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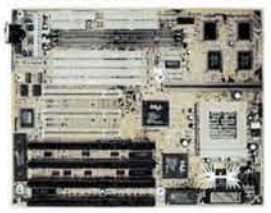

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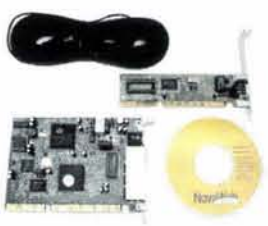

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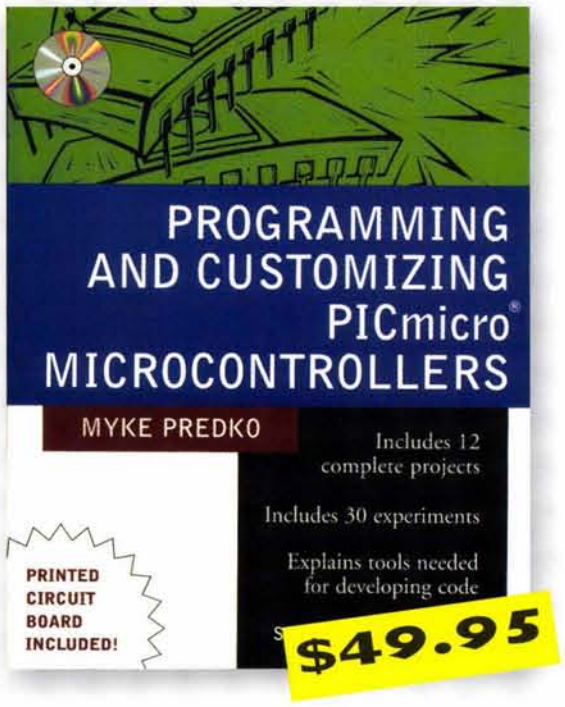


Programming & Customizing PICmicro Microcontrollers (2nd Edition)

by Myke Predko (published by McGraw Hill)

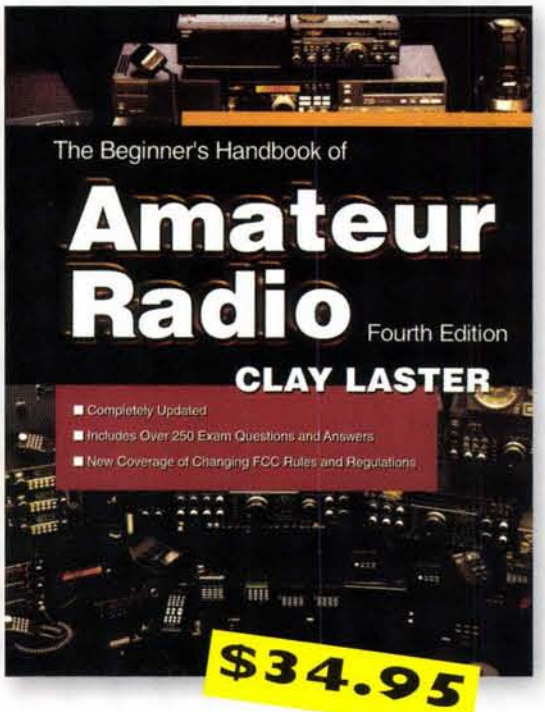
This book is a fully updated and revised compendium of PIC programming information. Comprehensive coverage of the PICMicro's hardware architecture and software schemes complement the host of experiments and projects making this a true, "learn as you go" tutorial.

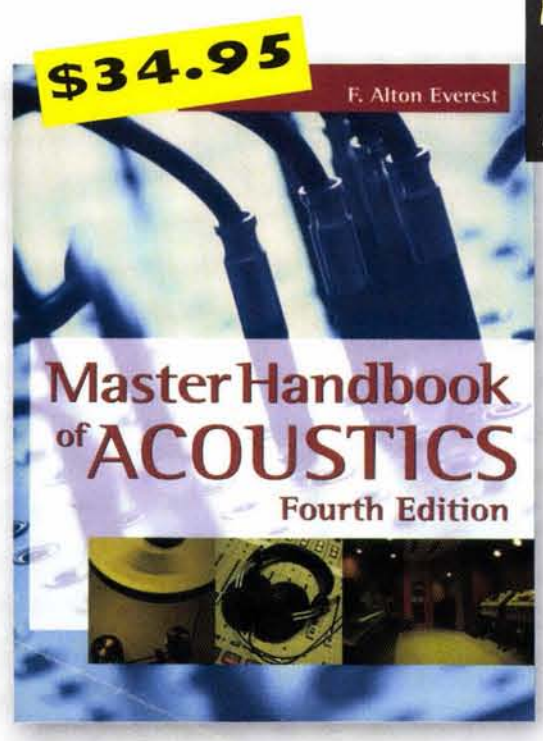
There are new sections on basic electronics and basic programming for less sophisticated users along with 10 new projects and 20 new experiments. New features have been added such as "Programmers Tips" and "Hardware Fast FAQs." **CD-ROM:**The CD-ROM contains all source code presented in the book, software tools designed by Microchip and third-party vendors for applications and the complete data sheets for the PIC family in PDF format. **Key Features:*** Foreword by Microchip Chairman Steve Sanghi. * Printed Circuit Board for a PICMicro programmer included with the book! This programmer will have the capability to program all the PICMicros used by the application.* Twice as many projects as the original book. The new projects include a PICMicro based Webserver * Twenty new "experiments" to help the user better understand how the PICMicro works. * An introduction to Electronics and Programming in the Appendices along with engineering formulas and PICMicro web references.

The Beginner's Handbook of Amateur Radio (4th Edition)

by Clay Laster (published by McGraw Hill)

The revised edition of the most trusted guide in ham radio is here just in time to help you pass the new No-Code Technician Class exams! Used by thousands of ham operators to set up their first shortwave transmitters and to get their licenses, Clay Laster's Beginner's Handbook of Amateur Radio, Fourth Edition delivers all the guidance you need – from radio and electronics fundamentals needed to set up a transmitter to the newest equipment to revisions to the Federal Communications Commission rules and tests. If you want to communicate over the airwaves both locally and globally and listen in on conversations heard by very few, take this book home, and it will take you into the realm of communication, new friends, good times, and technical mastery beyond your dreams.





Master Handbook of Acoustics

by F. Alton Everest (published by McGraw Hill)

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*Features an entire chapter devoted to Acoustical measurements and calculations.

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Keeping his target audience of hobbyists, electronics enthusiasts, and audiophiles always in mind, the author makes the science of sound interesting and understandable. Only someone who understands acoustics as well as Everest – Senior Member of the Society of Motion Picture and Television Engineers, the Acoustical Society of America, and the IEEE – could explain these principles so simply, informally, and with such relevance to home projects. Short on mathematical derivations and long on easy-reading translations of difficult technical subjects.

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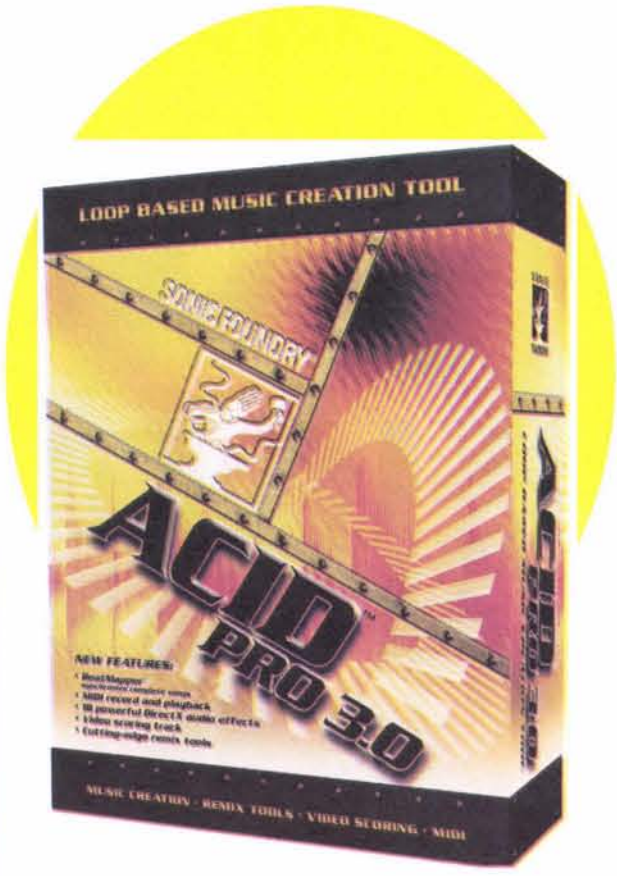
Articles

Abbey Road in a Box: Using a PC to Make Your Own Music

by Edward B. Driscoll, Jr.



Ever dream of writing a throbbing rock song, hypnotic trance rhythm, or twangy country tune? Or, do you have a guitar, a keyboard (the musical kind, not the kind that says QWERTY on it), or other musical instrument gathering dust in the closet and would like to get back to performing with a group, but want to avoid the hassle of finding other musicians and rehearsal space? Or, do you want to record your own music and sound effects to accompany PowerPoint presentations, web sites, or other productions?

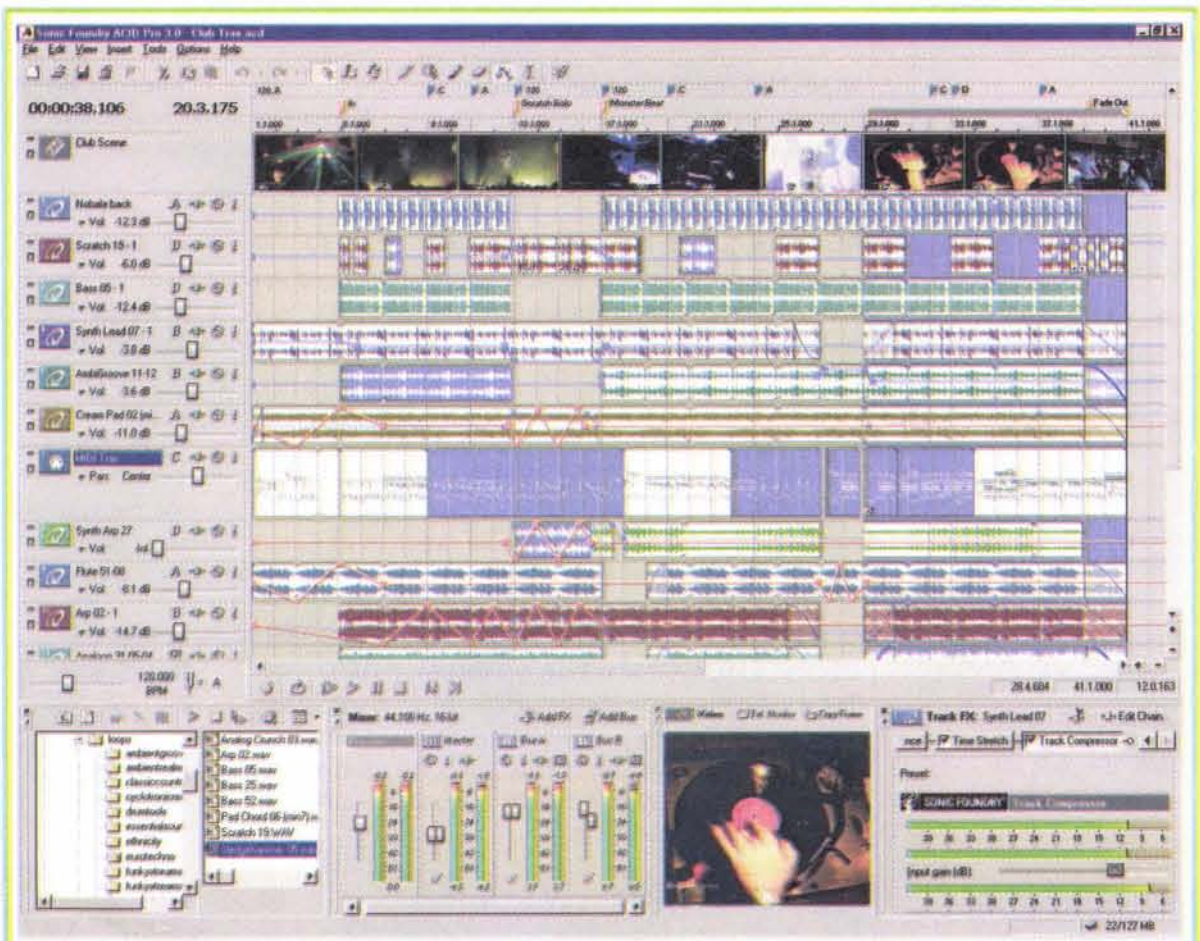
Whatever the case, that PC sitting innocently in the corner can be configured to both create and record an astonishing variety of sounds.

Who is the Typical Home Recording Enthusiast?

Bill Park, a Sysop of Compuserve's MIDI and Home Recording Forum, has a few guesses. He says, "No doubt that there are a lot of first timers out there, thrashing their way through their first guitar or keyboard riffs, and laying them down to MP3 to share with their friends."

But Parks is willing to bet that most home recording enthusiasts are average fellows over 30 with some music experience. "Once you get past that age, there is enough income for some discretionary spending, and there is the need for an outlet." And by that age, with the combination of a steady job, a family, and responsibilities, it becomes harder to be in a band. "But the creative urges are still there. The school teachers, accountants, and other typical adults are finding that with a modest investment they can still make music without all of the hassles involved in keeping a band together, and end up with a CD that they can inflict on their friends."

With the right equipment, some creativity, and just a little skill, music recorded at home can sound virtually indistinguishable from music recorded in a studio. Paul McCartney's first solo album, recorded just before he left the Beatles in 1970, was recorded entirely in his Scottish farm house, and yielded "Maybe I'm Amazed," a gorgeous hit song. In between big-budget studio albums, Bruce Springsteen recorded "Nebraska," a collection of stark, personal tunes, entirely on his Fostex four-track cassette recorder. Phil Collins' first solo album contained songs such as "In the Air Tonight," which began life in his home studio, but were completed in a professional studio.



Screenshot from Acid, a home recording program by Sonic Foundry.

A Brief History of Home Recording

Ever since Thomas Edison invented his recordable cylinders, recording was thought to be the province of a specialized studio, crammed full of all sorts of equipment. In the early 1950s, that began to change. Les Paul (when he wasn't busy inventing arguably rock & roll's greatest electric guitar) designed and built an embryonic recording studio in his Mahwah, NJ home, and created numerous Top Ten hits there. (Now in his mid-80s, Les Paul still plays his namesake guitar every Monday in the Iridium club in Manhattan.)

Then in the 1960s, rock musicians who couldn't read and/or write music such as Pete Townshend of the Who, began to use home studios to give the rest of their groups' members demo tapes of potential songs to later flesh out in the recording studio. Some musicians (such as the aforementioned Paul McCartney) actually record entire albums in their home studios. What they sometimes lacked in sound quality, they often made up for in spontaneity and excitement. There's nothing like getting a spon-

taneous musical inspiration and immediately recording it before it's forgotten.

The 1980s: The decade of the Four-Track

In the early 1980s, 'four-track' cassette decks, using technology adapted from the failed quadraphonic sound systems of the 1970s, began to be sold by companies such as Fostex and Tascam, to offer any musician with a spare $1,000.00 or so (often much less) the ability to record demos. These — still available — machines allow four separate tracks to be recorded, either by different members of a band, or by one or two individuals. These tracks would then be mixed down to a standard two track stereo mix, for distribution on cassette, CD, MP3, etc.

The 1990s: Enter the PC

To add more tracks to a four-track cassette recorder or add special sounds that the musicians themselves couldn't play required more equipment, space, and money. But the combination of rapidly falling prices, and equally rapid increases in computing power, has allowed the PC to become a powerful recording tool, capable of performing tasks which in the past required tens of thousands of dollars worth of professional studio gear to achieve.

Today, simple home recording software allows anyone to compose and record music entirely from within his or her own PC. Many entry-level programs are automated sufficiently to allow even non-musicians to assemble and record personal compositions.

So why record on a PC instead of a dedicated recorder? Chris Rice of Cakewalk (www.cakewalk.com), a leading music software publisher, says that a big reason is that "a dedicated recording deck does not give you any visual representation of the music. And for you to go and try to edit what you've recorded is quite laborious and quite painful. You often have to go back and just punch-in, and record over."

Rice describes the difference as significant as the equivalent of typing on a typewriter, and using a word processor. "All the drag and drop editing, the graphical representation, that just expands on your editing capabilities, and your song writing capabilities for that matter. It allows people to much more quickly experiment with a new idea, and try something in a different key. Or, 'you just played the one note wrong? Let's just go back and fix that.' Or 'why don't we just shift that whole chorus down an octave? Let's try that. Let's try it with different types of instruments'."

The first level of home recording programs, such as Acid, by Sonic Foundry (http://www.sonicfoundry.com), utilize pre-recorded loops, which can be assembled, mutated, and modified into a seemingly infinite variety of permutations by a PC user with absolutely no previous music knowledge. And for many people, these loop-based programs are all that they need to begin to make their own music.

Tascam US-428 mixing board.

Doing Acid

Rob Uhrina, manager of product marketing for Sonic Foundry, describes how the program, and by extension, most other loop-based programs, such as Fruity Loops by Cakewalk, work. "Let's just say that you want to create a dance track. The interface is pretty user-friendly in Acid. You go in, and there's a little window called the Explorer Window. And the Explorer Window explores what's on your loop library, categorized by instrument or sound type.

"So the first thing you probably want to do, is to lay down the drums. So you click on the drums directory, and there's all kinds of different drumbeats." Once an interesting sounding drumbeat is found, double clicking on that file automatically puts it onto a track where it can be repeated as is, or slightly modified.

This basic technique is then repeated for each instrument, typically bass, keyboards, and guitar each of which has its own loop. Uhrina adds "many of the libraries we have are full construction kits, which means, more or less, it's like a band in a box." This

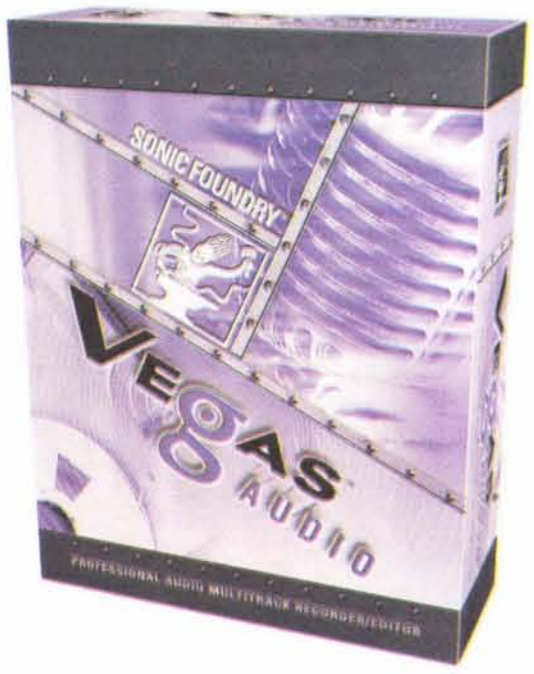
A Mini MIDI Primer

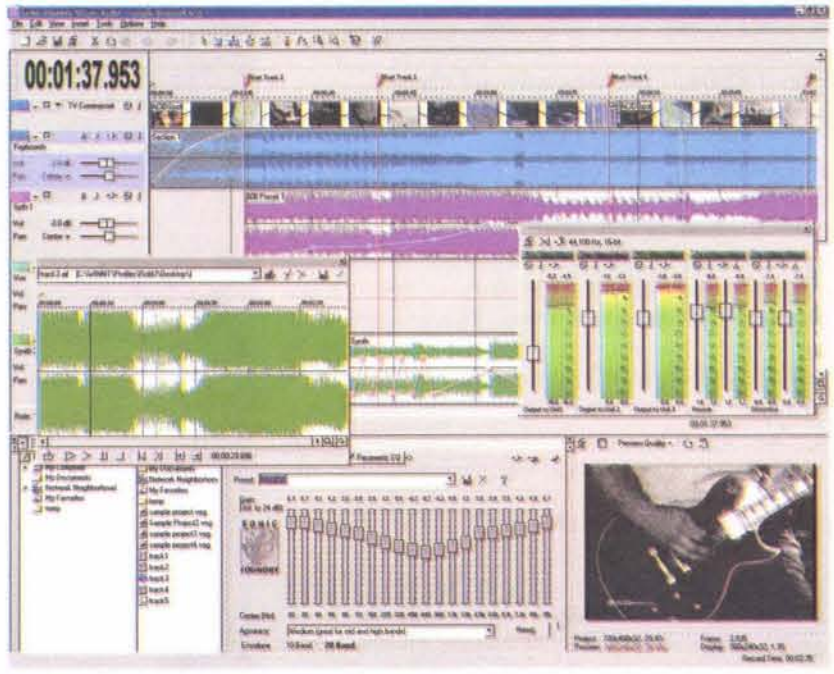
Musicians frequently refer to MIDI, a common computer language for electronic musical instruments, developed in the early 1980s, which allows any MIDI-equipped instrument to talk to another MIDI-equipped instrument. MIDI equipped instruments can be programmed to record performances, or to be programmed via an external device (such as a PC) to allow for more complex or precise playing than any human can perform.

Originally, MIDI instruments were mostly electronic keyboards and drum machines. And while those instruments are still in the vast majority, MIDI-equipped guitars, wind instruments, electronic sound processors, amplifiers, and other musical and sound equipment have joined them.

MIDI is also a musical language for a PC's sound card, allowing it to play an endless variety of sounds and melodies. Being able to manipulate that data is the next step beyond looping, and allows for new music to be recorded, in addition to the editing and manipulation of pre-recorded audio loops.

For more information about MIDI, search the web, where there are numerous sites about both the language and the numerous devices that use it; www.harmony-central.com/MIDI/ has an extensive collection of FAQs, links, and other material.





Sonic Foundry's top home recording program, Vegas Audio.

way, even someone who doesn't play even one instrument can record several.

"Then when you're done," Uhrina says, "maybe you want to add some vocals, so you plug in a mike into your sound card, and record vocals on top of it."

Feed Your Hard Drive: Acid Versus Plasma

One of several makers of programs that use the MIDI electronic musical language (see sidebar for an explanation) is Cakewalk. Cakewalk has been making home recording programs since 1988, when it began shipping Cakewalk 1.0 for DOS. Chris Rice, Cakewalk's vice president of marketing, says, "It was strictly MIDI at that point, and very limited graphical editing, since that was all pre-Windows." However, in 1995, Cakewalk released Cakewalk Pro Audio, their integrated digital audio and MIDI recording program.

What is a 'Cakewalk'? Rice says "The big misconception was that you had to be a rocket scientist to use this stuff. And in the US at least, Cakewalk means something easy to do." It's also a reference to a style of ragtime music popularized at the turn of the 20th century.

Competing with Acid is Cakewalk's Plasma program. It's representative of programs that go beyond loop-based products, but unlike most multi-track recording programs, doesn't require the ability to actually play an instrument. Chris Rice of Cakewalk says that Plasma "not just allows you to create and arrange music by mixing and matching pre-recorded loops, it also allows anybody to add their own layers of music by using the included software synthesizers."

Software synthesizers allow a computer's sound card to be programmed to sound like a wide variety of musical instruments, using MIDI to program in melodies and riffs.

The loops and software synths can be treated or modified with a Direct-X plug-in called Plasma FX Pad, a joystick-controllable multi-effects processor. "It's amazing," Rice claims. "You're basically painting in effects in real-time, as the music plays back. It's a multi-effects processor, so it will do things like chorus, flange, digital delay, and then some sound effects. It will have all these different pre-sets in it that are tweaked just to create a very specific special effect."

Rice promises that Plasma's FX Pad will be "a lot of fun, because it's all done graphically — you don't have to know anything about what the effect and coordinates are. You just drag your mouse around and use a joystick. So it really is a blast, and it gives anybody the experience of mixing in real-time, without having to know a thing."

Bringing Music into the PC

For those who wish to go beyond loop-based or loop plus synthesizer programs, where the computer program does much of the compositional work, and who wish to combine audio loops with live instruments, there are sophisticated multi-track recording programs which will record dozens of MIDI and audio tracks to a PC. With some programs, there is no fixed number of tracks — the only limitation is how much the PC can handle without crashing or slowing down.

Sonic Foundry's top home recording program is called Vegas Audio. Cakewalk's is called Sonar XL. These are very sophisticated programs that combine loops, digital multitrack recording, MIDI, sophisticated audio effects, and lots of room for expansion. Think of them as having EMI's Abbey Road Studio in a box. Chris Rice says, "Let's go back to the stand-alone multitrack recorder. Okay, you've got a multitrack recorder. You're a guitarist. What about the other parts? What are you going to do? You've got a drummer to come over? You've got a singer to come over? You've got some horns?"

With programs like Sonar and Vegas Audio, "all that's built in," Rice says. "You can put together the other parts yourself if you want to, or you can bring your band in, and you can all record right into the PC. It just offers you so much flexibility."

Music Meets Technology

With the right software, computer hardware, a few microphones, and pieces of outboard gear, Bill Park says that today's musician has access to better technology in his basement "than the Beatles, Pink Floyd, or Lynyrd Skynyrd had access to when they cut their best work."

Park says that "in the end it is all about the music, not the technology." But technology interacting with music in a home studio can be a powerful force — or at least a wonderful hobby. **NV**

What Kind of Hardware Do I Need?

Rob Uhira of Sonic Foundry says that to make tracks using loop-based programs such as Acid, "then all you really need is a decent computer, say over 200 MHz, and a sound card, and a decent monitor to see everything on the screen, and that's it — you're able to create music on your PC. Beyond that, you may want a CD burner, so that you can burn the track to CD once you're done."

More sophisticated recording programs such as Vegas Audio and Sonar require some fairly potent computer hardware to work. "This is a personal bias," Uhira says, "because it really depends on what you're doing, but I wouldn't begin a home studio without a PC with a minimum of a 400 MHz processor, and a 7200-RPM hard disk drive, which pretty much is on everything these days." Also, some programs, such as Sonar, are happiest running under Windows 2000 (this article was written before Windows XP hit the street), rather than Windows98 or WindowsMe.

For programs such as Vegas Audio, Uhira suggests that dual monitors (which most versions of Windows support) can be very handy, because "you can undock the windows in Vegas, and maybe you'd want to move your mixer to the left monitor, and then everything else to your right monitor."

You also need a sound card, and there are numerous ones on the market designed for home recording. Some of the under $100.00 cards (such as Soundblaster's Live! card; www.soundblaster.com) have become increasingly sophisticated, do a marvelous job of supporting software synthesizers, and may be all that's necessary for a single musician to record multitrack demos.

However, sound cards have limitations. At some point, some sort of separate mixing board provides much more flexibility, allowing the recording of multiple tracks, the use of multiple microphones, and the ability to record multiple musicians simultaneously. All of these are made much easier by the use of a stand-alone mixing board. Uhira recommends MidiMan's Delta 1010 board, which has been specially designed to work with Sonic Foundry products (www.midiman.com). Bill Park is a big fan of Mackie Designs' 1202-VLZ Pro Mixer, which packs a surprising number of features for its approximately $379.00 retail price (www.mackie.com).

While the Mackie 1202-VLZ has gotten raves as a low-cost mixing board, it's still a conventional mixing board, and was not designed specifically to work with PCs. Tascam has come out with a board that for a $625.00 MSRP may be the best of both worlds. The US-428 looks remarkably like a Portastudio, but it connects to a PC via its USB port. It adds to a computer not just two XLR microphone inputs, two balanced and two unbalanced 1/4" inputs, SPDIF digital inputs and outputs, and four channels of audio in and two out simultaneously via USB, but perhaps more importantly, physical controls. There are physical knobs that can be adjusted. Faders raised and lowered. Play, record, rewind, and fastforward buttons.

The US-428 comes bundled with a custom version of Steinberg's Cubasis VST audio recording/MIDI sequencing software. On Tascam's web site are drivers that will allow it to work with a variety of other home recording programs, including varying degrees of support for the aforementioned Vegas and Sonar. (See www.tascam.com/products/us428/downloads.cfm for a regularly updated list of supported programs.)

So how much will all of this set you back? Uhira says, "With what I'm talking about, you pretty much can get all this, including a microphone, for less than $2,500.00, so you can pretty much be on your way." Bill Parks says, "Some decry the expense but it is far cheaper than a divorce, a hair transplant, a Ferrari, and a 22-year-old trophy girlfriend," and often far more therapeutic than all of those, too!

TechKnowledgey 2001

Events, Advances, and News From the Electronics World

by Jeff Eckert

Advanced Technologies

Helios Prototype Sets Altitude Record

Helios Prototype in flight over lake bed during second battery-powered flight. Photo by Tom Tschida, courtesy of NASA Dryden Flight Research Center.

A new world record altitude of 96,500 ft (approx. 23,350 m) over the Pacific Ocean was reached by the solar-powered Helios Prototype flying wing back in August. This is the first time a non-rocket-powered aircraft has maintained flight this far above the Earth. The remotely-piloted wing, built by NASA's Dryden Flight Research Center (**www.dfrc.nasa.gov**) and AeroVironment, Inc. (**www.aerovironment.com**), took off from the US Navy's Pacific Missile Range Facility on the Hawaiian island of Kauai. Flying at about 25 mph, the mission lasted nearly 17 hours.

The record altitude was achieved during daylight hours, relying on solar cells on the wing's surface to provide electrical power. Descent after dark was possible, as the 14 electric motors were no longer needed to maintain altitude. During descent, the propellers acted as generators, providing electrical power to control the aircraft.

The record flight sets the stage for follow-up missions that will use a regenerative fuel system now under development to enable Helios to remain aloft continuously for months at a time. Production variants of Helios might see service as long-term Earth environmental monitors, as well as communications relays, reducing dependence on satellites and providing service in areas not covered by satellites. The successful flight at high altitude also provides NASA with information about flight on Mars, since the atmosphere at that height above the Earth replicates the atmosphere near the Martian surface.

For those who are interested in the specifications, Helios has a wingspan of 247 ft (75.3 m), a length of 12 ft (3.7 m), and an empty weight of 1,322 lb (493 kg). Depending on the instrumentation carried aboard, it can lift a payload of up to 726 lb (271 kg). The craft is powered by 14 brushless DC motors, each rated at 2 hp. Top speed is 25 mph (40 km/hr). Additional information is available at **www.solaraircraft.com**.

Aging Spacecraft Still at Work

Also making news at NASA was the Deep Space 1 (DS1) probe, which was launched in October 1998 to test 12 novel technologies, including the advanced ion drive engine. The mission was completed successfully in September 1999 and, by all rights, the craft should be space junk by now. And, in fact, in late 1999, DS1 lost its star tracker, which helped determine the spacecraft's orientation. Faced with what could have been a mission-terminating injury, the controllers reconfigured the spacecraft to use its photographic camera to orient itself by the stars around it and sent it off on a new mission: to fly by the comet Borrelly and take a look inside the comet's glowing core of icy dust and gas.

According to NASA, the space probe's close encounter with Borrelly on September 22 provided the highest-resolution pictures of any comet to date. With no protection from the little-known comet environment, DS1 survived a pass that took it only 2,200 kilometers (1,400 miles) from the rocky, icy nucleus of the 10-kilometer-long comet. Exceeding the team's expectations of how this elderly spacecraft would perform, the unit sent back high-quality black-and-white photos of the inner core of the comet. It also measured the types of gases and infrared waves around the comet, and how the gases interacted with the solar wind.

Artist's conception of Deep Space 1 encounter with comet Borrelly. Courtesy of NASA Jet Propulsion Lab.

According to Laurence Soderblom, leader of Deep Space 1's imaging team, "These pictures have told us that comet nuclei are far more complex than we ever imagined. They have rugged terrain, smooth rolling plains, deep fractures and very, very dark material."

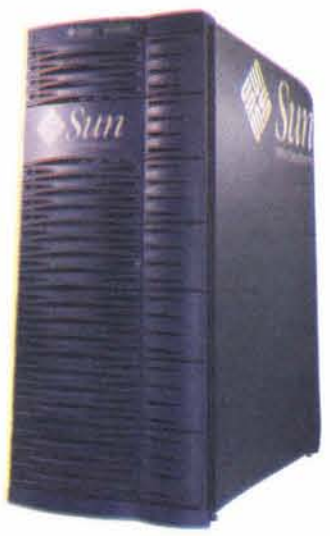
Scientists had expected that the solar wind would flow symmetrically around the cloud, with the nucleus in the center. Instead, they found that, although the solar wind was flowing symmetrically around the cloud, the nucleus was off to one side, shooting out a great jet of material that forms the cloud that makes the comet visible from the Earth.

DS1 is a 486-kg device that operates on 2,500W of maximum power (2,100W of which is used to drive the ion engine). It communicates in the X and Ka bands. Total cost of the mission so far has been $149.7 million. Many photos and other information can be found on the Deep Space 1 home page at **http://nmp.jpl.nasa.gov/ds1/**.

Computers and Networking

72-Processor Server Introduced

At the end of September, Sun Microsystems, Inc. (**www.sun.com**), announced a new line of computers that are designed to compete with IBM in the Unix server market. The Sun Fire 15K (code-named Starcat) is expected to be on the market by the end of the year. The machine will be offered in four different configurations that range from a $1.4 million 16-processor unit to a $4 million one based on 72 processors. By employing the 18 I/O hubs, processing power can be boosted to 106 processors. The computer, built by Texas Instruments, employs 900 MHz UltraSPARC™ copper-based chips, embedded memory controllers, and 576 GB of memory. The operating system is Sun's Solaris 8 OS.



Sun Microsystems' new Sun Fire 15K server. Courtesy of Sun Microsystems, Inc.

Internet Conferencing Now Available

With an eye on the worldwide threat of terrorism, Yahoo!, Inc. (**www.yahoo.com**), is now offering a "Virtual Conference" alternative to traditional business conferences, sales meetings, and trade shows, allowing thousands of "attendees" to participate in such meetings online. Delivered through Yahoo!'s Broadcast Services division (**business.broadcast.com**), Virtual Conference is intended to circumvent rising travel and meeting costs and newly imposed travel restrictions. The service combines any combination of the following:

· Audio, video, and informational slides synchronized to presentations in a

particular meeting.

· A browser to view other meetings associated with the same conference.

· Interactive tools such as polling, question and answer sessions, document sharing, and audience surveys.

· Registration, live attendance tracking, and after-event reports on attendees.

· Archiving and hosting.

· A pay-per-view capability.

The price has been reported at $350,000.00 for a package of five conferences. It usually takes 10 days to set up a virtual conference, but Yahoo! says it can produce a simple Internet broadcast with as little as four hours notice.

Top 500 Supercomputers Listed

If you were wondering who built and who owns the fastest supercomputers in the world, you might find it enlightening to check out the TOP500 web site, presented by the University of Mannheim and the University of Tennessee. The site includes a list (**www.top500.org/lists/2001/06/**) of the 500 most powerful machines as determined by the LINPACK Benchmark. LINPACK is a widely accepted performance-based standard, and numbers are available for almost all relevant systems. According to the most recent list, IBM remains the number one supercomputer maker, with 201 of the 500 top installations. It is followed by Sun Microsystems (81), Silicon Graphics, Inc. (61), Cray (45), Hewlett-Packard (41), NEC (18), and Compaq (10).

Free Virus Protection

With the continuing proliferation of Internet-transmitted viruses, no one can afford to be without protection. Many anti-virus programs are available, but an interesting (and free) one is available from Grisoft, Inc. (**www.grisoft.com**). Developed in the Czech Republic and upgraded since 1990, AVG Anti-Virus runs under Windows 95, 98, NT, and 3.x, as well as DOS. According to Grisoft, the product is certified by the International Computer Security Association and is periodically tested to assure a 100 percent detection rate. Whereas most virus-protection routines simply scan files and compare them to a database of known viruses, the AVG Virus Stalker module uses a "heuristic analysis" approach that analyzes the instruction set of tested files, emulates these instructions, and is able to comprehend their meaning.

Because a virus by definition contains incorrect instructions, Virus Stalker can detect even unknown viruses. For $39.95, you can upgrade to the "professional" edition, which includes some customization options, advanced functions, and unlimited technical support.

Circuits and Devices

IR-Imaging Helmet for Firefighters, Military

Helmet-mounted IR imaging system showing infrared system (above) and image intensifier (below). Courtesy of Zybron Inc.

With support from the US Air Force Research Laboratory, Zybron, Inc. (**www.zybron.com**), an optical electronics research firm in Beavercreek, OH, has developed a helmet-mounted, long-wavelength infrared imaging system that can "see" through darkness, dense smoke, fog, snow, dust, and other conditions that are typical of burning building interiors, battlefields, and other hazardous environments. The company's Advanced Rescue Vision System (ARVS) incorporates advanced wireless video and audio capabilities to enhance communications, speed up rescue processes, and allow firefighters to quickly locate victims in smoke-filled buildings or aircraft. The helmet-mounted system also allows the images to be transmitted to a remote television monitor.

While the ARVS is designed specifically for fire-fighting applications, its potential for military uses is obvious. In addition, variations could be built for examining fine art to determine age, condition, and authenticity, and it could be used in the construction industry to locate metal beams behind interior walls. It can be configured as a multi-sensor system that combines a silicon bolometer, IR imager, low light level color CCD camera, remote thermometer, wireless color video and audio transmitter, and a color LCD, all powered by three batteries. The complete system weighs only about two pounds, and it uses a see-through color display that will not become cloudy even when subjected to high temperatures.

Other features include voice-activated switching and automatic target recognition. Depending on the configuration, the price is between $13,000.00 and $14,000.00, for single units, and drops to about $10,000.00 in quantities of 50 or more.

Cordless Soldering Iron

If you need to perform soldering in locations where an AC power source is not available, you might want to consider the P100 tool build by BS Manufacturing in the UK This pen-style tool is 19 cm (7.5 in) long and weighs just 57g but delivers up to 120W output, allowing it to be used for heavy-duty electrical work and silver soldering, as well as precision electronic and model-building applications. The tool is designed for mobile installation, repair and maintenance personnel, and any factory staff that need mobility, particularly automobile mechanics, hi-fi installers, and security alarm technicians.

Gas-powered soldering iron produces 120 W output. Courtesy of Vulcan Gas Tools.

The P100 uses catalytic conversion for most of its application configurations, delivering heat to the tip by means of infrared radiation. The fuel is liquid butane/propane gas stored in the translucent handle of the tool (similar to a disposable cigarette lighter). The tank can be refilled with a squirt from a gas canister, which is a low-cost consumer item in use around the world. Each refill

provides around 45 minutes of continuous use at a typical setting.

The gas is ignited by means of a spark from a flint incorporated inside the tool's cap. Gas flow is regulated using a slider, allowing fine adjustment down to 20W to optimize the heat output for a particular application. A range of attachments are available to configure the tool for soldering, silver-soldering, hot knife cutting, slicing, heating, igniting, shrink wrapping, melting, shaping, and other uses. Tips are available in eight styles ranging from 4.8 mm wedges for high-power applications, down to chisels as small as 1mm for fine work. The iron costs approximately $35.00 and can be purchased online at Vulcan Gas Tools (**www.vulkangt.com**).

Industry and the Profession

Troubles Continue at AMD

Plagued by a continuing sales slump in the PC market and the loss of customers to Intel, Advanced Micro Devices, Inc. (AMD, **www.amd.com**), has announced that it will lay off 2,300 employees (15 percent of its workforce) and close two chip fabrication plants in Austin, TX, to cut operating costs. Following IBM's lead, Gateway Computers recently announced that it will be phasing out AMD microprocessors in its machines, which leaves Hewlett-Packard and Compaq as the only major brands that still employ AMD chips in desktop PCs.

Approximately 1,000 of the job cuts will come from the Austin facilities. The balance of the reductions will result from realigning and restructuring activities in the Penang, Malaysia, facility. When fully implemented, these actions are expected to result in an overall annual cost reduction of approximately $125 million. The job cuts are scheduled for completion by the end of the second quarter of 2002.

More Amazing Internet Losses

The Internet operating and development firm CMGI, Inc. (**www.cmgi.com**), reported a net quarterly loss of $1.276 billion (yes, that's billion) for the quarter ending July 31. This is notably worse than its loss of $963.3 million in the previous quarter. Net revenues were only $255.5 million, a 12 percent drop from the previous quarter.

Total net losses for fiscal year 2001 came to a stunning $5.4 billion, as compared to a loss of $1.4 billion in 2000. The good news, though, is that revenues were up from $890 million in 2000 to $1.2 billion this year. A quick computation shows that, if the current trend continues, the company should generate 2002 revenues of $1.6 billion on which it will lose $20.8 billion. However, CMGI predicts that revenues will decline next year by 10 percent. Among CMGI's holdings are NaviPath (an Internet access provider that is currently being phased out), uBid (an ebay clone), and the AltaVista search engine. **NV**

reader FeedBack

Dear Nuts & Volts:

In response to Mr. Herzmark's letter to the editor. Your semantics, misstatements, and misquotes are the best reason for my argument to not include physics 101.

There is no mention in my answer of a "Net Charge." Any present ion contains a charge, and thus removing them removes a charge. All charges [ions] are electrical in nature. If water were distilled and free of contaminants, then and only then, would it be in perfect equilibrium. No tap water can be in a perfect balance because it can't add or subtract more impurities or ions on its own to find that balance, thus it always has some "Net Charge" even if it's minuscule or just one ion extra.

"The resultant material is water with no charge" contradicts your own statement that says it starts off with no charge. All water except distilled contains contaminants which have charge, and regardless of this balance, it contains a charge nevertheless, and this charge can be utilized no matter how small or what process is used.

Long-winded scientific statements are what I tried to avoid by leaving out the 101 and inserting common language for the common folk. My analogy in its entirety is sound and explanatory for the non-chemist.

Chris
Bieber, CA

Dear Nuts & Volts:

Nuts & Volts ran a brief piece about our project back in April, and I thought you all might be interested in a brief update on the latest activities of our National Science Foundation research project — HPWREN ...

We have now connected the Palomar Observatory to our 45 Mbps network.

Information regarding this work is at http://hpwren.ucsd.edu/news/010801.html.

The PI for our project recently testified before Congress. Details can be found at http://hpwren.ucsd.edu/news/010803.html.

And, we've added a "Public Information Materials" section to our website (http://hpwren.ucsd.edu/info/index.html), which features flyers, posters, maps, etc., regarding the network.

Kimberly Mann Bruch
University of California
San Diego

Dear Nuts & Volts:

Since the time that I wrote the printed circuit board article in December and its publication in the August issue, the program PhotoPrinter I listed in my article will no longer run. I have found that to make this program run, you must reset the date on your computer to the year 2000.

After you reset the date, the program will run normally. I have written to the author, and am also attempting to get a more recent version of this program from him. The file from my website MntnWeb as listed in the article will run if you simply reset the date on your computer before running it.

I was made aware of this when a reader wrote to me. Needless to say, I had not tried running the program since December due to being so busy. DOH!

Kerry Barlow
Admin@MntnWeb.com

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News Bytes

AccuWeather.com Offers Free Access to Afghanistan Weather Maps and Forecasts

No country is on the world's radar screen more than Afghanistan right now, so AccuWeather, Inc., is providing free weather forecast maps on www.AccuWeather.com for Afghanistan and central Asia. Consumers can access free graphic and satellite weather maps, daily streaming video forecasts, and text forecasts to see the latest weather and learn the climatology of a region that is currently a source of national discussion and debate.

The full-color weather maps, updated daily at 2 p.m. Eastern time, general forecasts for weather conditions for all of Afghanistan, Pakistan, and other countries in central Asia, as well as specific forecasts for 550 locations in Afghanistan, are available from a link located on the AccuWeather.com homepage.

The graphic forecast maps include regional condition overviews and frontal systems, while text forecasts include high and low temperatures and expected conditions within individual regions in Afghanistan. And with an AccuWeather.com exclusive, consumers can view streaming video forecasts presented by AccuWeather expert meteorologists that help explain weather conditions as they happen, and the impact they will have on the region.

Also available are free, full-color extended forecast maps for Afghanistan, highlighting several cities throughout the country. These maps are also updated daily.

"Americans are profoundly interested in information about Afghanistan and its surrounding region during this time of national crisis," says Dr. Joel N. Myers, founder and president of AccuWeather, Inc. "The weather conditions in central Asia can vary greatly, with temperature swings of 60 degrees or more in a day, along with high winds and snow or rain. Those conditions could well have an effect on military plans."

"Our decision to offer weather maps and data for free to the public is designed as a public service for all Americans to help provide as much information as possible about the region's climate and weather conditions."

Crosby, Stills, and Nash and Clear Channel Interactive Group Select Liquid Audio to Support The ClearChannel.com Relief Fund With Exclusive Digital Download of 'Half Your Angels'

Liquid Audio, Inc., announced that it has been selected by Crosby, Stills, and Nash and Clear Channel Interactive Group to distribute an exclusive, unreleased new single entitled, "Half Your Angels" to more than 1,100 Clear Channel radio station web sites nationwide. Proceeds from the sale of this downloadable song will be donated to the ClearChannel.com Relief Fund organized to help victims and survivors of the September 11th attacks. To date, the fund has raised more than $11 million dollars for the American Red Cross and appropriate New York and Washington, DC-area police and fireman department funds.

"Half Your Angels" was written by Graham Nash and was originally penned as a tribute for the Oklahoma City bombing tragedy. As David Crosby says, "the song is even more poignant and timely today." The song is available as a paid download and is burnable to CD with proceeds going to the charitable fund. The song can now be digitally downloaded via Clear Channel Interactive Group Web sites. The effort is also being promoted via the trade publication Album Network. According to CSN's manager Gerry Tolman, a commemorative CD single release is also being planned for on-line and retail purchase. For further information on CSN, you can find them on the web at www.crosbystillsnash.com.

Despite Tech Slowdown, Nation's CFOs and Treasurers Are Moving Ahead With E-Commerce

An overwhelming majority (70 percent) of corporate CFOs, controllers, and money managers say that the level of urgency within their companies for business-to-business e-commerce is as strong or stronger today than it was one year ago, according to a survey conducted by the Association for Financial Professionals (AFP), JP Morgan Treasury Services and Ernst & Young.

Continued on page 79

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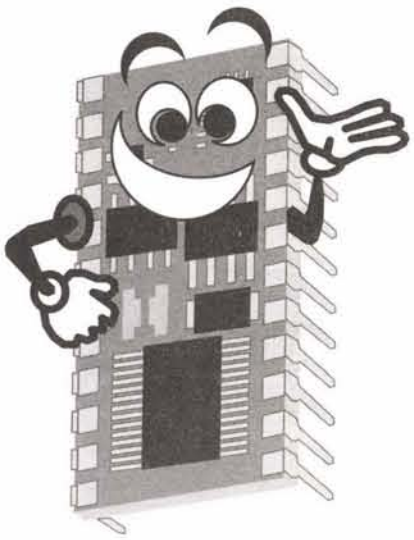


by Jon Williams

Stamp Applications

EXPAND YOUR STAMP'S I/O WITH I2C

BASIC Stamp Projects, Hints, and Tips

Now me personally ... I'm not that interested in computer networks beyond my connection to the Internet and getting email. What does interest me, however, is microcontroller networking – especially with the BASIC Stamp.

Two Little Wires – Lots 'o Neat Devices

This month's "network" experiments will be conducted via the Philips I2C bus. Briefly, the I2C bus is a synchronous, two-wire bi-directional bus. A device (or devices) that controls messages on the bus is called a master. Devices that respond to the messages are slaves. Note that with the BS2p, it can only serve as a master.

There are a lot of interesting I2C parts available. Two, in particular, are the Philips PCF8574 eight-bit I/O expander and the Philips PCF8591 D2A/A2D. I selected these devices because they are very useful parts and because using them with the BS2p requires a slight adjustment with the BS2p syntax.

What's The Address?

