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Electronics NOW
Combined with Radio Electronics
Vol. 70 No 10

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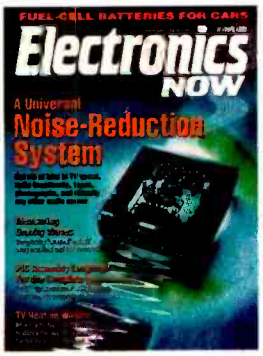
ON THE COVER

27 Universal Noise-Reduction System



Most noise-reduction techniques require that the original source material be specially encoded. One example of that is Dolby noise reduction that is often used with prerecorded audio tapes. However, there are countless other audio sources that suffer from white noise—or hiss—that could benefit from some noise reduction...and this month's cover project provides it. The Universal Noise-Reduction System is easy to install and does not require pre-processed material to be effective. It also features an audio compressor that can be used to reduce the volume of excessively-loud TV commercials. — *Richard Panosh*

TECHNOLOGY

BUILD THIS

DEPARTMENTS

AND MORE

ELECTRONICS NOW, (ISSN 1067-9294) October 1999. Published monthly by Gernsback Publications, Inc., 500 Bi-County Boulevard, Farmingdale, NY 11735-3931. Periodicals Postage paid at Farmingdale, NY and additional mailing offices. Canada Post IPM Agreement No. 334103, authorized at Mississauga, Canada. One-year subscription rate U.S.A. and possessions $24.99, Canada $33.15 (includes G.S.T. Canadian Goods and Services Tax, Registration No. R125166280), all other countries $33.99. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $4.99.

POSTMASTER: Please send address changes to ELECTRONICS NOW, Subscription Dept., Box 55115, Boulder, CO 80328-5115.

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EDITORIAL

The Late Shift

Love the Internet or hate it; spend hours a day or never go there; what you can't deny is that the Internet has changed "everything." When it comes to commerce, communications, and information, the Internet represents the "mother of all paradigm shifts."

Let me explain what I mean. A paradigm is, in essence, a set of laws, assumptions, and/or procedures that describe how things "get done." However, since the only constant is change, it is inevitable that due to some set of factors, some paradigms cease to work. When that happens, a paradigm shift is said to have occurred.

Some paradigm shifts sort of sneak up on us, taking years, decades, or centuries to occur. Those hardly anyone notices. Others occur with the suddenness of a gunshot, and sometimes with equally devastating results to those unable to shift with the paradigm.

The Internet, of course, falls into the latter category. And while it has had a profound effect on individuals, that is nothing at all compared to the effect it has had on business. One of the latest to have to deal with a rapidly shifting paradigm is the music industry.

In the July issue of **Electronics Now**, our "Computer Connections" column introduced you to the new world of Internet-distributed digital audio, or, more specifically, MP3 files. Among other things, that format allows new or alternative artists to bypass the recording industry and distribute their work in a high-quality format directly to the public. It also lets traditional record companies and artists distribute promotional tracks to publicize upcoming releases. Coming away from the Internet, using software "rippers," users can create MP3 files from their own CDs for storage on their PCs or for play on new portable hardware players.

Unfortunately, there is a dark side to the MP3 explosion, and the last point mentioned is the key to it. While there's nothing wrong with making MP3 files of your own legally purchased music for your own use, the Internet abounds with illegally "ripped" MP3 files of commercial CDs, and that fact has the music industry scared witless. To combat the spread of MP3 files, the recording industry filed suit (and lost) to ban the sale of MP3 players that did not meet the provisions of the 1992 Audio Home Recording Act.

They've also established a closed, competing standard called SDMI (Secure Digital Music Initiative) to compete with MP3; their aim is to have players on the market by the holiday season. And, of course, it will most likely fail as badly as DIVX because the recording industry does not "get" the paradigm shift.

For one thing, there is talk that the SDMI standard includes a provision that could someday prevent compliant players from using open MP3 files. That won't fly. The public, in general, and the Internet public in particular, will not stand for a closed system in this new age of open information. Yes, some way to protect the rights of recording artists is needed, but not at the expense of those artists who want to reach the public directly.

While we have lot's more to say on this topic, space does not permit. If you want to learn more about MP3, SDMI, and the related issues, you can visit www.mp3.com and www.eff.org (the Electronic Frontier Foundation) on the Web. Happy Listening!

Carl Laron
Editor

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Soldering Revisited

I was delighted to read Skip Campisi's article "How to Succeed In Soldering" (**Electronics Now**, July 1999). I have been soldering electrical and electronic projects somewhat longer than Mr. Campisi and have been mightily puzzled by the persistence of conventional soldering instructions. Mr. Campisi is absolutely and completely right.

I wonder how many people have become discouraged and have given up when following conventional instructions.

H. C. DOENNECKE
Tulsa, OK

Help Wanted

I need information on how to hook up a "Rustrak" Model 288 Strip Chart Recorder. It seems to be operational, but I don't know how to input a signal to it. A current address for this company (a division of Gulton Industries) would be appreciated, too.

Thanks for your help.

RICHARD FLAWS
212 Mondovi Drive
Oswego, IL 60543-8408

More April Fooled

I would like to congratulate you on a well-written article "The EC909-12 Analog Microprocessor" (**Electronics Now**, April 1999) by Ken Kemski. The only thing that I caught that made me wonder if it was for real was the fact that it seamlessly went into the processor slot and could accept the new "analog memory with no motherboard modifications" and current hard drives are set up to 1 and 0, so that was another problem. However, when I first read it I believed it until I thought about it a while. The April 1 thing went right by me at first.

I hope you enjoyed your laughs, because I sure as heck did.

NAME NOT PROVIDED
via e-mail

You might think it's funny to place an article about an analog processor in your April issue, but I don't. I purchased this issue after quickly looking at the contents, intending to read it fully at home. From this day forward, you can guarantee I won't purchase another magazine of yours again. I will also convey this story to as many friends on the Net and at home as I can to show that there are better sources of information.

MARC HUDSON
via e-mail

You got me! I was suspicious because I fell for another April Fools joke in *PC Computing* where they said that there was a microphone hidden in every computer since 1996 and that employers and ISPs could use these to eavesdrop on you within 5 feet of your computer. But I wish the EC-909-12 was true. You guys will have to get busy and build one.

PHIL JOHNSON
via e-mail

"Four-Star" Rating

The item "Twinkle, Twinkle, Little Lights, and More" in "Tech Musings" (**Electronics Now**, June 1999) brought back memories for me. While serving as Electronics Material Officer on board the U.S.S. Saratoga CVA 60 in 1960, I made the described neon light device in the shape of the symbol on the rating badge for Electronics Technicians in the US Navy. I then hung it from the cable trays in the overhead with #32 enameled wire so that it was about a foot in front of my desk. It appeared to float in the air and always got a lot of comments.

After finishing the assembly, I masked the glass portions of the lamps and spray painted the whole thing with gold colored paint so you could not read the values of the components. Paint did not affect the operation.

I have enjoyed your publication for many years.

ROY A. NORMAN
Brunswick, GA

EN

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

EQUIPMENT REPORT

EPSON POWERLITE 7500C PORTABLE MULTIMEDIA PROJECTOR

Epson's new compact multimedia projector weighs less than 10 pounds but is loaded with convenient presentation features.

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It is many people's job to visit another company or group of individuals and put on some sort of presentation. Of course, today's technology permits far more interesting presentations than yesterday's simple chalkboard or overhead projector did. Typically one will deliver a presentation today using a notebook computer. Modern computers allow presentations to include fancy color, graphics, sound, video, and more.

The problem with doing presentations on a notebook computer is that not too many people can see the presentation at once. Even with a 15-inch display, a notebook computer's screen can only be viewed by two or three people at once. The solution to this problem is a multimedia projector. Similar in theory to a TV projector, a multimedia projector, at the very minimum, accepts a VGA input from a computer and projects an image onto a wall or screen that an auditorium filled with people to see.

The Epson PowerLite 7500C

Presentation projectors are getting better all the time, and the Epson PowerLite 7500C is a perfect example of that. This compact multimedia projector weighs only 9.4 pounds and measures 9.3 inches wide by 13.6 inches deep by 3.6 inches high, yet it features a bright, 120-watt ultra-high-efficiency lamp rated at 800 ANSI lumens. The lamp should remain adequately bright through 400 hours of use. The projector has a native XGA resolution of 1024 × 768. An infrared remote control is included.

The best thing about the PowerLite 7500C is its simplicity and ease of use. Not loaded down with features that nobody will ever use, the unit packs in all necessary features such as built-in stereo audio and composite and S-Video inputs in addition to VGA. Keeping the feature set lean makes for a compact, lightweight unit that is not at all confusing to use. That is important because a lot of people who must use projectors are not as technically adept as the typical **Electronics Now** reader. The PowerLite 7500C simply powers up and automatically projects the active input. The PowerLite 7500C is compatible with PC and Mac computers.

The PowerLite 7500C has VGA, S-Video, composite video, and audio inputs. The unit supports NTSC, PAL, and Secam video. Not only can it be used for computer presentations, but the 7500C also turns a DVD player into big-screen entertainment system. The PowerLite 7500C also has built-in 1-watt amplified stereo speakers that are powerful enough for a roomful of people to hear. Sound is enhanced with SRS 3D technology. Users can connect the projector to more powerful audio systems for doing larger presentations.

In the most basic setup, the VGA output from a notebook or desktop computer connects to the VGA input on the PowerLite 7500C using the included cable. When the projector is turned on, it automatically displays the active input. Epson's second-generation resizing technology allows the PowerLite 7500C to automatically compress inputs of 1280 × 1024 (SXGA) or enlarge VGA or SVGA resolutions of 640 × 480 or 800 × 600 to fill the projected 1024 × 768 image.

The PowerLite 7500C comes with mouse cables for PC and Mac computers that allow a connection between the host computer's mouse input and the mouse output on the projector. Then the remote that comes with the projector can be used to control the PC just like using a mouse.

The same remote can be used to adjust the projector settings from a distance. Both the remote control and the control panel on top of the PowerLite 7500C can be used to turn power on and off, access help functions, switch between input sources, resize the display, freeze the display, mute and black out audio and video, and adjust on-screen functions. On-screen functions include image settings, audio and video settings, and special effects. Adjustable-height feet make the PowerLite 7500C easy to aim.

A ceiling mode turns the output image upside down so that if the projector is mounted upside down on a ceiling as might be the case in a permanent installation, the projected image appears right side up. A rear-projection mode flops the image so that it appears correctly on the front of the screen when projected from the rear.

The PowerLite 7500C's display engine is built around three 0.9-inch active-matrix XGA LCD panels and Epson's own prism technology. A micro lens array puts an ultra-tiny lens in front of each pixel and generates a display comprised of 2,359,296 pixels.

The projector's lens must be focused manually by rotating the ring around the lens—this is about the only functional aspect that is similar to yesterday's film projector. The lens also has a manual zoom setting to enlarge or decrease image size without having to move the projector toward or away from the

screen. The image size can vary from about 19 to 300 inches measured diagonally when projected from a distance of between 3.3 and 50 feet.

Power consumption for the 7500C is approximately 220 watts when turned on, and it also has a low-current 30-watt sleep mode. Its operating noise level is less than 42 dBA, which means that the projector is fairly quiet and will not be a distraction during presentations. Its heat output cannot be avoided, and the unit will warm up a closed room after a period of time, but that's the case with all projectors—bright bulbs always generate lots of heat. The projector will not allow the cooling fans to shut down before the bulb is adequately cooled.

The PowerLite 7500C comes with an AC cable, a VGA cable, Macintosh and PS/2 mouse cables, a composite RCA-type AV cable, an infrared remote control with batteries, a detachable carry strap, and a user's manual. An S-Video cable is not included. The standard one year limited warranty includes Epson's Road Service Program (in the U.S. and Canada only) and a dedicated toll-free support line. Optional accessories, such as replacement lamps and carrying cases, are also available.

The PowerLite 7500C is a versatile projector that is easy to carry and use. The picture is sharp and bright enough to be seen in a well-lit room, but a darkened room is preferred. Unfortunately, you really have to have a need for a multimedia projector to buy one of these, because it is in no way cheap. The PowerLite 7500C costs $9999, though street prices are, as always, lower (around $6799 at the time of this writing). For more information, circle 15 on the Free Information Card or contact Epson America, Inc. (20770 Madrona Ave., Torrance, CA 90503; Tel: 310-782-0770; Web:www.epson.com) directly. EN

BY SAM GOLDWASSER
SERVICE EDITOR

Monitor Repair: The Finale!

AS REGULAR READERS OF THIS COLUMN KNOW, WE'VE BEEN DEALING WITH THE TOPIC OF COMPUTER AND VIDEO MONITORS FOR QUITE SOME TIME. WELL, ALL GOOD THINGS MUST COME TO AN END. BUT BEFORE WE MOVE ON TO other servicing topics, we need to tie up some loose ends. This month we conclude our discussion of monitor technology and repair with some "items of interest," resources for advanced troubleshooting, and service information.

Monitor Specifications

There is no easy way to tell the monitor's specifications or whether or not it supports SVGA by just examining the monitor visually. Even those with only a 9-pin rather than a 15-pin connector are sometimes SVGA *(e.g.,* Mitsubishi AUM-1381 and NEC Multisync II, which will do 800 × 600 at 56 Hz V non-interlaced and 1024 × 768 interlaced at 43 Hz V). You cannot even safely test scan rates on all monitors—some (mostly older ones) will blow up or get damaged by being driven with incorrect video.

For a monitor that you already have, looking it up in a monitor database is really the only way to be sure of its capabilities (well, pretty sure anyway as these listings are not always correct!). If this doesn't help, you could try posting the information you have (model number, FCC code, etc.) to the newsgroups: comp.sys.ibm.pc.hardware.vidèo and sci.electronics.repair. When none of this is productive, here are some quickie tests:

1. Check the video connector. If it has a high-density (VGA) 15-pin connector, then there is a greater likelihood of SVGA, but not always.

2. Check the manufacturing date on the back. If it has a manufacturing date of 1991 or later, the likelihood of it supporting SVGA is higher as demand for VGA-only monitors was rapidly declining by that point.

3. Check the dot pitch on the CRT by examining the screen with a magnifier. If it is really coarse, the monitor probably cannot do anything beyond VGA.

4. Become familiar with the major manufacturers and models so that you will recognize the most common SVGA models.

5. Check the databases at the sites given below.

Web Sites With Monitor Specifications

Check out the following when you have an SVGA, MAC, or workstation (possible fixed frequency) monitor and need to know its specifications:

- Σhttp://e-mac.com/ (Apple support)
- Σhttp://www.mindspring.com/~nunez/info/monitors/ *(Computer Shopper)*
- Σhttp://www.griffintechnology.com/ (Griffin Technology)
- Σhttp://www.hercules.com/monitors/mdb.htm (Hercules)
- Σhttp://www.monitorworld.com/ *(Monitor World)*
- Σhttp://www.monitorsolution.com/Monitorsdata/ (Rasterstone)
- Σhttp://hawks.ha.md.us/hardware/monitor.html (table of monitor specs)

Some of these are companies that sell various video products that may be useful. However, I am only recommending these sites for the information on monitor specifications. Note that since the data on these sites comes from undetermined sources, it isn't always accurate—check with more than one site to see if they agree.

How High A Refresh Rate Should I Use?

It is the vertical refresh rate that impacts display appearance. The visual effect of too low a vertical scan rate is excessive flicker.

Up to a point, higher is obviously better. Everyone agrees that appearance improves up to at least 70- to 75-Hz (vertical) non-interlaced, but improvement beyond that point is a hotly debated issue (and a topic for a never ending discussion on your favorite newsgroup). The use of interlaced scanning can reduce apparent flicker for a given scan rate for typical gray scale or color images, but might result in annoying flickering or jumping of fine horizontal lines in graphics and text displays.

In any case, you must not exceed the maximum scan rate specs of your monitor. Also, very high refresh rates may result in decreased graphics performance particularly with DRAM-based video cards due to the bus contention between the PC memory accesses and the video readout to the RAMDAC. And, a horizontal scan rate below the specified limits may blow the HOT instantly.

Interlaced vs. Non-Interlaced Monitors

The difference between interlaced and non-interlaced displays is in the video timing. Nearly all monitors can handle either. Monitors are specified as

non-interlaced because, for a given screen resolution and vertical refresh rate, this is the tougher (higher) horizontal (H) scan rate, and it is desirable to minimize flicker in a graphical display (fine horizontal lines will tend to flicker on an interlaced display). The H scan rate is double the interlaced H scan rate since all scan lines—rather than just the even or odd ones—are being displayed for every vertical scan.

Digital vs. Analog Controls

There is no inherent reason for a digital monitor to have a better picture, but as a practical matter I would expect this to be the case in the vast majority of monitors—especially models from the same manufacturer. The digital monitors will be the ones that the designers concentrate on. Digital controls (both those you can access and those used only during setup at the time of manufacturing or servicing) permit more flexibility in setting parameters and more-consistent adjustments on the assembly line (at least this is possible in principle).

For the average, not-terribly-fussy PC user, the major difference is in the convenience of not having to adjust size and position whenever the scan rate changes. While the price difference between monitors having analog or digital controls but with the same screen size, resolution, and scan range specifications may seem excessive, the added convenience of digital controls and scan-rate-parameter memory makes the added cost well worthwhile.

Frequent Scan-Rate Switching

This most often happens in a PC software-development environment where the programmer needs to go back and forth between a Windows display and a DOS debugger, for example. Is it something to be concerned about?

Obviously, without knowing the precise design of your monitor, there can be no definitive answer. It is true that some older monitors blew up if you looked at them the wrong way. Newer monitors from well-known manufacturers like Nokia, NEC, and many others are designed with a moderate amount of scan switching in mind. However switching is stressful for the monitor's power supply and deflection circuitry. I would suggest that you use a dedicated monochrome monitor for debugging if you really are switching multiple times per minute. If you cannot afford the space, you can probably assume that if the first few days of this kind of treatment have not induced a failure, the monitor is robust enough to withstand it indefinitely. If you really are switching many times per minute 8 hours or more a day, then what may wear out are the internal relays (the clicks you hear are from those). You are still talking about years, however. They are rated in hundreds of thousands or millions of operations when used within their ratings.

Or, just go for the peace of mind provided by an extended warranty or service contract.

Surge Suppressors and Line Filters

Should you always use a surge suppressor outlet strip or line-filter circuit? Sure, it shouldn't hurt. Just don't depend on those to provide protection under all circumstances. Some are better than others, and the marketing blurb is at best of little help in making an informed selection. Product literature—unless it is backed up by testing from a reputable lab—is usually pretty useless and often confusing.

Line filters can also be useful if power in your area is noisy or prone to spikes or dips.

However, keep in mind that most well-designed electronic equipment already includes both surge suppressors like MOVs and L-C line filters. More is not necessarily better, but may move the point of failure to a readily accessible outlet strip rather than the innards of your equipment if damage occurs.

Very effective protection is possible through the use of a UPS (Uninterruptible Power Supply), which always runs the equipment off its battery from the internal inverter (not all do). This provides very effective isolation from power line problems since the battery acts as a huge capacitor. If something is damaged, it will likely be the UPS and not your expensive equipment. Another option is to use a constant voltage transformer (SOLA), which provides voltage regulation, line conditioning, and isolation from power spikes and surges.

It is still best to unplug everything in the face of an impending lightning storm or another event that could cause power problems.

Monitors On Foreign Power

Using a monitor on a different voltage or frequency is usually not a serious problem. Your PC and monitor should be fine, requiring at most a transformer (not just an adapter for heating appliances, however) to convert the voltage. They both use switching power supplies, which don't care about the line frequency.

Some power supplies are universal—they automatically adapt to the voltage they are fed without requiring even a transformer—but don't assume that is the case, check your user manual or contact the manufacturer(s) to determine if jumpers or switches need to be changed. You could blow up the PC or monitor by attempting to run it on 220 VAC when it is set to run from 117 VAC. If you are lucky, only a fuse will blow, but don't count on it.

For non-switching power-supply devices like printers and wall adapters that use line-power transformers, in addition to matching the voltage (or setting jumpers or switches), running on a lower line frequency may be a problem. There is a slight chance that the power transformer will overheat on 50 Hz if designed for 60 Hz. (The other way around should be fine.) It is best to check the nameplate—it should tell you. If it does not, then best to contact the manufacturer.

Monitor Life, Energy Conservation, and Laziness

A common misconception about the care and feeding of computer monitors is that they should be left on all the time. While there are some advantages to this, there are many more disadvantages:

1. CRT life: The life of a monitor is determined by the life of the CRT. The CRT is by far the most expensive single part, and it is usually not worth repairing a monitor in which the CRT requires replacement. The brightness half-life of a CRT is usually about 10,000 to 15,000 hours of "on" time, independent of what is being displayed on the screen. To put that in perspective, 10,000 hours is only a little more than a year. By not turning the monitor off at night, you are reducing the life of the monitor by a factor of 2 to 3. Screen savers do not make any substantial difference, especially with modern displays using X-Windows or MS Windows where the screen layout is not fixed (and subject to burn in).

2. Component life: The heat generated inside a monitor tends to dry out parts like electrolytic capacitors, thus shortening their life. These effects are

particularly severe at night during the summer when the air conditioning may be off, but it is always a consideration year around.

3. Safety: While electronic equipment designed and manufactured in accordance with the National Electrical Codes is very safe, there is always a small risk of catastrophic failure resulting in a fire. With no one around, even with sprinklers and smoke alarms, such a failure could be much more disastrous.

4. Energy use: While modern monitors use a lot less energy than their older cousins, the aggregate energy usage is not something to be ignored. A typical monitor uses between 60 and 200 watts. Thus, at a $0.10-per-kWH electric rate, such a monitor will cost between $48 and $160 a year for electricity. During the night, half to two-thirds of this is wasted for every monitor that is left on. If air conditioning is on during the night, then there is the additional energy usage needed to remove the heat generated by the monitor as well—probably about half the cost of the electricity to run the monitor.

The popular rationalization for what is most often just laziness is that power-on is a stressful time for any electronic device and reducing the number of power cycles will prolong the life of the monitor. With a properly designed monitor, this is rarely an issue. Can you recall the last time a monitor blew up when it was turned on? The other argument, which has more basis in reality, is that the thermal cycling resulting from turning a monitor on and off will shorten its life. It is true that such thermal stress can contribute to various kinds of failures due to bad solder connections. However, these can be easily repaired and do not affect the monitor's heart—the CRT. You wouldn't leave your TV on 24 hours a day, would you?

Most of the newest ("green") monitors have energy-conserving capabilities, but it is necessary for the software to trigger those power reduction or power-down modes; not all workstations or PCs are set up to support them, and many older monitor still in use lack such features altogether. However, if your monitor and computer do support an energy-saving mode, by all means set them up to take advantage of it.

Even if the monitor does not support power-saving modes, a blank screen or dark picture will reduce stress on the CRT and power supply. Electronic components will run cooler and last longer.

In short, please make it a habit to turn your monitors off at night. This will extend the life of the monitor (and your investment) and is good for the environment as well. For workstations, there are good reasons to leave the system unit on all the time. However, the monitor should be turned off using its power switch. For PCs, my recommendation is that the entire unit be turned off at night since the boot process is very quick and PCs are generally not required to be accessible over a network 24 hours a day.

PC Video-Connector Pin Outs

Figure 1 shows the connector configurations for the monitors you are most likely to encounter. The pin out for the original VGA (31.5 kHz, 640 × 480)/SVGA (35-37 kHz, 800 × 600) 15-pin sub D connector is shown in Table 1.

