphone. My microphone was a 600-ohm dynamic type, and I found that I needed the Q2 pre-amp stage before the LM386 chip. If you use a high-output ceramic MIC or a high-output electret or condenser MIC, you could skip building the Q2 audio stage and connect the MIC directly across the R6 potentiometer.

Now that everything is working, here is what takes place in the circuit. The oscillator Q1 gets its positive feedback from capacitor C2. For the oscillator to maintain a steady and stable frequency, the base bias must hold steady. Well, we deliberately applied a strong fluctuating DC voltage (the audio) onto the base to cause the oscillator to frequency modulate.

A careful analysis of the oscillator output reveals

*Learn how to build your own miniature
Frequency-Modulating transmitter.*

FM TRANSMITTER

PARTS LIST FOR THE FM TRANSMITTER

SEMICONDUCTORS

IC1—LM386, audio amplifier
Q1, Q2—2N2222 NPN transistor

RESISTORS

(All resistors are 1/4-watt, 10% units.)
R1—100,000-ohm
R2—470-ohm
R3—120,000-ohm
R4—10,000-ohm
R5—47,000-ohm
R6—10,000-ohm potentiometer

COILS

L1—3 turns of #20 wire on a 1/4-inch form, spaced 1/4-inch per turn

CAPACITORS

C1—50-pF, ceramic disc
C2—10-pF, ceramic disc
C3, C8—.1-μF, ceramic disc
C4—3–15-pF, variable capacitor
C5—5-pF, ceramic disc
C6—.001-μF, ceramic disc
C7—.05-μF, ceramic disc
C9—.01-μF, ceramic disc
C10—10-μF, 25-WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS

S1—SPST toggle switch
Perf board for circuit construction
1/4-inch phone jack for MIC input
9-volt battery clip

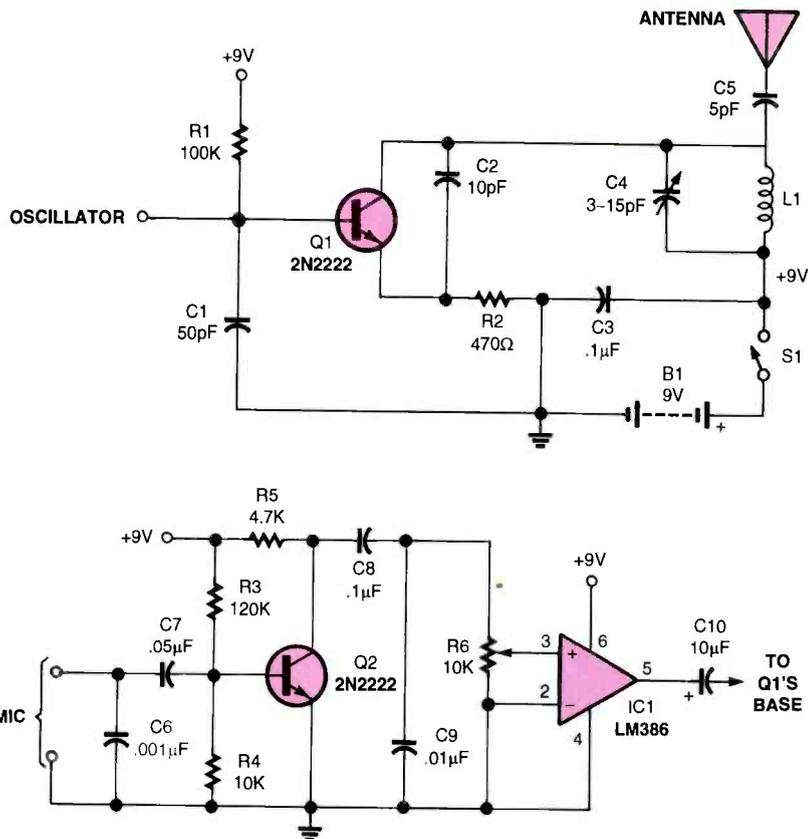


Fig. 1. As you can see by the schematic above, the FM Broadcaster Circuit is relatively simple to fabricate. Using an LM386 audio amplifier to boost the audio signal, it is then fed to the base of a NPN transistor (Q1). This transistor functions as an oscillator in this circuit, and its frequency modulates the carrier based on the audio input's (intelligence) voltage.

that there is also a fair amount of amplitude modulation that takes place—but don't worry about it, your FM receiver simply ignores it. There are other ways to cause an oscillator to frequency modulate, but this was the method we used.

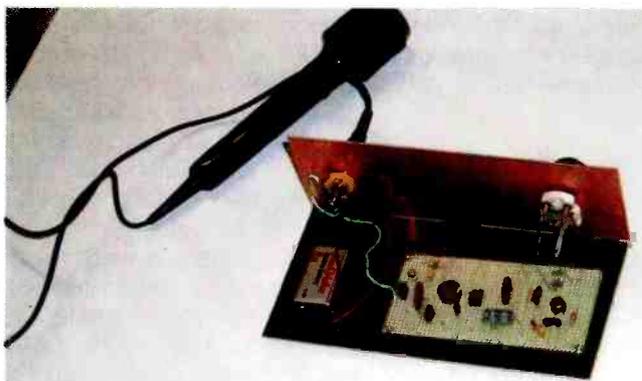
Troubleshooting. If you cannot hear a carrier at either end of the FM dial, try replacing Q1 with another device. I have found that some of the big "bargain"

bags of 2N2222 transistors contain units that really do not meet factory frequency specifications. Play it safe and purchase top quality transistors to begin with. Accidentally substituting a 10-μF for a 10-pF capacitor at C2 will prevent Q1 from oscillating.

A common reason for a lack of audio is a poorly wired IC or a poor solder connection. It never hurts to have a friend check your wiring after you have scrutinized it for errors. A fresh set of eyes really helps. If your circuit works one day and not the next it is not a faulty component; but it's rather more likely that you have an erratic solder connection or have left the battery on over night. A good general approach to troubleshooting is to build and test only one circuit at a time. Make sure your oscillator is working before you worry about the audio sections.

Begin Broadcasting. After all parts are in place, connect your MIC to the input and listen for yourself on a nearby radio. As stated earlier, no antenna is necessary to transmit a surprising distance. A 3-foot wire will extend your transmitting range; but in most cases this range extension is unnecessary. Adjust R6 for the best level of audio. If you wish to play CDs over the radio, simply mount another jack on the cabinet and feed

(Continued on page 32)



A piece of 2- × 4-inch perf board was the fastest way to fabricate the experimental circuit. Most of the items on the Parts List are easy to find, and none of the values are critical.

The Atari 2600: The Cartridge Family Rides Again

EDWARD B. DRISCOLL, JR.

Remember the 1970s? Vietnam, Watergate, stagflation, a flat stock market, bellbottoms, *Saturday Night Fever*, *Star Wars*, gas rationing, and other events that made that decade, at least in retrospect, seem like one of the sillier ones.

In the middle of all of that, there was the birth of a trend that's taken for granted today: the home-video game. The precursor to today's Nintendo, PlayStation, and Xbox systems was of course, the Atari 2600. Amazingly enough, it's still popular today, with cartridges and complete systems fetching top dollar on auction sites such as eBay.

Why does the popularity of the 2600 continue to this day? Leonard Herman, the author of *Phoenix: The Fall and Rise of the Videogame Industry* (Rolenta Press; ISBN: 096438485X) says, "The reason why I think it's so popular today is the same reason why old music's popular, old paintings are popular: it's an innocent art form. What Atari did with those games was that because it had so much more of a limited memory, they had nothing for graphics, so everything that they put into it was to make the games fun."

Many of today's video games are similar to those developed for the 2600 and its coin-operated big brothers, but with much better graphics and eye-candy. "But if you strip away all the eye-candy," Herman says, "you come out with a basic game, and that's what Atari was."

Understanding The Phenomenon. What led to the development of the 2600 and its phenomenal success? In 1971, Nolan Bushnell was a recently hired Ampex employee with a BS from the University of Utah, making about \$12,000 a year. Bushnell, who had worked at a Salt Lake City amusement park, was very interested in *Spacewar*, a Jurassic video-game, that ran on his university's PDP-1 mainframe computer.

To make a long story short, he converted *Spacewar* into what ultimately became a complex, slow, difficult-to-play, coin-operated version called *Computer Space* that failed to generate much revenue. With

that failure behind him, Bushnell and his partner, Ted Dabney, went on to create *Pong*, and they hired Al Alcorn, an engineer from Ampex, to build it.

Unlike the complex *Computer Space*, *Pong* is the *I Love Lucy* or *Honeymooners* of video games—black and white, one set, tiny cast, no special effects, minimal action, totally addictive. The games carried the explicit instructions: AVOID MISSING BALL FOR HIGH SCORE.



An Empire Is Launched.

Eventually named Atari for a key move in the classic Japanese board game Go, Bushnell's company created home versions of *Pong*, but they couldn't convince the retail store buyers to take a chance on the units.

Bushnell traces the success of *Pong*, and later the 2600, to a Sears sporting goods buyer, Tom Quinn. "In the Midwest, and various parts of the country," Bushnell says, "the sporting goods department is sort of relegated to ping-pong tables and home billiard tables in the winters. And so Quinn thought, that gee you know, there are billiard tables in homes, and billiard tables in bars, there are games in bars, maybe this is the time to put it in the home, so he took a gamble, and won."

While the placement of Atari's home version of *Pong* was a short-term success, Atari faced an obvious problem. Each of the early single-game consoles had a very long and expensive gestation period. Even an avid game player's attention span was shorter than the development time for new games. So people were getting bored and losing interest, while they waited for the next single-game console.

The triumphant rise and tumultuous fall of the Atari 2600.

Eventually, the engineers at a Grass Valley, CA consulting lab that Atari had acquired hit upon the concept of a game system with interchangeable cartridges. Bushnell says, "The economics looked really good. I mean, the razor/razorblade marketing always tended to work, and in addition to that, we felt that people wanted that variety, and that was the way to give it to them."



In late 1977 this bundle of joy was showing up at homes across the United States. The original Atari 2600 system came with the console, a power supply, two joysticks, two paddles, and Combat. Who can forget their first dose of Tank Pong?

The Release Of The 2600. Thus, the Atari 2600 Video Computer System (later, more popularly known as simply the 2600) was released in late 1977. In the previous year, Atari had been purchased by Warner Communications for 28 million dollars, based on its early console sales, and the success of Atari's coin-operated game division. For a while, Atari was a drain on Warner's resources, as initial sales of the 2600 were respectable, but not spectacular. Then, in 1980, Warner bought the home rights to *Space Invaders*, a smash hit of a coin-op game, from Midway. Suddenly, the Atari, heck, the whole home videogame industry, had its killer app. At the time, with the cable television industry just starting to take off, so many people were playing Atari, that it was known as "the fourth television network."

Of course, the 2600 wasn't even supposed to be around by then. Bushnell says, "The day that we launched the 2600, I told the guys at Warner, 'this product, you have to think of it as over.' And they said, 'What??!! This is really, really great!' And I said, 'No, you've got to think of it as over, because if we start a



Only die-hard console fans will recognize this distant-cousin of the 2600—the Atari 2600 JR. Unfortunately, this console would be part of the collective Swan Song of Atari, which some say was caused by dissension within the ranks. In 1984 Atari split up into a personal computer division and an arcade division, prior to the "Japanese-Console Invasion."

new product right today, by the time it's really ready for the market, you're going to need it."

Warner rejected Bushnell's advice, and he later left the company in 1978. The 2600 soldiered on, even in the face of increasingly complex opposition, such as Mattel's Intellivision and Coleco's aptly named ColecoVision cartridge systems.

1982: The Year of Living Dangerously. By 1982, video games were hot, even making the cover of *Time* magazine. However, the 2600's aging technology and Warner's rapacious exploitation of it caught up which each other. *Pac-Man* was the beginning of the end for the 2600's glory days. Curt Vendel, the chief "curator" for <http://www.atarimuseum.com/> says that Warner Communications gave Todd Frye, the programmer assigned to translate *Pac-Man* into an Atari cartridge, three months to get the job done "and even that time-frame was actually reduced." For an incentive, Vendel says that Warner "flashed a million dollar check plus royalties."

Unfortunately, Frye wasn't thrilled with the original coin-op *Pac-Man*, or with the thought of having to simplify for the 2600. Frye wanted Atari to use an 8k-memory chip, rather than the 4k-chip that Atari used for most of their cartridges (early 2600 cartridges used only 2k of memory!), which would have allowed a better program to be written; but, according to Vendel, they decided that "'Well, we're going to sell twenty million of these cartridges, so lets go with the cheaper chip, we'll make even more profit off this, and we're going to make a killing.'"

Unfortunately, because of the smaller chip, the result was a gross simplification of a game that millions had played, and knew intimately. Vendel describes the 2600 *Pac-Man* as being "completely off the wall, not even close to the original rendition of the game."

After *Pac-Man* was released, Frye became infamous in Atari lore for photocopying his one million dollar check and taping it to his office door for all other Atari employees to see, a far cry from the counter-culture atmosphere of Atari during its early Bushnell days.

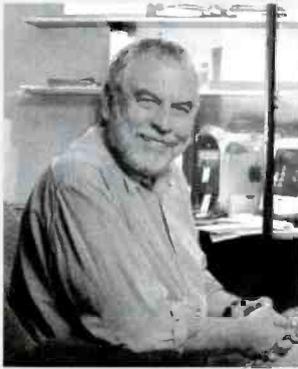
1984: The Crash. By 1983, Atari's monopoly-like status as the video game system was drawing to a close. Competitors' technology had caught up with it. A glut of video games flooded the market, and magazines had sprung up with video game reviews, so people didn't blindly purchase Atari products. There were also some quality issues. Atari's attempt at a replacement for the 2600, the 5200, was initially shipped with joysticks that had protective rubber boots that would easily tear after a few hours of play.

All of this is why 1929 was to capitalism what 1984 was to the video game industry. A deep depression in the video game industry had occurred, leaving many wondering if it would survive. At Atari, the number of employees fell to just 200 in July of 1984, down from a peak of 10,000 employees in December 1982.

Obviously, the home video game industry did survive, but with radical changes. With US companies like Atari and Coleco eventually neutered, Japanese-

uWINK: BUSHNELL'S CURRENT VIDEOGAME PROJECT

What happened to Nolan Bushnell? After collecting a reported 16 million dollars on the sale of Atari to Warner Communications, in the early 1980s, he founded the Chuck E. Cheese's family restaurants chain. After owning several video game-oriented companies, consulting for others, and serving



on the boards of dot-com startups, he's now CEO of uWink Inc. (<http://www.uwink.com/>), a company he founded in the late 1990s. "We make coin-operated games that are connected by the Internet, and we download new games all the time, and they're in bars and restaurants and coffee shops and airports," Bushnell says. "In some ways, it's back to our roots, because many of the games are very, very hip. You know, highly engineered, but simple. They're made for everybody who wants to play, relax, have a good time, but they don't want to have a Ph.D. in the damn game to play it."

Bushnell feels that video games have gotten too complex and too violent. "I believe that the typical game today disenfranchises most of the casual players." He jokes that "anybody with a wife" can't play them, because they just don't have the time to play them. "I mean, have you picked up a Nintendo controller lately? It has so many buttons, and you know, they're useful, but it's not a ten-minute exercise to figure out what to do with them. Ours are simple touch screens. Anyone can play within 30 seconds of being in front of them, and we're having people play who haven't played games in years."

Sort of like the 2600: Grab the joystick, start clicking a few buttons, and hours of excitement await. Have you played Atari today?

based businesses such as Nintendo and Sega were able to clean up for the rest of the 1980s into the 1990s, arguably until the release of Microsoft's Xbox (and the jury's still out on its long-term impact).

Also occurring in 1984 was the split up of Atari. The consumer division went to Jack Tramiel, the founder of Commodore, who focused his efforts on Atari's personal computers, in order to compete with his old company. Atari's arcade division stayed with Warner Communications for a while, and eventually became Time-Warner Interactive, who sold it to Midway Games, Inc., the coin-op manufacturer. And Midway recently discontinued the name Atari for its coin-op games, possibly the end of the line for the name Atari in the arcades.

In 1996, Jack Tramiel's Atari merged with JTS, a disk drive company, which eventually went out of business. In 1998, Hasbro bought the rights to its home titles. In 2000, Hasbro sold the rights to their Atari titles to

Infogrames, Inc. "And that's where Atari is right now," Herman says.

The 2600 in the PC Age. The spectacular growth of both PCs and the Internet has created several options for fans of the 2600 who want to recreate its heyday. eBay typically has a vast collection of 2600 games, accessories, and even whole systems available for purchase, mostly used. New and unused equipment (as well as used and refurbished equipment) can be purchased from Telegames, Inc. (<http://www.telegames.com/>), Best Electronics (<http://www.best-electronics-ca.com/>) and others. O'Shea Ltd. claims it recently discovered a cache of one million 2600 cartridges, which it's selling at \$5 each. Check out <http://www.atariclassic.com/> for details.

Several of the games and their late-70s, early-80s coin-op big brothers, are available for the PC. Microsoft has released several Arcade packages, which include *Asteroids*, *Ms. Pac-Man*, *Centipede*, *Missile Command*, and other classic games.

Hasbro released many of the same titles, and other classic video games in two different forms: one as bundled reissues of several coin-op games, the other as remanufactured versions of individual titles—the same basic games, but with vastly improved graphics. These games are now available from Infogrames, but have been more than a little controversial amongst gamers.

Curt Vendel says, "Hasbro has done very good with the original *Frogger*, but they tried *Frogger II*, and that that didn't work out. They re-released *Centipede*, and they tried to do what they thought was a classic mode on it, and they just got ripped a new hind-end on that one. *Galaga* was a flop." Vendel says that the problem that Hasbro and Infogrames have been running into is that either the companies they're hiring to do these titles appear to have no idea of how to update them, "or they're coming up with their own new flare, and their new take on it, and that's not how you do this."

Vendel says that the only thing that Hasbro and Infogrames have done well so far, "because it's difficult to mess up" is to re-release a couple of versions of what they've titled Arcade Hits. Hasbro took the original ROM code for the games and added a half hour interview with Nolan Bushnell, plus lots of archive information and trivia. "And that's been good", Vendel says, "because they're doing original emulation, you've got the look, you've got the feel," and Hasbro even has an option of framing the games with graphic recreations of the original coin op's cabinets.

In contrast, Activision, in the mid 1990s, released a CD-ROM called *The Atari 2600 Action Pack* that included a 2600 emulator and several of the original Activision and Atari games. Vendel's take on these CD-ROMs is that they "were really good, because you were playing the original ROM code" through a 2600 emulator via a PC and joystick. Unfortunately, the title has been discontinued by Activision, but it can still be found on some shelves, or possibly by a diligent search of the Internet.

Speaking of emulators, several different 2600 emulators can be found on the Web, along with the software to recreate 2600 games via a PC. The site <http://www.atariage.com/> has a FAQs page with a list of emulators.

Scott A. Jones

A Man With A Mission

MARIA ORLANDO

He says he wants to change the world. Here's a man who can—and probably will—do just that.

An extraordinary inventor of our time, Scott A. Jones has been called a “contemporary Thomas Edison.” He is the “Voicemail Tycoon,” the creator of the mass-user voice mail system. Scott is also a co-founder of the highly successful technology company, Escent Technologies. Designers of award-winning technology products, his companies are innovators in telephone data storage and the merger of consumer electronics with the Internet.

On the personal side, Scott treasures spending time with his young sons, ages 6, 8, and 10. He cherishes his 27,000-square foot home in Indiana, as well. Scott, who is divorced, was considered a very eligible bachelor by *People* magazine in 2000—one of fifty in this country. He also teaches an extremely popular college course, engages in community activities, gives generously to many charities, and offers his advice and assistance to entrepreneurs who are just getting started.

Remarkably relaxed for someone who oversees five companies and is involved in all the aforementioned activities, Scott retains a calm demeanor and a great sense of humor, and he is extremely approachable and pleasant.

A Fascination With Technology. Scott A. Jones had a keen interest in gadgets and electronics, even as a child. He would disassemble clocks and other electronic devices and try to put them back together again to try and figure out how they worked (sounds like the amazing Grace Hopper from last month's article!).

Scott described scenes in the basement, where he was elbow deep in dismantled electric train sets, transformers, and switches, getting electrocuted while his parents were upstairs, oblivious to their son's ingenious, mischievous activities. When he was a teenager, his mom, a freelance journalist, was having a problem with her typewriter. He promised to fix it, and she entrusted her son with her primary work tool. Scott stayed up through the night tampering with it, and Mrs. Jones awoke to find her prized possession in two hundred pieces. Suffice it to say she was not pleased, but Scott kept his promise, and by the end of the day

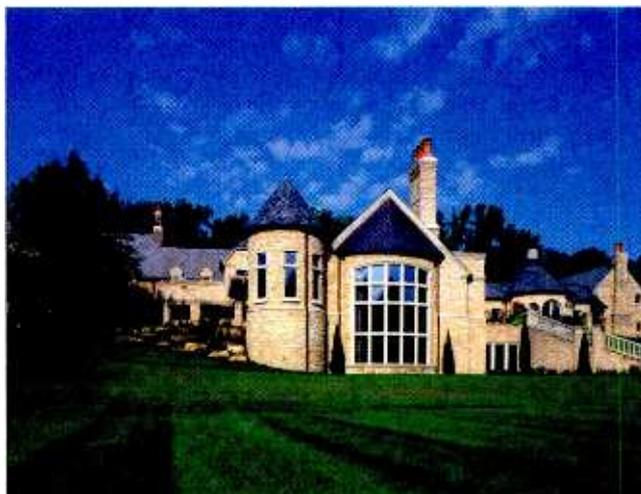
it was back together and in perfect working order.

As a college student, he lived off campus where he convinced his housemates to let him use the basement as a workshop. An avid reader of *BYTE* magazine, he placed a classified ad in which he asked (practically begged) industries to send him parts and gadgets—free of charge. And they did. He had loads of “stuff” to play with.