If you check the PBASIC manual, you'll find the BS2p I2C commands look like this:

· I2CIN SlaveID, Address {\LowAddress}, [InputData]

· I2COUT SlaveID, Address {\LowAddress}, [OutputData]

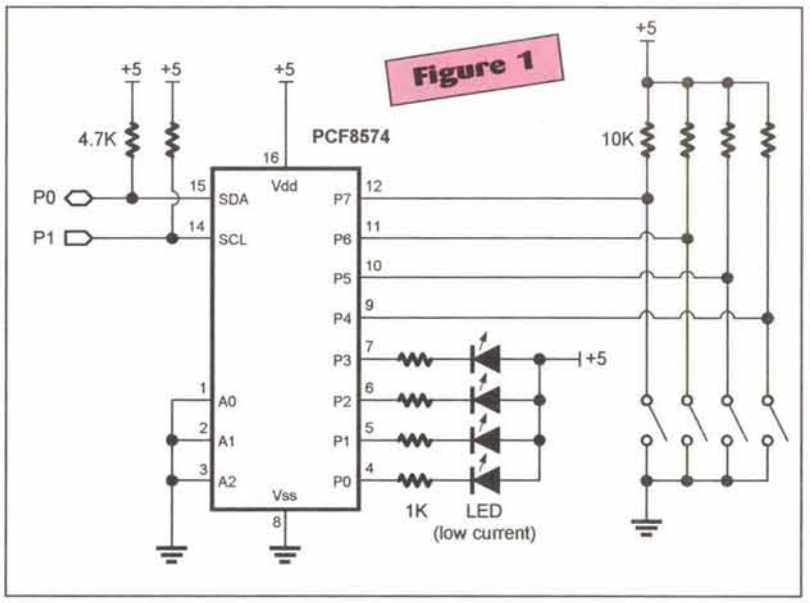
I point this out because most I2C devices have multiple internal addresses (i.e., memory devices). The PCF8574 and PCF8591 are configured differently though, and don't use the Address parameter. It's okay – this poses no problem for the BS2p.

Unless you've been asleep for the past several years, computer networking has become the rage. Want proof? Just head down to your favorite book store and take a look at the computer section. It's certainly an important field — many of us rely on LANs, WANs and, of course, the Internet as a normal part of our personal and technical lives.

Eight Bits At A Time

The PCF8574 gives us eight bits of additional I/O for the price of only two Stamp pins. And guess what? The device is addressable and we can drop up to eight of them on the same I2C bus, giving us up to 64 bits of I/O (if you use the PCF8574A, you can have 16 for up to 128 I/O points!). Also remember that the BS2p will support two unique I2C bus systems (on pins 0 and 1; pins 8 and 9), doubling the possible number of I/O points.

Using the PCF8574 is very easy. The only thing we have to do is replace the Address parameter in the Stamp's I2C commands with a value that represents the desired direction (input = 1, output = 0) of the device's pins. Additionally, we have to refresh the state of output pins whenever we do a read (I2CIN). This is accomplished by ORing the output bits with the direction value.



Take a look at Listing 1. This is a very short, very simple program that will read four switches and then display an incrementing counter on four LEDs – remotely, of course, using the PCF8574. The count displayed on the LEDs is limited by the value input on the switches.

We start with an I2CIN statement to get the counter limit value from the switches. Notice that the value of the counter is ORed with our direction value since we're doing a read. This will keep any set output bits set. The tilde (~) is used to invert the counter bits since the LEDs are connected in an active-low configuration.

The same holds true for our inputs, so again we'll use the tilde. The inputs are connected to I/O bits 4-7 of the PCF8574, so we can use the HighNib modifier to pull them out. The program does a quick check to see if the count has reached the input limit and, if so, resets the counter to zero. After that, a DEBUG display lets us know what's going on and the PCF8574 outputs are refreshed (using I2COUT) with the counter value.

Next, the counter is incremented and a short delay is inserted so we can see the LEDs light. Then, we start all over again at the top.

Easy, huh? You bet. I am particularly excited about using this device in my growing robotics experiments. By running an I2C bus through my robot chassis, I can drop I/O points wherever I need them and I only need to bring two wires back to the BASIC Stamp.

Oh ... one final note on the PCF8574. It may seem a bit counter-intuitive to connect the LEDs in an active low configuration. This is actually a requirement of the device. While it can sink (active low) up to 25 mA, it can only source (active high) 300 uA – even the lowest low-current LED will not light with only 300 uA.

Easy Analog I/O Expansion

We've just seen how easy it is to add extra digital I/O to the BS2p. Wouldn't it be nice if we could just as easily add analog I/O? Of course – and it is.

The device that makes this possible is the PCF8591. Like the PCF8574, this device is addressable and communicates to the host

STAMP APPLICATIONS
EXPAND YOUR STAMP'S I/O WITH I2C

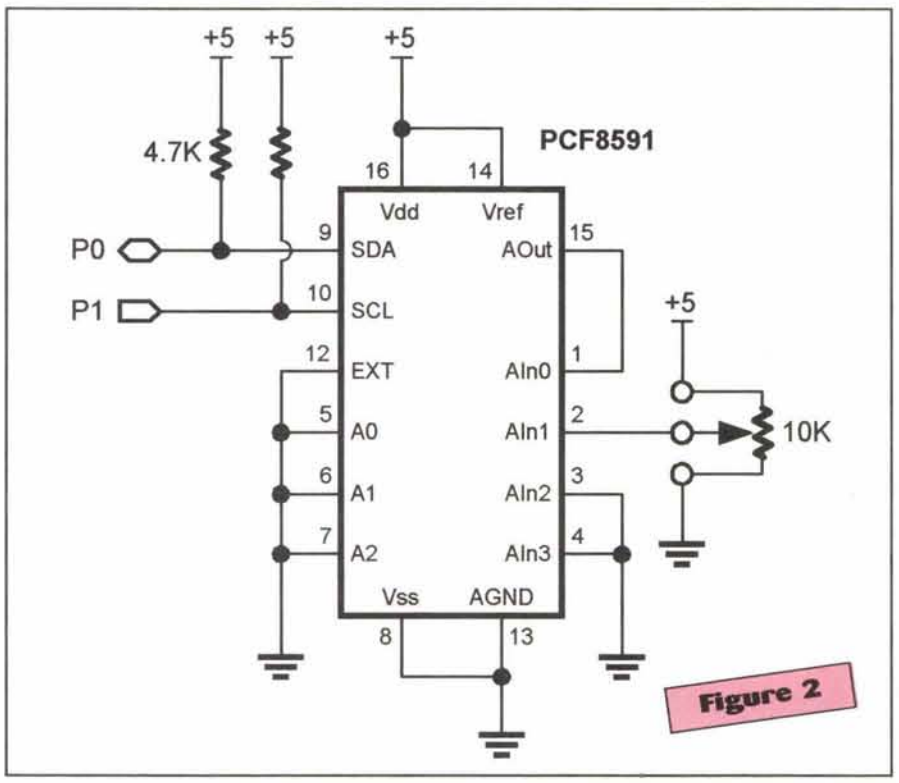


Figure 2

via I2C. It has four eight-bit analog input channels and one eight-bit analog output channel. The analog inputs can be configured as single-ended, differential, or mixed.

Let's keep things simple, shall we? For our demo program (Listing 2), we'll put the program in a loop and send the value of the aOut variable to the analog output pin. This output will be read back through analog input channel 0 on the PCF8591. Analog input Channel 1 will read the voltage from the wiper of a 10K potentiometer. Channels 2 and 3 are not used and are tied to ground (do not leave unused inputs open).

When using the PCF8591, a control byte is sent after the SlaveID. When using the BS2p, we'll put the control byte in the Address parameter position. For this program, we've created a constant value for the control byte that enables the analog output pin, sets the analog inputs to single-ended, and causes the analog channel number to be incremented after each conversion.

At the top of the program, we use I2COUT to send the analog output value (held in aOut) to the PCF8591. The next thing we do is read back the four analog input channels. Notice the use of the dummy variable in the input data. This is necessary because the channel data lags by one byte. Using the dummy value aligns the analog data array (aIn) with the output from the PCF8591. The STR modifier and \4 parameter cause the I2CIN to retrieve four bytes. This is facilitated by the setting of the auto increment bit and setting the channel address to zero. You can, of course, read the channels individually. This requires a change in the control byte.

Okay, now that we have the values, let's display them. A simple loop iterates through the four channels and we use the */ (star-slash) operator to multiply each input value by 19.6 (each input bit equals 19.6 millivolts). DEBUG is used to display the current aOut value and the analog data for each channel.

After a slight delay, the aOut variable is incremented and the loop starts again. Once again, very easy. Am I right?

For those of you who want to do more with the PCF8574 and the PCF8591, I've included the Philips technical documentation in this month's files. Have fun with them – they really are a breeze to use.

Parts Is Parts

If this article has sparked your interest in I2C components, and in particular with the BS2p, take a look at the Parallax "Plus Pack." This is a collection of I2C and Dallas 1-Wire components and code to help experimenters and engineers get started with the BS2p. Both the PCF8574 and PCF8591 are included in the Plus Pack. It also includes a 2x16 character LCD.

No BS2p? No Problem ...

As you've seen, the BS2p makes I2C communications incredibly easy. If you're a BS2, BS2e, or BS2sx user – take heart; you can still use I2C. Sure, it takes a bit of code, but it can be implemented on the non-BS2p Stamps. The best source of Stamp code for I2C communications is at Professor Peter Anderson's site. Here's the URL: www.phanderson.com/stamp/.

Remembering September 11th

It's difficult – as a proud American – to close without commenting on the events of September 11th. Like many, I was glued to the news for the hours and days that followed that horrific set of events. Even still, I find my TV spends more time tuned to CNN than to any other channel.

I bring all this up because of my own human nature. I went to California a few weeks after the attack and the normally-bustling DFW airport was like a ghost town. And I'll admit that I looked at the passengers I traveled with differently than I had ever done in the past. I wondered if I could have the courage to protect others like those heroes who brought down that plane in Pennsylvania, instead of allowing it to bring harm to more innocents.

I've even caught myself wondering about the many pieces of spontaneous email I receive. Several questions about GPS (something I've been experimenting with) have caused me to wonder what the person is going to do with it – I've even gone so far as to ask. Of course, all have answered with interesting and peaceful applications. I was almost ashamed that I had even asked.

Technology is neither good nor bad – it's how we apply it that makes it so. I hope that you always use technology, including the BASIC Stamp, for applications that help people and never for anything that would do harm.

Happy Thanksgiving. Happy Stamping. Peace be with you all. **NV**

Resources:

Jon Williams
3718 Valley View Lane, #3040
Irving, TX 75062
(972) 659-9090
jonwms@aol.com

Parallax
599 Menlo Drive, Suite 100
Rocklin, CA 95756
(888) 512-1024
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STAMP APPLICATIONS
EXPAND YOUR STAMP'S I/O WITH I2C

```
' Listing 1
' Nuts & Volts "Stamp Applications" -- November, 2001

' -----[ Title ]-----------------------------------------------------------
'
' File..... PCF8574.BSP
' Purpose... Demonstrates remote I/O via the Philips PCF8574
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started...
' Updated... 7 OCT 2001

' {$STAMP BS2p}


' -----[ Program Description ]---------------------------------------------
'
' This program reads for remote switches and uses this reading as a limit for
' a counter that is displayed on LEDs connected to the other four bits.
'
' Note: Most (not all) I2C devices have multiple internal addresses, so the
' I2CIN and I2COUT commands support this with an address parameter (this byte
' comes after the Slave Address byte).  With the PCF8574, replace the address
' byte with a value that reflects the desired state of the I/O pins, where
' 1 is an input, 0 is an output.  For example:
'
' %11110000 = Bits 0 - 3 are outputs, bits 4 - 7 are inputs
'
' For the PCF8574 the syntax becomes:
'
'    I2CIN  pin, ddr_value, [in_byte]
'    I2COUT pin, ddr_value, [out_byte]
'
' Special Note: When reading inputs while using the PCF8574 in mixed I/O mode,
' you must refresh the output bits during the read. This is easily accomplished
' by ORing the state of the output pins with the DDR value.
'
'    I2CIN  pin, (ddr_value | out_bits), [io_byte]
'
' This program uses the bits in mixed mode and will use the syntax described
' immediately above.
'
' I/O Notes:
'
' The input bits are pulled up to Vdd (+5) through 10K. The inputs are
' connected to Vss (ground) through a N.O. switch. The inputs will read 1 when
' the switches are open, 0 when closed.
'
' PCF8574 can sink current, but provide almost no source current.  Inputs and
' outputs for this program are setup as active-low.  The tilde (~) in front of
' variables inverts the bits since we're using active low inputs and outputs.


' -----[ Revision History ]------------------------------------------------
'

' -----[ I/O Definitions ]--------------------------------------------------
'
I2Cpin          CON     0                       ' SDA on 0; SCL on 1


' -----[ Constants ]-------------------------------------------------------
'
DevType         CON     %0100 << 4              ' Device type
DevAddr         CON     %000 << 1               ' address = %000 -> %111
Wr8574          CON     DevType | DevAddr       ' write to PCF8574
Rd8574          CON     Wr8574 | 1              ' read from PCF8574

MixDDR          CON     %00001111               ' 1 = input, 0 = output


' -----[ Variables ]-------------------------------------------------------
'
ioByte          VAR     Byte                    ' i/o byte for PCF8574
limit           VAR     Nib                     ' counter limit
cntr            VAR     Nib                     ' counter


' -----[ EEPROM Data ]-----------------------------------------------------
'


' -----[ Initialization ]--------------------------------------------------
'
Initialize:
  DEBUG CLS                                     ' let DEBUG open
  PAUSE 250
  DEBUG "PCF8574 Demo", CR


' -----[ Main Code ]-------------------------------------------------------
'
Get_Inputs:
  I2CIN I2Cpin, Rd8574, (MixDDR | ~cntr), [ioByte]
  limit = ~ioByte.HighNib                       ' invert limit bits
  IF (cntr <= limit) THEN Update_LEDs           ' check counter limit
  cntr = 0                                      ' clear counter if at limit

Update_LEDs:
  DEBUG Home, 10, 10
  DEBUG "Limit..... ", BIN4 limit, " (", DEC limit, ") ", CR
  DEBUG "Counter... ", BIN4 cntr, " (", DEC cntr, ") "
  I2COUT I2Cpin, Wr8574, MixDDR, [~cntr]        ' send new value

  cntr = cntr + 1 // 16                         ' update counter
  PAUSE 250
  GOTO Get_Inputs

' -----[ Subroutines ]-----------------------------------------------------
'
```

```
' Listing 2
' Nuts & Volts "Stamp Applications" -- November, 2001

' -----[ Title ]-----------------------------------------------------------
'
' File..... PCF8591.BSP
' Purpose... PCF8591 A2D/D2A Demo
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started...
' Updated... 07 OCT 2001

' {$STAMP BS2p}


' -----[ Program Description ]---------------------------------------------
'
' This program demonstates the Philips PCF8591 4-channel A2D plus 1-channel
' D2A.  Channel 0 input is tied to the output of the D2A pin.  Channel 1 input
' is tied to the wiper of a pot.  Channes 2 and 3 are tied to Vss.
'
' The PCF85591 uses a control byte after the Slave Address.  The control byte
' data (see details in PCF8591 documentation) is used to enable the analog
' output bit and set the kind of analog inputs. In this demo, the analog output
' bit is enabled and four single-ended analog inputs are used.
'
' Note that the first byte transmitted in a read cycle contains the conversion
' result code of the previous read cycle, so a dummy byte is placed ahead of
' the analog input array in the I2CIN command.


' -----[ Revision History ]------------------------------------------------
'


' -----[ I/O Definitions ]-------------------------------------------------
'
I2Cpin          CON     0                       ' SDA on 0; SCL on 1


' -----[ Constants ]-------------------------------------------------------
'
DevType         CON     %1001 << 4              ' device type
DevAddr         CON     %000 << 1               ' address = %000 -> %111
Wr8591          CON     DevType | DevAddr       ' write to PCF8591
Rd8591          CON     Wr8591 | 1              ' read from PCF8591

EnableD2A       CON     %1 << 6         ' enable analog output
FourSngl        CON     %00 << 4        ' four single-ended inputs
ThreeDiff       CON     %01 << 4        ' three differential inputs
SnglDiff        CON     %10 << 4        ' two single; one differential
TwoDiff         CON     %11 << 4        ' two differential inputs
AutoInc         CON     %1 << 2         ' auto increment a2d channels

Ctrl            CON     EnableD2A | FourSngl | AutoInc

MVPB            CON     $139C           ' millivolts per bit factor


' -----[ Variables ]-------------------------------------------------------
'
aOut            VAR     Byte                    ' analog out value
aIn             VAR     Byte(4)                 ' analog input channels
mVolts          VAR     Word                    ' convert to millivolts
dummy           VAR     mVolts.LowByte          ' place holder
chan            VAR     Nib                     ' channel number


' -----[ EEPROM Data ]-----------------------------------------------------
'


' -----[ Initialization ]--------------------------------------------------
'
Initialize:
  DEBUG CLS                                     ' call DEBUG window
  PAUSE 250                                     ' let it open
  DEBUG "PCF8591 Demo"


' -----[ Main Code ]-------------------------------------------------------
'
Set_D2A:
  DEBUG Home, 10, 10, "D2A Out..... ", DEC aOut, "  ", CR
  I2COUT I2Cpin, Wr8591, Ctrl, [aOut]

Get_A2D:
  I2CIN I2Cpin, Rd8591, Ctrl, [dummy, STR aIn\4]

  FOR chan = 0 TO 3
    DEBUG "Channel ", DEC1 chan, " In... ", DEC aIn(chan), "  ", Tab
    mVolts = aIn(chan) */ MVPB
    DEBUG "(", DEC mVolts DIG 3, ".", DEC3 mVolts, " volts)", CR
  NEXT

  PAUSE 250                                     ' delay between updates
  aOut = aOut + 1                               ' increment analog output
  GOTO Set_D2A                                  ' go again

  END


' -----[ Subroutines ]-----------------------------------------------------
'
```

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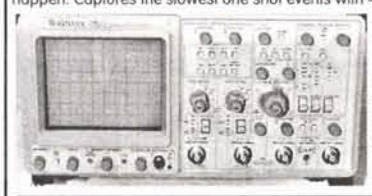

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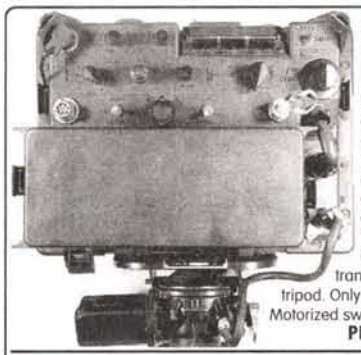

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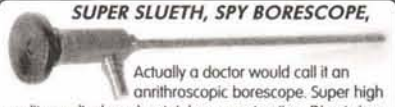
SALE, GMV-35KOSD.....$399ea.
High performance lens, 12mm, f1.2...$69ea.

SUPER SLUETH, SPY BORESCOPE,



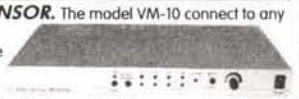
Actually a doctor would call it an anrithroscopic borescope. Super high quality medical grade, stainless, construction. Direct view eyepiece with a 6.5" long, 5mm diam. tube. Objective end optic is at a 30 degree angle for easy viewing of surrounding area. 7.5mm diam. External light port.
Hospital Price...$800ea. SPECIAL.....$229ea.

X/Y, MIRROR GALVOS, Open Loop, with 25mm, first surface mirrors. Galvos are from General Scanning. Both are pre mounted on a black anodized aluminum plate and pre aligned for operation. Limited quantity. **GALVOXY-2...$249 set**

VARIABLE-DENSITY BEAM SPLITTER is MOTORIZED. The 50mm diameter wheel is mounted to a 3VDC Canon precision gear-motor. Includes a 5mm photo-voltaic cell for optical feedback. Riser & base machined from a single block of aluminum, black anodized. Optical center 46mm high. Size: W63mm x H92mm x D69mm. Used.
SPECIAL, VARIDENS.....$99ea.

A VIDEO MICROSCOPE in the PALM of your HAND! NEW, MAGCAM, VIDEO INSPECTOR, OFFERS HIGH POWER and LOW COST. Two optical magnifications at the flick of a lever. Choose either 40X or 140X.
A high quality, digital, color CCD camera, with dual optical magnification settings and built in object illumination via two ultra bright, white LED's. Entire system is fully integrated into a rugged and ergonomically designed, hand held unit only 2.7"W x 3"H x and 1.8"D Video output is standard NTSC via a RCA jack. 12VDC powered. CCD provides 380 lines of resolution and 0.8lux sensitivity . Complete with power supply and 3 foot RCA cable. A fantastic and useful device for inspection, diagnostics and observation of small objects. Perfect for SMT inspection.
SPECIAL, GM- MAGCAM....$199ea.

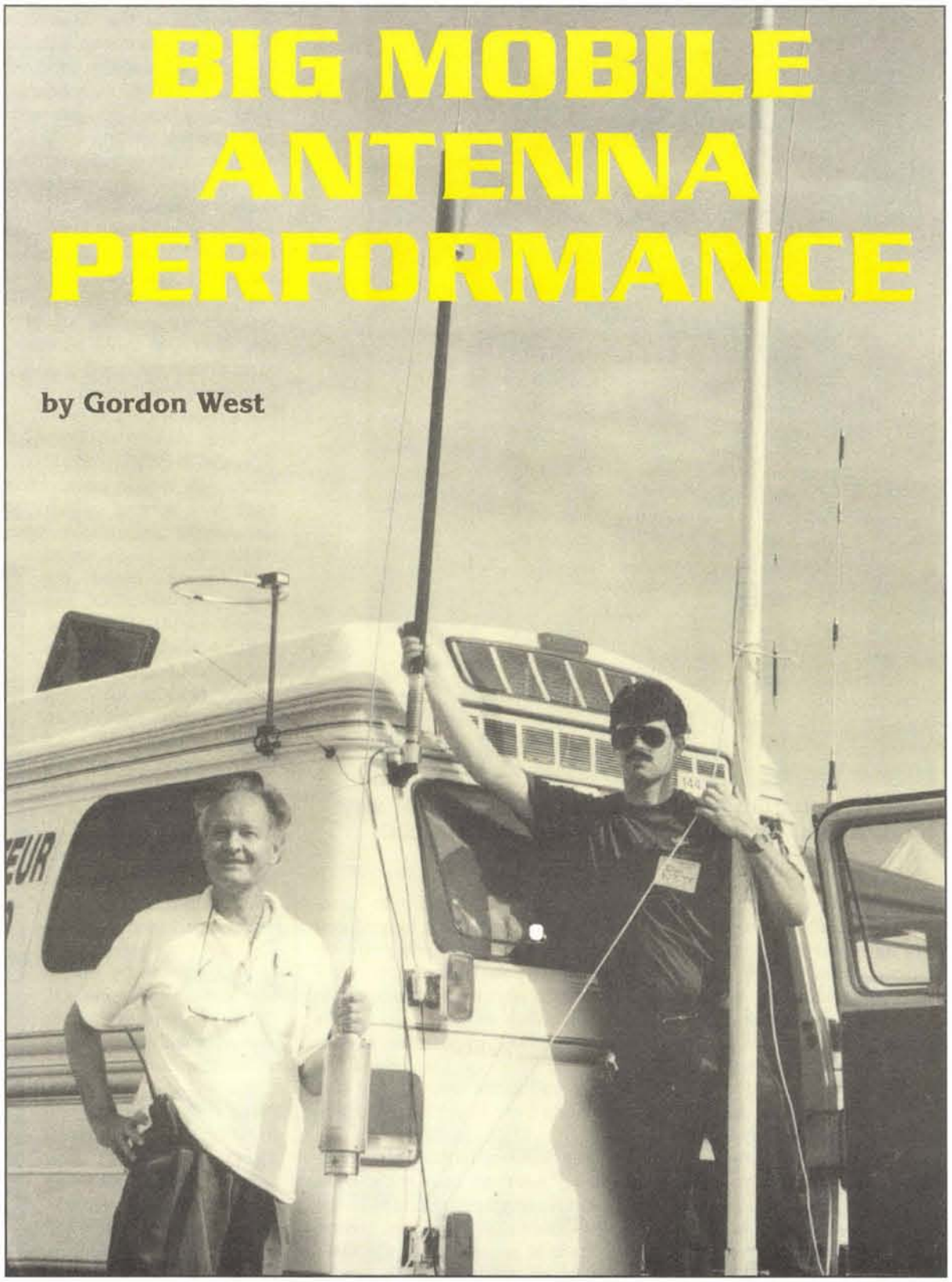
BRAND NEW, VIDEO MOTION SENSOR. The model VM-10 connect to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses a change. Auto or manual reset. Internal buzzer with volume control and adjustable on time. VCR record and VCR stop output. (use with time lapse VCR.) 110VAC powered. Adjustable sensitivity. Video loop through. **NEW, VM10.....$179ea.**



UNUSUAL, DUAL ROTARY MOTION TABLE offers 2 independent drives with 0.02° per step!
A heavy duty, 23"L x 15.25"W x 5/8" thick, black anodized alum. panel serves as the base for two concentrically aligned, rotary motion units. The outer, "platter" is 13" d x 0.1" thick blk. anodized alum. Drive is via a toothed belt & direct coupled 3.2" toothed pulley, driven by a stepper mounted 1/2"diam. pulley. Stepper is: 2.2° d, size 23, 1.8° / step, 5V@1Amp, 4 wire. The inner "platter" sits 2.7" above the 13" platter. Its' outer diameter is 4". An additional raised center section of 2" diam. elevated 1" above the 4" diam. can act as a "hub" The inner platter drive is via a toothed belt & direct coupled 3." toothed pulley, driven by a stepper mounted 1/2"diam. pulley. Stepper is: 1.5" sq., 1.8° /step, 4V@1Amp, 4 wire. Steppers are fully independent allowing. The large base provides the perfect area to "breadboard" your mechanical marvel. Removed from new equipment.
SPECIAL, DUAL PLATTER....$49ea.

BIG MOBILE ANTENNA PERFORMANCE

by Gordon West



The overall winner on 75 meters and 40 meters — the big Hi-Q system.

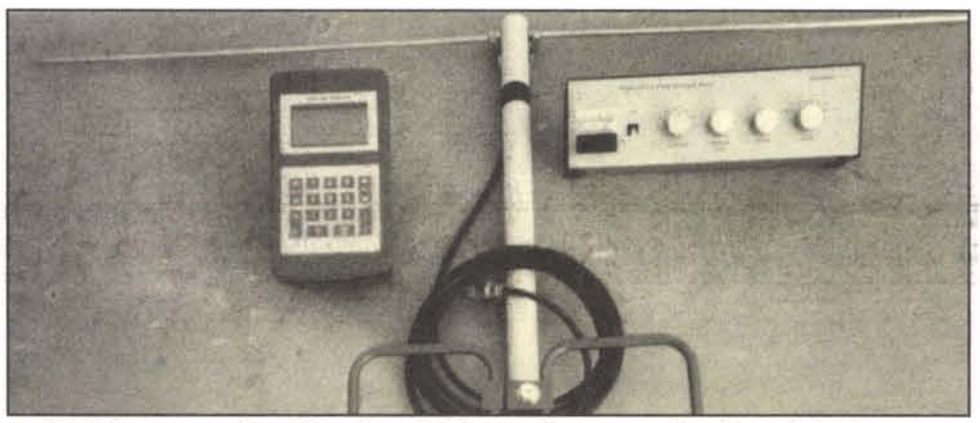
Last month in *Nuts & Volts*, we described our comparison tests of 20 various high-frequency mobile whips. All of these whips were designed around the typical 3/8" x 24 threaded receiver, with some smaller whips screwing onto a common coaxial cable receiver, SO-239. All of the whips we described were self-resonant. No manual or automatic antenna tuner required, other than the built-in motor drive remote tuning capabilities of Yaesu's ATAS 100 with Yaesu equipment or aftermarket remote accessory tuners, and the up-and-down tuning with the motor driven Hi-Q antenna.

Our tests revealed little surprises. The taller the antenna with less loading, the greater the reported signal on both groundwave, as well as skywave. While the shorter antennas did a very nice job of pumping out signals on the worldwide ham bands, it was the dramatically longer whips that distant stations could clearly hear as a stronger signal and an increase in their signal strength meters.

It was no surprise that the overall tall winners all stood around 11 feet tall — giving you just 24 inches of mounting elevation so as not to exceed the magic 13-1/2 foot highway limit. Our top performers were the SGC 303 double-resonant, helical-loaded whip, driven by the fully automatic SGC SG-237 automatic antenna coupler, housed in the unique SGC QMS (quick mounting system) strap and suction cup arrangement.

The 11-foot Alpha Delta Outreach was another top performer, with its best attribute as simple manual band taps and a relatively lightweight but extremely rugged fiberglass construction with the stainless steel whip tip. The Outreach may also be ordered as a 500-watt model, capable of pumping out an extremely strong signal when driven by the 500 watt, SGC "power cube" solid-state, mobile amplifier. Just be cautious you don't park under a tree, and accidentally light up the branches!

The third top-performing mobile antenna with the common 3/8" x 24 threads was from well-known German antenna designer and engineer, "Charlie" VE7BOC/W6(HA5CMG). He calls his family of antennas "Hi-Q," classified as "stealth." Hey, Charlie, these precision-made antennas with their mammoth loading coil are anything but "stealth," but maybe you came up with that name to illustrate how a relatively medium-length mobile antenna can pump out such a strong signal.



Field strength with the AEA analyzer and a far field loop.

For ham radio operators or commercial high-frequency marine and emergency long-range mobile services, the Hi-Q line of antennas offer a unique feature of non-stop selectable resonance from 3.5 MHz to 30 MHz. The Outbacker doesn't offer this, unless you buy the custom-band model. While the SGC offers 1.8 MHz-54 MHz coverage, the tuning system is altogether different than what and where Hi-Q accomplishes whip loading.

The Hi-Q antennas perform loading in the center with a relatively large, and somewhat bulky, adjustable loading coil. The lower the frequency, the less resistance in series with an increase of capacitive reactance. To tune out the capacitive reactance, series inductive reactance is dropped in by the adjustment of a contact ring inside the clear-coated Hi-Q coil. The higher up the mobile mast, the greater the need for inductance because the capacitance of the whip above the coil is low. Although placing a relatively large coil halfway up a mobile mast increases wind resistance and negative comments from your better half, radiation resistance and more optimum antenna current is increased.

Just hanging a big series inductance on a mobile mast does not necessarily mean your high-fre-

Charlie can custom build an antenna for almost any application, including marine and commercial.

quency transceiver is going to put out its full output. Most newer high-frequency ham sets and single-sidebands incorporate VSWR output power shut down circuitry, and this means a slight mismatch at the antenna feedpoint down low on the body of the vehicle will result in as much as 50 percent power reduction coming out of the high-frequency mobile SSB, which detects a less-than-optimum feedpoint impedance. This impedance mismatch was negligible on the several Hi-Q antennas we tested from 10 meters to 40 meters, but on 75 meters, the perfectly resonant antenna through manual coil adjustment looked more like 30 ohms rather than 50 ohms. To correct this, an ultra-simple base-matching network of a tapped coil on a stainless steel spring put us back at 50 ohms in a jiffy. MFJ Electronics also offers a selectable LC matching network, yet other manufacturers may offer broadband transformers. The homebrew tapped coil is the way Charlie recommends base impedance matching.

The Hi-Q antennas also offer another "twist" to help reduce the age-old problem on mobile high-frequency antennas of current returning back to ground near the base because of an inadequate length whip above the loading coil. Keep in mind that 13-1/2 foot limit if you plan to operate HF in motion.

Increasing the capacitance at the top of the antenna with a capacity that dramatically improves current distribution, depends on how bold you want to get with any arrangement on top of the flexible stainless steel rod above the coil.

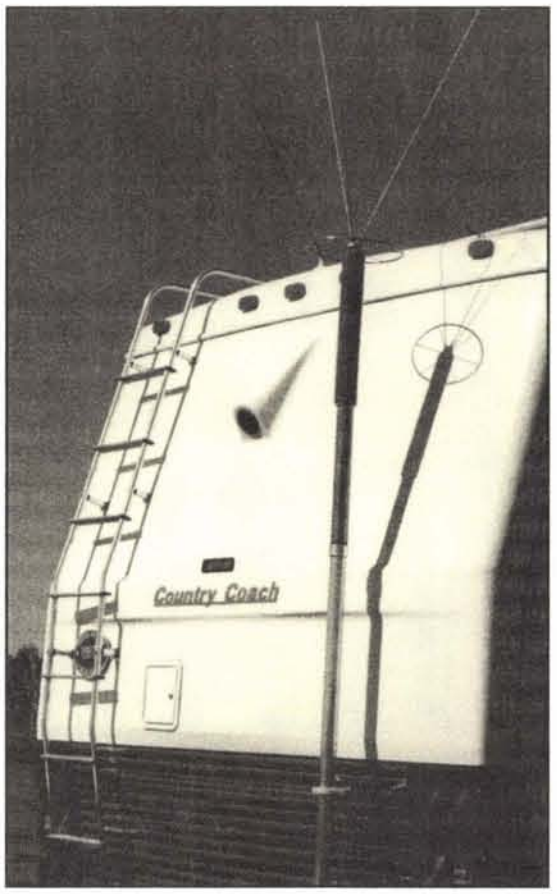
Dramatic improvements in radiation resistance and distant reports of increased signal strength have been achieved with all sorts of capacitive top-loading techniques. Art Godson W7AEG chose to capacitively load the top of his big coil whip with three additional stiff rods, jutting out at 45 degrees a few feet above the loading coil. Art puts out a monster signal on 40 meters.

The American Radio Relay League Antenna Handbook recommends simple geometric forms such as a sphere, cylinder, or disk because of the relative ease with which their capacitance can be calculated. My friend Bill WA6CAX has tested the Hi-Q antenna with a homebrew capacity hat resembling the outline of his favorite kitty. Yet other hams like Julian N3JF adapted an old 8mm motion picture reel as the perfect spoked "top hat" for his relatively rigid Hi-Q antenna system.

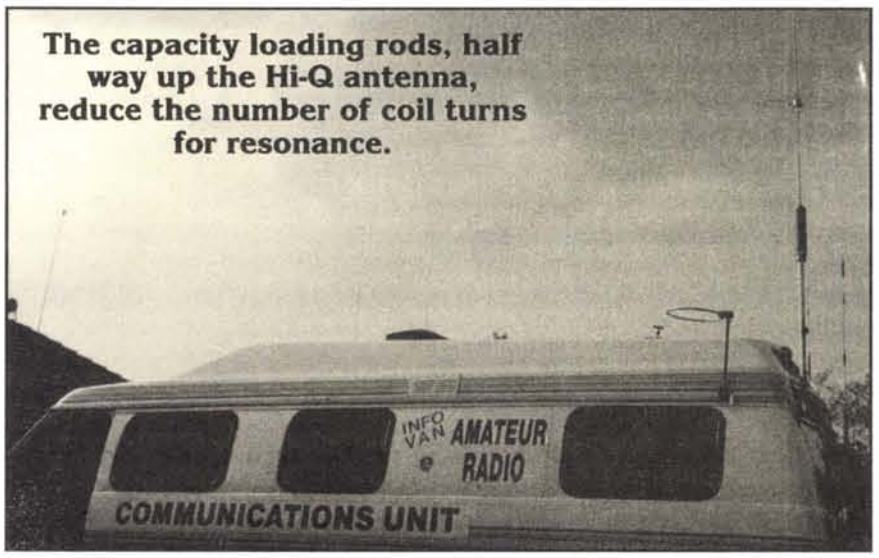
Charlie at Hi-Q and other antenna experts point out that the more capacitive loading at the tip whip, the less amount of inductance necessary to create resonance. Charlie offers the Hi-Q antennas with both manual slide-inductance settings, as well as motorized. The motorized antenna is relatively heavy, and works best when mounted relatively low on the vehicle. Charlie has a longer base-shaft for low-level mounting, allowing the coil to distribute the RF up and away from passengers in the vehicle. This makes sense.

But mounting the base of the antenna relatively high on the vehicle — as we do with the communications van — really gets the signal up and away, but limits the amount of height you could add with a big tall whip tip. So Charlie goes to work and develops a manual slide-tuning system that decreases the length between the 3/8" x 24 thread base to just 24 inches at the base of the coil. The coil is massive, but relatively lightweight, and now the high-frequency sideband operator gets to play antenna games with the upper whip section. And this is where the fun begins!

Since the Hi-Q coil is infinitely adjustable, you may try different combinations of capacitive top-hat loading above the coil, and see whether or not you found some-



The W7AEG big long coil antenna design requires two support brackets. Note capacity hat.



The capacity loading rods, half way up the Hi-Q antenna, reduce the number of coil turns for resonance.

thing that allows you to decrease a couple of coil turns. With the manually-adjusted Hi-Q antenna system, you can hear the results on your receiver on the 40-meter band by simply going up and down with the shaft adjustment and listening for a peak in band noise.

On our communications van, we travel with the manual antenna with all sorts of different whip screw-on elements, allowing us to cautiously exceed street height levels when we get to our demonstration site.

CAUTION: NEVER ADD A WHIP ON A HIGH-MOUNTED MOBILE ANTENNA SYSTEM THAT COULD COME IN CONTACT WITH POWER LINES. YOU COULD BE KILLED!

At a recent hamfest, we got all sorts of ideas on what we could do to capacitively load our signal on 75 meters, including the temporary addition of wire on the tip of the whip that is extended to a nearby tree branch, letting us decrease the number of turns of antenna loading.

Every time we could capacitively reduce the number of coil turns selected by either motor or manual adjustment on the Hi-Q antenna, the greater the apparent signal strength at the other end of the circuit. A couple of turns didn't mean much, but a big long wire allowed us to make contact higher up on the coil, decreasing coil loading and increasing radiation efficiency.

Probably one of the best things I like about the Hi-Q line of antennas are all of the different varieties of shafts, coils, coil sizes, manual and motor tuning, top whips, and friendly advice from an antenna expert who says he gets just about as much excitement on working with the antennas as we did comparing them in the field. The coil assembly allows our ham radio students to visualize the concept of antenna loading, and changes in the whip can easily be seen as big or little changes on where the new coil settings may be.

If I couldn't get to the whip to make adjustments, certainly the precision aeronautical motor drive unit would be best. No little screwdriver motor here! But since we do a lot of antenna "playing," and since I need to get to the back of the van anyway to change solid-state amplifier band settings, the manually adjusted whip is a delight.

I just loosen the adjustment knob, go up or down on the coil, and listen for the radio to peak on noise. And on 40 meters, I don't even need to fiddle with any tapped impedance-matching coil at the base. And 75 meters is close enough that the amplifier keeps the radio happy at 50 ohms input, and it doesn't seem to matter that it's going into an impedance that may not be exactly 50 ohms. The amp still runs cool, and I have one of the loudest signals on 75 meters around.

Finally, I still heartily endorse the Alpha Delta Outbacker Outreach for certain applications, as well as the SGC fully automatic active antenna tuner big whip system. Each of these has their specific applications, and they fit into the top three categories nicely.

And yes, there *are* more massive loading coils, more massive capacitive loaded systems, but these terminate to a major antenna mast that won't simply screw into a 3/8" x 24 threaded receiver. My test was to try and find out which antenna might work best for a very common mount that I already have on our two test vehicles. And chances are, if you're into high frequency at all, you are all set for the 3/8" x 24 threaded high-frequency antenna system.

For a very technical analysis of what we determined on our AEA antenna analyzer, log onto www.hiqantennas.com, or drop Charlie an email at this same address @aol.com. **NV**

Charlie (R) inspects a finished coil out of the coil winding machine.

GIGATRONICS 1497724 Synthesized Source, 8-16 GHz, 1MHz res., GPIB $2,250.00
GIGATRONICS 6061A-830 Signal Generator, 0.1-1050 MHz, 10 Hz res., AM, FM, GPIB $1,900.00
GIGATRONICS -365202 Signal/ Sweep Generator, 2-8 GHz, 1 MHz res., GPIB $1,750.00
HP 11707A Test Plug-in, for HP 8660 series $400.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $450.00
HP 8642M Signal Generator, 0.1-2100 MHz, 1 Hz res., HPIB $3,750.00
HP 8656B-001 Signal Generator, 0.1-990 MHz, 10 Hz res., HPIB, OCXO $2,750.00
HP 8657A Signal Generator, 0.1-1040 MHz, 10 Hz res., AM, FM, HPIB $3,000.00
HP 8660C/603A/633B Signal Generator, 1-2600 MHz, 1 or 2 Hz res., AM, FM $3,250.00
HP 8660D/86603A-002 Signal Generator, 1-2600 MHz, 1 or 2 Hz res., phase modulation $6,000.00
HP 8672A Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +3 dBm $4,500.00
HP 8672A-008 Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +8 dBm $5,000.00
HP 8673H-212 Signal Generator, 2.0-12.4 GHz, 1 kHz res., AM, FM, +8 dBm $8,500.00
HP 8673M Signal Generator, 2-18 GHz, 1 kHz res., AM, FM, +8 dBm $9,500.00
HP 8683B Signal Generator, 2.3-6.5 GHz, cavity tuned, AM/ WBFM/ Pulse $2,250.00
HP 8683D Signal Generator, 2.3-13.0 GHz, cavity tuned, AM/ WBFM/ Pulse $3,750.00
HP 8684B Signal Generator, 5.4-12.5 GHz, cavity tuned, AM/ WBFM/ Pulse $2,250.00
HP 8684D Signal Generator, 5.4-18.0 GHz, cavity tuned, AM/ WBFM/ Pulse $3,750.00
MARCONI 2019 Signal Generator, 80 kHz-1040 MHz, 10 or 20 Hz res $850.00
WAVETEK 952 Signal Generator, 1-4 GHz, +10 dBm, AM, FM $750.00
WAVETEK 955 Signal Generator, 7.5-12.4 GHz, +7 dBm, AM, FM $750.00
WAVETEK 957 Signal Generator, 12-18 GHz, +7 dBm, AM, FM $750.00

SWEEP GENERATORS

HP 8350B/ 83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled $3,750.00
HP 8350B/ 83525A Sweep Oscillator, 10 MHz-8.4 GHz, +13 dBm levelled $5,000.00
HP 8350B/ 83540A-002 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step atten. $3,250.00
HP 8350B/ 83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step atten. $3,750.00
HP 8350B/ 83570A Sweep Oscillator, 18.0-26.5 GHz, +10 dBm levelled $7,000.00
HP 8350B/ 83592A Sweep Generator, 10 MHz-20 GHz, +10 dBm levelled $9,000.00
HP 8350B/83570A-H22 Sweep Oscillator, 17-24 GHz, +10 dBm levelled $5,000.00
HP 8620C Sweep Oscillator Frame $500.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm, 70 dB step atten. $1,250.00
HP 86222B-E69/8620C Sweep Osc. & frame, 0.01-2 GHz & 2-4 GHz bands $1,200.00
HP 86241A RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86251A RF Plug-in, 7.5-18.6 GHz, +10 dBm levelled $500.00
HP 86260A RF Plug-in, 12-18 GHz, +10 dBm unlevelled $400.00
HP 86260A-H04 RF Plug-in, 10-15 GHz, +10 dBm unlevelled $400.00
HP 86290A RF Plug-in, 2-18 GHz, +7 dBm levelled $1,200.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled $1,650.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled $1,850.00
WAVETEK 2001 Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB atten. $750.00
WAVETEK 2002B Sweep Generator, 1-2500 MHz, +13 dBm, GPIB $1,750.00
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm, GPIB $4,500.00
WILTRON 6717B-20 Synthesizer/ Sweeper, 10 MHz-8.4 GHz, +13 dBm,GPIB $6,000.00

POWER METERS

BOONTON 42B/ 41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $400.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz $900.00
HP 436A-022/ 8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB $1,200.00
HP 436A-022/ 8482A Power Meter, -30 to +20 dBm, 100 kHz-4.2 GHz, HPIB $1,200.00
HP 436A-022/ 8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB $1,200.00
HP 436A-022/ 8485A Power Meter, -30 to +20 dBm, 50 MHz-26.5 GHz, HPIB $1,500.00
HP 436A-022/ 8485D Power Meter, -70 to -20 dBm, 50 MHz-26.5 GHz, HPIB $1,700.00
HP 8477A Power Meter Calibtator, for HP 432 series $400.00
HP Q8486A Power Sensor, 33-50 GHz, -30 to +20 dBm, for 435/6/7/8 ..... $1,500.00
HP R8486A Power Sensor, 26.5-40 GHz, -30 to +20 dBm, for 435/6/7/8 ..... $1,500.00

RF MILLIVOLTMETERS

BOONTON 92C RF Millivoltmeter, 3 mV-3 V f.s., 10 kHz-1.2 GHz $500.00
RACAL-DANA 9303 RF Millivoltmeter, -70 to +20 dBm, 10 kHz-2 GHz, GPIB $750.00

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz $950.00
BOONTON 82AD Modulation Meter, AM/ FM, 10-1200 MHz $500.00
C.P.I. VZC6961K1 TWT Amplifier, 35 dB gain, 4-8 GHz, 20 Watts $3,500.00
ENI 525LA Amplifier, 50 dB gain, 1-500 MHz, 25 Watts $3,250.00
HP 11713A Switch / Attenuator Driver, HPIB $800.00
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz $1,900.00
HP 415E SWR Meter $200.00
HP 8403A-002 Pulse Modulator, 0.8-2.4 GHz, 80 dB dynamic range $450.00
HP 8406A Comb Generator, 1/ 10/ 100 MHz increments, to 5GHz $500.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output $650.00
HP 8447F-H64 Dual Amp., 0.01-50 MHz 28 dB & 0.1-1300 MHz 25 dB $900.00
HP 8673D Signal Generator, 50 MHz-26.5 GHz, 1-4 kHz res., HPIB $18,500.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz, HPIB $1,500.00
HP 8970A Noise Figure Meter, 10-1600 MHz, HPIB $3,750.00
HUGHES 8010H13F000 TWT Amplifier, >30 dB gain, 3-8 GHz, 10 Watts $2,500.00
RACAL 9009 Modulation Meter, 30-1500 MHz, AM, 1.5-100 kHz pk FM $350.00
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28 V $200.00
ROHDE&SCHWARZ ESH2 Test Receiver, 9 kHz-30 MHz $3,250.00

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz $300.00
AMERICAN NUC. AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) *NEW* $95.00
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in & out $450.00
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz $350.00
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f) $75.00
GENERAL RADIO 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ..... $450.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz, N connectors $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33327L-006 Prog. Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm $1,000.00
HP 7.78E-09 Dual Dir. Coupler, 20 dB, 0.1-2.0 GHz, APC7 ..... $450.00
HP 87300C-020 Directional Coupler, 20 dB, 1.0-26.5 GHz, 3.5mm $475.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K752A WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz $450.00
HP K752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $250.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz $400.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz $450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45322H-1110/1120 WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz $350.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $750.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz $900.00
HUGHES 45721H-2000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 G $1,000.00
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz $1,000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz $1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz $250.00
HUGHES 45752H-1000 WR22 Direct Reading Phase Shifter, 0-360, 33-50 GHz $1,400.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz $400.00
HUGHES 47316H-1111 WR10 Tunable Detector, 75-110 GHz, pos. polarity $600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32 GHz, +18 dBm $2,000.00
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42 GHz, +18 dBm $2,750.00
KRYTAR 201020010 Directional Detector, 1-20 GHz, SMA(f/f)/SMC $200.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz $450.00
NARDA 3000-series Octave Band Directional Couplers, N connectors $150.00
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz $500.00
NARDA 3022 Bi-Directional Coupler, 20 dB, 1-4 GHz $450.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $375.00
NARDA 3090 Precision High Directivity Couplers $225.00
NARDA 368BNM Coaxial Hih Power Load, 500 Watts, 2-18 GHz, N(m) $500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz $900.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz $950.00
NARDA 4000-series Octave Band Directional Couplers, SMA connectors $75.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f) $200.00
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Laser Insight

by Stanley York

In previous issues, we have looked briefly at different optical properties exhibited by laser optics, and how the quality of a laser beam can be determined and changed by some of these properties. We have also looked closely at one of the most common types of gas laser, the HeNe (Helium-Neon) laser. This month, I would like to introduce you to two of the most common types of high power industrial lasers. The first one I will describe is a gas laser, and the other is a solid-state laser.