Note that many of the pins shown in Table 1 as "no connection" (actually, these were sometimes used as monitor ID bits by many manufacturers) are now defined under the VESA Display Data Channel standard. That standard provides two protocols for display ID and control, including support for the full ACCESS.bus interface. The current definition of the "VGA" pin out per the DDC standard is shown in Table 2. Pin outs for EGA-TTL (15.74 to 21.85 kHz) 9-pin connectors are shown in Table 3; for CGA-TTL (15.75 kHz, 320 × 200 or 640 × 200) 9-pin connectors in Table 4; for monochrome-TTL (18.43 kHz, 720 × 350) 9-pin connectors in Table 5; for Mac II-analog (35-kHz H, 66.67-Hz V, 640 × 480) and Mac II- and Quadra-analog (49.7-kHz H, 74.55-Hz V, 832 × 624) 15-pin connectors in Table 6; and for the Sun workstation 13W3 connector in Table 7.

VGA to BNC Cable

Should I use a VGA to BNC cable if my monitor has BNC connectors? The answer is an unqualified maybe. In principle, the BNC cable should have higher bandwidth and better transmission-line characteristics (impedance, termination) and result in sharper crisper images with less ghosting, ringing, and other artifacts. However, this will only likely be significant at higher refresh rates and, depending on your monitor and video card, you may see no change or things might even get worse.

Potential advantages of using the BNC connector inputs on your monitor with a good quality cable are higher video bandwidth, which leads to a sharper display and proper connectors (at one end, at least) and correct termination, leading to less ghosting and ringing.

If you decide to build a BNC cable, the job is straightforward, if time-con-

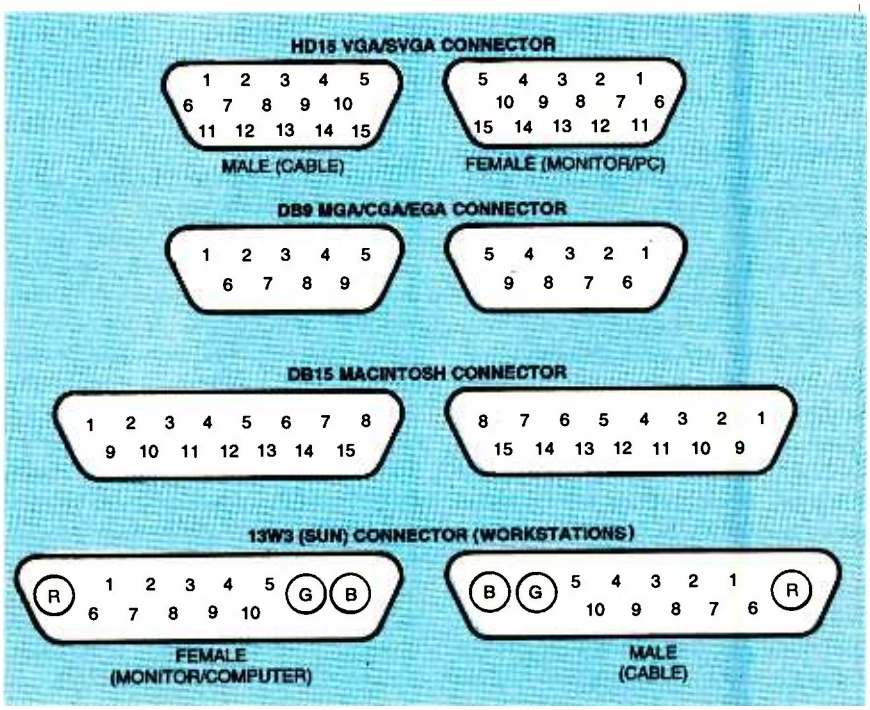


FIG. 1—HERE ARE SOME OF the various types of monitor connectors you are likely to run across. The pin outs are provided in Tables 1 to 7.

suming and tedious. The five coaxial cables (75 ohm, RG59 typical) are wired as shown in Table 8. The corresponding VGA connector pin numbers are in parenthesis.

Advanced Monitor Troubleshooting

If the solutions to your problems have not been covered in this series, you still have some options other than surrendering your monitor to the local service center or the dumpster.

Manufacturer's service literature: Service manuals may be available for your monitor. Once you have exhausted other obvious possibilities, the cost may be well worth it. Depending on the type of equipment, these manuals can range in price from $10 to $150 or more. Some are more useful than others. However, not all include the schematics so if you are hoping to repair an electronic problem try to check before buying.

Inside cover of the equipment: TVs often have some kind of circuit diagram pasted inside the back cover. In the old days, this was a complete schematic. Now, if one exists at all for a monitor, it just shows part numbers and location for key components—still that could be very useful.

SAM'S Photofacts: These have been published for over 45 years but have never been common for monitors. There are a few for some early PC monitors but for anything modern, forget it.

Additional Information

For general information on PC video cards and monitors, see the FAQ of the USENET newsgroup: comp.sys.ibm.pc.hardware.video. This document has a wealth of data on nearly everything you could possibly want to know about video for the PC world. The FAQ is available at: http://www.heartlab.rri.on.ca/vidfaq/.

Some Possible References

There don't seem to be that many readily available books on monitor repair, but here are a few:

Troubleshooting and Repairing Computer Monitors
Stephen Bigelow
McGraw-Hill, 1995

Computer Monitor Troubleshooting & Repair
Joe Desposito
Howard W. Sams & Co, 1997

Hi-Res Computer Display Systems
Part # ST1496-1093LE/KGPGC
Philips Service Co.
P.O. Box 555
Jefferson City, TN 37760
Tel: 423-475-0044

Since monitors share much in common with color TVs, books on their repair would also be applicable for many problems and may be readily available from your local public library. For example, try:

Troubleshooting and Repairing Solid State TVs, 3rd Edition
Homer L. Davidson
TAB Books, Inc. 1996

The following doesn't specifically deal with monitors but may be of interest as well:

Video Demystified: A Handbook for the Digital Engineer
Keith Jack
Brooktree Corporation, 1993

The sci.electronics.repair Newsgroup

Where you have a specific question on a particular monitor (or other equipment), posting the make and model and a concise description of the problem, and what you have already attempted on the USENET newsgroup sci.electronics.repair might result in suggestions from both professionals and others like yourself who have had experience with your monitor.

See the document: "Troubleshooting of Consumer Electronic Equipment" at my www.repairfaq.org Web site for many additional on-line resources to aid in monitor servicing.

FCC ID Numbers

Only a few manufacturers actually produce the vast majority of computer and video monitors. For example, RadioShack, Magnavox, and Emerson do not make their own monitors (I can tell you are not really surprised!). All those house-brand monitors that come bundled with mail order or "Mike and Joe's Computerama" PCs are not actually put together in someone's garage! (Well, not that many, at least.)

How do you determine who actually made your monitor? For most types of consumer electronics equipment, there is something called an "FCC ID" or "FCC number." Any type of equipment that might produce RF interference or be affected by such interference is required to be registered with the FCC. This number can be used to identify the actual manufacturer of the equipment. A cross-reference for those numbers and other links can be found at www.repairfaq.org/REPAIR/F_FCC_ID.html.

TABLE 1—ORIGINAL VGA

Pin	Signal
1	Red (Analog)
2	Green (Analog)
3	Blue (Analog)
4	Reserved
5	Ground
6	Red Return
7	Green Return
8	Blue Return
9	No Connection
10	Ground
11	(ID0)GND (Color)
12	(ID1) NC (Color)
13	Horizontal Sync
14	Vertical Sync
15	No Connection

Note: Monitor ID Lines ID1, ID0=NC, G for color; G,NC for Monochrome. ID0 only may be used.
Monochrome VGA is similar using only the Green Video and Return.

TABLE 2—CURRENT VGA

Pin	Signal
1	Red (Analog)
2	Green (Analog)
3	Blue (Analog)
4	Reserved
5	Return
6	Red Return
7	Green Return
8	Blue Return
9	+5 VDC (from host)*
10	Sync return
11	Monitor ID0 (opt.)
12	Data (SDA)
13	Horizontal Sync
14	Vertical Sync
15	Data clock (SCL)*

Note: Those signals marked with an asterisk would be supplied by the host only if the host supports the DDC2 protocol (I2C or ACCESS.bus).

TABLE 3—EGA

Pin	Signal
1	GND
2	Secondary Red Video
3	Primary Red Video
4	Primary Green Video
5	Primary Blue Video
6	Secondary Green Video/Intensity
7	Secondary Blue Video
8	H Sync TTL Positive
9	V Sync TTL Negative

TABLE 4—CGA

Pin	Signal
1	GND
2	Unused
3	Red Video
4	Green Video
5	Blue Video
6	Intensity
7	Unused
8	H Sync TTL Positive
9	V Sync TTL Positive

TABLE 5—MONOCHROME

Pin	Signal
1	GND
2	Unused
3	Unused
4	Unused
5	Unused
6	Intensity
7	Video
8	H Sync TTL Positive
9	V Sync TTL Negative

TABLE 6—MACINTOSH

Pin	Signal
1	Red Ground
2	Red Video
3	Composite Sync
4	Sense 0
5	Green Video
6	Green Ground
7	Sense 1
8	Reserved (+12)
9	Blue Video
10	Sense 2
11	Ground
12	Vertical Sync
13	Blue Ground
14	Ground
15	Horizontal Sync

TABLE 7—SUN

Pin	Signal
R	Red video
G	Green or greyscale video
B	Blue video
1	*
2	*
3	Sense 2
4	Sense common (ground)
5	Composite sync
6	*
7	*
8	Sense 1
9	Sense 0
10	Composite sync common (ground)

* May be NC, ground, or H or V sync, depending on model.

Sense table: 1=NC, 0=strap to ground

Sense Type
0: TBD (?)
1: Reserved
2: 1280 × 1024, 76Hz
3: 1152 × 900, 66Hz
4: 1152 × 900, 76Hz, 19 inches
5: Reserved
6: 1152 × 900, 76Hz, 16 or 17 inches
7: Nothing (no monitor connected)

TABLE 8—COAX-TO-BNC

Coax Center	Coax Shield
Red Video (1)	Red Return (6)
Green Video (2)	Green Return (7)
Blue Video (3)	Blue Return (8)
H Sync (13)	Ground (5,10)
V Sync (14)	Ground (5,10)

Notes: Tie pin 11 (ID0) to ground to indicate a color monitor. Leave pin 12 (ID1) open.

Monitor Schematics and Manuals

In some cases, schematics and manuals might be available from the manufacturer and even be reasonably priced. However, more often than not, this will not be the case.

The following companies offer computer monitor service manuals and schematics. Typical prices are between $25 and $100.

Computer Component Source (CCS); Tel: 800-356-1227: CCS catalog "centerfolds" have had schematics for some common monitors like the IBM 8513. So, just asking for a catalog may get you some information.

MI Technologies; Web: www.mitechnologies.com: Note that there have been some complaints about the quality of some of this company's schematics, so, make sure you check out what you are buying. On the plus side, they will accept returns.

Electronix; Web: www.electronix.com/schematics/.

Eagan Technical Services, Inc., 1380 Corporate Center Curve, Suite 115, Eagan, MN 55121; Tel: 612-688-0098: Eagan has several schematics for IBM monitors. I believe that includes the 8503, 8512, 8513, 8514, 8518 and 8511. Most are $50. The 9517 schematic is an unbelievable $165. You can order them directly from Eagan or through SAMS' Photofacts (Web: www.hwsams. com/) at the same price.

Chuntex is another source; Tel: 800-888-2120.

For Apple monitors (and other Apple peripherals), the E-MAC Web site (http://e-mac.com/) has a variety of information, including some (mostly user) manuals, specifications, and technical forums.

If you are responsible for a few hundred monitors from several dozen manufacturers, Anatekcorp (http://www.anatekcorp.com) has a set of nine CD ROMs that contain the full technical manuals (in most cases) produced by the manufacturer. Go to: http:// www.anatekcorp.com/schematic/monsch.htm.

Monitor Parts Sources

For general electronic components like resistors and capacitors, most electronics distributors will have a sufficient variety at reasonable cost. Even RadioShack can be considered in a pinch. However, for modern consumer-electronics or video-monitor repairs, many of the usual sources do not have that good a selection of Japanese semiconductors or components like flyback transformers or degauss Posistors.

The following are good sources for consumer-electronics replacement parts, especially for VCRs, TVs, and other audio and video equipment:

MCM Electronics; Tel: 800-543-4330; Web: www.mcmelectronics.com/

Dalbani; Tel: 800-325-2264; Web: www.dalbani.com/

Premium Parts; Tel: 800-558-9572

Computer Component Source; Tel: 800-356-1227

Sources For Adapters And Cables

Office and computer-supply companies like Inmac and Global may have some very common types, like VGA switch boxes and extension cables, though they might be of unknown quality. Another place to try is Black Box Corporation; Tel: 412-746-5500; Web: www.blackbox.com/.

Also see the documents: "Troubleshooting of Consumer Electronic Equipment" and "Electronics Mail Order List" for additional parts sources at www.repairfaq.org.

Wrap Up

And there you have it! Monitor troubleshooting in a nutshell. I hope you have enjoyed this series and benefited from it in some way.

For additional information on monitor repair and many other areas of electronics, check out my Web site: www.repairfaq.org. I welcome comments (via e-mail only, please, at sam@stdavids.picker.com) of all types. See you next time with something new and exciting in the world of electronics servicing! EN

BY DON JENSEN

A Short History of Shortwave

AS WE NEAR Y2K, SHORTWAVE MAY SEEM, TO SOME, CURIOUSLY QUAINT. IN ONE SENSE, PERHAPS, THAT VIEW IS UNDERSTANDABLE IN AN ERA WHEN EVEN YESTERDAY'S TECHNOLOGY IS OFTEN OBSOLETE. INDEED, SHORTWAVE BROADCASTing has been around for a long time; the first regular worldwide broadcasts date to the late 1920s.

But viewed from a different perspective, we should remember that it's not really ancient history we're talking about. After all, there are among us some SWLs, now octogenarians mostly, who recall those first SW broadcasts.

The rest of us may not have those personal memories of the early days, but we still can find fun and, yes, excitement in tuning in to the world on shortwave today. Perhaps, as this century winds down, it is appropriate that we pause to look back on the history of our hobby and how it all began.

Happily, Jerome S. Berg has captured both the detail and flavor of those pioneer years of shortwave broadcasting and the listening hobby in his book, *On The Shortwaves, 1923-1945*, published earlier this year.

Berg, a veteran DXer and avid SWL historian, draws upon both old-timers' memories and information from his extensive collection of early radio publications to weave a fascinating account of SW radio's earliest days.

Berg quotes Hugo Gernsback, pioneer publisher and "spiritual father" of today's **Electronics Now** magazine, speaking of shortwave some 66 years ago:

"On the shortwaves, DX listening is, of course, commonplace; because a good two-tube set will bring in stations from the maximum distance on this planet, i.e., 12,500 miles.... (T)hese records are so common that every schoolboy in the United States today who owns a shortwave set thinks nothing of listening to stations in Australia and other parts of the world."

Memories, Memories

A more personal look comes from Canadian Dxer Tom Williamson's reminiscences of what shortwave listening was like in the in the early 1930s.

"The usual Europeans were heard, as in modern times, including Radio Moscow. Switzerland was heard on various channels with call signs like HBJ, HBQ, and HBO, and the slogan 'Radio Nations' (it was the site of the League of Nations).

"France was one of my favorite sources of jazz music, but mainly on AM from Radio Paris. Each Saturday we could tune in to a period of musical history in the form of the 'Hot Club de France,' which featured...hot rhythms from the immortal (jazz violinist) Stephane Grappelli...Django Reinhardt, and others. They really set the airwaves jumping."

And Jack Jones, growing up in Mississippi, recalled getting hooked on SW when he was still in his early teens:

"I started a campaign to get Dad interested in a shortwave adapter I saw advertised, but he kept stalling until one day he said that Mr. Jess Huffman, two houses down and a radio bug, wanted to show me his shortwave receiver.

"I didn't even know there was one within 100 miles of Tupelo, Mississippi! This was probably late 1929. Needless to say, I hurried down to see Mr. Jess. There I found a Pilot Super Wasp four-tube shortwave set! I had seen them in magazines and approached his with the respect and awe due royalty.

"He plugged in the yellow ring coil and got 8XK on its meter wave, 2AXF

RADIO NEWS, EDITED BY pioneer electronics publisher Hugo Gernsback, took a humorous look at the DX listening hobby in this 1926 cover reprinted in Jerome S. Berg's new history, *On The Shortwaves, 1923-1945*.

CREDITS: Brian Alexander, PA; Ralph Brandi, NJ; Jeff Findlater, CA; Bob Fraser, MA: Joe Hanlon, PA; Harold Levison, PA; Don Nelson, OR; Betsy Robinson, TN; Mike Strain, NJ; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.

on 31 meters and HKC (Colombia) on 49 meters (orange ring coil). I was absolutely enthralled. To top it off, he called me early one morning and said he had Australia. All the homes on our street had hedges and I either ran through them or jumped over them getting down to his house. Sure enough, 3ME, Melbourne, was heard.

"I visited Mr. Jess often and he'd sit at the Super Wasp and fiddle around. Finally he'd say, 'Jack, I can't get anything. Get over here and see what you can do.' Mr. Jess would stomp out of the room in a bad humor, and I'd be in seventh heaven!"

This month, and in the last two "DX Listening" columns of the 20th Century, I'd like to focus on some of the pioneer SW stations that still can be heard today, seven decades later.

In the meantime, if you'd like to know more about the early days of SW and SWLing, I highly recommend Berg's history, *On The Shortwaves: 1923-1945*, as both a fine radio reference and a fascinating read. The 272-page book is available for $46.50, postpaid, from McFarland & Co., Inc., Publishers, Box 611, Jefferson, NC 28640 (Order line: 800-253-2187, or Web:, www.mcfarlandpub.com).

Yesteryear's DX Today

Europe was home to many of the major players in the shortwave broadcasting game way back then, Berg notes.

The British Broadcasting Corp. transmitter base at Daventry had eight SW transmitters and 18 antennas, and would continue uninterrupted service for some 65 years, until this venerable broadcasting site was closed down on March 29, 1992.

As early as 1927, the experimental station, G5SW was operating with 20 kilowatts of power. How successful were these transmissions? According to reports at the time, the results were mixed.

"Australia—Good and clear reception of one of three broadcasts only—namely, a midday organ recital and a message of greeting.

"United States—Picked up 5SW, but it was suffering from excessive fading and local static.

"Canada—Successful rebroadcast of speech by Prince of Wales and other items in evening program.

"India—Not even a carrier wave heard."

Other reception reports indicated that the broadcasts reached Buenos Aires, Argentina, and Lagos, Nigeria, though with marginal signals. No definite reports were received by the station from New Zealand or South Africa.

By the early 1930s, two frequencies would be used on each of five beams to various parts of the globe. Berg notes that these stations included GSB, 9510 kHz; GSD, 11,750 kHz; and GSI, 15,260 kHz—in the early days, call letters often were assigned to specific transmitters.

The Sun Never Set...

The BBC's international-shortwave operation at first was known as the Empire Service, which began on Dec. 19, 1932. Like most of the major European SW voices, a main goal of the BBC was in maintaining contact with its colonies around the world. Programming all was in English until 1938, when foreign-language broadcasts began.

In time, the Empire Service became known as the General Overseas Service, and then, the World Service. Soon it had established a reputation for quality programming, especially its news broadcasts, and became must listening for many.

In the 1930s, the New York Times reported, Big Ben, the famous clock chimes, "comes in so regularly from London at 6 o'clock in the evening that one family in Washington has dubbed it 'our dinner bell.' "

Today's SWLs find BBC reception equally reliable. At this writing, the BBC's World Service programming can be heard evenings, say between 0000 and 0400 UTC, on a number of different frequencies, including 5975, 6175, 6195, 9410, 11,955, 15,310, and 17,790 kHz.

In the 1930s, a tradition began that has continued each year since. On Christmas Day, the British monarch delivers a holiday greeting via the BBC to English-speaking listeners throughout the world.

For the shortwave listener one way to mark the end of this century would be to tune in to Queen Elizabeth II's traditional Christmas message at 1600 UTC on Dec. 25. Some BBC frequencies to try are 9515 and 17,840 kHz.

Down The Dial

Other interesting listening on shortwave? Here are some targets to tune for:

ASCENSION ISLAND—7160 kHz, British Broadcasting Corp. relay on this south Atlantic dot in the ocean beams programs to the African continent. Look for English news and sports after 0630 UTC.

BULGARIA—11,720 kHz, Radio Bulgaria, Sofia, usually puts in a nice signal for its English programming at 2100 UTC.

ECUADOR—17,660 kHz, HCJB, the Voice of the Andes, is noted with English programs around 1900 UTC.

PARAGUAY—9737 kHz, Radio Nacional de Paraguay is noted with Spanish language sports talks around about 2235 UTC. Paraguay is one of the more difficult South American countries to log on shortwave.

PERU – 6115 kHz, Radio Union in Lima is another nice Latin American logging. Again, don't expect English programs, but its frequent Spanish language identification announcements stand out. Tune for this one around 0700 or 0800 UTC.

ROMANIA—9510 kHz, Radio Romania International, Bucharest, has an English-language transmission from 0200 to 0255 UTC on this frequency and also on parallel channels of 9570 and 11,725 kHz.

SWITZERLAND—13,710 kHz, Swiss Radio International has been logged here with cultural programming in English after 2000 UTC, switching to German at 2030 UTC.

TURKEY—7370 kHz, Turkiye Polis Radyosu, or Turkish Police Radio from Ankara is a very nice DX catch, and not at all an easy one. This has been reported heard at 1200 UTC with Turkish music and news. The Voice of Turkey, 11,655 kHz, is an easier way to hear this country. Listen at 0300 UTC sign on for its English service.

UNITED KINGDOM—21,550 kHz, Merlin Radio One, Britain's pop-programming commercial shortwaver is heard around 1600 UTC on this frequency high in the shortwave range. EN

Prototype

Fuel-Cell Batteries for Cars

Many auto-industry experts feel that very abundant and exceptionally clean-burning hydrogen is the transportation fuel of future. As evidence of that, Chrysler, Ford, GM, Mercedes and several others are developing fuel cells that run on hydrogen for vehicle propulsion. But another prominent automaker, BMW, is marching to a slightly different drummer. While they also predict a "hydrogen society" for the 21st century, BMW believes that hydrogen-fueled internal-combustion engines rather than hydrogen-fueled fuel cells is the way to go when it comes to propelling a car. For one thing, that approach assures the performance people have come to expect in a BMW.

Considering their past efforts, that approach is not surprising. For over two decades, BMW has been doing research on hydrogen-fueled vehicles. Several 5- and 7-Series BMWs have been converted to run on hydrogen for testing and demonstration purposes. It is currently preparing a number of hydrogen-fueled 7-Series sedans for next year's EXPO 2000 World Exposition to be held in Hanover from June 1 to October 31, 2000.

But that does not mean that fuel cells will have no part in tomorrow's BMWs. Indeed, the EXPO 2000 cars will also include small fuel cells, but they will be in the trunk, not under the hood.

BMW in partnership with International Fuel Cells (IFC) in Groton, CT is developing a small fuel cell to replace the conventional battery. According to BMW, when used in that way a fuel cell has a chance to perform the task it can do best—generate electricity efficiently. In the hydrogen-fueled 7 Series BMWs, fuel for the fuel cell will be tapped off the hydrogen tanks supplying fuel to the engine.

LOCATED IN THE TRUNK rather than under the hood, BMW envisions the fuel-cell as a replacement for today's lead-acid battery.

Gas and Go

Hydrogen fueled cars are likely many years away. For one thing, it could be quite a while before hydrogen is available at the corner filling station. But that does not mean that the wait for a fuel-cell replacement for the lead-acid battery is that far off.