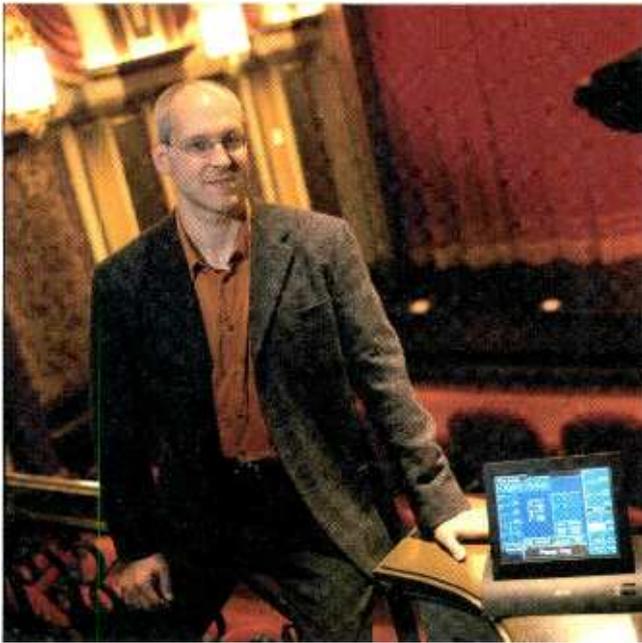
When he first entered Indiana University, he started out as a pre-med student, only to find out he was much more intrigued by computer science. During his years as a student, Scott worked as a programmer at the college's speech-recognition laboratory where he designed a computerized system that helped monitor electro-chemical activities in the brain.

After graduation he engaged in high-tech research at MIT Artificial Intelligence Lab, which included robotics, vision systems, massive optical storage, parallel competition, and the Internet. In the true entrepreneurial spirit, Scott used his technological background to co-found his first company, Boston Technology, Inc. As chairman and chief scientist, this is where he created the Voice Mail system that millions of us use every day.

Voice Mail Was Born. It was timing combined with genius that led to the birth of Voice Mail. In 1988 the U.S. District Court ruled that the Baby Bells (Regional Bell Operating Companies) would be allowed to offer



Exterior of his 27,000-square foot home in Indiana, nestled on 47 acres. (Photo courtesy of E. Anthony Valainis).



Scott A. Jones, standing on the balcony of the Digital Palace, a high-tech theater in his home. (Photo courtesy of John Bragg Photography).

voice-processing services through their networks to businesses and residences, but they could not manufacture the systems themselves. They needed a product that could handle their huge customer base and a system that was adequate enough to offer these voice-processing services to their massive network.

Boston Technology, Scott's company, had already invented a design for a very scalable system, and Scott promised that he could deliver a voice-mail system "20 times bigger and much more reliable than any system out there." He wasn't entirely truthful, as he hadn't worked out all the kinks—yet. With the burden of finding a huge solution to a huge problem, he slipped into the seclusion of his office where he stayed for one entire month. He ate and slept there and, in a month's time, he developed the technology needed to deliver his promise.

There was a glitch, however. There was one component missing from the puzzle. Boston Technology needed to get a hold of a telecommunications switch that was affordable as well as capable of handling such an enormous task. The existing switches on the market were either very high-priced or, if they were inexpensive, were inefficient.

At the time there was a recently defunct company called LanTel who had produced equipment similar to what Boston Technology was in search of. BT got in touch with the Vice President of the bankrupt company and met with him to discuss their problem.

As it turned out, the VP had a garage full of components—or junk—that were exactly what BT was looking for. The solution to their momentous dilemma was right before their eyes. The VP was back in business, and mass-user voice mail was on its way.

The World Of Business. Bell Atlantic was the first to buy Boston Technology's equipment in 1988, followed

by Southwestern Bell and BellSouth.

Eventually Boston Technology merged with Comverse Technology, Inc. (Boston Technology was actually in litigation with Comverse prior to the merger. Both parties thought it beneficial to join forces instead of fighting each other.) This resulted in a multi-billion-dollar company that supplied products and services to telephone companies around the globe.

In the early nineties Scott retired from Boston Technology to spend some time with his family and relax a bit. He also learned to fly—everything. He piloted hot air balloons, jets, helicopters, gliders, and anything else he could get his hands on. This new hobby was sparked by a fear of heights and of flying, which, he says, he has completely overcome.

That very quality is what drives him forward every day. He gets a charge out of looking obstacles straight in the eye, then tackling them with all he's got. He quoted one of his favorite sayings as we talked about his ability to conquer hurdles in his life: "That which doesn't kill you makes you stronger."

In 1996 Scott co-founded Escent Technologies, LLC, where he oversees all corporate activities as well as applies his expertise in technology and business to one of the company's ultimate goal: to merge Internet power with consumer electronics.

Scott seems very sincere when he expresses the desire to change the world. He says: "One of my primary goals is to continue to create devices and products that will simplify people's lives. Whether we are speaking of voice mail or a system that stores an entire collection of music and movies at one's fingertips, I'd like to think that I've made people's lives a bit easier to manage."

Escent has five affiliate companies, all technology-related: Gracenote, Escent Convergence Corp., OpenGlobe, Inc., PowerFile, and Escent Solutions, Inc.

The Philanthropist. Since his success, Scott continues to remember his community and those around him. In 1994 he established the Scott Jones Foundation which is dedicated to helping children through educational activities, especially in the area of advancing technology in schools to enhance the quality of their education. Supporting students in the areas of information technology, communications, and medical and life sciences will offer them unique opportunities in fields they would have only dreamed of.

Scott also sits on many boards of community organizations like the Indianapolis Zoo—where he recently donated a water park that is extremely popular with the kids, and now a roller coaster ride is currently in the works.

Recognized as a "life-giving angel" to start-up businesses, Scott is looked up to by entrepreneurs for advice and even financial assistance. He dedicates himself to these companies not only because of his benevolent nature, but also in the interest of the entire state of Indiana, where he wants the economy to thrive so that all businesses can benefit.

Digital Wheels. Scott doesn't like to waste time, 27

that's for sure. Truly "in touch with the world" wherever he goes, Scott A. Jones is hooked up to cutting-edge communications devices and high-tech electronics. His Chevy Express Van is rigged with everything and anything he needs to conduct business or enjoy an entertaining, leisurely cruise.

Together with his team Scott decided that on his commute to or from work or on business trips, he needed to make excellent use of his time. They designed his mobile work place to do just that. The van is armed with multimedia computer equipment, a cellular connection to the Internet, a conference table, a voice-activated GPS system, a color laser printer, and much more.

With pleasure being almost as important as business operations while en route, the van is also rigged with a VCR and DVD player, hundreds of hours of MP3 digital music stored on hard discs, TV reception, home-theater-quality sound, and a touch-screen that controls all audio and video devices. His trip to the office is just a bit different from ours!

An Extraordinary Abode. Scott is the owner of one of the most charming, breathtaking, technologically advanced homes in America. The 27,000-square foot (yes, I said 27,000!) English country manor is nestled on a 47-acre estate in the midst of lush lawns and tall evergreens. The mansion is considered to be a fine balance of aesthetically pleasing furnishings and décor and state-of-the-art electronics and communication devices.

Just some of the home's unique and amazing features include:

- A 20-seat multi-media theater
- A state-of-the-art temperature controlled wine cellar (with a 2000 bottle capacity)
- Integrated controls for whole-house automation
- A highly sophisticated home-security system that can be controlled from anywhere in the world via the computer
- A three-story great room with a third-story balcony for musicians
- A game room with a restored carved-mahogany billiards table from 1860
- A 2500-gallon saltwater aquarium with a live coral garden and various sea creatures
- A 28-foot circular mahogany slide with its own staircase

Although this is his home, Scott also uses the estate to hold various functions and meetings, sometimes hosting hundreds of people at a time.

Intech Park—The Envy Of Us All. Whether Scott designed the Intech Office Park—which houses



Intech Office Park, headquarters of Escient Technologies, situated on a 210-acre site overlooking Eagle Creek Park.

Escient Technologies, among other companies—because he truly cares about his employees or he is just trying to hold on to them is not the issue. The truth of the matter is that it is an attractive workplace with many amenities, designed to make it more appealing and provide an easier lifestyle for the people who work there.

The two-hundred acre site overlooks scenic Eagle Creek Park and is very accessible to the airport, downtown Indy, and the city's two major universities. An employee hardly has to leave the Park to take care of errands or tend to personal needs. Features within the Park include dry cleaning services, restaurants, child-care, a hotel, bank, and more. There is a fireplace in the main building where Scott holds "fireside chats" on Friday mornings for employees. Realizing the positive ramifications of establishing such an enticing place to work, Scott does admit that there is not a lot of turnover in his company.

The Road Ahead. Although Scott's main focus is Escient Technologies, he keeps a personal notebook filled with ideas in other areas of technology, including aviation and life-sciences. He says he's got some unique concepts on transporting people scribbled in his notes—I can only imagine. We'll just have to wait and see.

One recent accomplishment he is extremely proud of is the Honorary Doctorate he received from Indiana University. Instead of furthering his formal education, he pursued research and development in the field of technology. Indiana University recognized his distinctive endeavors in the form of an Honorary Doctorate, which was well deserved. Congratulations, Scott!

When I asked about his sons' interest in technology, he mentioned that there was a T1 line pumped into their tree house, and that the middle son is requesting a Palm Pilot with cellular phone capability for Christmas. That pretty much answered my question.

For now, Scott will maintain his vision for the integration of technology and consumer-related products. He will also run his five companies, host functions, sit on boards, father his three sons, travel to meetings, and maybe find some time to enjoy his estate. In the pursuit of changing the world, however, who knows what the future holds for Scott Jones and the rest of us? **□**

A CENTURY OF ELECTRICITY

ALVIN G. SYDNOR

The history of the advancements of science and particularly electricity clearly shows that its progress has not lacked continuity. No one man or any generation of men can be justly credited with all that is involved in any one of the great scientific inventions or great

discoveries that have enriched the world. All the electrical scientific achievements have been built upon the labors of their predecessors. To understand the completed work it is necessary to know something of the history of the various stages of advancements.

Electricity traces back to Homeric times. In the *Odyssey*, reference is made to the "necklace hung with bits of amber" presented by the inhabitants of ancient Phoenicia to the queen of Syria. Amber was highly prized by the ancients and was extensively used as an ornamental gem. Many different theories were suggested as to its origin. Some of the theories, although mythical, were near the truth. Amber was the first known source of electricity and when rubbed it attracted light bodies. This is a power it was known to possess in the earliest times and was the one single experiment in electricity that came down from ancient times.

Progress from the beginning to the end of the Eighteenth century

Frequent references to amber can be found in many early writings. Among them is the statement that those engaged in grinding and polishing amber for ornamental purposes were often seized with a violent tremor throughout their arms and bodies—a greatly-exaggerated account of what may have resulted from rubbing the substance.

More than two thousand years ago, Thales, a Greek philosopher, spent much of his life among the priests of Memphis from whom he is thought to have learned of the peculiar property of amber. True to human

instincts, he undertook to construct a theory to account for its behavior.

The power of certain fish to produce electricity was also known at an early period and was studied by Pliny and Aristotle. Its effect in the human body was recognized, and it was thought that some individuals were capable of emitting electric sparks and flames.

The possible value of electricity as a medical agent was recognized in these early days, and some extraordinary accounts of various cures by its application were reported.

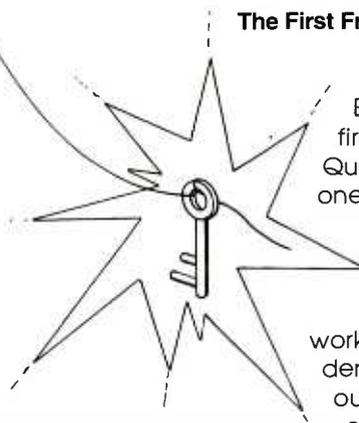
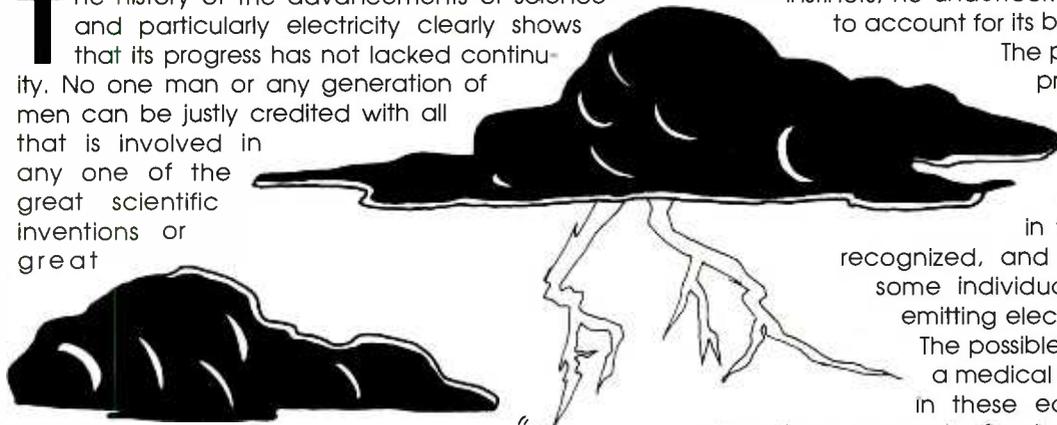
But, throughout all these centuries, even up to the sixteenth, there seems to have been no attempt to study the electrical phenomena in a really scientific manner. Isolated facts were known, but there was no classification, generalization, or even examination by experimentation.

Electricity as a science was above all other areas of science in that it depended for its development on experimentation. Naturally, it had to wait for the realization of the importance of experimental and inductive methods that occurred at the close of the sixteenth century.

The First Fruits of Experimental Philosophy.

Dr. William Gilbert of England was the first physician to Queen Elizabeth, and one of the most extraordinary men of his time. In the preface of his great work *De Magnete*, he denounced in vigorous terms the methods of "philosophiz-

ing." His sentiments and language were very similar to those of Lord Bacon. Gilbert's work is often referred to as the "first-fruits of experimental philosophy." Gilbert can justly be called the creator of the science of electricity and magnetism. His experiments were extraordinary in their number, and many of his conclusions were correct and



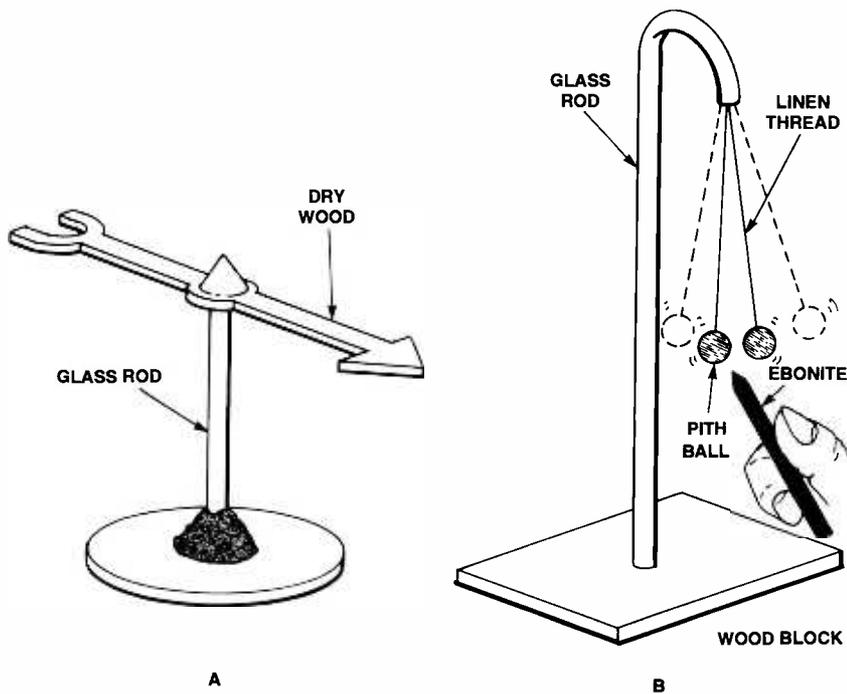


Fig. 1. In 1745 Dr. William Gilbert built the world's first electroscope (A) using a needle of dry wood resting on a cup suitably balanced on a support. Later the pith-ball electroscope (B) was used to demonstrate the conduction of electricity.

lasting. To him we are indebted for the name "electricity," which he bestowed upon the power that amber exhibited in attracting light bodies. He borrowed the name from the Latin word for the substance itself, in order to define one of its attributes.

In 1745 Gilbert built the world's first electroscope. Gilbert's original electroscope used a needle of dry wood resting on a cup suitably balanced on a support. (See Fig. 1A.) Later the pith-ball electroscope, shown in Fig. 1B, was used to demonstrate the conduction of electricity. With this instrument, he discovered that the power of attracting light bodies did not belong to amber alone, but that many other substances possessed it when they were properly excited. He examined the conditions that were favorable and not favorable to the production of electrical phenomena, and he discovered the influence of a moist or dry atmosphere upon electricity.

The experiments into the study of electricity by Gilbert were industriously pursued by those who came after him, and the next two centuries witnessed a rapid development of the science. Among the students of this period were the

English philosopher Robert Boyle, and the celebrated burgomaster of Magdeburg, Otto Von Guericke who first noted that sound and light accompanied electrical excitation. These were afterwards independently discovered by Dr. Wall, an Englishman, who made the somewhat prophetic observation, "This light and crackling seems in some degree to represent thunder and lightning." Sir Isaac Newton made a few experiments in electricity, which he exhibited to the Royal Society. He did not, however, allow his interest in electricity to divert his attention from his other studies, although he made electricity the subject of several of his famous *Queries*. Francis Hawksbee was an active contributor to the experimental investigation of electricity by calling attention to the resemblance between the electric spark and lightning.

Electric Virtue. The most ardent student of electricity in the early years of the eighteenth century was Stephen Gray. He performed a multitude of experiments, nearly all of which added something to the rapidly accumulating stock of knowledge. His most important contribution was his discovery of

the distinction between conductors and non-conductors.

In endeavoring to see how far the "electric-virtue" as he called it could be carried or transmitted, he had experimented with its transmission in a vertical direction by means of suspended cords, rods, etc. The distance in the vertical direction being limited, he started to use horizontal lines of transmission, in which he sometimes succeeded and sometimes failed.

He finally supported his lines by means of silk thread, which was more successful than other supports, "on account of its smallness," as he thought. On one occasion the silk thread broke under the weight of his long line, and he substituted a metal wire and to his surprise, he was unable to produce a very small electrical effect at the other end of the line. As, a result of this experiment he was led to believe that "electric-virtue" had leaked out through the metal, and that the smallness of the silk was not the reason of its effectiveness.

The separation of bodies into conductors and non-conductors, arising out of this experiment, was a decided advance in both theory and practice. By experimenting with two oak blocks, one solid and the other hollow, he found that the hollow blocks were electrified as easily and as strongly as the solid blocks. He even electrified a soap bubble, and had a boy suspended by hair ropes that proved that the human body was capable of exhibiting electrical phenomena.

Some of Gray's research papers fell into the hands of Dufay, an officer of the French army, who, after several years of service, resigned his post to devote full time to scientific pursuits. He repeated many of the experiments described by Gray and became an enthusiastic student of the science of electricity. His work demonstrated great acuteness of mind as well as remarkable experimental skills. He critically examined all experiments made by Gray. His most important discovery was the existence of two distinct species of electricity, which he named "vitreous" and "resinous;" the first being applied to that which exists on glass when it is rubbed,

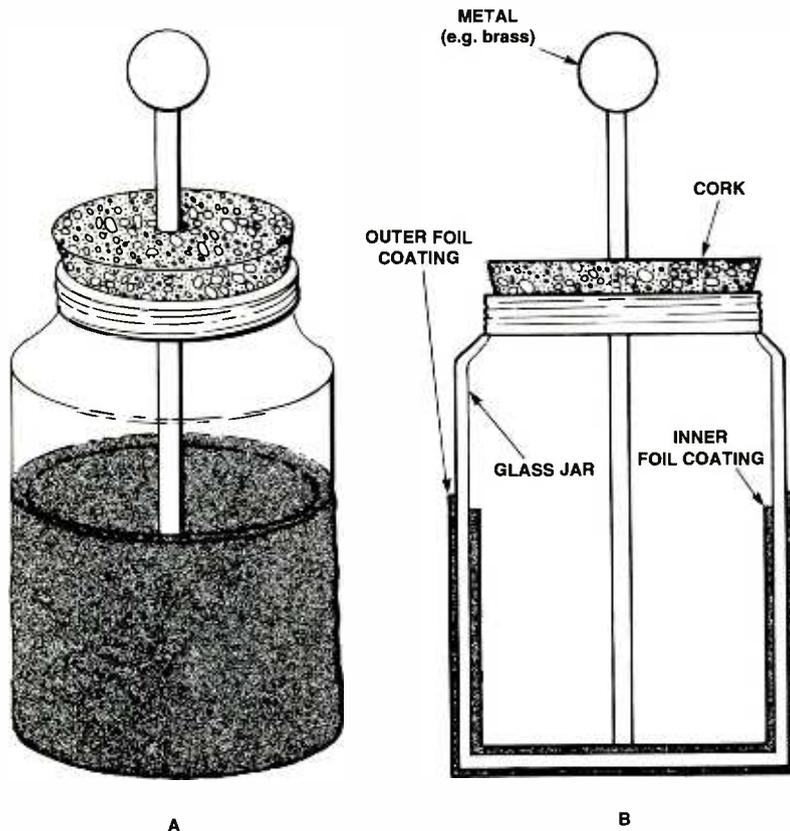


Fig. 2. A Leyden jar consists of a condenser (a glass jar) having a wide mouth coated with tinfoil, both on the inside and outside, and extending a few inches below the top. The mouth of the jar is usually closed by a piece of dry wood through which a metal rod is extended, reaching to the inner coating of tinfoil, as shown in "B" above.

and the second to that of amber and other resinous substances.