The CO_2 Laser

One of my earliest experiences with CO_2 lasers was in England, where I grew up, and where I got my first job in the laser industry. That was over 20 years ago now, and although the lasers I worked on were very powerful (over 2,500 watts of output power), their power would be dwarfed by present day systems. These were huge machines, built on a 15ft I-beam with a 28ft (yes, 28 feet!) folded resonator. In fact, it was one of these laser systems that brought me over to the United States, back in 1979.

There are many configurations for the resonator of a CO_2 laser, depending on the power output, excitation means, and other factors that we'll get to later. There are also smaller 'sealed' CO_2 lasers that have been available for several years now that are becoming very popular. These systems are completely self-contained and run off low voltage power supplies. You could conceivably run them off a couple of car batteries!

But before we get into details of the construction of the various types of CO_2 laser, lets take a quick look at the different excitation means that these systems use. There are two predominant methods of exciting a CO_2 laser. One method uses a high-voltage discharge within the gaseous medium, similar in operation to a HeNe laser. The other involves an intense RF field around the chamber holding the gas. For high-power applications, DC excitation by a high-voltage discharge within the laser medium are usually used, with RF excitation typically reserved for lower power output systems (<500 watts).

In the lasers I worked on in England, the resonator consisted of four high-voltage discharge regions that were optically in series (see Figure 6-1). Each discharge arm was initiated with about 30kV, which dropped to about 15-20kV when the discharge was running. The machine had a two-stage rotary vane vacuum pump, capable of reducing the internal pressure of the system to about 2 x10-6 Torr (2 x 10-6 mm of mercury). When back filled with the laser gas mix, the system pressure came up to about 50 Torr (about 1PSIA). Each arm of the discharge could pull up to 150mA of current! So you can imagine the size and power involved here to produce the 2,500 watts output. The laser gas mix was circulated through the system by a roots-type blower.

This type of laser was generally referred to as a fast axial flow system, because of the way the lasing medium (gas mixture) was circulated through the discharge arms, passing axially along the optical centerline, and was typical of the time for high power machines. The roots blower forced the gas to pass from the anode section, past the tungsten electrodes, down the discharge arms, and into the cathode box (which was grounded). The reason it was called a fast axial flow is that during its passage down the discharge arms, the gas would actually become supersonic. However, because of the low internal pressure, there was little sound to be heard from the discharge regions.

The construction of this machine is one method of achieving high power output. Another method is the so-called cross-flow method, where the low pressure gas flow, high voltage discharge, and laser beam are mutually perpendicular (Figure 6-2). A variation of this laser is called a TEA laser (for Transversely Excited Atmospheric), wherein the laser gas volume is held at or even above normal atmospheric pressure instead of under a partial vacuum, as in the fast axial flow system. Because the gas volume is at higher pressure than in the previous example, there is more active gas per unit volume, and so the flow (or gas exchange rate) can be reduced considerably.

In the sealed CO_2 lasers mentioned earlier, the excited volume occupies a small space within a larger volume, similar to a HeNe laser (Figure 6-3). In this type of laser, the gas volume is held constant by the sealed chamber. A fill port is provided for periodic gas replenishment (about every 10,000 hours or so!) The mirrors for the laser are held in a fixed relationship to each other, in a similar manner to a HeNe laser. In Figure 6-3, the RF field is applied to the parallel plates above and below the excitation region.

The RF field in the sealed systems and the DC excitation in the high power machines forces the Nitrogen molecules into a higher than normal energy state, which transfers their energy by collision to the CO_2 molecule. Upon relaxing to the ground state, the CO_2 molecule releases its energy in the form of a photon of light with a characteristic wavelength of 10.6µM (10,600nM). The Helium gas serves no other purpose than to stabilize the discharge, and cool by diffusion the other gases in the chamber.

In all these systems, there are many ways of boosting the output energy levels of the laser. Figure 6-3 shows a simplified cross section of a sealed CO_2 laser looking down the axis of the laser into the discharge region. Here only a single discharge path is depicted, and is

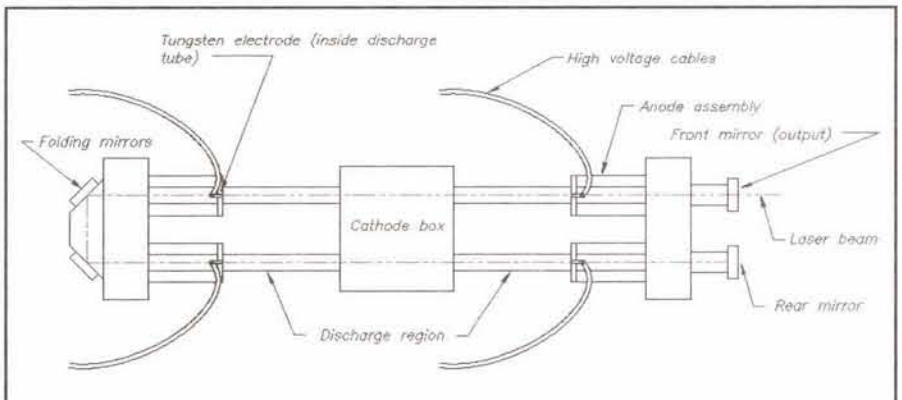

Figure 6-1 – Basic overhead view of a high power, four arm, fast axial flow CO_2 laser system.

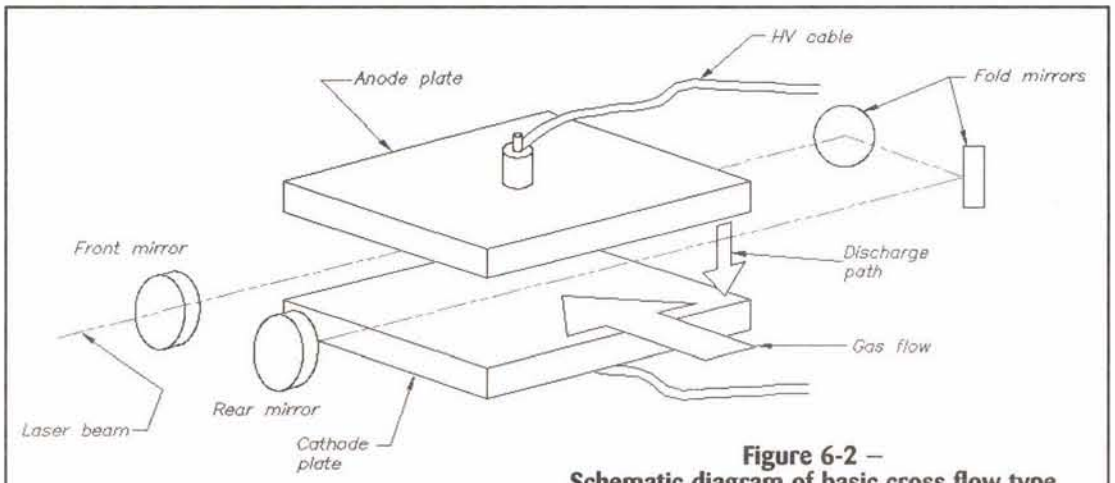

Figure 6-2 – Schematic diagram of basic cross flow type CO_2 laser system.

traveling in a direction perpendicular to the paper. However, Figure 6-4 shows a plan view of how a typical sealed CO_2 laser really looks.

Fixed mirrors within the discharge region cause the light beam to cross the excited gas mix many times before exiting the laser. These multiple beam crossings within the excitation region have the same effect as having a much longer resonator. This allows more power to be extracted from the fixed gas volume. It is usual to have N, M, and NV configurations of the discharge region in order to maximize the yield from a given volume. The configuration depicted in the drawing is of the "M" type, with three folding mirrors. These lasers are available in many beam output types; CW (continuous wave), pulsed, or quasi-CW (a combination CW and pulsed).

Many of these small sealed CO_2 lasers find their way into industry. Low power lasers (<100W output) usually are used in laser marking systems, resistor and wafer trimming systems, and some medical devices. The small size of the resonator and the fact that these low power systems are self-contained make them ideal candidates where small size and portability is a requirement. Larger sealed systems – up to 500W – are widespread in the low power welding, cutting, and soldering areas of industry. Production lines in many industries use these laser systems to weld or cut on-the-fly as parts move past on conveyor belts.

Above about 500W lies the realm of the higher power systems, and this brings us back to the high power lasers I started with. These monsters can now be made to produce up to 50kW of continuous output power! Continuous seam welds on thick plate, and cutting up to 2" steel plates can be done with these giant machines.

The gas mixture for all types of CO_2 laser, whether it is a fast axial flow machine or a sealed unit comprises mainly Helium (80%) with Nitrogen (15%) and CO_2 (5%). The gas mix may vary a little depending on the age of the system, the internal working pressure, how good the vacuum seals are, etc., but are usually close to these figures.

The Nd:YAG Laser

The Nd:YAG laser (for Neodymium-doped:Yttrium-Aluminum-Garnet) is a solid-state laser that uses a manufactured crystal as the amplifying medium. They are available in many configurations in both CW and pulsed modes. The YAG is the crystal in this laser, with neodymium dopant as the actual lasing medium. The dopant level is usually kept at a very low level (on the order of .5% - 2%).

In these lasers, the YAG part is often referred to as the host material. The laser is usually pumped (or excited) by a krypton arclamp (in CW lasers) or by a xenon flashlamp (in pulsed lasers). Figure 6-5 shows schematically a typical medium power Nd:YAG laser equipped with a spatial mode filter, a beam expander, and an AOQ-switch (more on this item in a later column). Note that this laser comprises several separate items that may be moved around on the optical rail to provide different operating conditions. Table 1 indicates what the various components are.

Nd:YAG lasers are also made with high output powers. Some years ago I was called into a military establishment to work on a 1kW Nd:YAG laser. The optical rail carried eight separate laser heads, each fed from its own power supply. Each head could produce up to 150W, and since all the heads were optically in series, the total output was the sum of the individual powers (about 1kW) minus some losses due to misalignment and mismatched polarization vectors.

In recent years, there has been a trend in the laser industry to use high power laser diodes to optically

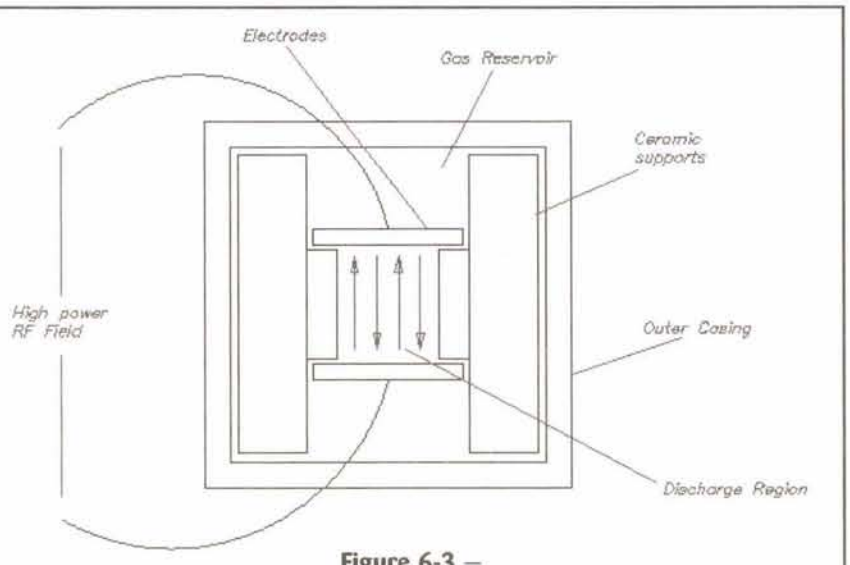

Figure 6-3 –
Cross section of basic waveguide type CO_2 laser system.

Table 1 (Referring to Figure 6-5)

Item	Description or function
1	Optical rail baseplate
2	Helium-Neon sighting laser
3	HeNe rail mount
4	Rear mirror mount
5	AOQ-switch mount
6	Laser pump chamber
7	Intracavity safety shutter
8	Spatial filter mount
9	Front mirror mount
10	Beam expander mount

1. Optical rail mount. This is probably the largest and heaviest single item that makes up a laser system. It has to be heavy for best stability, both mechanical and thermal.

2. The helium-neon sighting laser is aligned to the center of the Nd:YAG beam and parallel to the optical axis. It is then used to align external optical equipment prior to firing the main laser.

3. The HeNe mount has both X-Y and gimbal adjustments to allow accurate positioning of the HeNe laser with respect to the main laser beam.

4. The rear mirror mount has fine adjustment screws to allow precise alignment of the rear mirror with respect to the laser rod. The mirror is highly reflective at the laser wavelength, and is usually set so that the reflecting surface is exactly perpendicular to the optical centerline of the rod.

5. The AOQ-switch mount allows the Bragg angle of the AOQ module to be adjusted during the set-up procedure. This is a special crystal that allows a CW (continuous wave) laser to produce fast risetime high frequency pulses. This particular item is very interesting and will be discussed in a future article.

6. The laser pump chamber is where the electrical power from the wall is converted to light via a high current arclamp. The light from the lamp excites molecules in the laser rod that, in turn, induces laser action.

7. The intracavity safety shutter allows the user to completely stop laser action by lowering a flag in the laser beam feedback path. It is a requirement on all laser systems, and is usually interlocked to various doors and safety shields to prevent unwanted exposure when covers and doors, etc., are opened.

8. The spatial filter mount allows the raw laser beam to be tuned to a finer operating mode (TEM00). Operating modes were discussed in an earlier column, and alter the way in which the laser beam propagates and interacts with the target material.

9. The front mirror mount is similar to the rear mirror mount, but instead holds the output coupler. This mirror is partially transmissive at the laser wavelength, and allows a given percentage of the intracavity energy to escape as laser light.

10. The beam expander allows the naturally occurring divergence of the beam to be reduced for special purposes. Reducing the divergence in this manner provides a smaller focused spot size at the target material.

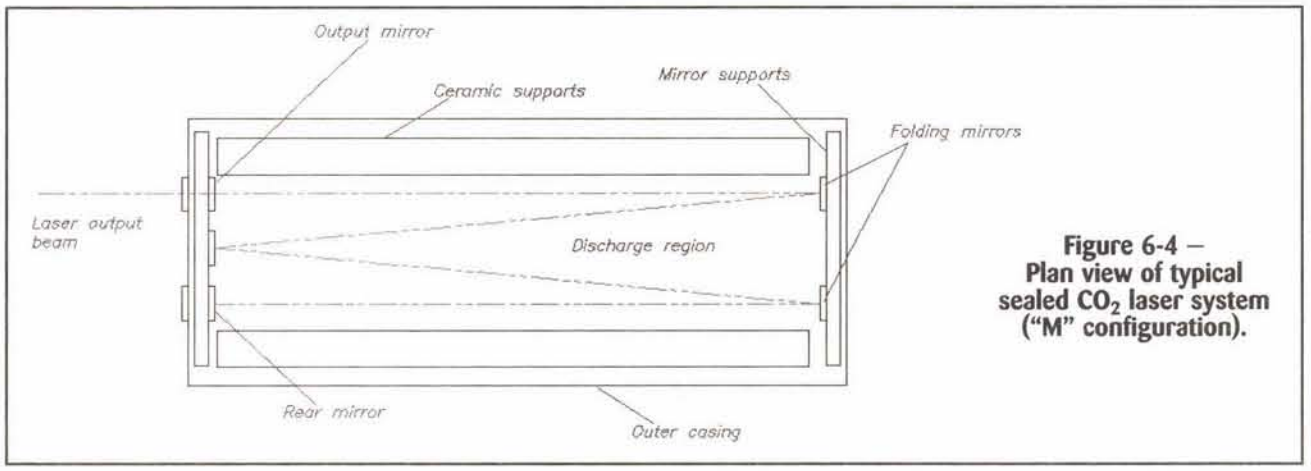

Figure 6-4 – Plan view of typical sealed CO_2 laser system ("M" configuration).

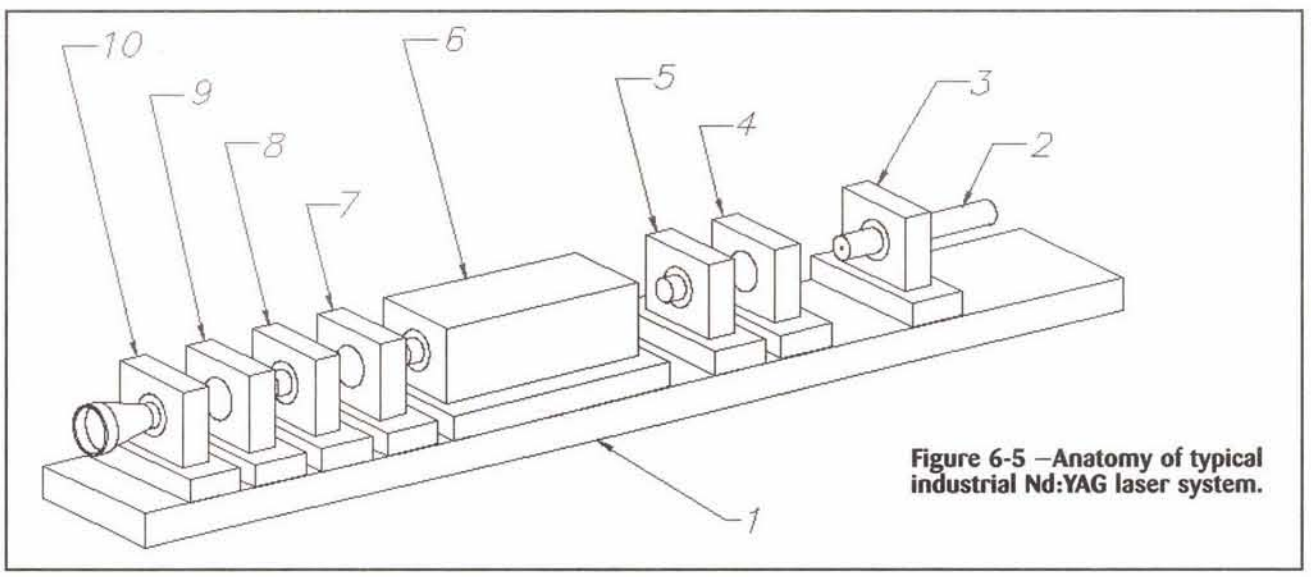

Figure 6-5 –Anatomy of typical industrial Nd:YAG laser system.

pump the Nd:YAG rod. The result is a much more compact and efficient laser that runs cooler, and does not require the frequent changing of the high voltage arc lamps. However, if a diode module goes bad, the repair is not as cheap as replacing a lamp. High power laser diode modules of this type are still expensive to produce, although as manufacturing processes improve, the cost of replacement modules will undoubtedly drop.

Another way of getting more power from a given laser rod volume is to create multiple beam paths within the laser crystal in a similar manner to that described above in the CO_2 laser. Figure 6-6 shows in schematic form how a slab laser works. In this laser, the laser rod is not the traditional cylindrical shape, but is instead a rectangular shape. The two long sides of the laser slab are highly polished and act as self-aligning mirrors. The rear mirror and front mirror serve the same purpose as before, but notice how many times the laser beam crosses the excitation region.

In this drawing, I show just a few crossings for clarity, but in practice there may be many crossings, each one extracting more power from the laser slab. In this manner, the eight-headed system I described earlier could conceivably be reduced to a single head. Slab lasers are very compact, very powerful, and have excellent beam quality.

In a typical low power CW Nd:YAG power supply (Figure 6-7), a DC voltage of about 300 volts from the lamp supply is output to the lamp terminals. This voltage is not enough to start the lamp though. The krypton lamp is ignited by a 25-30kV lamp trigger pulse sent down one of the lamp leads, from the main DC supply. This 2-4µSec pulse creates a streamer down the length of the arclamp similar in appearance to a miniature lightning bolt. As soon as the conducting path is established, a large 'boost' current is drawn from the main supply in order to reinforce the arc, and prevent any large fluctuations in supply voltage from extinguishing the lamp.

As the plasma grows in the lamp, the power supply voltage will reduce to a steady-state running current. This all takes place very quickly, of course, and the lamp is stabilized after a few tens of milliseconds. A water tank is usually housed within the power supply in a closed loop cooling system. A pump circulates cold deionized (DI) water around the lamp and laser rod to extract the heat build-up from the arclamp.

There is usually a water-to-water heat exchanger within the laser power supply frame, so that heat build-up in the water tank may also be removed easily, usually through an external, self-contained refrigerated water chiller. Temperature control of the DI water is maintained by a temperature sensor immersed in the water tank.

On the return side of the water from the laser head, there is usually an over temperature sensor that will shut off the DC power supply if the water temperature exceeds set limits. A portion of the returned water is split off and sent through an oxygen-ion removal filter to maintain a high resistivity in the water circulating through the laser head.

If the resistivity falls too low, the high voltage spike that initiates the krypton lamp will not be able to break down the gas, but instead will bypass the high impedance lamp to be conducted through the low impedance water. Therefore, it is very important that the internal water filtration be done properly, and not allowed to become contaminated.

Applications

If you remember the first article in this series, I mentioned the fact that some of my first encounters with laser optics bought about some surprising facts. One of the most fascinating things I saw was a seemingly opaque piece of material that would allow CO_2 laser radiation to pass through without loss. Another was an apparently transparent piece of glass that totally reflected Nd:YAG laser wavelengths! I stated then that the determining factor in all these things was the wavelength dependent coatings on the particular optics I was describing. Essentially,

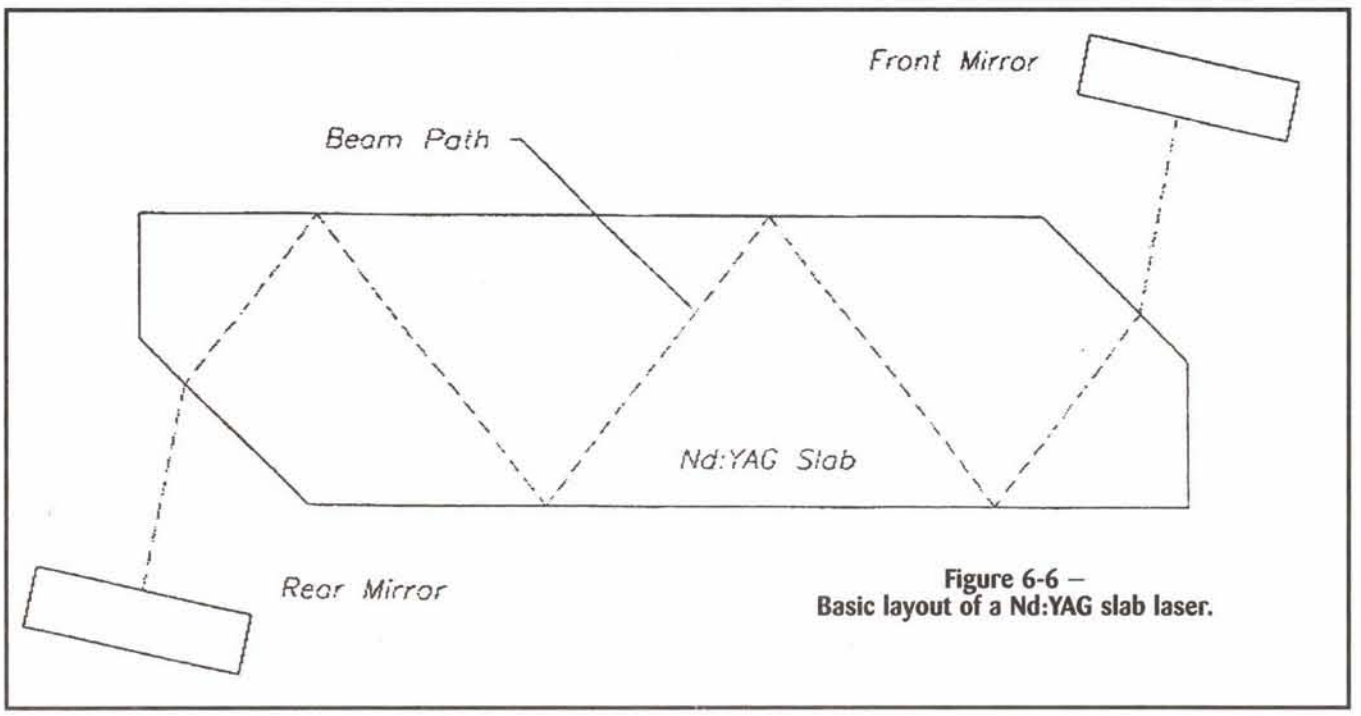

Figure 6-6 – Basic layout of a Nd:YAG slab laser.

the same rules apply when it comes to using a laser for industrial applications.

The typical Nd:YAG laser wavelength is 1.06µM (1,064nM), and the most common CO_2 wavelength is 10.6µM (10,600nM). These wavelengths are in what is typically referred to as the near infrared (Nd:YAG) and the far infrared (CO_2). The wavelength dependent reactions of these lasers govern the types of material each laser will efficiently react with.

Most metals will react favorably in cutting or welding applications with both Nd:YAG and CO_2 lasers, but the so-called red metals (copper, brass, bronze, and their various alloys) do not react well at all with either laser, unless high power levels are used. The reason for this is that these metals are very reflective at both laser wavelengths, therefore very little of the available light is absorbed by the material.

Cellulose-based materials (wood, paper, and their derivatives) show very little reaction to the Nd:YAG laser, but do react strongly with the CO_2 laser. A popular gift is a desk set that has an engraving done with a CO_2 laser.

Transparent Plexiglas will allow a Nd:YAG laser beam to pass through with almost no loss in power, but a CO_2 laser will be stopped in its tracks! In fact, the CO_2 beam will melt the Plexiglas with the deepest melt going at the highest intensity points in the beam profile. Colored Plexiglas will behave differently with the Nd:YAG laser, depending on the color of the tint and the depth of coloration.

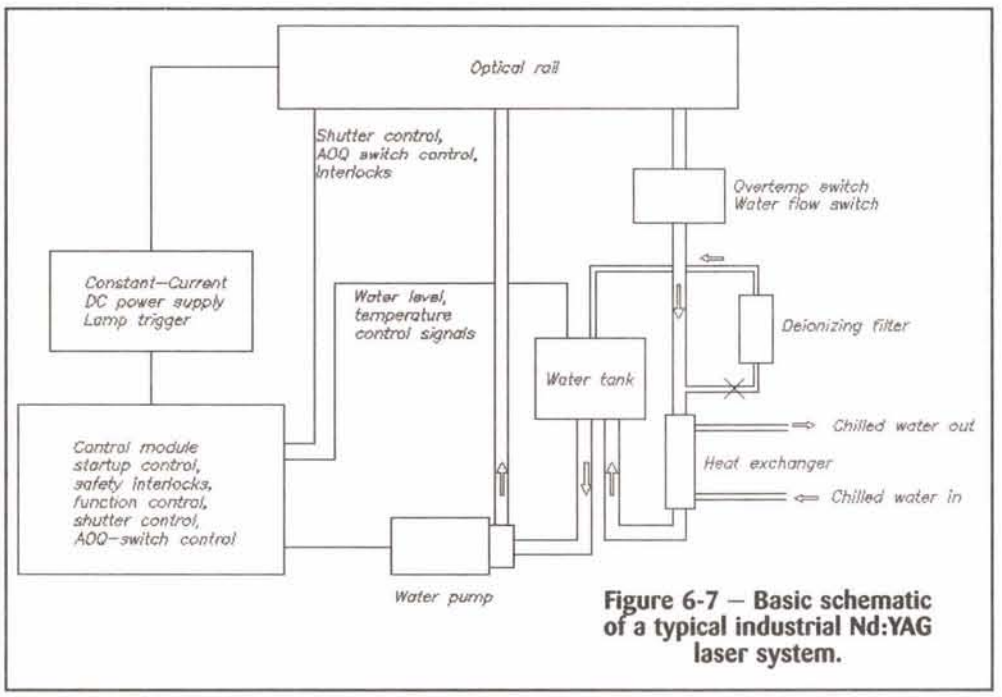

Figure 6-7 – Basic schematic of a typical industrial Nd:YAG laser system.

Window glass is almost transparent to Nd:YAG with slight absorption losses due to the impurities left in the glass, but again will stop a CO_2 beam. When CO_2 light hits a glass plate, either the glass will melt in the same manner as Plexiglas, or it will shatter, depending upon its thickness and temperature. Glass is a poor heat conductor, and you may find that the side facing the laser will crack first, and the cracks gradually propagate through the glass.

I want to keep this column as interesting for you to read as it for me to write. If you have any questions about lasers, optics, or laser applications, let me know through this column. If you have any ideas for projects, drop me a line, and we'll see if we can work it in.

Next month, we're going to look at laser diodes and the impact they have had on the laser industry in the last few years. We'll also be constructing a project you'll find very useful using a laser diode as the light source. Stay tuned and remember, don't look into the light! **NV**

This column welcomes your participation. If you have questions, comments, or perhaps an idea for a future project, please let me know. Any ideas or suggestions are welcome. You can write to me in care of *Nuts & Volts* or you can email me at stanley.york@att.net.

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Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

383 Lafayette St.
New York 10003

OHIO
Footsteps
4925 Jackman Rd. Store #58
Toledo 43613
Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952
Keyways, Inc.
204 S. 3rd St.
Miamisburg 45342

OKLAHOMA
Taylor News & Books
133 W. Main, Ste. 102
Oklahoma City 73102

OREGON
News & Smokes
1060 S.E. M St.
Grants Pass 97526
Norvac Electronics
7940 S.W. Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial N.E.
Salem 97303
Tower Books
1307 N.E. 102nd Ave.
Portland 97220

PENNSYLVANIA
Tower Books
425 South St.
Philadelphia 19147
Tower Records
340 W. Dekalb Pike
King of Prussia 19406
Tower Records
Land Title Bldg.
100 S. Broad St.
Philadelphia 19110

TENNESSEE
Tower Books
2404 W. End Ave.
Nashville 37203
Tower Records
504 Opry Mills Dr.
Nashville 37214

TEXAS
BDL News, Inc.
809 Pierce
Houston 77002
Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063
Mouser Electronics
958 N. Main St.
Mansfield 76063
Tanner Electronics
1301 W. Beltline #105
Carrollton 75006
Tower Records
2403 Guadalupe St.
Austin 78705

VIRGINIA
Tower Records/Video
6200 Little River Turnpike
Alexandria 22312

4110 W. Ox Rd. #12124
Fairfax 22033

1601 Willow Lawn Dr.
Richmond 23230

8389 E. Leesburg Pike
Vienna 22182

WASHINGTON
A-B-C Communications, Inc.
17541 15th Ave. N.E.
Seattle 98155
Supertronix
16550 W. Valley Hwy.
Seattle 98188
Tower Books
10635 N.E. 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN
Amateur Electronic Supply, Inc.
5710 W. Good Hope Rd.
Milwaukee 53223

WYOMING
Western Test Systems
2701 Westland Ct. #B
Cheyenne 82001

Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by Nuts & Volts readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and NO GUARANTEES WHATSOEVER are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

Don't forget to check out the new online electronics forums at the *Nuts & Volts* website. There are currently boards for discussing Robotics, Microcontrollers, Radio, Computers, CNC, and a General forum for discussing any electronic topic at all. We'll even add new dedicated boards for hot topics. Just let us know!

Want to get a jump on things before the magazine arrives? The Tech Forum questions are posted on our website on or before the first of each month. Unanswered questions from recent issues are there also.

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 92879, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

QUESTIONS

What is the easiest (and least expensive) way to obtain a hard copy of a waveform on a PC printer? Is it necessary to have a GPIB controller?

The oscilloscope I am using is a Tektronix 7603 with the 7D20 digitizer plug-in. Ideally, I would like to print the entire magnified record across the continuous pages of a dot-matrix printer.

11011 **Tom Noelle**
Bradenton, FL

I am looking for information (manual/schematic) for an Elcom Engr. Co. standard frequency receiver.

No part/model number is available. It is a small panel mount unit that receives both 5 and 10 MHz. The unit also has controls for mix, power, and a signal-strength meter.

11012 **Phil**
via Internet

Two years ago, I intended to give my hobby a boost by building my own frequency counter. I ordered a chip from the Newark catalog that goes by the name ICM 7724IPL.

The cart is before the horse on this project as it didn't come with hook-up information and I have been unable to find a circuit diagram for a home-built counter.

This chip is suppose to be a complete frequency counter except for a few external components. The reader think tank at Nuts & Volts could be a big help here.

11013 **Gordon McKittrick**
Havre, MT

The buyer of my company recently purchased HV ionization equipment minus operational manuals. Varian, the company that had previously used the equipment is now defunct.

Glassman, the manufacturer of the equipment (see reference frame) informed us that the equipment now is very expensive, contains proprietary state-of-the-art design, and separate documentation cannot be purchased.

We are presently trying to find related documentation. Sundry Certified Calibration Labs have been contacted in locating the equipment manuals, but the results have been negative.

Reference Frame:

200 KVE Beam Driver Power Supply
Ser. M865406-01EV (DRV)
V115 E11000173A Rev. A
GHV PS/EX 200 P005
MFG 1-16-98
Glassman High Voltage
White House Station, NJ

Remote Control Unit
Ser. M865406-01EV (ACI)
V115 E11000171 Rev. A
GHV PS/EX 200 P005
MFG 1-16-98
Varian/Glassman
Unit E11000171 Rev. A

HV Open Stack
Ser. 279850-03, Stack
PS/PG-200P5-ASM
MFG 1-16-98
Glassman High Voltage
White House Station, NJ

Gravitic would greatly appreciate your assistance in locating schematics, manuals, etc., for this equipment.

11014 **James M. Dean**

I recently acquired a Philips PM3310 digital storage scope. It ran for about 20 minutes, then quit.

I contacted Fluke Technical Center (as they are listed as the calibration and support vendor) and was informed that it is an obsolete product and that no information is available.

I have isolated the problem to the power-supply board and would hate to throw this unit out when it appears to be a fairly simple fix.

My problem is that I am unable to find any information, parts, schematics, etc., on this unit. Could anybody point me in a direction for repair information, parts list, suppliers, etc.?

11015 **Kevin Steinhaus**
Hutchinson, MN

How do I program a programmable unijunction transistor, bought from All Electronics, part #2N6028, no base information either.

Can I bias this transistor so that it can work as a conventional unijunction transistor?

11016 **Robert Geier**
Gig Harbor, WA

I am looking for a second-hand Hallicrafters radio. Models SX-62, SX-62A, SX-88, SX-71, SX-96, SX-99, SX-100, SX-101, or SX-101A. I will consider others.

11017 **Tom Smith**
Gross Pointe Woods, MI

In a 1999 magazine, I saw a "SlimPak 1" described as containing a slim CD-ROM and a slim 3.5" floppy drive. It fits into one 5.25" bay. I wrote to the magazine asking for the current price. My SASE was not returned; perhaps it was forwarded to the manufacturer who ignored it.

Are SlimPaks still being manufactured? If so, what is the name of the company?

11018 **Emil Rossdeutscher**
New York, NY

I had acquired a FRITZEL, German multi band , 2 KW Windom ham radio antenna several years ago, and decided to sell it which was a mistake. This antenna utilizes a 6 to 1 balun which matches RG/8U 52 ohm coax to approximately a 300-ohm impedance feed point, off center feed approximately 30 percent of the antenna length which is 136 feet covering the 80 through 10 meter ham band. Would someone be able to advise me exactly how to construct this balun, probably utilizing #14 enamel wire to handle approximately 1 KW and probably utilizing a ferrite core made by Palomar Corp., or Amidon Corp. Amidon makes this balun, but charges $100.00 which is costly considering what goes into it. I would need a step-by-step procedure if this is going to be successful. I have already spoken to The Wireman, Radio Works, Davis RF,

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed. Be sure to include your mailing address if responding by E-Mail or we can not send payment.
- Your name, city, and state, will be printed in the magazine, unless you notify us otherwise. If you want your email address printed also, indicate to that effect.
- The question number and a short summary of the original question will be printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED

All questions should relate to one or more of the following:
1) Circuit Design **3)** Problem Solving
2) Electronic Theory **4)** Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address, Phone Number, and email. Only your name, city, and state will be published with the question, but we may need to contact you.

TECH FORUM

Palomar, Amidon Corp., etc. I believe this procedure was covered in a publication entitled *Baluns and Ununs* by Dr. Jerry Sevick and another publication by the same author entitled *Transmission Line Transformers*, both out of print. Any assistance that you can render, would be greatly appreciated.

11019 **Stan**
Stank1wtf@aol.com

I am looking for a hard drive that is made entirely from memory modules, specifically, 256MB SDRAM modules. This drive would contain 10 or more said modules to produce a 2.56GB IDE logical drive. A box with a 40-pin IDE spigot that contains no moving parts (no platter or heads) just sockets for memory modules, a lithium battery to refresh the modules when power is removed, and the IDE controller.

This box could easily fit into a 5.25 drive slot, memory and all.

Since SDRAM is so cheap now, this would be a viable alternative to magnetic media.

This drive would offer superior boot time, as well as access time. It would be used in place of a hard drive.

Boot time would be reduced to 10n seconds or less, a boon to those who do financials or serious engineering/scientific/graphic work, as well as reduced time to load applications.

110110 **Tom Thompson**

I am looking for schematics and or designs for an IR repeater. I've found a few designs on the Internet, but they are noted to be possibly effected by ambient light and the emitter and transmitter need to be hard wired together. A wireless design would be ideal.

110111 **Bob Novisky**
Minneapolis, MN

I have a key fob transmitter for a vehicle remote start. Is there anything I can do to increase the working distance of the transmitter? Thanks for any help you can provide.

110112 **Bruce**

ANSWERS

ANSWER TO #100112 - OCT. 2001

I found a set of E.A.W. speaker cabinets with the 12" woofers missing. I want to use them as a small P.A. system.

I have a set of blown 12" J.B.L. E120s that I want to use in the cabinets. I am going to recone them with a 4-ohm voice coil rather than an 8-ohm coil, because the Carvin P.A. amp I am using puts out 250 watts per channel at 4 ohms, but only puts out 175 watts at 8 ohms.

What value cap can I add or replace to the low pass crossover to make it cut off at the original frequency with the new 4-ohm coil?

The crossover frequency occurs when Xc=R. In other words, when 1/(2*PI*F*C)=R. So, F=1/(2*PI*R*C) and it is evident that if R is reduced by half, then C must increase by two to have the same crossover frequency.

Russell Kincaid
Milford, NH

ANSWER TO #100113 - OCT. 2001

I installed an array of 4 and 3" solar cells onto the wings of a styrofoam glider, with a Mibuki electric motor in the nose. I was ready to fly.

What I need is a simple timer to break the circuit to let my glider glide to earth. Use of a 555 timer would be an answer, but how? And an even better fix would be some sort of radio frequency control that would allow me to control the rudder (for turning) and elevators for up and down.

I don't have money to purchase servo's and remote controllers like radio-controlled airplanes use, so I need help in designing a remote control that will allow me to fly my glider, powered by the sun.

Look at used remote-controlled cars or trucks. You should be able to get one at a yard sale for a few bucks, especially if they are not working.

What you will find most likely is that the wires between the motor and the PC board are broken (I know, since I fixed my son's twice already). The boards work typically on 4.8 volts from a rechargeable battery pack and control forward and reverse of a relatively large DC motor through an H-bridge. The steering is done through a smaller H-bridge to a small DC steering motor or DC magnets. Get the one with the DC motor, since they seem to work better.

Walter Heissenberger
Hancock, NH

ANSWER TO #10011 - OCT. 2001

Is it reasonably easy to convert an automotive alternator tester like the RadioShack handheld LED tester for use as a 36-volt golf cart gas gauge?

The RadioShack 22-112 alternator tester can easily be used for batteries other than 12 volts even without opening up the unit. Just use a voltage divider hooked up to an NPN emitter follower. Size the divider 0.7 volts more than the required 2:1 ratio since the follower drops about 0.7 volts. Connect a 2.2 kohm 1% resistor between collector and base. Connect a series combination of 150 ohms and 1.0 kohm between base and GND. A 100 mAmps fast blo fuse connects the collector and 2.2k resistor to the 36-volt battery in case anything goes bad. The tester is hooked up to the emitter and GND. The transistor should be a 100- volt NPN type capable of dissipating 1.1 watts and have a beta of 100 or more. The whole assembly will draw about 55 mAmps and can be used with resistor changes on 24 volts, as well.

Walter Heissenberger
Hancock, NH

ANSWER TO #10019 - OCT. 2001

I just discovered a Heathkit GR-91 shortwave receiver that I built probably more than 25 years ago. It seems to work, but I really need a couple of things: antenna selection/hookup, any information on operation (a copy of the assembly/use manual) would be wonderful. Also information on obtaining tube replacements, if needed.

Of course, I will pay all copying/shipping costs.

The website: **www.heathkit-museum.com/gr-91.html** says that the antenna connection is 300 ohms or 75 ohms. If there are three screws on the back for the antenna connection, the two outer are 300 ohms and the center and one side is 75 ohms.

There is a downloadable manual (39 pages in .gif format) at: **ftp://bama.sbc.edu/downloads/heath/gr-91/**.

Russell Kincaid
Milford, NH

ANSWER TO #10018 - OCT. 2001

Can someone show me how to rewire a PC plug to a MAC 15 pin plug so I can hook up my MAC SVGA monitor?

I know they have an adapter for a PC monitor to hook into MAC, but what I want is an adapter MAC montior to hook into a PC min tower or a wire diagram design.

A few months ago, I was given two old Macs with 14" Macintosh (MultipleScan) monitors. After some searching, I was able to come up with an adaptor. Now those displays are connected to PCs that I gave to family members. The displays are quite nice, with built-in speakers. But the Macs themselves were too old to be useful.

I posted instructions on how to build this adaptor on my website: **http://fina.lly.org/macmontor.html**.

If you have the time/money, I would recommend: **www.macadapt.com/MSDPC_Sheet.htm** for a pre-built adaptor for an excellent price. It would probably have higher quality than home made, since the video signals tend to bleed if not shielded properly.

Eric Hungerford
Seattle, WA
finatronics@yahoo.com

TECH FORUM

ANSWER TO #100110 - OCT. 2001

I am looking for information on how to build a "routing or a switch type" device. It would have two inputs, both analog, low voltage (from a tape player and a radar detector or scanner), and one output (which would go to a headset).

One circuit would be open continuously, unless the other was activated, then the "switch" would allow input from the second source to pass through.

Once the second signal stopped, it would return to the original input. Power would come from a 12-volt DC source.

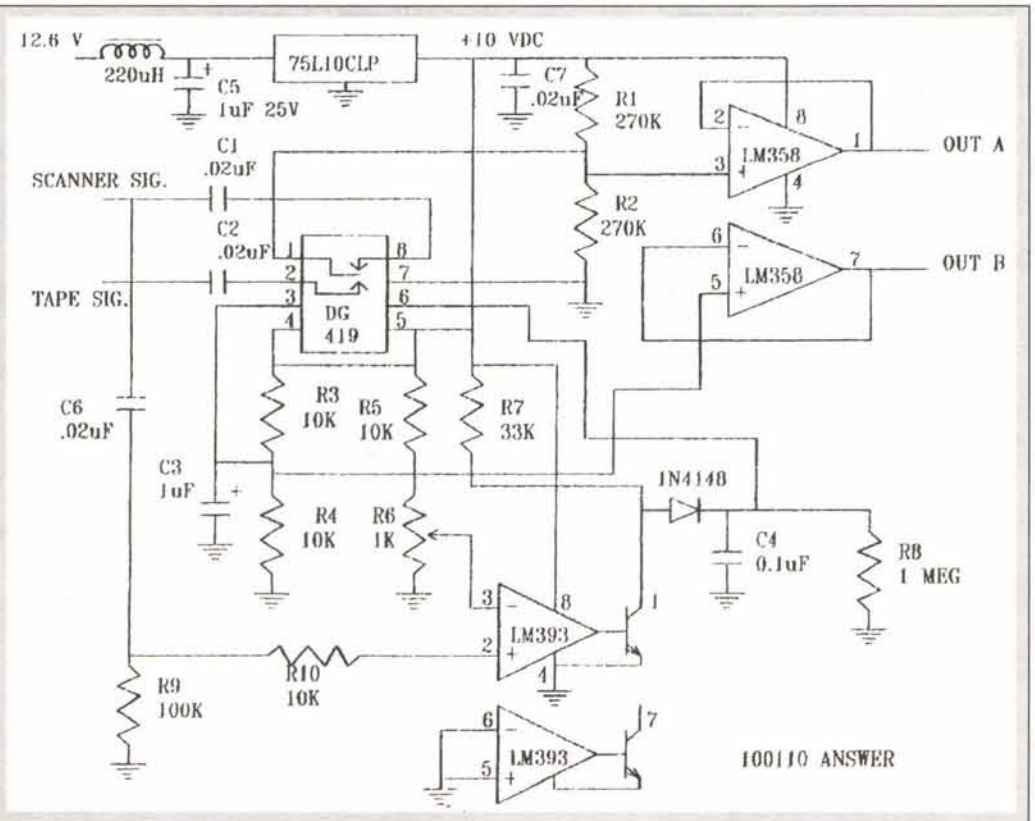
The DG419 IC is a single pole, double throw switch. The switch between terminals 1 and 2 is normally closed, passing the tape signal to output A. When a scanner signal is received, the LM393 comparator output goes high, charging C4.

A high level on pin 6 closes the switch between terminals 1 and 8 and opens the switch between terminals 1 and 2.

Output A is the signal, output B is a five-volt reference, so you can connect headphones or a transformer between A and B without needing a capacitor.

If your headphones are 8 ohms, a transformer is recommended. The potentiometer, R6, is adjusted so switching occurs only when a scanner signal is received. If the scanner signal is at DC ground, C6 and R9 are not needed, connect R10 to the scanner signal.

Russell Kincaid
Milford, NH



by Don L. Powrie

USB-MICROCONTROLLERS FOR THE MASSES

Microcontroller, Flash programmer, and high-speed USB-to-PC interface ... all in one tidy little package.

Introduction

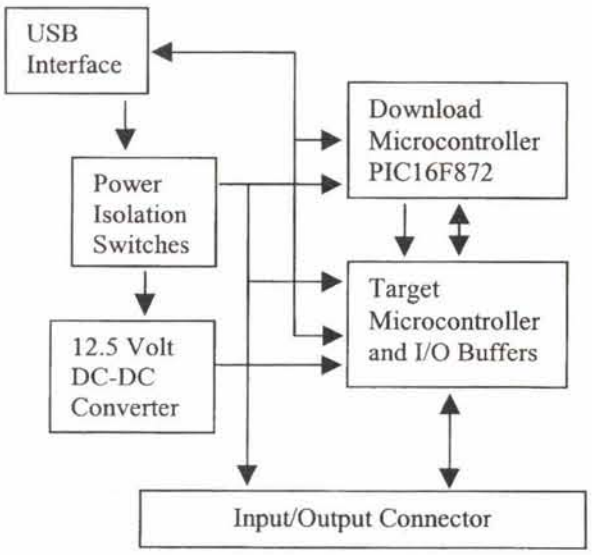
Using a microcontroller to interface an electronic device to a PC typically requires the acquisition and development of three things: the microcontroller and its support circuitry (target electronics), a compiler or assembler to create the firmware for the microcontroller, and a device programmer for downloading the firmware into the Flash (ROM) of the target microcontroller.

Once you have obtained all of these components and start developing the firmware for your project, you can expect to spend a significant amount of time on the "download" process. This process consists of removing the microcontroller from the target electronics and erasing it either by bulk erasing (Flash device) or placing it under an ultraviolet light source for 10-20 minutes (EPROM device). Then the device must be loaded into the device programmer so that the latest version of your firmware can be downloaded.

Once the download has been verified, the device must be returned to the target electronics so that you can continue developing the project. If the project is complex and development time lengthy, this download process may need to be repeated dozens or even hundreds of times.