BMW is working with Delphi Automotive Systems to develop an entirely new type of fuel cell that will be able to generate electricity using gasoline. That new fuel cell is called a Solid Oxide Fuel Cell or SOFC. The SOFC converts hydrogen into electricity at a temperature of approximately 800 degrees C (1470 degrees F) using a zirconium-oxide ceramic transformer. The first step in this conversion process is to evaporate the gasoline to obtain hydrogen through a splitting process in a reformer that also operates at about 800 degrees C. Then, like any fuel cell, the hydrogen reacts with oxygen in the air fed in during the process to generate electricity and, as a waste product, water. By operating on gasoline, the use of the SOFC does not have to wait until a widespread hydrogen-supply infrastructure is in place.

According to BMW, the SOFC has a couple of key advantages over proton-exchange-membrane fuel cells (PEM) that are the focus of most fuel cell developments today. Compared with PEM fuel cells, the SOFC is far less sensitive to impurities created during the reforming process. Also it does not require any expensive precious-metal electrodes (the polymer membrane in the PEM fuel cell

FOR MORE INFORMATION

BMW of North America
300 Chestnut Ridge Road
Woodcliff Lake, NJ 07675

is coated with a platinum catalyst). Incidentally, PEM fuel cells developed in conjunction with International Fuel Cells (IFC) are used in the hydrogen-fueled 7 Series BMWs.

BMW says the SOFC could eventually replace both the battery and alternator in gasoline-fueled BMWs. A small, special purpose lead-acid battery would still probably be used for starting and emergencies.

Since the SOFC's output far exceeds that of a lead-acid battery, this fuel-cell APU (Auxiliary Power Unit) would not only be able to supply power to all conventional electrical-power-consuming items whose numbers are continually growing, but also would allow new functions. Being able to generate electricity independent of the engine, for example, it could power an independent climate-control system supplying warm or cold air even when the engine is switched off. This would mean zero emissions when the vehicle is parked.

BMW is predicting that the ongoing development of the SOFC for gasoline-powered automobiles will still take another five years or so.—By Bill Siuru PT

Three-Dimensional Collaboration

Dimension Technologies, which holds most of the world's major patterns in three-dimensional stereoscopic-imaging technology, has been chosen to provide its 3-D LCD displays to the NASA Ames Virtual Collaborative Clinic Project at the Ames Research Center in California. The clinic combines sophisticated medical imaging with high-speed, high-performance networking.

The system allows doctors to receive and manipulate high-resolution 24-bit 3-D color images in near-real time, providing collaboration and consultation over long distances for diagnosis and treatment. Using a "CyberScalpel," doctors can also "cut" into images and move "bone" around for surgical simulation, with the aid of 3-D images created from serial sections of tissues and organs generated by electron microscopy, MRI, or CT scans.

The DTI 2018XL display, which will

DIMENSION TECHNOLOGIES' 3-D LCD DISPLAY allows doctors to receive and manipulate high-resolution 24-bit 3-D color images in near-real time. These 3-D images are created from serial sections of tissues and organs generated by electron microscopy, MRI, or CT scans.

be part of the technology package, features an 18.1-inch TFT LCD screen, display resolutions to 1280 × 1024 pixels, and 16.7 million colors. The viewing mode can be switched instantly from 2-D to 3-D, and includes selectable side-by-side and field sequential stereo viewing formats. The display is compatible with virtually all computing platforms, and it accepts S-video, standard NTSC, and PAL input signals.

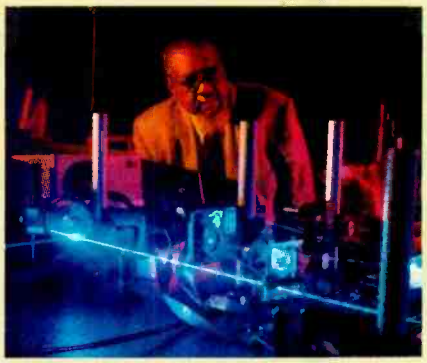
Among the participants in the demonstration were physicians at NASA Ames, Stanford University, the Cleveland Clinic, UC Santa Cruz, Salinas Valley (CA) Memorial Hospital, and the Northern Navajo Medical Center in New Mexico. Other commercial participants in the demonstration included Intel, Silicon Graphics, Cisco Systems, Hughes, and MCI. PT

Aging Vehicles, Increasing Pollution

With six years of emissions data on more than two million metro Atlanta vehicles, researchers have determined the city's fleet is getting older and polluting the air more. The average vehicle in Atlanta has about 90,000 accumulated miles on it, and there are a significant number of vehicles with more than 200,000 miles on them, according to Georgia Tech's Air Quality Laboratory. Researchers analyzed emissions inspection and vehicle-registration records to make these estimates.

"Atlantans drive more per day and keep their vehicles longer than drivers in many other major U.S. cities, particularly those in the North where vehicles don't last as long because of salt on the roads," says Dr. Michael Rodgers, director of the Air Quality Laboratory. "Our concern is

➤ Optical Film



DR. DON FRAZIER IS SEEN working with Laser Imaging ID System.

NASA researcher Dr. Donald Frazier uses an ultraviolet blue laser shining through a quartz window into a special mix of chemicals to generate a polymer film on the inside quartz surface. As the chemicals respond to the laser light, they adhere to the glass surface, forming optical films. Frazier and Dr. Mark S. Paley developed the process in the Space Sciences Laboratory at NASA's Marshall Space Flight Center in Huntsville, AL. Working abroad the Space Shuttle, a science team led by Frazier formed optical computing thin-films with fewer impurities than those formed on Earth.

Preprogrammed patterns of these films can be traced onto the quartz surface. In the optical computers of the future, these films could replace electronic circuits and wires, making the systems more efficient and cost effective, as well as lighter and more compact. PT

that we expect this trend to continue, and as vehicles get older, there is degradation. Their emissions control systems become less efficient, and the vehicles release more pollution into the air."

Short-term studies conducted in other eastern U.S. cities: New York City; Boston; Baltimore; Nashville; and Raleigh, NC complement the findings of the long-term Atlanta monitoring program. Studies are planned for parts of Oregon, Utah, and California this year. Altogether, they are giving researchers cause for concern.

Fuel-injected vehicles manufactured since the mid-1980s tend to deteriorate more slowly than the previous generation of vehicles, Rodgers says. But people are driving their vehicles longer, even over 300,000 miles. So Atlantans can expect to see an increase in catastrophic failures in vehicle emissions control systems, though such failures are presumably detected by emissions inspections. In reality, however, only 1 percent of vehicles manufactured in the past six years has failed an emissions test.

The researchers use remote sensing, vehicle registration data, emissions-inspections records, roadway observation studies along the metro Atlanta area's interstate highways, and laboratory testing to compile emissions data that provides insight into ozone-pollution problems. In remote-sensing studies, researchers gather vehicle information on entrance and/or exit ramps. In just seven-tenths of a second, remote sensing equipment measures a vehicle's emissions as it breaks an infrared beam in its path. Other equipment photographs the vehicle's tag: researchers later use this photo to correlate emissions data with registration data.

In a typical day, researchers gather information on 4000 vehicles—30,000 a month. Since 1993, they have collected data on more than two million vehicles in the 13-county metro Atlanta area, which was compared with findings in three other Southern control cities.

The Air Quality Laboratory also conducts vehicle tests in it new dynamometer lab, determining when and why vehicles release high and low amounts of emissions. This detailed information complements the less-detailed data gathered in the remote-sensing studies. PT

Bubbles, Tiny Bubbles

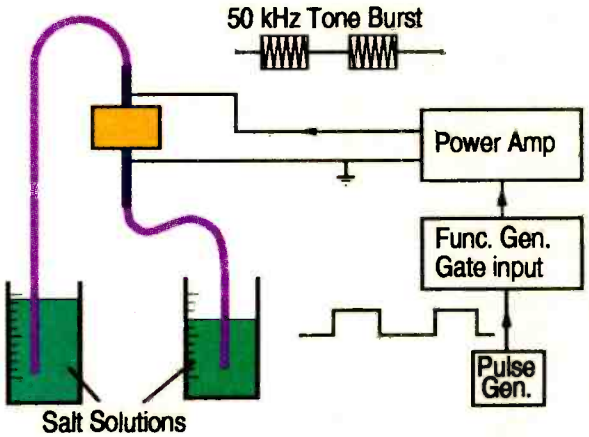
Researchers are racing to develop miniature high-tech devices—each smaller than a postage stamp—to treat medical conditions, test new drugs, and monitor pollutants. All of these require a tiny pump that can repeatedly and reliably push small amounts of liquid through narrow channels for rapid analysis. Engineers at The Johns Hopkins University have invented a micropump powered by the repeated growth and collapse of a single bubble for this purpose. Because the bubble is generated by heat, it is easy to control, the inventors say. And because the bubble-powered pump has no moving mechanical parts, it is unlikely to wear out too quickly.

"It's very different from having a pump with a valve that has to open and close any number of times," says Andrea Prosperetti, the university's Charles A. Miller Jr. Distinguished Professor of Mechanical Engineering. "With no moving parts, the bubble-powered pump's prospects of failure are minimal." Prosperetti, an international expert on the physics of bubbles, worked with two other Johns Hopkins mechanical-engineering researchers—Hasan Oguz and He Yuan—to design, build, and test a prototype bubble-based pump.

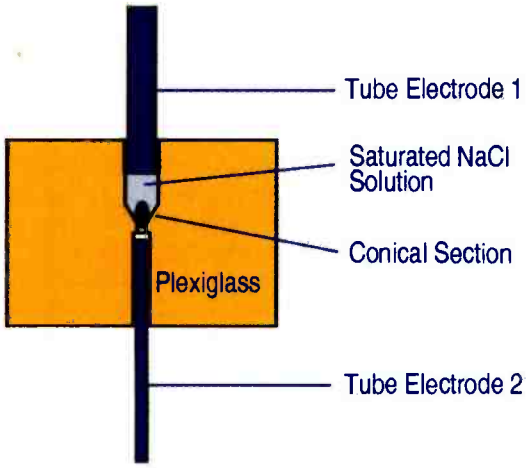
The team's prototype utilizes two main tubes—one that's 1.6mm wide and another that's half that diameter—but it is thought that smaller tubes would work on the same principle. The prototype's main tubes are connected by an even narrower passage or "throat," measuring 0.5mm in diameter. The engineers inserted steel needles into each of the larger tubes, connected the needles to a power source, and filled the tubes with a salt solution to complete the circuit. The current was "squeezed" as it passed through the narrow throat, causing the water to boil or vaporize at that location and form of a bubble. As it expanded like a balloon into the wider channel, the bubble pushed fluid ahead of it.

When the electrical current stops, the bubble shrinks. Its final collapse, however, takes place not in the throat, but in the wider channel. As a result, bubbles created in this system pump fluid through the tubes as they repeatedly expand and collapse. The prototype is capable of generating about five bubbles per second, but much higher rates are expected to be easy to reach.

The bubble-powered pump could play a crucial role, for instance, in micro total analysis systems. Engineers in this field are creating tiny devices on silicon chips, capable of detecting and analyzing small samples of fluid, and then directing that an action occur. Their tiny size makes them ideal for a range of specialized tasks. For example, a small chip implanted in someone who's diabetic might regularly check the blood sugar level and order the release of appropriate amount of insulin. Other applications include micro-devices: in the pharmaceutical industry where only a tiny drop would be needed for analysis



THIS DIAGRAM SHOWS the experimental setup of the Johns Hopkins bubble-based micropump, for use with an electrically conductive liquid.



THIS CLOSE-UP SHOWS the micropump's main tubes, with electrodes within each one. The bubble forms in the narrow connecting throat and expands into the wider tube, pushing liquid ahead of it.

or in manufacturing where they could monitor liquid pollutants.

Although this prototype creates bubbles with electrical current and a salt solution, Prosperetti believes that the system could also work with non-conductive fluids. For such liquids, tiny heaters embedded in the walls of the tubing could be used to form the bubbles. Prosperetti and his colleagues have applied for a U.S. patent covering the bubble-based micropump technology. The research was sponsored by the U.S. Air Force Office of Scientific Research and DARPA. PT

Digital Content Protection Technology

Sony Electronics has announced the introduction of the i.LINK (IEEE1394) LSI "CXD3200 family" that provides robust protection for digital content transmitted between digital electronic products, such as set-top boxes, video recorders, TVs, and DVD players. CXD3201R (link layer LSI) and CXD1945R (physical layer LSI) chip samples are now available for evaluation and early product development efforts, at a sample price of $50 and $10, respectively. Sony plans to begin volume production of the i.LINK LSI that integrates the link layer and a three-port physical layer in one device with a U.S. product launch slated for this year.

The digital content protection method used by Sony's new LSI is based on The Digital Transmission Content Protection method (DTCP), jointly developed by five companies, including Hitachi, Ltd.; Intel Corp.; Matsushita Electric Industrial Co., Ltd.; Sony Corp.; and Toshiba Corp. Technical information about the "5C" (for five-company) DTCP method and licensing information can be found at www.dtcp.com. The newly developed LSI supports the secure, two-way transmission of digital content across the i.LINK (IEEE1394) interface at speeds up to 200Mbps. Designed for use in a wide variety of digital electronics products, the chip reduces the load on the system's microprocessor by internally encrypting and decrypting AV content, such as MPEG data streams. This process allows for robust, high-speed protection of high bandwidth content such as video and animation.

The CXD3200 family supports simultaneous transmission of two separate isochronous streams over a single connection, allowing recording and playback at the same time, or it can simultaneously transmit two separate isochronous signals. The chip supports the Program ID (PID) parser and packet insertion functions used by electronic program guides (EPGs) and other interactive broadcast and network applications. These functions are used to isolate both individual TV programs and additional service information from the data stream.

The LSI also supports many modes of data interfaces for isochronous communications including dedicated MPEG-2 transport stream input and output interface, IEC958 audio stream input and output interface, and an output interface to D/A converter. The LSI contains multiple FIFOs to support high bandwidth demand and can accommodate up to 512 bytes of asynchronous communication. The CXD3201R, packaged in a 144-pin LQFP (plastic), uses a 3.3-volt power supply, ideally suited for low-power applications. PT

"Big Brother" is Protecting You

NASA scientists have invented promising, new software technology to help law-enforcement agencies catch criminals by improving the analysis of crime-scene video. This technology, developed at NASA's Marshall Space Flight Center in Huntsville, AL, already has helped the FBI improve video of the bombing at the 1996 Olympic Games in Atlanta. NASA software clarified dark, nighttime videotapes made with a handheld camcorder, revealing important details that had been obscured.

The Video Image Stabilization and Registration (VISAR) software eliminates flaws in a dark crime scene captured on videotape, removes blurs, and stabilizes images. The clarified video will make it appear as if the crime happened in daytime, helping to identify valuable clues.

The Marshall-developed video-stabilization system has many advantages over other systems being studied, because it does more than just remove noise or "snow" from videos. It eliminates several problems often found in poorly recorded video.

"It's like a video eraser," said Dr. David Hathaway, the technology's co-inventor at the Marshall Center. The VISAR software stabilizes camera motion in the horizontal and vertical as well as rotation and zoom effects; produces clearer images of moving objects; smoothes jagged edges; enhances still images; and reduces video noise, or "snow." Once NASA's new software improves the video quality, it is possible to use existing software to sharpen and "de-blur" images, thus further enhancing video clarity. PT

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Q & A

READERS' QUESTIONS, EDITORS' ANSWERS
CONDUCTED BY MICHAEL A. COVINGTON, N4TMI

What Is I²C?

Q *I've been reading about microcontrollers and have come across the term "I²C bus." What's that?—J.H., Elwood, IN*

A I²C stands for IIC, which in turn means "inter-integrated-circuit." It's a two-wire bus for serial communication between microcontrollers and their peripherals. As shown in Fig. 1, the two lines are pulled up to +5V through resistors. Each IC in the system can read each line through a CMOS buffer and can also pull each line down through an open-drain FET. Thus, each line is both an input and an output for every chip.

I²C is a synchronous serial protocol; that is, bits are transmitted serially (one after another) and transitions on the clock line indicate when to read the data line. Each data packet is preceded by an address indicating which device should receive it.

Introduced by Philips around 1980, I²C is more fully described in their data book IC12, I²C *Peripherals*; see also www.philips.com on the Web. Many special I²C chips are available, including clock-calendar and an LCD display driver. In addition, the I²C protocol is easily emulated by any microprocessor or by a PC parallel port.

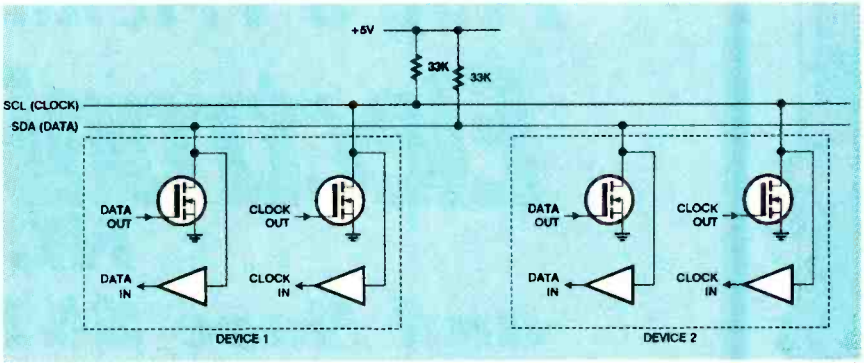


FIG. 1—THE INTER-INTERGRATED CIRCUIT (I²C) bus allows any device to send or receive using just two wires (plus ground).

Gently Falling Frequency, Again

Q *I would like to give a 555 solution to the gently falling frequency question in the June "Q&A" column. My circuit (Fig. 2) uses a 555 with a capacitor instead of a resistor between pins 6 and 7. On power up or after S1 is depressed and released, the uncharged capacitor acts like a short circuit and the frequency is 1/(0.693 x R1 x C2). As the capacitor charges, the impedance between pins 6 and 7 increases, causing the frequency to fall until oscillation stops. The parts were calculated for a starting frequency of 500 Hz and a 10-second decay time.—Glenn Bray, Montreal, Quebec, Canada*

A Excellent work! It's not often these days that I see a novel 555 circuit; I breadboarded yours and it worked as advertised. A CMOS TLC555 (similar to LMC555 or 7555) is shown in Fig. 2, but the circuit works equally well with a bipolar-transistor NE555.

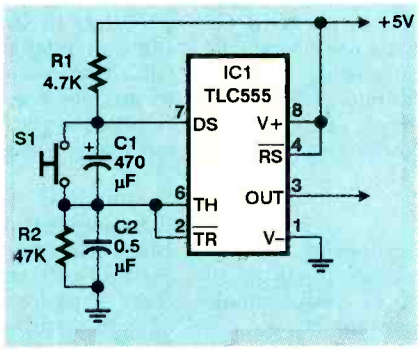


FIG. 2—IN THIS READER-SUPPLIED CIRCUIT, the frequency falls gradually from 500 Hz to zero on power-up or after S1 is pressed and released.

Making An Isolation Transformer

Q *I have a transformer that weighs 32 pounds and has four windings: two 120-volt windings that can be put in series for 240 V or parallel for 120 V, and two 12-volt windings that can be put in series for 24 V or parallel for 12 V. Can I use the two 120-volt windings as an isolation transformer?—E.A., Moraga, CA*

A Probably, but make some tests in order to be sure. I did something like this with a smaller transformer many years ago.

First, use an ohmmeter to make sure the two 120-volt windings are electrically isolated from each other. The next question is whether those two windings are well coupled magnetically. If the transformer is built around a single core, you're in luck. If it's built like two separate transformers, it won't work so well.

To find out, connect one 120-volt winding to the 120 V line and connect the other one to a 100-watt light bulb. Don't connect anything to either 12-volt winding.

If the bulb shines at full brightness, all is well; your isolation transformer can probably handle many hundreds of watts. If the bulb doesn't receive full voltage, you don't have enough magnetic coupling for one of the 120-volt windings to drive the other.

It Worked, But Why?

Q *I have an old AT&T cordless phone that would only work when I touched its cir-*

cuit board in a certain place. So I soldered a 1-nF capacitor there, thinking it would substitute for the capacitance of my body. That didn't work. I then unsoldered one lead of the capacitor, and the phone has worked fine ever since. Is this possible? How can half a capacitor affect a tuned circuit?—J.S., Baton Rouge, LA

A Two possibilities. Maybe, even with one end disconnected, the capacitor is still adding a few pF of stray capacitance.

More likely, though, you fixed a defective solder joint or soldered over a hairline crack in the circuit board. I'll bet that if you remove the capacitor completely, taking care to leave a good solder joint behind, the cordless phone will continue to work well.

TV Mystery

Q *I have two Sanyo 25-inch TVs with almost identical problems. Neither one will show cable channels—but one of them will do so, poorly, if I tap it hard on the side. This is a Sanyo DS25330, chassis number 25330-01. Any and all help will be appreciated.—C.S.C., via e-mail*

A I forwarded this to our service editor, Sam Goldwasser, who replied as follows:

"There's no way to know specifically, but if you can tap the TV and affect the problem, bad connections are indicated, probably in the tuner or its power supply or controller."

So look for bad connections, especially bad solder joints. This is not a CRT problem, and you do not have to de-energize the CRT as long as you stay away from the high-voltage section when working on the TV. For further guidance, order the appropriate service manual from Sanyo or from Howard W. Sams. You can also inquire on the newsgroup sci.electronics.repair to see if anyone there recognizes the symptoms.

CRT Pinouts

Q *I am very much in need of a chart showing the pinout of all the modern CRTs. I also would like to know of a source for all the CRT sockets so I can adapt an older B&K tube checker to check the new tubes.—M.W., Hollis, OK*

A Unfortunately, there is no longer anything like the *RCA Receiving Tube Manual*; CRTs seem to come from mysterious companies located overseas. Some CRT pinouts are in Sam Goldwasser's system of Web pages at www.repairfaq.org/sam/crtfaq.htm#crtpin. Of course, the pinout for any particular CRT will be shown on the Sams' service manual for a TV that contains it. The best source of CRT sockets is discarded equipment.

Perhaps your letter will inspire someone to compile and publish a CRT pinout guide. In fact, if you can track down the information, here's your golden opportunity.

Old Keyboard Amplifier

Q *I am hoping to find another reader who might have a schematic or other information about a late-1960s solid state keyboard amplifier, Farsifa model 80, also labeled Chicago Musical Instrument Company. In particular, I need data on the output transistors, labeled ELM127 7849.—Rene Bernier, PO Box 689, Boonton, NJ 07005*

A We're publishing your name and address so others can reply. Farsifa is

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci. electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio. amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

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

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

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

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

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1994 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

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

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

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

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

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

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

still in business in Italy, but you indicate that you have not been able to get in touch with them.

The number 7849 on the transistor is probably a date code (49th week of 1978), indicating that the amplifier is about ten years younger than you thought. We were not able to identify type number ELM127, but if they date from 1978, the transistors are almost certainly silicon, and you should be able figure out their pinouts and working voltages by measuring the voltages on the transistor socket with the transistor removed, or by testing one of the transistors if at least one of them is still good.

Keyboard Transplant

Q *I have a keyboard left over from my late AT&T 6310 computer. It has a good feel and I would like to use it with my current PC, but it has a 9-pin DB-9 connector. Can I do this? Is there more to it than just finding a DB9-to-DIN adapter?—J.T.W., Westminster, CA*

A Well, a DB9-to-DIN adapter isn't a standard item, and I suspect, but do not know for certain, that the signals sent by the keyboard are different. (Why would the AT&T keyboard use a 9-pin connector if it only needed five wires?) But I could be wrong. Is there a reader out there who has tackled this problem?

Fuel Cells Revisited

Q *Your reply to J.P. ("Q&A," April 1999, p. 5) revealed appalling ignorance. Fuel cells are much more efficient than combustion engines at producing electricity and motion. Perhaps if you spent a little time at www.fuelcells.org and less time on juvenile April Fool's gags you could provide an intelligent reply to your readers' questions.—R.J.L., via e-mail*

A I stand corrected; nobody knows everything, least of all your Q&A columnist.