It was Mr. Kindersley, an experimenter and associate of Franklin, who immediately recognized what Dufay had failed to see, and that was that the two electricities described as "vitreous" and "resinous" were actually positive and negative charges.

The Leyden Jar. The next important advance in the early study of electricity was made in 1745 with the invention of the Leyden jar, shown in Fig. 2. Basically the Leyden jar is a condenser that was made using a glass jar having a wide mouth coated with tinfoil, both on the inside and outside, and extending a few inches below the top. The mouth of the jar was usually closed by a piece of dry wood through which a metal rod extended, reaching to the inner coating of tinfoil, as shown in Fig 2B. The rod extending from the top had a small metal ball attached. Basically, the Leyden jar consisted of two con-

ducting surfaces separated by a non-conductor.

As first used by Muschenbroeck, the inner conductor was water and the outer conductor was the moist hand of the experimenter. Connecting either coating with the source of electricity charged the jar, while the other was connected to earth.

As often happens in the history of scientific discovery, it seems that this interesting device was hit upon by at least three persons working independently of each other. A monk named Kleist and Professor Muschenbroeck of Leyden are credited with the discovery of the Leyden jar. To this day it still retains its name "Leyden," the city in which it was first exhibited and experimented with.

Using the Leyden jar, experimenters were able to work on the mysterious "electric-virtue" or "effluvium" at higher voltages and produce effects entirely unknown before. It was Sir William Watson who perfected it by adding the outside metallic coating, thus enabling

him to be able to fire gunpowder and other inflammables.

Professor Watson, working along with other experimenters at the Royal Society, used the Leyden jar to perform various experiments on the velocity of current passing through various metallic conductors. They also succeeded in sending current through a wire that was more than twelve thousand feet long, thus reaching the conclusion that the transmission was instantaneous.

The Work of Benjamin Franklin. In early 1747, Peter Collinson of London, who was a Fellow of the Royal Society, sent Benjamin Franklin a Leyden jar that Collinson called an "electrical tube" along with instructions on how to use it. Franklin began a series of experiments, resulting in discoveries that were described by a celebrated English authority as giving a form and dignity to the science of electricity it had never before possessed.

Franklin wrote Mr. Collinson a letter dated March 28, 1747 saying: "For my own part, I never was before engaged in any study that so totally engrossed my attention and my time, for what with making experiments when I can be alone, and repeating them to my friends and acquaintance (who, from the novelty of the thing, come continually in crowds to see them) I have, during some months past, had little leisure for anything else."

The results and deductions that Franklin made during all his experiments were sent to Mr. Collinson on a steady basis and were read to the members of the Royal Society. At first Franklin's letters did not meet with a cordial reception by the distinguished members of the Royal Society. Some were laughed at, and none were thought to be worthy of publication in the *Royal Society Transactions*. They weren't given recognition until experimenters in other countries, notably in France, had repeated the experiments and acknowledged the genius of the author of the letters.

The letters at that time were not published in the *Royal Society Transactions*, but were published in London and later translated into French, and in France they met

with greater appreciation. Soon, word got out that French experimenters were interested in following Franklin's experimental results. Finally, the Royal Society was obligated to reconsider the matter of publishing Franklin's letters. In the *Royal Society Transactions* for the year 1751, there appeared a fair and favorable account of all Franklin's experiments up to that time. In order to make honorable amends, Sir William Watson wrote the following introduction:

"On the whole, Mr. Franklin appears in this work in light of a very able and ingenious man; that he had a head to conceive and a hand to carry into execution whatever he thought might conduce to enlighten the subject of which he was treating; and though there are in this work some few opinions in which Mr. W. could not perfectly agree with him, he thought scarcely any body was better acquainted with the subject of electricity than Mr. F. was."

It is important to point out that respect and justice must be paid to the Royal Society because when Franklin visited England in 1775, he was received by its members with honor and was elected as a fellow member. The Copley Medal was bestowed upon him, and the Society's Transactions were sent to him for the remainder of his life at no cost.

The Lightning Rod. There is no question that Franklin's contributions to the science of electricity were numerous and comprehensive. His experiments were well planned and skillfully executed. His discussion of principles and his elaboration of hypotheses were characterized by the simplicity and clarity of his writings on all subjects. He was the first to perform further research into the Leyden jar in which he improved its sensitivity. The discovery that gave him the

greatest fame was to identify lightning and electricity; also he is credited with the use of the known laws of electricity, principally those that he himself had discovered in the invention of the lightning rod, which was a means of protecting buildings from damage by lightning.

The germ of this discovery seems to have existed in his mind in 1749, and it was on November 7, 1775 that the following passage appeared in his notebook:

"Electrical fluid agrees with lightning in these particulars: 1. Giving light. 2. Color of the light. 3. Crooked direction. 4. Swift motion. 5. Being conducted by metals. 6. Crack or noise in exploding. 7. Subsisting in water or ice. 8. Rending bodies it passes through. 9. Destroying animals. 10. Melting metals. 11. Firing inflammable substances. 12. Sulphurous smell. The electric fluid is attracted by points, - we do not know whether this property is in lightning. But since they agree in all the particulars wherein we can already compare them, is it not possible they agree likewise in this? Let the experiment be made."

Shortly after writing this in his notebook, the hypothesis was elaborated upon and sent to Mr. Collinson in London and soon reached France, where Franklin's suggested experiment of drawing electricity from the clouds was taken very seriously. Soon, the experiment was performed by Monsieur D'Alibard at Marly, France on May 10, 1752 and a few days later it was repeated by M. de Lor in Paris. The results of these two experiments were sent to the Royal Society.

Among those studying the science of electricity during the eighteenth century, the distinguished German philosopher Epinus must be mentioned, as well as the equally distinguished Englishman, Harry Cavendish. Cavendish was the first to make accurate experi-

ments on the conducting powers of different substances, and also the first to study the chemical effects of electricity, which became extremely important in the advancement of electrical science.

Cavendish was the first to explode mixtures of oxygen and hydrogen by means of a spark, and by varying the proportions of each he obtained a combination where nothing but water was the result, thus proving the composition of this substance.

The Laws of Attraction and Repulsion. Reference must be made to the work of one of the most brilliant experimental philosophers of the eighteenth century, Charles Augustin Coulomb. To him the science of electricity is forever indebted for the discovery and proof of the law of electric attraction and repulsion. He exhibited marvelous skill and ingenuity when he demonstrated that the force exerted was, as Newton had found, that the attraction of gravitation was inversely proportional to the square of the distance. The methods Coulomb devised were of such value that many of them are still in use today, and are being used by most quantitative researchers.

As outlined here, there was much activity into the study of electricity and you cannot fail to note that the experimenters' and philosophers' knowledge was at that time to some degree unscientific. It consisted largely of a considerable collection of experiments that were often brilliant and ingenious, and were at times isolated and unrelated as well as far from being orderly as an exact science when comparing the research and experiments of today. The golden age is now and will always be the present. It was George Santayana who said, "Those who cannot remember the past are condemned to repeat it." P

FM BROADCASTER

(continued from page 22)

the low-level audio from the ear-phone jack of the CD player directly across R6. Do not try to

feed the audio into the preamp Q2, since it will be overdriven and distort. This is a monaural transmitter, so feed both the L and R side of the audio together into

the same jack. While you drive around town with this project, a portable CD player lets you enjoy your own music over the car radio! P

Crystal Oscillators and Circuits

It is often required to produce a signal whose frequency or pulse rate is very stable and exactly known. This is important in any application where time or exact measurement is crucial. It is relatively simple to make an oscillator that produces some sort of a signal, but it is another matter to produce one of relatively precise frequency and stability. AM radio stations must have a carrier frequency accurate within 10 Hz of their assigned frequency, which may be from 530 to 1710 kHz. SSB radio systems used in the HF range (2–30 MHz) must be within 50 Hz of channel frequency for acceptable voice quality and within 10 Hz for best results.

Frequency Stability—Measuring Up

Some digital modes used in weak signal communication may require frequency stability of less than 1 Hz within a period of several minutes. The carrier frequency must be known to fractions of a hertz in some cases. An ordinary quartz watch must have an oscillator accurate to better than a few parts per million. One part per million will result in an error of slightly less than one half second a day, which would be about three minutes a year.

This might not sound like much, but an error of 10 parts per million would result in an error of about a half an hour per year. A clock such as this would need resetting about once a month, and more often if you are the punctual type. A programmed VCR with a clock this far off could miss the recording of part of a TV show. Narrow-band SSB communications at VHF and UHF frequencies still need 50 Hz frequency accuracy. At 440 MHz, this is slightly more than 0.1 part per million.

Ordinary L-C oscillators using conventional inductors and capacitors can achieve typically 0.01 to 0.1 percent frequency stability, about 100 to 1000 Hz

at 1 MHz. This is okay for AM and FM broadcast receiver applications and in other low-end analog receivers not requiring high tuning accuracy. By careful design and component selection, and with rugged mechanical construction, .01 to 0.001%, or even better (.0005%) stability can be achieved. The better figures will undoubtedly use temperature-compensation components and regulated power supplies, together with environmental control (good ventilation and ambient temperature regulation) and “battleship” mechanical construction.

This has been done in some communications receivers used by the military and commercial HF communication receivers built in the 1950–1965 era, before the widespread use of digital-frequency synthesis. But these receivers were extremely expensive, large, and heavy. Many modern consumer-grade AM, FM, and shortwave receivers using crystal-controlled digital-frequency synthesis will do as well or better from a frequency stability standpoint.

Waveforms

An oscillator is basically an amplifier and a frequency-selective feedback network (Fig. 1). When, at a particular fre-

quency, the loop gain is unity or more and the total phase-shift at this frequency is zero, or some multiple of 360 degrees, the condition for oscillation is satisfied, and the circuit will produce a periodic waveform of this frequency. This is usually a sine wave, or square wave, but triangles, impulses, or other waveforms can be produced. In fact, several different waveforms often are simultaneously produced by the same circuit, at different points. It is also possible to have several frequencies produced as well, although this is generally undesirable.

In an oscillator, the feedback network determines the frequency and stability of the generated signal. Frequency is of course the number of cycles per unit time produced and is generally specified in Hz, kHz (1000 Hz), MHz (1 million Hz), or even GHz (1 billion Hz). Stability is another matter. What we are trying to express is how much the oscillator frequency will change in a certain amount of time.

Duration Is The Key

The key here is the length of time. Long-term stability is generally expressed in frequency drift (ΔF or ΔF) per unit time or specified time interval.

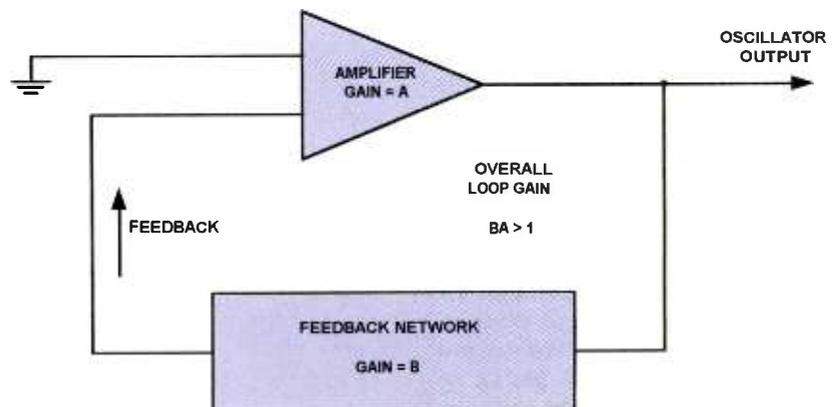


FIG 1
BASIC OSCILLATOR

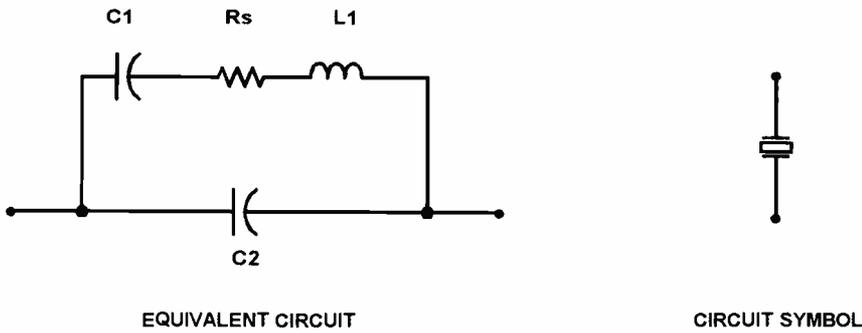


FIG 2
QUARTZ CRYSTAL AS A CIRCUIT ELEMENT

below 1 milliwatt (or 10 microwatts) of noise power and assorted garbage in the adjacent 1010-kHz channel. This is quite lousy performance, and unacceptable. If used as a receiver local oscillator, this noise power would act as a "spurious" local oscillator, causing unwanted noise from reception of signals 10 kHz away.

This effectively overrides and effectively destroys any really good IF selectivity that the receiver may possess. Used to drive a 10-kW AM broadcast transmitter, this oscillator would generate 1 watt of RF noise at 1010 kHz, causing interference with any weaker signals on that channel. This, of course, is unacceptable. Poorly designed frequency synthesizers would also behave like this. If the noise spec of the oscillator were -110 to -120 dBc at 10 kHz, this would be much more acceptable. This concept may prove a little difficult to understand at first, but it is very important in practice.

The Feedback Network

The key component in determining oscillator stability is the feedback network, assuming the amplifier portion has relatively good noise performance. In the amplifier, a low-noise transistor or other active device should be used. The more stable oscillators tend to have better noise specs. Phase noise and drift are manifestations of frequency instability on different time scales. The stability of an oscillator, all other things being equal, can be related to the rate of change of feedback network phaseshift versus frequency.

This, in plain English, implies something with very high selectivity and therefore high Q, the higher the better. These devices include quartz crystals,

Long-term drift is caused by component aging due to electrical, thermal, physical, and chemical changes in components over a relatively long (100 hours or more) time period. This is generally, but not always, permanent. This is generally compensated for by readjustment of circuit parameters, either manually or automatically. Short-term stability is usually caused by component changes due to circuit heating, warmup, temperature fluctuations, and instability of components, both electrical and mechanical. Generally time periods here are minutes to an hour or so. This is often temporary and tends to follow a pattern, but can be random due to cyclic temperature changes, etc.

Even shorter term frequency drift involving periods of a few seconds down to millisecond intervals is caused by circuit noise and mechanical factors (shock and vibration). As the time interval gets shorter, we run into random frequency fluctuations caused by noise in the amplifier and circuit components, as well as naturally occurring thermal noise generated in resistances. This noise is generally called "phase noise" as it appears as random noise modulation in AM, FM, and phase modulation (they are mathematically all related) on the generated signal. This noise is generally measured in a given bandwidth at some specified frequency away from the main carrier. This is done with a spectrum analyzer and notch filters to notch out the main carrier.

Note that the main carrier is often 60-120 dB higher in amplitude than the noise level we are trying to measure. This measurement is then converted to a figure expressed in decibels per Hz of bandwidth with respect to the main carrier and expressed as dBc. One often sees oscillator phase noise measurements given

in specs for oscillator circuits and prepackaged oscillators.

It is hard to say what a good figure is as it depends on application. Low-phase noise is important in radio receivers and communications systems. It is less important in applications such as computer clocks, and noncritical timing oscillators used in digital systems and circuits. An oscillator that has high-phase noise is said to be "dirty." As an example, suppose a 10-milliwatt output oscillator running at 1 MHz is specified as having -70 dBc/Hz @ 10 kHz phase noise.

Noise Power

Sounds good at first? Let's look at the noise at 1010 kHz (1.01 MHz) in a 10-kHz bandwidth. Since noise power is additive, in a 10-kHz bandwidth we will have 10,000 times the noise power, or 40 dB more. The noise power would be minus 30 dBc in a 10-kHz bandwidth.

Of course, the noise spectrum is not flat with frequency, but we will assume for illustration that it is. In this case our 1-MHz oscillator is producing 30 dB

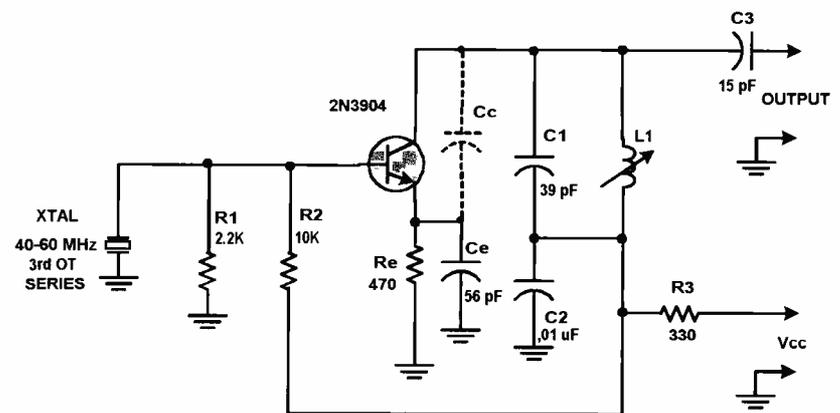


FIG 3
SIMPLE 3rd OVERTONE GROUNDED BASE OSCILLATOR

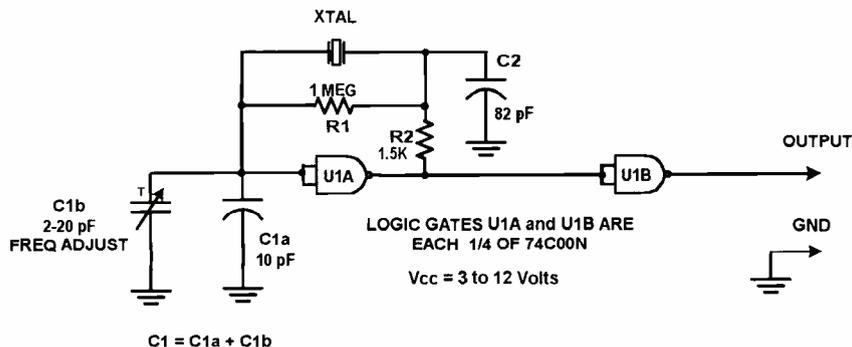


FIG 4
LOGIC GATE XTAL OSCILLATOR

ceramic resonators, resonant cavities (UHF and microwave only), and other exotic devices.

The quartz crystal is the most widely used frequency-determining element. It is relatively cheap, widely available, and comes in frequencies from audio to low UHF. Frequencies in the HF range (2-30 MHz) are most common. Distributors generally stock commonly used frequencies as "microprocessor" crystals. Since these are manufactured in large quantities, they are often available for less than a dollar. Custom frequencies specially manufactured are generally several times as costly. By varying the way the crystal is cut and its size, the resonant frequency and temperature characteristics can be controlled.

There are many different cuts that are specified by the way the crystal is oriented and cut from the mother crystal (AT, BT, SC, etc.). AT crystal cuts are generally used above 1 MHz. Crystals can be operated in a mode called overtone mode. Third overtone and fifth overtone crystals are commonly used in the lower VHF range—30 to 150 MHz. Seventh and ninth overtone crystals are also used and can operate up to a few hundred MHz. Most fundamental crystals can be operated on their third and often fifth overtone, and higher order overtone crystals can be operated on their lower order overtones and fundamental, as well.

Also, spurious modes may exist in many crystals, particularly higher overtone types, which can be totally unrelated mathematically to any "legal" overtones or frequencies. The circuit designer must be aware of these effects and may have to design in certain circuit features to ensure oscillator operation on the expected oscillator and crystal frequency. This may involve extra tuned circuits and components to suppress unwanted modes.

A Crystal Circuit

Figure 2 is an approximate equivalent circuit of a crystal. This circuit is a pretty good approximation near the crystal resonant frequency. It has two fundamental resonances, one series, the other parallel (anti-resonant). The crystal behaves as an inductor at certain frequencies, as well. In many crystals, the effective series inductance may be measured in henries, while the capacitance is a small fraction of a picofarad, and the resistance is in the 20Ω to 100Ω range.

Since the Q value of a series resonant circuit is $2\pi fL/R$, if the frequency is 1 MHz, the series effective capacitance $C1 = .025 \text{ pF}$, the inductance $L1 = 1 \text{ henry}$, and resistance $R_s = 50 \text{ ohms}$, the circuit Q is 125,600. The shunt capacitance, C2, is usually a few pF. This resonator would have a bandwidth of about 8 Hz at 1 MHz center frequency. Contrast this with a typical Q of 100 at 1 MHz with a 10-kHz bandwidth obtainable using conventional small size coils and capacitors.

The crystal gives a 1250 times

improvement in this example. Crystals may be purchased for series or parallel operation. Parallel crystals are usually specified with a circuit capacitance (usually 18, 20 or 32 pF) load. This capacitance is that with which the crystal will operate on its marked frequency. Series crystals do not have this specification.

Commonly parallel crystals are fundamental types and series crystals overtone types, but there are many exceptions to this rule, so no reliable data can be assumed for any crystal. Either a series or parallel crystal usually will work in a given circuit, but the oscillation frequency may not be as marked. This discrepancy could be several kHz, with inability to adjust the frequency to specs. The crystal should be placed in a suitable test circuit and measurements made to obtain reliable data.

Crystal-oscillator circuits are similar to L-C oscillator circuits, often substituting the crystal for L-C components. In some circuits the crystal is used as a series resonator, in others as a parallel inductor or resonator. The main difference is that in an L-C oscillator we can employ a tapped or multi-winding inductance. Since we cannot install taps on a crystal, capacitance divider techniques and configurations are used instead. It is no trick at all to get stability an order of magnitude better than the best L-C oscillators from a crystal oscillator. A few parts in a million (ppm) would be typical. (One ppm = .0001%.) With careful design, proper choice of crystal cut, and the use of temperature compensation, 1 part in ten million is achievable over a reasonably wide (50 degrees C) range without too much trouble.