Wouldn't it be nice if you didn't have to remove the microcontroller from the target electronics – thereby risking hardware and ESD damage – every time you wanted to download new firmware?

This article will detail a design that accomplishes just that. This design contains a USB interface for communicating with a host PC, a target microcontroller, and an additional "download" microcontroller that does nothing but handle firmware downloading. The download is performed via a USB interface that can also be used in your project by the target microcontroller for communicating with the host PC.



Free C Compiler

The Microchip PIC16F84A was chosen as one of two target processors for this project due to the availability of a free, optimized C compiler from Hi-Tech Software. The free version is limited by the inavailability of printf() support for longs or floats, and only supports a few devices such as the 16F84A. Hi-Tech's standard PIC C compiler must be used for larger processors like the 16F877.

Various other companies offer both C and Basic compilers that work well with Microchip microcontrollers, and range in price from under $100.00 to several thousand dollars. To access a few of them, follow the links shown below:

Hi-Tech Software LLC
http://www.htsoft.com/

Custom Computer Services, Inc.
http://www.ccsinfo.com/

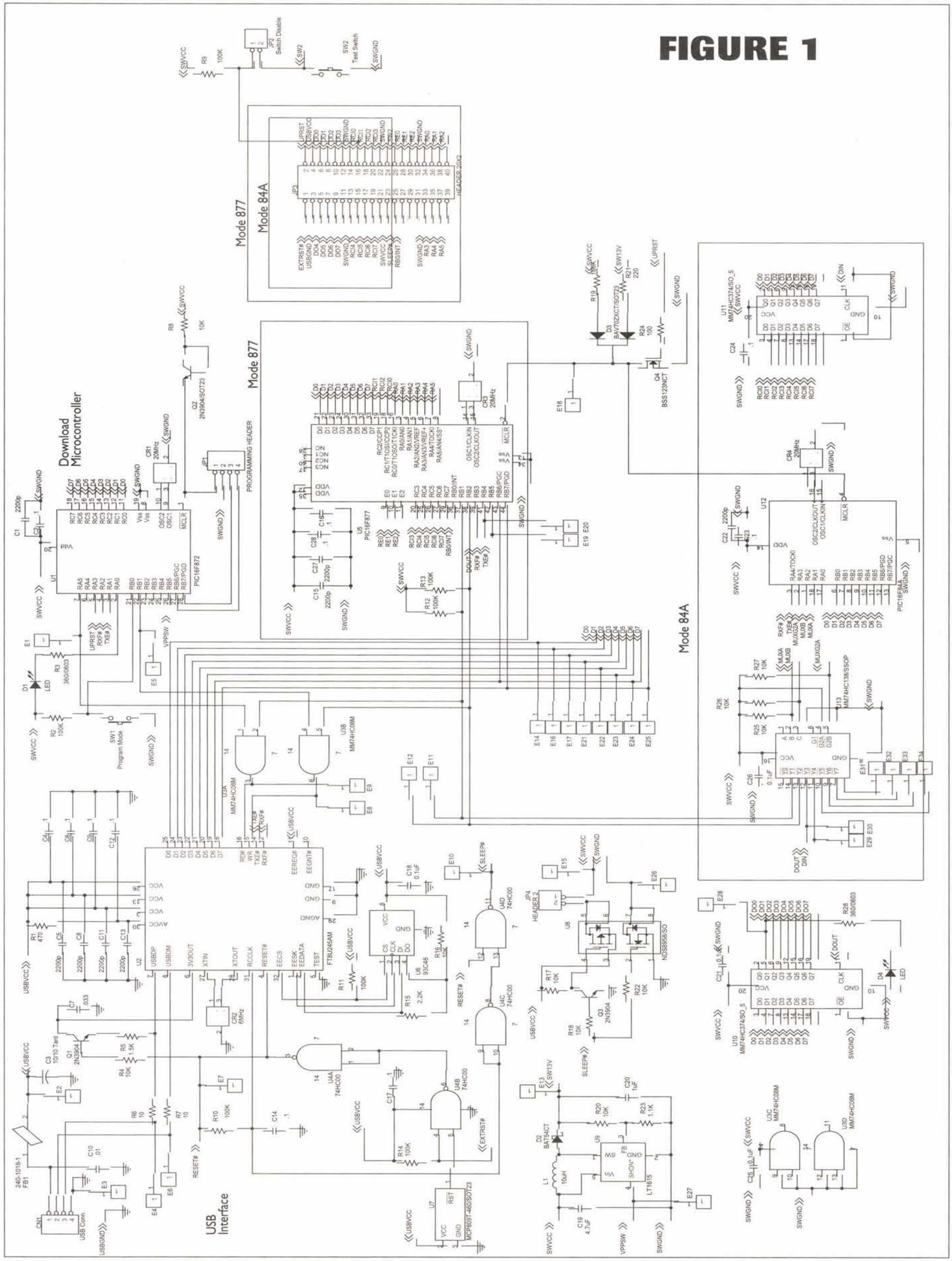
MicroEngineering Labs, Inc.
http://microengineeringlabs.com/

Grich RC Incorporated
http://members.aol.com/piccompile/

ByteCraft
http://www.bytecraft.com/

IAR
http://www.iar.com/

FIGURE 1


Download Microcontroller
USB Interface
Mode 877
Mode 84A
PROGRAMMING HEADER
HEADER 20X2
PIC16F872
PIC16F877
PIC16F84A
FT8U245AM
MM74HC374/SO_5
MM74HC138/SSOP
MM74HC08M
74HC00
BAV70ZX/CT/SOT23
BSS123NCT
ND5858/SO
2N3904/SOT23
BAT54CT
LT1615
MCP809T-460/SOT23
93C46
USB Conn
Switch Disable
Test Switch
Program Mode
LED
SWVCC
SWGND
USBVCC
USBGND
VPPSW
DOUT
DIN

B Knudsen Data
http://www.bknd.com/

Free Assembler

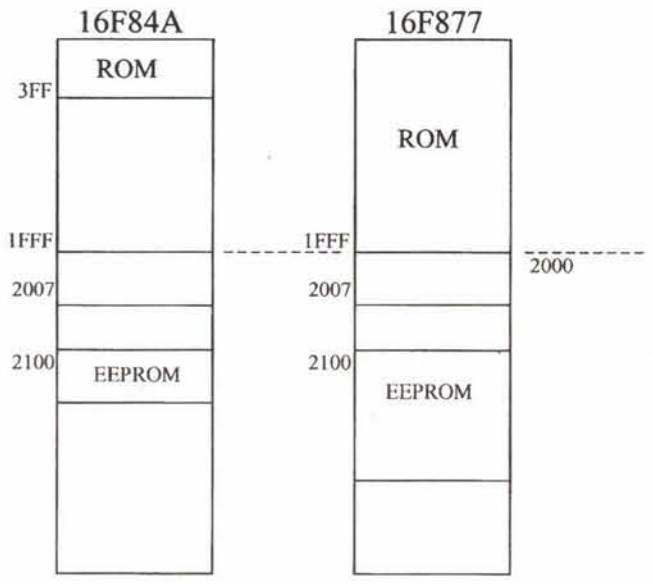
Microchip offers as a free download their MPASM assembler. MPASM is a full-featured universal macro assembler that will produce HEX files for any PIC microcontroller. This, of course, requires that you know how to program in assembly language.

While programs created in assembly language are more compact and — in some cases — execute faster, the learning curve can be considerably longer than learning a high-level language such as C. With careful coding, some C compilers can approach the compact size and execution speed of firmware created with assembly language.

Download Microcontroller

For this project, I utilized a Microchip PIC16F872 for the download microcontroller. The target microcontroller can be either a 16F84A or a 16F877. The schematic (Figure 1) details a design that supports both microcontrollers. Figure 2 illustrates my prototype of the board that was used to develop all of the software. This prototype shows the 16F84A as a surface mount device. The finished product will have the target processors socketed.

The download microcontroller serves two purposes: the reset function and the firmware download process. When the reset button is pressed, the target micro will be reset and held in the reset state by the download processor for approximately five seconds while flashing the LED. During the five seconds, if the host attempts to communicate and initiate a download, then the LED will stay on, and the target microcontroller will remain in the firmware download mode until released. If the host does not attempt to communicate within five seconds, then the target micro is released from reset and begins executing its firmware.



Target Microcontroller

When the download microcontroller is activated by pressing the reset button, it starts by taking the MCLR line low (reset) on the target micro. If a firmware download is then initiated by the host, port pins RB6 and RB7 on the target micro are held low, and 12-14 volts are applied to the MCLR line with a fast enough rise time such that the target micro does not begin to increment the program counter. If the rise time is too slow and the program counter in the target microcontroller is able to increment by one, then the firmware will not download into Flash location zero and the microcontroller will not run correctly.

Once the MCLR line reaches 12 volts, all port pins on the target micro are configured as inputs (high impedance), the program counter is pointing to address zero, and the device is ready for firmware download. The download micro communicates with the target micro over a serial interface using only a clock and a bi-directional data line. The command set in Table 1 is all that is required to read and write the Flash memory in the target microcontroller. Each command is a six-bit command, and is written to the target by toggling the clock line six times while writing the command LSB first in the data line.

Data is written and read 16 bits at a time in the format of SDDDDDDDDDDDDDDS, where the "S" character represents the start and stop bits and "D" is the data. For timing requirements, refer to the Microchip application note EEPROM Memory Programming Specification (DS39025E).

To write HEX program data to the Flash memory, the Load Data for Program Memory command is issued followed by 14 bits of data and then the Begin Programming command. After a 10-millisecond pause, the Increment Address command is called, and the process is repeated until done. Locations in the microcontroller's memory that are not written are left in the all 1's (0x3FFF) state.

To write configuration data to the configuration register, the Load Configuration command is issued. This command sets the program counter to address 0x2000. Since the configuration register resides at address 0x2007, the Increment Address command must be called seven times.

COMMAND MAPPING FOR PIC16F84A/PIC16F877 **Table 1**

Command Mapping	(MSB ... LSB)
Load Configuration	(0 0 0 0 0 0) + data
Load Data for Program Memory	(0 0 0 0 1 0) + data
Read Data from Program Memory 4	(0 0 0 1 0 0) + data
Increment Address	(0 0 0 1 1 0)
Begin Erase Programming Cycle	(0 0 1 0 0 0)
Begin Programming Only Cycle	(0 1 1 0 0 0)
Load Data for Data Memory	(0 0 0 0 1 1) + data
Read Data from Data Memory	(0 0 0 1 0 1) + data
Bulk Erase Program Memory	(0 0 1 0 0 1)
Bulk Erase Data Memory	(0 0 1 0 1 1)

Finally, the Load Data for Program Memory and Begin Programming commands can be called. Ten milliseconds later, the data is stored and is ready for use.

Memory Map

The internal EEPROM memory resides at address 0x2100 and can also be programmed at download time. EEPROM data is only eight bits wide, but writing the data still requires that 16 bits be clocked in even though only the least significant eight bits are actually stored.

Once in Load Configuration mode, the program counter will wrap around to 0x2000 if incremented continuously. The only way to get the program counter back to address zero is to reset the device. After a reset, the program counter will wrap back to zero once it reaches 0x1FFF.

HEX File Format

Each line of an Intel HEX data file is structured as follows:

:nnaaaattd-
ddddddddddddddddddddddddddddd
dd...cc

":" indicates the start of a data record, "nn" indicates the number of bytes in the record, "aaaa" is the load address of the record, "tt" is the record type, "d" is the actual data, and "cc" is the checksum. All values are in ASCII/HEX. The checksum is calculated by performing eight-bit additions of every byte between nn and the end of data. The two's complement is then taken of this sum to get the checksum.

The HEX file stores the actual firmware that is to be written into the Flash of the target microcontroller. A HEX file can also contain configuration data and EEPROM data. The Flash programming system is responsible for setting the program counter in the target microcontroller for the appropriate location in memory that should be written.

Windows Download Software

A 32-bit Windows application (Figure 3) that performs the download process with the 16F872 can be downloaded for free from my website (dlpdesign.com) and supports both the 16F84A and 16F877 microcontrollers. The application uses the DLL version of FTDI device drivers that are also available for download.

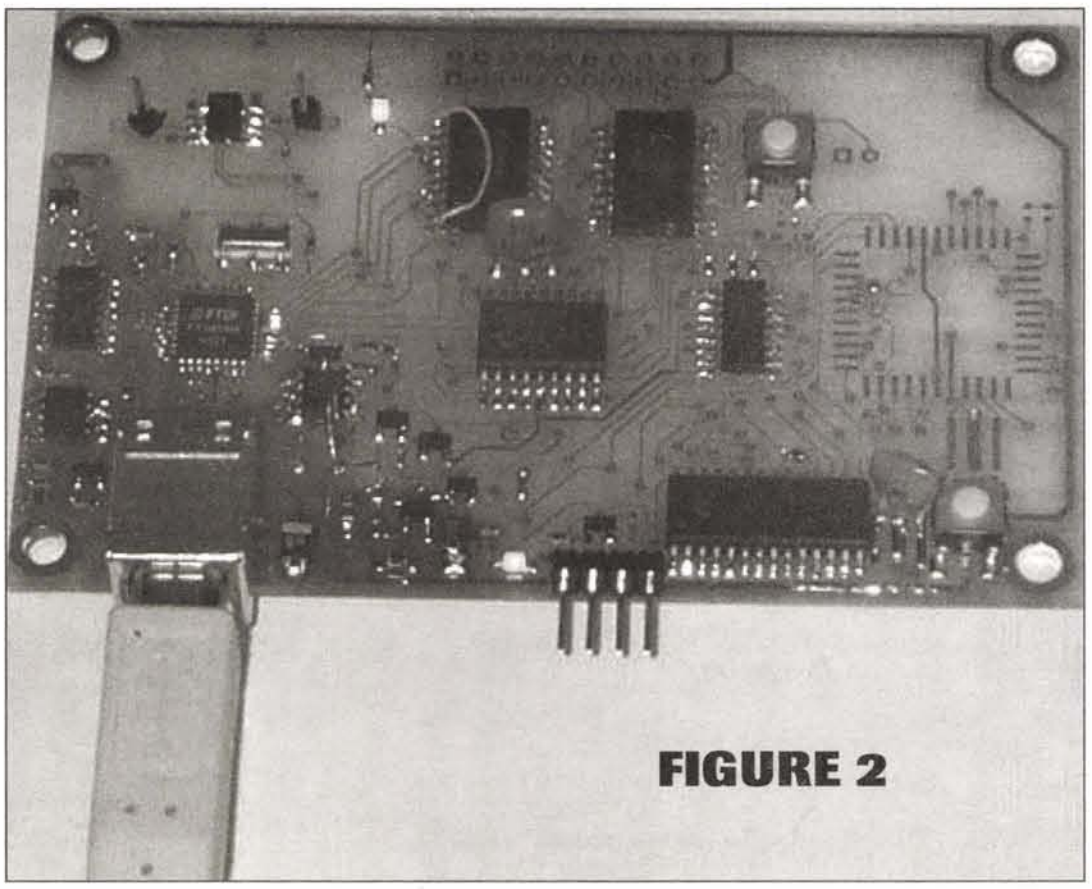


FIGURE 2

The DLL version of FTDI's drivers has an "OpenEx" function that allows multiple DLP-IOx devices to be connected to the same PC in a well-organized manner. This function will open the named device and return a handle that will be used for subsequent accesses. The device name can be its serial number or a device description; both are text strings that are programmed into an EEPROM that is directly connected to the FT8U245AM. The above-mentioned Windows download software has a search function that can quickly locate and present a list of all FTDI devices connected to the PC such that a specific target can be selected for firmware download. A third method – open by device number – can be used for new boards that have not had a serial number or description string written to the non-volatile RAM.

Download options include enabling or disabling the Watchdog Timer, Power-up Timer, Brown-out Reset, In Circuit Debugger (see Al Williams article in this issue on page 65), and Code Protection modes. (Refer to the datasheet for each device for a full description of each download option.) If a PIC Flash device is code-protected, the read function will return all 1's for the data read, and a standard bulk erase will not work correctly. The only way to erase a device that was previously programmed with code protection turned on is by issuing commands 1 and 7 while in Load Configuration mode. The download application mentioned above will

```
#include  <pic.h>

#define MUXA   RA0
#define MUXB   RA1
#define MUXG2A  RA2
#define TXE   RA3
#define RXF   RA4
#define LED   RB0

void long_delay(unsigned char x);//function prototype

//*********************************************************************
void main()
{
        unsigned char dtime;
        //set port A inputs/outputs
        //1=input 0=output
        TRISA4 = 1; //RXF
        TRISA3 = 1; //TXE
        TRISA2 = 0; //MUXG2A
        TRISA1 = 0; //MUXA
        TRISA0 = 0; //MUXB

        PORTB = 0xff;//Port B all high
        TRISB = 0xfe;//d0-output, the rest inputs

        MUXB = 1; //correct decode state for DOUT
        MUXA = 0;
        MUXG2A = 1; //data latch
        dtime=200; //initial setting for the LED flash rate

        while(1)//continuous loop
        {
                if(!RXF)//if USB chip reports a byte was received then read
                {
                        MUXB = 0; //correct decode state for USB Read
                        MUXA = 0;
                        TRISB =0xff;//Port B set to input
                        MUXG2A = 0;//enable read
                        //read USB data without any error detection (crc, etc...)
                        dtime = PORTB;//dtime=0 will cause watchdog timer to
reset the device
                        MUXG2A = 1;
                        TRISB = 0xfe;//d0-output, the rest inputs
                        MUXB = 1; //decode state for DOUT
                        MUXA = 0;
                }

                LED=0;//LED on
                MUXG2A = 0;//latch data
                MUXG2A = 1;
                long_delay(dtime);

                LED=1;//LED off
                MUXG2A = 0;
                MUXG2A = 1;
                long_delay(dtime);
        }
}

//*********************************************************************
void long_delay(unsigned char x)
{
        int e;

        while(x--)
                for(e=0; e<330; e++)//1mS
                        CLRWDT();
}
```

Example Source Code

perform both a standard bulk erase and a code-protected bulk erase when the Erase function is selected. This allows the target processor to be code-protected such that the firmware cannot be read, but will still allow for future downloads to occur.

A firmware version string of 16 characters (maximum) can be written to the EEPROM memory in the download microcontroller. This string is read automatically every time the download process is initiated, and can be written any time the download application is running and connected to the target. EEPROM memory in the download microcontroller was used for storage of the version string instead of the target microcontroller's EEPROM so that all of the EEPROM memory in the target would remain available for project use.

USB Interface

The USB interface is implemented with FTDI's FT8U245AM (see the June 2001 issue of *Nuts & Volts* for more information), which connects to the target microcontroller via its eight-bit data bus and four handshaking lines. The USB interface also connects to the download microcontroller via the eight-bit data bus, although only four bits of the bus are actually used for communication.

After firmware download, the USB port can be used by the target microcontroller to communicate with the host PC. The actual USB data rate is limited by the speed of the target microcontroller. In the case of a PIC microcontroller running at 20MHz, you can expect maximum data rates of approximately two megabits per second.

The most noteworthy aspect of the USB interface is the fact that no Windows driver need be developed. The latest version of the drivers can be downloaded from either FTDI or DLP Design.

Two versions of the driver are available from FTDI: Virtual COM Port (VCP) and DLL. Since the firmware download program uses the DLL version of the drivers, if your project uses the VCP version of the drivers, then you will have to uninstall the VCP version of the drivers and reinstall the DLL version. (This process is quite simple, and only takes a few seconds to perform.)

The VCP drivers are the easier of the two to use. Your application software running on the host PC simply has to open, read from, and write to the standard RS-232 ports. The VCP drivers intercept the serial data, reroute it to the Windows scheduler, and then send it out the USB port to the target electronics. The DLL version of the drivers requires the application to open and read the DLL at runtime. Example code for several programming languages (Visual C++, Visual Basic, etc.) that illustrate the use of both driver types can be downloaded from either ftdichip.com or dlpdesign.com.

Inputs and Outputs

As stated earlier, the design presented here contains two dif-

ferent target processors. The first processor chosen was the 16F84A because of the availability of a free C compiler from Hi-Tech.

The 16F84A will hold 1K of ROM, 68 bytes of eight-bit RAM, and 64 bytes of eight-bit EEPROM. The second was the 16F877, which was the largest 14-bit Flash device available from Microchip when this project was under development. The 16F877 will hold 8K of ROM, 368 bytes of eight-bit RAM, and 256 bytes of eight-bit EEPROM.

The DLP-IO16 uses the 16F84A and provides eight buffered digital inputs and eight latched digital outputs. The DLP-IO16 is limited in the number of inputs and outputs available to the target electronics primarily due to the 12 port pins that are required to connect to the USB interface.

The DLP-IO26 provides eight latched digital outputs and 18 bi-directional, general-purpose digital I/O lines, eight of which can be configured as 10-bit analog-to-digital converter inputs for measuring voltages in the range of 0-5 volts. Adding an external resistor voltage divider can extend the voltage input range. These boards can be purchased from dlpdesign.com in either configuration.

Theory of Operation

The schematic for this project shows a 40-pin connector at JP3. The DLP-IO16 only uses the first 26 pins, while the DLP-IO26 uses all 40 pins. Both boards are shipped without a header installed since connection to your project can be made in a number of ways.

As mentioned earlier, the target microcontroller enters Flash program mode when its MCLR line is driven to 12 volts. The 12 volts are generated by U9 which is a Linear Tech LT1615 switching regulator. U9 takes five volts from the USB interface, and outputs approximately 12.5 volts when the VPPSW input is high.

The output voltage is set by resistors R20 and R23. The output of the regulator will generate whatever voltage is necessary to maintain 1.23 volts at the feedback pin (pin 3).

U8 is a dual MOSFET switch configured to isolate the target electronic's power and ground from the USB interface when the host PC enters standby mode. If the target electronics are self-powered, then a jumper (JP4) can be removed. If using USB port power, be careful not exceed a total of 500 milliamps for both the DLP-IOx board and your target electronics.

Both the DLP-IO16 and DLP-IO26 have an LED and a momentary contact switch that can be used for firmware debug or with the target electronics. Example code included here shows how to use the LED.

Since both the download and target microcontrollers need to access the USB interface, a pair of AND gates was added to handle the read and write functions. During the firmware download process, the target microcontroller is disabled, and its outputs to the AND gates are left high.

This allows the download microcontroller to perform both the USB read and write functions. When the target microcontroller is running, the download microcontroller leaves its USB read and write outputs high so that the target micro can have access to the USB port.

A 74HC138 3-8 decoder was added to expand the input/output capability of the DLP-IO16. The 74HC138 allows the selection of USB read, USB write, digital data out, and digital data in. An example of how to access the decoder is shown here.

Example C Source Code

Using the free C compiler from Hi-Tech, the C source code will produce a HEX file that will run on the DLP-IO16. All the code does is toggle the LED at a rate that is received from the host PC via USB. Visual C++ source code for the Windows software that accompanies the example shown here can be downloaded from my website (dlpdesign.com).

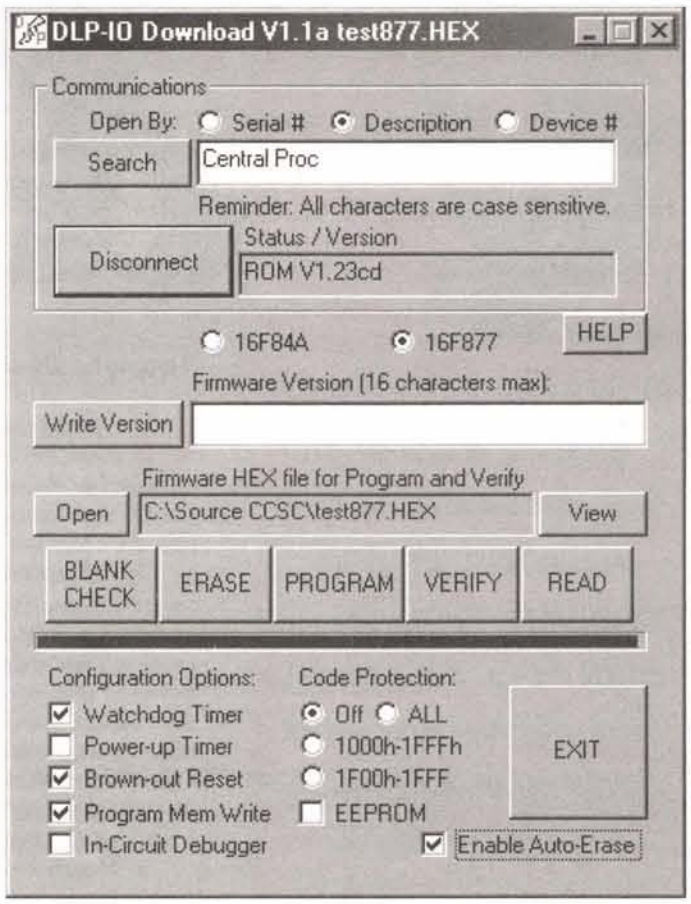


FIGURE 3

Conclusion

The firmware for your next project can be developed using either the DLP-IO16 or DLP-IO26, and then a finished product can be designed which excludes the download microcontroller as a cost-saving measure.

Many companies sell device programmers that will take a HEX file and write it to the Flash of a microcontroller. To my knowledge, no one offers a USB-based programmer simply because the speed of USB is not required. A minimum 10-millisecond delay must follow every write to Flash memory. Given this restriction, there is no advantage to designing a high-speed programmer.

However, when the USB port remains available to the target microcontroller for host communications after firmware download — as is the case in the design presented here — then there is ample reason to include USB in the design.

Developing quality firmware can be challenging regardless of your level of experience. Why not simplify the process by including a device programmer in the target electronics? **NV**

ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.

Feel free to participate with your questions, as well as comments and suggestions.

You can reach me at:

TJBYERS@aol.com

or by snail mail at

Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

New devices and shrinking footprints require novel identification techniques. So do evolving schematic symbols. Both are defined, explained, and exampled. How to control speaker volume at the speaker level. A simpler VCO? Plus a lot of reader feedback on previous Q & A topics — check out the S-Video.

Today's Shocking Reality

Q. I have an odd requirement — actually two of them. I need to make two different "shocker" devices. Let me explain. I frequent an area outside of the US that has a high crime rate. Two types of criminals are common.

1. Pickpockets that operate by stealth. The shocker I need for this crime should not cause harm nor cause immense pain. It just needs to be noticeable enough to cause a "jerk" reaction so I will know when someone is trying to pick my pocket. I already know how to build the contact assembly within my pocket, I just need to know the best way to build the shocker circuit. A shock I received at work leads me to believe that 1,000 Hz is a good frequency for this because it seemed more like a burn or cut than a shock.

2. Muggers who do not use guns or knives, usually running in packs of two or three assailants, and often in broad daylight. The biggest guy grabs you from behind with a police choke hold, while the second rifles through your pockets. Sometimes, a third guy grapples your ankles. Often you pass out from lack of oxygen. In this instance, I'd rather startle or stun rather than anger my attackers. I have considered a loud alarm and an exploding dye-pack, but I don't know where to buy such. In both cases, I don't want the security device to backfire on me lest I forget about them.

G. Frank Humiston
via Internet

A. These are trying times, and I've had several requests for stun guns and the like for self-protection. It's also for this reason that I'd rather not describe how to build these devices, because I can't guarantee they will perform as advertised, but instead list companies who sell commercial units made specifically for the task. Here's a short list of suppliers along with a couple of informative articles.

American Science & Surplus
847-982-0870; www.sciplus.com/category.cfm?subsection=17&category=168

Security Products Super Store
800-981-9456; www.securityplanet.com

Security Plus
863-635-4544; www.secure-u.com

Security World International
877-981-4046; www.securityworld.com/library/college/securitydevices.html

A Guide to Personal Security Devices
http://nsi.org/Tips/devices.htm

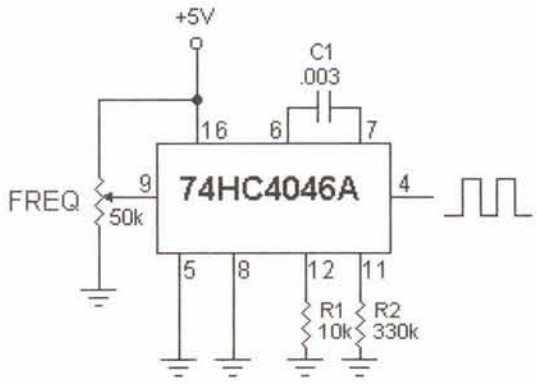
Personal Security
by Robert Haru Fisher
www.frommers.com/tips/health/health32.html

VCO

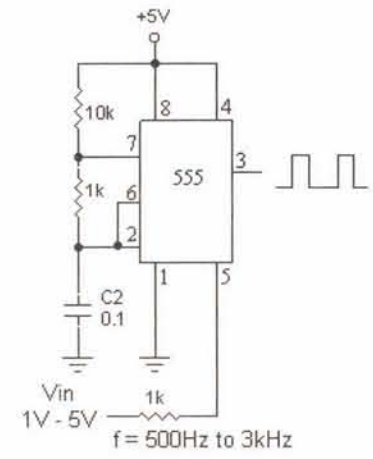
Q. I am trying to build a circuit that uses a VCO (voltage-controlled oscillator), in particular the LM566. However, this IC is classified as obsolete by Texas Instruments, and they don't have an alternate part. I have searched for similar VCOs from other manufacturers, but can't find a suitable replacement. What could I use?

Al W.
via Internet

A. I don't know your frequency requirements, the LM566 goes to 1 MHz, so I'll give you two options. For square and triangular waveforms — as well as sine — the ICL8038 will work as a VCO for frequencies up to 300 kHz (although I've heard of selected devices reaching 1 MHz). For frequencies up to 18 MHz, there is the 74HCT4046A, which consists of a VCO and a PLL (phase-locked loop); use only the VCO function, as shown below.



If you're looking for something really simple and can live with a pulse instead of a squarewave, this 555 circuit will function as a VCO.



Too Hot To Handle

Q. I'm having a problem with an electronic control module in a 1987 car. The problem is that module was mounted in the top center of the dash — upside-down. Over time, the potting material has leaked down through the heater controls into my car and ICOM dual-band radios. I would like to save the radios, but the several cleaning solutions I tried have no effect. Do you know how to dissolve or get this potting out of the radios without destroying them?

WA4YOG
via Internet

A. My guess is that heat from the car's heating fan melted the potting compound and caused it to ooze. Which means you should be able to remove it with heat. Do you know how to remove candle wax from a rug? It's done by placing a kitchen towel over the spill and placing a hot iron on the towel. The towel is more absorbent than the rug, hence the candle wax is transferred from the rug to the towel. You should be able to use the same method on your radios using a hair dryer with an absorbent material to sop up the molten potting compound. I suspect folded layers of cheesecloth (available at most markets in the baking section) would be your best mopping material. Of course, it will take several applications of heat to get it all up because the "rag" fills up quickly.

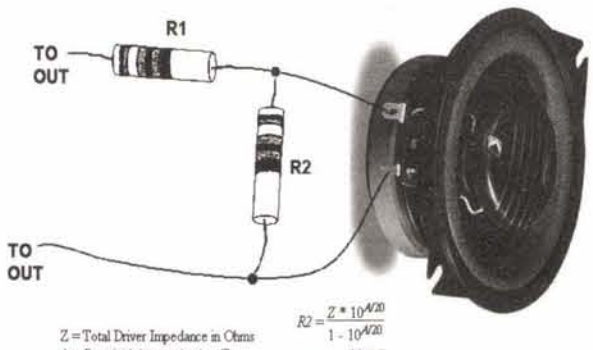
L-Pad Volume Leveler

Q. I have a Teac AG-V8520 receiver with an annoying problem. The problem is that the center speaker is more efficient than the other speakers and is so loud that it swamps out the sounds from the rest. The receiver has an adjustment for center channel

volume, but it is limited to ±10% and I need about -20% to balance things out. Would placing an eight-ohm resistor in series with the speaker leads cure the problem?

Grumpy, the Third Dwarf
(Dave Johnson)
via Internet

A. It would reduce the volume, but it would also change the impedance load on the amplifier's output. What I suggest is an L-pad (Loss Pad). While less efficient than a preamplifier volume control, an L-pad can be used to decrease the output level of a driver — like the center speaker output of your receiver — by inserting a resistance in the output line while maintaining a constant output impedance. An L-pad works just like a volume control at the speaker level, and is often used in a multiple driver system where the transducers don't have the same sensitivity. An L-pad is simply two resistors — one in series (R1) and one in parallel (R2) — placed between the output of the receiver and the speaker.



$$R2 = \frac{Z * 10^{A/20}}{1 - 10^{A/20}}$$

$$R1 = Z - \frac{R2 * Z}{R2 + Z}$$

Z = Total Driver Impedance in Ohms
A = Required Attenuation in -dB

As you can see, the math is rather involved, so for your convenience, I've calculated the values for up to 20 dB of attenuation. These values are calculated for an output of 100 watts, which is reflected in the listed wattage values of R1 and R2. For smaller amplifiers, the wattage can be adjusted downward proportionally.

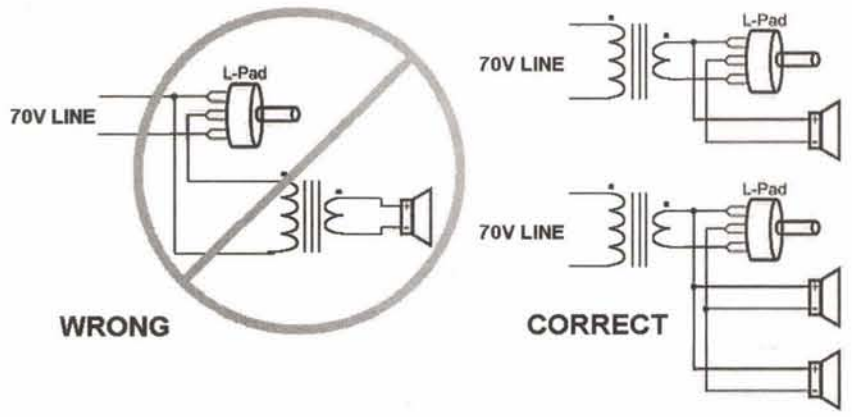
Insertion	4 ohms		8 ohms		Wattage	
Loss	R1	R2	R1	R2	R1	R2
1 dB	0.44	32.8	0.87	65.6	1.3W	100W
2 dB	0.82	15.5	1.65	30.9	5W	95W
3 dB	1.17	9.70	2.34	19.4	11W	89W
4 dB	1.48	6.84	2.95	13.7	18W	82W
5 dB	1.75	5.14	3.50	10.3	25W	75W
6 dB	2.00	4.02	3.99	8.04	33W	67W
7 dB	2.21	3.23	4.43	6.46	40W	60W
8 dB	2.41	2.65	4.82	5.29	48W	52W
9 dB	2.58	2.20	5.16	4.40	54W	46W
10 dB	2.74	1.85	5.47	3.70	60W	40W
11 dB	2.87	1.57	5.75	3.14	65W	35W
12 dB	3.00	1.34	5.99	2.68	70W	30W
13 dB	3.11	1.15	6.21	2.31	73W	27W
14 dB	3.20	1.00	6.40	1.99	76W	24W
15 dB	3.29	0.87	6.58	1.73	80W	21W
16 dB	3.37	0.75	6.73	1.51	82W	18W
17 dB	3.44	0.66	6.87	1.32	84W	16W
18 dB	3.50	0.58	6.99	1.15	86W	14W
19 dB	3.55	0.51	7.10	1.01	88W	13W
20 dB	3.60	0.44	7.20	0.89	89W	11W

L-Pad Location

Q. I am having a strange problem with a 70-volt speaker installation. The system includes three separate speakers runs. Two of the runs end with one speaker and one L-pad each. The last run has three separate speaker controlled by one L-pad. The problem is that if the amp is turned up past half-volume, it goes into the protect mode and shuts down. The amplifier can deliver 200 watts and each of the speakers are tapped at half or one watt. Any ideas as to why the system is shutting down?

Dan
via Internet

A. Yep, you have the L-pad on the wrong side of the 70-volt speaker transformer. The clue was when you mentioned three remote speakers controlled by one L-pad. No can do! Each speaker must have its own L-pad, as shown below.



If you wish to control multiple speakers with a single L-pad, either wire the speakers in series or in parallel, and treat them as a single speaker across the L-pad.

IC Temperature Specs Defined

Q. I've always been curious about the difference in IC temperature ratings. What is the difference between commercial and military temperature rating? Is there a way to tell what temp rating an IC is by its part number?

Jim Hamilton
via Internet

A. Actually, there are three popular temperature ranges used to grade ICs: commercial, industrial, and military. And yes, you can tell the temperature range by the part's number. In fact, it's the only way you can order them from the manufacturer — by package style and guaranteed temperature operating range. Let's start a chart and let me describe the entries as I expand on their meaning.

Temp. Range	Spec.	Examples					
		555	LS7404	AD7824	LM324	LT1111	LTC1503
0C – +70C	Commercial	LM/NE555	LS7404	AD7824K,L	LM324	LT1111C	LTC1503C
-40C – +85C	Industrial	SA555		AD7824B,C			LTC1503I
-40C – +105C	Industrial				LM224	LT1111I	
-55C – +125C	Military	ICM7555M	LS5404	AD7824T,V	LM124	LT1111M	LTC1503M

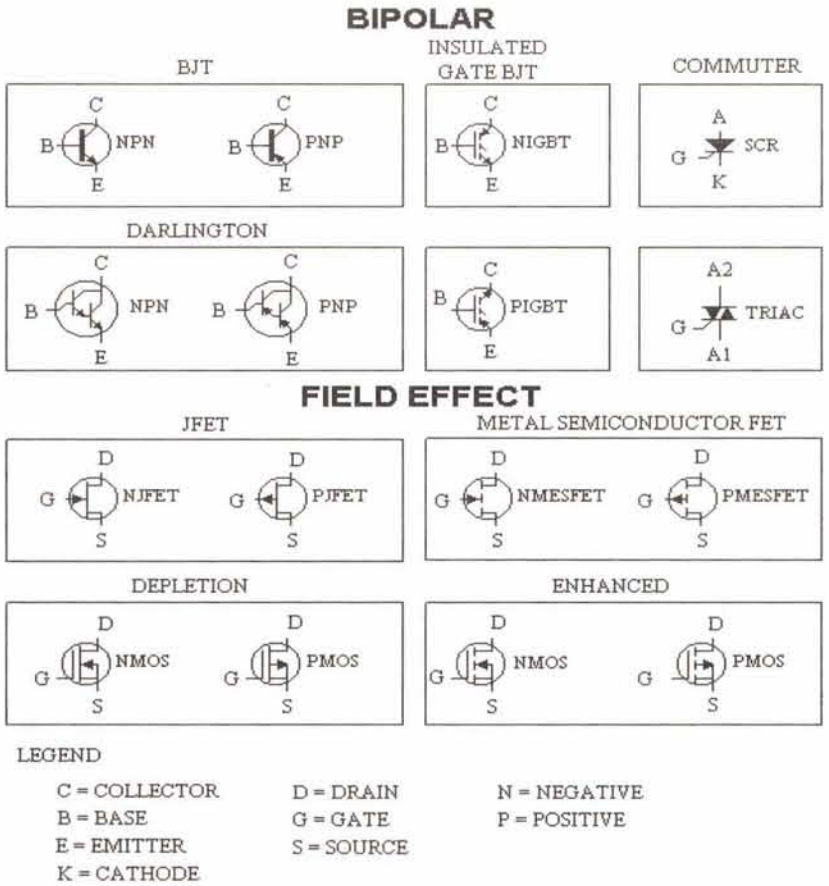
The commercial temp range is used indoors, typically in electronic appliances, like radios and TVs. They can operate over a temperature range from freezing (32°F) to steamy hot (158°F). Industrial comes in two strengths, both of which have a much lower operating temperature — all the way down to near Arctic conditions (-40°F). One upper range extends to 185°F, which is adequate for field test equipment and outside surveillance cameras; the other extreme extends to 221°F and is used for automotive applications where temperatures often exceed the boiling point of water. Military is, well military. These devices must withstand conditions which range from the peak of Mt. Everest to the slopes of Mt. Oyama.

Transistors, Too!

Q. Could you or someone on staff provide a physical picture of the multi-leaded devices that are sometimes shown in schematic form only? Specifically MOSFETs, transistors, and any other specific devices. Me and my colleagues see that the ICs are numbered, however, not all of us have resources for physical layouts that distinguish gates, drains, sources, etc. Maybe a separate page or a space could be dedicated to the devices depicted in the answer responses, it would be oh-so helpful!

J. M. Drawes
Ft. Wayne, IN

A. If it's transistor symbols you're looking for, here they are. All the component charts in the column, including the chart below, can be found on our web site (**www.nutsvolts.com**) under the name SYMBOLS.ZIP



LEGEND

C = COLLECTOR	D = DRAIN	N = NEGATIVE
B = BASE	G = GATE	P = POSITIVE
E = EMITTER	S = SOURCE	
K = CATHODE		

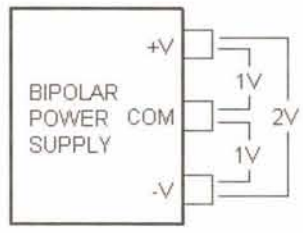
To find out more information on international symbol notation, check out Ray Marston's article "Electronic Circuit Symbols and Notation" at **www.nutsvolts.com/PDF_Files/circuit.pdf**.

Stack 'Em High

Q. In your Sept. 2001 reply to Ryan Weiss ("Newbie Needs Power") you said: 60 volts at 1.5 amps if you stack them. Stacking means what? Two identical circuits with the +V, -V, and COM outputs tied together?

Ken and Anne Schultis
via Internet

A. Yeah, that statement by itself was a bit unclear. When you stack two 1.5-volt batteries, one atop the other, their voltage is doubled, but the current remains the same. This is what happens in a flashlight. When you place one battery across another, the voltage remains the same, but the current is increased, as is what happens when you jumper a car battery. Stacking means you put the two power sources in series; tied together like you explain is placing them in parallel. So if you measure the voltage across the +V and -V outputs of a bipolar power supply, you get 2x volts.



Keep Your Kool

Q. Saw your "Newbie Needs Power" circuit on page 20 of the Sept. 2001 issue. Tell me what's going to happen to the LM317 or LM337 when Newbie sets the output voltage to 5 volts and then puts a 5-ohm resistor across the output, expecting one amp to flow through the resistor? Note that the regulator must drop at least 25 volts and will thus be dissipating at least 25 watts. The result? Phfffft!

Myron A. Calhoun
Visiting Professor of Computer Science, Graceland Univ.

A. The result? The LM's heatsink will generate as much heat as a 25-watt light bulb — which is easily removed with proper ventilation. Moreover, the LM series of voltage regulators are thermally protected. If the junction temperature reaches critical mass, the chip shuts down.

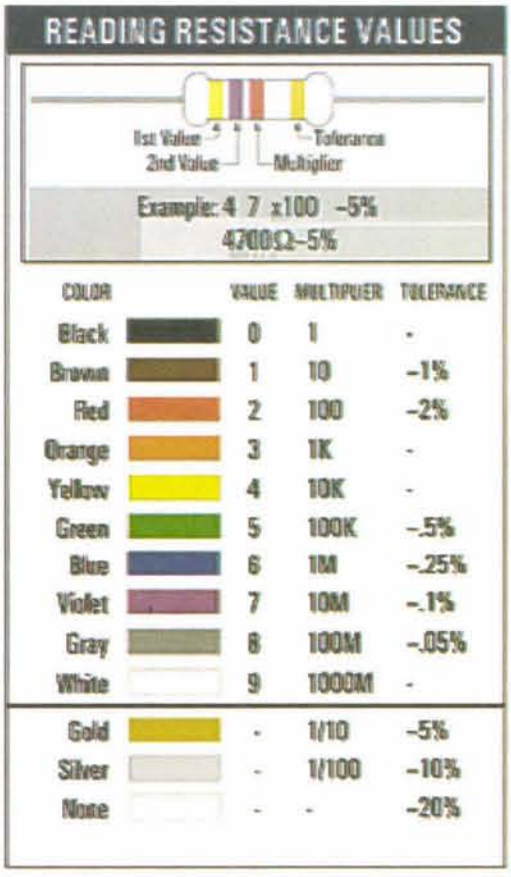
Capacitor And Resistor Codes Demystified

Q. Sorry to bother you again, but I have a second question. I've recently been building different circuits and some call for a .022uF or some such capacitor. I know these are the small ceramic ones, but how do you decode the numbers on these small caps to something meaningful? Does 102 mean 1000pF?

Jim Hamilton
via Internet

A. Yes. The last number represents the number of zero following the stamped value. For example, 102 means 10 pF followed by two zeros, or 1000pF — or .001uF. I know this is confusing, so here is a table that might make it clearer. Might be handy to copy this table and post it on your wall for reference. The chart is for 10x disc caps only. If the cap is labeled 121, it means 120 pF.

Capacitor Marking	pF	uF
10	10	.00001
101	100	.0001
102	1000	.001
103	10,000	.01
104	100,000	0.1



Now before you ask about resistors, here is that chart, complements of Parallax, the BASIC Stamp people.

If you wish to have a program figure out the color code for you, check out this cool web site: **www.dannyg.com/javascript/res/resload.htm**.

Editor's Tip

A while back two readers asked me where they could find LED substitutes for standard panel lamps, like the #47 or #327. At that time, sources for the LEDs were sketchy because not all incandescent lamps had a direct replacement. Since that answer, **LEDtronics (800-579-4875; www.netdisty.net/cross)** has established an on-line "Direct Incandescent to LED Replacement Guide" that lists hundreds of bulb-to-LED substitutions. Most come in 16 different colors ranging from blue to white to red to IR, and some very interesting colors in between. Although prices hover around $8.00 to $20.00, they outlive their replacements by 100 to 1. Also check out **Data Display Products (800-421-6815; www.ddp-leds.com/crossref.htm)**.

TJ Byers
Q & A Editor

MAILBAG

Dear TJ:

In the Sept. 2001 issue, which has just arrived, I read your reply to Phil Combs about converting composite video to S-Video. Coincidentally, I happened to receive a catalog from **Parts Express (800-338-0531; www.partsexpress.com)** with just such a device:

180-140 — RCA to S-video
180-141 — S-Video to RCA

Check these devices at **www.partsexpress.com/pe/pshowdetl.cfm?&PartNumber=180-141&Did=7**

Larry Monroe
via Internet

Dear Mr. Byers:

In the Sept. 2001 issue, Mr. Phil Combs wrote about converting his NTSC composite signal from his VCR to a S Video signal for input to his receiver. I was curious that you didn't mention that SVHS machines commonly have S-Video inputs and outputs. Purchasing an SVHS VCR, while perhaps not as much fun as building an adapter, should offer superior results. In addition, back-to-back SVHS VCRs offer superior editing and duplication of video tapes, since the chroma and luminance signals are recorded as separate signals on the tape.

John Pesuit
via Internet

Dear TJ:

When recently I read the question from "Mickey D" (Jul. 2001, "Dear, Deer ... Outa Here) I just had to say "been there, done that." Mickey the electric fence is a good idea to keep the deer out if you do it correctly. You can buy an inexpensive 110VAC fence charger at various farm supply stores. You will also need to buy insulators, a spool of fence wire, and a bundle of steel fence posts. The whole kit-and-caboodle cost me around $100.00 to surround my 170' x 85' garden.

Just place the charger inside the house or barn and run #14 stranded wire out to the fence. I placed a bottom wire about 6"-8" above the ground to keep out the wood chucks and raccoons (worked really well) and the top wire as high as possible to keep the deer out of my watermelon patch (yes, deer love to take a bite). The fence needs to be close enough to discourage a running jump over, but far enough back they can't sample — about 4'-5' high worked for me.

Jim Sheldon
via Internet

I was building the logic probe in "Getting Started on a Shoestring" (Sept.