The automobile industry is indeed expressing confidence in fuel cells as a way to power electric cars, as reported in two articles in *IEEE Spectrum* (November 1998 and May 1999). But *IEEE Spectrum* also reports continuing problems with the high cost of fuel cells.

Remember that the goal of an electric car isn't electricity—it's motion. The efficiency of the fuel cell is only part of the problem; the electric motor has its own inefficiency. That's why most present-day cars convert fuel directly into motion.

By the way, see this month's "Prototype" section for a look at one manufacturer's approach to vehicular fuel cells.

Sick Ohmmeter Revisited

Further to our March 1999 column, p. 3, John V. Cook, of Pittsburgh, Pa., writes to tell us that another cause of the problem may be partial demagnetization of the magnet in the meter. In that case, the meter will be inaccurate on all ranges. Some meters are adjustable so you can compensate for partial demagnetization.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to:

(1) include plenty of background information (we'll shorten your letter for publication);

(2) give your full name and address on your letter (not just the envelope);

(3) type your letter if possible, or write very neatly; and

(4) if you are asking about a circuit, include a complete diagram.

Questions can be sent to Q&A, **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735; or e-mailed to q&a@gernsback.com, but do not expect an immediate reply (because of our backlog) and please don't send graphics files larger than 100K. Due to the volume of mail, we regret that we cannot give personal replies. EN

BY KONSTANTINOS KARAGIANNIS
COMPUTER EDITOR

Optimizing Windows

IS YOUR PC ACTING A LITTLE SLUGGISH LATELY? DO YOU FEEL LIKE IT WAS A LOT FASTER WHEN YOU FIRST GOT IT? IF SO, YOU'RE NOT ALONE.

WINDOWS KEEPS GETTING BETTER WITH EACH VERSION released. Let the critics of Microsoft say what they will, but when you compare features and stability, the OS is continuously improving. However, that's not to say it doesn't have its flaws. The biggest of these, perhaps, is Windows' tendency to get fussy with day-to-day use. You can't just let the OS run on its own for the life of your computer. It needs some tweaking from time to time to keep things running right.

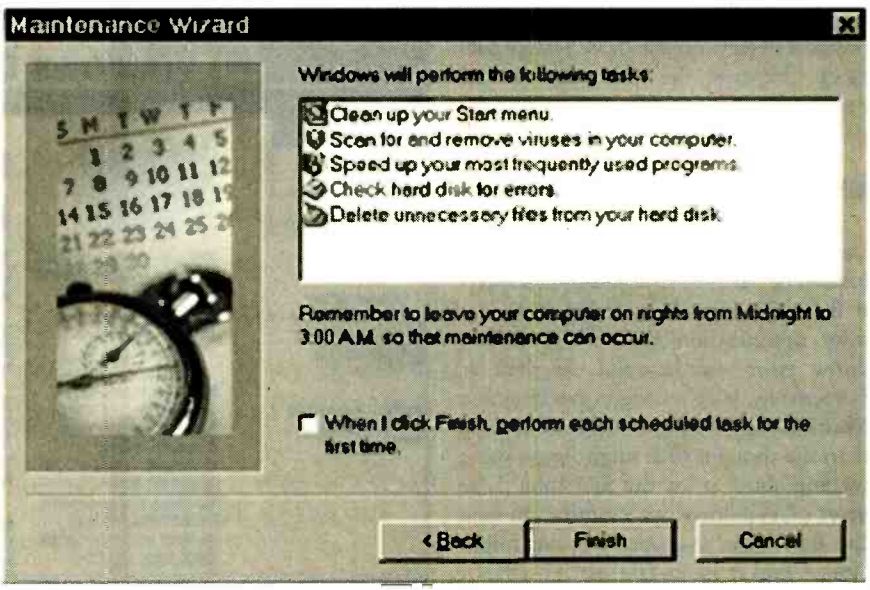
As with any computing task, there is software available to make system optimization easier. But we won't be looking at commercial fixes this month. Instead, we'll be relying on the true do-it-yourself spirit of hobbyists everywhere. There's no need to spend any money to get your PC running at its peak. All you need are some simple optimization tips.

Because there are different flavors of Windows, and because this is a column and not a book, I had to choose one version of the OS to focus on. My choice was the first release of Windows 98 (yes, there is a Service Pack available from Microsoft—click on Windows Update in your Start bar for more information), because most PCs shipped in the past year have this OS, and many of these systems will be just getting bogged down about now. Further, Win98 comes with features that make optimization a bit easier, making it a good choice for users who want to be able to keep on top of things without third-party utilities.

Maintenance Wizard

While it won't perform magic, the Maintenance Wizard in Win98 could help keep you from thinking your PC is cursed. It is composed of three main utilities: Disk Cleanup, Disk Defragmenter, and ScanDisk. You can schedule these to run on their own or activate them at any time. If you do want to schedule them, be certain to select a time when you're sure to be away from your PC, such as during your lunch break or overnight (if you leave the computer on 24/7). Also, as you read the description of each utility keep in mind that you can run them on their own by activating them in Start/Programs/Accessories/System Tools.

When Disk Cleanup runs, it allows you to remove certain types of files from your hard drive to provide extra disk space. At first glance, this wouldn't seem to provide any system-optimization speed boosts. However, Disk Cleanup lets you delete Windows Temporary Files, which do slow down startup of the OS and some programs. I recommend you check this option in the dialog box when setting up Cleanup. The utility can also delete Internet Temporary Files—if you have a slow Internet connection, checking this box will cause frequently visited pages to download just as slowly as ones you've never been to before. However, the space you free up by deleting these files could be significant if you browse the Web a lot. My



MAINTENANCE WIZARD CAN KEEP YOUR PC in good shape with minimal effort on your part. Just pick the utilities you want it to run and tell it when to do so.

Internet temp files totaled 78MB at last check!

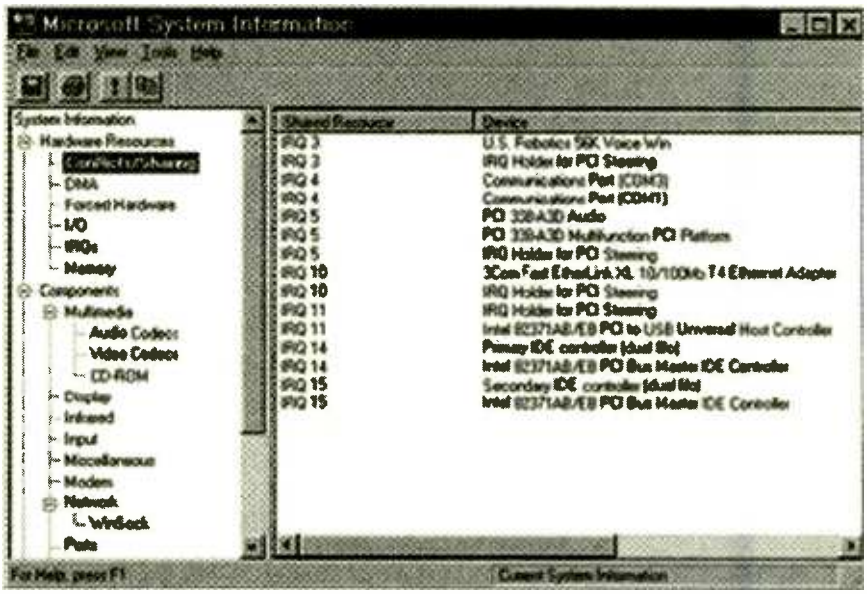
Disk Defragmenter features a creative subtitle that appears when you load it. As "Speed Up Programs" indicates, running a defrag can help Windows load and operate applications quicker. The reason for this is that hard drives store data in clusters. With a typical cluster size of 32K, it's likely that even a small application or file will be divided among several of these data-storage cells. As you open and modify files or program settings, these clusters end up moving around somewhat on a hard drive. Though your software will always be able to find the data, the more fragmented these clusters are the longer it will take for the program to do so. The result is a slowing down of programs. To alleviate this, run Disk Defragmenter (again, either manually or as part of the Wizard's automated routine). It will put all related clusters next to each other on the hard drive, and consequently speed up programs as claimed.

With ScanDisk, the final utility in the Maintenance Wizard trilogy, you can let your PC check itself for errors in file structure and the hard drive itself. As for the former, the most common file problems are cross-linked files (when two files appear to own one cluster) and lost clusters (clusters not being used, but not available or free for use). Both of these aforementioned problems can be detected and repaired by ScanDisk. The hardware problems are a little trickier as ScanDisk can't just whip out a toolbox and fix things like bad sectors (which are physical defects on the drive platter surface). However, the utility can do the next best thing, moving data away from defective sectors and over to good ones.

Microsoft System Information

Also located in Start/Programs/Accessories/System Tools, System Information or Msinfo32 (if you want to start if from the Start/Run dialog box) is a nifty optimization tool. Nifty if you know your way around it, that is. Fortunately, with a little exploration the Msinfo32 app becomes less intimidating than the thought of it might be to some reading about it for the first time. Like most of Windows, it's intuitive. In fact, the first time you open it, you might almost find it looks familiar, as it has a two-pane layout that is similar to Windows Explorer's.

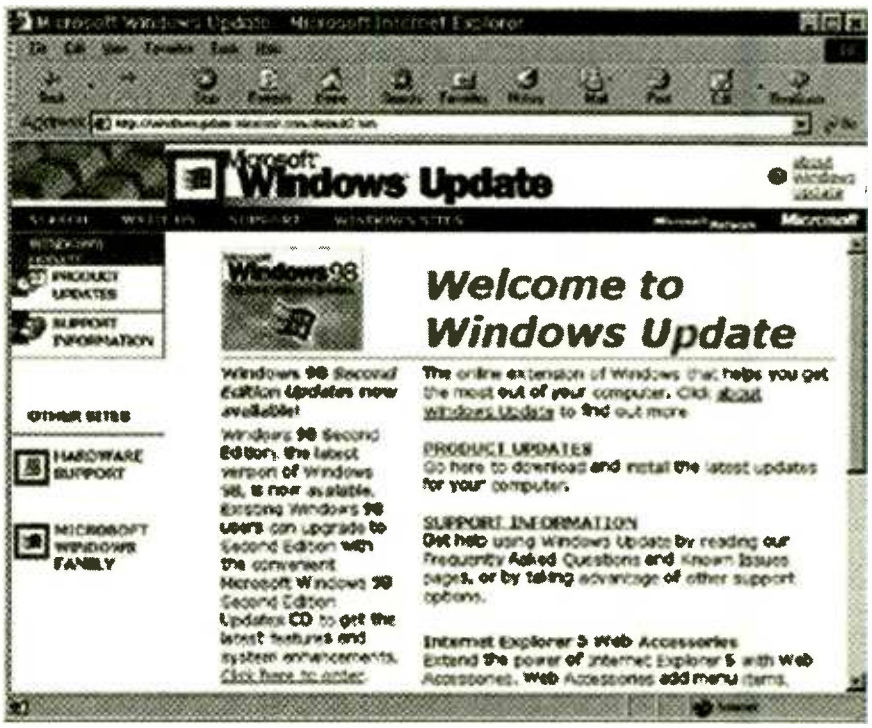
You can choose from four main menus in the left window: System Information, Hardware Resources, Components, and Software Environment. Let's look at each.



INFORMATION ON IRQ CONFLICTS is only one of the useful bits of diagnostic data that Windows System Information can provide.

System Information, as its name implies, offers details about your system, such as the release build or version of Windows 98, the network name of your computer, the RAM and processor in your machine, and how long your PC has been running since its last bootup. You can even learn the size of your swap file (a portion of the hard drive that Windows keeps available to act as virtual memory). Useful info, but not particularly necessary for optimization.

Hardware Resources is more helpful, with subsections that can provide a high level of detail: Conflicts/Sharing can help you find why two or more peripherals aren't getting along in their battle for owning one IRQ or other resource. DMA lets you know which direct-memory-access resources are in use should



WHILE SOME OF ITS DOWNLOADS are less than perfect, Microsoft Windows Update generally provides good fixes and performance boosters to Win98.

VENDOR INFORMATION

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052
Tel: 425-486-9258
Web: www.microsoft.com

you have a non-Plug and Play card to get running. Forced Hardware also helps with such cards that force their hold on certain resources. IRQs makes you aware of which interrupt request lines are being used—watch for devices that try to use the same ones, as these could be the ones causing crashes.

Moving on to Components, we find listings for all types of devices, including information like driver versions, configuration details, and some data that may look arcane. Of most interest to home users is the History listing that could help you figure out when a pesky device first started acting up.

The Software Environment will let you know about software that's loaded into system memory. This includes Drivers, 16-bit Modules Loaded, 32-bit Modules Loaded, OLE Registration, Running Tasks, and Startup Programs. The last is of particular interest.

Thanks to the Internet, we're installing more trial and free versions of programs than ever before. Some of these even plant themselves in the Startup folder, automatically loading with Windows. This can cause two major problems. For one, too many of these programs loading can severely slow down your bootup and even cause the occasional boot-crash. Second, because you forget they are there, some of these less-than-perfectly written programs may crash your system at unexpected moments, using more system resources than your system can safely offer. So, by all means, take a good look at the programs loading up automatically, and maybe check off a few of their boxes in the Msinfo32 window (look in the System Configuration utility) to prevent the little leeches from loading.

There are some other goodies in Msinfo32, too. First, we can all agree that not every Microsoft update to Windows is perfect. One recent one, for instance, took away the ability for your Start menu to be alphabetized. To get rid of updates that have a negative effect on your PC, use Msinfo32's Update Wizard Uninstall.

A real interesting utility, System File Checker can hunt for corrupt or missing system files and reinstall them from the Windows CD-ROM. This can cut down on some of those obscure error boxes that you've seen pop up from time to time.

Registry Checker can find problems in the Registry and load up the backup copy of it, which often means the difference between a corrupted system running or not. On a similar note, try the Automatic Skip Driver Agent to keep pesky drivers from loading (until you can find a better or non-corrupted version).

If you're having a really hard time with your system and need expert help, try the Windows Report Tool. It can generate a report on your PC's general health or lack thereof to prevent you from having to answer dozens of questions.

That's all the time and space we have this month. Till next time, I hope your system's running up to speed. If you'd like to get in touch, you can send e-mail to connections@gernsback.com, or snail-mail to "Computer Connections", Electronics Now, 500 Bi-County Blvd., Farmingdale, NY 11735. EN

BY MARC ELLIS

Opening the Mail

IT'S THE END OF JUNE AS THIS IS BEING WRITTEN, AND AROUND THIS TIME EVERY YEAR, SUMMER HOUSE AND YARD PROJECTS BEGIN TO CUT INTO MY SOLDERING-IRON TIME. HOWEVER, I'VE DONE SOME WORK ON OUR ONGOING PHILCO 70 restoration, beginning on the cabinet and cosmetic cleaning of the chassis. My supplier sent another electrolytic to replace the defective one, and that's installed. As you know, the set is already working quite well so (except for a touch-up alignment) the electronic work is almost over. More on the project next month! In the meantime, there's a lot of interesting stuff in the mailbag, so let's take a look at it.

From The Readers

Dennis Gifford (PO Box 304, Henagar, AL 35978) has for sale a Hickock model 539C in excellent condition except for the wooden case. He also has additional equipment that might be of interest to some of you readers. Drop him a note if you'd like to know more!

Hank Schulz Jr. (Erie, PA) writes that our Philco restoration awakened pleasant memories of now-classic sets he played with as a boy. He wonders if my transfer to **Electronics Now** from **Popular Electronics** means that **Popular Electronics**. is being phased out (Ziff-Davis Publishing's discontinuance of the original **Popular Electronics**. back in the 1980s is still fresh in his mind). But, as readers who have been closely following the transition at Gernsback Publishing realize, nothing could be further from the truth. What is going on is a re-orienting of the editorial content of both magazines to give each a sharper focus and added reader interest.

Eric Fleharty (Berwick, LA) asks where he can get a Philco #44 tube. Well actually, Eric, unless you are restoring a Philco set and want to make it look just as it did when it left the factory, you don't really need a Philco branded tube. Any brand will do. Also, this tube is more commonly known as the 39/44. What happened was that two different tube manufacturers happened to register new types (the 39 and the 44) that were virtually identical in specifications. Each was assigned a separate number, but a few years later the two were combined as a single type that would replace both. My 1998 *Antique Electronic Supply* catalogue lists a new-old-stock 39/44 at $5.00. Write AES at 6221 South Maple Ave., Tempe, AZ 85283.

Joe Wisemann e-mailed me a while back to call my attention to a mental lapse I had back in the July column, when I reviewed the standard AC-DC. series-string tube complement that became known as "The All-American Five." I correctly listed the 12SA7 pentagrid converter, 12SK7 RF/IF amplifier, 12SQ7 detector/amplifier, and 35Z5 rectifier. However, the typical output tube was a 50L6, not a 35L6 as I mentioned. This results in a voltage drop of 121—slightly more than the nominal line voltage of 115 rather than slightly less (106) with the 35L6.

And speaking of the All-American Five, Charlie Wilson (Spokane, WA) writes of his success in adapting for 115-volt operation a *Greek* Kosmophon set designed to operate on European 220-volt mains. The Kosmophon had the All-American Five tube set (I guess that country's radio industry wasn't big enough to have a "Pan-Hellenic Five!) with a large dropping resistor to make up the voltage difference. Charlie substituted an American cordset for the original, bypassing the dropping resistor, and the Kosmophon now operates happily in Anywhere U.S.A.

Another success story comes from Arthur L. Manning, N4XNM, of Brunswick, GA. Art owns two Knightkit Star Roamer sets and noted that both suffered from high-end audio distortion at medium and above audio levels. He

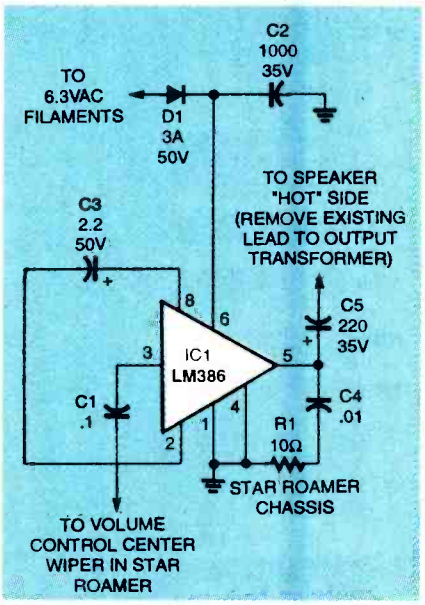
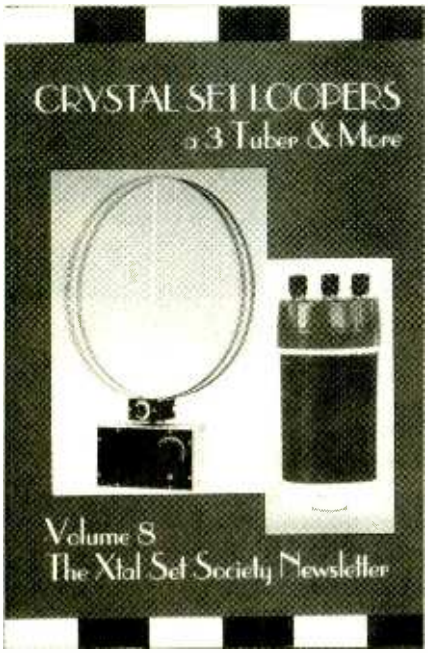


FIG. 1—ART MANNING'S REVERSIBLE STAR ROAMER modification used parts from the RadioShack catalogue. After doing the modification, try a .0047-µF capacitor across the volume control for more pleasing tone.



THE LATEST OFFERING from the Xtal Set Society contains all of the 1998 member newsletters.

corrected the problem with a non-destructive and completely reversible modification. The 12AX7 and 6AR5 audio stages were disabled simply by removing the tubes. Then an LM386 low-power audio amplifier chip was wired in as shown in Fig. 1. The result: Audio gain was increased and both audio distortion and current drain from the power supply were considerably reduced. Art is a retired Voice of America Broadcast Engineer/Manager.

Finally, a big thank-you to reader Harold McCullen (Saginaw, MI) who took the trouble to send me copies of the Philco Model 70 service notes from his personal collection. Harold was a radio serviceman in the mid 1930s, and remembers that most of the trouble with the early Philcos (even then!) was shorted caps in the Bakelite blocks. Towards the end of the 1930s, he obtained his First Class Commercial Operator's license, then worked in Radio and Television broadcasting until 1956. The next 24 years were spent with Michigan Bell, and Harold has been retired for the past 19 years.

Recent Books And Publications

Crystal Set Loopers And More, edited by Rebecca Hewes. Published by The Xtal Set Society, P.O. Box 3026, St. Louis, MO 63130; e-mail: xtalset@midnightscience.com; Order line: 800-927-1771. 128 pages; 5fi by 8fi inches; soft cover; $15.95 plus $3.75 S&H.

This fun book is actually volume 8 of the Xtal Set Society newsletter, a complete collection of the member newsletters from January though November 1998. The issues contain correspondence from members all over the world, focusing on simple and elegant old-time radio circuits. There are construction projects, schematics, theory articles, and nostalgia pieces.

Among the projects are a simple shortwave crystal set with a loop antenna, a 3-tube AM/SW receiver, a "universal loop" that can be used with a variety of experimental circuits, an antenna tuner wavetrap that will add sensitivity to your sets and tune out interfering strong local stations, and a crystal set built into a stick deodorant dispenser(!). Experimental articles explore such topics as the use of molybdenite as a detector and the effects of biasing on crystal detectors.

If you are charmed, as I am, by the variety and quality of the Society's publications, you may want to consider becoming a member. Cost in U.S. (which includes a subscription to the bimonthly newsletter) is $12.95 for a year; $23.95 for two years. Canadian subscriptions are $14.00 per year; $19.00 per year elsewhere.

On The Short Waves, 1923-1945—Broadcast Listening In The Pioneer Days Of Radio by Jerome S. Berg. Published by McFarland & Company, Inc., Box 611, Jefferson, NC 28640; Order line: 800-253-2187. 280 pages; 7 by 10 inches; casebound; $42.40 plus $4.00 S&H. NC residents add 6% sales tax.

A flyer describing this book came across my desk recently, and though I haven't seen the volume itself, the description looked interesting enough to tell you a little about it. As the name suggests, the author devotes himself to the development of shortwave broadcasting from its beginnings in the 1920s through the end of World War II. The broad-based coverage includes early radio personalities and broadcasters, frequency utilization, set building, commercially made sets, wartime broadcasting and listening, reception reporting and the birth of The Voice of America. There are 171 illustrations from shortwave's early days.

Tube Collector (Bulletin of The Tube Collector's Association), PO Box 1181, Medford, OR 97501). Number of Pages varies; 5½ by 8½ inches; soft cover; published six times per year. Annual dues are $20.00 in North America and $25.00 elsewhere.

This is a newly-formed organization of collectors and history enthusiasts focusing on all phases and vintages of tube design. The founding president of the group is Al Jones, W1ITX, who is known for his award-winning tube collection. The publication is edited by Ludwell Sibley, a recognized vacuum-tube expert who for several years edited The *Old-timer's Bulletin*, quarterly publication of The Antique Wireless Association. Several other recognized experts serve on the board of this fledgling organization. Those with a serious interest in vacuum history and lore should seriously consider joining. Write to the address given above for more information.

YOU CAN HELP the Committee to Preserve Radio Verifications preserve these precious bits of radio history!

(Continued on page 87)

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A UNIVERSAL STEREO NOISE FILTER AND COMPRESSOR

Reduce noise and increase clarity of any audio signal.