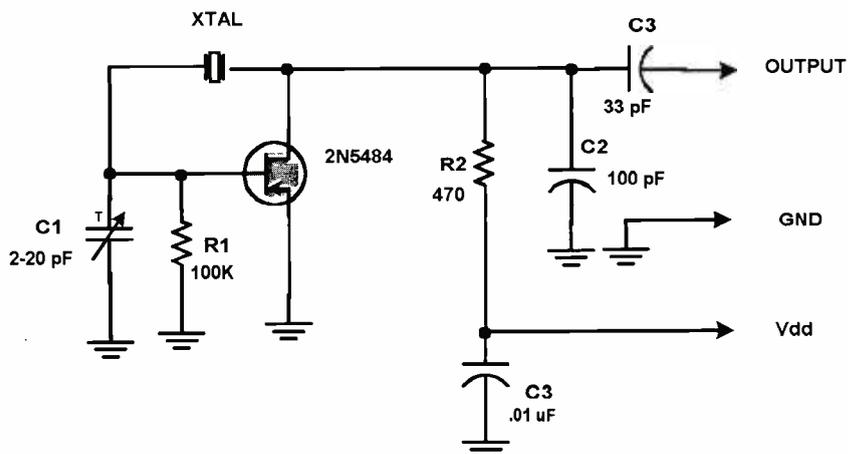


FIG 5
PIERCE XTAL OSCILLATOR

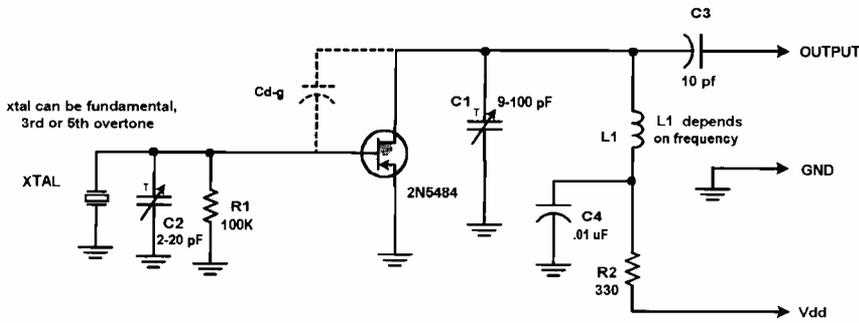


FIG 6
JFET TUNED DRAIN XTAL OSCILLATOR

These circuits are called temperature-compensated crystal oscillators (TCXOs). With solid-state components the entire crystal and associated circuitry can be placed in an oven heated by a watt or less of power, and the internal temperature maintained at a specified figure (60 to 85 degrees C typically). Stabilities of another order of magnitude (1 part in 100 million) can result. These are called oven-controlled crystal oscillators (OCXOs) and can be obtained as prepackaged assemblies. There are circuits in which the amplitude of oscillation is also regulated with automatic gain control, keeping the amplitude of oscillation within the linear region of the circuitry. It is also possible to do this with L-C and crystal oscillators, rather than depending on circuit nonlinearity for amplitude limiting. The Wein Bridge oscillator is an example of an R-C oscillator that uses a tungsten-lamp filament or a thermistor to do this. This improves noise performance, waveform purity, and frequency stability, as it minimizes drive to the crystal. This helps to keep thermal frequency drift to a minimum. However, these circuits will not be covered here, as they are not generally encountered by the hobbyist or experimenter.

Grounded-Base Oscillator Circuit

Figure 3 is a circuit of a grounded-base oscillator, using the crystal as a series resonator. This circuit is usually used for overtone operation. It is simple in concept. The transistor Q1 is biased in the active region as an amplifier. A resonant circuit L1C1 is placed in series with the collector. Note that Cc is a relatively "small" capacitor (not the usual 470 pF to 0.1 μf we might use in an RF amplifier stage). Cc is used to bypass the emitter resistor. The internal collector to emitter capacitance, Cc, provides feedback to the emitter, the ratio set by the values of Cc and Ce.

At a frequency where the crystal is series resonant, the base is effectively grounded. This allows oscillation, the transistor acting as a common base amplifier at this frequency. This oscillator is efficient and has a good power output (10-20 milliwatts); but the stability and phase noise are not the greatest, since the base circuit resistance in series with the crystal lowers the operating Q somewhat.

It is also somewhat susceptible to stray oscillation modes, since there is little selectivity in the crystal circuit other than the crystal itself. By tuning L1 and C1 over a wide range, it is possible to produce oscillation on unwanted overtones and spurious modes. Also, stray capacitance across the crystal and associated leads may allow for uncontrolled spurious oscillation, and off frequency operation away from the true series resonant frequency. The crystal has to be specially ordered with an offset in frequency to get the exact desired frequency.

This has to be determined by experiment. A series inductor or capacitor in the base circuit can be used to adjust or "pull" the frequency somewhat. Replacing the crystal with a dead short allows the circuit to function as a straight common base oscillator. This circuit is OK for

general-purpose use, but it is not recommended where critical frequency control or phase noise is an issue.

Logic Gate ICs

Figure 4 is a circuit using logic gate ICs. A crystal is used as a parallel inductor together with capacitors C1 and C2 to form a resonant circuit, with an inductor (xtal) and tapped capacitor network. There is a 180-degree phase inversion at resonance. The CMOS logic gate (74C00N, 74C04, CD4049, etc) used as an amplifier supplies the other 180 degrees phaseshift. This circuit, actually a "Pierce" oscillator, is very simple and cheap, and is widely used in digital applications.

Like the previous circuit, it has less than ideal phase noise and in addition, can overdrive the crystal with its high drive voltage, causing spurious operation. Use of fast logic chips and too much feedback can cause unwanted third overtone operation, producing clock frequencies around three times that expected. A resistor, R2, in series with the output of the logic gate can be used to control drive and is typically a few hundred ohms to several kΩ. C1 can be made variable to adjust frequency.

A parallel-mode fundamental crystal is best used with this circuit. The oscillator output can be fed to another gate on the same IC chip to square it up and buffer it before using it to drive other circuits. This circuit is not the best one for use in critical applications needing really good stability and low phase noise. It is fine for digital system and computer clocks, microprocessors, and as a reference for frequency synthesizers where lowest phase noise is not necessary. We are not implying that the noise performance will be really rotten, only that it will not be as good as can be obtained

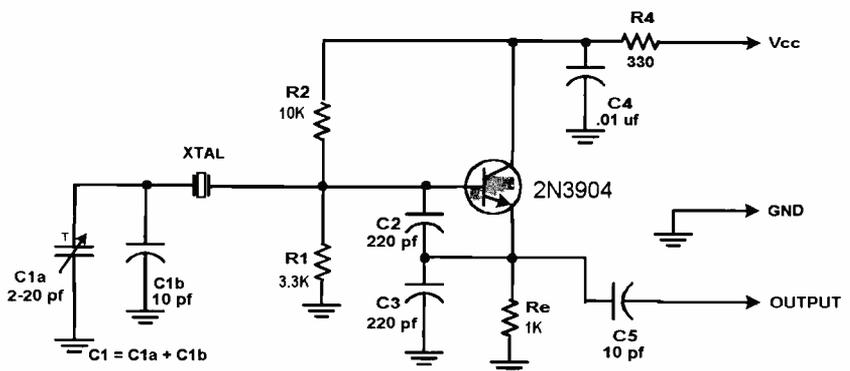


FIG 7
COLPITTS XTAL OSCILLATOR

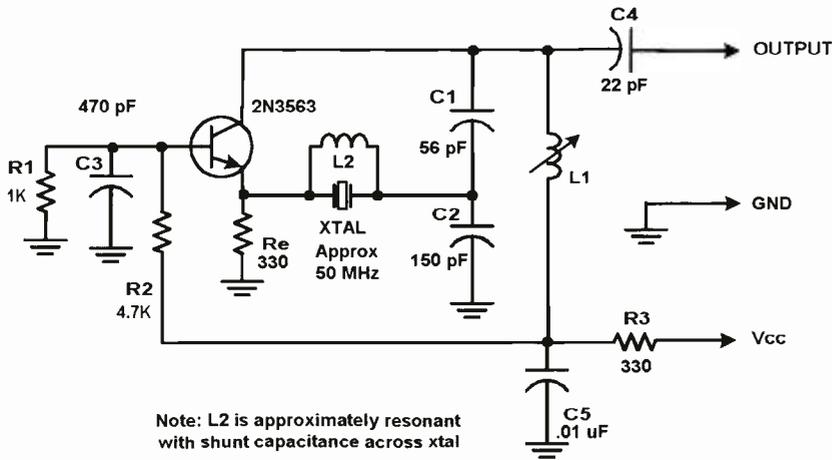


FIG 8
IMPROVED COMMON BASE XTAL OSCILLATOR

using other circuits. Even a poor crystal oscillator is usually quite “clean” as compared to a good L-C oscillator.

Conventional “Pierce”-Type Oscillator

Figure 5 shows a more conventional “Pierce”-type oscillator using a JFET. It uses fundamental mode crystals. It is simple and, with a low-noise JFET or transistor, is reasonably decent and reliable as to performance. The capacitance, C1, from collector (or drain) to ground controls the feedback. A parallel-mode crystal is used, and a shunt capacitance, C2, across the crystal can be used to adjust frequency. This circuit is good in applications where a number of crystals must be switched in and out over a frequency range, as there is no tuning required.

Tuned Plate-Tuned Grid

Figure 6 is a JFET equivalent of the old-fashioned vacuum tube “tuned

plate-tuned grid” oscillator. It is useful for overtone operation and uses parallel-mode crystals. Basically, the drain circuit contains a tuned circuit, L1 and C1, tuned slightly above the expected output frequency, therefore looking inductive. By feedback via the collector to drain capacitance, the input resistance of the JFET appears as a negative resistance. This allows oscillations to start. As in the previous circuit, shunt capacitance across the crystal, C2, can be used to adjust the output frequency to specs. This circuit configuration was widely used in the vacuum tube days as an overtone oscillator. However, it can work well with fundamental-mode crystals as well.

Colpitts Crystal Oscillator

Figure 7 is a Colpitts crystal oscillator using a transistor and a parallel-mode crystal. The crystal acts as an inductance in this circuit. A large value capacitive divider is used between gate, source, and

ground; and a small series capacitor is placed in the crystal circuit. The ratio of C2+C3 to C1 should be as high as possible, 5 to 10 to 1 is usually used. Typical values are shown in the circuit. This circuit places little loading on the crystal, and the relatively high values of C2 and C3 “swamp out” variations and drift caused by variations in device characteristics. Frequency is adjusted with C1. A relatively clean sine wave appears at the emitter of the transistor.

Base-Overtone Oscillator

Figure 8 is a common base-overtone oscillator, which uses a series-mode crystal. It is somewhat better than the circuit of Fig. 1 as the crystal sees a low-drive impedance and feeds a low-load impedance, keeping the effective Q somewhat higher. It is also more predictable as to output frequency, as the crystal can be operated exactly at series resonance without circuit problems, and its loading can be controlled. A small inductor, L2, is placed across the crystal to tune out its shunt capacitance. This circuit can be made with high selectivity by using a high Q circuit for L1, C1, and C2, and this enables predictable high-order (7th and 9th overtone) operation, with little difficulty and good performance.

While there are other crystal-oscillator circuits, we cannot cover them all due to space limitations. However, most of the circuits that the experimenter or service technician is likely to encounter have been covered, and the reader can consult the literature for others, as well as for design information. **P**

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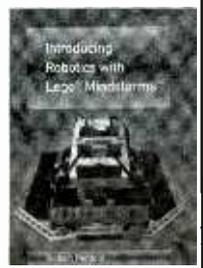
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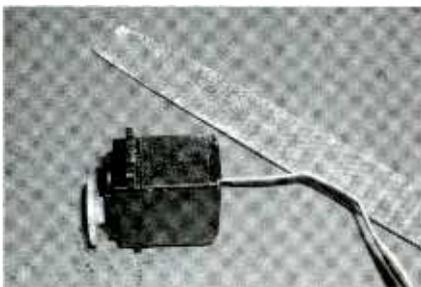


Bi-Pedal Walker Robot, Part 2

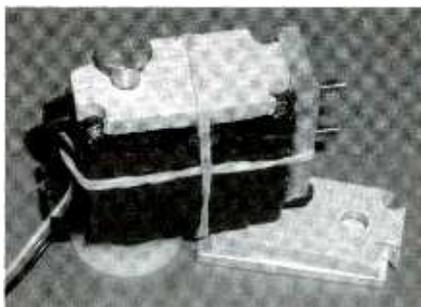
Welcome to Part 2 of our bi-pedal robotic walker. Sorry for the delay between articles, but the mechanics of building a bi-pedal walker are greater than I realized. Well let's continue. As I expressed in Part I (published in the June issue) a three-servomotor leg may be one servomotor short. This turned out to be the case. I assembled two three-servomotor legs, and, attaching them together via a hip-bar, I manually moved the servomotors to make the legs walk. I did this just to get an idea of how the programming should run. What I found is that I didn't have enough "degrees of freedom" in each leg to move the legs convincingly enough for me to believe I could program the legs to walk.

Aside from this, another problem reared its ugly head. Despite using a strong epoxy glue to mount my connecting pieces to the servomotors, the connecting pieces broke off when a little too much force was applied. The smooth plastic surface of the servomotor didn't provide much bite for the epoxy to hold on to.

To correct this gluing problem, I roughed up the plastic mounting surfaces of the servomotors using a coarse wood file. Next, I roughed up the mounting surfaces of the wood components. Instead of mixing an epoxy, I used



The smooth plastic surface of the servomotor didn't provide much bite for the epoxy to hold on to. To correct this gluing problem, I roughed up the plastic mounting surfaces of the servomotors using a coarse wood file



Secure the glued wood components to the servomotor using a couple of rubber bands. Let the glue set for 24 hours before proceeding with the project.

general-purpose glue. I placed an even coat of glue on all mounting surfaces. Make sure to mount the 4-40 screws and binding posts into the wood components before mounting them to the servomotor.

Then I secured the glued wood components to the servomotor, using a couple of rubber bands. Let the glue set for 24 hours before proceeding with the project. Aside from roughing up the mounting surfaces, you can pretty much use the directions from Part 1.

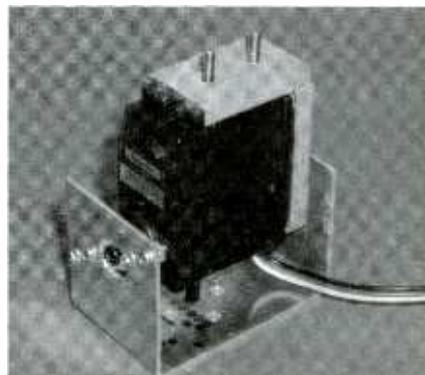
The five diagonal holes at the end of the U-Bracket mate to the holes to a stock Hi-Tec servomotor horn. Mount the servo horn to the inside of the U-Bracket, using #4 \times $\frac{1}{8}$ -inch sheet metal screw. Place the servomotor shaft to its center position. Slide the binding head post screw through the hole on the opposite side of the U-Bracket. Then slide the servomotor shaft into the horn and secure with the horn screw.

Building a Servomotor Leg

Each leg is made using four servomotors, and two legs equal eight servomotors. After working with one of the legs, I quickly realized that while the PIC Microcontroller will not have a problem operating the eight servomotors, trial and error testing to position the servomotors and experiment with a walking

gait would be unrealistic. So what I needed is to find a way to dynamically control the eight servomotors, so I could test leg position and steps before programming the microcontroller.

I found what I thought would be a suitable Windows program that is capable of dynamically controlling eight servomotors in conjunction with a PIC microcontroller. The main Windows program serially sends servomotor position information to the PIC microcontroller. The PIC microcontroller reads the serial information and outputs the proper pulse information to the servomotor. Unfortunately the program only issued updates to the servomotors upon user intervention (when the user changed a servomotor position). This created a situation where the servomotor would move to the desired position, but not maintain its position. Since the position command to the servomotor is only provided once, the servomotor could easily fall or drift to any position. This doesn't work for designing a walking program because the legs need to maintain their position while other servomotors in the leg(s) are moving. So what I needed was a program that continually updated all the servomotors' positions. Since this tool(s) was not



Place the servomotor shaft to its center position. Slide the binding head post screw through the hole on the opposite side of the U-Bracket.



The Visual Basic program I wrote has been tested under Win95 and Win 98. The program continually updates each servomotor position, but not as quickly as needed for completely smooth operation.

available, I had to write a program and build the tools myself.

The Visual Basic program I wrote has been tested under Win95 and Win 98. The program continually updates each servomotor position, but not as quickly as needed for completely smooth operation. The servomotor movements are jumpy, due to the slow updating speed. The main programming speed bump problem turned out to be the serial communication. When I pushed the communication faster than 2400 baud, errors crept into the serial data stream. A few error-checking schemes I tried, while reducing errors, did not eliminate them completely; and this is unacceptable. When an error creeps in, three or four servomotors could jump out of position

for a few seconds before coming back into sync—not what we want to happen when learning how to walk.

Of course, if I take the time I could implement a full handshaking scheme between the PC and PIC to eliminate any serial errors from creeping in, but I'm not sure at this point it is necessary.

A screen image of the PC program is shown above. Right now the program accesses the COM2 port at 2400 Baud. By the time this goes to press, I'll add a COM port option to the program for the user to choose a different COM port. In addition, I am not too thrilled with the knob controls for changing the servomotor position. I think it's a little hard to adjust so I may change this to sliders. In any case the current version

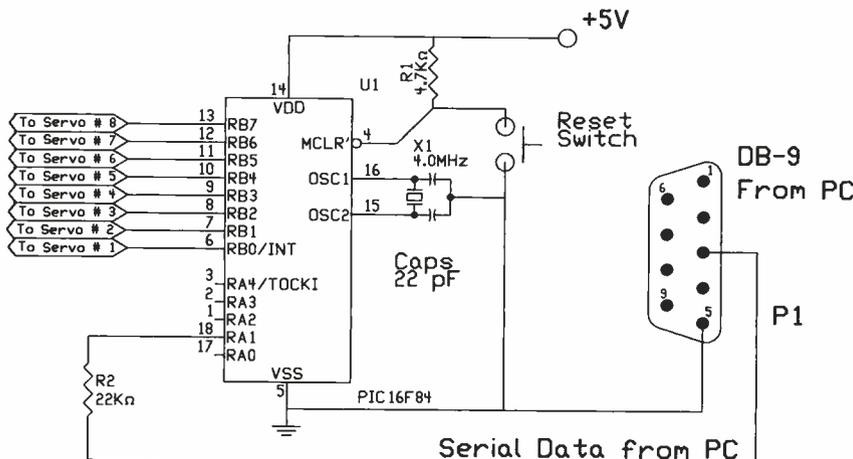


Fig. 1. This is the schematic for the PIC Microcontroller circuit. The RB0 to RB7 line connects to the servomotor's control line. The +5V in and the ground to the servomotors are not shown.



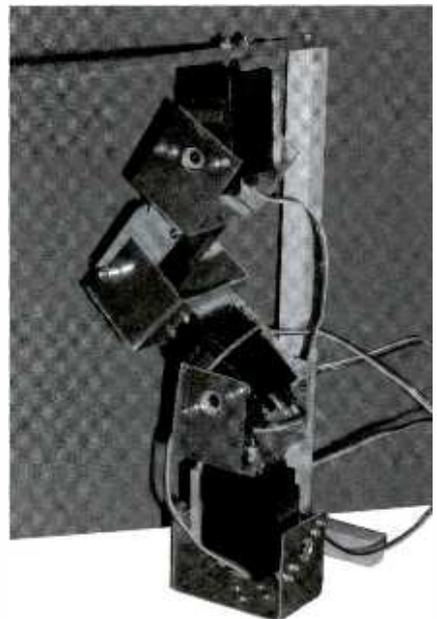
While this stand works, it is a little small (short) for the application. At times the leg can lift and topple itself along with the stand. It appears possible that when both servo motor legs are attached they will be able to lift and walk the stand in place.

and/or improved versions of this program may be downloaded for free from: www.imagesco.com/catalog/biped/walker.html.

Schematic

The schematic for the PIC microcontroller is shown in Fig. 1. Communication from the PC is through the DB-9 connector.

The RB0 to RB7 line connects to the servomotor's control line. The +5V in and the ground to the servomotors are not shown. When operating this circuit, I used a separate 5-volt battery power supply for the servomotors.



Just using one leg, I have been able to lift the stand completely with one leg and tilt it to the left and right without falling. This is more than what I had expected to do at this point.

Getting A Leg Up

Follow these instructions to assemble a four-servomotor leg. The bottommost servomotor is aligned horizontally, so that the servomotor action will tilt the upper portion of the leg left or right. The next three servomotors are aligned vertically. Each servomotor connects to the base of the next servomotor using two of the four base holes in the U-Bracket. The 4-40 machine screws fit through the holes and are secured using 4-40 hex nuts.

Once the leg is assembled, you will come to realize as I did, that a single freestanding leg will easily topple over

when testing. We could connect two legs together using a hip-bar, but then both legs will topple over as soon as we starting testing.

What I decided to do was to build a stand to hold the legs in an upright position. This would allow me to run tests with the legs without too much concern of the legs toppling over. The stand I built, holding one four-servomotor leg is shown in a photograph. While this stand works, it is a little small (short) for the application. At times the leg can lift and topple itself along with the stand. On the advantage side, it appears possible that when both servo motor legs are

attached they will be able to lift and walk with the stand in place. Depending upon the results of the tests I am running, I may need to build a larger stand where the legs will hang like a puppet.

Results So Far

The results so far are promising. I have only tested one leg for a very short time; I was basically checking the software. Even so, just using one leg, I have been able to lift the stand completely with one leg and tilt it to the left and right without falling. This is more than what I had expected to do at this point. The U-Brackets are aluminum and the bottom servomotor uses the U-Bracket as a base. The metal is slippery. I plan to secure a rubber base to the bottom of these brackets to make it less slippery, which will help facilitate walking.

Next Month

Next month, we will incorporate our second leg into the project. 

LISTING 1

PIC Program

The PC program communicates servomotor position to a PIC microcontroller. The microcontroller sends out the position signal to each servomotor. I wrote the microcontroller program using the PICBasic Pro.