Continued on page 78

The "Flying Cloud" Radio Restoration Project

by Ray T. Gilbert K7VQF

Boeing Model 307 "Flying Cloud" at Boeing Field prior to First Flight on July 11, 2001. If you look close, and use your imagination, you can see the long wire antenna stretching from the mast above the cockpit to near the tip of the tail. Also visible is the Loop Antenna enclosure. The restored plane looks now as it did back in 1940.

Background

The Pan American Airways (PAA) "Flying Cloud" was one of nine production, pressurized, four-engined airliners produced by the Boeing airplane company. The Model 307 was the world's first pressurized airliner. It is the last survivor of the nine Model 307 passenger planes.

It was delivered to PAA on March 20, 1940. It flew into Seattle's Boeing Field on a ferry flight from Arizona, June 29, 1994, and was towed into the Boeing Plant 2 factory building where it was produced half a century before.

PAA purchased three of the airliners. The Flying Cloud was the first to be delivered to PAA and is now the last survivor. Licensed as NC19903, the plane was initially used for crew training and proving flights to Mexico City and Panama. The plane served the Pan Am's South American routes.

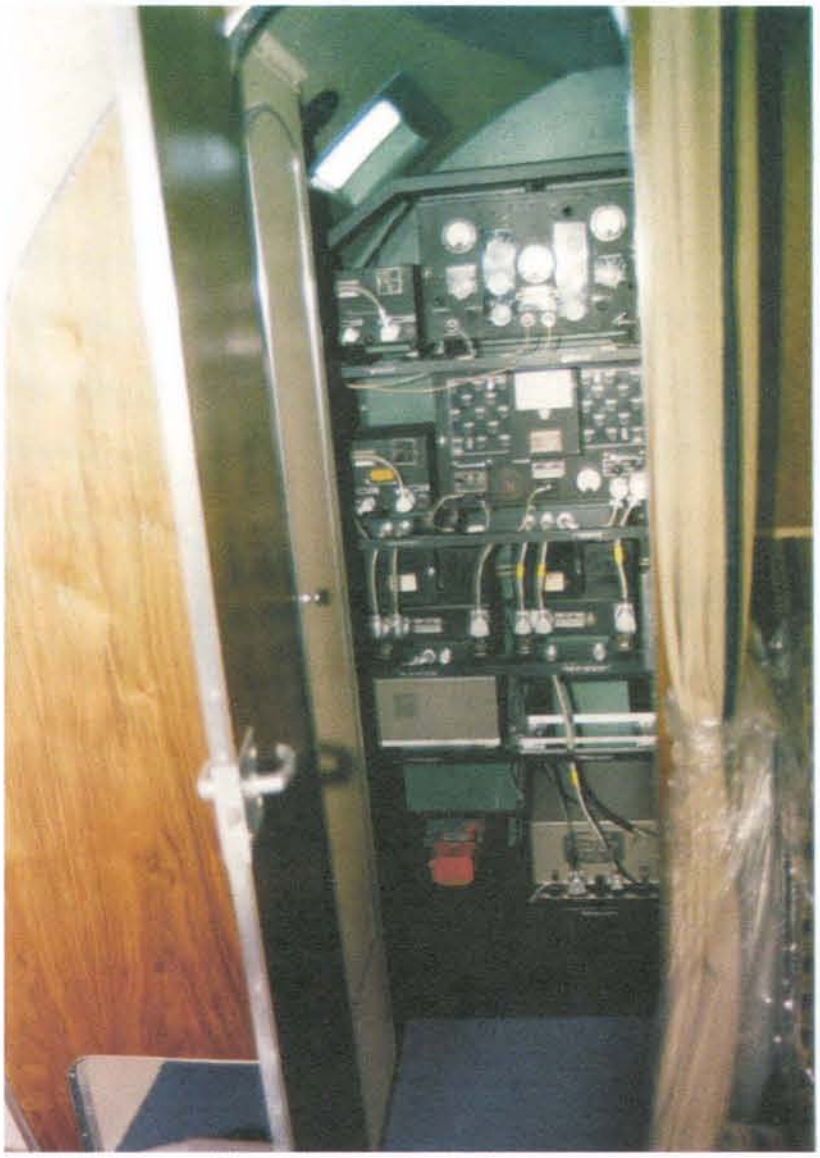
It was sold to Continental Airlines Charters in 1948, went through several other airlines, and ended up alledgedly as Papa Doc's (dictator of Haiti) personal aircraft. At the very least, it was in the Haitian military service for a while, and served with Arkansas Air Freight in 1965.

Now it was back for complete restoration for the National Air and Space Museum's Steven F. Udvar-Hazy Center at Dulles. The plane, when refurbished with Pan Am markings, will be licensed as an airliner and, until it is turned over to the National Air and Space Museum in 2003, will be operated by Boeing. When the plane is placed in the museum in 2003, it will probably never be flown again.

The restoration work is shared by Boeing retiree volunteers, airplane and radio enthusiasts, and by Boeing employees. This story is not about the structural and interior rework, but what a few radio amateurs decided to do to acquire and restore the plane's antique communications equipment from 1939-1942 to working condition.

Prior to the ferry flight up from Arizona where the plane had been located, a group of volunteers had begun a restoration effort and one of the men — Ralph Conly N6VT, retired Radio Officer who operated from this plane — had been stockpiling the radio equipment and had collected enough for the complete installation. Much of this equipment was supplied through the courtesy of Frank Stacy W4ZTH, ex-CEO of Aerocom Corporation in Miami, which was the follow-up company from PAMSCO, a Pan Am subsidiary. (More on PAMSCO later.) Robert Stubbs, PAA Flight Engineer (retired), from this early plane restoration group, agreed to bring the gear up to Boeing's Seattle Plant 2 in his RV. So now we had something to work with.

Our ham group was overseen by Nate Andrews and Mark Kempton of the Boeing Flight Test Group. They were in charge of the complete restoration. The radio restoration tasks were split between four radio amateurs. The receiving equipment would be rebuilt by Craig Stewart K7SKP, transmitting equipment restoration by Chuck Driskell W7ZIR, mechanical restoration such as radio racks, radio equipment cabinets, etc., to be designed by Bill Wright KB7BMF, and Ray Gilbert K7VQF. Technical support by almost daily email contacts with Ralph Conly N6VT kept us focused on how the Pan Am radio equipment was configured, name plate lettering, etc. The wiring of the electrical systems of our old equipment to the plane's system would be shared between our small group and the Boeing experts.



The radio rack is mounted aft of the Radio Officer's desk on the left side of the dividing bulkhead. Top shelf shows the 75AX2 transmitter (not utilized) and the smaller cabinet to the left is the CDF-P power supply for one of the CDF-R receivers on the Radio Officer's desk. Second shelf contains the 75AX24 transmitter set up for use on the ham bands. Beside it is the power supply for the second receiver mounted on the shelf above the Radio Officer's desk. Third shelf contains the AM-100 power supplies for the two transmitters. Fourth shelf contains the Bendix MN-26C radio compass receiver with cabling running to the control head between the pilot and copilot.

Flight Radio Officer's position — Left side of fuselage, behind the Captain. View shows the two rebuilt CDF-R receivers, the two control boxes designed from old photographs and completely wired for use, and the vintage key mounted on the desk awaiting use on the ham bands. Above, you can see the graduated wheel control for the manual direction finding loop. On the bulkhead to the left are two control boxes containing meters for monitoring the aircraft electrical power. The cylinder shaped object on the bulkhead is the radio operator's lamp.

The Boeing archives provided microfilm of many of the old S-307 drawings. However, back in those early days, engineering drawings were made on vellum with pencil lead lines and lettering that by now had practically disappeared. Reconstruction of drawings by looking at photographs and guessing on almost invisible lines on prints from these microfilm drawings took a considerable amount of our time at the beginning of the project.

In The Beginning

It was decided between the four of us and agreed to by Boeing company reps that our rebuilt transmitting and receiving equipment would be placed on the 40 and 80 meter amateur radio bands. The long wire running from the antenna mast just above the cockpit to the vertical tail would provide a great ham antenna. An airborne ham shack was the incentive driving this group! Modern communications equipment to be installed by Boeing would be utilized to run the plane's vital communications while in flight.

We found out that when the plane was delivered to Pan Am in 1940, they had removed all the radio equipment that Boeing had installed for the delivery flight and replaced it with new equipment designed and built by PAMSCO. This made things rather difficult for us as very little information was available on the radio gear and the PAMSCO company was long departed from this world. However, the PAMSCO equipment was more modern than the Boeing installation and had voice capability, as well as key operation. The lack of drawings and schematics made this project a real challenge. The replacement radio equipment rack installed by Pan Am had to be designed using old photographs of the plane's innards as supplied by retired flight engineer Bob Stubbs and radio officer Ralph Conly. Luckily, drawings for the radio operator's desk and shelf were found in the Boeing archives and the desk and shelf were fabricated and installed by Boeing.

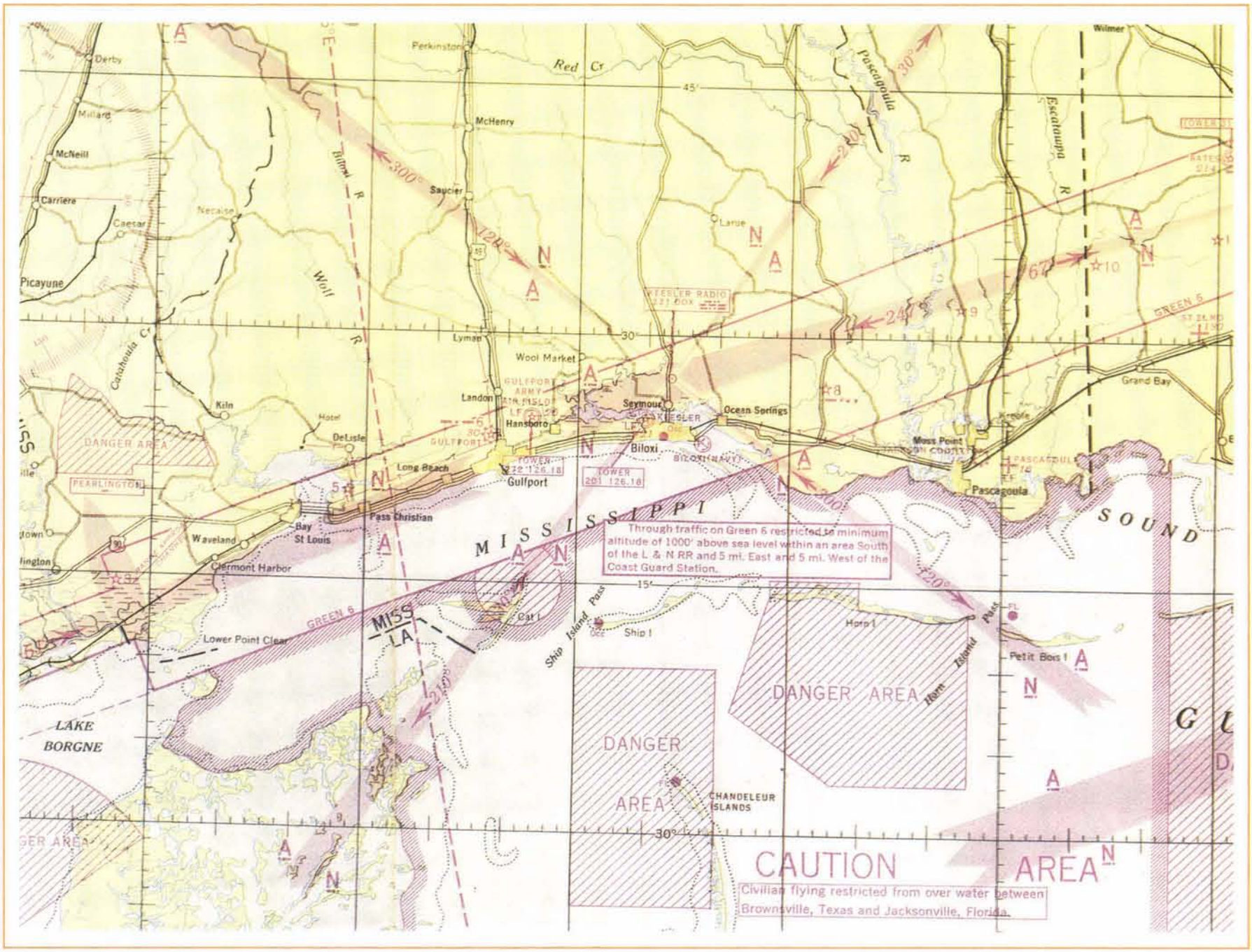
Receiver Fun

Craig K7SKP soon found that he had lots to look forward to in the restoration of the receivers. Inoperative 24-volt vibrators in the power supplies had petrified sponge rubber innards and the vibrators had to be rebuilt. Some wafer switches had broken contacts way within the receiver where access was miniscule! But soon the two PAMSCO CDF-R receivers and CDF-P power supplies were operating like new and were installed in the Radio Officer's compartment. The two CDF-R receiver units are shown in the photograph of the Radio Officer's location. The two CDF-P power units can be seen in the photograph of the radio rack. They are located on the two topmost shelves, on the left side, beside the large transmitters.

Transmitter Problems

Chuck W7ZIR had an even more difficult task. No data was available on the PAMSCO 75AX24 transmitter nor was there information regarding the AM-100 power supply. Ralph N6VT supplied data on similar models used by Pan Am which gave some help. Chuck soon found that the two 4D22 tubes were unusable and a frantic search was on for replacements. Two of these very hard-to-find tubes were found and purchased. Boeing fabricated phenolic rings to replace broken coil insulators and Chuck did the installation.

The innards of this transmitter show that construction of electronic gear has changed considerably in the last 60 years! Before firing up the set, Chuck had to go through the transmitter and draw up the schematic. The frequency changing



This is a partial Sectional Aeronautical Chart from back in 1945. It shows how the radio range beacons were oriented and how the frequencies of these ranges were shown on charts. Also shown is how the pilot could identify a beacon by the Morse code identification shown on the chart and also transmitted on the beacon.

Cockpit view showing the control head for the Bendix Radio Range receiver mounted in the console between the pilot and copilot's seats. Headphone jacks are mounted to the right of the control head. The receiver covers 150-1500 Kcs, so it is usable for the broadcast band for the pilot's convenience.The round object near the headphone jacks is a lamp to illuminate the airplane trim controls below.

circuitry was very weird. Finally, while bench testing the transmitter, Chuck W7ZIR was able to contact Ralph N6VT in Sunnyvale, CA. There was great hope for the final installation in the plane.

The Radio Range Receiver and Its Operation

We found a Bendix MN-26C radio compass receiver at Fair Radio Sales. It was a dead ringer for the unit shown in the radio equipment rack in one of the old Pan Am radio photos. Then we thought, if we have a radio range receiver, we surely should receive the old radio range "A" and "N" signals.

For those of you not familiar with the range signals, the aeronautical charts of long ago showed lines of radio signals on noted compass headings radiating out from the range stations located at or close to the major airports. The chart also showed the frequency alotted to each range line and the call letters of the airport sta-

tion which were sent in Morse code. So when you tuned your receiver to the correct frequency and you heard a steady tone in your earphones, it meant you were right on the beam, flying directly toward your destination. If you heard an "A," you were turning left, away from your destination. If you heard "N," you were turning right away from the straight and narrow.

A pilot would not go straight down the center of the beam, but would stay to the right of the steady tone. Those pilots flying in the opposite direction on the same beam would be off to their right, thus avoiding collisions. There were also conventions regarding altitude – odd/even 1,000 feet for certain directions and also odd/even 500-foot separations. A photograph of a portion of a typical aeronautical chart from back in those days shows the range signals, directions, call signs, and frequencies transmitted.

So, back to our original Radio Officer, Ralph Conly. He remembered the Miami identification of "MM" on 365 kc and Havana as "SA" on 382 kc. About that time, reading *Nuts & Volts*, I thought of writing to TJ Byers and asking if he could come up with a schematic for a device that would transmit the range signals of "A" or "N" and also identify either "MM" or "SA," and all of this to be transmitted in a few milliwatts on the correct frequencies. Tuning the old Bendix to the correct frequency would provide the range signals, a sound the old flyer visitors to the plane would enjoy hearing once again.

TJ Byers became interested in the project and not only came up with the schematic, but made the complete unit ready to install near the receiver. The unit was to be crystal-controlled on the two transmitting frequencies noted above. The control head for this radio range receiver is installed in the console between the pilot and copilot. It can be seen in the photograph of the cockpit.

The Bendix main receiver cabinet is in the lower shelf of the radio rack and is connected to the control head by a mechanical tuning cable and electrical cable. None of this peripheral equipment was in very good condition, and time-consuming restoration had to be made. These cables are installed under the flooring and go from the unit on the bottom shelf of the radio rack forward to the console shown in the cockpit photo.

Direction Finding Equipment

The Direction Finding (DF) loop used on this plane back in 1940 was hand-operated with a wheel graduated in degrees above the Radio Officer's head. (See the photograph of the Radio Op's position.) The shaft of the wheel went directly up through the fuselage into the loop assembly. This loop assembly, mounted above the cockpit, had the streamlined, black football-shaped enclosure of later motor operated loops, but there the resemblance ended.

We started with the Pan Am photographs and designed the control wheel, the shafting and, then using the housing from a later motor driven loop, redesigned the loop's insides back to direct the shaft drive. We kept the Boeing machinists busy building these parts! Of course, this wasn't the end on this particular part of the project. The loop base on the original Boeing manual loop of 1939-40 vintage was smaller than our newer loop. This meant that the body fairing where the loop attached to the fuselage had to be enlarged to accommodate the larger footprint of the more modern loop base.

A redesign of the fairing, design, and fabrication of die tooling to press out the new fairing and installation onto the fuselage completed this task. The Boeing crew did a great job and the installation looked like the old photographs. The unit now operates as it did back in 1940.

Utilizing the Equipment

The exciting results of this restoration are now being realized. The flight from Seattle to the airshow in Oshkosh, WI this last July was an exciting event. The plane was awarded the Antique Judge's Choice Trophy and the Warbird's Classic Transport Award. During further long flights scheduled in 2002 and shorter flights in the Pacific Northwest this fall and winter, our Radio Officer's station will be manned and in operation on the following amateur bands and frequencies:

75-80 meters: 3.670 MHz CW, 3.680 MHz CW, 3.875 MHz AM voice, 3.885 MHz AM voice

40 meters: 7.040 MHz CW, 7.050 MHz CW, 7.060 MHz CW, 7.285 MHz AM voice, 7.290 MmHz AM voice

Notification of flight dates, hours of flights, and possible showings of the "Flying Cloud" will be posted on the ARRL web page as soon as the dates are determined. QSL cards for inflight and airfield QSO's are now available.

Hopefully, many of you will be able to contact the plane in flight or on the ramp and also view this beautifully restored airplane in the years to come. In 2003, you will be able to visit the plane in the National Air and Space Museum at Dulles. **NV**

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Robotic House Servant

by Thomas Bock

For the past 20 years, I have been tinkering with robots. I've built all types of robots, from manipulator arms with six degrees of freedom to six-foot tall bipedal walking robots. When most people saw my robot projects, the most frequent comment I received was "yes, that's nice, but can it do anything useful?" I cringed every time I heard that comment, but I have to admit, the majority of my projects didn't really do anything that might be considered useful.

Like most hobby robots, my projects moved around, flashed lights, and made cute little sounds, but were not capable of doing the dishes or vacuuming the carpet. Recently, I decided to design and build a useful robot. The result, seen in Photo 1, was given the name ROM (Re-programmable Objective Mechanism). ROM is, without a doubt, the most useful and user-friendly robot I have ever built.

Photo 1: ROM the Robotic House Servant.

All-Purpose Robot

ROM was designed to be an all-purpose house servant. It was designed to perform reasonable tasks like vacuuming the floors, wiping dust off the counter tops, watering the plants, serving drinks, and greeting guests at the front door. It was given a humanoid appearance in order to make it more enjoyable for people to interface with.

Without going into too much detail about the entire mechanism, here is the basic idea behind the robot's intended functionality. ROM has a mobile base equipped with sensors that allow it to navigate around the house from point A to point B, and so on. ROM has two arms, each with a gripper for object manipulation. Once ROM arrives at its destination, it can perform some useful tasks using its arms and mobile base.

ROM can be programmed and trained by the user to perform certain tasks on its own. The tasks are made up of individual instructions and commands chosen by the user. The user can store each task in one of four separate memory buffers. The stored tasks can be edited or re-played right away or after a programmable timer triggers them.

Robot Mechanism

The robot body was built around a wheeled mobile base (Photo 2) made from plywood, caster wheels, and two lawn mower wheels, each independently driven by a large 12 VDC worm-gear motor. The mobile base can rotate left or right about its center, as well as move forward or in reverse. A photo-reflective incremental shaft encoder is used on one of the wheels for measuring distance traveled. Two bump switches were mounted on the front of the robot for collision detection and an electronic compass is used to keep the robot's trajectory straight when it moves forward.

The body was made from half-inch thick foam-core board held together with double-sided mounting tape. There is no easier way of rapidly prototyping a robot frame than this. Foam-core board is great stuff to work with. Structurally, it's fairly strong and lightweight and it's easy to cut, using only an X-ACTO knife. A special chrome paper was attached to the robot's exterior to give it a metallic appearance. The foam-core board and the chrome paper can be found in

Photo 2: ROM's mobile base uncovered.

Photo 3: ROM serving a can of pop to his maker.

most large arts and crafts stores.

The robot has two arms. Each arm has four degrees of freedom. Its head is also automated and was equipped with an IR Detector module and a speaker to allow the robot to emit a pre-recorded message. High-torque RC servos are used to actuate the arms and head (Photo 3). A Polaroid sonar sensor was mounted on the front of the robot for collision avoidance. The robot stands six feet tall and can reach any table or counter top with its arms.

Main Control Circuitry

ROM's control circuitry is centered on the BASIC Stamp 2 SX microcomputer (Photo 4). The BS2SX is a souped-up version of the BASIC Stamp 2. It runs at 50MHz and has eight times the amount of programming space that the BS2 has. The BS2SX was ideal for this project mainly because of the extended amount of programming space available, as well as the ease of use. A second BS2SX is used in a separate, handheld, programming box. The programming box allows the user to select modes of operation and download instructions serially to the robot's main microcomputer (Photo 5).

The Solutions Cubed RAMPack B module and Pocket Watch B module, and Scott Edwards Electronics Serial LCD Display module and Mini SSC II Serial Servo Controller module, were also incorporated into this project to enhance the BS2SX's capabilities. Although this article describes a particular application, the principles outlined in this article can be applied to any type of robot you may wish to build.

Control Circuit Configuration

In this application, a RAMPack B module was connected to the BS2SX using a one-wire interface, which served as a signal line from the master (BS2SX) to the slave (RAMPack B) and from the slave back to the master (Figure 1). The RAMPack B module comes with an 8Kx8 SRAM IC, however, in this application the volatile SRAM IC was replaced with a 32Kx8 non-volatile RAM IC so that any program stored in the memory would remain there when power was turned off.

A Pocket Watch B module was connected to the Stamp using a two-wire interface configuration. One line was used for transmission to and from the Pocket Watch module and the other line was used for the ALARM signal. This module was used to activate stored programs after a delayed period programmed by the user. The Pocket Watch B module can be programmed to activate its alarm in increments of seconds, minutes, hours, days, months, or even years.

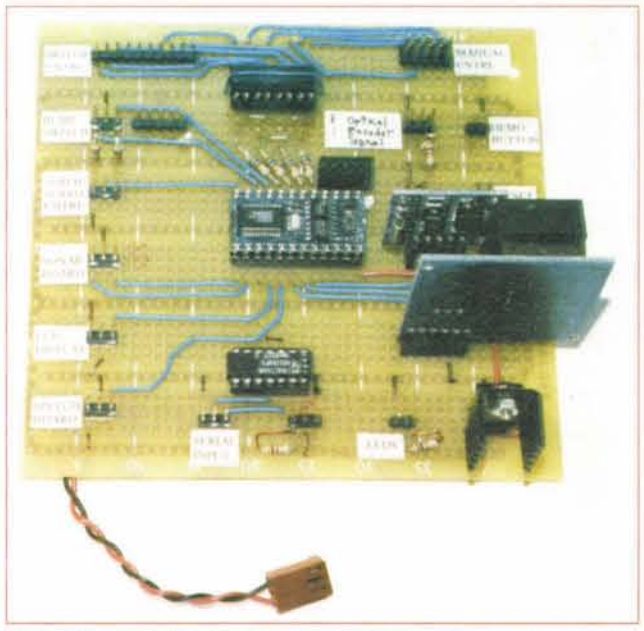


Photo 4: ROM's main control circuit board.

Two SSC II Serial Servo Controllers were added to allow the BS2SX to control up to 12 R/C servos. Both SSC II Servo Controllers only required one signal line to the BS2SX and a ground line. In this application, one of the SSCII boards was configured to access servos addressed from 0 to 7 and, with the placement of a jumper on the other SSCII boards "identification" header pins, access servos addressed from 8 to 15.

A Serial LCD Display module is used on the robot to allow the user to view activity in the microcomputer. Another Serial LCD Display module is used in the programming box to allow the user to view menus and select available programming options.

Several other devices were also incorporated into ROM. These include a Polaroid 6500 Sonar ranging module, a Sharp GP1U52X IR Detector module, a RadioShack VM-1110A Voice Record/Playback module, a home-made, photo-reflective incremental encoder, a Precision Navigation, Inc., Vector-2XG Electronic Compass module, and a Black & Decker Cordless Hand-Vac, as well as various micro-switches and LEDs.

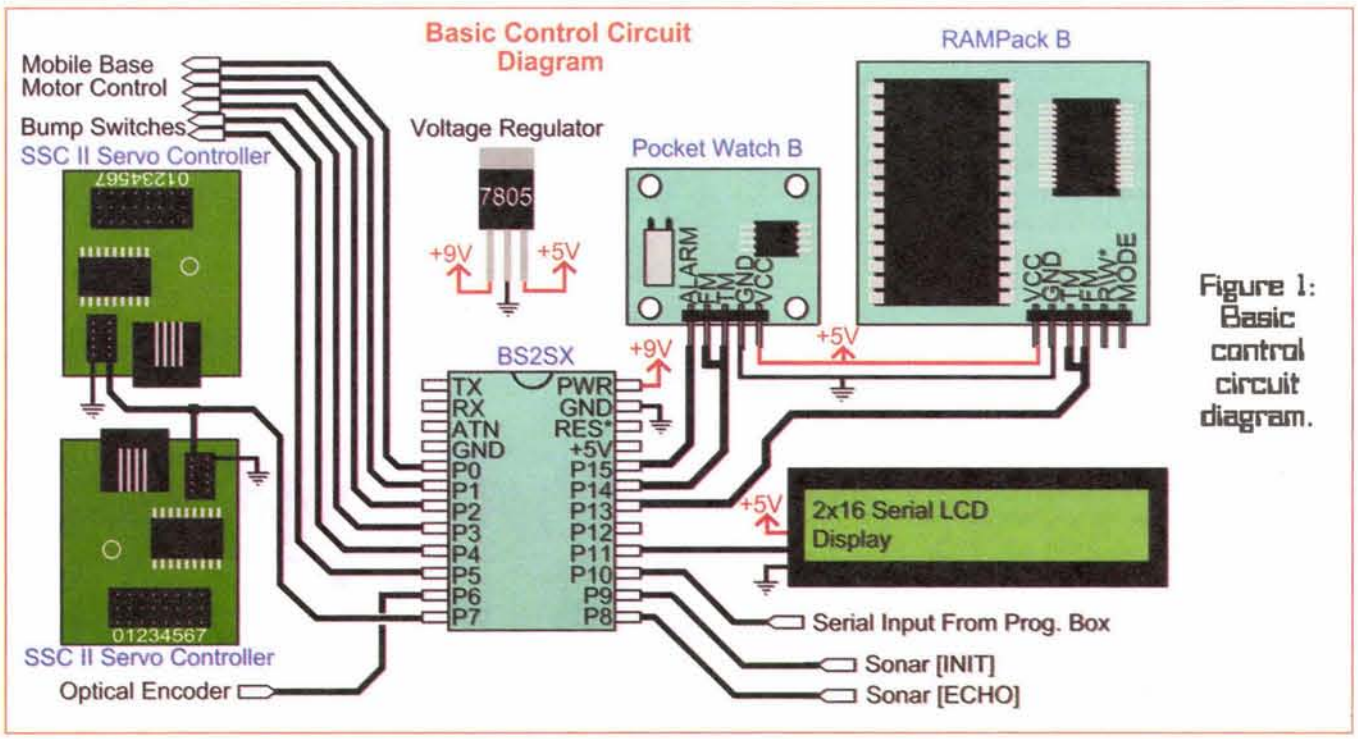


Figure 1: Basic control circuit diagram.

How it All Works

Here's how it all works. Like an employee starting at a new job, the robot is trained to perform a desired task. Since there are many steps to learn in a given task, the robot must be guided through each step by the user. The advantage of programming a robot this way is that it reduces the amount of intelligence required by a robot to carry out a task. Instead of letting the robot figure out for itself how to perform a task, the user just shows the robot how to do it right away. When the user is finished training the robot how to perform a task, ROM can be commanded to carry out the task stored in its memory.

The BS2SX in the robot stores the instructions sequentially in the RAMPack B memory module in one of four buffers. The tasks, stored by the user, can be replayed, sequentially, as they were stored. When the last instruction in the task has been executed, the robot returns to idle mode and waits for the next command.

The user interfaces the handheld programming box to the robot using a serial cable and selects options from menus viewable in the programming box's LCD display. The user can select from a list of options in the programming box using a six-pin keypad. Four keys — labeled 1 through 4 — select menu options and two keys — labeled with up and down arrows — allow the user to either scroll through stored programs or increment/decrement timer settings. For example, if the user wishes to program the robot to perform

Photo 5: The serial programming box used to store and play back instructions in ROM.

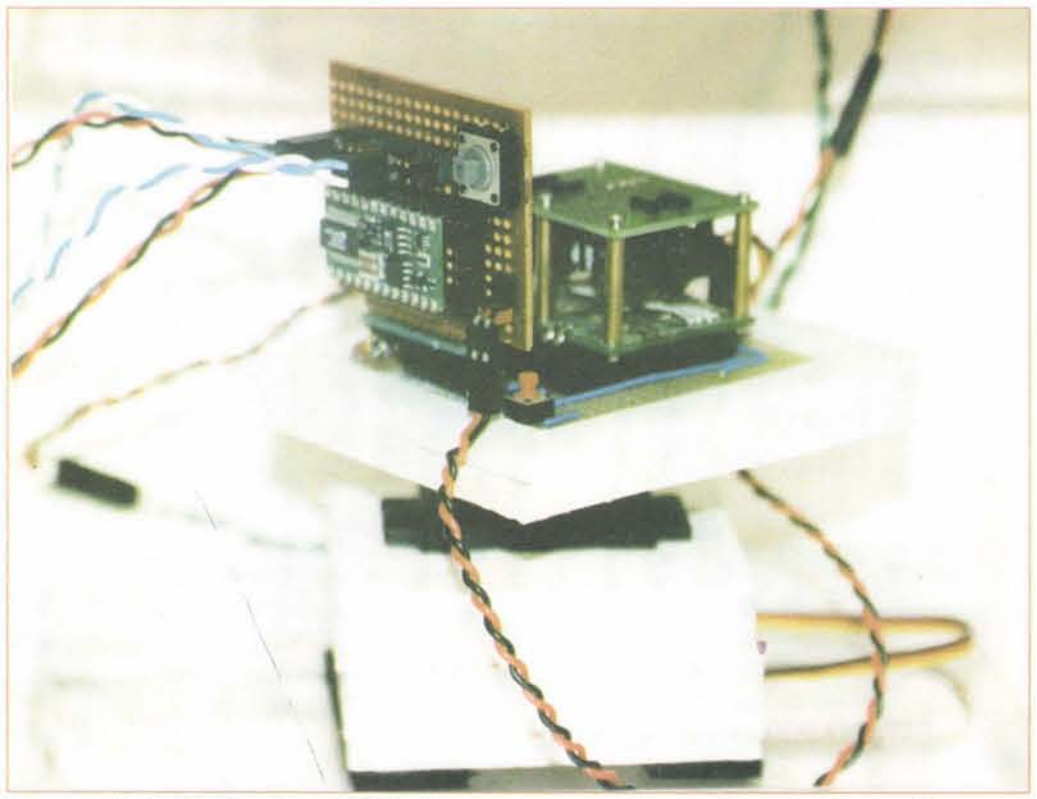


Photo 6: Vector 2XG electronic compass and control circuit.

some useful task, he would select the 'Program/Train" option.

Next, one of four memory buffers would be selected to store the following program. After a memory buffer is selected, different instructions can be chosen from the menu and transmitted to the robot to train it to perform the task. The robot performs each instruction as it is being stored in memory, so the user can see how well the instruction is being implemented. Examples of some of the instructions used are listed below:

Drive Forward
Drive Backwards
Turn Left
Turn Right
Pause
Loop
Speak
Lift Right Arm
Lift Left Arm
Rotate Right Arm Wrist
Rotate Left Arm Wrist
Search for IR Beacon A
Search for IR Beacon B

After a program has been stored in the robot's memory, the user can re-play the task by selecting the "Run" option in the programming box. If the user wants to delay running the robots programmed task, he can select the "Timer/Alarm" option from the programming box. This mode allows the user to set the time a selected program is to activate. The user can also set the number of times the robot can be activated to perform the selected task. The task can be activated once after a pre-defined delay, or the task can be activated over and over again after a certain delay. For example, the robot could be programmed to water the plants every nine hours without ever having to be re-activated by the user.

There are also options in the programming box available to activate each individual actuation and sensor and view and edit any tasks previously stored by the user. Manual switches were also built into the robot to position the mobile base where desired.

A BASIC Stamp II microcomputer is used to monitor the Vector 2XG Electronic Compass in the robot (Photo 6). The BS2 waits for the main controller to activate the "Drive Forward" signal. When this signal is activated, the robot will start to move forward. The BS2 starts reading the heading data from the compass module and compares several consecutive readings with the initial reading taken. If there is a significant difference between the latest heading data and the initial heading read, then relays — controlled by the BS2 — momentarily de-activate either the left or right drive motor depending on which direction the robot is veering off.

Several infrared beacons are used to help the robot navigate through the house (Photo 7). Each IR beacon was configured for a different output frequency. A 40kHz-carrier signal is modulated with frequency between 100 Hz and 1000 Hz. This is the recommended detectable frequency range for the Sharp GP1U52X IR Detector module used in the robot. The beacons have a detection range of about 15 feet. One beacon is placed in every room to allow the robot to know where it is.

A sonar sensor was added to the robot to allow it to detect the presence of a moving object or detect the distance between the robot and an obstacle. If ROM was trained to greet guests at the front door for example, it would use the sonar sensor to detect motion. When motion was detected, the robot would speak and raise one of its hands. If ROM was trained to dust a counter top, it would use the sonar sensor to help it determine the correct distance from the surface to be dusted.

Final Thoughts

There are many different approaches to getting a robot to do something useful. It all depends on how complex you wish your design to be. I attempted to solve this problem in the simplest way possible. By training the robot to perform a useful task, I can get it to repeat the task in a fast and efficient way. If you are a Stamp enthusiast, you may find this particular application very useful and entertaining. If you are interested in more information on the construction and programming of ROM, you can contact me at xi_yiao@att.net. **NV**

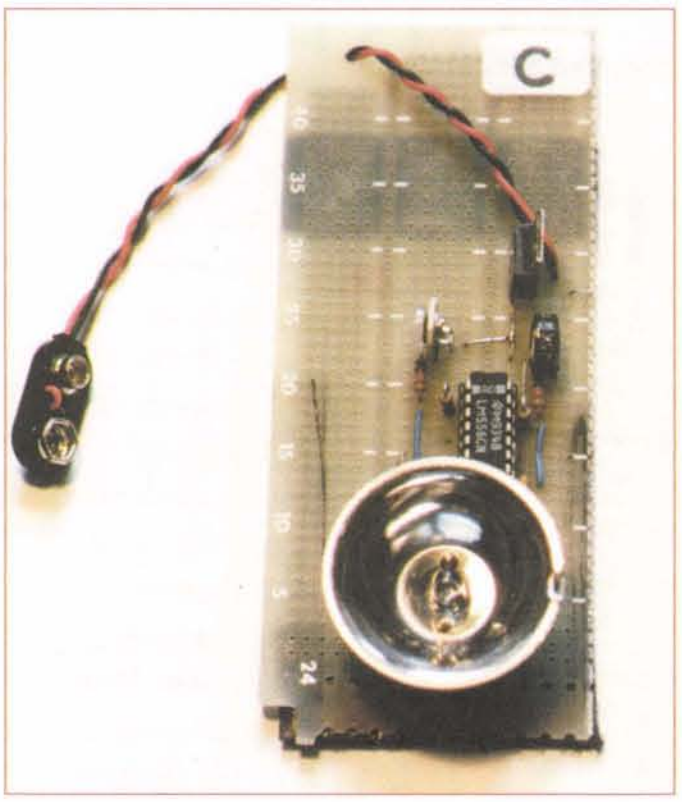
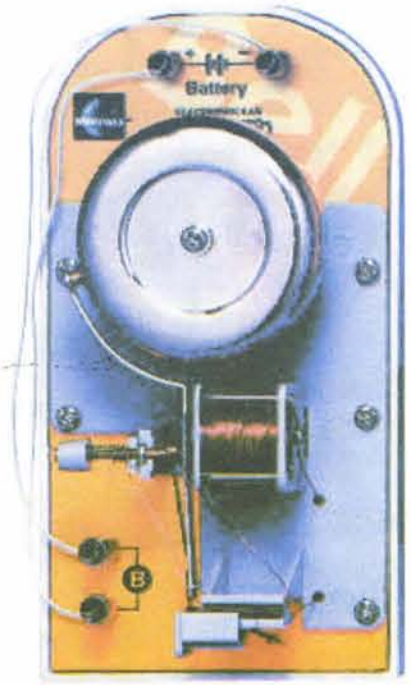


Photo 7: IR beacon circuit with reflector.

Parts List for ROM

Item	Where to get it
BASIC Stamp 2-SX	Jameco Electronics (www.jameco.com)
BASIC Stamp 2	"
RAMPack B Module	"
Pocket Watch B Module	"
2x16 Serial Backpack LCD Module	"
SSCII Servo Controller Module	"
Polaroid 6500 Ranging Module	Acroname, Inc. (www.acroname.com)
Sharp GP1U52X IR Detector	RadioShack (1-800-THE-SHACK)
Vector 2XG Electronic Compass	Jameco Electronics
Hitec Mega HS-805BB Servos	ServoCity (www.ServoCity.com)
Misc. Electronic Items	Jameco or RadioShack

BATTERY PROJECT



BELL PROJECT

GENERATOR PROJECT

MOTOR PROJECT

Building the Action Kit Lab

Four "solderless" projects — a battery/meter/key switch, a bell, a motor, and a generator — can be a fun parent-child introduction to basic electricity. Based on principles used to generate electricity and operate machinery in the real world, building these four toy kits can be the first steps to a child becoming fascinated and involved with electricity and electronics.

This article will briefly describe and comment on each of the four projects so you can decide if this kit is something you want and, if so, to help you in the process of building each project.

by Fred Blechman

It seems like 100 years ago, but it was only 64 years ago, that as I was approaching 10 years old, I discovered batteries, bells, buzzers, lights, and tiny motors.

I scrounged around for wire and parts to build little projects from magazine articles, or bought simple kits of parts. Then I added switches and lights to make alarm systems to keep my room safe from invaders. This led to a lifelong fascination with electronics — as well as writing hundreds of magazine articles and six books about electronics.

Unfortunately today, electronics has become so sophisticated with transistors, integrated circuits, and tiny surface-mounted components, that it is difficult for a beginner to get basic knowledge of some real-world devices — like bells, motors, generators, and analog meters.

But there is hope! The under $20.00 "Action Kit Lab" allows kids 10 and up — without soldering — to build four separate projects: a bell, a motor, a generator, and a battery/meter/key switch — and to learn how each one works.

The Good News and the Bad News

The good news is that all four of these projects work and provide educational value. The nicely-illustrated "Owner's Manual" provides step-by-step instructions for building each project, with simple descriptions of how each one works. This can start a child off on a future in electronics.

The bad news is that once built, each project is too limited to be of any practical value beyond the principles learned. They are toys to play with and perhaps modify. The manual shows you how to interconnect them in seven "experiments."

Buy or Pass?

If you have a child that has any kind of curiousity about electricity, the Action Kit Lab would be a good parent-child set of simple projects, each taking from one to two hours to build. With the "Helpful Hints" I provide in this article, you will have little or no trouble building the projects. However, without the Helpful Hints you may run into some difficulties.

Don't expect these projects to do anything really useful. They are intended to teach, not to perform. The Generator will not power your home during a blackout. The Motor will not run your pool pump. The Bell won't be heard for any distance. And the Meter will only read over a very limited voltage or current range.

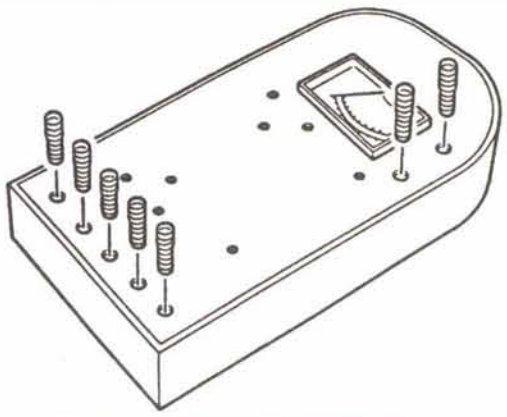


Figure 1 — Spring terminals are pushed into the panel small end first.

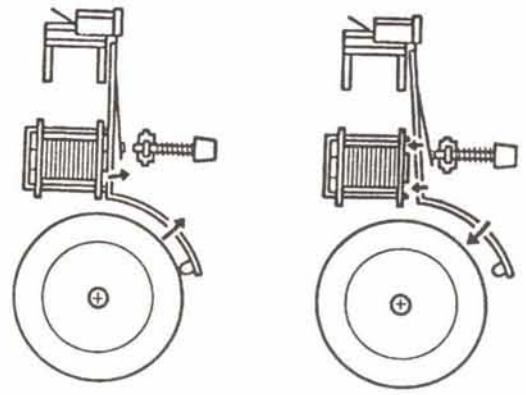


Figure 2 — Adjusting the bell to ring properly.

Helpful Hints

Assuming you decide to build these projects, I have a few observations about each of them. I won't attempt to repeat the Owner's Manual instructions, but simply to add things that were not included and that will help you build the projects.

Each project has its own "hints." Some are minor additions to the kit instructions, others are intended to clarify instructions. Some are intended to help you if something isn't working properly. This is called "troubleshooting," and often more is learned from fixing something that isn't working.

Some general comments apply to all the projects. They all use the same type of open-bottom plastic frame, but each has a specially printed and hole-punched cardboard panel. All parts — even grease, sandpaper, or double-sided tape — are provided where required. All you need for assembly is a small Phillips-head screwdriver and small pliers.

Instead of solder connections, spring terminals are used. These are shown in the manual illustrations (see Figure 1), but their installation and usage are not described. These tightly-wound stainless-steel springs have a smaller diameter at one end, and this is the end to be inserted into the holes in the cardboard panels of each project. This is a very tight fit and takes some effort to install. The springs should be pushed into the holes to about half their length, so roughly half fits above and below the panel.

In use, you simply bend the spring, thus opening up gaps for you to insert the ends of wires. When the spring is released, the coils clamp the wire for a good connection. Simple, quick, and effective for this kind of project.

The Meter/Battery/Key Switch

This simple project uses a battery box that holds two AA batteries arranged so you can use either 1.5 volts or 3 volts. A small analog (needle-type) meter is included, replacing lights used in a previous design. A push-to-close switch is also included.

Other than getting the spring terminals installed, there is no problem with assembling this project. Each of the three items — the batteries, the meter, and the switch — are independent of each other, and are accessed through separate sets of spring terminals.

The meter (which has a series resistor installed, not shown in the manual illustrations) has a scale marked from 0 to 10. A full-scale reading is only .65 volts when used as a voltmeter, or 250 microamps (.25 milliamps) when used as an ammeter.

The three spring terminals connected to the two-cell battery box allow you to connect either 1.5 or 3 volts to any external circuit. *Do not* try to read the battery voltages on the meter; they will pin and possibly destroy the meter!

When installing the two AA batteries in the holder, observe the polarity markings inside the holder. Both batteries should *not* face in the same direction (an error I made!).

The Bell

There are three things — not mentioned in the manual — that may cause you problems in assembling the bell project: cleaning enamel from the ends of the wires, winding the wire around the spool, and setting the adjusting screw and forming the hammer for a proper ring.

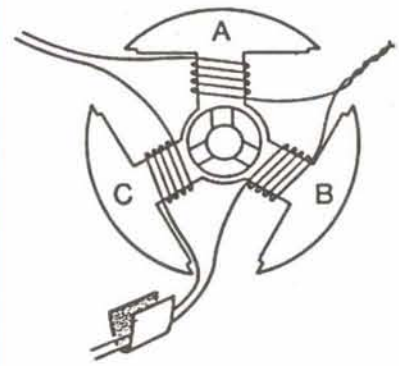


Figure 3 — Joining the three rotor coils in series.

The enamel-insulated wire used is provided in a coil. Sandpaper is provided to scrape the enamel coating off the ends of the coil. This is clumsy at best. I found it much easier to lay each wire end on a flat surface and use a razor blade to scrape off about an inch of the coating. You'll need to turn the wire as you scrape to remove the coating all around the wire end.

When unwinding this coil to wrap around the metal spool, it easily tangles. To prevent this, put two or three fingers through the center of the wire coil to control it as you unwind it around the spool.

In two places, wire ends are wrapped around bare metal lugs. For each of these, make sure the

Source

The Action Kit Lab, Model MX-902, is made in Taiwan by Maxitronix, but is distributed exclusively by Elenco Products. It can be ordered by mail directly from Elenco's sales arm, C&S Sales, 150 W. Carpenter Ave., Wheeling, IL 60090. The regular price is $24.95, but mention *Nuts & Volts* for the special price of $19.95 plus $5.00 shipping. Illinois residents add 8.25% sales tax on the $19.95. The order telephone number is 1-800-292-7711.

Circle #93 on the Reader Service Card.

wire coating is removed and the wire is wrapped tightly around each lug to insure good contact, since no solder is used.

Once the project was assembled, getting the bell to actually ring was a challenge. A hammer-contact subassembly has to be bent by trial and error (see Figure 2) so that when sufficient voltage is applied to the spring contacts, and the hand-adjusted screw is properly positioned, the hammer strikes the bell. It took two fresh AA batteries to sound the bell I built, and it worked much better with higher battery voltage from a DC power supply.

The Motor

While the bell project was somewhat challenging, the motor project was the most difficult to build and operate. For one thing, you must wind three coils around a stack of three-pole rotor metal laminations, and then connect the scraped ends of the wire in the proper sequence.

Getting the shaft through the two plastic end pieces for the rotor stack was a hard press fit, with no indication in the instructions as to where along the shaft the rotor should be positioned. The end of "plastic coil A" should be placed 3/8ths of an inch from one end of the shaft.

Use the fingers-inside-the-coil method when winding the three coils around the three rotor poles or the wires will get hopelessly tangled. There are about 80 turns per pole. Then, after scrapping the six wire ends, you need to carefully determine the beginning and end of each coil, and join them in series as shown in Figure 3.

After winding all three coils, I had trouble identifying the six wire ends. I should have labeled them as I wound each of the three sections. Instead — too late now — I used a continuity meter or common ohmmeter to identify the two leads for each coil, and then was easily able to determine the outer lead of each and join the three coils properly.

Three brass strips are installed on the shaft to be used as "commutators," contacted by brass "brushes" that wipe against the commutators as the shaft turns. The manual shows the brushes, but does not indicate which face of each concave-shaped brush should be placed against the commutators. The outer side of each brush should be used, so each makes a single point of contact as the shaft turns. You will probably have to bend the brushes slightly toward the shaft to assure contact with the commutator strips.