RICHARD PANOSH

While there are many techniques for reducing noise on audio signals, few are universal or "single-ended." Most noise-reduction methods need the original signal to be encoded at the source and decoded at the receiving end; examples of that method include Dolby and dbx. Also, noise-reduction systems many times require a license from the patent owner to use the encoding system (and sometimes the decoding!).

The best solution would be a "universal" noise-reduction system. Such a system should be able to work with any signal without any encoding. What's more, the circuit should be usable by anyone who has the ability to pick up a soldering iron without worry of running afoul of the law.

The good news is that a truly universal noise-reduction system exists. The Universal Noise Reducer presented here has those features that make it a delightful addition to any audio system. Built around a special noise-reduction integrated circuit, it does not require encoded material; the signal-to-noise ratio of any signal can be improved by 25 dB. Any line-level audio source such as tapes, records, FM radio, stereo TV, and satellite signals will benefit. It is also quite effective with CD copies of older analog sources. The system also improves the sound quality of video games and electronic keyboards.

Noise-Reduction Basics. Figure 1 illustrates the frequency and amplitude envelope of a typical audio signal within the bandwidth of an audio amplifier. While the signal might occupy any frequency or amplitude within the amplifier envelope, it does not occupy that area completely at all times. That is especially true during quiet passages or a pause in either the music or speech. During those periods, the large audio bandwidth is not required and noise becomes quite evident. By its nature, noise has a wide bandwidth and is perceived as a hissing sound known as *white noise*. When the audio signal is present, the noise is covered up, or "masked", by the signal. That concept is well known to the field of *psychoacoustics*, which studies the psychological aspect of sound and its perception. Whenever a sound is being perceived, it reduces the ability of the listener to hear another sound. During those quiet passages, the noise is "unmasked" and heard as a hiss.

The unmasked white noise that occurs during those quiet passages can be reduced with a reduction of the overall audio bandwidth. That technique has been available for a number of years and is referred to as *Dynamic Noise Reduction* (DNR is the registered trademark of National Semiconductor). An example of that technique was covered in an article that appeared in the July 1994 issue of our sister publication, **Popular Electronics**. That project used a voltage-controlled variable low-pass filter to track the audio-frequency envelope and maintain the required bandwidth to pass the signal information. Since the signal-to-noise ratio is improved with the square root of the bandwidth reduction, a reduction in bandwidth from 35 kHz to 1 kHz can improve the signal-to-noise ratio by

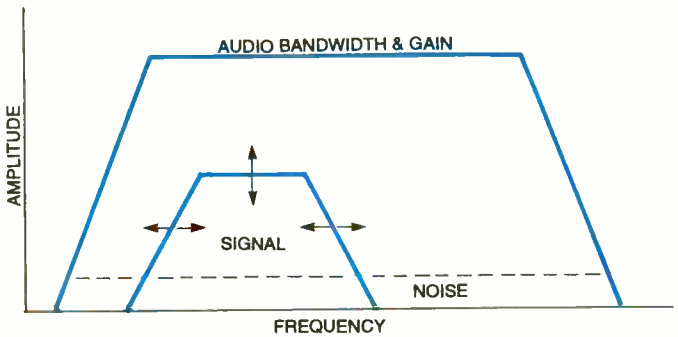


Fig. 1. Noise is inherent in any audio signal. As long as the level of the audio is loud enough, our ears ignore the noise. It's when the music becomes quiet that the noise becomes apparent.

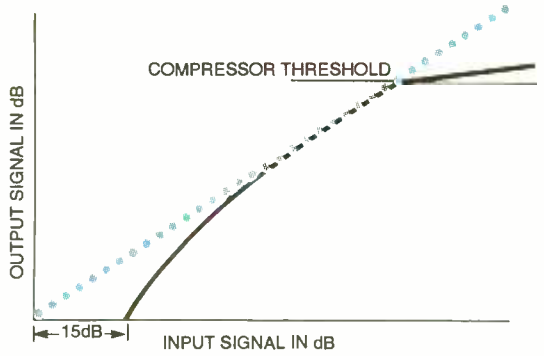


Fig. 2. If louder passages are attenuated and softer passages boosted, a further reduction in noise can occur.

nearly a factor of 6, or about 15 dB.

A second technique that can be used for noise reduction is the use of a variable voltage-controlled amplifier. By controlling the amplifier's gain, the level of the background white noise, or *system noise floor*, can be further attenuated. With this method, signals that are above a certain threshold are passed with a gain of one so that no distortion is added to the program material. However, signals below the threshold are attenuated as shown in Fig. 2; the result is an additional noise reduction of 15 dB. Combining those two techniques results in an improvement of about 25 dB or a factor of nearly 18:1!

A drawback in trying to reduce noise in unencoded signals is that different recording equipment, media, and environments have different requirements. In addition to the methods discussed above, the Universal Noise Reducer uses an automatic adaptive threshold that senses the noise floor of different audio sources. This lets the unit automatically maintain the best possible signal-to-noise level at all times.

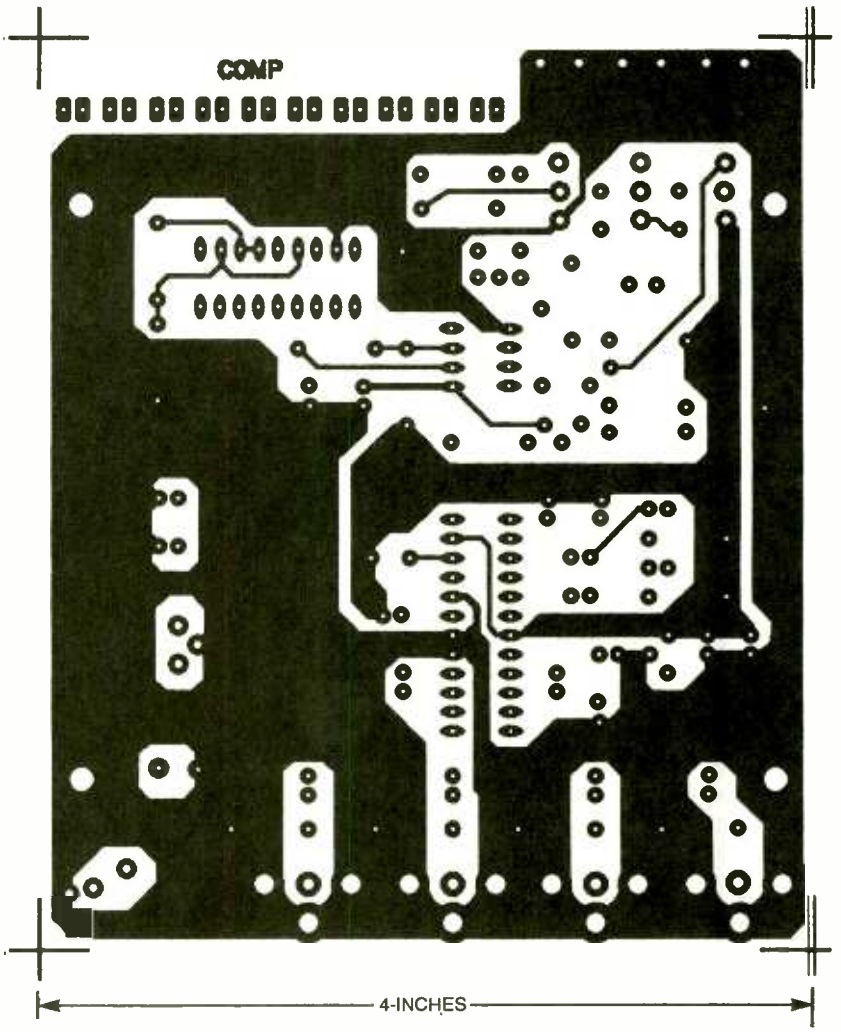
An added bonus noise-reduction technique available through the use of the voltage-controlled amplifier circuit is a *compressor*. In the compressor mode, signal levels above an adjustable threshold level will be attenuated. That feature is particularly useful to attenuate commercials that are sometimes much louder than the program material. It can also be used to improve softer sounds below the threshold by attenuating loud sounds, thereby reducing the dynamic range. The compressor and nose reduction functions are independent and can be used individually or together.

Circuit Description. Follow the schematic diagram shown in Fig. 3 during the following description of the Universal Noise Reducer's circuit.

Power from a 12-volt DC wall transformer is connected to J5. The voltage is regulated to a 9-volt level by IC4. That supply voltage is also divided in half by IC5 to provide a "pseudo ground;" working with op-amps is much easier with a "split" power supply.

Stereo audio signals are input through J1 and J2. Those signals are applied to the heart of the Universal Noise Reducer, IC1. That chip, made by Analog Devices, handles all of the noise-reduction and signal-compression techniques discussed before.

Stereo FM and stereo TV signals use a pilot signal to separate the left and right channels. A tuned passive filter formed by L1, C16, and C13 attenuate any 15-kHz or 19-kHz



Here's the foil pattern for the component side of the Universal Noise Reducer. A large ground plane aids in reducing stray noise pickup.

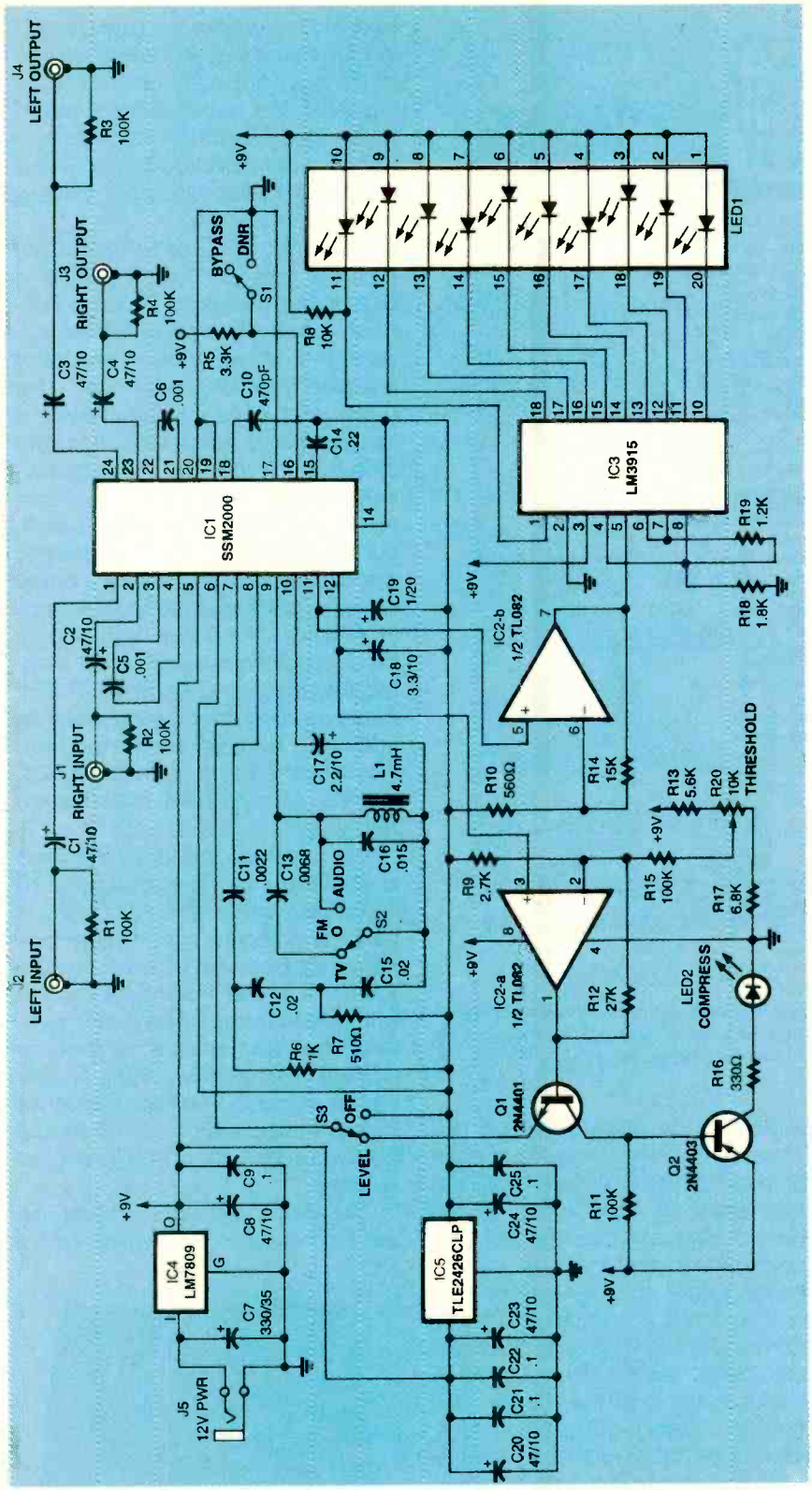


Fig. 3. The Universal Noise Reducer is built around an Analog Devices component that handles all of the noise reduction and compression tasks.

pilot signals if they are present in IC1's control loop. A 15-kHz pilot is used to encode the stereo or SAP (secondary audio program) signals in television; 19 kHz is used for stereo FM. Switch S2 is used to select filtering for one of those frequencies or no filtering at all. Older audio equipment was more prone to leak the pilot signal into the audio signal; newer equipment removes the signal better.

Each section of IC2 handles a different function. Op-amp IC2-b is used as a high-gain buffer to isolate pin 11 of IC1—the control voltage for the voltage-tuned low-pass filter's bandwidth. Note that IC1 processes that voltage internally to remove any variations in amplitude. The voltage level present at pin 11 is still a function of signal amplitude but for normal line-level signals it is suitable for an indication of filter bandwidth. The buffered signal is displayed on a bar-graph LED display with IC3; variations in the low-pass filter bandwidth can be tracked. During quiet passages in the audio signal, the low-pass filter should be at the minimum bandwidth of 1 kHz; the first LED should be extinguished. If a pilot signal is leaking into the control loop, the lower LEDs will remain on, indicating that noise reduction is not working as well as it should be.

The other op-amp, IC2-a, closes IC1's compressor loop. It monitors the level of the source-signal detector on pin 12 of IC1. That voltage level is compared to the threshold level set by R20. Levels above the threshold level switch Q1 on. The feedback signal passes through S3 to pin 7 of IC1, which then attenuates the signal until the level falls enough to turn IC1-a and Q1 off. If the compressor feature is not wanted, simply throwing S3 breaks the feedback loop. When Q1 switches on, the voltage drop developed by R11 switches on Q2 and, in turn, LED2, indicating that the compressor is active.

The processed output signal is available on J3 and J4. Switch S1 is used to bypass the Universal Noise Reducer without having to disconnect the unit from the signal path. By switching the unit in and out of the audio path, an "A-B" type of comparison is easily done as to the effectiveness of the various settings of the Universal Noise Reducer.

Construction. Because of the nature of audio circuits, the Universal Noise Reducer is best built on a PC board; less stray noise and hum will be picked up. After all, the pur-

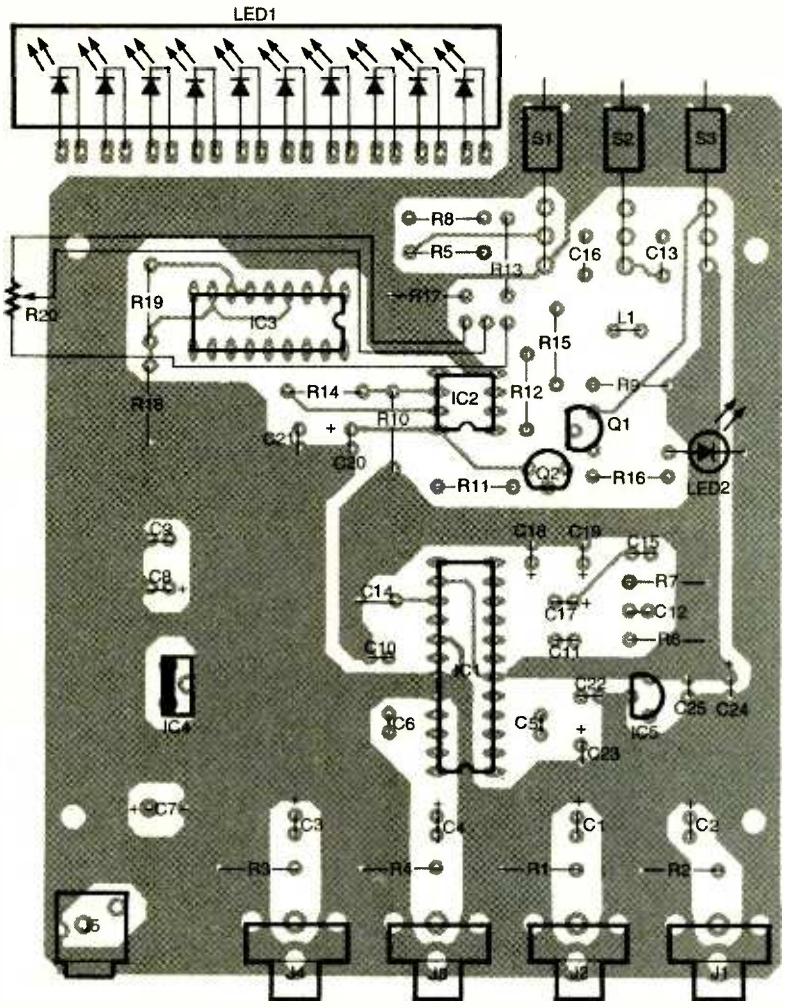


Fig. 4. The Universal Noise Reducer uses a double-sided PC board. If your board doesn't have plated-through holes, don't forget to solder the traces where pads are on both sides of the board. No jumpers are needed; all connections between sides are made at component leads.

pose of the project is to *reduce* noise—not add to it!

Foil patterns for a double-sided layout have been included here for those who wish to etch and drill their own board. If you do not want to etch a board, one is available from the source given in the Parts List.

If you are using a board from the source given in the Parts List or one made from the foil patterns, use the parts-placement diagram shown in Fig. 4. The best order for mounting the components is to start with the smallest parts first; electrostatic-sensitive parts, such as semiconductors, should be mounted last irrespective of their size. If you want to use sockets for the integrated circuits, mount them first, followed by the resistors and capacitors.

Note that if you are using a PC board that you etched yourself, you will have to make some provision for making connections between both sides of the board where there are traces on both sides. One method (certainly the easiest) is to simply solder to the component lead on the top side as well as the bottom side. Special eyelets have also been used with success in both industry and the hobby. The ultimate solution, of course, is plated-through holes. While that technique is simple to do in an industrial or commercial setting, it is messy, time-consuming, and occasionally dangerous due to the type of chemicals and equipment needed for creating a plated-through hole. The foil patterns do not have any "via" holes (holes that pass a signal from trace to trace between the two sides without a component lead in them) in their design, so you don't have to worry about soldering short pieces of jumper wires to make those connections. If you are using a purchased board, all of the holes are plated through, making construction a snap.

Note that all of the semiconductors, as well as the electrolytic capacitors, are polarized; double-check their orientation before soldering them in place. Any part installed backwards will be destroyed as soon as power is applied for the first time. It is also possible that an improperly-installed polarized component can take out other components with it. For example, an electrolytic capacitor that is installed backwards might work for a few seconds or minutes; but it can explode or burst into flames, sending an electrical surge into a nearby IC that could destroy that component as well. Also beware of components that look the same, such as IC5, Q1, and Q2. Always check twice before soldering!

The switches and jacks specified in the Parts List are designed to mount directly to the PC board. If you are going to substitute panel-mounted parts, you'll have to wire them up in the traditional fashion with short pieces of insulated wire. Keep the wire lengths as short as possible, especially where audio signals are being carried. Note that S2 is a three-position unit; it should be in the middle of the group of switches.

The leads for LED1 should be bent down at a 90-degree angle

Fig. 5. The Universal Noise Reducer fits easily into a stylish case.

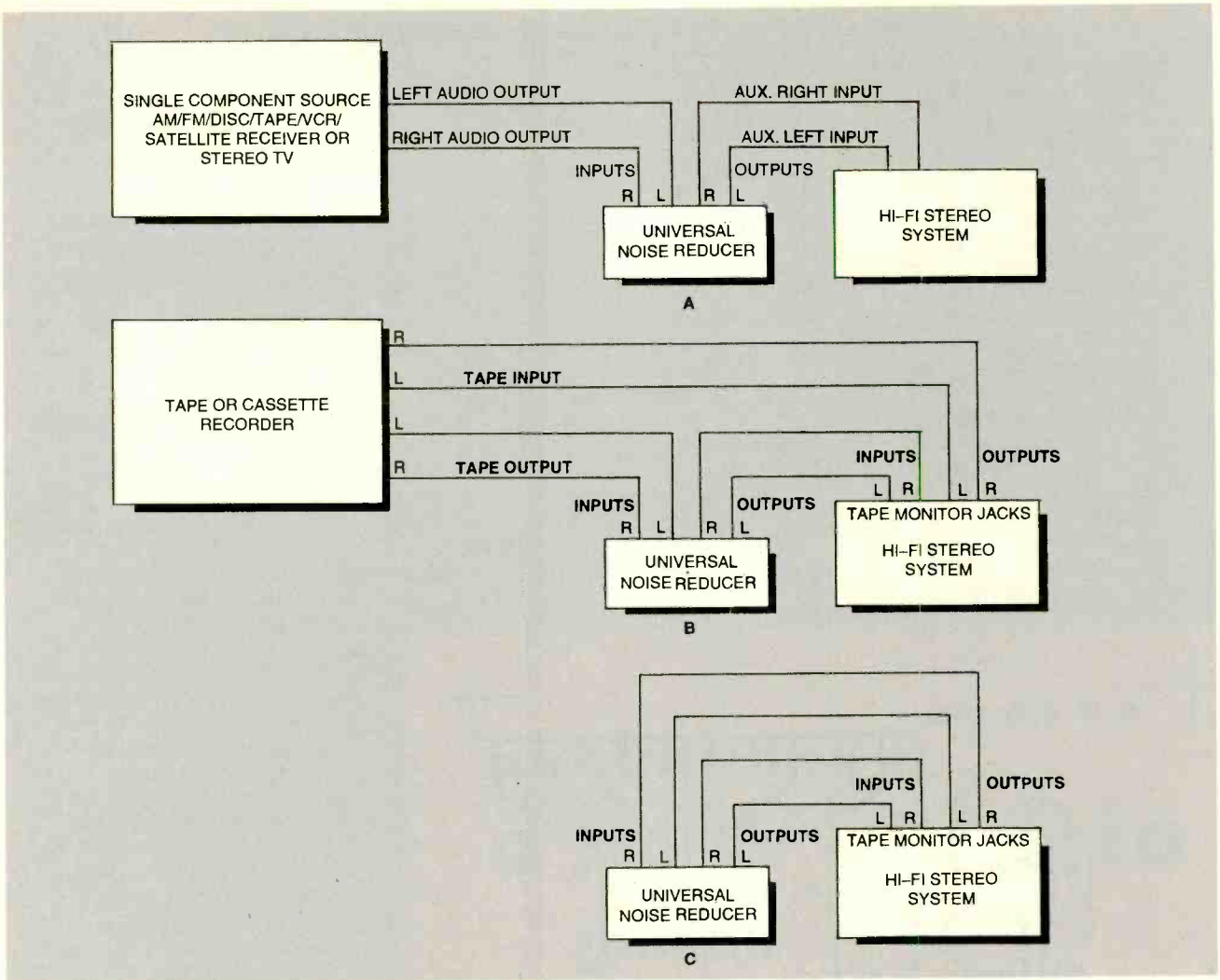


Fig. 6. There are several ways to connect the Universal Noise Reducer to your stereo equipment. It is important to remember that the system works best with an unmodified audio signal. Even if you don't have an amplifier that allows processing equipment to be added to the path, you can always use the tape recording and monitoring jacks.

about /-inch back from the plastic case. A /-inch thick piece of stock can be used as a guide. Check the polarity of the LEDs before bending the leads. A longer (anode) lead will be nearest the corner of the PC board. The display is seated down against the board to obtain the correct height.