Servomotor Controller

```
d0 VAR BYTE
d1 VAR BYTE
d2 VAR BYTE
d3 VAR BYTE
d4 VAR BYTE
d5 VAR BYTE
d6 VAR BYTE
d7 VAR BYTE
```

```
Pause 250      'Pause to stabilize circuit
```

```
start:
```

```
'Gather updated pulse width values from PC
```

```
SerIn PORTA.1,4,{30,gout,[7,11],d0,d1,d2,d3,d4,d5,d6,d7}
```

```
gout:
```

```
'Output servo information to servomotors
```

```
PulsOut PORTB.0, d0      'Servomotor 1
PulsOut PORTB.1, d1      'Servomotor 2
PulsOut PORTB.2, d2      'Servomotor 3
PulsOut PORTB.3, d3      'Servomotor 4
PulsOut PORTB.4, d4      'Servomotor 5
PulsOut PORTB.5, d5      'Servomotor 6
PulsOut PORTB.6, d6      'Servomotor 7
PulsOut PORTB.7, d7      'Servomotor 8
```

```
GoTo start
```

For those who do not have a PICBasic Pro compiler, a downloadable HEX file of this program is available from the same page as the VB program. The HEX file can be uploaded into a 16F84 PIC Microcontroller.

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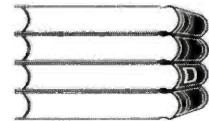
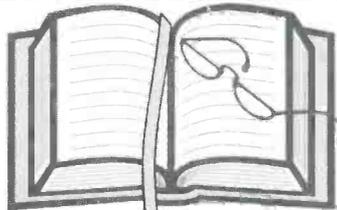


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ET11

The World Of Analog

Welcome back to PIC-tronics, your monthly column for PIC projects and programming. I hope you enjoyed last month's project, a scale-model traffic light. I know I did. Although flashing lights are fun and a favorite PIC subject, microcontrollers can do more serious work. This month the PIC meets the analog world—I'm going to kick things up a notch and show you how to interface the PIC to an analog sensor. Moreover, it gives me an opportunity to talk about how the PIC communicates with the real world using an *analog-to-digital (A/D)* converter.

The project is a temperature monitor with an over/under temperature alarm. I developed this device in response to a real-life incident—an overheated incubator. At the time I was helping a local elementary school with a nature project that involved hatching chicken eggs. Well, there was a power surge that shorted out the heater switch and turned the incubator into an oven. You can guess the rest—hard-boiled eggs. Not cool! Had there been a temperature monitor, at least an alarm would have gone off or the heater disconnected.

When designing this project, I realized that the alarm could also detect when the temperature drops too low, as would be the case if the temperature inside a greenhouse dropped too low for your precious orchids. The alarm is pushbutton programmable with a range of 0°F to 128°F and can sound a buzzer or activate a relay. An up/down switch determines if the alarm triggers on a rising or falling temperature. In addition to the alarm feature, the monitor displays the current temperature and alarm temperature on a two-line LCD.

Making It Modular

All code can be downloaded for free at www.gernsback.com. Due to space limitations the code isn't presented in print. As promised, I'll keep the code simple by using predefined modules. In case you don't understand how modular pro-

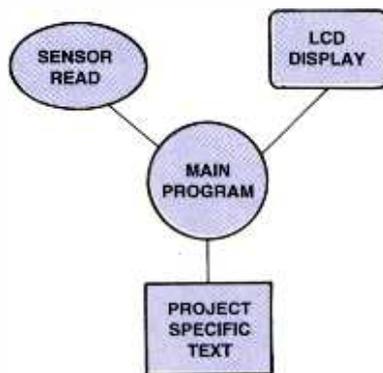


Fig. 1. Modular programming uses satellite codes that are linked to a Main Program.

gramming works, take a look at the “flow” diagram in Fig. 1. This diagram shows just a few pieces (modules) of the complete program, not the whole program, but it illustrates the concept.

The actual temperature over/under program is the Main Program code listed in Fig. 2. Focus on the bottom eight **#include** lines (under Modules) for this discussion. The statement **#include** tells the Main Program that there are eight satellite codes—modules—that are part of the total program. The first is the temperature sensor routine, which converts an analog voltage into serial digital data for input to the PIC. It's contained in the module labeled ADC0831.INC.

There's also a standard library module (LCD.INC) for a two-line LCD dis-

play. I'll be using this module often as the column goes along, so you may wish to keep a copy if it on your hard disk for future PIC-tronics projects. The third module in the diagram contains LCD display information that's specific to this project. I've printed a few lines from the module below so that you can see what I mean when I say “project specific.”

OverTemp Project-Specific LCD Messages

Normal_Message

```

bcf STATUS,RP0
;clear bit
bsf STATUS,RP1
;set bit
movlw 'T'
;the letter T
movwf 0x30
'E'
;the letter E
movwf 0x31
'M'
;the letter M
movwf 0x32
'P'
;the letter P
movwf 0x33
':'
;the symbol :
movwf 0x34
''
movwf 0x35
    
```

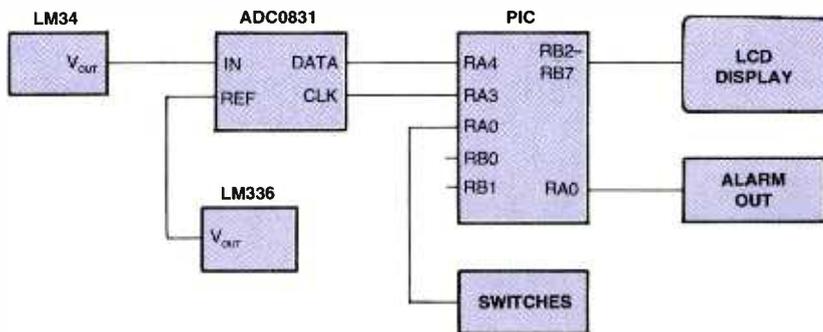


Fig. 2. The over/under temperature monitor and alarm block diagram.

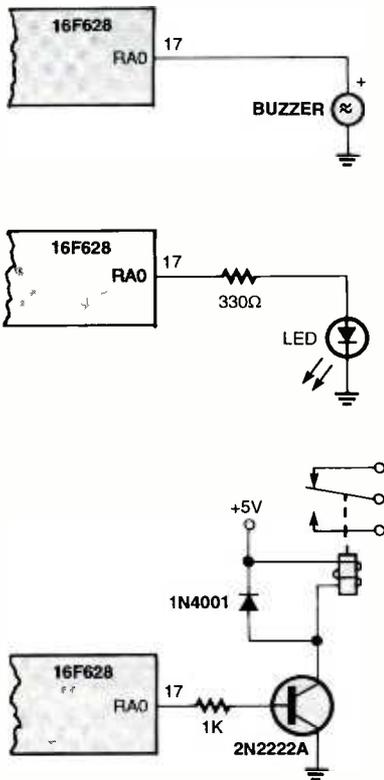


Fig. 3. There are a variety of methods you can use to interface the alarm pin to a buzzer, relay, or other actuators. This pin goes high when the alarm is tripped.

Next month's project will also use an LCD display and will need its own module of LCD messages. What we have for this project are two project-specific modules (LCD_MSG.INC and CHK_PUSH.INC) and five standard library modules. When the Main Program is assembled into HEX format for programming the PIC chip, the coding in these modules is included.

Making It Happen

The program begins with the usual header of commands that turns on and off different functions inside the chip. For this project the internal 4-MHz clock (INTRC) is enabled and a clock output (CLKOUT) pin is enabled for the ADC0831 data converter. By using the PIC clock, I have eliminated several external components often associated with the ADC0831. The watch-dog timer (WDT) is off, as are the power-up (PWRTE) and low-voltage programming (LVP) routines. The last statement (LVP_OFF) frees up an output pin that is now used for the LCD display.

Next the PIC registers are assigned to specific tasks, such as the LCD display and ADC0831 chip data. Finally, the 16F628 pin numbers are assigned, and

the Set Up Routine defines them as input or output.

That brings us to the Main Line Program. This is where it all happens, so let's take this one line at a time. There are two dominant commands here: Call and Goto. Call initiates a routine that begins with a Call label. For example, "call read_ADC0831" executes a routine that runs the code in the ADC0831.INC module, which reads the output voltage from the temperature sensor. Not all Call commands initialize modular routines. Although that's what they are mainly used for, they can also run subroutines nested inside the main program.

For example, the first line of the Main Line Program calls an embedded routine (call load_alarm_value) that checks for a temperature limit and to see whether that limit should trigger on the rising or falling edge. However, right on its heels is a call command that turns on the LCD by calling the routine contained in the LCD.INC module.

The program moves on to the next section—'Main_Loop'—where all the real action takes place. Like the section title says, it's a looping routine that constantly compares the sensor temperature to the alarm set point and springs into action if it detects an over/under temperature condition. By the line: it reads the value input from the sensor and scales it for output for a temperature reading to the LCD. It then compares the temperature to the alarm temperature. The sensor temperature is displayed on the LCD just above the alarm set point temperature line.

Next, the program checks to see if one of the pushbuttons is pressed. If it is, it means you're changing the temperature limit up or down. This routine, listed in the CHK_PUSH.INC module, is specific to this program only—but I may modify it to fit a standard module for future projects because of its versatility.

The final line tells the loop to go back to the beginning and do it again. If at some point the routine breaks out of the loop, the program goes to one of the modules or nested subroutines in the Main Program. When that little detour is completed, you'll find a Return command (see the last line of the Load Alarm Value routine), which essentially returns the looping routine back to the point where it left off.

Making It

When I started this column I promised that I wouldn't belabor the

PARTS LIST

LM34 temperature sensor
 LM336-2.5 voltage reference
 ADC0831 A/D converter
 16F628 PIC microcontroller
 16 × 2 LCD display
 Toggle switch
 Pushbutton switch (2)

A kit of the above parts is available for \$28 from Futurlec (www.futurelec.com), 1133 Broadway, Suite 706, New York, NY 10010, and includes a programmed PIC. A programmed PIC is also available separately for \$12.

programming aspects of the project so that readers who wish to just build the darn thing will have equal time. That time has come for this installment.

The temperature monitor consists of four IC chips: an LM34 temperature sensor, an ADC0831 A/D converter, an LM336 voltage reference, and a 16F628 PIC. The remaining components are an LCD display and direction switches. Here's a block diagram of the circuit (Fig. 3).

The LM34 is a precision IC temperature sensor with a linear voltage output that's equal to 10 mV per degree Fahrenheit. At 100°F the output voltage is 1.000 volts. Although the LM34 output voltage range extends from -50°F to +300°F, I've limited the range from 0°F to 128°F by grounding the sensor (a negative power supply is required to pull it under zero volts) and limiting the A/D input voltage range. I figured that if the eggs got hotter than 128°F, it was too late. Furthermore, these numbers fit better with an 8-bit A/D converter and 8-bit 16F826—something you want to keep in mind if you plan on programming your own sensor projects; keep the math simple.

The next stage is the analog-to-digital converter, commonly called an A/D or ADC. I've read and written books on using these devices, so I'm gonna keep this just to the project at hand so that this function doesn't become an article by itself. Basically, the ADC0831 chip has an input range that's scaled by a reference voltage. For this application, the scale is zero to 1.280 volts, which translates into 256 bits and 128°F. Hmm, and you wondered why I wrote a scaler software routine that divides the A/D input by two: $256/2 = 128$, which now goes to the LCD. (Sorry for the programming backslide.) The reference voltage is established by an LM336 chip.

To minimize PIC pins and leave room

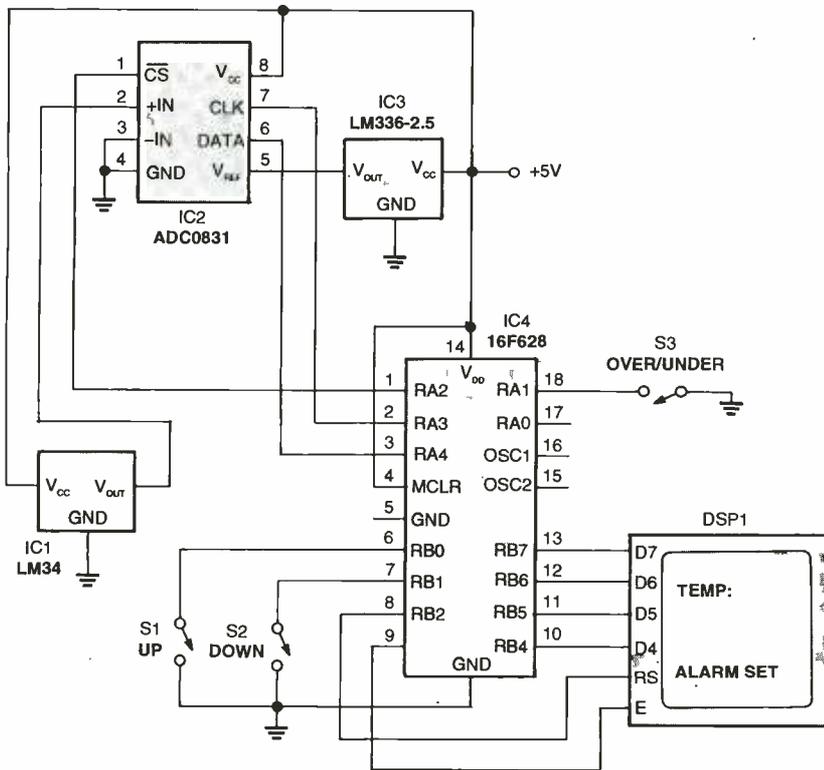


Fig. 4. Schematic of the over/under temperature monitor and alarm. The pins are shown as they physically appear on the chips. For the sake of clarity, the PIC V_{DD} and GND lines have been moved, so you will notice a duplication.

for expansion, I chose an ADC0831 A/D converter, which has a serial data output that's known as Microwire. Some day I'll go into the details of Microwire communications (which are described in the ADC0831.INC module), but not today. Suffice it to say that the serial interface uses about half the number of input pins that a parallel interface demands.

The LCD is a generic display that you can buy from several sources. What is unique about it is that it, too, uses a form of serial interface called "nibbles"—one-half of a byte, or 4 bits. Again it's done to reduce the number of pins needed to interface the PIC to the outside world.

The final two components are the switches and a buzzer or relay of some type. This I'm going to leave to you, but I will make some suggestions as shown in Fig. 4. Oh, I'd bet you'd like to see a schematic by now. Okay, here it is (Fig. 5).

As always, you can build this yourself from scratch using the programs located at www.gernsback.com. Or you can buy a programmed PIC and major components from the supplier listed in the Parts List.

Coming Up Next Month

Next month I'll continue with the analog interface theme by introducing a

humidity sensor and a second LM34 temperature sensor into the mix. To do that the ADC0831 will have to be changed to an ADC0834—a four-channel version of the A/D used for this project.

The LCD module will be upgraded, too, to display four lines instead of two. There is a direction to this, which may be an eventual weather station or smarter robot. Temperature and humidity sensors can always be replaced with sonic and light sensors. The focus is on making the PIC aware of its surroundings, whatever they may be. 'Til then, have fun!

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Cereal Port: Battle Creek, Michigan

Q I have been reading up on interfacing the serial and parallel ports on my computer. However, it seems that while the parallel port always uses a 25-pin connection, the serial port sometimes uses a 25-pin as well as the 9-pin connection. I was wondering how to tell if a 25-pin jack/plug was for serial or parallel use. Thank you.—J.R., via e-mail

A Well, the title sounded cute at first. But then I discovered that Battle Creek, the serial ... uh, cereal capital of the world, isn't even on one of the lakes. They have HOMES there, but not the kind I needed this time.

When I built my Altair back in 1975, the serial ports were 25-pin "DB-25" connectors. That was, in fact, so much the standard connector for serial ports that those connectors were often erroneously called RS-232 connectors. That standard carried through the first IBM PCs, and there always was confusion for many people as to which connector on the back of the computer was which, for they all looked alike.

It took folks quite a long time to realize that it was pretty silly to use a 25-pin connector for a communication link that only had 4 wires. Gradually, as newer computers were developed, the large 25-pin connector was replaced by the now-familiar 9-pin (DB-9) connector. Whether using the DB-25 or the DB-9 connector, the computer uses the male version for the serial ports, while the parallel port uses the female DB-25.

With cables, you have to be more careful. Just because there is a DB-25 connector on either end does not mean that the cable is good for serial or parallel use. Cables can be made up with any combination of connector sexes on the ends, depending upon the application. For instance, to connect two computers together using their parallel ports, the cable has to have male connectors on both ends. For connecting two serial ports together, both connectors must be female. A cable can be an "extension cord," having a male connector on one end and a female on the other.

More than likely, if the cable is male on both ends, it'll be a parallel cable; but use an ohmmeter to check continuity of all 25 pins just to be sure. Often times, there may be only a few wires in the cable and so it will only work for serial applications. Other times, you may run across a "null-modem" serial cable

where some pin switching goes on, much like what happens with a crossover cable for CAT-5 computer networking.

Above all, don't forget that DB-25 connectors may be in use on cable or equipment, but it doesn't mean that the "port" is serial or parallel. Oddball equipment can use those connectors for anything at all,

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Many electronic component manufacturers have Web pages; see the directory at www.hitex.com/chipdir/, or try addresses such as www.ti.com and www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online: www.questlink.com features IC data sheets and gives you the ability to buy many of the ICs in small quantities using a credit card. You can also get detailed IC information from www.icmaster.com, which is now free of charge although it formerly required a subscription. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org

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

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Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, 130 N. Cutler Dr., N. Salt Lake, UT 84054.

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

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

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

including power distribution, so don't make any rash assumptions.

Smart Outlet Box

Q Do you have a circuit that can sense the current when an apparatus is turned on and turns on another? For example, I turn on my table saw, and the shop vac will automatically come on.—C.W. via e-mail

A Heathkit used to sell the GD-1295 "Smart Outlet Box," a switched outlet strip that did exactly as you described. And now, a few quiet moments for Heathkit. [Silence.] I always like the smart box idea, but didn't necessarily like Heath's implementation because it was sensitive to some of the control loads and might not necessarily actuate properly. I quit using one with the computer I was using back around 1988 when it went into a series of quick multiple on-off cycles. Also, Heath's was line-operated, so had to be limited to the inside of an enclosure.

Figure 1 is a circuit I put together that seems to work just fine. It's a little more complicated than Heath's original circuit, but it's isolated from the control load by T1, is sensitive enough to trigger on the 13 milliamp load of a muffin fan, and seems to work fine when triggered by universal motor loads or fluorescent lights. It's designed to operate from a simple +12 volt regulated or unregulated supply, such as a simple "wall wart" adaptor.

T1 is the current-sense transformer. I chose a toroid core from an old computer power supply. The secondary is around 100 turns of 22-gauge magnet

wire. The hot side of the line is poked through the core as the primary. You need to select a core that can handle lower frequencies rather than radio frequencies. My core wasn't all that great, probably designed for a 20-kHz switching supply, but still worked fine. The core saturates quickly, so the output waveform is a really peaky-looking thing rather than a sine wave. D1 and D2 clip the output waveform to protect the op-amp and is capacitively-coupled to the op-amp input by C1. Resistors R1 and R2 set the bias on the non-inverting input to half the supply voltage, while R3 through R5 do the same for the inverting input. IC1a forms a comparator. Its output is rectified by D3 and filtered by C2 and R6, which set up a time constant so that the circuit won't be triggered or affected in any way by spikes or an oddball waveform that a controlling load may have. This DC voltage triggers another comparator, which drives the output transistor, Q1. Q1 acts like a switch to turn on the relay, while D4 protects Q1 from reverse voltage spikes from the relay coil.

I added R4 so that the circuit can be finely adjusted to accommodate small control loads. If you're going to use the circuit with large loads (table saws come to mind here), you can eliminate R4 and just connect the junction of R3 and R5 to pin 2 of IC1a. R4 is adjusted so that the output of IC1a is near zero volts with the control load turned off and the relay switches in reliably with the load on. I connected an oscilloscope to IC1a pin 1 and adjusted R4 to the center of the range that produced a waveform, making sure that pin 1 went to zero

when the load was turned off. R9 and R10 help pull the low-level saturated output voltage of U1b down so that Q1 won't turn on at that point. Some op-amps just won't go quite low enough to do the trick by themselves.

Use a relay with a 12-volt coil. You might have to use this relay to control a larger relay (normally called a contactor) for heavy loads. Be sure to enclose the circuit, especially the 120 V_{AC} mains portions, in a secure, grounded metal box. Mounting the box to the metal frame of your table saw will probably do the grounding trick. I'd suggest a line cord and outlet in the box for powering the table saw, kind of like a single-outlet extension cord, with the black hot wire routed through the toroid before being connected securely to the hot side (brass color) of the receptacle. That way, everything is safe and enclosed. The best way to handle the power supply in this particular application is to build one from scratch so that it can be included within the box. I'm afraid that any wall-wart solution would end up constantly falling out of its outlet from the saw vibration or would present a trip hazard if plugged into another outlet.

"Well!" said Mr. Benny.