In five places (three at the shaft, two at the brushes), wire ends are wrapped around bare metal lugs. As with the bell, for each of these connections, make sure the wire enamel coating is removed and the wire is wrapped tightly around each lug to insure good contact, since no solder is used.

The completed motor is not self-starting, so after applying battery power, twist the shaft with your fingers to get it started. If you twist it in the wrong direction, you'll feel resistance.

It takes about 350 milliamperes of current at 1.5 volts to operate, so you'll need fresh batteries or an external DC power supply. Reverse the battery polarity and the motor runs in the opposite direction.

The Generator

This project rapidly turns the shaft of a small DC motor, using two small gears and one large gear, to generate electricity. However, the manual leaves out the fact that there is a hole in the shaft used with the large gear. This hole, when used with the provided nut and setscrew, places the gear in the proper critical position on the shaft.

The gear box is made from clear plastic and is brittle and can crack, unlike the gray opaque plastic used elsewhere. When I attempted to mount the gear assembly to the base — as shown in Figure 4 — the mounting holes in the case were not large enough for the screws supplied, and in try-

ing to bottom the screws, one of the mounting holes broke away! I was more cautious with the other three screws ...

The Experiments

Experiment 1 uses the batteries from the Meter/Battery/Key Switch to ring the Bell. Using wire supplied with the kit as shown in Figure 5, and using fresh batteries, the Bell rings faintly if the hammer-contact subassembly and adjusting screw are properly installed and set.

Experiment 2 operates the Motor from the batteries. Again, fresh batteries were required, together with a finger twist of the shaft to get the rotor to start turning.

Experiment 3 simply reverses the Motor direction by reversing the battery leads.

Experiment 4 is to show how colors look when they are mixed. A round paper disk divided equally into red, blue, and green areas is mounted in a round plate which is then pressed onto a plastic piece at the free end of the motor shaft. When the motor is turning fast, the colors are supposed to blend. Looked like a whitish blur to me.

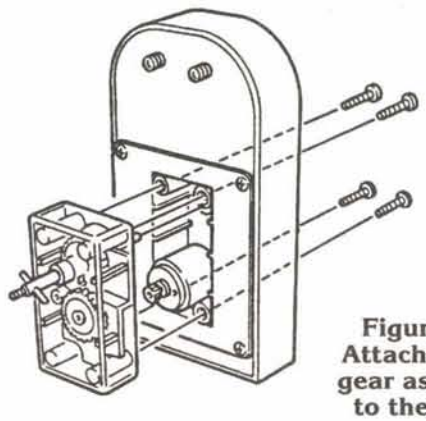


Figure 4 — Attaching the gear assembly to the base.

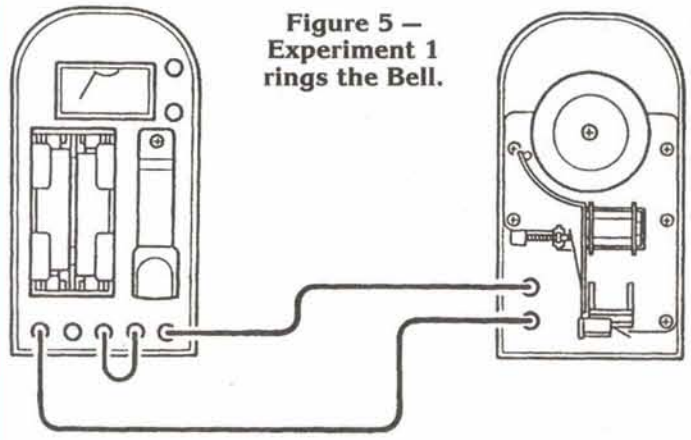


Figure 5 — Experiment 1 rings the Bell.

When each of the colors is covered with white paper, as instructed in the manual, I saw no changes — and I am not color blind. Bad experiment. By the way, a fan is also supplied, obviously for use with the Motor, but it is not mentioned in this or any other experiment.

Experiment 5 has you connecting the Generator to the Meter, observing the plus and minus markings on the panel springs. When you turn the Generator handle clockwise, its output easily goes to full scale on the Meter needle.

Experiments 6 and 7 did not work for me. They were supposed to have the Generator operate the Bell and Motor, respectively. The Generator output voltage and current are far too low to do either.

Summary

As learning tools and toys, the four Action Kit Lab projects can be useful and create interest in a budding inquisitive mind. All necessary parts are provided, and with the Helpful Hints in this article, assembly and testing should be trouble-free. **NV**

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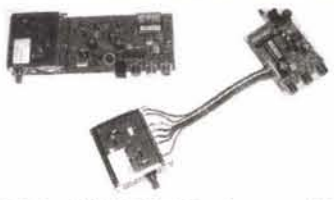

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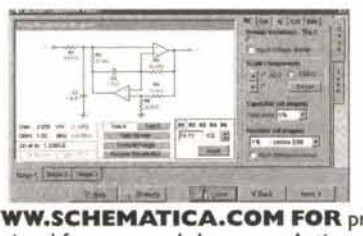

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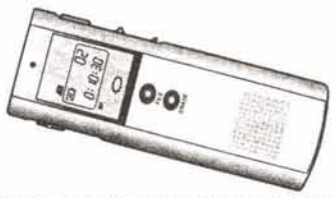

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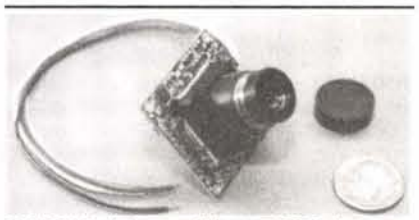

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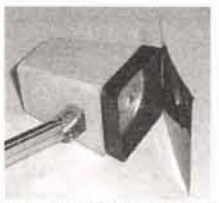

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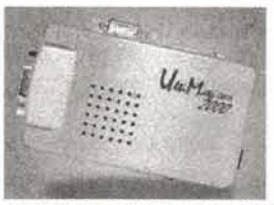

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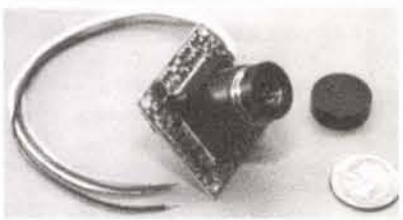

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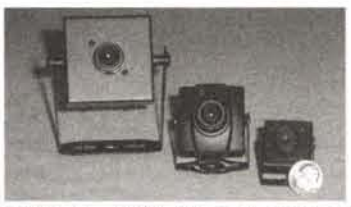

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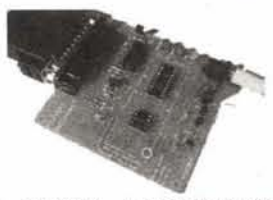

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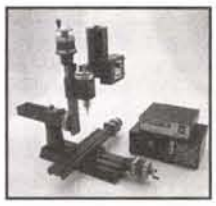

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A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos. Photos may be emailed to classad@nutsvolts.com.

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You may email or fax in ad copy or changes before the closing date (5:00pm on the **5th**) using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Email ad(s) to classad@nutsvolts.com or fax to 909-371-3052. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL, EMAIL, OR FAX BACK VERIFICATION OR QUOTES OF EMAILED AND FAXED-IN ADS.** For verification of emailed or faxed-in ads, please call 909-371-8497.

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Prepaid ads received by 5:00pm on the **closing date (5th of the month)** will appear in the following month's issue. Ads postmarked through the **5th**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 5th. Cancellations and changes must be submitted in writing.

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Events

CALENDAR

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

NOVEMBER 2001

November 2-3

TX - ODESSA - Hamfest. West Texas ARC, Craig Martindale W5BU, 915-366-4521. Email: w5bu@arrl.net

November 3

FL - UMATILLA - Hamfest. Umatilla High School Annex, 60 Smith St. VE exams. Talkin: 147.255+. Lake ARA, John Gabele W8KCE, 352-394-2723. Email: w8kce@aol.com Web: http://www.qsl.net/k4fc
OK - ENID - Hamfest. Garfield County Fairgrounds, Hoover Bldg. 8am-5pm. VE testing. Talkin: 145.29 -600, 444.400+ 5.0. Enid Hamfest Group, Tom Worth N5LWT, 580-233-8473 or Fred Selfridge WA5OU, 580-242-3551. Email: enidhamfest@yahoo.com
WA - BLAINE - Hamfest. Mount Baker ARC, Al Norton K7IEY, 360-354-4622. Email: k7iey@netscape.net Web: http://www.qsl.net/k7skw

November 3-4

GA - LAWRENCEVILLE - State Convention. Gwinnett County Fairgrounds. Alford Memorial RC, Randy Bassett KR4NQ, 770-663-4244 xt 3989. Email: KR4NQ@bigfoot.com Web: www.totr.radio.org

November 4

IA - DAVENPORT - Hamfest. Davenport RAC, Dave Mayfield W9WRL, 309-762-6010. Email: hamfest@gwltd.com Web: http://www.w9wrl.com/hamfest
MI - ST. JOSEPH/BENTON HARBOR - Hamfest. Blossomland ARA, Duane Durflinger KX8D, 616-982-0404. Email: comdac@comdac.com Web: www.comdac.com/bara
WI - APPLETON/MENASHA - Hamfest. Fox Cities ARC, John Ensley N9RJZ, 920-733-3113. Email: n9rjz@arrl.net Web: http://www.w9zl.ampr.org

November 10

AL - MONTGOMERY - Hamfest. AL State Fairgrounds, Garrett Coliseum, Federal Dr. 9am-3pm. CAVEC testing. Talkin: 146.84 W4AP. Montgomery ARC, Dennis Rumbley KS4UO, 334-409-9971. Email: ks4uo@arrl.net Web: http://jschool.troyst.edu/~w4ap/
FL - PORT ST. LUCIE - Hamfest. Port St. Lucie ARA, John Cruz KT4VI, 561-465-9533. Email: brothercruz@cs.com
OH - GARFIELD HEIGHTS - Hamfest. Laura Lonczak, 216-663-3258. Email: 1n4js@visn.net
OH - GEORGETOWN - Hamfest. Grant ARC, Dot Silman KB8TQU, 937-446-2234. Email: Huggee@Bright.net
SC - MYRTLE BEACH - Hamfest. Grand Strand ARC, Gordon Mooneyhan KE4HXL, 843-448-9379. Email: beachfest2001@hotmail.com Web: http://www.w4gs.org
TX - AZLE - Hamfest. Tri-County ARC, Jim Aiello N5QU, 817-444-9465. Email: drjaiello@aol.com Web: http://www.qsl.net/tcarc-ntx

November 11

IL - CHICAGO - Auction. DeVry Institute of Technology, 3300 N. Campbell. Chicago ARC, Inc., Melissa Meneely KB9QWZ, 773-384-7514 or Dean NB9Z, 708-331-7764. Email: carc_inc@hotmail.com Web: http://www.chicagoarc.com

November 16-17

MS - OCEAN SPRINGS - Hamfest. West Jackson County ARC, Ernie Orman W5OXA, 228-392-2816. Email: w5oxa@arrl.net Web: http://www.datasync.com/~w5oxa

November 17

LA - MONROE - Hamfest. Twin City Hams ARC, Scott Dickson W5WZ, 318-644-2215. Email: w5wz@arrl.net Web: http://www.tchams.org/users/hamfest/
MA - NEWTONVILLE - Auction. Waltham ARA, Eliot Mayer W1MJ, 617-484-1089. Email: w1mj@arrl.net Web: http://www.wara64.org/auction
NH - LONDONDERRY - Hamfest. The Lions Club Hall, Mammoth Rd. VE session. Talkin: 146.850- PL 85.4. Interstate Repeater Society, Paul Gifford K1NL, 603-883-3308. Email: k1nl@juno.com

November 17-18

IN - FORT WAYNE - State Convention. Allen County War Memorial Coliseum Expo Center, 4000 Parnell Ave. Sat: 9am-4pm, Sun: 9am-3pm. Talkin: 146.88-. ACARTS, James Boyer KB9IH, 219-489-6700. Email: jboyer@ail.com Web: http://www.acarts.com

November 18

NC - BENSON - Hamfest. Johnston ARS, Bill Lambert AK4H, 919-894-3352 or 919-894-3100 (7-10 pm). Email: blambert1@mindspring.com Web: http://www.jars.net

November 24

FL - OCALA - Hamfest. Booster Stadium, NE 36th Ave. 8am-2pm. Marion County, 352-236-0744 voice. Email: jtcomm@atlantic.net
FL - OKEECHOBEE - Hamfest. Okeechobee ARC, Josh Osterman KF4JHI, 863-634-9862. Email: kf4jhi@flweather.com Web: http://www.flweather.com/oarc/
IN - EVANSVILLE - Hamfest. Vanderburgh Co. 4-H Center Fairgrounds Auditorium. 8am-2pm. EARS, Neil Rapp WB9VPG, 812-479-5741. Email: ears@w9ear.org Web: http://w9ear.org.hamfest.htm

November 25

IL - WHEATON - Radio Fest & Flea Market. DuPage County Fairgrounds. Fire & Radio Traders Society of Northern IL., 630-826-7981. Email: alf3148@megsinet.net

DECEMBER 2001

December 1

AZ - MESA - Hamfest. Superstition ARC, Ed Cole KB7RMO, 520-468-9015. Email: colej@cybertrails.com
LA - MINDEN - Hamfest. Minden ARA, Jimmy White KB5SUE, 318-377-2501. Email: kb5sue@microgear.net Web: http:www.bayou.com/~k5dlh/fest.html

December 1-2

FL - PALMETTO (TAMPA) - Hamfest. Manatee County Convention and Civic Center, One Haben Blvd. at US 301. Sat: 8am-5pm, Sun: 9am-2pm. VEC exams. Talkin: 145.430- and 442.950+. The Florida Gulf Coast ARC, Fred Hendershot N3BUL, 813-671-9556. Email: fgcarc@fgcarc.org Web: http://www.fgcarc.org

December 2

MI - HARRISON TOWNSHIP - Hamfest. L'Anse Creuse ARC, Gregg Crump KC8PXJ, 810-463-0729. Email: grcrump@home.com Web: www.ameritech.net/users/lc_arc/index.html

December 9

IN - GREENFIELD - Hamfest. Greenfield Central High School Pavilion, 810 N. Broadway St. 8am-2pm. VE testing. Talkin: 145.330-. Hancock ARC, email: kb9vzl@excite.com Web: www.w9atg.org

JANUARY 2002

January 5

WI - WAUKESHA - Hamfest. West Allis RAC, Phil Gural W9NAW, 414-425-3649. Email: janphil@execpc.com

January 11-12

FL - FT. MYERS - Hamfest. Shady Oaks Community Center, 3280 Marion St. Fri: 1pm-9pm, Sat: 9am-3pm. Ft. Myers ARC, Earl Spencer K4FQU, 941-332-1503. Email: k4fqu@juno.com

January 13

IN - SOUTH BEND - Hamfest. Michiana Valley Hamfest Assn., Bob Denniston KA9WNR, 219-291-0252 (7-11pm EST).

January 19

MO - ST. JOSEPH - Hamfest. MO Valley ARC & Ray-Clay ARC, Carlene Makawski KA0IKS, 816-279-3406. Email: nem3238@ultra.ccp.com

January 20

MI - HAZEL PARK - Hamfest. Hazel Park ARC, Jeff Albrecht N8WR, 248-642-3608. Email: n8wr@arrl.net Web: http://www.qsl.net/w8hp
NY - NORTH BABYLON - Convention. Great South Bay ARC, Diane Ortiz K2DO, 631-286-7562. Email: k2do@aol.com Web: http://www.arrlhudson.org/nli

January 27

OH - DOVER - Hamfest. OH National Guard Armory, 2800 N. Wooster Ave. 8am-1pm. Talkin: 146.730-. Tusco ARC, Gary Green KB8WFN, 740-922-4454. Email: kb8wfn@tusco.net

FEBRUARY 2002

February 1-2

MS - JACKSON - State Convention. Jackson ARC, Ron Brown AB5WF, 601-956-1448. Email: ab5wf@arrl.net Web:

COMPUTER SHOWS

AGI Shows, 317-299-8827
E-Mail: info@agishows.com
http://www.agishows.com

Blue Star Productions
612-788-1901
http://www.supercomputersale.com

Computers And You, 734-283-1754
www.a1-supercomputersales.com

Computer Central Shows
630-782-4625 Fax 630-834-2594
E-Mail: cc@gats.com
www.computercentralshows.com

Computer Country Expo
847-662-0811 Web: www.ccxpo.com

Five Star Productions
810-379-3333 E-Mail: jeff@fivestar
www.fivestarshows.com

Gibraltar Trade Center, Inc.
734-287-2000 Taylor, MI.
E-Mail: taylor@gibraltartrade.com
www.gibraltartrade.com

Gibraltar Trade Center, Inc.
810-465-6440 Mt. Clemens, MI.
E-Mail: mtclemens@gibraltartrade.com
www.gibraltartrade.com

KGP Productions
1-800-631-0062, 732-297-2526
E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229
http://www.marketpro.com

MarketPro, Inc., 301-984-0880
E-Mail: md@marketpro.com
http://marketpro.com

ComputerShow
770-663-0983
E-Mail: narisaam@aol.com
Web: http://www.shownsale.com

Northern Computer Shows
978-744-8440
E-Mail: inquiries@ncshows.com
Web: ncshows.com

Peter Trapp Computer Shows
603-272-5008
Web: www.petertrapp.com

Events CALENDAR

http://www.jxnarc.org

February 2

SC - NORTH CHARLESTON - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. Email: brycemyers@aol.com Web: www.qsl.net/wa4usn/index.html

February 2-3

FL - MIAMI - Tropical Hamboree. Dade Radio Club of Miami, Evelyn Gauzens W4WYR, 305-642-4139. Email: w4wyr@arrl.org

February 8-9-10

FL - ORLANDO - Convention. Orlando ARC, Harold Prosser KK1B, 321-235-7513 (days) or 407-365-2444 (eves). Email: hal@mpinet.net Web: http://www.oarc.org/hamcat.html

February 9

MN - ST. CLOUD - Hamfest. St. Cloud ARC, L. Scott Hall KA0DAQ, 320-252-4498. Email: lscotth@aol.com Web: http://www.w0sv.org

February 10

OH - MANSFIELD - Hamfest. InterCity ARC & MASER, Scott Yonally N8SY, 419-522-9893. Email: n8sy@arrl.net Web: http://www.maser.org

February 23

NY - HORSEHEADS - Hamfest. The National Guard Armory. 8am-3pm. Talkin: 146.700-, 444.20. ARAST, Randy 607-738-6857. Email: n2syt@arast.org Web: http://www.arast.org

February 24

FL - ZEPHRYHILLS - Hamfest. Zephyrhills Area ARC, Ron Russell N8VFE, 813-782-1602. Email: ron301@aol.com

NC - ELKIN - Hamfest. Briarpatch & Foothills ARCs, Pat Hill AE4HK, 540-236-6747. Email: Craig Patton @ kg4fla@hotmail.com

NY - HICKSVILLE - Hamfest. Long Island Mobile ARC, Ed Muro K2EPM, 516-520-9311. Email: hamfest@limarc.org Web: http://www.limarc.org

NY - WILLIAMSVILLE - Hamfest. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667. Email: luke@towncountryflorist.com Web: http://gbhamfest.hamgate.net

MARCH 2002

March 2

FL - NEW PORT RICHEY - Hamfest. Gulf Coast ARC, Rick Brown AG4JN, 727-934-8741. Email: ag4jn@arrl.net Web: http://www.gulfcoastarc.org/

March 3

NY - LINDENHURST - Hamfest. GSBARC & SCRC, Walter Wenzel KA2RGI, 631-957-0218. Email: info@gsbarc.org Web: http://www.gsbarc.org

March 9

AR - HARRISON - Hamfest. North AR ARS, Bill Rose N5VKF, 870-741-7074. Email: billrose@cswnet.com Web: http://www.qsl.net/naars/hamfest/index.html

March 16

NJ - CLINTON - Hamfest. North Hunterdon Regional High School, Rt. 31. VE testing. Talkin: 147.375. Cherryville Repeater Assocation II, 908-788-4080. Web: www.qsl.net/w2cra

March 17

OH - MAUMEE - Hamfest. Toledo Mobile Radio Assn., Paul Hanslik N8XDB, 419-385-5056. Email: kb8iup@arrl.net Web: http://tmrahamradio.org

March 23

FL - PLANTATION - Cy Harris W4MAQ Memorial Free Flea. Robin Terrill N4HHP, 954-583-3625. Email: kg4chw@arrl.net http://www.geocities.com/bcepn/freeflea.html

March 30

TX - BRENHAM - Hamfest. Brenham ARC, Dan Lakenmacher N5UNU, 979-836-8739. Email: briang@comwerx.net Web: http://www.alpha1.net/~barc

APRIL 2002

April 6

MN - ST. PAUL - Hamfest. Robbinsdale ARC, Jerry Dorf N0FWG, 763-537-1722. Email: k0ltc@visi.com Web: http://www.visi.com/~k0ltc

April 6-7

MD - TIMONIUM - Greater Baltimore Hamboree. Timonium Fairgrounds. Sat: 6am-5pm, Sun: 6am-3pm. Baltimore ARC, James Green WB3DJU, 410-426-3378. Email: w3ft@juno.com Web: http://gbhc.org

April 14

NC - RALEIGH - State Convention. Raleigh ARS, Chuck Littlewood K4HF, 919-872-6555. Email: k4hf@arrl.net Web:

Events CALENDAR

http://www.rars.org/hamfest
WI - STOUGHTON - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. Email: n9vwh@arrl.net Web: http://www.qsl.net/mara

April 20-21

CA - PALO CEDRO - EMCOMM Convention. Sacramento Valley Section ARES, Jerry Boyd K6BZ, 530-396-2256. Email: k6bz@arrl.org Web: http://www.qsl.net/k6soj/

MAY 2002

May 3-4

MO - LEBANON - State Convention. Lebanon ARC, Bill Wheeler K0DEW, 417-532-4642. Email: bwheeler@advertisnet.com

May 5

PA - WRIGHTSTOWN (BUCKS COUNTY) - Hamfest. Warminster ARC, Bill Strunk K3ZMA, 215-822-0749. Email: k3zma@aol.com Web: http://www.k3dn.org

May 11

WA - STANWOOD - Hamfest. Stanwood-Camano ARC, John McCann N7MZ, 360-629-2921. Email: huppert@whidbey.net

JUNE 2002

June 2

VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, Jack McDermott N4YIC, 703-335-9139. Email: n4yic@arrl.net Web: http://www.qsl.net/olevahams

June 8

PA - BLOOMSBURG - State Convention. Columbia Montour ARC, George Law N3KYZ, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.qsl.net/cm-arc

JULY 2002

July 7

PA - WILKES-BARRE - Hamfest. Murgas ARC, Frank Karcheski N3WPG, 570-824-7579. Email: n3wpg@juno.com Web: http://www.qsl.net/k3ytl

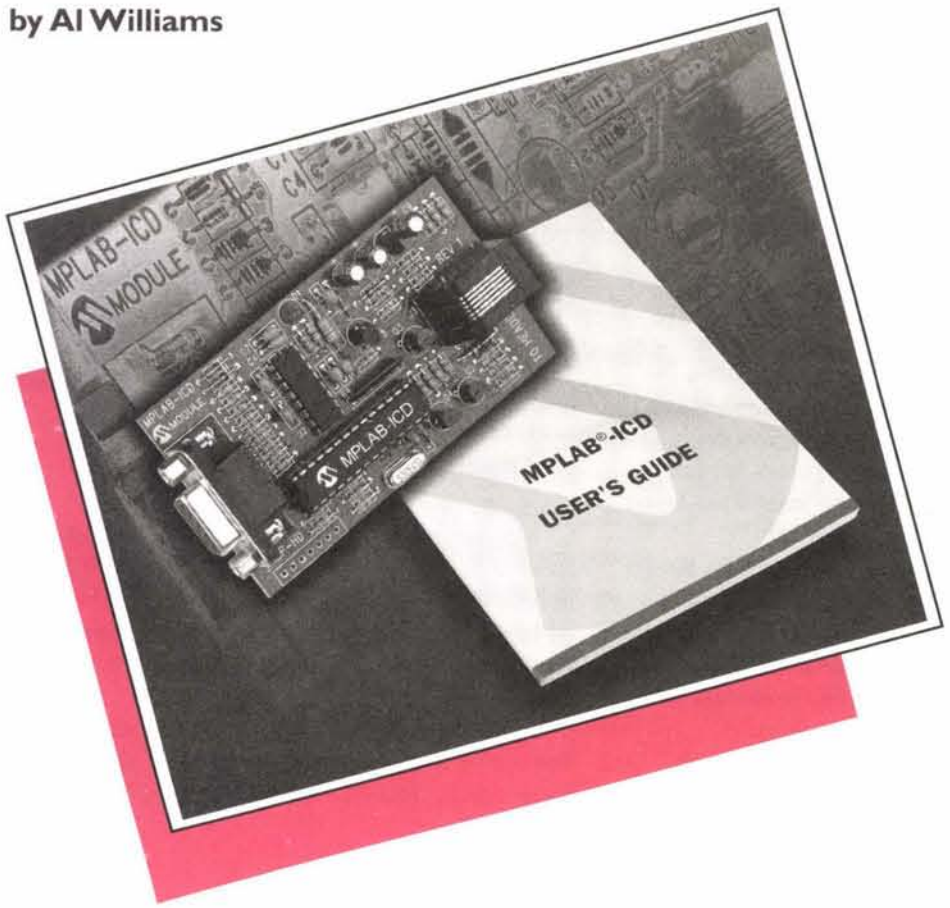
AUGUST 2002

August 3

OH - COLUMBUS - Hamfest. Voice of Aladdin ARC, James Morton KB8KPJ, 614-846-7790. Email: kb8kpj@cs.com

Write in 38 on Reader Service Card.

by Al Williams



The Hundred Buck Debugger

In the April 2001 issue, I showed you how the new PIC16F87x family of microprocessors can simplify your projects. Microchip's development tools are very well-developed, and with their MPLAB suite, you can even simulate your programs before you burn a chip.

However, sometimes simulation just isn't good enough. Working with UARTs, A/D converters, or complex timing can be difficult or impossible with software simulation. Software emulators are nice, but typically quite expensive.

However, Microchip makes an In Circuit Debugger (ICD) for the PIC16F87x family that can really help you write and debug code. The price is under $100.00 (although you can pay more if you want). Here's the best part: You already know how to use it. The ICD interfaces with MPLAB — the same software you already use to write your PIC programs.

Two Flavors

You can get the Microchip ICD in a $100.00 flavor or a $160.00 package. The only difference is that the more expensive package contains a header board that you can use to plug between the target processor and the socket, and you also get a demo board and power supply so you can program a part right away.

Both packages contain printed manuals for MPLAB and the other tools, the ICD board, and all the cables. You get a CDROM with MPLAB and the other tools, but you might as well just download the latest version off the web anyway.

The ICD has two cables. One is a regular DB9 connector that plugs into a PC's serial port. The other is a six-conductor telephone jack (RJ11). The Microchip boards have the mating connector. I wanted to build circuits on a solderless breadboard, so I simply cut the cable on one end and soldered the wires into a SIP socket (if you don't have a SIP socket, break apart a machine pin DIP socket). Then you can plug the wires into a standard breadboard and use that as your target board.

It would be nice to get the header board — I'd have rather had that than the DB9 cable and the printed manuals. However, you can easily make a variety of adapters from two DIP sockets of the correct size, so the header is not that important.

The bargain kit doesn't come with a power supply. That's okay because the ICD expects power from the target board (through the RJ11 connector). The kit I got had a few sample parts included.

The $100.00 version is part number DV164002, while the complete kit is number DV164001. For some reason, you won't find the DV164002 in many catalogs (Digi-Key's, for example), so you have to ask for it.

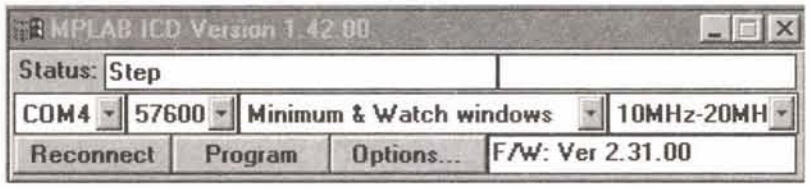


FIGURE 1

What Does it Do?

The ICD takes advantage of the special debugging mode in the new PIC chips. It integrates with MPLAB and acts as a device programmer. As it programs the chip, it adds a special debugging executive. Then you can use MPLAB to execute the program, single step, view registers, or run at full speed with a single hardware breakpoint.

When your program is complete, you can also use the ICD to burn a non-debugging chip. As programmers go, it isn't as convenient as a dedicated programmer, but for low volume use, you don't even need a programmer if you have the ICD.

This sounds great, right? It is very useful. However, there are a few downsides you should know about:

- The serial link runs at 57600 baud maximum. This means that loading all the registers takes some amount of time, which can make single stepping tedious. To combat that, you can ask the ICD to load only a minimum set of registers, or just the minimum plus any watches you've specifically asked for.
- The hardware breakpoint occurs after the instruction it is set on executes. This is a minor thing and you quickly get used to it.
- Single stepping always steps into calls.
- The ICD reserves some chip resources for itself.
- When you build your program, you must remember to program it to the chip before debugging. This is such a common mistake that Microchip has a dialog box to remind you. However, if you turn it off like I did, you'll sometimes forget to reload the chip. (If you do this, change the SuppressReprogramICD variable in MPLAB.INI back to 0.)

If you are filling up your chip, you may not be able to use the ICD. The ICD requires you to put a NOP at location 0 of your program. You also can't use addresses from 0x1F00 to 0x1FF (on a 16F877, at least). In addition, the ICD reserves registers 0x70 and 0x1EB to 0x1EF.

An Example

To test the ICD, I decided to write a simple pulse width modulation program. The 16F877 has two hardware PWM outputs, but I decided I wanted to do the job in software. I reasoned I might want many PWM outputs, and a software scheme would allow me to expand in the future.

The scheme for generating PWM is simple. You simply add a duty cycle value to an accumulator at a fixed interval. The PWM output tracks the

Listing 1. This program outputs PWM on port B pins 0 and 1.

```
;; PWM Demo for 16F877 with ICD
;; Al Williams

        PROCESSOR 16F877
        __CONFIG 0x3FF6
        INCLUDE <P16F877.INC>   ; PIC include file

; NOTE: ICD uses RAM at 0x70 and 0x1EB-0x1EF
W_TEMP  EQU     0x7F    ; shared between banks
STATUS_TEMP     EQU     0x6F
PCLATH_TEMP     EQU     0x6E
PWM0    EQU     0x20
DUTY0   EQU     0x21
PWM1    EQU     0x22
DUTY1   EQU     0x23
IMAGE   EQU     0x24  ; port image
TICK_L  EQU     0x25
TICK_H  EQU     0x26
FLAGS   EQU     0x27
TIMEOUT         EQU     0


        ORG 0
        NOP     ; ICD Wants a NOP here
        GOTO START

        ORG 4   ; ISR
        MOVWF W_TEMP ;Copy W to TEMP register
        SWAPF STATUS,W ;Swap status to be saved into W
        CLRF STATUS ;bank 0, regardless of current bank, Clears IRP,RP1,RP0
        MOVWF STATUS_TEMP ;Save status to bank zero STATUS_TEMP register
        MOVF PCLATH,W ;Only required if using pages 1, 2 and/or 3
        MOVWF PCLATH_TEMP ;Save PCLATH into W
        CLRF PCLATH ;Page zero, regardless of current page

        MOVF DUTY0,W
        ADDWF PWM0,F
; change port and keep time constant
        BTFSS STATUS,C
        BCF IMAGE,0
        BTFSC STATUS,C
        BSF IMAGE,0

        MOVF DUTY1,W
        ADDWF PWM1,F
; change port and keep time constant
        BTFSS STATUS,C
        BCF IMAGE,1
        BTFSC STATUS,C
        BSF IMAGE,1

ISROUT:
        MOVF IMAGE,W
        MOVWF PORTB   ; do real output

        BTFSC FLAGS,TIMEOUT
        GOTO NOTICK
        MOVLW 1
        SUBWF TICK_L,F
        BTFSS STATUS,C
        DECF TICK_H,F
        MOVF TICK_L,W
        IORWF TICK_H,W
        BTFSC STATUS,Z
        BSF FLAGS,TIMEOUT
NOTICK:
; adjust TMR0 to turn over in 250 cycles
; @20MHz this gives a 50uS tick instead of 51.2uS
        MOVLW 6
        ADDWF TMR0,F

        MOVF PCLATH_TEMP,W ;Restore PCLATH
        MOVWF PCLATH ;Move W into PCLATH
        SWAPF STATUS_TEMP,W ;Swap STATUS_TEMP register into W
        ;(sets bank to original state)
        MOVWF STATUS ;Move W into STATUS register
        SWAPF W_TEMP,F ;Swap W_TEMP
        SWAPF W_TEMP,W ;Swap W_TEMP into W
        BCF INTCON,T0IF
        RETFIE

START:  CLRF DUTY0
        CLRF DUTY1
        CLRF PWM0
        CLRF PWM1
        CLRF PORTB  ; output 0's
        CLRF IMAGE
        CLRF TICK_L
        CLRF TICK_H
        CLRF FLAGS
        BSF FLAGS,TIMEOUT ; start timedout
        MOVLW 0xFC  ; bit 0 and 1 are outputs
        BSF STATUS,RP0
        MOVWF PORTB ; direction register
        MOVLW 0x0F  ; pullups on, timer on
        MOVWF OPTION_REG&0x7F
        BCF STATUS,RP0
        MOVLW 0xA0  ; timer 0 interrupt on
        MOVWF INTCON

MLOOP:
        ; Set up a 1 second pause
        ; Since timeout=1, no chance ISR
        ; will mess up the count in the middle!
        MOVLW 0x4E
        MOVWF TICK_H
        MOVLW 0x20
        MOVWF TICK_L
        BCF FLAGS,TIMEOUT  ; GO GO GO
; wait for 1 second
ILOOP:
        BTFSS FLAGS,TIMEOUT
        GOTO ILOOP
; DUTY0++, DUTY1--
        INCF DUTY0,F
        DECF DUTY1,F
        GOTO MLOOP

        END
```

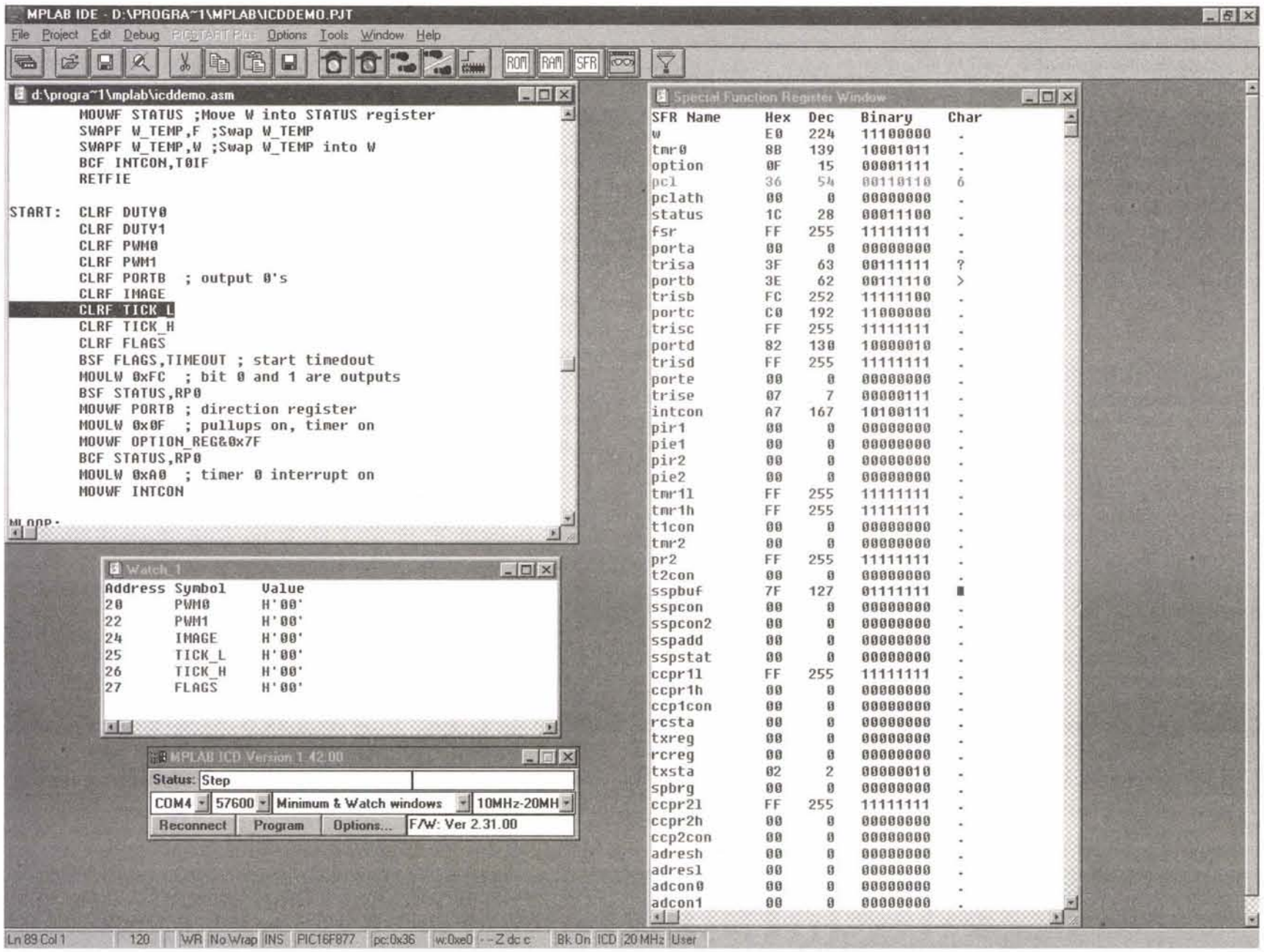


FIGURE 2

carry from the last addition. So for an eight-bit PWM output, you'd use 0x80 for a 50% duty cycle. Consider the sequence:

Step #	Accumulator	Output
0	0	0
1	80	0
2	0	1
3	80	0
4	0	1

After the first cycle, the bit flips on and off on each step, providing a 50% duty cycle. This requires precise timing, of course, so I wanted to use the timer interrupt. At the same time, I decided to implement a count-down timer the program could use to time events up to around three seconds or so. Try the math with a duty cycle of 0x01 and then with 0xFF to get a feel for how this works.

The timer interrupt is easy to use, but it has one annoying property. Since it counts to 256 before it interrupts, you wind up with odd timing. For example, with a 20MHz clock, the timer interrupt occurs every 51.2uS. I decided I wanted to force it to a round number like 50uS to make timing easier.

This interrupt routine will be generally useful. As an example of using it, I decided I'd just ramp two channels — one up and one down — with a one second delay between steps. PWM like this is well-suited for dimming lights or LEDs. With a simple RC integrator, it can also generate a voltage between 0 and 5V that is proportional to the duty cycle.

Microchip claims the ICD won't debug interrupt service routines. However, I've found that if you set a breakpoint in the middle of the routine, it works fine. I haven't tried putting a breakpoint at the start or end of the interrupt (where context switching occurs). Also, you can't step from main code to an interrupt. Once you've had a breakpoint in the interrupt code, however, you can single step with no problem.

The Circuit

For the circuit I used a solderless breadboard, a PIC16F877, and a 20MHz crystal. The crystal goes between pins 13 and 14. The breadboard has enough capacitance that you shouldn't need loading capacitors. Of course, you need to hook 5V to pins 11 and 32. Ground goes to pins 12 and 31. You also need to hook up the ICD according to Microchip's instructions. Pin 1 of the RJ11 is supposed to connect to RB3, but the ICD doesn't really use that pin and you can leave it disconnected if you wish.

You can use a different speed crystal, if you like. Of course, this will change the timings significantly. Also, you need to tell the ICD what speed you are using so it can communicate with the device properly.

The Project

You'll find complete steps to using the ICD in the Microchip manuals. However, here is a quick overview.

1) Run MPLAB.

2) From the Project menu, select New Project. Name the project whatever you want.

3) From the Project dialog, the Development Mode should read: MPLAB ICD PIC16F877. If it doesn't, select the Change button and make the correct selection.

4) Select Add Node, and enter in the name of your .ASM file (which probably doesn't exist yet).

5) Select the hex file in the Project Files box and click Node Properties. Review your options. I personally like to turn off case sensitivity.

6) Dismiss all the project dialogs.

7) Use File New to create a new file and save it using the file name you used in step 4.

8) Enter your program (see Listing 1 for my PWM code).

9) Use Project Build to build a hex file.

10) Assuming you have no errors, use the ICD window (see Figure 1) to select the correct COM port and options you need.

11) You might want to review the Options dialog to make sure all options are set correctly. You want to make sure the Enable Debug Mode box is checked (unless you don't want to debug). If any of the other options interfere with debugging, the program will warn you.

12) Press the Program button to burn your program into memory.

13) You can now single step through your code with F7, or right click in your program to set a breakpoint and then use the F9 key to execute. The F5 key will halt the program at its current location if you are running.

Debugging PWM

If you want to get a feel for how the PWM program works, try running it with the debugger. It takes a long time to download every register, so you should probably change the All Registers option in the ICD window. Instead try Minimum and Watch Windows. Then set up a Watch Window (use the Window menu for this) to view the PWM0, PWM1, DUTY0, DUTY1, and IMAGE variables. Put a breakpoint just after the NOTICK label and you'll be able to watch the PWM calculations very easily.

If you have a scope, it is very easy to watch the PWM outputs. If you don't have a scope, try connecting an LED (with a current limiting resistor, of course) to the output and watch the LED's brightness change. This will assure you that the results you see on the ICD screen are really working. Of course, while you are at a breakpoint, the PWM outputs won't continue, so keep that in mind.

You'll notice that the routine adds 6 to the current TMR0 value, so it will roll over early. This provides the 50uS tick time instead of 51.2uS as would normally be the case.

The only other tricky part of the ISR is the count down timer. TICK_H and TICK_L form a 16-bit counter. When the first bit of the FLAGS register is 0, the interrupt routine will subtract one from the counter. When the counter reaches zero, the ISR sets the bit and stops counting.

In practice, this works well. You can load a 16 bit number without fear of interference from the ISR as long as the flag is set to 1. Then you clear the flag to start the counting process. Obviously, at worst case you might start the timing just after an ISR completes and so you'd be almost 50uS off. For the timing I wanted to do with this counter, that is a very small error (.005% of one second). Once the timer is done, the flag is set ready for the program to react to it and set the count over again.

Figure 2 shows a debugging session in progress. Notice that the ICD will show you registers and EEPROM even if they are not correct (because you are not loading them). You have to be careful about that. You can always load all the register by using Update All Registers (a command on the Debug| Run menu).

More ICD Tricks

The ICD is ideal for debugging things like software UARTs where real-world timing is critical. Also, since the PIC16F877 is a super set of most of the other 14-bit PICs, you can practically cross develop using the ICD. In other words, if you have a PIC16F84 project, for example, you could develop your code on a PIC16F877 with the ICD. You simply discipline yourself not to use the PIC16F877 features that are not common with the PIC16F84. Also, you have to be careful about base memory locations and related items like EEPROM addresses. But 99% of the code will remain the same. I usually define for dual targets like this:

```
#if DEBUG
#define IRPORT PORTD,7
#define IRPORT0 PORTD,6
#define MEMBASE 0x40
#else
#define IRPORT PORTB,3
#define IRPORT0 PORTB,4
#define MEMBASE 0x20
#endif
```

If you don't like cutting up the ICD's cable, you can get six-conductor RJ11 jacks and wire them to your projects or breadboard. However, be sure you realize that most RJ11 hardware you find will only have four conductors. You can get six-conductor items at home improvement stores and electronics stores, but most department stores will only have the four-conductor cable and jacks.

If your time is worth anything to you, the ICD will quickly pay for itself. Not only can you debug PIC16F87x code, but with some care, you can debug code for many other Microchip parts, as well. Will the ICD obsolete $10,000.00 emulation systems? No, and Kia won't run Jaguar out of business either. However — like a Kia — the ICD will get you where you are going at a price you can afford. **NV**

by Robert Nansel

Amateur Robotics

I got no robotics work done whatsoever after the madness of September 11th. Instead, I spent most of my time listening to the news, reading the paper, hugging my kids and wife, wondering how these attacks could have happened, wondering what more might happen, and wondering what it all meant. I do not yet have any satisfactory answers to my questions, and I suspect I never will. Nothing is normal anymore. I certainly don't have any clear idea what Amateur Robotics should be about in time of war (if this truly be war).

I do know that, like everybody else, I have to get back to work and find out what the new normal is to be. Manufacture normalcy, if necessary.

I also know that I'm way behind on the Heavy Iron project. I've decided the only way to get caught up is to dedicate the next two months to blitzing the project without writing it up for this column. With your forbearance, I intend to return to Heavy Iron in January 2002. This month and next, I will cover topics of general interest to robot builders. I won't write as much – and for dang sure I won't draw as much – so that I can devote more time to finishing Heavy Iron.

Before getting to this month's topic, though, there's some unfinished business from last month.

The Elusive Figure One

In my October column, Figure 1 was supposed to show both the internal component layout and the front panel drilling layout. By some gremlin, the figure did not come through whole in the final magazine layout. Only about three-quarters of the component layout showed up and none of the more important drilling layout appeared. To help the instructions given last month make more sense, I'm making a second try this month. To keep things simple, just the drilling layout is reproduced here full scale so you can photocopy it to use directly as a template for center-punching hole locations.

Figure 1 wasn't the only casualty in last month's column. Figures 2 and 3 came through okay, but Figures 4 and 5 both got their bottoms lopped off. With Figure 4, it's not much of a problem since the critical dimensions shown were referenced to the top of the chassis. The only thing missing in that figure is the end of the dimension line at the bottom of the chassis.

Figure 5 was a similar story; all of the layout dimensions except one made it through unscathed, but that one dimension determines how far from the bottom of the chassis all the rest of the dimensions should be! The dimension in question is 3.167".

I hope this answers your questions (but if not, don't hesitate to drop me a line).

Now on to this month's topic.

Cambrian Intelligence

Rodney Brooks of MIT is the most influential robotics and AI researcher of the last 20 years – and for a good deal of that time he has been the most controversial. In the 90s, thousands of amateur robot builders got their introduction to robot building and the concepts of subsumption architecture through reading *Mobile Robotics*, written by Joe Jones and Anita Flynn, students of Brooks.

I had read articles since the early 90s when subsumption architecture robots first burst onto the covers of popular magazines. I even had the chance in the autumn of '92 to have dinner with Grinnell More who had, along with Brooks and Colin Angle, designed and built Genghis in 12 weeks in the summer of '88. Genghis was the famously photogenic robot that started the hexapod craze among us gearheads.

Grinnell told me he began his experiments with just four servos, a standard RC transmitter and receiver, some cardboard, tape, and chopsticks. With them he built in one evening what he called the "lobster" as a proof of principle machine.

Despite all of this exposure, I had never actually read any of Rodney Brooks' papers on the subject until recently. *Cambrian Intelligence: the Early History of the New AI* (MIT Press, Cambridge, Massachusetts, 1999; hard: ISBN 0-262-02468-3; paper: ISBN 0-262-52263-2) had been waiting on my bookshelf for months, and I gave it a read during the worst of the dark weeks after September 11.

The book is a compilation of eight of Brooks' milestone papers on subsumption architecture robotics (also known these days as "behavior-based" robotics) with new introductory material describing when, how, and why each paper came to be written.

Brooks has divided the book into two groups of four papers. The first four deal with details of the technology – though don't expect schematics or plans for any of the robots. The second group deal with the philosophies behind the new and old AI, with a little history thrown in to give perspective.