When you are finished mounting all of the components, double-check your work for bad solder joints, poor workmanship, and missing, incorrect, or backward components. When you are satisfied with your work, mount the board in a suitable enclosure. The author's prototype, shown in Fig. 5, used a PacTec enclosure. Drill holes as needed for the jacks, switches, displays, and controls. Note that R20 is a slide potentiometer rather than the traditional rotary style. It is mounted above LED1 and connected to the board by short lengths of insulated wire.

Once the Universal Noise Reducer is mounted in its case, it is ready for testing and use.

Set-Up and Operation. The Universal Noise Reducer can be hooked up in a couple of ways. The most obvious way is shown in Fig. 6A, where the audio sorce is connected to J1 and J2, with J3 and J4 connected to the amplifier's inputs. Wherever possible, the unit should always be placed in the audio path after any preamplifiers and before the volume control or tone controls. That way, the signals will be of a uniform level and provide a flat-frequency response. Many modern amplifiers have separate preamplifier output jacks for just such a use.

If you don't have such a rig, the Universal Noise Reducer can be placed in the tape-loop or signal-processing loop; see Fig. 6B. Again, that will provide flat-frequency signals with levels in the range of 100 millivolts to 1 volt rms. If you have an equalizer in the same loop, it is important to locate the Universal Noise Reducer *before* the equalizer. Again, the unit works best with a flat bandwidth before you do any equalizing. If you don't have a tape unit, simply connect the Universal Noise Reducer in place of one as shown in Fig. 6C. By monitoring the tape playback, the unit becomes a part of the audio path on even the most basic stereo equipment as long as tape input and output

PARTS LIST FOR THE UNIVERSAL NOISE REDUCER

SEMICONDUCTORS

IC1—SSM2000 stereo noise attenuator/compressor, integrated circuit (Analog Devices)
IC2—TL082 operational amplifier, integrated circuit
IC3—LM3915 bar-graph display generator, integrated circuit
IC4—LM7809 9-volt positive voltage regulator, integrated circuit
IC5—TLE2426CLP split power supply ground converter, integrated circuit
LED1—Light-emitting diode bargraph display, 10-segment
LED2—Light-emitting diode, green
Q1—2N4401 silicon transistor, NPN
Q2—2N4403 silicon transistor, PNP

RESISTORS

(All resistors are 1/4-watt, 5% units unless otherwise noted.)
R1–R4, R11, R15—100,000-ohm
R5—3300-ohm
R6—1000-ohm
R7—510-ohm
R8—10,000-ohm
R9—2700-ohm
R10—560-ohm
R12—27,000-ohm
R13—5600-ohm
R14—15,000-ohm
R16—330-ohm
R17—6800-ohm
R18—1800-ohm
R19—1200-ohm
R20—10,000-ohm, linear potentiometer

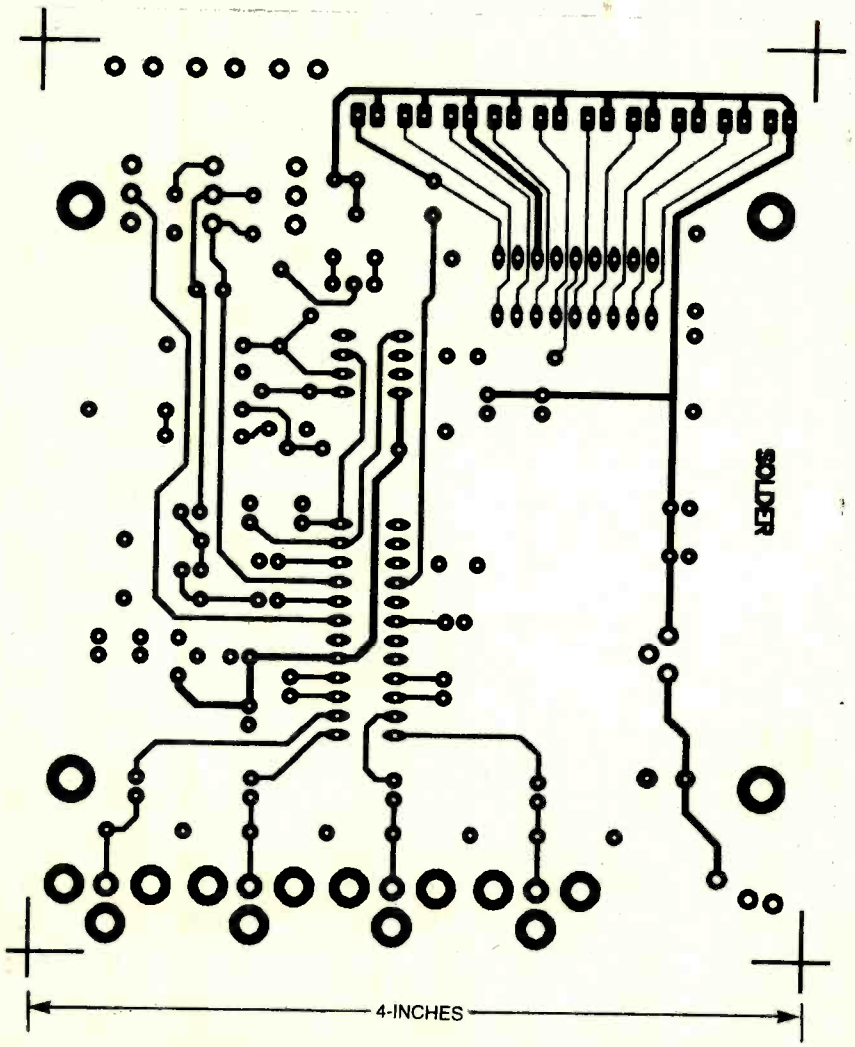
CAPACITORS

C1–C4, C8, C20, C23, C24—47-µF, 10-WVDC, electrolytic
C5, C6—0.001-µF, ceramic-disc
C7—330-µF, 35-WVDC, electrolytic
C9, C21, C22, C25—0.1-µF, ceramic-disc
C10—470-pF, ceramic-disc
C11—0.0022-µF, ceramic-disc
C12, C15—0.02-µF, ceramic-disc
C13—0.0068-µF, ceramic-disc
C14—0.22-µF, ceramic-disc
C16—0.015-µF, ceramic-disc
C17—2.2-µF, 10-WVDC, electrolytic
C18—3.3-µF, 10-WVDC, electrolytic
C19—1-µF, 10-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

J1–J4—RCA-style phono jack, PC-mounted
J5—Co-axial power jack, PC-mounted
L1—4.7mH inductor, shielded
S1, S3—Single-pole, double-throw switch
S2—Single-pole, double-throw, center-off switch
Case (PacTec CM125 or similar), 12-volt DC wall adapter, IC sockets, knob for R20, wire, hardware, etc.

Note: The following items are available from Vista, PO Box 142 Bolingbrook, IL 60440-1532; Tel: 630-378-5534: Assembled and tested unit (SSM-2000-ASSEM), $125.00; Complete kit of all parts and case (SSM-2000-KIT), $95.00; etched, drilled, silk-screened PC board with plated-through holes (SSM-2000-BOARD), $18.00; IC5, $3.90; IC1, $18.00. All mail orders will be shipped by first class US mail with a shipping/handling charge of $3.00. All telephone orders will be shipped by priority mail with a shipping/handling charge of $6.00. Illinois residence must include 7.5% sales tax. Visa, Mastercard, and American Express credit cards are accepted.



Here's the foil pattern for the solder side of the Universal noise Reducer. All connections between the two sides are done at component pads, making it easier to build the unit without using plated-through holes.

jacks are available.

With a 12-volt power source connected to J5, throw S1 to BYPASS, S2 to AUDIO, and S3 to OFF. Unmodified audio should be heard. Switch S1 to DNR and a reduction in noise should be heard. Try using audio sources that have different gain levels, such as a quiet passage of a piece of classical music. If you are using a television or radio as an audio source, you might have to set S2 to the appropriate mode as mentioned before in case the carrier signal is leaking into the audio path. Finally, throw S3 to test the compressor; note that compression takes place at different levels by varying R20. The level of compression should be seen on LED1. Ω

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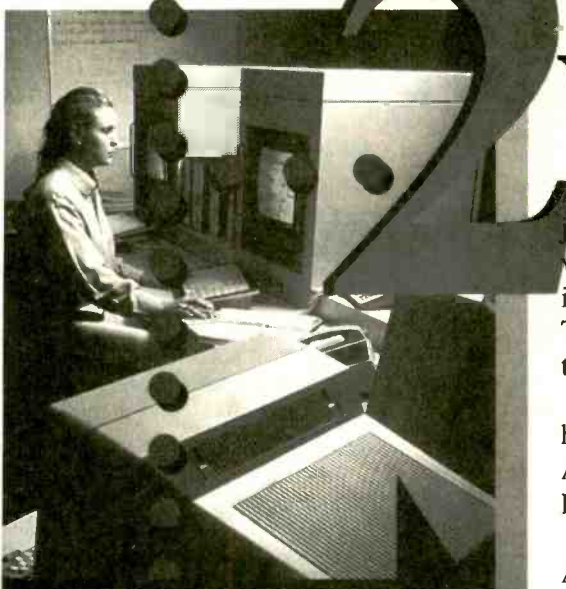

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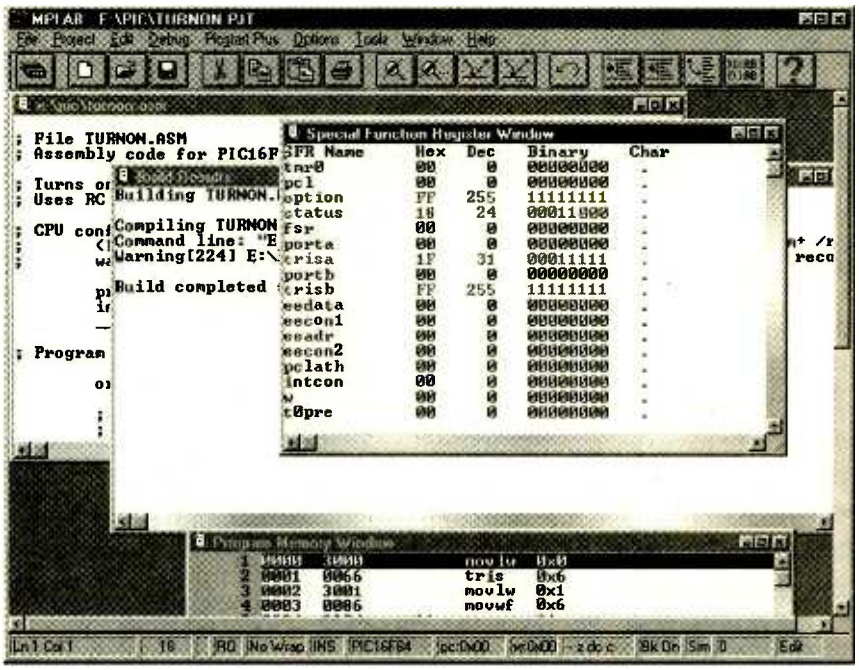
PIC Assembly Language



For the Complete Beginner

MICHAEL A. COVINGTON

Microcontrollers have revolutionized the world of electronics, but they are useless to you if you don't know how to use them. This month we look at more of the code that will help you get with the "program."

It goes without saying that microcontrollers have become one of the most important components in today's electronics. As evidence of that, virtually every modern electronic device makes use of those units. Further, microcontrollers have become increasingly important to the electronics hobbyist. More and more, the best projects in the pages of **Electronics Now** and other electronics publications make use of microcontrollers.

What that means, however, is that, if you don't know how to program and use microcontrollers, you are missing out on some of the best of what's available to today's electronics hobbyist.

Well, we can't allow that to happen! Last month we looked at some microcontroller basics and showed you how to program a microcontroller with a simple program. This month we'll continue that discussion and then tackle a project that is a little more ambitious.

First, however, let's take another look at last month's program.

How The Program Works. Let's look back at Listing 1 (which appeared last month and is repeated here for your convenience) and consider the program in detail. More than half of what you see there consists of comments; everything after the first semicolon (;) in each line is a comment ignored by the computer.

The program starts with a number of *pseudo instructions*, commands that give information to the assembler but are not translated into machine instructions. The first pseudo instruction:

```
processor PIC16F84
```

tells the assembler what kind of CPU you're using. It's immediately followed by another instruction:

```
include <p16f84.inc>
```

telling the assembler to read the file P16F84.INC, which contains a lot more pseudo instructions giving the memory addresses of the ports and other particulars of this CPU.

Next comes the __config macro instruction:

```
__config _RC_OSC & _WDT_OFF
& _PWRTE_ON
```

Notice that there are *two* underscore marks at the beginning of __config. This instruction specifies some configuration settings to be programmed into the PIC. It says you're using an RC oscillator (resistor and capacitor, not crystal); the watchdog timer is off; and the power-up timer is on. The power-up timer imposes a slight delay at start-

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up to give the 5-volt supply time to stabilize. The watchdog timer is a built-in device for rebooting the PIC every 18 milliseconds; some programs use that to protect themselves from endless loops, but it's very important to turn it off if you're not using it, or your program will keep restarting itself at inopportune moments.

The last pseudo instruction is:

```
org 0
```

which means, "The next instruction should go at address 0 in program memory." That is, you're telling the assembler where to start. Then come the program instructions, and finally the pseudo instruction:

```
end
```

which tells the assembler that the program is over. Unlike END in BASIC, end in assembly language does *not* tell the program to stop running.

What The Instructions Do. Now look at the actual CPU instructions in the program, namely:

```
    movlw B'00000000'
    tris  PORTB
    movlw B'00000001'
    movwf PORTB
fin: goto  fin
```

What the program needs to do is set up port B for output, place a 1 into the lowest bit of port B (causing pin B0 to go high), and stop. Consider the last of these first: How do you stop a program? Not by making the processor go dead, because then the output at B0 would disappear and the LED would turn off. Nor by exiting to the operating system, because there isn't an operating system. Your program has the PIC all to itself.

The way you stop this program is by putting it in an endless loop. That's accomplished by the instruction:

```
fin: goto fin
```

which simply jumps back to itself, over and over.

Now look at the previous step:

LISTING 1

```
; File TURNON.ASM
; Assembly code for PIC16F84 microcontroller

; Turns on an LED connected to B0.
; Uses RC oscillator, about 100 kHz.

; CPU configuration
;       (It's a 16F84, RC oscillator,
;       watchdog timer off, power-up timer on.)

        processor 16f84
        Include     <p16f84.inc>
        __config  _RC_OSC & _WDT_OFF & _PWRTE_ON

; Program

        org       0          ; start at address 0

        ; At startup, all ports are inputs.
        ; Set Port B to all outputs.

        movlw     B'00000000'        ; w := binary 00000000
        tris      PORTB              ; copy w to port B control reg

        ; Put a 1 in the lowest bit of port B.

        movlw     B'00000001'        ; w := binary 00000001
        movwf     PORTB              ; copy w to port B itself

        ; Stop by going into an endless loop

fin:    goto      fin

        end                          ; program ends here
```

How do you place a 1 in the lowest bit of port B? From the CPU's viewpoint, port B is an 8-bit register and we want to place binary 00000001 in it. But there is no CPU instruction to place a specified value (a "literal") directly into a port. Instead, the program places 00000001 into the W register using a movlw instruction ("move literal to W") and then copies W to port B using a movwf instruction ("move W to file register").

Note that in assembly language, "move" always means "copy." That is, every "move" instruction actually *copies* data from one place to another, leaving the original unchanged. This is true of all the assembly languages I've seen, regardless of the kind of CPU.

Note also that in PIC assembly language, the name of port B is PORTB (all capitals), not "portb" (lower case). This name was defined in P16F84.INC. MPLAB will recognize both names but the assembler won't—a possible source of confusion.

In order for port B to work as intended, it has to be set up as an output port. Actually, each of its eight bits can be set as input or output, independently of the others, but in this program, all eight bits are set to output. This is done by zeroing the corresponding bits in the TRISB special-function register.

Deprecated Instructions. And here we run into a "deprecated instruction," an instruction that works perfectly well but which the assembler tells us not to use. That is tris, the instruction that copies W into that special function register. To set up port B for output, we use the instructions:

```
    movlw B'00000000'
    tris  PORTB
```

LISTING 2

```
; File CHASER.ASM
; Assembly code for PIC16F84 microcontroller

; Blinks LEDs on outputs (Port B) in a rotating pattern.
; Reverses direction if port A, Bit 0, is high.
; Uses RC oscillator, about 100 kHz.

; CPU configuration
;       (It's a 16F84, RC oscillator,
;       watchdog timer off, power-up timer on.)

        processor 16f84
        include     <p16f84.inc>
        __config  _RC_OSC & _WDT_OFF & _PWRTE_ON

; Give names to 2 memory locations (registers)

J       equ     H'1F'     ; J = address hex 1F
K       equ     H'1E'     ; K = address hex 1E

; Program

        org     0         ; start at address 0

        ; At startup, all ports are inputs.
        ; Set Port B to output and initialize it.

        movlw   B'00000000'       ; w := binary 00000000
        tris    PORTB             ; copy w to port B control reg
        movlw   B'00000001'       ; w := binary 00000001
        movwf   PORTB             ; copy w to port B itself

        ; Clear the carry bit

        bcf     STATUS,C

        ; Main loop.
        ; Check Port A, Bit 0, and rotate either left or right
        ; through the carry register.

mloop:
        btfss   PORTA,0           ; skip next instruction if bit=1
        goto    m1
        rlf     PORTB,f           ; rotate port B bits to left
        goto    m2
m1:
        rrf     PORTB,f           ; rotate port B bits to right
m2:

        ; Waste some time by executing nested loops

        movlw   D'50'             ; w := 50 decimal
        movwf   J                 ; J := w
jloop:  movwf   K                 ; K := w
kloop:  decfsz  K,f               ; K := K-1, skip next if zero
        goto    kloop
        decfsz  J,f               ; J := J-1, skip next if zero
        goto    jloop

        ; Do it all again

        goto    mloop

        end                       ; program ends here
```

and the second of these always generates a warning message, as we saw last month.

The reason for the warning message is that some other PICs lack the tris instruction, and in the interest of program portability, Microchip, Inc., would like us not to use it. Instead, they want us to do something a good bit more complicated, involving switching over to a different bank of registers, then addressing the TRISB register by its address.

Well, that's their preference, but it need not be yours or mine. The tris instruction is fully supported on the 'F84; there's nothing wrong with using it; it is not unreliable or risky in any way. It just generates an error message you have to ignore. The same is true of the option instruction, which lets you set some CPU configuration options without switching register banks.

A More Elaborate Program. Now it is time to tackle something a little more interesting: a more elaborate PIC program that makes eight LEDs blink on, one at a time, in a "chaser" sequence. The sequence reverses direction when you change the logic level on pin A0. The program for that is shown in Listing 2.

The circuit used to implement the program is shown in Fig. 1. As you can see, the circuit is not too complex so it can be easily built on perfboard. You can also make this circuit out of the demo board that comes with the Ramsey PICPRO programmer (discussed last month and available for $59.95 plus $6.95 postage and handling in the U.S. from Ramsey Electronics, 793 Canning Parkway, Victor, NY 14564; Tel: 716-924-4560; Fax: 716-924-4886; Web: www.ramseyelectronics.com), if you add a switch or jumper so that you can connect pin 17 (A0) to either V+ or ground. With this program, do not leave pin 17 floating; it's a CMOS input and will pick up noise. Also, do not modify the program to light more than one LED at a time; the PIC can't output that much power.

Describing Bit Patterns. Before going any further, we need to lay some groundwork. Each PIC file

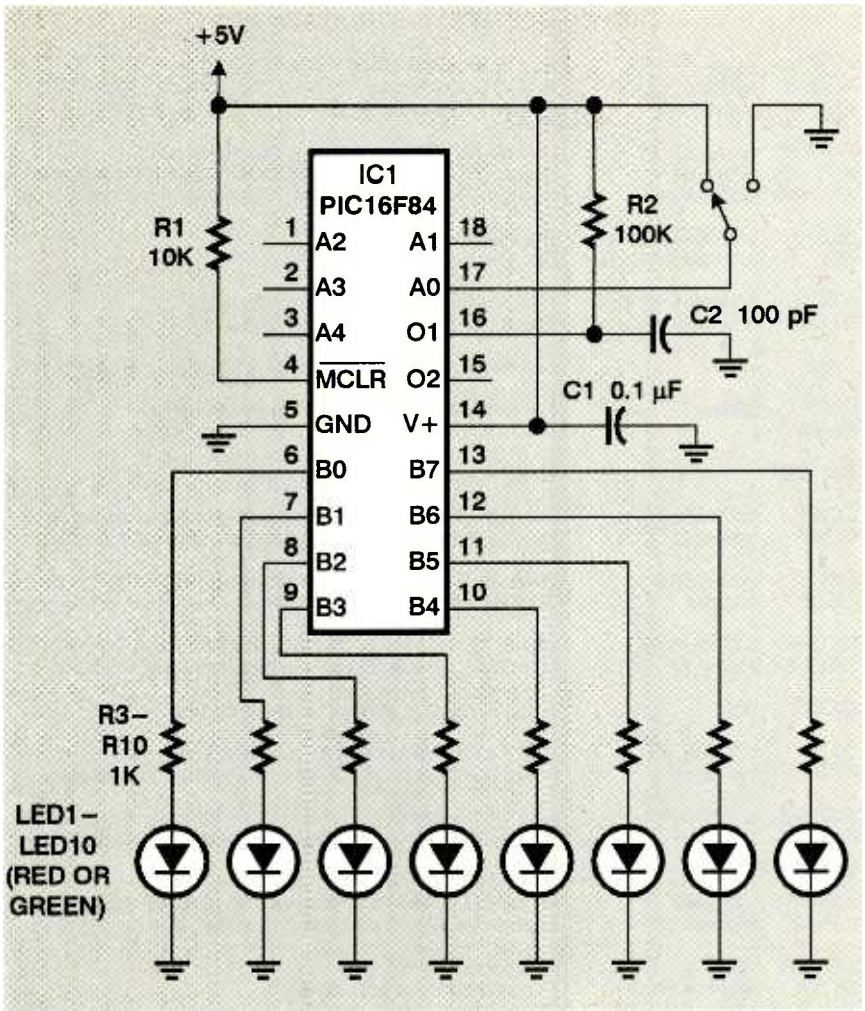


Fig. 1. Use this circuit to implement the program in Listing 2. It is simple enough to build from scratch or can be made from a demo board included with a PIC programmer available from Ramsey Electronics (See text). The Ramsey programmer is based on the author's NOPPP PIC programmer, which originally appeared in the September 1998 issue of this magazine.

register, I/O port, and memory address consists of one 8-bit byte. Thus, any PIC assembly-language program is going to contain a lot of groups of eight bits. There are three main ways to describe a bit pattern: in binary, in hexadecimal, or in decimal.

Obviously, you can describe a bit pattern by writing out the bits themselves, such as B'00011101'. In PIC assembly language, the B and quotes are required. The lowest-numbered bit comes last; if you output B'00000001' on port B, pin B0 will go high, but B'10000000' will make pin B7 go high.

You may have been told that computers treat everything as numbers. That's not true; computers treat everything as bit patterns. Nonetheless, one common way of interpreting bit patterns is to take them as binary numbers. When this is done, you can write the same number more concisely in another base (radix). For example, binary 00000110 is $1 \times 4 + 1 \times 2$, or 6 in ordinary (decimal) notation. (In this context "decimal" does *not* imply that there are digits to the right of the point.) Converted to decimal, the 256 possible 8-bit bytes, B'00000000' to B'11111111', range from 0 to 255.