Q I have been trying to design a circuit that would let me know when a home water pump, which is 200 feet underground, turns on and off. I think there may be a leak underground, causing the pump to run often to keep the pressure built up. The circuit could pick up a signal on the power line that goes to the pump, operating a relay that would turn on a lamp for the length of time

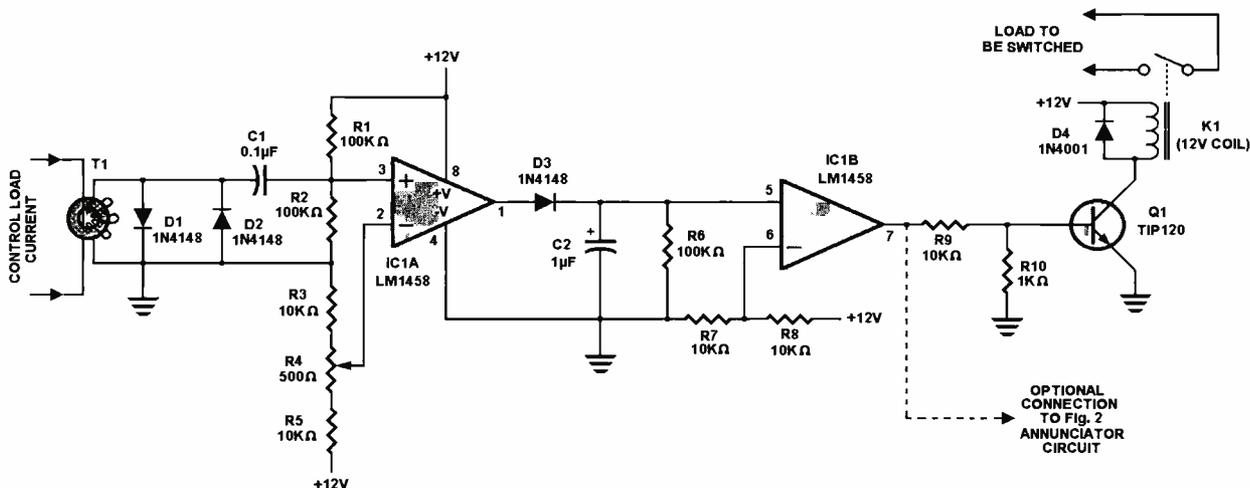


Fig. 1. A current-sense transformer coupled to a comparator/rectifier circuit can be used to indicate the status of an appliance or circuit or to remotely control a secondary load.

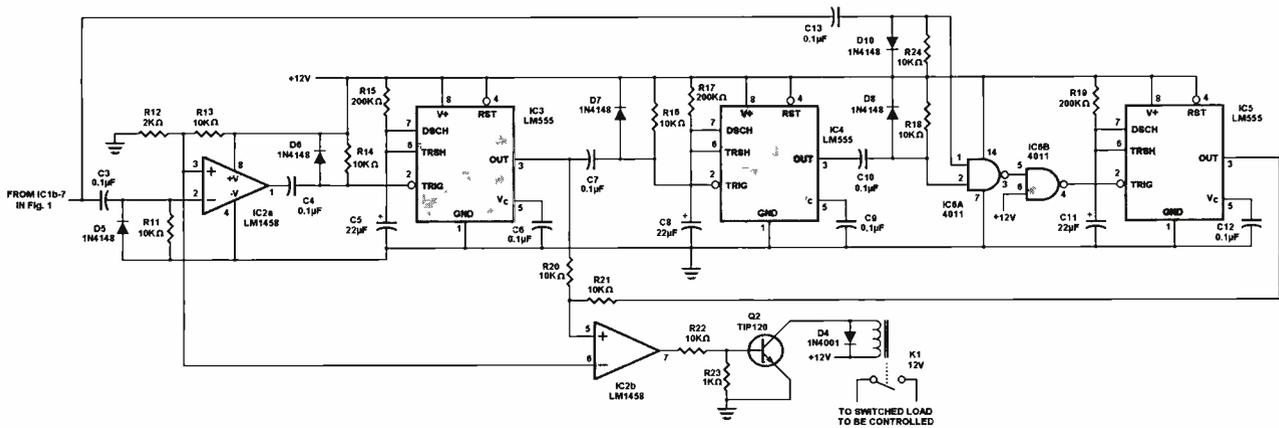


Fig. 2. This annunciator circuit is used in conjunction with the circuit of Fig. 1 to provide an audible indicator for monitoring the actuation of a load in a remote location. The specific application here is the monitoring of a deep-well submersible pump to help detect underground leaks.

the pump is running. In addition, at the time the pump turns on, I'd like a door bell to ring for 5 seconds, stop for 5 seconds, and ring again for 5 seconds. Then when it stops running, the bell will ring just one time for 5 seconds.—K.S., Philadelphia, PA

A If the title to this item doesn't make sense to you, run it by Grandma and Grandpa for an explanation. The first part of this one is easy. Notice how I grouped two questions together that had a similar application solution? When I read the second part, I thought you were pushing your luck with me with that extra bit of annunciator design. Then I realized that the audible announcement would be needed if you're going to be alerted to a problem with a leaking pressure system. I, too, have a 200-foot well, and last autumn, when I saw a continuing wet patch in the soil and kept having high electric bills, I was wondering the same thing as you. I realize that in science, the water cycle is a closed loop, but we really don't need any leakage paths, do we? And dead shorts are out of the question!

The circuit of Fig. 1 that we designed for the table saw will work just as well for your application as far as the sensing circuit goes. You can build this circuit and eliminate R4 just as we did with the table saw. PLEASE be very, very careful hooking this circuit to the mains. In fact, local codes may forbid you to use this circuit within your breaker panel or allow you to mess with the wiring to the pump in any way. You'll have to make that determination yourself. If it's OK to do that, you should turn off the main switch, kill the pump breaker and the breakers on either side of it (for safety), remove the breaker panel front-panel cover, remove the black wire going to

the 240-volt load, and insert it through the toroid before reconnecting it to the breaker. You can run the wires of T1's secondary out the side of the panel before replacing the panel cover, making sure that the wires aren't pinched and shorted anywhere. You might have to run the wires through some heavy, cushioning insulation to protect them. The rest of the circuit through IC1b remains the same except that you can eliminate D1 and K1, replacing K1 with a 12-volt incandescent lamp such as an automotive tail light lamp. It will light up any time the pump is running.

The circuit of Fig. 2 connects to the circuit of Fig. 1 to provide the annunciator portion. The input of Fig. 2 connects to IC1b pin 7 of Fig. 1. Since K1 isn't used in Fig. 1, I've labeled the relay in Fig. 2 as K1, so don't let that confuse you.

This is an analog timer circuit. Next month, I'll try to publish a digital version that'll be a lot simpler with a reduced component count. If you have a lot of op-amps and timers on hand and no CMOS digital chips, then this circuit may be less expensive for you.

The circuit consists of three timers. IC3 provides the timing for the first ring time of the bell, IC4 provides the timing for the bell's rest cycle, and IC5 provides the timing for the bell's second ring time. The circuit is triggered one of two ways. C3, D5, and R11 create a positive-going spike from the rising edge that's created when the pump turns on. It's fed to IC2a, a comparator that inverts this spike into one that's negative-going. It's coupled to the trigger input of IC3. When triggered, its output goes high for about 5 seconds, that time determined by R15 and C5. This high is coupled through R20 to comparator IC2b and turns on Q2, which closes the relay

and rings the bell.

When the output of IC3 falls after the timeout, it creates a negative-going spike through C7, D7, and R16 that triggers IC4, another timer with a 5-second pulse width that's determined by R17 and C8. The length of this timer's output determines the time period between the two rings of the bell. When this pulse falls, a negative-going spike is created by C10, D8, and R18 and fed to NAND gate IC6a. IC6b is wired as an inverter, so the combination of the two gates together creates an AND gate. The negative-going pulse from IC6b triggers IC5, another timer with a 5-second pulse. The output of IC5 is fed through R21 to IC2b, which turns on Q2 and causes the bell to ring.

The second trigger path is through C13, D10, and R24, which creates a negative-going spike upon the falling edge of the input pulse when the pump turns off. The pulse is fed past the first two timers to the other NAND gate input and feeds on through to trigger IC5. This causes the bell to ring just once.

So, the rising edge of the input pulse that occurs at pump turn-on goes through all three timers to make the bell go RINGgggggg-rest-RINGgggggg and the falling edge of the input pulse that occurs at pump turn-off triggers the last timer to make the bell ring only once.

Five seconds for bell duration may get on your nerves after a few days. You can shorten the bell rings and the delay between them by making the values of C5, 8, and 11 smaller. The time for the 555 is $T=1.1(RC)$. R and C are the components connected to pins 6 and 7 of each timer. I usually select a value for C first, and then calculate R since you have a better selection of standard resistor

values to help you zero-in more accurately on your intended pulse width.

If you use this circuit to actuate a standard electromechanical bell, do not connect the bell in place of the relay. The bell **MUST** be driven from its own bell transformer power source. An electromechanical bell generates so much hash that the timers will go bonkers. Yes, you could decouple the smitherens out of the supply lines, but ... well, a bell like that isn't much different than having an arc welder on the same circuit as your TV and short-wave receiver, if you get my drift.

Remember the fiasco in this column over the last few months with the NE558 vs. NE5558? Well, **USE THOSE NE558 QUAD TIMERS HERE!!** They're set up to be one-shots, so this is a perfect application for them.

Interesting Logic Solutions

As shown in Fig. 3, reader Bill Brown has submitted an alternate logic circuit that uses fewer gates to solve the logic problem presented in the April 2002 column. I had used a Karnaugh map to verify that the original Boolean equation was as simple as possible. Karnaugh maps are easy to use, but have their limitations. All you have to do is throw an exclusive OR gate into the mess and the Karnaugh map sometimes begins to have problems. Bill's circuit saves us an integrated circuit, using only three rather than four, discounting my multiplexer solution. Still, it will be nearly impossible to ever use these circuits in high-speed situations, for the varying propagation delay paths will cause all kinds of glitches. Bill's will have a two-gate delay in some cases and up to four gates in a logic path in others. My circuits weren't any better.

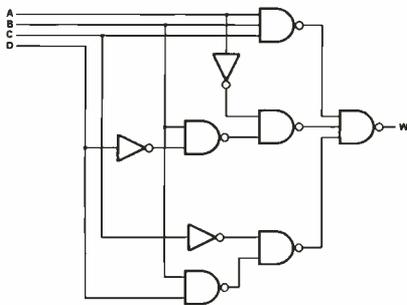


Fig. 3. Reader Bill Brown has submitted an alternate logic solution for a "messy" logic problem posed in the April 2002 column. His combinational logic circuit is more cost effective than the original.

Good job, Bill. As you mention, whether the inverters are inverter chips or NAND gates wired as inverters, the package count will be the same.

RG-135 Coax?

Q Concerning your answer to "Stereo Phone Plugs" (May 2002), what is RG-135/U? I haven't been able to find this coax in my catalogs. Where does one buy it?—F.B., via e-mail

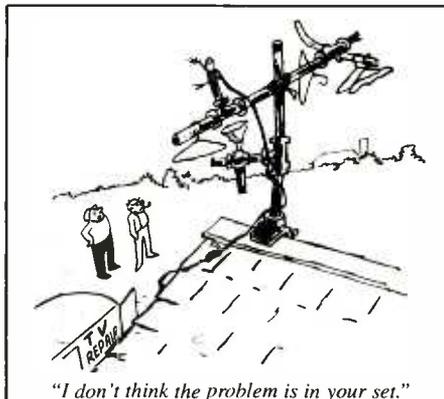
A Good question. I don't think it exists. I depended too much on my aging memory for that number, and I was wrong. How about we try RG-178B/U coax instead? It has an outer diameter of 0.071 inches and is Belden's type number 83265, sold by Newark Electronics (www.newark.com) as catalog number 02F5780 for a measly \$48.58 for a 100-foot spool. It's a little hard to justify 48 cents a foot for a 100-foot minimum just to make a couple of 3-foot cables. You may have to shop around a bit or find a few friends who'll share the cost and the cable with you. But it is good cable, with 96% shield coverage!

Writing to Q&A

As always, we welcome your questions. Please be sure to include:

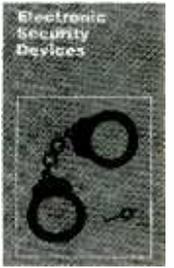
- (1) plenty of background material,
- (2) your full name and address on the letter (not just the envelope),
- (3) and a complete diagram, if asking about a circuit; and
- (4) type your letter or write neatly.

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CLX2

Performance Testing Of Video Monitors

This article provides a guide to the testing of computer and video monitors for functional characteristics like color purity, convergence, geometry, focus, resolution, Moire, switching between scan rates (where applicable), and acoustic noise. A subset of these tests applies to television sets as well.

Although flat-panel monitors based on LCD and other discrete technology are increasing in popularity, their higher cost and spotty performance (especially when not used at their native resolution) means that CRT monitors will continue to be important for several years to come. Many of these tests apply to flat-panel displays, as well.

WARNING: No monitor is perfect. Running these tests on your monitor or one you are considering may make you aware of deficiencies you never realized were even possible. You may never be happy with any monitor for the rest of your life!

Note: The intent of these tests is ****not**** to evaluate or calibrate a monitor for photometric accuracy. Rather they are for functional testing of the monitor's performance.

Obviously, the ideal situation is to be able to perform these sorts of tests before purchase. With a small customer-oriented store, this may be possible. However, the best that can be done when ordering by mail is to examine a similar model in a store for gross characteristics and then do a thorough test when your monitor arrives.

What About The New Flat-Panel Displays?

This information applies directly to the vast majority of CRT- (picture tube) based equipment. However, what may

be surprising is that much of it also applies to the new generation of flat-screen SVGA monitors based on LCD, plasma, or other discrete pixel-based technology. Why? While these devices cannot suffer from some of the problems inherent with CRTs (like imperfect geometry, convergence, or non-linearity), many characteristics can still be quite variable from one design or even one sample to another. These include brightness, brightness uniformity, range of viewing angle, color rendition, flicker, and ghosting (if analog interface).

Furthermore, digital-scan converters need to be built into autoscans (SVGA type) flat-screen monitors since they are basically fixed-format devices. These are needed to accommodate the multiple scan rates and resolutions produced by PC-based video cards when used with DOS/Windows or in any situation where the resolution does not match the native resolution (number of pixels and lines) of the physical

display device. Problems can arise from less than optimal resampling or inadequate conversion speed where motion is involved.

These include: reduced sharpness, Moire, flicker or limited frame rate of changing/moving images, stability, and more.

Basic Monitor Performance Criteria

The following are among those characteristics of a monitor that should be evaluated:

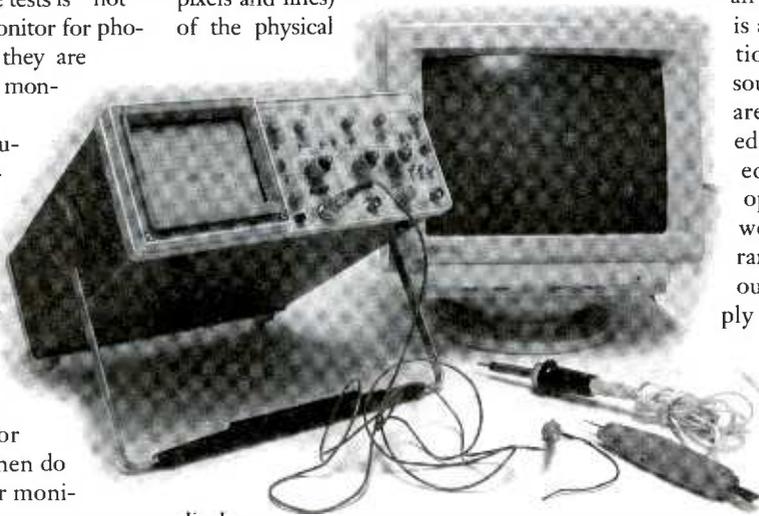
- Screen size and general appearance
- Brightness and uniformity, purity and color saturation
- Stability
- Convergence
- Edge geometry
- Linearity
- Tilt
- Size and position control range
- Ghosting or trailing streaks
- Sharpness
- Moire
- Scan-rate switching
- Acoustic noise—buzzing and whining

CAUTION: Since there is no risk-free way of evaluating the actual scan rate limits of a monitor, this is not an objective of these tests. It is assumed that the specifications of both the video source/card and the monitor are known and that supported scan rates are not exceeded. Some monitors will operate perfectly happily at well beyond the specified range or will shut down without damage. Others will simply blow up instantly and require expensive repairs.

Note: Throughout this article, the term 'raster' is used to refer to the entire extent of the scanned portion of the screen and the terms 'picture,' 'image,' or 'display' to refer to the actual presentation content.

Test Patterns

Three kinds of test patterns will be needed:



- Solid, saturated primary colors (R, G, B) and combinations of these (Y, C, M, W). These will be used for brightness and color purity tests. Total black will also be required to set background level and evaluate black level retention.
- White cross hatch, fine dot, alternating vertical and horizontal line patterns and bounding box outline. These will be used for convergence, geometry, size, and position, focus, and Moire tests.
- High-quality graphic or photographic image for general color appearance and overall aesthetic tests. If no suitable material is available, a Windows desktop with a vibrant color scheme (computer monitors) or an outdoor scene on a sunny day (studio video monitors) may be used.

For computer monitors, software programs are available to conveniently generate the required test patterns. However, an application like Windows MSPAINT in conjunction with a picture with vibrant colors can be used to create anything that is needed. It just will not be quite as easy to switch between patterns. Video cards like those from ATI come with a software Install program that provides a bounding box pattern at all (PC DOS/Windows) resolutions and scan rates.

Test-pattern generators for TV monitors are readily available and relatively inexpensive. However, a camcorder viewing appropriate printed material or a prerecorded tape can be used in a pinch.

Testing a New or Used Monitor

Before starting the series of tests, allow the monitor to warm up for at least a half hour and make sure it is completely degaussed. Power the monitor up in the physical orientation you will be using it (front-back facing North-South if you do not know how your setup will be arranged) and don't rotate it on its tilt swivel base after degaussing and for the duration of these tests. Make sure the monitor is not near any sources of electromagnetic interference (i.e., other powered monitors, loudspeakers, motors, transformers, etc.). Subdued lighting is best.

Use only the original video cable that came with the monitor or high quality BNC cables as appropriate. If you have a

choice, opt for a BNC cable—the quality at higher scan rates will be noticeably better. Do not use any extension cables, any video switch boxes, or excessively long BNC cables.

Obviously, if you can do any of this in a store at all, then you may not quite have the luxury to fully control your environment!

Note that for an auto-scan monitor, all tests should ideally be performed at several points including the extremes upper and lower limits of each scan range. Most aspects of an auto-scan monitor's performance are affected by scan rate.

Unless otherwise noted, all controls are those available to the user. For each test, adjust the size and position controls so that the raster fills as much of the screen as possible or as appropriate for the particular test.

Screen Size and General Appearance

Screen dimensions are normally measured diagonally—corner to corner. So you thought you were buying a 17-inch monitor, right? Wrong. A monitor that is advertised as 17 inches (or 15 or 21) will rarely give you anything near that viewable size. The specification is of the CRT—including what is covered up by the front bezel and not considering the actual maximum size picture that may be possible in all scan modes.

Easily, 1.5 to 2 inches of your valuable diagonal screen real estate may be lost to marketing hype. As a result, you might find as much as a 20% difference in usable screen area between monitors that claim to be the same size. This is like buying a 17-inch monitor and getting one that is only 15 inches!

At certain scan rates, it may not be possible to get a picture corner to corner so even more usable area will be lost.

Some advertisements now include actual viewable screen size. Hopefully, this will become a universal practice, but I will not hold my breath.

Check these aspects, also:

- Screen curvature—some are curved, others are nearly flat, Trinitrons are cylindrical. For the most part, this is strictly a matter of preference. However, if you intend to photograph (still or video) off the screen, a flatter screen (all other factors being equal like geometric accuracy) will result in less distortion.

- Screen-surface finish—this may be highly polished resulting in annoying reflections or dull (flat), which if excessively grainy will decrease the crispness of the display. A highly polished surface with an anti-reflective coating (see below) is probably best.

- Antireflective and/or black (smoked) glass—usually, a CRT with a dark appearance will produce a higher contrast picture; but possibly at the expense of overall brightness. Antireflective coatings like those on camera lenses help also, but are easily smudged and may be damaged by excessive cleaning.

- Convenience of the user controls. Digital controls are nice in that the settings for each resolution and scan rate are stored in memory. However, knobs are much easier to adjust in many cases. I prefer knobs for at least brightness and contrast.

- The aesthetics of the case. While this is usually unimportant from a performance point of view, it could be of great significance to your happiness. However, I know of some incredibly ugly monitors with great performance!

Brightness and Screen Uniformity, Purity and Color Saturation

Display a black—totally blank screen (but don't just pull the video cable as the monitor will be running with the normal voltages and signals) so that the raster is just barely visible. This adjustment should be possible but as noted below, not all monitors have totally independent brightness and contrast controls—you may need to bring up contrast a bit also.

The raster should be of uniform intensity and neutral gray. If it is not of uniform intensity or has hum bars—full width areas of varying brightness—or full height vertical rippled areas, the monitor's power supplies may be defective or of poor design. The only way to be sure is to compare several samples of the same model.

If the raster is not a neutral gray but has a tint, the color balance may need to be adjusted. Make sure you can actually set the brightness for total black (turn out the lights and check). If not, you will never have truly dark shadow areas in

your display. Blacks will never be black and the display will always look washed out. This may be adjustable internally.

However, inability or difficulty in adjusting for a totally or nearly black raster and vibrant bright display—or if the background brightness shifts as the picture content changes—may indicate a deficiency or defect in the black-level retention circuitry. Since video signals are usually AC coupled, a clamping circuit is needed to set the black reference. If this does not work correctly or is poorly designed, the black level may shift depending on the picture content. Modern monitors should be nearly perfect in this regard. This problem is still seen in some cheap TVs, however.

Now set brightness to make the raster just disappear. Set the contrast control all the way up. Display a pure red (R) full intensity raster. The entire screen should be a pure, fairly uniform fully saturated red. There should not be any areas that are not pure red. Repeat with the other two primaries—green (G) and blue (B). Follow this up with tests of pairs of primaries resulting in yellow (R+G), cyan (G+B), and magenta (R+B). Again, these should result in pure vibrant colors.

Finally, display a pure white full intensity screen. The raster should be pure white. There should be no patches of discoloration. It may be a warm white (somewhat reddish) or a cool white (somewhat bluish), but not objectionably so. Some monitors permit this color ‘temperature’ to be adjusted by the user. If the screen is noticeably colored and there are no user adjustments, then the internal video gain controls need attention.