Methodological Maxims

The main ideas behind behavior-based robotics are:

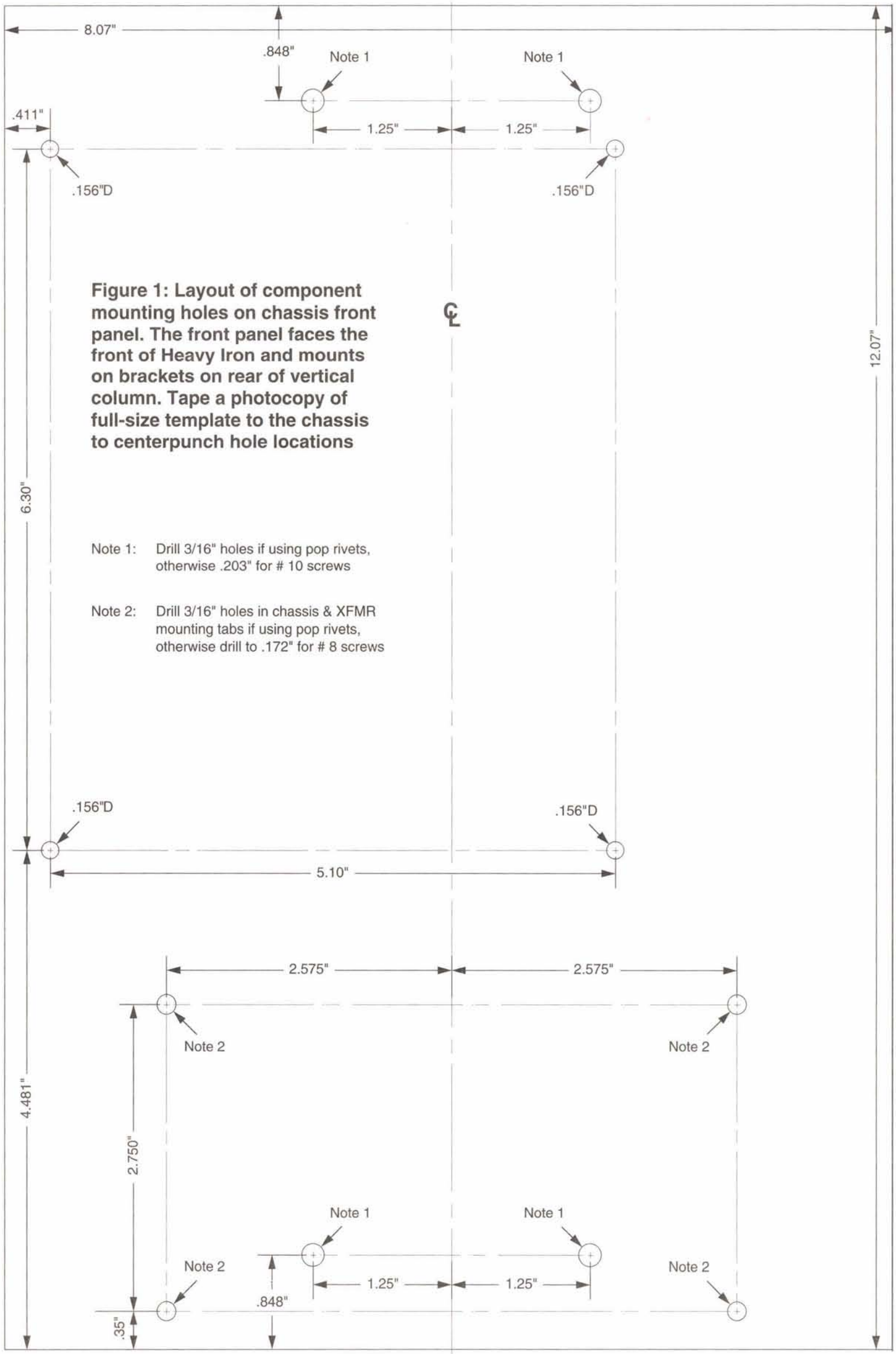


Figure 1: Layout of component mounting holes on chassis front panel. The front panel faces the front of Heavy Iron and mounts on brackets on rear of vertical column. Tape a photocopy of full-size template to the chassis to centerpunch hole locations

Note 1: Drill 3/16" holes if using pop rivets, otherwise .203" for # 10 screws

Note 2: Drill 3/16" holes in chassis & XFMR mounting tabs if using pop rivets, otherwise drill to .172" for # 8 screws

• The world is its own best model.

This means it isn't essential to build detailed world models as long as you sample the world frequently.

• The world grounds regress.

Symbolic AI has always tended to work at the highest level of abstraction possible, deferring so-called "lower-level" details of dealing with perception and action to future research. Such disembodied AI systems never make contact with the world. Real robots, however, must eventually deal with the world through sensors and actuators, so behavior-based robots tackle this problem first.

• Intelligence is determined by the dynamics of interactions with the world.

Complex behavior of a creature is not necessarily inherent in the complexity of the creature, but perhaps in the complexity of the environment. An example is an ant wandering the beach.

• Intelligence is in the eye of the observer.

A system may appear to exhibit intelligent behavior to observers ignorant of the system's internal details, and these observers may thus impute greater complexity to the supposed internal workings of the system. Psychological and neurological tests show people are very unreliable at introspecting how their own mental machinery works. Most of intelligence seems to work at a lower level than is accessible to conscious thought. From Brooks' point of view, all the power of intelligence arises from the coupling of perception and actuation systems.

Importance of Testing

You have to test robots you build in the real world, test each layer of behavior as it's built and, only when a layer is thoroughly debugged, may you add additional layers.

When a new layer is added to an old layer, there can be three sources of bugs: the old layer, the new layer, or the interaction between the two layers. Eliminating the first of these sources of bugs makes debugging much easier since there is then only one thing possible to vary to fix the bugs — the new layer.

Sensing the world with lots of sensors is part of the robustness of behavior-based robotics. Since individual sensors may be unreliable, use more total sensors and more different kinds of sensors.

Another part is that lower-level behaviors which have been well debugged continue to run as higher levels are added. A higher level can only suppress the output of one or more lower levels. In the case that it can't produce results fast enough, the lower levels will still produce sensible results, albeit at a lower level of competence.

Layered Competence

In the sense-model-plan-act framework of classical AI, not one of the functional modules generate the behavior of the total system at any given time. Many modules must operate together to get any behavior at all from the system. In behavior-based AI, each module by itself generates a behavior, and you improve the competence of the system by adding new modules to the system. Even if a particular behavior isn't working the way it should, other behaviors keep the robot performing.

If you have suggestions, questions, or comments about amateur robotics topics, you can now reach me at:

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Ambridge, PA 15003

Email: **bnansel@nauticom.net**

The traditional AI methodology breaks intelligence into functional information processing modules whose combinations provide overall system behavior. The behavior-based methodology breaks intelligence into individual behavior-generating modules, whose coexistence and cooperation allow more complex behaviors to emerge.

Connections between layers are relatively few; most of the action is on sensor inputs and actuator outputs. There is no central locus of control with behavior-based robots. Rather, the sensor data drives networks of finite state machines, delays, and combinational logic, and the outputs of those state machines and logic comprise the behavior. The arrival of data or the expiration of designated time delays cause the finite state machines to change state.

Evolution and Intelligence

In comparing classical AI techniques with those of the "nouvelle" AI, Brooks uses ideas about the evolution of biological intelligence as a rough and ready reality check. His argument goes something like this:

Single-cell life evolved on earth 3.5 billion years ago. A billion years passed before photosynthetic plants appeared, and another 1.5 billion years before the first fish and vertebrates arrived. Insects came just 100 million years later so, in our history, we can say that it took, crudely speaking, about 2.6 billion years to evolve insect-level intelligence.

By comparison, reptiles arrived 80 million years after insects, followed by dinosaurs after 40 million years, and mammals 80 million years after the first dinosaurs. Paleontologists aren't sure how intelligent dinosaurs or early mammals were, but their modern avian and mammalian descendants are ranked as the most intelligent creatures on earth. It's fair to say that once insect-level intelligence was achieved, lizard-level intelligence took on the order of 100 million years, and mouse-level intelligence took perhaps 200 million years to evolve.

From mouse-level intelligence to the first primates took 130 million years, and the immediate ancestors of the great apes appeared 102 million years after the first primates. If you make an arbitrary cutoff at the primate level for the beginnings of sophisticated intelligence, it took evolution altogether about 330 million years to go from insect-level to primate-level intelligence.

This is not to say that there is an evolutionary lineage going from insects to primates, or even a trend toward increasing intelligence among animals — there most definitely is neither, and the vast majority of animals past and present have gotten along fine with very little individual intelligence. Rather, it's to say that evolution's random walk of 2.6 billion years produced creatures with intelligence comparable to insects, and a further random walk of just 330 million years from that level produced primates.

Design Space

Another way of looking at this is to understand evolution as a constrained search through an infinite design space. In that design space, it takes about eight times longer to build the bodies and brains of creatures as competent as insects (or ancient fish) as it does to further elaborate on those basic designs to produce creatures with the sophisticated behavior of primates.

We humans arrived in roughly our present form 15.5 million years after the first primates, just 2.5 million years ago. We invented agriculture 10,000 years ago, writing less than 5,000 years ago, and "expert" knowledge only in the last 1,000 years. In terms of searching design space, it took evolution less than 1/20th the time to find human-level intelligence as it did to stumble across our primate forebears.

To Brooks, this suggests that problem-solving behavior — language, abstract reasoning, and learning, the staples of classical AI — are relatively simple once the templates for being and reacting are available to animals. Those templates include the ability to move around in a dynamic environment and sense surroundings well enough to enable maintenance of life and reproduction.

Brooks does acknowledge the dangers of studying biological systems too closely: "Their design was not highly optimized from a global systems point of view. Rather they were patched together and adapted from previously working systems in ways which most expeditiously met the latest environmental pressures. Perhaps the solutions found [by evolution] for much of intelligence are terribly suboptimal."

Minuses

The book lacks an index, which is a shame, though it does have an exhaustive bibliography. Also, there is a surprising amount of typos and strange punctuation (at least in the edition I have), but nothing serious enough to obscure meaning.

All eight of these papers are available individually elsewhere (though without the author's new introductions), and none of them can be considered cutting edge since the newest of them was published in 1991. Still, it's quite handy to have them all gathered in one place, and Brooks' introductions give context. This is stuff straight from the horses mouth, and I recommend it.

Lonely Gearhead Contest

I get lots of letters and email from folks who are convinced they are the only robot builders in their area. Sometimes these people live in places where there are vibrant amateur robotics groups, such as Seattle, San Francisco, or Hartford. Others come from isolated places in third-world nations.

Periodically, I try to connect these people up with any local robotics groups I'm aware of, because there is no substitute for sitting down with another gearhead to compare notes and 'bots.

To help our lonely brothers and sisters, I'm announcing the Third Lonely Gearhead Contest. Anybody anywhere who wants to find a local club or get one going can send me a letter or email. Also, anybody who has a club going should give me contact information. Those listings I receive by December 31, 2001 will make it into my February 2002 column.

Send me contact names, addresses, URLs, email addresses, phone numbers, etc., whatever way you would wish other robot builders to get in touch with you. If you have a club you want folks to know about, drop me a line. Likewise if you are looking for a club.

All who respond by December 31, 2001 will get their names thrown in a hat; I will randomly select one person to receive a Solarbotics BEAM experimenter board. Real names and addresses only, please. Let's hear from you.
NV

by Ray Green

Control Lights, a Burglar Alarm, and Appliances Using the Computer's Serial Port

Plug a cable into your computer's serial port and control a coffee pot, appliances, lights, and a very effective burglar alarm featuring a 20-second entrance delay and a two-minute alarm. All times may be changed as you desire. Sounds interesting doesn't it. Build this yourself with a few low-cost parts and it gets even more interesting.

The serial port can be used for controlling devices with many advantages. The serial port only uses eight wires and is easy to hook up, and it's relatively easy to program. Using the serial port also keeps your parallel port for your printer.

Any IBM-compatible computer can be used, and the Windows platform is not used for control purposes. In fact, an old 286, 386, or 486 computer is ideal because it will probably have either the required programming file 'GWBASIC.EXE' or 'QBASIC.EXE' generally located in the DOS directory. You will probably not have a BASIC program on any computer using Windows95 or later, but a BASIC program from an old computer can and will work on even the very latest Pentium.

Control with a computer doesn't even require a hard drive, as the programs are small enough to easily fit on a floppy disk. Ask around and you should be able to find a neighbor with an old one in their attic. You can also find them at garage sales or flea markets for a few dollars. For most people, they have become obsolete as new applications require faster and bigger computers to operate effectively on the Internet. Try and find a small one though, simply because they take up less desk space. A monochrome monitor will display the control program nicely, although a color monitor displays the program in attractive colors.

Programs for control purposes ideally operate in the BASIC language, because they can be easily modified for any application. If you don't know anything about programming, don't worry. I've written the program for you to copy or it's available free on our web site.

To determine if your computer has the BASIC language, close windows (if you have it) to go to DOS. Type CD\DOS <Enter> to change the directory to the DOS directory. You should now see C:\DOS> on your screen. Next type: GWBASIC <Enter>. If it's there, you'll get a screen showing something like GW-BASIC 3.22, followed by (c) Copyright Microsoft, etc., 60300 bytes free then, OK. Your version may be different, but it should do the job. To return to DOS type: system <Enter>. If you don't have GWBASIC, try typing: QBASIC <Enter>. You should see a big box stating "Welcome to MS-DOS QBASIC." To exit to DOS, press the Esc key to clear the box, then click on File, then Exit. If you want to go back to Windows, type: EXIT <Enter>. If nothing happens, then type WIN <Enter>. This program will also run without modification in Power Basic, Quick Basic, or Visual Basic for DOS.

Copy the program, "SERPORT.BAS" or download it free from our web site (www.nutsvolts.com). Put it in the directory where GWBASIC.EXE or QBASIC.EXE is located. This will probably be the DOS directory if the computer does not use Windows95 or Windows98. Of course, if you want it in a separate directory, use the make directory command: C:\>MD control, and locate serport.bas there along with a copy of GWBASIC or QBASIC.

Switch to DOS and Load and Run the control program by typing GWBASIC SERPORT <Enter> or by typing QBASIC/RUN SERPORT <Enter>. As the program runs, it will display the status of the four inputs and three output circuits. You'll also hear an alarm coming from the loudspeaker. This is the burglar alarm signifying an open input on pin 8 of the serial port plug. To stop the program and turn off the alarm, hold down the Control Key and press the Break Key. The program must be stopped before you can exit or print a listing.

To run the program again in GWBASIC, press F2 or type RUN <Enter>. To exit the program in GWBASIC, type "SYSTEM." To run the program again in QBASIC, click on RUN (or press the Alt key and type R, then S). To exit, click on file (or press the Alt key) and click on Exit or type X. Now we're ready to make it work for us. At this point, you should be able to use SERPORT.BAS to control things and read inputs without any pro-

```
+-------------------------------------------------------+
|  Computer Controlled Home  -  'SerPort.bas'   By Ray Green
|-------------------------------------------------------|
|  04-16-2001                Serial Port - Home Control System.
|  12:58:14
|-------------------------------------------------------|
|  Input Ports :   '0' = no input        '1' = alarm input.
|        Numbers in parentheses are Pin number connections.
|
|    (1) Spare      [ 0 ]          (8) Smoke Alarm   [ 0 ]
|    (6) Spare      [ 0 ]          (9) Burglar Alarm [ 0 ]
|-------------------------------------------------------|
|  Output Ports :
|
|    (3) Security Lights [OFF]     (7) Burglar Alarm [OFF
|    (4) Coffee Pot      [OFF]       Alarm Clock   [OFF]
|
+-------------------------------------------------------+
```

Screen-type view of SerPort.bas

Serial port with 9 pins. DB-9 Connector		Serial port with 25 pins. DB-25 Connector
Pin 1 Input	(Carrier Detect)	Pin 8
Pin 3 Output	(Transmit Data)	Pin 2
Pin 4 Output	(Data Terminal Ready)	Pin 20
Pin 5 Ground	(Signal Ground)	Pin 7
Pin 6 Input	(Data Set ready)	Pin 6
Pin 7 Output	(Request to Send)	Pin 4
Pin 8 Input	(Clear to Send)	Pin 5
Pin 9 Input	(Ring Indicator)	Pin 22

Table 1

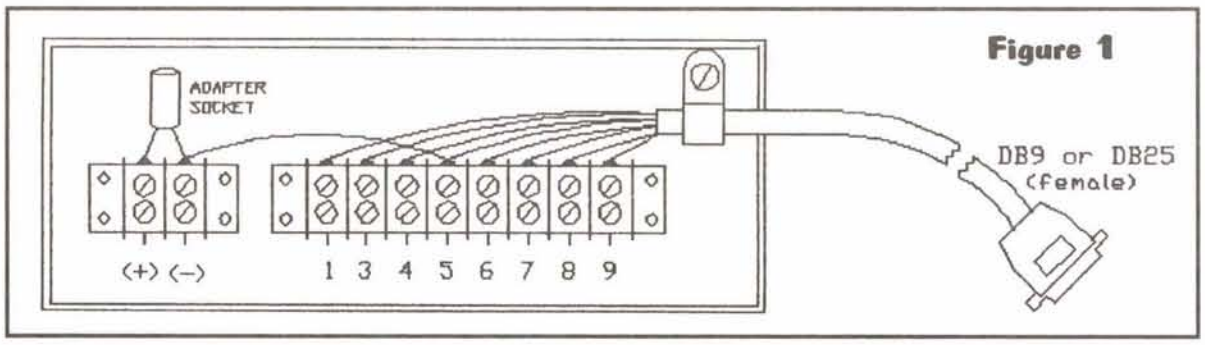

Figure 1

gramming knowledge.

About the Serial Ports

A lot has been written about using the parallel printer port to control your home, but very little has been written about using the serial port in its simplest form. I was attracted to the serial port because of the challenge it offered, so I decided to explore the possibilities. Most computers have two, and they are called COM1: and COM2:. Either one may be used. In some computers, a mouse is plugged into COM1: and a modem is internally connected to COM2:. If your particular computer has a PS/2 type mouse that plugs into a small round socket (which I think is desirable), COM1: will probably be free for control purposes. If you decide to use COM2:, make sure any internal modem is removed and COM2: is enabled in the CMOS setup or on the Interface card. The serial port socket will probably be a nine-pin male oval socket on the back of the computer. It may also be labeled COM1: or COM2:.

Earlier computers used a 25-pin male oval socket and either may be used. Some computers may have one of each.

Because of the wide variety of readers, I'll try to keep this article as simple as possible. To begin with, the serial port as I use it can switch "on" or "off" three external power circuits. These circuits can include lights, motors, alarms, a coffee pot, or anything else electrical.

In addition, there are four different available inputs that can read the status ("0" or "1") of four different devices. These inputs are simply open or closed switches from a smoke or burglar alarm, a thermostat calling for heat, fan, or air conditioning, a freeze detector, water-level detector, photo cell, or a host of other things. Table 1 shows the serial port connections. Later on, I'll show you how the inputs and outputs are connected. The official connection title is shown in parentheses between the plug pin numbers, but it has no real purpose here.

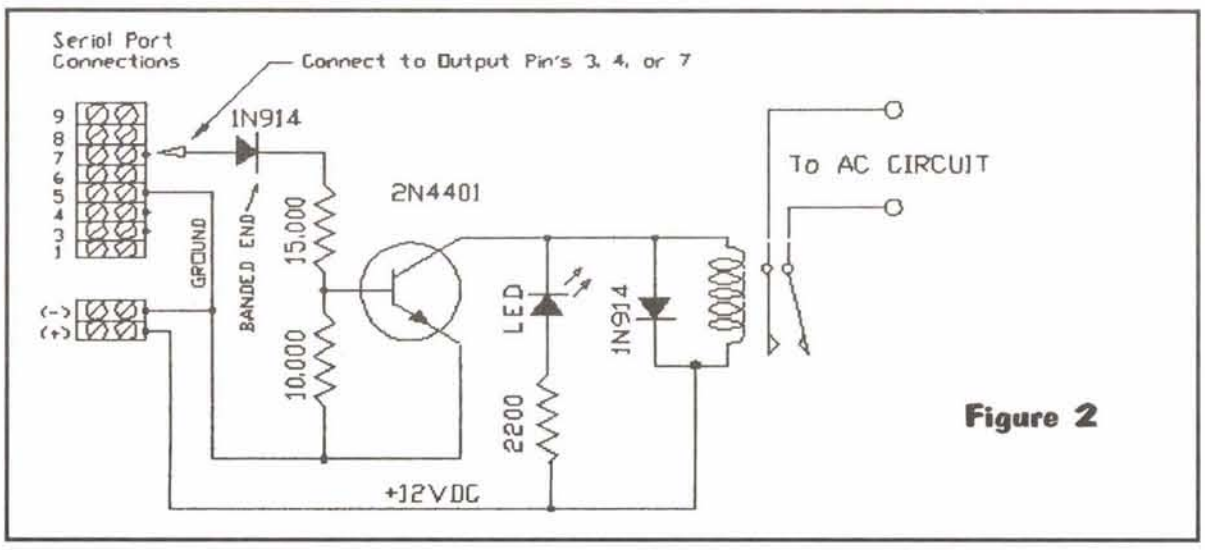

Figure 2

The Serial Port Connections

All discussion of input and output pin numbers will refer to a nine-pin serial port connector. If you have a 25-pin connector, simply substitute those pin connections instead. As an example, when I specify pin 1, use the wire from pin 8 if you have a 25-pin connector. (See Table 1.)

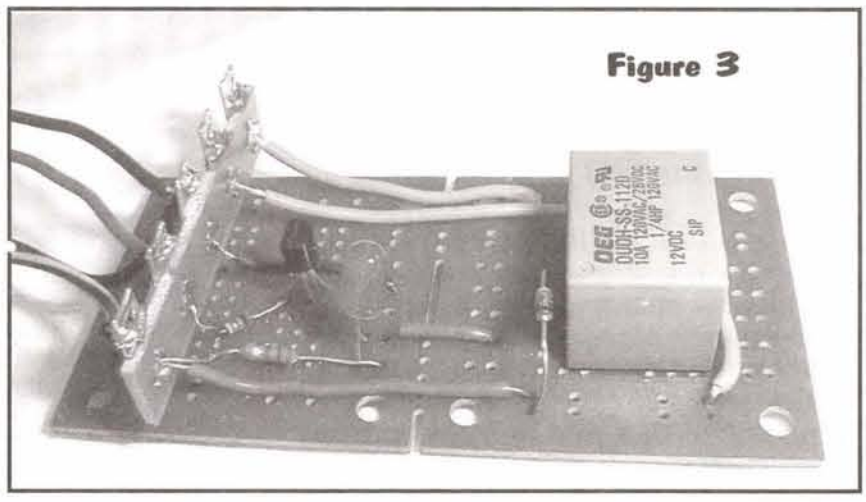

Figure 3

Note that pin 2 (receive data) is not used because it is not easily programmable.

To use your serial port to control external circuits, mount two barrier strips — RadioShack™ part numbers 274-670 and 274-656 — on a block of wood as shown in Figure 1. Connect the eight-terminal strip through an eight-wire cable to the serial port female plug. Use part number 276-1538 for a nine-position connector or part number 276-1548 for a 25-position connector. Number and connect the barrier strip with the same pin numbers as the nine-pin serial port, 1 through 9, omitting pin 2. All external devices will connect to this barrier strip. The two-terminal barrier strip is simply used as a convenient tie point for the output of the 12 VDC adapter. Note that a single jumper connects serial port pin 5 to the negative lead on the adapter's barrier strip. This jumper provides circuit ground for the adapter.

Hooking Up the Output

An easy way to connect the serial port output is to build and wire a simple relay circuit. It's a good idea to wire at least one of these circuits so you can test your control system. Build three of these units and connect each one to an output pin. Pin 3 controls the security lights, pin 4 controls the coffee pot, and pin 7 connects to the burglar alarm.

Figure 2 and the photo in Figure 3 shows the circuit and layout for a relay switching unit you can use to switch up to 1,250 watt AC loads for control purposes. Wiring is fairly simple and you should be able to build a unit in a couple of hours, if you've built circuits before. Note the 2N914 (or 1N4148) diode in series with the input to block the polarity shift. This circuit gives great isolation because the 15,000-ohm resistor in series with the input to the transistor limits the load to less than 1 mA. The + 12 VDC input connects to the adapter jack.

Although the RadioShack unit listed will work fine in the circuit, I have bought many adapters at the flea market for 50 cents to $1.00. Any unit with an output over 200 mA may be used. Buy one made for a radio or cassette player because it'll have better filtering. Check the output polarity with a voltmeter to make sure which side of the adapter jack is positive and connect it in the circuit accordingly. Of course, all the relay units, the input circuits, and the motion detector is connected to one adapter, and only one is required to power the whole system.

Hooking Up the Inputs

The circuit in Figure 4 actually makes a very simple and practical burglar alarm input.

The four inputs are on plug pin number's 1, 6, 8, and 9. These pins are normally '0' (Lo) when open and switch to '1' when an external positive DC voltage is applied. All input circuits require a (+) voltage on the pin to switch. This may be any voltage above 5 VDC. Because we are using the DC adapter, we'll also use a resistor in series with each input and the (+) connection on the adapter.

This is because most adapters have no regulation and the output voltage will likely be 18 VDC without load. This resistor provides isolation and reduces loading on the serial port pins. A resistor in the range of 10,000 to 22,000 ohms should be used. If you decide to experiment, measure the series input current and use a resistance value to keep the current below 1 mA. The (-) lead of the adapter is grounded to pin 5.

To wire the burglar alarm, connect all of the normally closed switches (NC) from your windows, doors, and infrared motion sensors so they are connected in series. That way, if a circuit is cut or broken, the alarm will sound.

Here is the suggested Parts List for one relay circuit.

RadioShack™ part numbers are shown
1 - PC board, No. 276-159
1 - Five-lug tie point solder type, No. 274-688
1 - 10A, 12 VDC, 400-ohm relay, No. 275-248
1 - 2N4401 NPN transistor, No. 276-2058
1 - 10,000 ohm, 1/4 watt resistor, No. 271-1335
1 - 15,000 ohm, 1/4 watt resistor, No. 271-1337
1 - 2,200 ohm, 1/2 watt resistor, No. 271-1121
2 - 1N914/4148 silicon diodes, No. 276-1122
1 - Red LED any type, with holder, No. 276-018
1 - Molded coaxial DC jack, No. 274-1565
1 - 12 VDC adapter, 500 mA, No. 273-1773 (Only buy one)

Each relay assembly only requires 40 mA so one AC-to-DC adapter will easily operate the three relay assemblies plus your infrared, motion sensors, smoke alarms, and other devices, as well.

Referring to Figure 4, one side of the series string connects to ground on pin 5 and the other connects through a 4,700-ohm resistor to pin 9 and a 2,200-ohm resistor to the +12 VDC adapter. When the door or window opens, the switch opens and the input voltage rises to '1' to sound an alarm. Note that I have included an LED indicator that will light at the same time.

The diagram also shows a smoke alarm switch (NC) connected to the junction of two 10,000-ohm resistors between pin 8 and +12 VDC. Other devices may be connected in the same manner. As with the burglar alarm, when

```
10 COLOR 14, 9, 3: CLS : KEY OFF: REM SerPort.BAS  Article SerPort3.doc
20 REM by Ray Green, contact - raygreen@juno.com  4/17/2001
30 REM Control your Home through the Serial Port. 'SerPort.bas'
40 BASE = &H3F8 : REM &H3F8 is Base Address of COM1:  Use &H2F8 for
COM2:
50 CLS
60 COLOR 14: REM *** DRAW COLORED BOX  ***
70 LOCATE 1, 1: PRINT CHR$(218); : FOR X = 1 TO 78: PRINT CHR$(196);
80 NEXT X: PRINT CHR$(191)
90 LOCATE 3, 2: FOR X = 1 TO 78: PRINT CHR$(196); : NEXT X
100 LOCATE 3, 40: PRINT "+"
110 LOCATE 7, 2: FOR X = 1 TO 78: PRINT CHR$(196); : NEXT X
120 LOCATE 13, 2: FOR X = 1 TO 78: PRINT CHR$(196); : NEXT X
130 FOR X = 2 TO 21: LOCATE X, 1: PRINT CHR$(179): LOCATE X, 80
140 PRINT CHR$(179): NEXT X
150 LOCATE 22, 1: PRINT CHR$(192); : FOR X = 1 TO 78: PRINT CHR$(196);
160 NEXT X: PRINT CHR$(217): COLOR 15
170 REM
180 LOCATE 2, 12
190 PRINT "Computer Controlled Home  -  'SerPort.bas'    By Ray Green"
200 LOCATE 4, 38 : PRINT "Serial Port - Home Control System."
210 LOCATE 8, 6
220 PRINT "Input Ports :     '0' = no input          '1' = Alarm input"
230 LOCATE 9, 13: PRINT "Numbers in parentheses are the serial plug pin
  numbers."
240 LOCATE 11, 10: PRINT "(1) Spare        [   ]"
250 LOCATE 11, 48: PRINT "(8) Smoke Alarm   [   ]"
260 LOCATE 12, 10: PRINT "(6) Spare        [   ]"
270 LOCATE 12, 48: PRINT "(9) Burglar Alarm [   ]"
280 LOCATE 14, 6: PRINT "Output Ports :"
290 LOCATE 16, 9: PRINT "(3) Security Lights"
300 LOCATE 16, 50: PRINT "(7) Burglar Alarm"
310 LOCATE 17, 9: PRINT "(4) Coffee Pot"
320 LOCATE 17, 54: PRINT "Alarm Clock"
330 LOCATE 4, 9: PRINT DATE$: LOCATE 5, 11: PRINT TIME$
340 REM
350 REM   ***   Start Control  ***
360 REM   ****  Read 4 Input Port Registers  ****
370 IN1 = -((INP(BASE + 6) AND 128) = 128): REM READ PIN #1 INPUT
380 IN6 = -((INP(BASE + 6) AND 32) = 32): REM READ PIN #6 INPUT
390 IN8 = -((INP(BASE + 6) AND 16) = 16): REM READ PIN #8 INPUT
400 IN9 = -((INP(BASE + 6) AND 64) = 64): REM READ PIN #9 INPUT
410 REM
420 REM   ****   Display Input Ports Status   ****
430 LOCATE 11, 28: PRINT IN1 : LOCATE 11, 67: PRINT IN8
440 LOCATE 12, 28: PRINT IN6: LOCATE 12, 67: PRINT IN9
450 REM
460 REM   ****   Set Event Times and Control Output Ports   ****
470 PIN3 = 0 : PIN4 = 0 : PIN7 = 0
480 REM
490 REM Set Alarm Clock Wake up Time to Play Tune for 30 seconds
500 ACLK = 0: IF LEFT$(TIME$, 5) = "06:30" THEN ACLK = 1
510 REM
520 REM Set Coffee Pot Time to switch Pin (4) On
530 IF TIME$ > "06:30:00" AND TIME$ < "08:30:00" THEN PIN4 = 1
540 REM
550 REM Security Lights are Clock Controled
560 IF TIME$ > "19:30:00" AND TIME$ < "23:30:00" THEN PIN3 = 64
570 REM
580 REM Burglar Alarm sounds after 30 seconds when Input is '1' (hi)
590 IF IN9 = 1 THEN TI = TIMER : WHILE TIMER < TI + 30 : WEND : PIN7 = 2
600 REM
610 REM  ***    Display Output Port Status   ***
620 LOCATE 16, 29: IF PIN3 = 64 THEN PRINT "[ON ]" ELSE PRINT "[OFF]"
630 LOCATE 16, 68: IF PIN7 = 2 THEN PRINT "[ON ]" ELSE PRINT "[OFF]"
640 LOCATE 17, 29: IF PIN4 = 1 THEN PRINT "[ON ]" ELSE PRINT "[OFF]"
650 REM
660 REM Switch Outputs On or Off
670 OUT BASE + 3, PIN3 : REM Output pin 3, Clock Controlled Security Lights
680 OUT BASE + 4, PIN4 + PIN7 : REM  Output pin 4 Coffee Pot and pin 7
    Alarm
690 REM Output Burglar Alarm for 120 seconds, turn it Off and end program
700 IF PIN7 = 2 THEN TI = TIMER : WHILE TIMER < TI + 120 : WEND
710 IF PIN7 = 2 THEN OUT BASE + 4, 0 : GOTO 950
720 REM
730 IF ACLK = 1 THEN LOCATE 17, 68: PRINT "[ON ]": GOSUB 860
740 LOCATE 17, 68: PRINT "[OFF]": REM Alarm Clock
750 IF IN8 = 1 THEN GOSUB 780: REM Sound Smoke Alarm
760 GOTO 330: REM Let's Check everything again!
770 REM
780 REM Sound Speaker Smoke Alarm
790 FOR X = 1 TO 10: REM 10 Second Alarm
800 SOUND 587, 4
810 SOUND 988, 8
820 SOUND 32767, 10
830 NEXT X
840 RETURN
850 REM
860 REM Alarm Clock Speaker Music Wake up
870 TI = TIMER: WHILE TIMER < TI + 30: REM 30 Second Timer on Alarm
880 PLAY "MF O3 L8 EE E4 EE E4"
890 PLAY "EG C. D16 E4 P4"
900 PLAY "FF F. F16 F EE L16 EE"
910 PLAY "L4 GG FD"
920 PLAY "C1"
930 WEND
940 RETURN
950 END
```

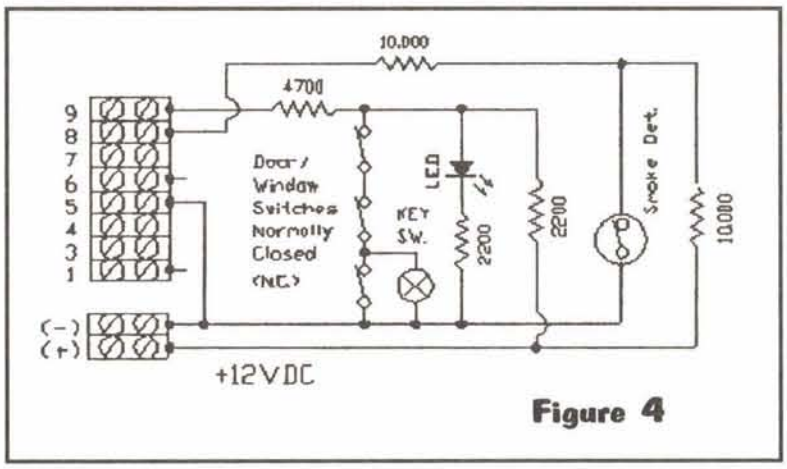

Figure 4

the smoke detector switch opens, the voltage at the junction of the resistors rises and the serial input switches high to '1.' A similar connection scheme may be used to switch the spare input pin's 1 and 6. For a dusk-to-dawn light switch, try replacing the smoke detector switch with a CdS photoresistor.

If used, smoke alarm and motion detectors require an additional 12 VDC to operate. These connections are not shown on the diagram, but should go to the adapter also.

Connect the key switch in parallel with the exit door's switch. It should be accessible from outside the house, or ideally in the garage beside an interior door from the house. Close the key switch before setting the alarm and leaving the house. Then switch it open after leaving to arm the door.

Of course, you will want to modify the program to re-label the inputs and tell it how to react. A little bit of study of the program may show you that this is a fairly easy thing to do. Enjoy your project!

I mentioned earlier that a computer may be used without a hard drive. To do so, boot the computer with a DOS boot disk and format a floppy with the system option FORMAT A:/S. This will make the floppy self-booting by putting the system files onto the disk. Copy either the program QBASIC.EXE or GWBASIC.EXE onto the disk. Copy the program SERPORT.BAS onto the disk, as well. Switch to the A: drive and in DOS, type EDIT AUTOEXEC.BAT and type in one line, GWBASIC SERPORT or QBASIC/RUN SERPORT. Click on Save, then Exit. Anytime the disk is in the A: drive, the computer will start and run the program as soon as it's turned on. The big advantage of not having a hard drive is the low power consumption of the computer. Of course, you may also turn the monitor off when it is not in use.

More About Serial Port Inputs

You can do everything in the preceding section of this article and build and operate a control system without knowing much about programming. However, since you have accomplished so much, let's see if we can learn some more about what we are doing. It would be a good idea, if at this point, you would print a listing (contents) of the program SERPORT.BAS. This will give you a chance to study the program and to follow the operation by reading the REM (remarks) lines, or the limited explanation shown later.

A line starting with a REM does not do anything. Its purpose is to divide the program or to give the reader instructions.

To print a listing in GWBASIC with the program stopped, type LLIST <Enter>. To print a listing in QBASIC, simply click on File (or press ALT) and then select Print.

When an external voltage between + 5 volts and + 15 volts is applied to an input pin on the serial port, the presence of this voltage can be read at the pin's address (like a street address). For my experiments, I used a six-volt lantern battery with the negative terminal connected to pin 5 (ground).

The positive battery terminal wire in series with a 4,700-ohm resistor is touched to the respective input pin to create an input. Higher voltages may also be used with a higher resistance value. The resistor provides isolation and reduces loading on the input pins. I used a 22,000-ohm resistor for voltages higher than 12 volts.

The base address for serial port COM1: is &H3F8 and is used for all program examples in this article. If you are using COM2: as your serial port, then type LIST 40 <Enter>. Simply replace &H3F8 with &H2F8 in line 40. Type SAVE SERPORT.BAS <Enter> to save the change in GWBASIC.

The input address for pin 1 (or pin 8 on the 25-pin connector) is written in GWBASIC as INP(&H3FD) AND 128. By adding a print statement, you may read pin 1 and display a "0" or "1" on your computer monitor, depending on whether or not a positive voltage is applied to the pin. This command may also be written using the base address + 6, or BASE = &H3F8 : PRINT -((INP(BASE + 6) AND 128) = 128).

Here's how to read all four input addresses.

For pin 1 input: PRINT -((INP(&H3F8 + 6) AND 128 = 28)

For pin 6 input: PRINT -((INP(&H3F8 + 6) AND 32 = 32)

For pin 8 input: PRINT -((INP(&H3F8 + 6) AND 16 = 16)

For pin 9 input: PRINT -((INP(&H3F8 + 6) AND 64 = 64)

The Serial Port Outputs

The three available outputs appear on plug pin numbers 3, 4, and 7. The RS-232 standard specifies that a "1" ("on") is defined for an output between +5 and +15 volts and a "0" ("off") is defined for an output between -5 and -15 volts.

If you use a voltmeter and measure each of these three between their respective pin and ground (pin 5), you will note that each output reads about -11 volts (or "0" as defined above).

Let's try some experiments. Plug your cable with its attached barrier strip into the serial port connection on your computer. Go to the "DOS" prompt and switch your computer to BASIC by typing the command: GWBASIC <Enter>. The screen should respond with "OK." If you use QBASIC, these tests must be made in the immediate mode, or a short program written to conduct them.

Now, connect the positive lead of your digital voltmeter to pin 3 and the negative lead to pin 5. It should read about -11 volts. Next, switch the output pin 3 to a "1" or "Hi" by simply typing the Basic command: OUT &H3FA, 64 <Enter>. Note that the output voltage changes to about +11 volts. To switch to "0" again use: OUT &H3FA, 0 <Enter>. The voltage should now read again about -11 volts.

To switch any of the three output ports to a "1," simply use BASIC command as follows:

For pin 3 output: OUT &H3FA, 64 or BASE = &H3F8 : OUT BASE + 3, 64

For pin 4 output: OUT &H3FB, 1 or BASE = &H3F8 : OUT BASE + 4, 1

For pin 7 output: OUT &H3FB, 2 or BASE = &H3F8 : OUT BASE + 4, 2

To switch both pin 4 and pin 7 to "1," use: OUT BASE + 4, 3

To terminate BASIC and return to the "DOS" prompt, use the command: SYSTEM <Enter>.

How the Program SerPort.bas Works

Put the correct port address in line 40 for COM1: or COM2:.

Lines 60 to 160 draws lines and colors the screen.

Lines 190 to 330 write information and layout the screen.

Lines 370 to 400 read the four input pins.

Lines 430 and 440 display the input data on the screen.

Line 500 sets your alarm clock wake up time.

Line 530 sets your coffee pot — on/off times.

Line 560 sets your security lights on/off times.

Line 590 sets the 30-second entry timer and turns on the alarm.

Lines 620 to 640 print output pin on/off status to the screen.

Lines 670 and 680 switch the outputs on/off.

Line 700 runs the burglar alarm for 120 seconds.

Line 710 turns off the burglar alarm and stops the program.

Lines 500, 730, 740, and 860 to 940 are the alarm clock.

Lines 750, and 780 to 840 are the smoke alarm.

Line 760 starts the program again and says "Let's do it again."

The Loudspeaker

The alarm clock and the smoke detector sound an alarm through your computer's internal loudspeaker. This internal speaker may not be loud enough as is, but I found that by connecting a separate speaker (in a cabinet) directly across the internal one, I was able to get more than enough volume for an alarm clock. Note that a sound card probably will not work in this program.

You may also run an extension speaker from the computer using an amplifier. Simply connect a .01 mF capacitor between one side of the speaker on the computer and the input to an amplifier. Connect the ground side of the amplifier to the computer's circuit ground or chassis. Try the capacitor on each side of the computer speaker to see which works best. Now connect your external speaker to the output of the amplifier.

While using the burglar alarm system, remember to use the entry key switch or you will have 20 seconds after entering your home to stop the program before the alarm sounds. Stop the program by holding down the Ctrl key and press the Break key. Switch off the alarm by turning off the 12-volt adapter.

When the burglar alarm sounds, it'll do so for 120 seconds. Of course, you may set the times as desired in the program, SerPort.bas. After the alarm sounds, it will shut off and the program will stop. This is to keep the alarm from sounding again. To restart the program, simply press F2 or type RUN <Enter>.

Enjoy Your Project

The Basic Program, SerPort.bas may be downloaded free from our web site (www.nutsvolts.com). I'd like to hear comments from those of you who build this system. Please contact me by email: raygreen@juno.com or FAX: (727) 866-1595.

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Cool Web Sites

Have questions? These web sites have answers.

Society for Amateur Scientists — weekly projects from the pages of Scientific American's Amateur Scientist column (recently retired), and other projects.

http://sas.org/

How OLEDs (organic light-emitting diode) work.

www.lumex.com/new/press_releases/Leddy29.html
komar.cs.stthomas.edu/qm425/01s/Tollefsrud2.htm
www.techreview.com/2free_popup.htm
www.kodak.com/US/en/corp/display/index.jhtml
http://nlo-serv.ethz.ch/staff/kiy/oleds/oleds.html

Silicon Zoo — a new collection of photomicrographs featuring many of the interesting silicon creatures and other doodling scribbled onto integrated circuits by engineers who designed them.

http://micro.magnet.fsu.edu/creatures/index.html

2001) and I noticed that the 1uF cap is supposed to be tantalum ... but aren't tantalum caps polarized? If so, would I be correct in assuming that the + side goes toward the 1M resistor?

Steven Shamlian
via Internet

Reponse:

In this design, the voltage across the cap reverses as the circuit oscillates, so it will alternately change polarity. Tantalums are hearty beasts and will not deteriorate with this use. But you are correct in assuming that the + side would be better placed toward the 1M resistor.

TJ Byers
Q & A Editor

Dear Readers:

I received a telephone call last evening from an individual identifying himself as an AT&T Service Technician who was conducting a test on telephone lines. He stated that to complete the test I should touch nine (9), zero (0), the pound sign (#), and then hang up. Luckily, I was suspicious and refused. Upon contacting the telephone company, I was informed that by pushing 90#, you give the requesting individual full access to your telephone line. This scam appears to have been originated from many local jails/prisons. I have also verified this information with Telecom, Pacific Bell, MCI, Bell Atlantic, GTE, and Verizon. The GTE Security Department requested that I share this information with everyone I know, so I'm passing it along. Please beware. DO NOT press 90# for ANYONE!

name withheld by request

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In addition, more than 80 percent of the respondents believed that the Internet will ultimately have a major impact on payments, collections, and investments. Seventy percent expected a major impact on borrowing and foreign exchange practices.

"The survey's participants do not believe their organization's commitment to the Internet has lessened with the widely publicized fall of many dot-coms. Very few respondents believed that their company's pursuit of web-based activities had lessened in the past year," according to the executive summary of the survey.

Less than one-third of the survey's respondents felt that e-commerce and the Internet had an "extremely" or "very important" impact on their treasury area in the past 12 months. However, they listed improved workflow efficiencies, including more "real time" information, sharing access to data and working from multiple locations, as the Internet's most significant impact on their companies' treasury operation.

The survey respondent pool included 1,000 professionals representing a broad range of industry segments. More than half have worked in the treasury profession for 10 or more years. About one-fifth were senior-level practitioners with titles including treasurer, controller, CFO or president, and just over half were middle-level practitioners.

LAND INFO Now Delivers Global Sub-Meter Russian Satellite Imagery; Satellite Photos for Major USA and International Cities

LAND INFO International, LLC, a provider of digital geospatial information across the world, announced the new availability of 0.95-meter, 1.56-meter, and two-meter imagery from Russian satellites. The data includes recent satellite photos for hundreds of major cities in the United States, Germany, Mexico, Italy, Brazil, Pakistan, Egypt, Turkey, and other regions.

"Our US and international clients are demanding satellite imagery worldwide, especially for the Middle East, South America, and the United States," commented Michael Blakeman, CEO and president of LAND INFO International. "The Russian satellite data, combined with our other digital map products, enable LAND INFO to continue delivering quality data as it has been for the past 10 years."

The expanded coverage includes archived panchromatic data from 1992 to 2001. The data is captured through Russia's DK-1, DK-2, and KVR-1000 satellites. Data coverage includes hundreds of major international cities, including Boston, MA; Dallas, TX; Washington D.C.; Islamabad, Pakistan; Buenos Aires, Argentina; Cairo, Egypt; Rio de Janeiro, Brazil; Vienna, Austria; and Berlin, Germany.

LAND INFO offers this data as low as $22.00 per square kilometer. Full pricing, availability, and product information is available at the company's website, www.LANDINFO.com.

LAND INFO International provides digital geospatial information of the world, including satellite imagery, 3D models, and topographic maps. LAND INFO markets to engineers, government agencies, project managers, and other international professionals for a variety of GIS, remote-sensing, and land-use applications. For more information, visit www.LAND INFO.com.

Microsoft Hails 10 Years of Publisher

This autumn brings two reasons to celebrate Microsoft® Publisher: it marks the 10th anniversary of the Microsoft Office desktop publishing solution and the release of Microsoft Publisher Deluxe with Photo Editing version 2002. Publisher Deluxe gives customers all the features of Publisher 2002, plus the photo-editing technology of Microsoft Picture It!® Photo 2002.

Designed specifically for small-business users who do not have training in desktop publishing, Publisher combines design and layout tools to help users set up the most common types of sales, marketing and communications documents, including brochures and newsletters, as well as assist them in designing a web site. The Publisher Task Pane makes it easy for users to modify design elements, including Color Schemes and Fonts Schemes.

Publisher Deluxe with Photo Editing version 2002 is on store shelves now. The software gives users more tools to edit photographs before adding them to a Publisher publication and includes a CD with more than 25,000 images.

"The approach we took with the original version of Publisher was to give users a powerful set of tools, while making it easy for them to use

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those tools," said Adam Eversole, a lead software development engineer for Publisher at Microsoft Corp. and member of the original Publisher development team.

Released in September 1991, Publisher 1.0 was widely acclaimed for making design accessible to non-professional designers, garnering a PC Computing Most Valuable Product award and a host of other recognitions. Successive versions have met with similar success, and through the years, Publisher has remained one of the best-selling desktop publishing programs for everyday business users.

Publisher, the first desktop publishing program from Microsoft, introduced wizards, step-by-step instructional guides that walk users through the setup of almost any type of document and allow those without formal design training to make use of the application's professional-level tools. The concept quickly caught on, and wizards have since become common in Microsoft software and operating systems.