It turns out to be even more convenient to convert binary numbers to base 16 (hexadecimal, or hex for short). In hex, there are sixteen digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. As you might guess, A means 10, B means 11, and so forth up to F = 15. Thus FF means fifteen sixteens plus fifteen ones, or 255 (binary 11111111).

The reason hex is used is that each hex digit corresponds to four binary digits. If binary 0110 equals hex 6, then binary 01100110 equals hex 66. With some practice, you can learn to do hex-binary conversions in your head. Many scientific calculators can interconvert hex, binary, and decimal.

A Word Of Warning. In PIC assembly language you should normally specify the base of every number you write, such as B'11111111', D'255', or H'FF'. If you write numbers without the quotes and base indication, they will normally be taken as hex, but it's best to be safe. If you write a character between quotes without a base specifier, such as '3', it will be interpreted as the bit pattern of that character's ASCII code.

How The Program Works. We're finally ready to look at the program. It uses rotate-right and rotate-left instructions, rrf and rlf, to shift bits around in a byte; thus 00000001, rotated left, becomes 00000010, then 00000100 and so forth. Rotating isn't just for LED chasers; it's a handy way to pick off the bits in a byte, one by one, for serial data transmission.

The bits being rotated pass through a ninth bit called the *carry flag*; as you might imagine, the carry flag is also used to keep track of the ninth digit when adding two eight-digit binary numbers. Accordingly, the first thing the program does, other than set up its ports, is clear the carry bit (set it to zero):

```
bcf     STATUS,C
```

Here STATUS and C are names given by P16F84.INC to the status register and the carry bit within it. They must be written in all capitals. You could refer to the carry bit by its address if you wanted to.

The actual rotating is done by one of the instructions:

```
rlf     PORTB,f
rrf     PORTB,f
```

but the program also has to decide which one of them to use, depending on the signal at pin A0, and

then introduce a time delay after each rotation.

Making Decisions. At this point it's a good idea to look at the full set of PIC instructions, shown in Table 1. A selling point of the PIC is that there are so few instructions (only 35 if you count them the way the brochure-writers do); what's more, every instruction that doesn't involve a jump executes in just one clock cycle. Thus, the PIC qualifies as a form of RISC (reduced instruction set computer). By contrast, the Pentium has hundreds of instructions, each of which takes several clock cycles to execute.

There is no "if" statement in PIC assembly language. Instead, the PIC has several instructions that test for a condition and skip the next instruction if it is true. For example, in this program, the instructions:

```
btfss PORTA,0
goto m1
```

mean "Go to M1 *unless* bit 0 of port A is set (=1)." The first instruction, btfss, stands for "*B*it *T*est *F*ile-register, *S*kip next instruction if *S*et." So if the appropriate bit is set, the goto is skipped. Even though port A is not a file register, this instruction treats it as if it were.

By interleaving skips and gotos in this way, the series of instructions:

```
    btfss PORTA,0
    goto m1
    rlf  PORTB,f
    goto m2
m1:
    rrf  PORTB,f
m2:
```

rotates the bits of port A to the left if A0=1 and to the right if A0=0.

If you know another assembly language, you may be wondering how the PIC gets away without having a byte compare (CMP) instruction. The answer is that bytes are compared by subtracting them and then checking whether the result is zero.

Minding Your Fs and Ws. Many PIC instructions, including rlf and rrf, come in two varieties, one ending in f and the other ending in w, which are actually abbreviations for 0 and 1 respectively. These are destination codes: f means the result should go in the file register or other memory address that you

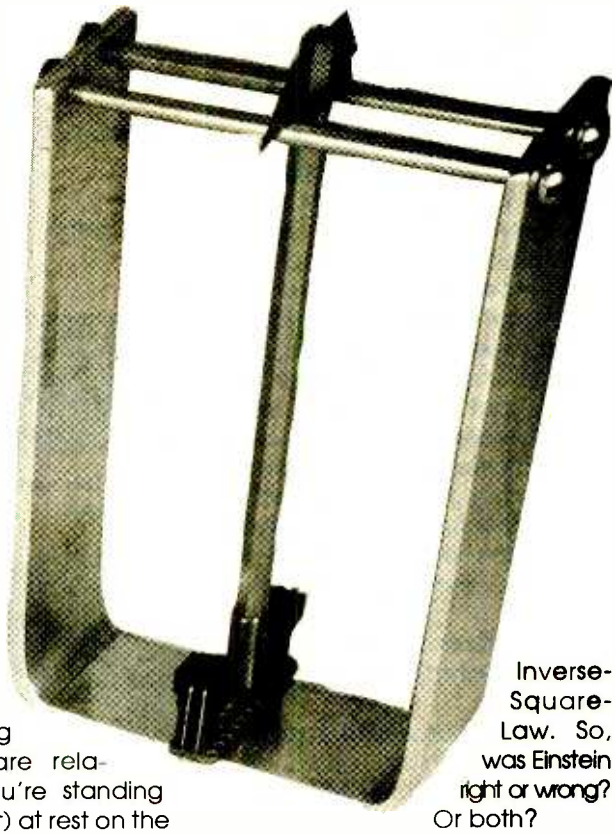
(Continued on page 74)

TABLE1—PIC16F84 INSTRUCTION SET

ADDLW	value	Add W to value, place result in W
ADDWF	address,F	Add W to contents of address, store result at address
ADDWF	address,W	Add W to contents of address, place result in W
ANDLW	value	Logical-AND W with value, place result in W
ANDWF	address,F	Logical-AND W with contents of address, store result at address
ANDWF	address,W	Logical-AND W with contents of address, place result in W
BCF	address,bitnumber	Set specified bit to 0
BSF	address,bitnumber	Set specified bit to 1
BTFSC	address,bitnumber	Test bit, skip next instruction if bit is 0
BTFSS	address,bitnumber	Test bit, skip next instruction if bit is 1
CALL	label	Call subroutine (will return with RETURN or RETLW)
CLRF	address	Set contents of address to binary 00000000
CLRW		Set W to binary 00000000
CLRWDT		Reset (clear) the watchdog timer
COMF	address,W	Reverse all the bits of contents of address, place result in W
COMF	address,F	Reverse all the bits of contents of address, store result at address
DECF	address,W	Subtract 1 from contents of address, place result in W
DECF	address,F	Subtract 1 from contents of address, store result at address
DECFSZ	address,W	Like DECF address,W and skip next instruction if result is 0
DECFSZ	address,F	Like DECF address,F and skip next instruction if result is 0
GOTO	label	Jump to another location in the program
INCF	address,W	Add 1 to contents of address, place result in W
INCF	address,F	Add 1 to contents of address, store result at address
INCFSZ	address,W	Like INCF address,W and skip next instruction if result is 0
INCFSZ	address,F	Like INCF address,F and skip next instruction if result is 0
IORLW	value	Logical-OR W with value, place result in W
IORWF	address,F	Logical-OR W with contents of address, store result at address
IORWF	address,W	Logical-OR W with contents of address, place result in W
MOVLW	value	Place value in W
MOVF	address,W	Copy contents of address to W
MOVF	address,F	Copy contents of address to itself (not useless; sets Z flag if zero)
MOVWF	address	Copy contents of W to address
NOP		Do nothing
OPTION		Copy W to option register (deprecated instruction)
RETFIE		Return from interrupt
RETLW	value	Return from subroutine, placing value into W
RETURN		Return from subroutine
RLF	address,F	Rotate bits left through carry flag, store result at address
RLF	address,W	Rotate bits left through carry flag, place result in W
RRF	address,F	Rotate bits right through carry flag, store result at address
RRF	address,W	Rotate bits right through carry flag, place result in W
SLEEP		Go into standby mode
SUBLW	value	Subtract W from value, place result in W
SUBWF	address,F	Subtract W from contents of address, store result at address
SUBWF	address,W	Subtract W from contents of address, place result in W
SWAPF	address,W	Swap half-bytes at address, place result in W
SWAPF	address,F	Swap half-bytes at address, store result at address
TRIS	PORTA	Copy W into i/o control register for Port A (deprecated)
TRIS	PORTB	Copy W into i/o control register for Port B (deprecated)
XORLW	value	Logical-XOR W with value, place result in W
XORWF	address,F	Logical-XOR W with contents of address, store result at address
XORWF	address,W	Logical-XOR W with contents of address, place result in W

Measuring Gravity Waves

Do gravity waves actually exist? Build any one of these experimental devices successfully and you may be the first to provide positive proof!



SKIP CAMPISI

By now, everyone has heard of "gravity waves." But why have they never been detected? The common answer from classical physics is that gravity waves are very "subtle and weak." To me, that answer appears to be a very subtle and weak explanation! To discuss this topic in an intelligent manner, we must first examine some facets of Relativity and Particle Theory, which both tend to be somewhat hazy in the areas concerning gravitation.

Take, for example, Einstein's Principle of Equivalence, on which his Relativity Theory is heavily (if not entirely) based. Here he has stated that there is absolutely no way for an observer in a fully enclosed environment to distinguish whether he is "at rest" in a gravitational field, or is being "accelerated" by a uniform force pushing (or pulling) his enclosure. Picture yourself in a rocket ship at rest on the Earth, and then experiencing a one-gravity rocket acceleration far away from any local gravitational fields.

At first glance, you'd agree with Einstein—the one-gravity rocket acceleration would feel exactly the same as sitting at rest in Earth's gravitational field. However, that's only because your senses are too limited to note any difference. What? You don't believe me? You've forgotten all about the Inverse-Square-Law!

The force of gravity falls off and weakens as the distance to the mass creating the gravitational field increases, adhering to an inverse-square relationship. Thus, if you're standing upright (in the rocket) at rest on the Earth, your feet are experiencing a slightly stronger pull from gravity than your head, agreed? What happens to you when the rocket is accelerating outside of a gravitational field?

Naturally, your head feels the exact same pull as your feet. As you can readily see, there is a difference between gravity and acceleration. But how do you measure this minuscule little difference? Fasten your seatbelts—here comes a very subtle contradiction in Relativity: Einstein himself gave us the means to make the measurement! In explaining his theories, he loved to use measuring rods and clocks. According to him, a clock placed within a strong gravitational field would run slower than one placed in a weaker gravitational field.

This aspect of Relativity was confirmed in 1960 at Harvard University using the Mossbauer Effect, which utilizes atomic nuclei as extremely accurate "clocks." The "clock" on the bottom floor of their lab ran slower than the one on the upper floor. Obviously, this result won't occur in an accelerating rocket, where the force is uniformly applied and not subject to the Inverse-Square-Law. So, was Einstein right or wrong? Or both?

Technically speaking, he was correct, as numerous proofs of his Special and General theories have upheld all of his assumptions to date. His Principle of Equivalence indeed appears to hold true, even though he himself has shown us that there is a method of distinguishing between uniform acceleration and gravitational force. What I'm attempting to point out here is that at least one stone has been left unturned. Perhaps we'll find others in our quest to understand gravitation.

Another peculiar aspect of Relativity is the so-called limiting velocity: A particle with mass can only attain speed-of-light velocity by acquiring infinite mass from infinite energy input, which are both impossibilities. This indeed appears to be true according to particle-accelerator experiments. But what about particles without mass? This is where we depart from Relativity and enter the equally strange world of Particle Theory.

Here we use the photon as an example. The photon is (according to current theory) the "exchange particle" for electromagnetic radiation. It has no charge or mass, and a "spin" of 1. It travels at one speed:

the speed-of-light (1C). As this radiation is very far-reaching, the photon's characteristics are necessary for propagation. (Other examples could include the exchange particles related to the "strong" and "weak" nuclear forces, which have extremely short-range effects. These particles are allowed to be quite massive and still function properly at much lower velocities, never achieving light-speed.)

From these theories, it was inferred that gravity waves should be generated when a massive object moves, and should also be far-reaching, just as the effects of gravity itself are felt over long distances. This implied that another exchange particle, again having no mass or charge, would be required. This exchange particle, as yet undetected, was named the "graviton."

To fit the theories, the graviton was given a spin of 2, and a velocity of 1C, as with the photon. But is that correct? What if the spin is actually 1 and the velocity equal to 2C? I hear you all grumbling—nothing can exceed light-speed, can it? Nothing with mass, that is. Let's try a little experiment (see Fig. 1) that appears to thwart Relativity a bit.

For this experiment, we'll need a fixed reference frame, which is actually simpler than it sounds. All that we need to do is attach two HeNe lasers onto a length of board so that they face each other, with their beams aligned parallel, traveling in opposite directions to each other. The beams are aligned so that they can't enter the emission aperture of the opposing laser, which could cause unstable lasing. A target is placed next to each aperture to display the opposing laser's beam.

If you turn both lasers on, you'll notice the beams' images displayed on their respective targets. If you now turn off only one laser, you'll notice that the remaining beam display has not changed in intensity or color. This result has only two possible explanations:

1) The beams passing in opposite directions interacted with each other in a "Relativistic" manner. The velocity of each beam was reduced to 0.5C, for a relative velocity shared by both beams of 1C, while the laser frequencies were doubled (wavelengths halved) to maintain the original color and intensity. (Difficult to

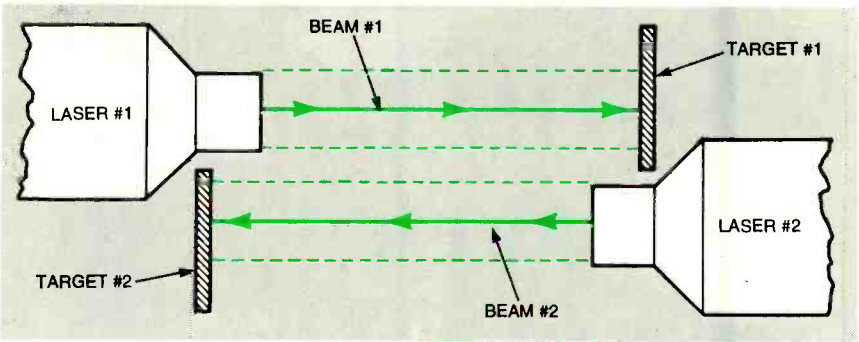


Fig. 1. This simple experiment in Relativity yields two possible conclusions that have profound implications.

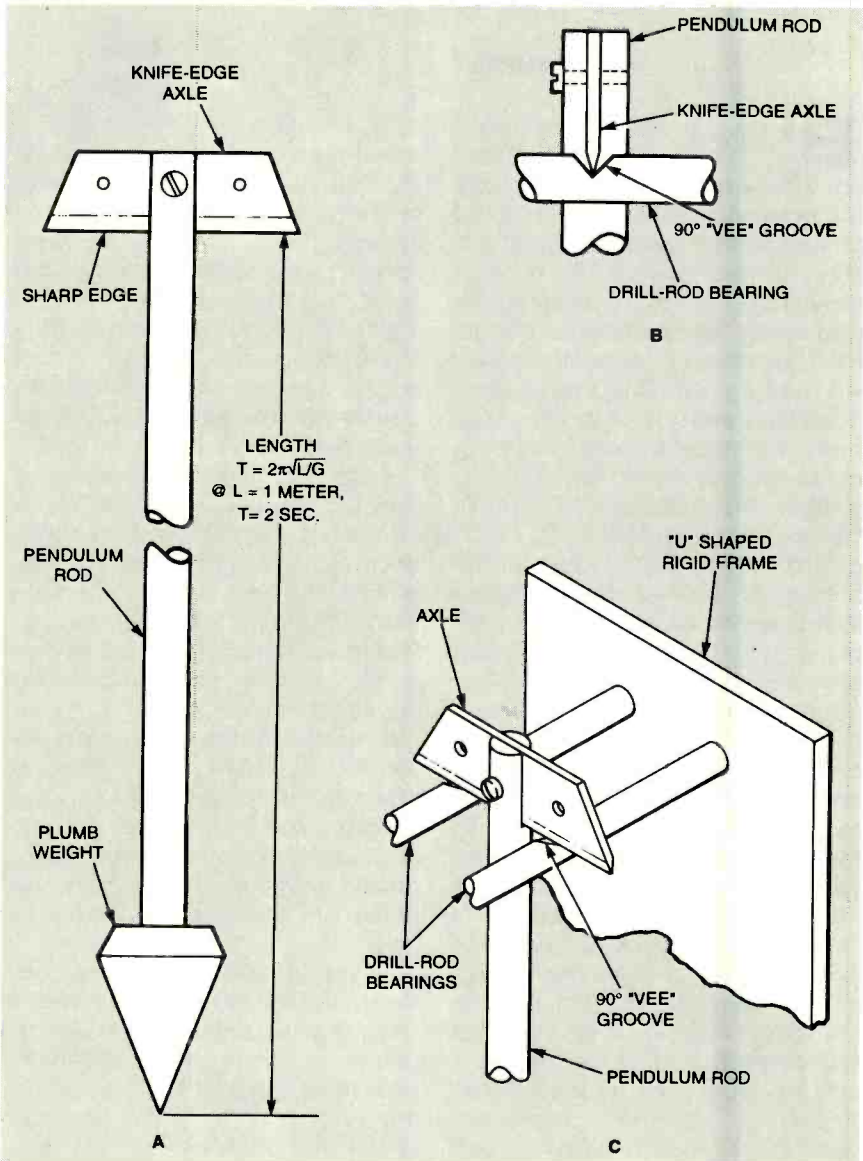


Fig. 2. Here is one possible method (using commonly available materials) of constructing a super-sensitive pendulum movement. The key concerns in any pendulum design are low friction and rigidity of components. The pendulum itself is shown in A, a side-view of the axle and bearing details is shown in B, while the sectional view in C shows the basic assembly.

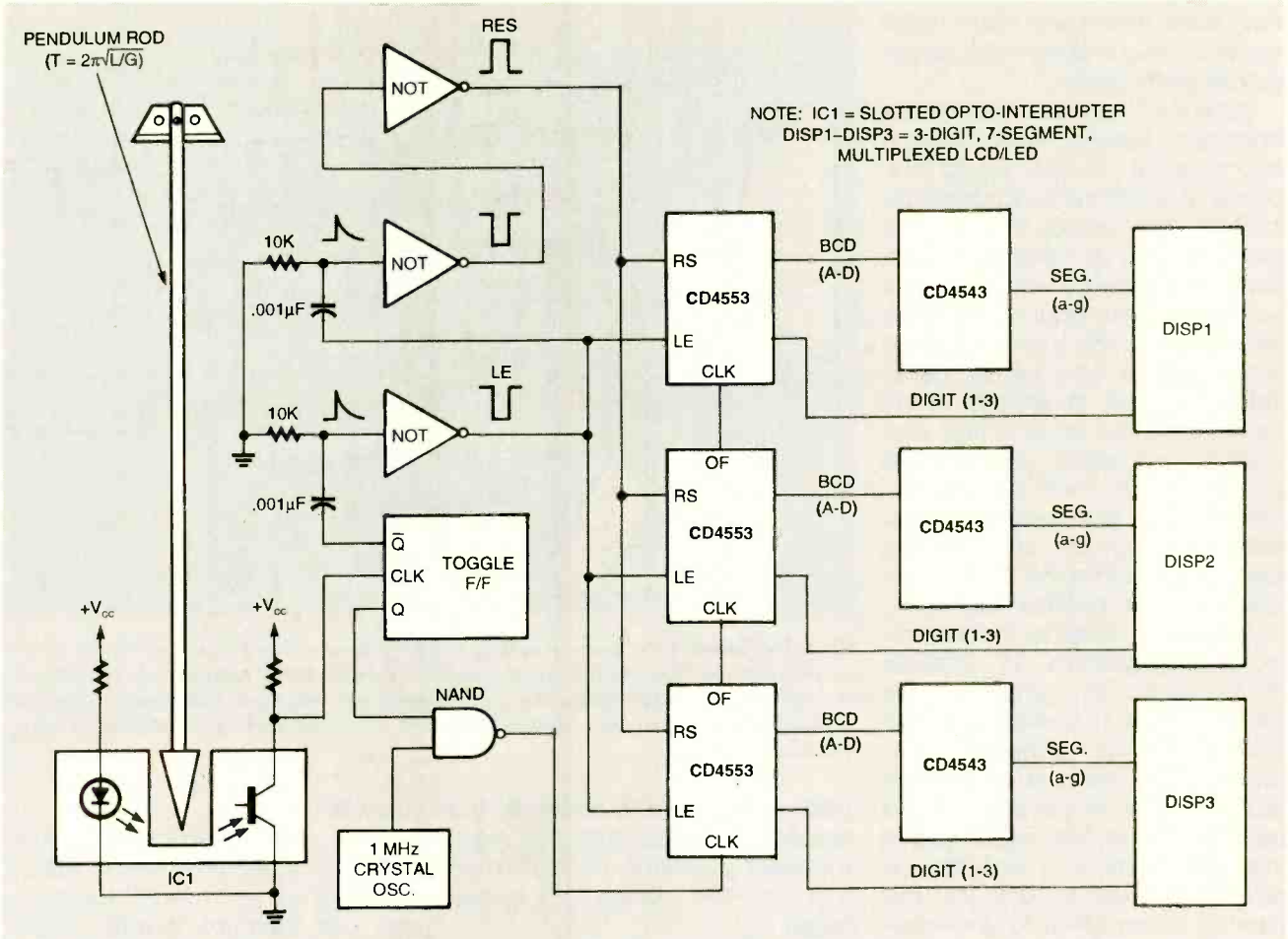


Fig. 3. As shown in this block diagram, the tip of the pendulum interrupting the light beam of IC1 provides a "gate" signal that triggers the display, which can be a standard frequency counter set up to read time period. Optionally, you could build your own high-resolution display as illustrated here or use a single-chip version such as the ICM7226A 8-digit counter.

believe, no?)

2) The beams passing in opposite directions had no interaction with each other. This leaves us with the assumption that a photon from one beam shares a relative velocity of 2C with a photon from the opposing beam and implies that certain particles are allowed to travel in excess of light-speed without violating any limiting laws. (Any better?)

Both explanations yield profound results: (1) appears to tell us that electromagnetic radiation is always traveling at changing velocities to compensate for the ever-present interaction of photons, reflected or otherwise, and (2) apparently tells us that light-speed can be exceeded by particles without mass. Explanation (1) looks like great fodder for another article, so we'll leave that alone for now. For the purposes of this article, explanation (2) will suffice.

We know a bit about photons, as they readily interact with normal matter. They don't appear to accelerate or decelerate, but are traveling at light-speed when emitted. One other particle without mass or charge is known to travel at light-speed: the neutrino. This particle was originally "designed" to maintain the Conservation-of-Momentum Law as related to other sub-atomic particles. It has a spin of $^1/_2$ and is necessarily ejected in certain nuclear reactions to maintain this law, among others.

The neutrino doesn't interact with matter to any great extent, making it undetectable until recently. Some had even speculated that it actually did have a very slight mass, which would not allow it to reach light speed. Fortunately, Supernova 1987A, located tens-of-thousands of light-years away in the Magellanic Clouds, showed us the truth: neutrinos from this vast explosion arrived at our planet within the same time-frame as the photons from its visible light. If the neutrinos had any mass, we'd still be waiting for them to arrive, due to the enormous distance they would have had to travel at sub-light velocities!

"Okay, so what's all this have to do with gravity waves?" you might now ask, and rightly so.

As I previously stated, the exchange particle theorized for gravity is the graviton. A moving massive object should produce gravity waves using gravitons, just as electromagnetic waves use photons as the exchange particles. Supposedly, gravitons interact to an

even lesser extent with matter than neutrinos, thus making them almost impossible to detect.