Note that the term ‘vibrant’ here is a subjective term but relates to the boldness, saturation, and, well, zappiness! However, this is affected both by the choice of spectral output of the primary color phosphors and to your perception. For a given CRT, the phosphors set the spectral characteristics of the display. Expensive studio monitors can be ordered with a specific CRT to suit the needs of the video standard.

This is rarely an option with computer monitors. You probably do not have control over your visual perception (but do take off those autocompensating sun glasses!) In other words, your mileage may vary.

If any of these tests detect a problem, the color purity may need to be adjusted. (By you or by a professional as appropri-

ate). A brand new monitor should not have purity problems unless it is near a source of magnetic fields like a loudspeaker or MRI scanner.

The pure white screen can also be used to evaluate the brightness uniformity of the CRT. Don’t expect perfection. The actual quantitative measured brightness may vary quite a bit even with a high-quality monitor. The corners and edges may be noticeably darker than the center even on the low deflection angle CRTs used in high-performance monitors.

With the high deflection angle CRTs in TVs and cheap monitors, this may be even worse. However, local significantly darker or brighter areas could indicate defects in the CRT dot/slot mask or aperture grille or phosphor screen, which should not be tolerated.

Should you see color or uniformity problems at full intensity, try turning down the contrast control. If the uniformity improves after a few seconds, the shadowmask in the CRT may be heating and deforming. This is not unusual with color monitors. One of the advantages of an InVar shadowmask is that it is less prone to these problems, however.

Also note if there is a brightness limiter circuit that is kicking in with the full white screen. As you turn up the contrast, is there a point where further increase has no effect on the intensity of the display or where the intensity actually decreases? These brightness limiters are designed to maintain the beam current at supposedly safe levels to minimize X-ray generation and/or to minimize the shadowmask heating effects. Is the maximum brightness adequate for your needs and viewing enjoyment?

Using the full white screen, adjust the contrast and brightness controls through their full range. The size of the raster should not change noticeably. A significant change in size—more than 1 or 2 percent—would indicate poor power supply regulation.

Examine the entire screen closely for blemishes both in the surface finish and for dead spots. If you see any dead or darker spots, confirm that these are not due to the video source: if they are CRT defects, they will not move as you adjust the position controls.

There is a specification for the number and size of acceptable CRT blemishes so you may have to whine a bit to convince the vendor to provide a replacement monitor under warranty. Defects in the corners will likely only be noticed

if you are looking for them. However, dead spots in the central area of the screen will always be a distraction. Before the purchase is the time to find these.

Stability

Display a picture having a complete range of colors and intensities. At refresh rates beyond 70-75 Hz, even a very bright display should appear rock solid. Turn off any fluorescent lights (whose possible flicker at twice the power line frequency can confuse the test) and examine the screen closely. There should be no shimmering, wiggling, jittering, or dark or light flashes. Any of these would indicate either (1) external electromagnetic interference or (2) a poorly designed or defective power supply in the monitor. It is also possible, though less likely, that the incoming AC power is noisy, but modern monitors generally do a decent job of filtering the power lines to eliminate most of this.

Convergence

Ideally, all three electron beams in a color CRT should be precisely coincident at every point on the screen. While this is never quite achieved, the degree of convergence even at the corners is generally quite impressive—less than .5 mm for many moderately priced monitors.

Display a white crosshatch pattern with boxes about ½ inch square. If you do not have this, use a white-on-black graphics or text screen with a lot of fine detail—small fonts or intricate patterns.

The lines should appear white without excessive color fringing. The individual primary colors should not be visible at a normal viewing distance. First, examine the center. This should be nearly perfect. If your monitor has any user-adjustable convergence controls, set these for best center convergence. Convergence will be worst in the corners but even there, it should not be objectionable.

A serious convergence problem in the center of the screen is definitely an indication of a defective monitor or one that needs internal adjustments. Slightly poorer convergence at the corners may be within specifications. A new monitor with significant convergence problems should be rejected.

Edge Geometry

Display a bounding box image—one that extends to the very edge of the

raster on all sides. Adjust any user pinch controls (amplitude and phase) for minimum distortion along the vertical edges. Amplitude moves the sides in and out. Phase sets where, vertically, this effect takes place. If there are any other user controls that affect raster shape, optimize these for a perfectly rectangular display.

Now, examine all edges for curves, wiggles, dips, keystoneing, or trapezoidal deviations from a perfect rectangle. These are all considered defects in the geometry of the raster. These will likely be more pronounced at high scan rates—near the limits of the specifications for the monitor.

In particular, you may see a wiggle or wave on the left and right edges near the top of the screen, which will become more pronounced as you approach the highest scan rate (this is a deflection problem, however, not strictly a CRT geometry problem).

During manufacture, various magnets are strategically glued around the CRT or carefully positioned on rotating swivels on the deflection yoke frame or elsewhere. You need to decide if any remaining errors in geometry are acceptable or not because improving upon these settings is not something that is easy or fun to do—by you or a professional! As noted, if the geometry becomes noticeably inferior at high scan rates, this indicates a problem in the deflection circuitry—adjustments will probably not help. Consider another monitor if you intend to run at these rates.

Linearity

Display a crosshatch pattern of roughly 1/2-inch spaced lines. Take a tape measure and compare the exact spacing of vertical lines in the left, middle, and right areas of the screen. Do the same for the horizontal lines in the top, middle, and bottom of the screen. Modern monitors should have very little variation—probably undetectable using a tape measure. Linearity may or may not be adjustable.

Tilt

Inspect the bounding box for tilt—is it perfectly aligned with the cosmetic bezel of the CRT? If the monitor has a tilt control, see if it will compensate. Few do. The only way to correct tilt on monitors without a tilt adjustment is to rotate the deflection yoke or entire CRT—not rec-

ommended. If the degree of tilt bothers you in the slightest and you are a perfectionist, reject the monitor or insist that the tilt be corrected—and be present if possible to make sure that the adjustment is done to your satisfaction.

Size and Position Control Range

Determine if the size and position controls have enough of a range to fill the screen totally (for computer monitors) or (possibly in conjunction with an under-scan switch) allow for a suitable reduced raster size (studio video monitors).

For computer monitors, these tests may need to be done in conjunction with the video card you will be using and the software setup program for that video card. Ideally, all size and position adjustments can be done in software with the monitor's controls left at their center (default) setting.

However, this is not always the case. Some people want their computer monitors to extend to or past the edges of the CRT. Many monitors may leave a large border around the picture particularly at higher scan rates. Test at the resolutions and scan rates you expect to use. Obviously, a monitor that will not fill the screen is shortchanging you in terms of how much screen size you purchased!

Often, slightly reducing the scan rate at a given resolution will allow for a larger picture. This is one alternative if the flicker is not objectionable.

Ghosting or Trailing Streaks

Display a picture with a large number of high-contrast vertical edges—a Windows desktop with many open folders, for example. Vertical edges should be crisp and clear. Examine these for smearing, ghosting, or trailing darker or lighter lines. Any deficiencies will be most evident at high scan rates since these require the most bandwidth from the video card, cables, and monitor. Also, any ringing, undershoot, or overshoot, will extend for a longer space following the edge.

Without substituting video cards, cables, and monitors, it is not usually possible to determine which is the limiting factor. The most common causes of these types of problems are inferior, defective, or excessively long cables; use of cable extensions or video switch boxes; or improper termination if there are termination options on the monitor.

Full-brightness vertical edges should not smear or bloom to the right—possi-

bly with a color change. This is due to the internal video gain controls being set too high and may be correctable, but possibly with a reduction in maximum brightness.

There should also be no trailing lines to the right of long bright or dark horizontal areas. Similarly, the edges of the raster should not bulge out where the picture is very bright. These symptoms would indicate problems with the power supplies or just poor design.

Sharpness

Display a white screen at the highest resolution and scan rate your system is capable of (or the highest you ever anticipate using). See if you are able to make out the individual scan lines. Turn down the brightness—this will decrease the effective spot size and make the scan lines more visible.

Display a fine dot pattern. The individual dots should be tiny, crisp, and fairly symmetric. If the spot size changes drastically with brightness, focus may need to be adjusted or the monitor's power supplies or CRT may be mediocre or defective.

Note that it is not always best to have super-sharp focus as long as the spot size is small enough. A slightly defocused spot will result in a smoother display and less likelihood of Moire effects.

Moire

Moire is caused by interference—beating—between the picture or raster and the phosphor dots or lines that make up the display. Technically, it is an aliasing artifact due to the relative sampling rates of these two structures.

There are several causes of Moire. The following will address two of these—scan line Moire and pixel Moire. Try these tests with any 'Moire reducing modes' both off and on. However, the use of such 'features' may reduce the quality of the display in other ways like reducing sharpness or stability.

Display a solid white screen at mid brightness. Look for patterns that look similar to contour lines on topographic maps. Adjust the vertical size and position controls to see if these move around or change their severity and spacing. Repeat with a display of alternating black and white horizontal lines.

Now, display a pattern consisting of alternating black and white vertical lines at the maximum possible frequency (alternating dark and light pixels for a

computer display—make sure your software is not doing any dithering). Look for serious contour lines in this display. Adjust the horizontal size and position controls to see how these affect any Moire.

Try these tests at multiple resolutions including the highest you will ever use. However, the highest may not necessarily be the worst with respect to Moire.

Other than using any 'Moire reducing mode' provided by the monitor, there may not be anything you can do to reduce the severity of Moire other than running at resolutions that do not exhibit a serious problem. Nonetheless, I think it is ironic that some people will end up returning otherwise superb monitors because of moire—when in many cases this is an indication of most excellent focus—something many people strive for! You can always get rid of it—the converse is not necessarily true!

Scan-Rate Switching

When running Windows or DOS with an auto-scan monitor, switching scan rates may be done quite frequently. Some monitors take longer than others to perform this switchover. There may be clicks (due to relays) and other sounds. Better monitors will blank the video until the new scan rate has stabilized. On cheaper monitors, you may see the image as it locks in.

Some monitors are very quick. Others can take several seconds—an eternity if you are doing this frequently. Try switching between scan rates at the limits of each scan range as this will be the toughest situation. While it is hard to pin down what makes for a suitable outcome of this test (unless there is an actual failure to properly sync), a monitor that appears to be struggling or which doesn't always make it may be trying to tell you something.

Acoustic Noise

Ideally, a monitor is seen and not heard. However, there are a variety of components inside that can vibrate and this may be quite annoying in a quiet room or late at night. A buzz may originate from the switching power supply or vertical deflection components. A high-pitched whine, squeal, or twittering may originate from the switching power supply, flyback (LOPT) transformer, or horizontal-deflection components. Some people aren't bothered by these sounds at all or cannot hear them. Others will be driven stark raving bonkers.

Listen carefully through the grille in the cover for any indication—even momentary—of annoying sounds. Try all scan rates—very often various resonances will only occur at particular horizontal or vertical scan frequencies. Even with high-quality monitors, these problems sometimes occur erratically and no quick test will identify such faults. Obviously, doing this in a quiet location is best.

Note that any decreasing hum or buzz that may be heard at power-on is due to the internal degaussing coil and is usually normal and unavoidable.

Final Evaluation

If after these tests, you determine that your monitor or the one you are considering is absolutely perfect—let me know as this is extremely unlikely. More likely is that you found a number of deficiencies. If this is a monitor you are considering purchasing, you need to decide if the benefits outweigh the defects.

Wrapup

With 19-inch name-brand computer monitors going for under \$200, the importance of getting everything perfect is somewhat less than it was when they cost \$2000. However, the monitor is still likely to be the longest lived part of any computer system, possibly outlasting several generations of CPUs and hard-drives. Therefore, it makes sense to spend some time evaluating monitors before purchase.

As always, I welcome feedback of almost any type via e-mail to sam-gp@repairfaq.org. Note change to my e-mail address: I was forced to disable the previous address due to excess SPAM. E-mail to that address will result in an autoreply with a Web address to use to contact me. P

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Laser Fun

This month we're going to do some experimenting with a low-cost laser sight. These sights are available at most sporting goods stores, as well as the large discount super centers like Wal-Mart. The one I'm using is an ACC-Laser Sight System for pistols or rifles (#7950) supplied with a remote touchpad switch from Daisy Outdoor Products, the Red Rider BB gun maker. The output is rated at less than 3.5 mW, at a wavelength of 650 nm. Other similar sights might also work in our circuits; however, each one will require basic testing to determine its compatibility.

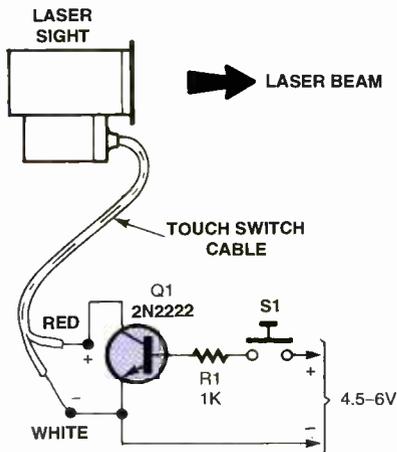


Fig. 1. Connect a NPN 2N2222 transistor to the laser's remote switch wires, as shown in Fig. 1. Closing S1 should turn the laser on. If so, we can continue with our next experiment to see how fast the laser can be turned on and off.

PARTS LIST FOR THE ELECTRONIC LASER SWITCH (FIG. 1)

- ACCU-LASER #7950, "Daisy Outdoor Products" (see text)
 Q1—2N2222 NPN transistor
 R1—1000-ohm, ¼-watt, 5% resistor
 S1—Normally open pushbutton switch

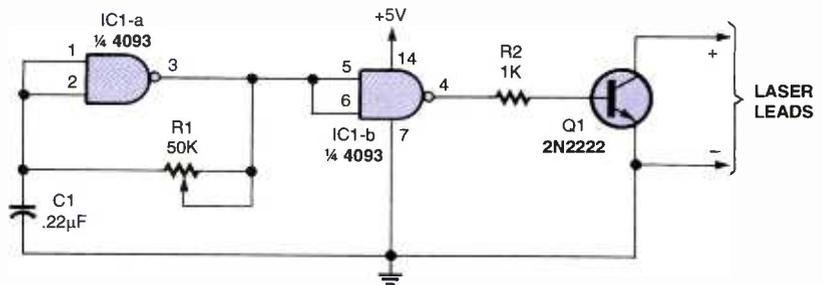


Fig. 2. The circuit is a variable frequency oscillator (100 Hz to over 5 kHz), with the output driving a 2N2222 transistor. The transistor operates like a switch, opening and closing at the oscillator's frequency turning the laser's power on and off at the same rate.

PARTS LIST FOR THE VARIABLE FREQUENCY OSCILLATOR (FIG. 2)

- IC1—4093 CMOS, Quad 2-input NAND Schmitt trigger
 Q1—2N2222 NPN transistor
 C1—.22-µF, ceramic-disc capacitor
 R1—50,000-ohm potentiometer
 R2—1000-ohm, ¼-watt, 5% resistor

First, we must determine if the laser sight can be turned on and off electronically. Cut the remote-control cable near the touch switch end and bare both wires. Connect a voltmeter to the leads and determine the polarity. In the one I'm using, the red wire is positive and the white wire is negative; however, never go by color-code alone without testing first with a voltmeter. If you do, Murphy will get the last laugh.

Danger: Avoid Direct Eye Exposure

Treat these devices with respect and follow all recommended precautions accompanying the laser product.

Connect a NPN 2N2222 transistor to the laser's remote switch wires, as shown in Fig. 1. Closing S1 should turn the laser on. If so, we can continue with our next experiment to see how fast the laser can be turned on and off.

The circuit in Fig. 2 is a variable frequency oscillator going from about 100 Hz to over 5 kHz, with the output driving a 2N2222 transistor. The transistor operates like a switch, opening and clos-

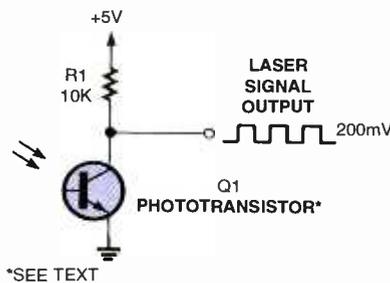


Fig. 3. You'll need something faster than our eyes to detect the interrupted laser beam. A phototransistor looking at the laser beam just might do the trick. A simple laser-detector circuit is shown above.

PARTS LIST FOR THE SIMPLE LASER DETECTOR (FIG. 3)

- Q1—Mouser Electronics #512-L14G1 or 512-QSD124 (see text)
 R1—10,000-ohm, ¼-watt, 5% resistor

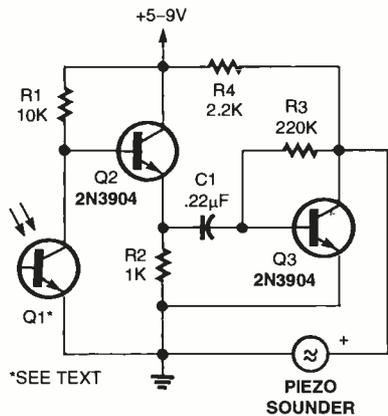


Fig. 4. In the circuit above the laser beam hitting the phototransistor supplies a forward bias that follows the on/off cycle of the oscillator-driver circuit in Fig. 2.

PARTS LIST FOR THE BASIC RECEIVER CIRCUIT (FIG. 4)

SEMICONDUCTORS

Q1—Mouser Electronics #512-L14G1 or 512-QSD124 (see text)
 Q2, Q3—2N3904 NPN transistor
 Piezo transducer

RESISTORS

(All resistors are 1/4-watt, 5% units.)
 R1—10,000-ohm
 R2—1000-ohm
 R3—220,000-ohm
 R4—2200-ohm

ADDITIONAL PARTS AND MATERIALS

C1—.22-µF, ceramic-disc capacitor

ing at the oscillator's frequency turning the laser's power on and off at the same rate. Even at 100 Hz the laser looks like a constant beam of light. Here we need something faster than our eyes to detect the interrupted laser beam. A phototransistor looking at the laser beam just might do the trick. A simple laser-detector circuit is shown in Fig. 3.

Several different phototransistors were tested in the circuit with the best results using a Mouser Electronic #512-L14G1 that is available for less than two bucks. A less expensive phototransistor, Mouser #512-QSD124, that's available for less than a buck also worked though with less sensitivity. Most any phototransistor should respond to the laser beam and produce a useable output.

Aim the laser beam at the phototransistor, from about a one-foot distance,

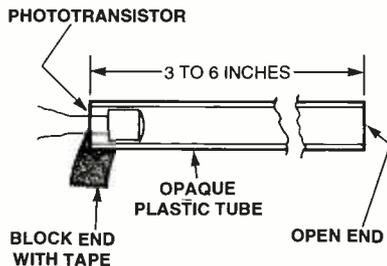


Fig. 5. Most phototransistors are sensitive to most available light sources and must be shielded from all but the laser beam. A simple method is to mount the phototransistor in one end of a long opaque tube, as shown in this diagram.

and monitor the phototransistor's output on an oscilloscope. Start with the oscillator at its lowest frequency and observe the waveform as the frequency is increased. Note the frequency when the output drops off to about one-half of the level obtained at the lowest frequency. This will be the laser's highest useful operating frequency for our experiments.

If an oscilloscope is not handy, jump ahead to the circuit in Fig. 4 and listen to the oscillator's tone to determine the maximum useable frequency. Also, we'll use this circuit for our next laser experiment.

First, let's take a quick look at the circuit in Fig. 4 and see how it works. The laser beam hitting the phototransistor supplies a forward bias the on/off cycle of the oscillator-driver

circuit in Fig. 2. Q2 is connected in an emitter-follower circuit to isolate the phototransistor from the loading effect of Q3. Q3 is connected in a common emitter audio-amplifier circuit, raising the phototransistor's output signal to a level sufficient to drive a piezo element.

Experimenting And Having Fun

Now, we'll find out just how far away we can intercept and monitor the laser beam's transmitted audio tone. Most phototransistors are sensitive to most available light sources and must be shielded from all but the laser beam. A simple method is to mount the phototransistor in one end of a long opaque tube, as shown in Fig. 5. Plastic tubing will do, as long as no light can enter anywhere except the open end. The tube can be any length, but should be at least 3 inches long.

The longer the tube the more directional the detector becomes. Bring the phototransistor's leads out and tape over the tube's end with black electrical tape. I used an old ball point pen housing that ended up being 5 inches long with the phototransistor in place.

The laser's maximum operating frequency was above 4 kHz with the circuits as shown; however, with a few component changes it's possible to go even higher in frequency.

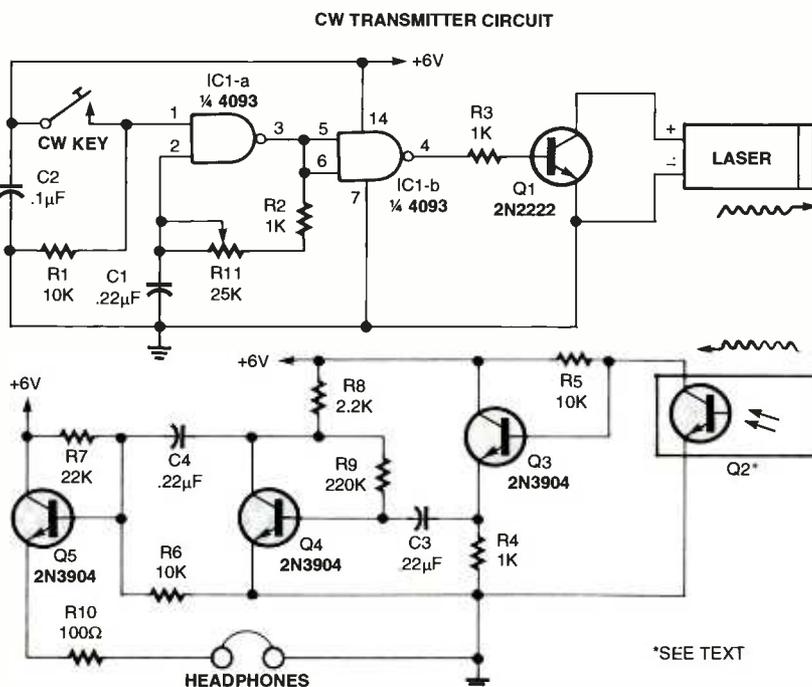


Fig. 6. This CW transmitter can be fun to use learning the code or for private communications over a reasonable distance, and it offers a feature not often found in other transceivers—the ability to transmit a signal at the same time a signal is being received.