It's all part of Publisher's empowering approach, which has resonated with consumers since the beginning. "Publisher has stayed true to its roots," Eversole said. "For the past 10 years, Publisher has been giving customers increasingly powerful capabilities to produce professional-looking results."

Palm-Powered Handhelds Enable Improved Patient Care Within Hospitals

Handhelds based on the industry-leading Palm OS® platform are helping hospitals ensure smoother, more efficient patient care, such as streamlining post-operative patient-management, medication-monitoring and risk-assessment procedures.

Miami Children's Hospital Uses Palm-Powered Devices to Track Pediatric Cardiac Patients

The Pediatric International Heart Center at Miami Children's Hospital uses Palm Powered™ devices to track the post-operative management of pediatric cardiac patients in the Cardiac Intensive Care Unit (CICU). Physicians and nurses who once used paper forms to collect patient data now use handheld devices to gather the information and then transmit it wirelessly over a network to the hospital's clinical outcomes database.

"Using the Palm OS based solution, doctors and nurse practitioners can now spend more time with their patients, rather than spending time filling out paper forms," said Jeffrey White, biomedical engineer and software developer, Miami Children's Hospital. "Progress notes and billing summaries that used to take several hours to write by hand are now completed in several minutes. In life-and-death situations, hospital staff have the information they need at their fingertips and can share it quickly as needed."

West Park Healthcare Centre Monitors Patient Medication with Palm-Powered Handheld Devices

West Park Healthcare Centre in Toronto uses Symbol 1740 handheld devices running on the Palm OS platform to manage medication distribution at bedside and enhance the safety and security of drug administration to its patients and residents. Nurses use the handheld device to access patient profiles, review medication that needs to be administered, and scan bar codes on the medication labels. A warning appears on the handheld if the medication selected and scanned by the nurse is different from the medication ordered by the physician. Nurses also can use the handheld to scan the patient wristband to help ensure that the right medications are administered to the correct patient at the right time.

"What the Palm Powered devices provide is a way to monitor that the five 'Rs' of medication administration — right drug, right dose, right time, right patient, right route — are being followed," said Anne Marie Malek, vice president, Programs, at the centre.

St. Joseph's Hospital and Medical Center Emergency Room Uses Palm Handhelds to Assess Heart-Attack Risk

Doctors at St. Joseph's Hospital and Medical Center in Phoenix, AZ, use Palm™ handhelds to streamline heart-attack risk-assessment procedures. When patients enter the emergency room complaining of chest pain, doctors use the Palm handheld solution to access an evidence-based risk-assessment evaluation, recording answers to a series of patient questions. The handheld program provides a risk-stratification based on patient questions. The risk assessment is used to assist with the decision to admit patients to a Cardiac Care Unit vs. a short stay in the Chest Pain Unit. Doctors using the system can now have more data available to assist rapid decision-making.

More information on case studies and the use of Palm Powered handheld computers is available at www.palm.com/enterprise/studies.

Scientific Energy, Inc., Announces Completion of a 24-Hour Battery Pack for Laptop Computers

Scientific Energy, Inc., announced that it has successfully tested a newly developed battery pack that will power portable laptop computers for up to 24 hours.

Todd B. Crosland, chairman and President of Scientific Energy, Inc. stated: "The *preliminary* test results from the portable battery pack have reached 24 hours of continuous operation for a laptop computer. We are now focusing on the design of the battery pack, as well as performing additional tests at various temperatures to assess the functionality of the battery pack under extreme conditions. If the testing and development continue as planned we would anticipate having product ready for the market by mid 2002."

Crosland continued, "We are extremely pleased with the efforts of our research staff. We look forward to reporting our progress in the coming months."

Scientific Energy's technology is designed to be incorporated into existing portable electronic devices. The target market for this technology includes; portable laptop computers, handheld devices, cellular phones, and a variety of other electronic devices.

Gateway 910 Series Delivers Server Performance at a PC Price

Gateway, Inc., has introduced the Gateway® 910 Series entry-level server for growing small businesses and home offices that need reliability and solid server performance. With a starting price point comparable to a desktop computer — just $699.00 — the 910 Series will enable more small businesses to purchase a server for file and printer sharing, Internet access, and email.

"Many small businesses are looking to move to a network architecture for the first time, and they need both comprehensive services and reliable hardware to make it happen — that's why they turn to Gateway," said Jim Jones, vice president of segment marketing, Gateway, Inc. "As the leading provider of personalized technology solutions in local communities, Gateway is well poised to help

our small business customers enhance office efficiency and collaboration with our new server offering. The combination of performance, low price point, and exceptional support available when and where they need it makes the Gateway 910 Series the server of choice for any small business."

Gateway will support its 910 Series customers on several levels — through its nearly 300 Country® stores located across the US, online at Gateway.com, and through its nationwide network of service providers. At Gateway Country stores, small businesses can receive consultative services, training, and technology and application demonstrations. Free on-site consultation, installation, and integration services further assist companies with limited IT resources.

Small businesses without in-house IT support will further appreciate the user-friendly design of the Gateway 910 Series server. The mini-tower can be opened via its tool-less entry for quick and easy servicing, resulting in reduced system downtime and increased productivity. Once inside the system, changes and upgrades are a snap with color-coded tabs that direct users to easily accessible components. And drives are securely mounted without the use of any screws, allowing quick upgrades.

The Gateway 910 Series incorporates reliability and performance attributes typically found on high-level servers. The base configuration of the fully configurable Gateway 910C model includes:

-- A single Intel® 1GHz Celeron® processor with 128KB L2 cache. The processor is supported by ServerWorks' Champion LC-T server chipset, which further improves performance and network productivity

-- 128MB PC 133 Error Correction Code SDRAM

-- 20GB ATA IDE hard disk drive

-- Integrated motherboard for improved performance and system access including 10/100 Ethernet and PCI Graphics

-- Five PCI expansion slots and seven drive bays

-- 64-bit PCI I/O technology for optimal system performance

The Gateway 910L2 model, priced at $1,499.00, is an example of how the 910 Series can be well configured to meet a range of small business needs in environments. The Gateway 910L2 model includes:

-- A single Intel 1GHz Celeron processor with 128KB L2 cache

-- A total of 256MB of PC 133 ECC SDRAM

-- 40GB ATA IDE hard disk drive

-- Microsoft Windows 2000 Server with five client access licenses

-- Integrated motherboard with 10/100 Ethernet and PCI Graphics

-- Five PCI expansion slots and seven drive bays

-- 64-bit PCI I/O technology

The 910 Series servers offer manageability features that make it easy to use and maintain. The system's HP® OpenView™ ManageX Event software proactively monitors key system operations such as voltages, temperatures, fan speeds, and ECC memory to ensure security and reliability. The software also helps ensure maximum uptime by alerting users to potential problems and allowing them to plan for preventative maintenance accordingly.

Gateway also introduced the Gateway 935 Series, a 1U-height rackmount server line, which gives customers fast, reliable performance, backed by Intel's 1.13 and 1.26GHz Pentium® III processors with 512KB high speed L2 cache. The system's slim 1.75-inch high space-saving design is ideal for small and medium businesses that have increasing server requirements, but limited physical space. Unlike many competitive systems, the Gateway 935 Series supports up to three hot-swappable hard disk drives, another must for growing and evolving businesses, such as Internet hosting sites. It is available at a starting price of $1,799.00.

The Gateway 910 Series server is backed by a one-year parts and labor, and on-site limited warranty. The 935 Series is backed by a three-year parts and labor, and on-site limited warranty.

The Gateway 910 and 935 Series can be ordered directly from Gateway by calling 800-846-2106, visiting the company's web site at www.gateway.com, or going to one of nearly 300 Gateway Country stores nationwide. **NV**

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AIBO TURNS TWO (Part 2)

by Jeff Mazur

The world of AIBO — Sony's robotic pet — continues to evolve. Last month, we discussed the wireless LAN card and some new software from Sony.

We continue now with a look at several other programs, most available for free over the Internet.

As described last month, AIBO Master Studio is a great program for creating custom behaviors and motions. However, the AMS motion editor lacks the ability to alter individual joints separately. Every keyframe specifies the position of all joints making it difficult to build up a motion joint-by-joint. For example, in creating the dance routines I discussed last month, it would have been nice to finish the entire body motions and then go back to animate AIBO's mouth separately.

Motion File Tools

One solution to this problem can be found on DogsBody & Ratchet's Domain website. The site offers a series of free tools to address this and other shortcomings of AMS. These tools are MSDOS command-line driven (no Windows interface), but are real timesavers. Here is a brief description of each of the five tools:

TAILWAG — Automatically generates tail wagging and applies this to an existing motion file. You give as parameters the motion filename, the angles and speed of wagging (both horizontally and vertically), and optionally, start/stop frame numbers.

MCOPYJOINT — Copies head/tail/leg position from one frame to one or more other frames. You can copy as few or as many joints as needed. You give as parameters the motion filename, the source frame, the start/stop frames to be altered, and finally a list of target joints.

MMIRROR — Mirrors head/tail/leg movements left to right and vice versa.

You give as parameters the motion filename, the body parts to mirror, and optionally start/stop frames to be changed.

MREFLECT — Reflects a motion file around a given frame (i.e., plays it backwards after the reflection point) You create your performance, and then have this program create the reverse to undo it back to the starting point. Parameters are the motion filename, and the reflection frame.

MSCALE — Adjusts motion file timing to match sound files. This program adjusts the spacing between keyframes. As mentioned last month, Master Studio doesn't accurately estimate the speed at which AIBO plays motion files. Thus, motion, sound, and LED performances diverge over time on AIBO versus the Action Composer simulation. The "Test Action" command also has problems because motion files played under RCode run slightly slower than when tested stand-alone. MSCALE can adjust motions (from one-half to twice normal speed) to compensate for these variations.

While these tools can be a real lifesaver when choreographing long routines such as dances, it still requires more effort than should be necessary. You have to save your work in AMS, switch to DOS, figure out the correct parameters, type in the DOS command, return to AMS, and finally reload the changed motion file. Hopefully, future updates to AMS will include functions like these or perhaps even a "plug-in" architecture so that third parties can add new features directly within the program.

Sony AIBO Messenger

While AIBO won't be fetching your newspaper any time soon, with the AIBO Messenger software you can have AIBO check your favorite websites and email, and read aloud what it finds there. The text-to-speech algorithm used is quite natural and there is a configuration page that lets you help AIBO speak certain words correctly. You also can select a speaking voice and speed for AIBO to use for normal text and a second voice to be used for quoted text within emails (see Figure 1).

Setting up Messenger is quite simple, once you get the wireless LAN card working (see last month). Although there are some restrictions on which email programs can be used, I had no trouble configuring it to work with Microsoft Outlook Express. You can also set an optional password to restrict access to your account. For web pages, you preset up to five URLs which are then accessed with a voice command such as "Read page number two."

As AIBO reads aloud an email or web page, it flaps its mouth in time with the speech. It often becomes quite animated, wagging its tail or flapping its ears. Its head also moves and tilts in an eerie fashion as if it

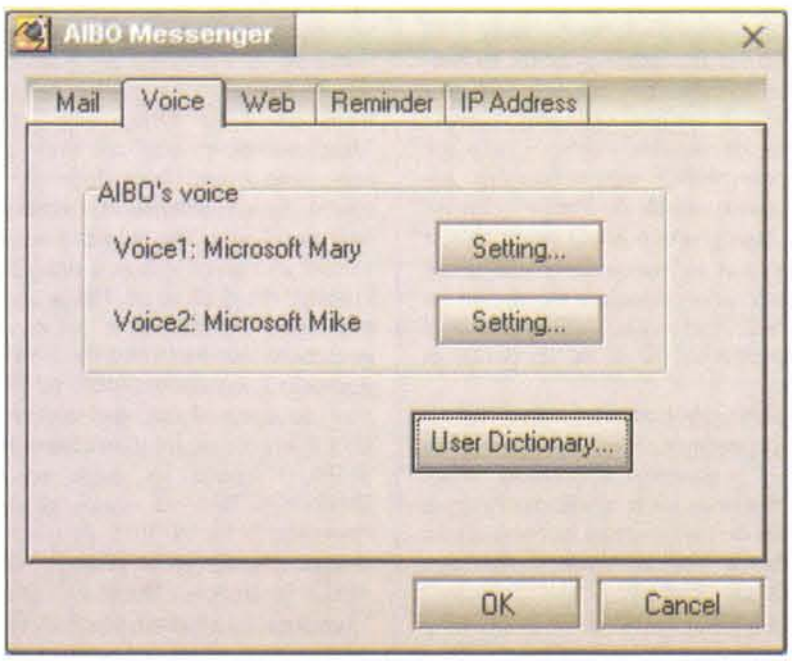


Figure 1. Setting AIBO Messenger's voice configuration.

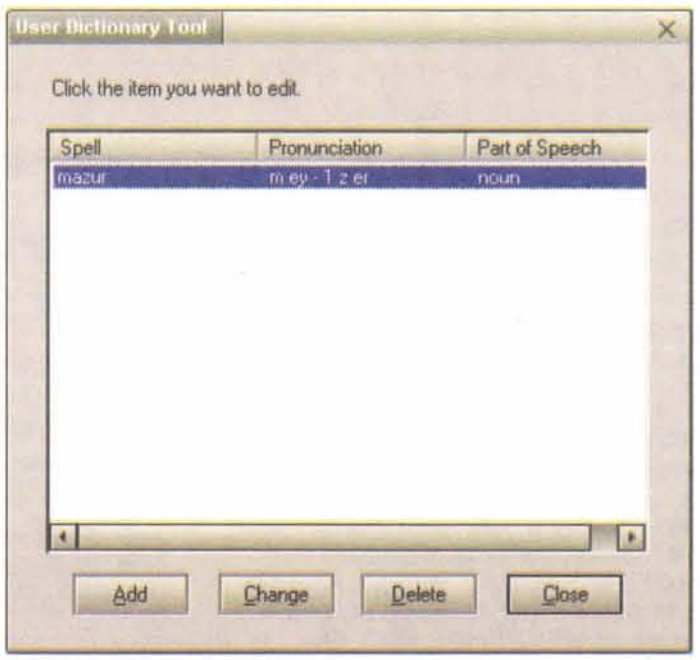


Figure 2. Using the User Dictionary Tool.

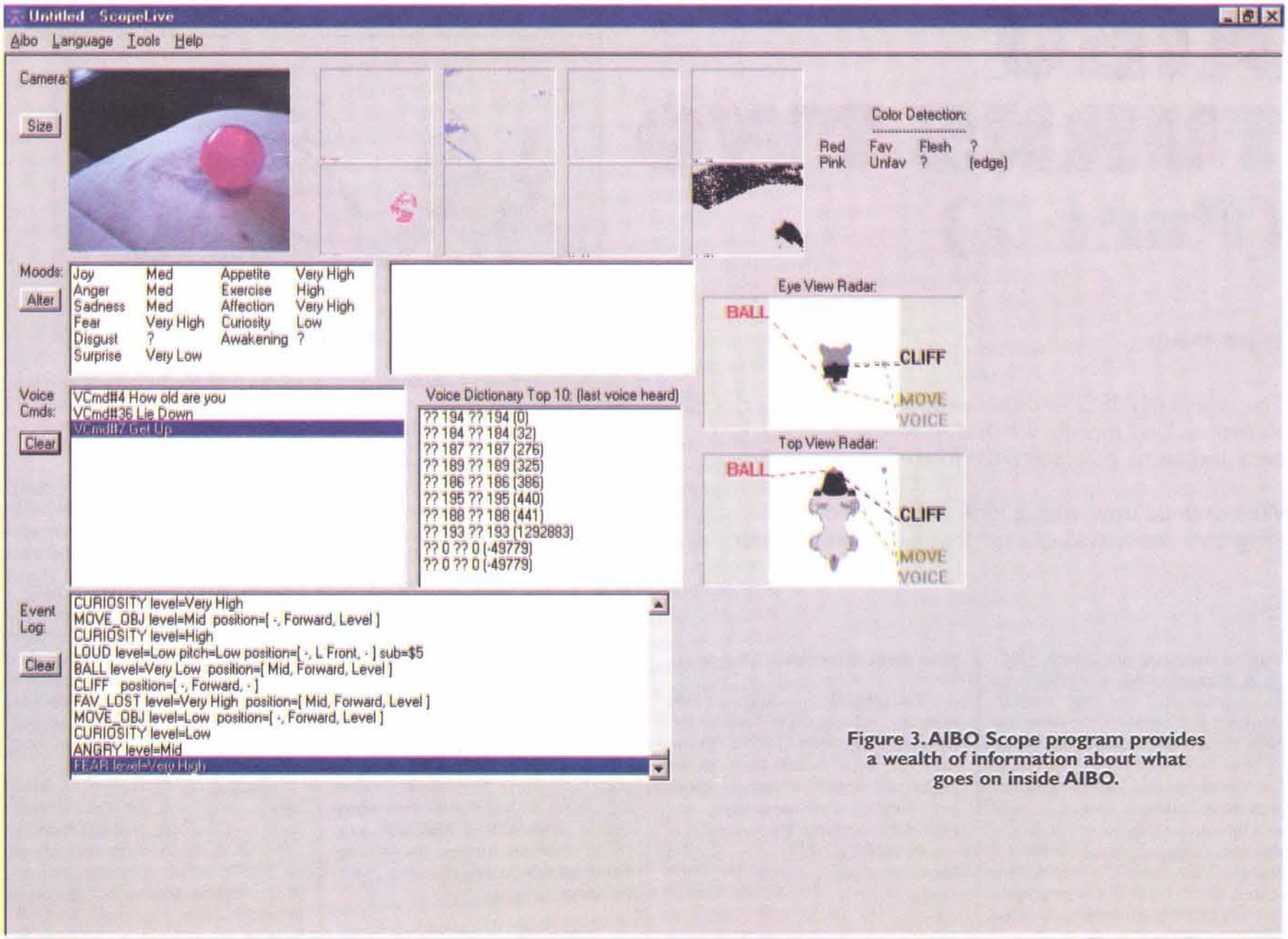


Figure 3. AIBO Scope program provides a wealth of information about what goes on inside AIBO.

really is talking to you. Certain key words will prompt AIBO to make particular motions. For example, when speaking the words hello, good morning, goodbye, etc., AIBO will wave its paw; it takes a bow after reading, "thank you." Words that express yes/no, happy/sad, and weather-related conditions also evoke an appropriate response. A complete list of key words is provided in the User's Guide.

While AIBO is speaking, it will not respond to further voice commands. However, AIBO's touch switches can be used to stop, re-read, or scroll through your email or web pages. Unfortunately, when not actively reading, AIBO doesn't do much of anything else. It will make cute noises and perform short skits, but otherwise just lies there. It doesn't even recognize its own name. I'll have more to say about this later. Also, as with all AIBO software, the voice recognition is sometimes "iffy" and you must make sure AIBO is in the correct mode (either sitting or lying down) for certain commands to work.

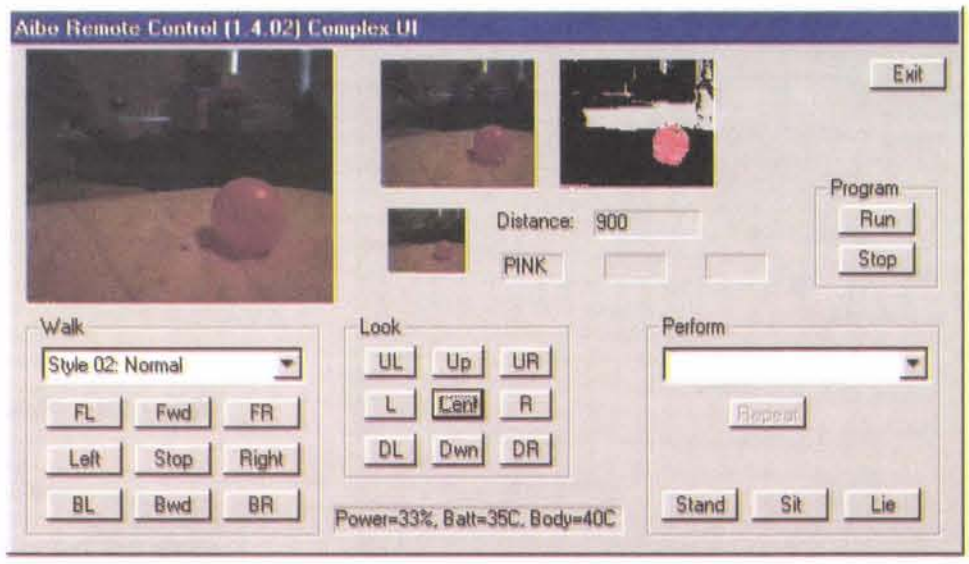
The User Dictionary contains a list of correct pronunciations. You specify pronunciation using 40 phonemes and other symbols to designate syllable boundaries and primary (and optional secondary) stress points, or accents. Without help for example, AIBO mispronounces my last name which is Mazur (rhymes with laser). When AIBO reads this, it comes out as "masser." By adding the correct pronunciation as shown in Figure 2, I can make AIBO appear as if it's known me all of its life (which it has!).

Strangely however, I also had to tell Messenger how to pronounce "email" correctly! Common email abbreviations such as RE: and FW: get spelled out when read, but you could configure the dictionary to have AIBO say "regarding" and "forward" instead. I also found some interesting surprises as AIBO read "Sept. 12" as "September 12," enunciating the full word from its abbreviation.

On the downside, I was disappointed to find AIBO having trouble speaking some of its own "canned" phrases. For example, when opening an email which is blank or contains only attachments, AIBO proudly announces, "There is no text to read out." The only problem is that AIBO pronounces the second to last word as if it were spelled "red." So much for its grammar engine. One can only wonder why Sony didn't hard code these phrases phonetically correct.

There is also a glaring omission from the User Dictionary Tool: a "Test" button to play out your phonetic entry and hear how it will sound. As a workaround, I created a new email with the words I wanted to test and saved this as a draft. Then I moved the draft to my Inbox so that Messenger would see it (of course, you could also just send the email to yourself). Then I asked AIBO to "Read mail" so it would read the latest message in my Inbox. If I didn't like what I heard, I could go back to the Dictionary Tool to make changes. However, I found that you cannot change Messenger's settings when AIBO is in the "Reading" mode. Therefore, you must issue the "Finish reading" command and wait for AIBO to lie down before you can access the

(a)



(b)

Figure 4. AIBO Remote's soccer (a) above, and complex (b) user interfaces shown at right.

configuration screens. After making the changes, you then have to go back to the reading mode (AIBO sitting) and try again.

Messenger has a couple of bonus features. You can ask AIBO for the current time, which it will speak back to you. There is also an alarm/reminder feature that you can configure to have AIBO speak any message at a given time.

AIBO Scope and Other AiboPet Contributions

While Sony has been busy creating new applications for AIBO, our favorite AIBO guru has also been hard at work. AiboPet first brought us Disco AIBO, Bender AIBO, and Obey Cat. Then, along with RCode Plus, AIBO Life Plus, and MasterStudioPlus, we got many of the features that Sony should have put in from the beginning. More importantly, these new tools unveil even more of the inner workings of AIBO and are invaluable in probing exactly what goes on inside your favorite robot pet.

AIBO Scope may be one of the best programs written to hack into the psyche of your AIBO. It works in conjunction with AIBO Life Plus (a modified version of Sony's AIBO Life). As shown in Figure 3, there is a color view of AIBO's camera in the upper left. To the right are eight color-separated views showing the favorite color and pink views, as well as an edge-enhanced image. This really helps show how AIBO's pattern recognition works.

Below this is a readout of the various mood variables used by AIBO to direct its actions. Then comes a list of the last voice commands that were recognized. This is augmented by the top 10 matches in the voice dictionary for the indicated command (indicating how AIBO looks for the closest match between what it hears and the list of commands stored in its dictionary). With this window, you can finally see all of the voice commands that AIBO hears, especially the ones that it seems to ignore. I often wondered whether AIBO was having difficulty with its speech recognition. Now I can see that it's not a problem with recognizing a command, AIBO just chooses to ignore it!

Below this is an event log that offers lots of juicy nuggets as to what AIBO is thinking. Finally, there are two screens to the right which indicate the direction of various stimuli to AIBO. One shows a forward-looking view and the other a bird's eye view. From these two "radar screens," you can tell where AIBO thinks a sound came from or where its ball is. It also shows the position of any cliffs sensed by the IR rangefinder, or any objects that seem to be moving. Here is proof that AIBO can use its stereo microphones to sense the direction from which a sound is coming. This can also be seen with the "ComeHere" command in ObeyCat, where AIBO follows you around by the sound of your voice.

AIBO Remote

The AIBO Remote program is similar to Sony's Navigator software, except that it's free! It also gives you three different ways to control AIBO: using a very simple interface — one that's soccer oriented with various kick buttons (Figure 4a) — or the full-blown configuration shown in Figure 4b. This program also shows various real time and edge detected views of what AIBO sees through its camera, as well as information from the IR sensor and the built-in pattern (color) recognition detectors. You can direct AIBO to walk in one of eight directions using any of over 40 different walking styles, such as creeping, skipping, careful, jiggy, or even limping. You can also have AIBO perform one of more than 1,200 actions or have it run a custom program created in AIBO Master Studio. Although most of the built-in actions have Japanese names, many are readily recognizable such as stand_smell, lookaround, and sneeze.

AIBO Cam

AIBO Cam is a simple capture program that records AIBO's video to an AVI file. As shown in Figure 5, you can select one of the three image sizes that AIBO uses, gaining resolution at the expense of frame rate. You

RESOURCES

AiboPet
Lots of great AIBO info, tools, and software
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A.L.I.C.E. AI Foundation
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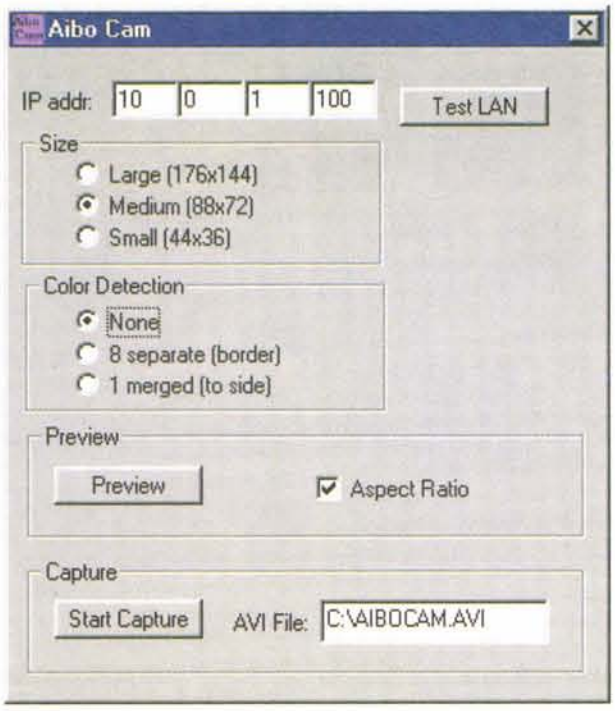

Figure 5. AIBO Cam captures video to an AVI file.

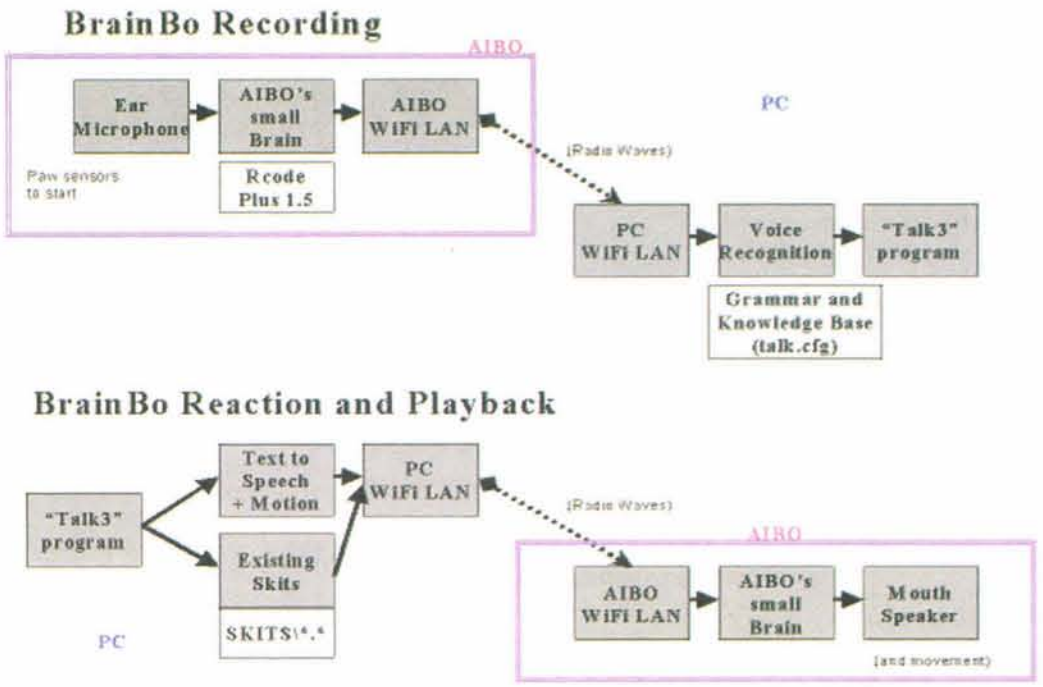

Figure 6. Block diagram of the BrainBo program.

can also elect to record the color detection images in one of two formats. Audio recording is promised for a future release.

BrainBo

This is the latest creation from AiboPet and opens up a new realm of applications for AIBO. BrainBo puts AIBO's voice recognition and speech skills on steroids. But it does this by moving all of the processing power onto your PC and basically just uses AIBO's microphone and speaker for input/output.

This brings the full power of your PC — running Microsoft's Speech.net software — to bear on the task of voice recognition and speech response. This software is available for free as part of the Microsoft Speech SDK (Software Developer's Kit) and includes the Microsoft continuous speech recognition engine (MCSR) and Microsoft concatenative speech synthesis engine (also called text-to-speech).

Using the wireless LAN card, your PC receives audio from AIBO and sends responses back to be "spoken" by AIBO. The responses come from a database which, at present, is mainly derived from a natural language program called Alice; this lets you hold a limited conversation with AIBO. For example, you can ask AIBO, "How do you feel?" and it will respond, "I am fine." Or you can ask, "What is 30 divided by four?" and get the response, "seven point five."

Figure 6 illustrates how AIBO interacts with the various programs on the PC. To aid in recognizing voice commands, BrainBo normally operates in a "push-to-talk" mode; you press one of the paw switches, wait for an LED "record" light, and then speak your command or query.

The recorded audio is then sent via the LAN card to the PC where the Speech.net software interprets the speech and sends it as text to the talk3 program. Talk3 then searches its grammar and knowledge databases to form an appropriate response. The reply is then converted from text to speech and finally sent as audio to AIBO where it comes out its speaker. Of course, all of this processing and network transfer takes considerable time, so AIBO may take up to four seconds to respond.

BrainBo can also be put into a continuous listening mode, eliminating the need to press the paw switch. As you might guess however, the voice recognition performance drops dramatically as can be seen on the PC status screen. Noise and superfluous talking make it difficult to determine exactly when a command is being spoken.

It is not hard to imagine how other programs could take advantage of BrainBo's concept. True, the PC could perform all of these functions without AIBO. Even as a remote microphone/speaker linked via a wireless LAN, AIBO extends this capability to users not sitting in front of a PC. But of course, you cannot dismiss the "adorable factor" of holding a conversation with a small pet-like creature that can also perform small skits at the same time.

Aside from the advanced voice recognition and basic math skills, BrainBo also does other tricks. You can ask for the time/day, AIBO's battery condition, or temperature. If you place an object in front of AIBO, you can ask what color it is and how far away it is from AIBO's nose. Of course, you can tell AIBO to "Take a picture," and it will do so, placing the image on your PC. And here's a new twist — ask AIBO to "Take a memo" and it will begin recording your voice; you tap its head lightly when finished. This voice recording is saved as a WAV file on the PC and the last recording can be played back by asking, "What was the last memo?"

More Advanced Utilities

Several other nifty programs can be used to explore AIBO's programming. AIBO Terminal, found on the COOL Online website, lets you talk directly to the RCode interpreter using a telnet connection. AiboPet's PidWalker is also an advanced tool that gives direct control over the servo characteristics in AIBO's joints. This can be used, for example, to change the way AIBO walks. Figure 7 shows how to manipulate these parameters.

As explained in the PidWalker instructions, "AIBO's servo control uses a standard "PID" algorithm to move the servo from its current position to a desired position. The algorithm uses three terms: Proportional, Integral and Derivative. By adjusting these terms, you can adjust the movement speed, strength, and bouncy-ness of how the legs move. (NOTE: Head and tail servos are also included, but most interesting PID values to change are for the legs.)

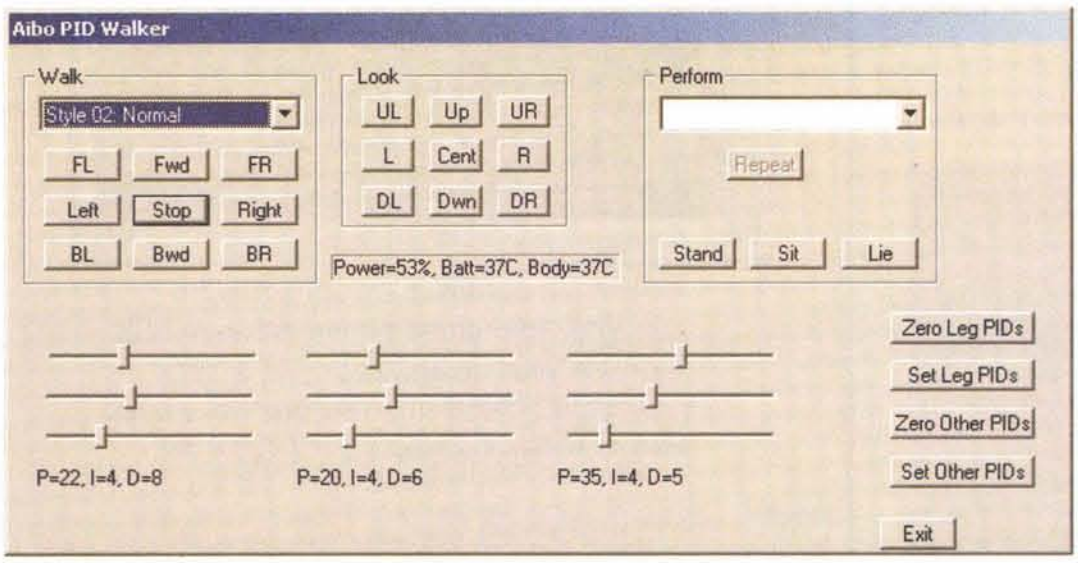

Figure 7. AiboPet's PidWalker program.

Conclusion

Since one of AIBO's most revolutionary features is its autonomous capability, it is interesting to note that programs such as Messenger and BrainBo move much of this function onto a host PC. While one can argue whether or not this diminishes AIBO's autonomy — after all, it now

Meet the Latest AIBOs

Next month, we'll introduce you to the newest additions to the AIBO line: LATTE and MACARON, also known as the ERS-311/312. Further down the road, we'll see the ERS-220, an update to the ERS-210. Hopefully, we can shed some light on this new model, as well.

depends upon an operating PC within wireless range — it certainly does not lower the coolness factor as you interact with this increasingly intelligent creature.

One problem I am beginning to observe as more programs become available for AIBO is this: You have to load a different memory stick into AIBO (and often have to run a special program on the PC) to get your pet to perform in one specific way. It seems critically important that some method be found to run more than one program at a time.

For example, why must I give up the functionality of AIBO Life just to run Messenger? It's like the early days of PCs when you had to load a dedicated floppy disk (or even earlier, a cassette tape) each time you wanted your computer to do something different. Kudos however go to AiboPet for including several Disco AIBO routines in BrainBo while also using the same program files on the ObeyCat memory stick.

Since Messenger requires 3.4 MB and AIBO Life consumes 3.1 MB (not including diary entries and photos), it is clear that larger capacity memory sticks would be necessary. While all current memory sticks for AIBO only hold 8 MB, larger sticks have been made for Sony's digital cameras and other computer uses.

Assuming that AIBO's other hardware can support larger sticks, perhaps we can soon see a mechanism for running multiple programs. Then this incredible robotic pet would indeed seem to grow — performing new and better tricks as we continually add new software.

Who said you can't teach an old dog new tricks? **NV**

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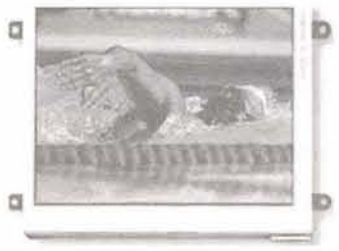

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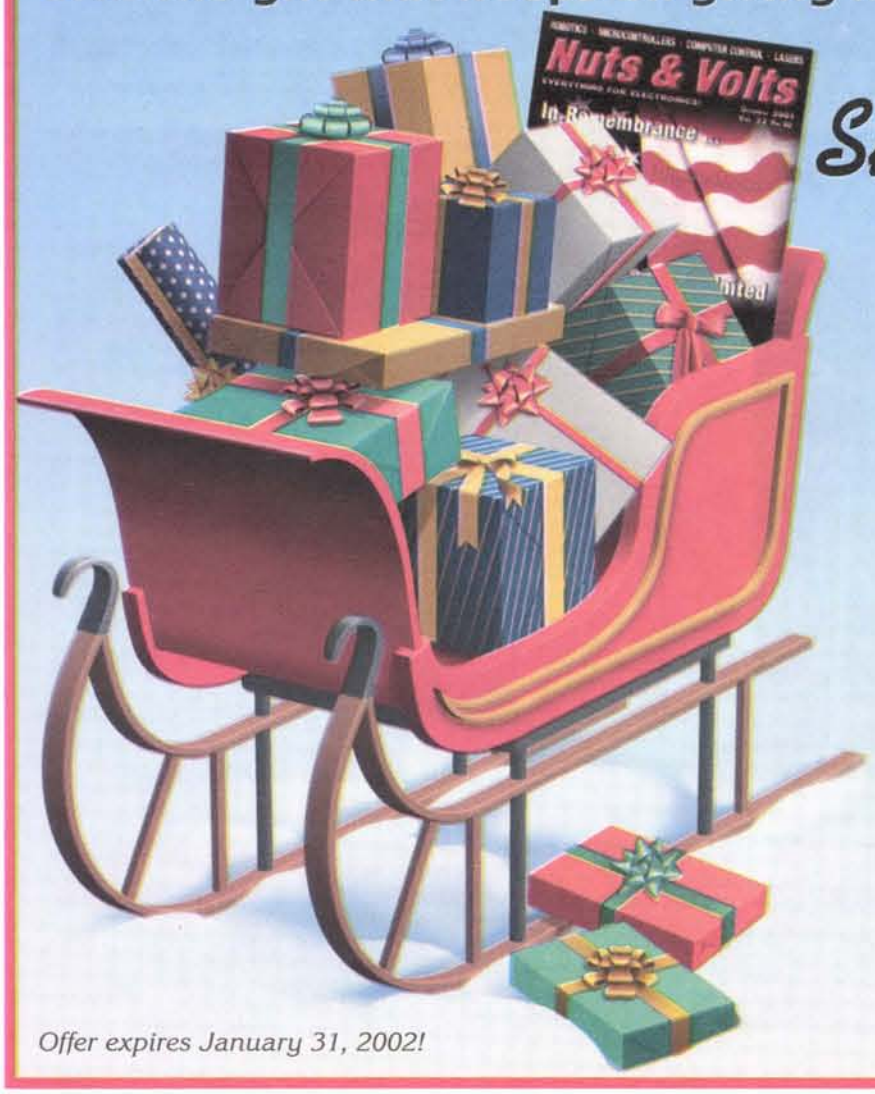

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New Product News

REMOTE ANYWHERE REMOTE CONTROL RANGE EXTENDERS

The Leapfrog family of products from TERK announces its latest solution for multi-room transmission of audio/video signals without additional wiring – the Remote Anywhere RF remote control range extender.

Remote Anywhere converts the infrared signal from a standard remote control into a long-range RF radio signal, allowing a remote control to operate any audio or video component from virtually anywhere in the home – whether it be the garage, lazy boy, bedroom, or outside pool lounger.

Remote Anywhere allows consumers to control their satellite receiver, A/V components, TiVo™, DVD player, tuner, etc., from other rooms up to 150 feet (46 meters) away. This capability is especially useful to owners of satellite systems looking to view programs from a single receiver or recorder on different televisions throughout the home, without purchasing another unit or incurring additional monthly programming charges. Remote Anywhere puts the full functionality of any satellite system right at the user's fingertips.

Remote Anywhere utilizes the 418 MHz frequency band, which delivers flawless, interference-free performance and allows the product to command components through walls and floors (upstairs or down, inside or out) via long-range RF signals. Remote Anywhere is ready to use instantly; by mounting the sending unit into the remote and plugging in the receiver, the product is ready for operation in seconds.

Remote Anywhere comes complete with all the required equipment, including batteries. Simply take it out of the box, set it up, and enjoy the show.

Available and shipping now, TERK's Remote Anywhere Remote Extender has an MSRP of $49.95.

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LOW-COST USB DAQ

LabJack Corporation announces the immediate availability of the inexpensive and easy-to-use LabJack U12.

Featuring USB connection, watchdog timer, 12-bit analog inputs (8SE/4Diff) with PGA, two analog outputs, 20 bits of digital I/O, and a 32-bit counter. The device provides a versatile interface between a PC and the real world.

Software timing provides update rates up to 50 Hz for all parameters, while hardware timing enables analog/digital input rates up to 1,200 Hz (continuous) or 8,192 Hz (burst).

Most connections are accessed using built-in screw terminals, eliminating the need for costly connection blocks.

Priced at $99.00, the device includes a USB cable, example application software, and drivers (DLL, ActiveX, VIs) that work with most languages including C, Visual Basic, and LabVIEW. Drivers are currently available for Windows 98SE/ME/2000/XP. All software and documentation can be downloaded for free at www.labjack.com.

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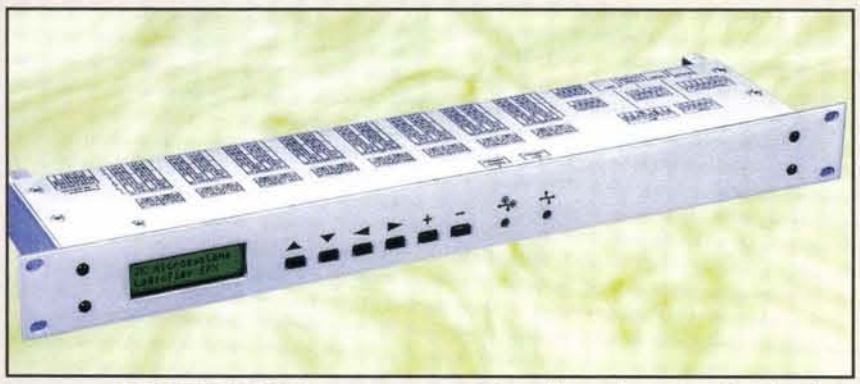

LOGICFLEX-EPX

By combining the LogicFlex controller with many desirable I/O features, the new LogicFlex-EPX is an excellent and powerful control solution.

Packaged in a slim 1RU rack mount enclosure, the LogicFlex-EPX uses two-part detachable screw terminals to easily integrate existing equipment without costly interface boards. This eliminates many wiring problems commonly associated with board-level product integration.

The LogicFlex-EPX incorporates 16 optically isolated inputs, 16 relay outputs, two serial ports, and onboard Ethernet, which connects directly to 10BASE-T networks. A back lit LCD, six push buttons, expansion bus for peripheral boards, optional eight-channel A/D, and flexible storage options, all add versatility to the LogicFlex-EPX system.

The LogicFlex-EPX is priced at a low $499.00 in single quantities. The development kit, which includes a LogicFlex-EPX, AC adapter, cables, manual and programming software with utilities is available for only $599.00.

For more information, contact:

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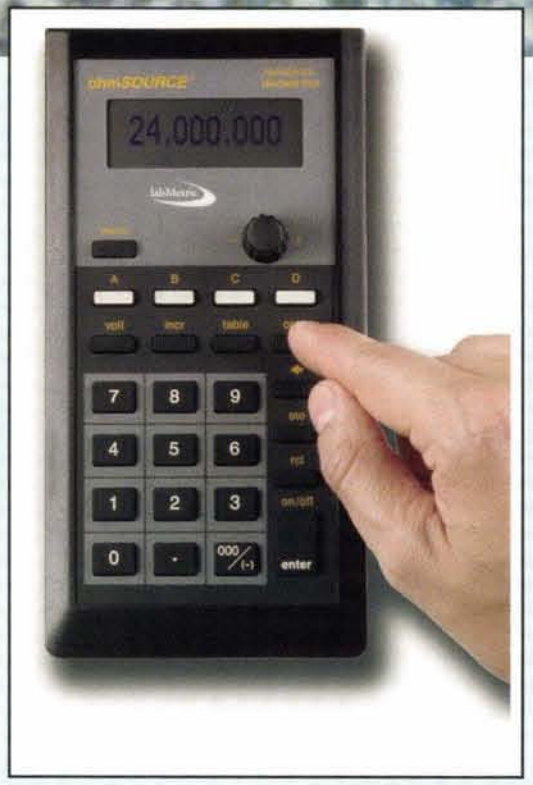

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The ohmSOURCE Resistance Decade Box is a high-precision resistance substitution device with a unique thermistor simulation feature.

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This device is ideal for circuit designers who need to simulate thermistor function without constructing a real-life environment. Also, this device can be used to calibrate devices and systems utilizing thermistors.

Other features of this resistance substitution device include 14 value memory keys for quick value recall, a current limiting feature to prevent overload damage to the device components, 100% device mechanical isolation from output resistance, automatic residual resistance added into output, an open key for immediate isolation from circuit being tested, field calibratable, and flash updates.

Pricing for the ohmSOURCE Resistance Decade Box starts at $499.00 with free ground shipping.

For more information, contact:

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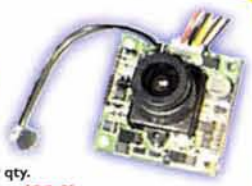

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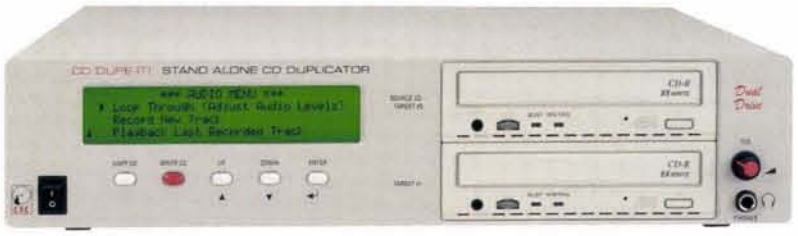

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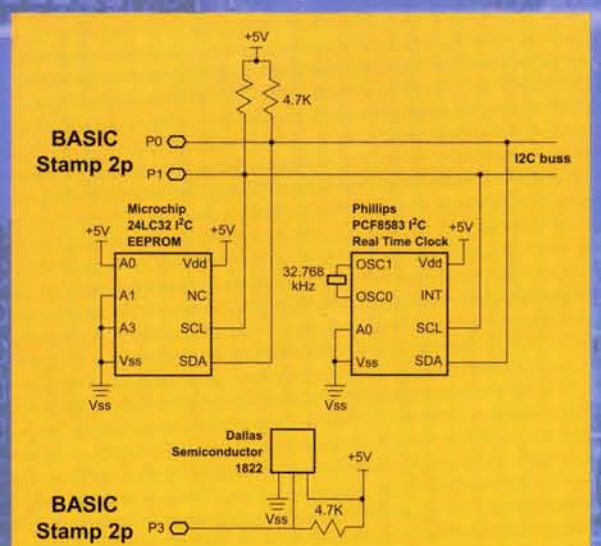

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