PARTS LIST FOR THE CW TRANSCEIVER (FIG. 6)

SEMICONDUCTORS

IC1—4093 CMOS, Quad 2-input NAND Schmitt trigger
 Q1—2N2222 NPN transistor
 Q2—Mouser phototransistor, see text.
 Q3, Q4, Q5—2N3904 NPN transistor

Going The Distance

Very little difference in the receiver's output was noted when moving from a distance of 10 ft. to over 50 ft. I ran out of shop room long before noticing much change in the received signal. At night the range could be well over 100 ft. Refinements in the receiver tube including the addition of a lens system and more audio gain to the receiver circuit could increase the range much farther.

Several applications come to mind for the laser transmitter/receiver combination. Even though CW is no longer a difficult matter to master for an Amateur radio license, it still remains a fun mode of communication. It's an easy matter to modify the two circuits and combine them for a dandy little CW laser transceiver, as shown in Fig. 6. This CW transceiver can be fun to use learning the code or for private communications over a reasonable distance.

There are some minor differences between our original two circuits and the CW transceiver circuit in Fig. 6.

PARTS LIST FOR THE LASER UNIT (FIG. 6)

RESISTORS

(All resistors are 1/4-watt, 5% units.)
 R1, R5, R6—10,000-ohm
 R2, R3, R4—1000-ohm
 R7—22,000-ohm
 R8—2200-ohm
 R9—220,000-ohm
 R10—100-ohm

CAPACITORS

C1, C3, C4—.22- μ F, ceramic-disc
 C2—.1- μ F, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

CW key, opaque tubing, headphones, etc.

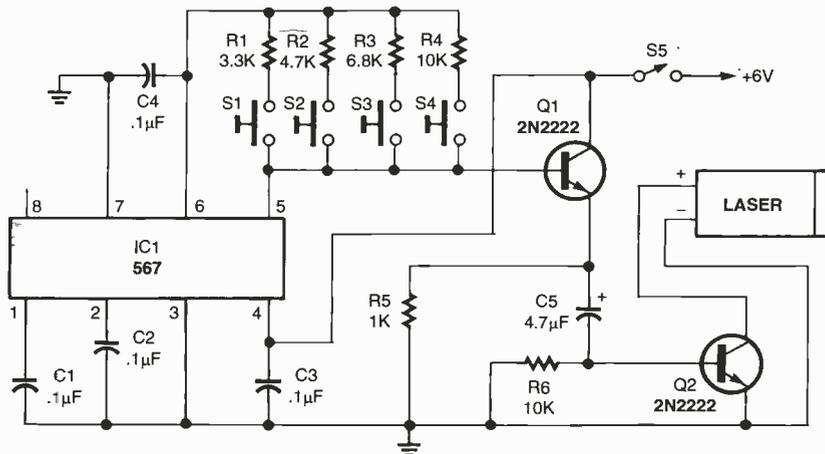


Fig. 7. A low-cost 567 phase-locked-loop IC serves as the multi-frequency tone generator set up for four separate output functions in this multi-channel remote control laser transmitter.

PARTS LIST FOR THE LASER REMOTE-CONTROL TRANSMITTER (FIG. 7)

SEMICONDUCTORS

IC1—567 PLL IC
 Q1, Q2—2N2222 NPN transistor

RESISTORS

(All resistors are 1/4-watt, 5% units.)
 R1—3300-ohm
 R2—4700-ohm
 R3—6800-ohm
 R4, R6—10,000-ohm
 R5—1000-ohm

CAPACITORS

C1-C4—.1- μ F, ceramic-disc
 C5—4.7- μ F, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1-S4—Normally open pushbutton switch
 S5—On/off SPST switch
 Laser unit

The oscillator circuit has been modified to operate with a CW key. The input, pin #1, of gate "A" is connected to ground, disabling the oscillator until the CW key is closed and taking pin #1 to battery positive. Each time the CW key closes the oscillator starts and sends an on/off laser signal at the oscillator's operating frequency toward the companion receiver. Resistor R11 allows the transmitted frequency to be adjusted for a pleasant CW tone. Normally, this is a frequency between 600 and 1000 Hz.

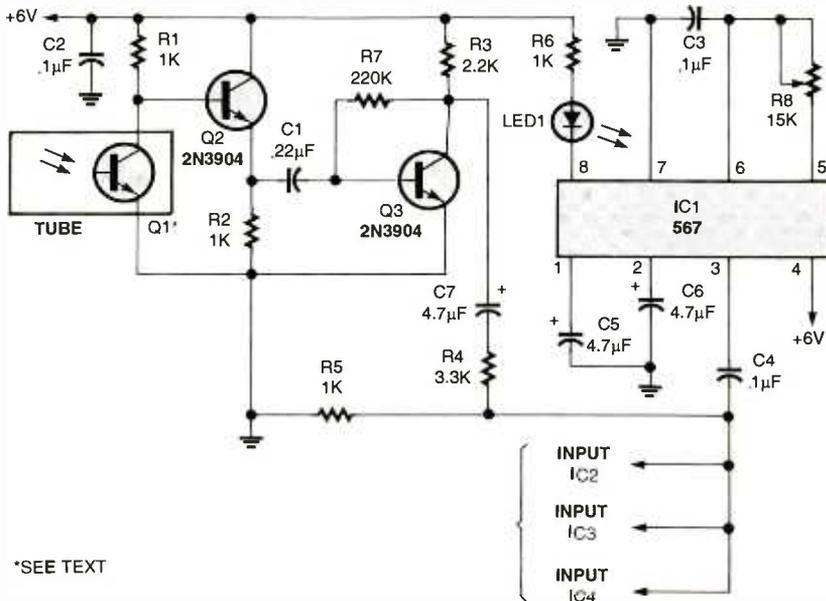
This laser CW transceiver offers a feature not often found in other transceivers, and that is the ability to transmit a signal at the same time a signal is being received. In an RF transceiver, the antenna is common to both the receiver and transmitter. Each time the transmitter is keyed on, the receiver must be disabled or sustain front-end damage. In our laser transceiver an antenna is not required, only a clear path between the two units. Of course it's difficult to talk and listen at the same so this feature may only be interesting and not a practical application for CW communication.

Laser Remote Control

If we can communicate over a laser beam, why not use the same beam of light to control circuitry or equipment at a remote location? Of course, we can. A multi-channel remote-control laser-transmitter circuit is shown in Fig. 7. A low-cost 567 phase-locked-loop IC serves as the multi-frequency tone generator set up for four separate output functions. Pushbutton switches, S1, S2, S3, and S4, select the output-tone frequencies.

Q1 is connected in an emitter-follower configuration to isolate the IC's output from loading by the driver transistor, Q2. Q2 operates like a switch, as in our previous circuits, to turn the laser on and off at the selected tone frequency. S5 is the power switch and may only be needed when operating from battery power.

The remote-control receiver circuit is shown in Fig. 8. To keep it simple, only one decoder channel is shown. The three other decoders are duplicates of the 567 circuitry in Fig. 7. Let's look



*SEE TEXT

Fig. 8. The remote-control receiver circuit is shown here. To keep it simple, only one decoder channel is shown. The three other decoders are duplicates of the 567 circuitry in Fig. 7.

over the receiver circuitry, and that may clear up any questions about the missing decoders.

The phototransistor, buffer amplifier, and voltage amplifier are the very same circuit used in our CW transceiver. Q3's

output is reduced, with the voltage divider made up of R4 and R5 to better match the input level requirements of the 567 decoder IC. The tone signal is fed to the 567's input at pin #3. The decoded output at pin #8 goes low when the correct tone is received.

By adjusting R8, the decoder-tone frequency is set to the same frequency as the transmitter is sending out for the corresponding channel. The remaining three channels are adjusted in the same manner.

The circuit in Fig. 8 shows the decoder turning on an LED when the correct tone is received; however, to control an external circuit or piece of equipment, take a look at the two circuits in Fig. 9.

The circuit in Fig. 9 "A" uses a

PARTS LIST FOR THE LASER REMOTE-CONTROL RECEIVER (FIG. 8)

SEMICONDUCTORS

- Q1—Mouser phototransistor, see text
- Q2, Q3—2N3904 NPN transistor
- LED1—Light-emitting diode, any color
- IC1-IC4—567 PLL IC

RESISTORS

(All resistors are 1/4-watt, 5% units.)

- R1—10,000-ohm
- R2, R5, R6—1000-ohm
- R3—2200-ohm
- R4—3300-ohm
- R7—220,000-ohm
- R8—15,000-ohm potentiometer

CAPACITORS

- C1—.22- μ F, ceramic-disc
- C2, C3, C4—.1- μ F, ceramic-disc
- C5, C6, C7—4.7- μ F, 25-WVDC, electrolytic

2N3906 PNP transistor to turn on a relay when a tone is received. Pin 8, on the 567 decoder, goes low when a correct tone is received. This takes the base of Q1 low, turning it on and closing the relay to activate the external equipment or circuit.

The circuit in Fig. 9 "B" is connected to a MOC3010 optocoupler triac-driver IC to control an AC-operated device. Here's a good place to use your imagination to come up with other ways to use the laser remote-control system.

I'm sure there are many more applications for our laser, but we've run out of time once again. Come back next month and see what's going on here at the lab and in the meantime may all of your circuits work Murphy free!

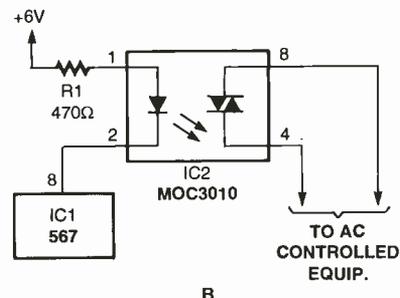
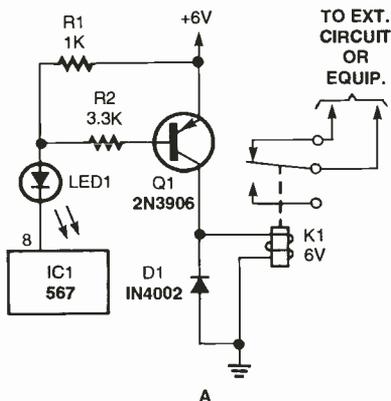
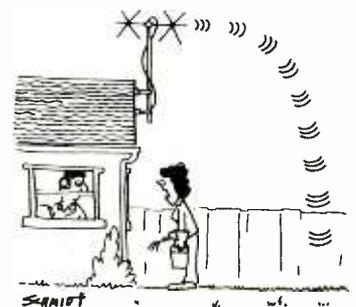


Fig. 9. Circuit "A" uses a 2N3906 PNP transistor to turn on a relay when a tone is received. Pin 8, on the 567 decoder, goes low when a correct tone is received. Circuit "B" connects to a MOC3010 optocoupler triac-driver IC to control an AC-operated device.

PARTS LIST FOR TWO LASER REMOTE-CONTROL SYSTEMS (FIG. 9)

- "A"
- Q1—2N3906 PNP transistor
 - IC1—567 PLL
 - D1—1N4002 diode
 - K1—6-volt DC relay

- "B"
- IC1—567 PLL
 - IC2—MOC 3010 optocoupler IC
 - R1—470-ohm resistor



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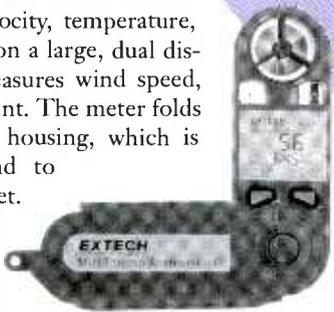
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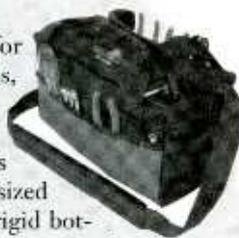
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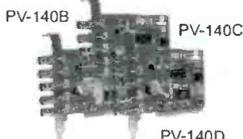
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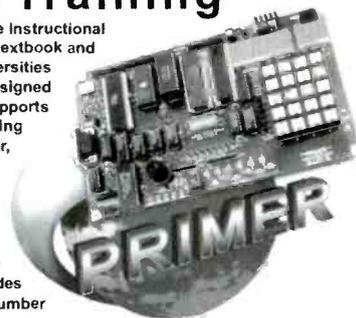
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Application Projects Include:

- Scan Keypad Input & Write to a Display
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- Measure Temperature
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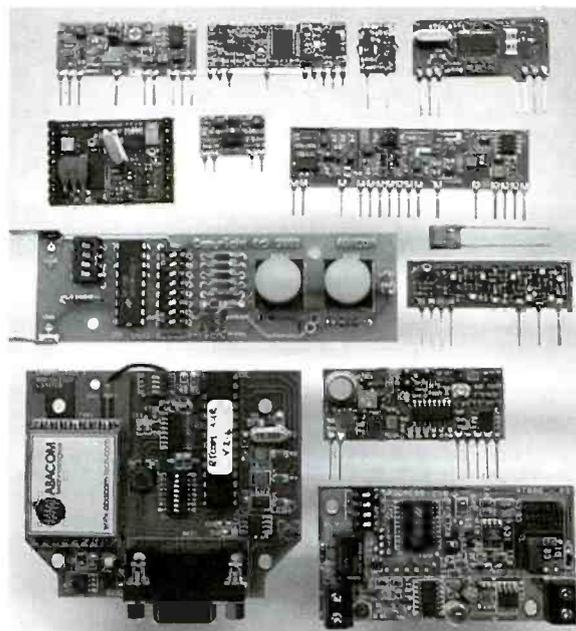
The PRIMER can be purchased as an unassembled kit (\$120) or as an assembled/tested kit (\$170). Upgrades provide battery-backed RAM and PC connectivity via an RS232 serial port (shown in picture). Additional options include a heavy-duty keypad (shown in picture) and a 9V power supply -- see our website. Quantity discounts are available. Satisfaction guaranteed.

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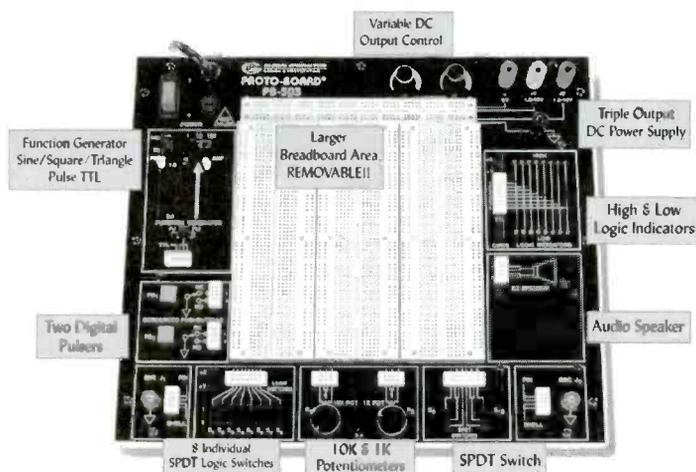
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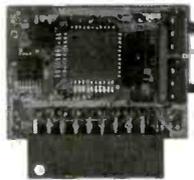


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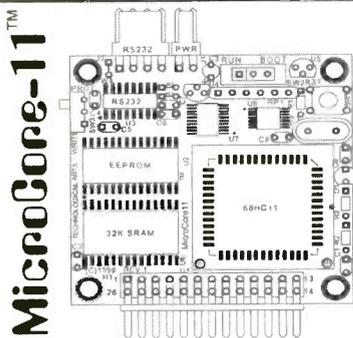


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BR-1 2-Way Monitor System Kit

This high end 2-Way Monitor is based on our popular 1-1/8" Silk Dome Tweeter (#275-070) and 6-1/2" Woofer (#295-305). It was designed to provide a low cost, easy to build 2-Way system for the speaker building novice. The end result is a kit that can be built in a couple of hours and that has a sound that will rival systems costing two or three times its modest price! Overall, the system is smooth and detailed, with a wide soundstage that belies their smallish size. The tonal balance is on the warm side of neutral, which is pleasing with most types of music. The bass is also impressive for a system of this size. If you need more bass, we recommend using the #300-630 10" subwoofer to create a matching satellite/subwoofer combination. The cabinets are made of 5/8" MDF finished in an unobtrusive "black ash" vinyl laminate and include grills with black cloth. All driver holes are precision cut with a CNC for a perfect fit. The tweeter is flush mounted to reduce diffraction effects. *Note: This system is offered in kit form and can be assembled in about 2 hours. The crossover needs to be assembled so soldering skills are necessary. We've included a tutorial that thoroughly explains the theory and design process making this kit perfect for educational programs. Each kit includes everything needed to build 1 pair of speakers.*

System Specification: ◆Frequency response: 43-18,000Hz ◆SPL: 85dB 2.83V/1m ◆Power handling: 100 watts max ◆Cabinet dimensions: 14-1/4" H x 8-5/8" W x 11" D ◆Net system weight: 35 lbs.



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#300-640

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#300-793

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- ◆ ASV voice coil
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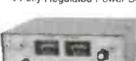


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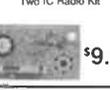
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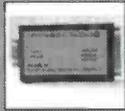
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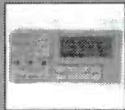
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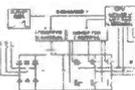
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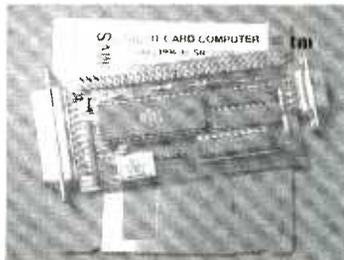
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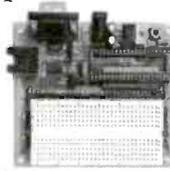
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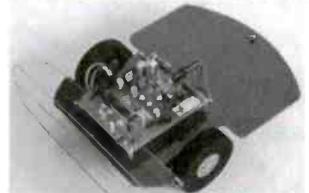
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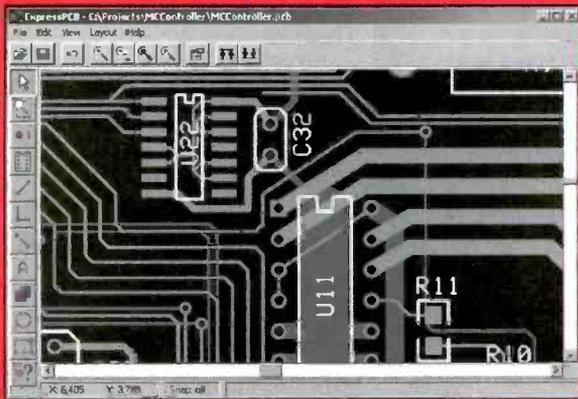
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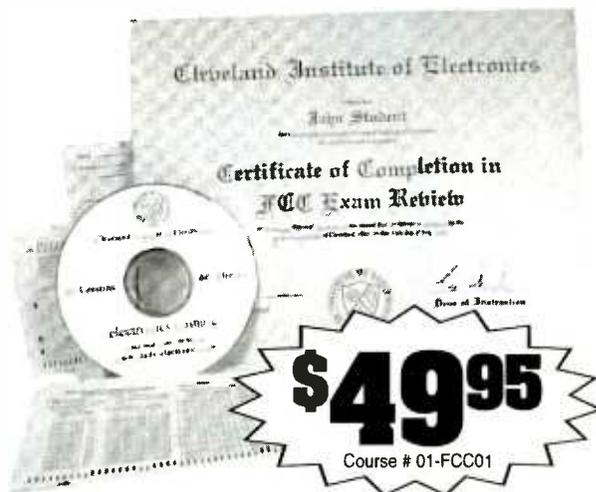
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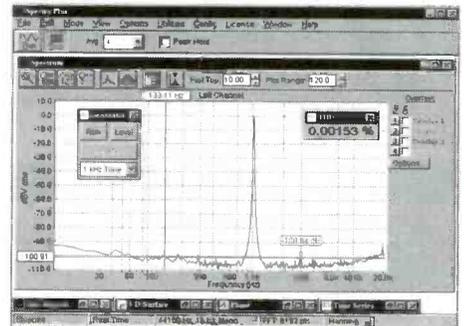
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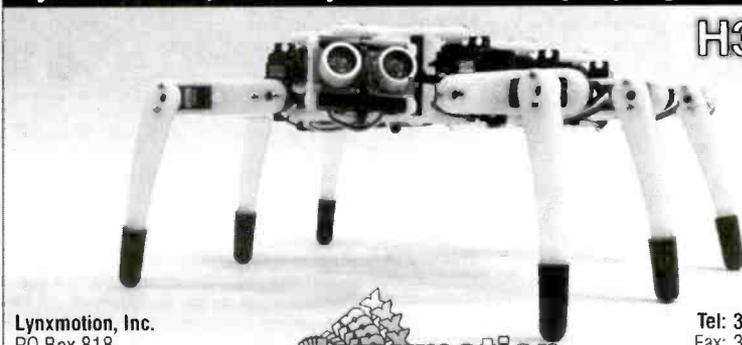
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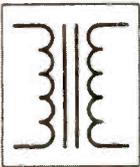
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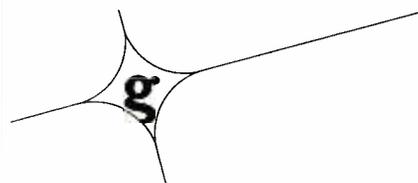
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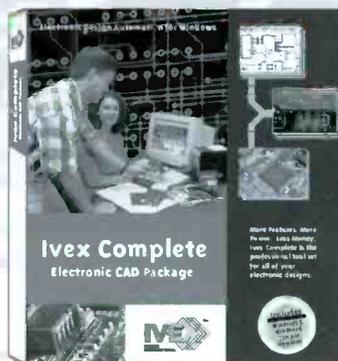
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