We know that photons and neutrinos don't have a mass or charge and travel at 1C. That would indicate that gravitons could share the same characteristics, but what if gravitons really do travel at 2C, with a spin of 1? (Energy-wise, this might be considered equivalent to a velocity of 1C with a spin of 2.) That could explain why we've never detected them: a velocity of 2C might not allow some of the predicted interactions with normal matter (which itself experiences time dilation, contraction effects, and mass increase at relativistic speeds) except for the usual gravitational effects already observed.

As you can imagine, this has profound implications in Particle Theory. Might any other particles exist that are in question? Could be. How about tachyons, for a starter? We'll need a brand-new technology to detect any of these particles. But we still might have a shot with gravitons, assuming a device can ever be built. Let me pass on a few ideas to you—perhaps one of our readers would care to make the attempt at constructing one of these—the successfully completed project would be Nobel material, without a doubt!

One of these ideas is based on the assumption that an incoming gravity wave will interact with our local gravitational field, either adding to it or subtracting from it. Another idea, which is currently popular, assumes that the gravitons interact in a direct manner with matter itself, changing the dimensions slightly (for example) of a solid, material object. The last idea assumes that photon emission wavelength varies with gravitational field strength. Could any of these ideas be sensitive enough to detect gravity waves? Only some R & D will tell!

The major problems with all of these ideas involve the apparent size of the wavefront encountered, and the wavelength of the "radiation." The wavefront, which may possibly be compared to "ocean" waves in a loose sense, is huge—

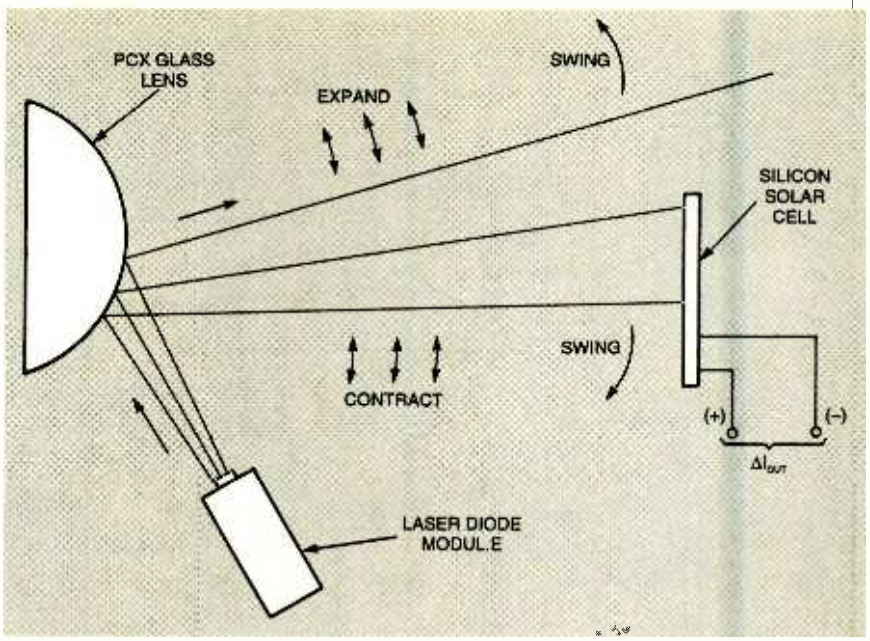


Fig. 4. The "laser bounce" system is perhaps the easiest detector to assemble, requiring only a simple glass lens, laser diode module, and a solar cell. The output current variations can be monitored on a high resolution DMM. Mount all of the components on a rigid frame, with as much distance as practical between the lens and the solar cell. The entire unit should be sitting in a sand box for vibration damping.

globe spanning at a minimum. This creates directional and other measurement problems, as you'll soon find out. The wavelength is also large.

Consider a rapidly rotating "pulsar," which is probably the highest frequency gravity wave generator we might find. If it rotates in one millisecond (note that none have been found this fast as yet), the wavelength would be 186 miles, assuming a propagation velocity of 1C. At a propagation of 2C, the wavelength doubles! We can safely assume that most wavelengths we'll be trying to detect are much longer than 186 miles. So, here we go....

Super-Sensitive Pendulum Method. Galileo originally determined that the simple harmonic motion of a pendulum resulted in a time period that depended only on the length of the pendulum and the acceleration of gravity. The mass of the pendulum only aids in overcoming friction. If you divide the length by the acceleration of gravity, extract the square-root of the result, and multiply it by 6.28 (2 x π), you'll obtain the period of the pendulum. This holds true over short distance swings of about 25% of the pendulum's length.

The pendulum's harmonic motion has proven to be so accurate that oil and mineral prospectors use them to locate buried deposits, which alter the strength of the local gravitational field. Assuming that incoming gravity waves alter local gravity in a similar fashion, pendulum-time-period variations present one possible method for detecting them.

The basic setup is actually quite simple, especially if you already have a frequency counter with time-period measurement capability. The main task then becomes only a matter of assembling a suitable pendulum movement. A suggested approach using common materials is shown in Fig. 2. If necessary, you could construct a high-resolution display (see the block diagram on Fig. 3) using standard logic chips of your choice.

The pendulum itself is fabricated from a rigid length of metal rod or tubing, with a short slot cut down the center of its axis on one end. A "knife-edge" axle (made from a standard "utility" knife blade) is centered in the slot with its edge fixed at 90° to the pendulum rod. Two parallel "bearings" made from drill rod are supported horizontally

and exactly level on a rigid frame, spaced just far enough apart to clear the pendulum. The pendulum swings between the bearings on its knife edge, which pivots in adjacent 90° "Vee" grooves cut into the bearings as "keepers." A massive weight, such as a carpenter's plumb, is installed on the free end of the pendulum rod.

A standard slotted opto-interrupter is located on the bottom section of the support frame (at the center of the pendulum's swing) so that the tip of the plumb can pass through the slot to break the light beam. The pendulum length should be selected to have a period of at least a couple of seconds, and the whole mechanism must sit in a sand box for vibration damping.

The opto-interrupter supplies the gate pulse for triggering the time period display. If you build your own display, you can use a 1-MHz crystal oscillator module along with 3-digit BCD counters driving three BCD-to-7-segrnent decoders. These in turn could drive three separate, 3-digit multiplexed LED (or LCD) displays, which would display the period in microseconds. (The ICM7226A counter is a good, single-chip alternative.) You may process the outputs with your PC, utilizing a plotter to provide hard copy of time-period variations.

Needless to say, that method is not useful for higher frequency gravity waves, due to the long period required for the pendulum to give high resolution. Very long-term changes, such as the daily influences of the Sun and Moon, can be easily factored out, especially if you're using a PC. To start the measuring process, gently set the pendulum in motion, giving it a few minutes or so to stabilize before attempting any measurements.

Laser Bounce Method. One school of thought suggests that gravitons may interact sufficiently with matter to actually cause dimensional changes (albeit very small changes) in solid objects. Looking at the diagram illustrated on Fig. 4, you'll find one possible method of detecting these changes.

Here we bounce an uncollimated laser beam off of a convex reflector, with the reflected beam directed to a large aperture photodetector. To take advantage of "angular magnification," the detector is mounted as far away as practical from the reflector. That allows for a large "moment arm" that functions just as a lever would in a mechanical system due to the convex shape of the reflector.

If the theory holds true, the dimensions of the reflector should change in step with an incoming gravity wave, causing the beam to move across the detector. It can also be inferred that the beam's angular diameter would vary due to the reflector's changes, providing additional amplification for the system. If we locate the detector in the outer fringes of the diverging laser beam, any beam movement would cause the detector output to vary as the gravity waves impinge on the reflector.

The reflector itself should have a precision-polished optical surface. A simple, uncoated plano-convex (flat on one side, convex on the other) glass lens of short focal length should perform well. Even though bare glass only reflects about 5% of the incident light, that is more than sufficient for our purposes. A standard silicon "solar cell" (shielded from ambient light) should make a reasonable detector, using a visible or infrared laser diode as a light source. Once again, the entire system must sit in a sand box for vibration damping, with all components mounted on a rigid frame.

Unlike the mechanical system discussed earlier, this system can handle higher-frequency waves, which might be a great advantage when considering what types of gravity-wave generators might produce the strongest radiation—the fastest moving objects! The output current from the detector can be processed by a PC and plotted for hard copy if desired or displayed on a high-resolution DMM.

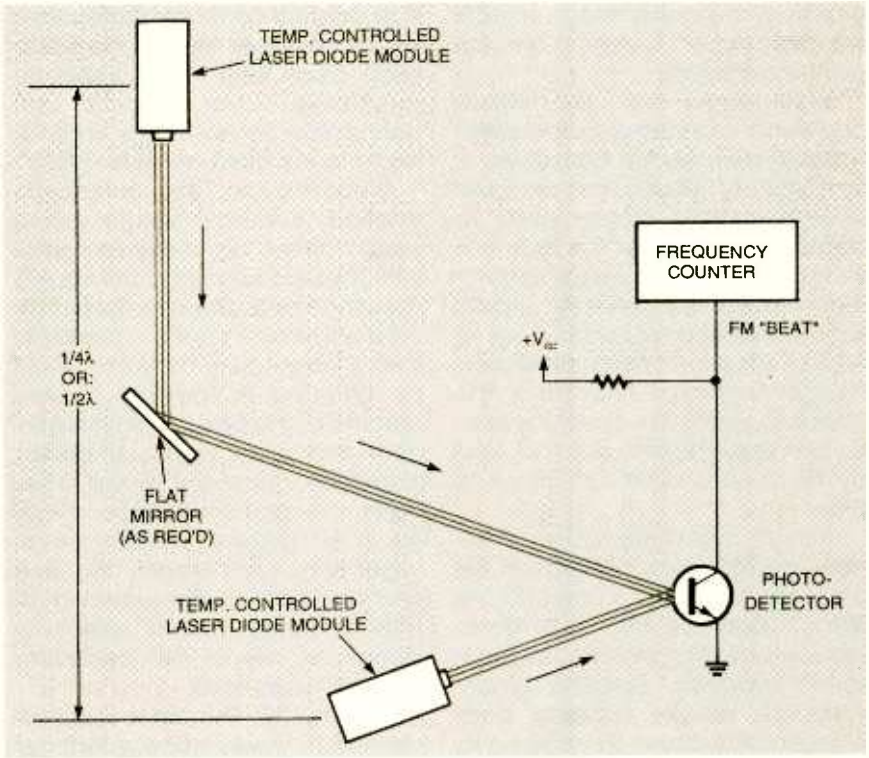


Fig. 5. A promising method of detecting gravity waves uses this unusual type of interferometer. Two temperature-controlled laser diodes apply their beams to a photodetector "mixer" where they are heterodyned. The incoming gravity wave might then frequency modulate this "beat" frequency, as each of its "crests" and "troughs" sequentially pass by the two lasers.

Optical Heterodyning Method. Einstein's Theory of Relativity also predicted *gravitational redshift*. All atoms emit photons at specific wavelengths related to the vibra-

tional rate of their orbital electrons; thus, they can be considered as "clocks." Recalling the 1960 Harvard experiment previously discussed, you'll see why a photon emitted in a strong gravitational field would have a longer wavelength than one emitted from a similar atom in a weaker field. Hence the term gravitational redshift. This has been observed in photons from our Sun.

If we assume that gravity waves affect these "atomic clocks" in a similar manner, we can construct a device such as the one illustrated in Fig. 5, which theoretically could detect the resulting redshift changes. This device is an unusual type of interferometer that uses two light sources, rather than bending the beam back from a single source onto a target.

The system operation is quite simple: One laser diode directly illuminates a photo-detector in close proximity. Another laser diode is located at an optimum distance from the detector, at the point where the greatest amplitude difference would occur (between the two lasers) on the incoming gravity wave. This would happen at one-half of the wavelength, with one-quarter of the wavelength being a more reasonable "antenna" length. As you can appreciate, this method is highly directional and tunable to the desired gravity-wave frequency and wavelength.

With both beams illuminating the detector, which can now be called a "mixer," optical heterodyning results. The mixer's output is the difference frequency between both lasers. If we assume that both lasers' emissions are undergoing redshift changes via the incoming gravity wave, we should be able to see a modulation in this "beat" frequency in step with the gravity wave's frequency as each "crest" and "trough" passes the lasers sequentially.

Selecting a reasonably low beat frequency might allow you to measure that frequency-modulation product. A standard frequency counter can be used as the display, with your PC processing and plotting the results. You might now be wondering how to select two laser diodes that are close enough in wavelength to have a beat frequency low enough to use conventional circuitry. The answer is that you don't really have to!

It is well known that a laser diode's efficiency goes up as its temperature goes down, and also, its wavelength decreases as its temperature drops. Thus, we have a practical method of "tuning" each laser's wavelength or frequency. By keeping the remote laser's temperature constant, while varying the other laser's temperature, we can actually select an appropriate beat frequency for display. As with any interferometer, vibration-free component mounting is an absolute must!

Detection Problems. At first glance, those three ideas appear to be workable methods for detecting gravity waves, assuming that the waves actually do exist in the first place! We've already pointed out the three major problems concerning detection: the huge wavefront, extremely large wavelengths, and the possibility of faster-than-light propagation velocities. The types of gravity-wave-generating objects we might expect to detect are also worth considering.

What about that one-millisecond pulsar I mentioned previously? It would certainly be convenient if that type of "neutron star" provided us with a 1-kHz gravity wave to detect! However, just the fact that it's rotating at high velocity doesn't mean that it will generate gravity waves. It would necessarily have to be lop-sided in its mass distribution for that to occur. That this is the case is suggested by the X-ray pulses that they radiate, but that fact by no means offers an absolute proof.

A much more likely source of reliable gravity wave generators will probably turn out to be variable stars. These fall into two basic groups: eclipsing binaries and pulsating variables. Eclipsing binary stars are rapidly rotating pairs whose orbital planes lie edge-on to us. Their periods are measured in days, which would make gravity-wave detection a chore. On the other hand, pulsating variable stars have periods measured in hours, with the fastest in minutes—much more reasonable! As you can see, a time-period display (as illustrated in Fig. 2) might be a better choice than a frequency display.

I'm sure that you'll now be wondering how a single star that only varies in brightness (magnitude) can produce gravity waves of any strength without moving to any extent. The fact of the matter is that they do move! According to current well-established theory, these stars actually contract and expand in sync with their magnitude pulsations. *Ergo*, they might generate something that could be detectable. So, how does all of this relate to our three detector ideas?

Returning to the pendulum method, just how would wavelength affect our measurements? With the pendulum and the display circuitry in near proximity (as dictated physically) it's quite a possibility that a local 1-MHz oscillator would be affected in the exact same manner as the pendulum time period, In that case, we would detect absolutely nothing! On the other hand, the oscillator may be affected in a different manner, which might effectively amplify the time period variations, This system does offer some directional selectivity along the axis of the pendulum rod—if it works at all.

Looking at the laser bounce method, it would appear that just by adding more convex mirrors to the light path, we could amplify even the smallest dimensional

(Continued on page 77)

FOR MORE INFORMATION

Both Relativity and Particle Theory are fascinating subjects, with many books having been published concerning them and their relationship with gravitation. If you wish to learn more about these subjects, in the opinion of the author, the following texts are among the best available and can be located through most booksellers:

Relativity, the Special and the General Theory, by Albert Einstein,

Atom : Journey Across the Subatomic Cosmos, by Isaac Asimov

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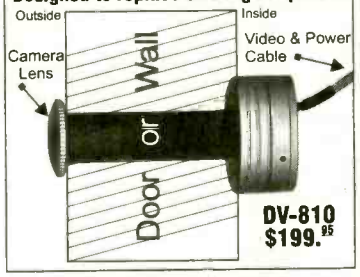

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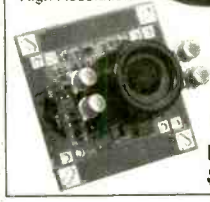

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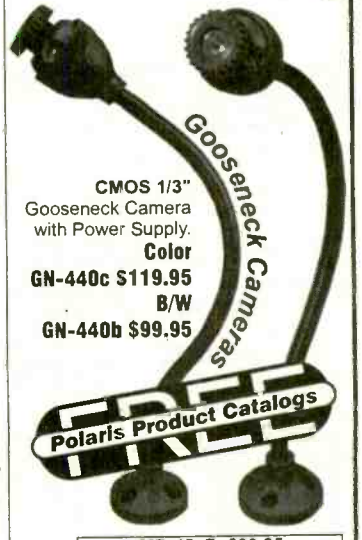

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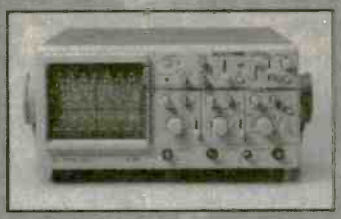

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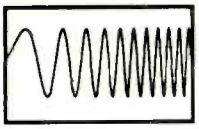

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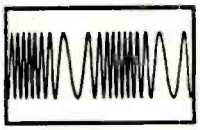
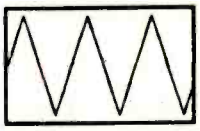
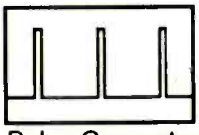


Int/Ext FM, PM, BPSK, Burst

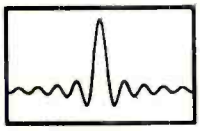


Ramps, Triangles, Exponentials

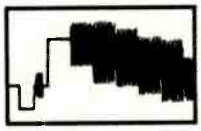


Pulse Generator

Noise



Arbitrary Waveforms



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Liquid Crystal Displays

240x64 dot LCD with built-in controller.

AND 4021ST-EO. *Unit is EL back-lit.* **$59.00 or 2 for $109.00 *or***
OPTREX. DMF5005 *(non back-lit)* **$49.00 or 2 for $89.00**

20 character x 8 line 7¾L x 2½H *The built-in controller allows you to do text and graphics.*

Alphanumeric—parallel interface

16x1	$7.00	20x2	$10.00	32x2	$8.00
16x1 (lg. char.)	$10.00	20x4	$15.00	40x1	$8.00
16x2	$7.00	20x4 (lg. char.)	$10.00	40x2	2 for $20.00
16x2 (lg. char.)	$10.00	24x2	$10.00	40x4	$20.00
16x4	$15.00	32x4	$10.00	4x2	$5.00

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$25.00	480x128	Hitachi	$10.00
640x400 (backlit)	Panasonic	$20.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$25.00**

Monitors

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $25.00 • 7 inch Amber $25.00
9 inch Amber or Green $25.00

5" COLOR MONITOR $39.00

2 for $69.00

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

9" COLOR SVGA MONITOR $179.00 Fully Enclosed – Tilt and swivel type.

Pos & Bar Code

MAGNETIC CARD READER $25.00

Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.
HP bar code wand (HBCS 2300) $19.00

Hacker Corner

Embedded 486 Computer $99.00

Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible

Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

SONY Miniature Color LCD Display (LCX005BKB) $29.00

• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

CELL SITE TRANSCEIVER $49.00 2 for $89.00

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

4 INCH LCD MONITOR $49.00

Compact (4.4" x 3.8" x 1.4") TFT active matrix LCD color monitor including fluorescent backlight. Analog RGB and composite sync input with switchable horizontal / vertical viewing. Low power consumption and long life backlight make it ideal for security and door phone use. Single 8 VDC supply and good resolution allow mobile operations or use with laptops. Standard ribbon cable - Molex connector interface. Complete specifications included.

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Elenco Quad Power Supply
Model XP-581

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4 Fully Regulated DC Power Supplies In One Unit

4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A
1 Variable - 2.5 - 20V @ 2A

Elenco Power Supply Kit
Model XP-720K

$54.95

- 1.5VDC - 15VDC @ 1A
- –1.5VDC - –15VDC
- 5VDC @ 3A
- 6.3VAC @ 1A & 12.6VAC center tapped @1A

XP-720 Fully Assembled $85

Elenco DC Power Supply

Model SPL-603 3A 0-30VDC $79.95

The SPL-603 is a solid-state DC power supply providing the exact output voltage no matter what current you use. It contains one fully regulated power supply. The variable voltage is capable of delivering 0-30V at up to 3A. The output is precisely held to the desired output voltage by a special regulating circuit. Output fully protected from overload.

Miscellaneous

Elenco Model EP-50

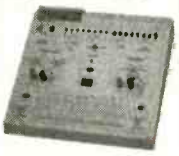
Electronic Playground and Learning Center Contains Over 50 Experiments

$19.95

Elenco Model XK-150

Digital/Analog Trainer

$89.95



Ideal for Schools

Elenco Model MX-9300
Four Functions In One

$450

Features:

- One instrument with four test and measuring systems:
  - 1.3GHz Frequency Counter
  - 2MHz Sweep Function Generator
  - Digital Multimeter
  - Digital Triple Power Supply - 0-30V @ 3A, 15V @ 1A, 5V @2A

Generators & Counters

Elenco Sweep Function Generator
w/ built-in frequency counter Model GF-8036

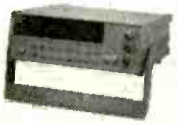
$225

This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulse over a frequency range from 0.2Hz to 2MHz.

10 Function 1.3GHz Universal Counter
Elenco Model F-1300

- Frequency .05Hz - 1.3GHz 3 Ranges
- Period - Can read 60Hz to 80.000000 Fm1/T
- Totalize - Counts to 199,999,999
- RPM - 3 to 2099994 RPM
- Duty Cycle
- Max/Min/AVG with Time
- Stop-watch set .2 sec. to 100 hrs.
- Math Functions
- Timer - 2 sec. to 99 days
- Pulse Width - 0.1ms to 66666.6ms

$225



Multifunction Counter

B&K Model

$189

1875
10Hz - 2.5GHz
Ultra sensitive synchronous detector bar-graph and RF strength.
3 Channels

Measures Frequency, Period, Data Hold, Relative, Memory (min., max., average). High Sensitivity, Microprocessor Controlled.

Elenco Handheld Universal Counter
10Hz - 2.8GHz
Model F-2800

$99

Features 10 digit display, 16 segment and RF signal strength bargraph.

Includes antenna, NiCad battery, and AC adapter.

Elenco RF Generator with Counter
(100kHz - 150kHz) Model SG-9500

Features internal AM mod. of 1kHz, RF output 100MV - 35MHz. Audio output 1kHz @ 1V RMS. $225

SG-9000 ..... $119.95
(analog, w/o counter)

B&K 20MHz Sweep/Function Generator with Frequency Counter Model 4040

- 0.2Hz to 20MHz
- AM & FM modulation
- Burst Operation
- External Frequency counter to 30MHz
- Linear and Log sweep

$445

10MHz Model 4017 $319
5MHz Model 4011 $249

Kit Corner

over 100 kits available

Model AK-870
Radio Control Car Kit

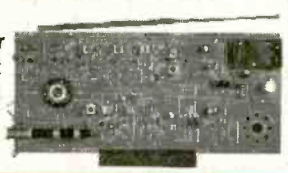
$24.95

- Solderless
- 7 Functions
- Radio Control Transmitter Included

Model AM/FM-108K

AM/FM Transistor Radio Kit w/ Stand

$29.95



Model AK-700
Pulse/Tone Telephone Kit

Ideal School Project

$15.95

Elenco Digital / Analog Trainer

Model XK-700

Elenco's newest advanced Digital / Analog Trainer is specially designed for school projects. It is built on a single PC board for maximum reliability. It includes 5 built-in power supplies, a function generator w/ continuously sine, triangular and square waveforms, 1,560 tie point breadboard area. Tools and meter shown optional. (Mounted in a professional tool case made of reinforced metal).

XK-700 Assembled & Tested $189.95

XK-700K - Kit $159.95

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Elenco LCR & DMM Model LCM-1950

12 Functions
Freq. to 4MHz
Inductance
Capacitance
and Much More

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Elenco Model M-1740

$39.95

11 Functions:
- Freq. to 20MHz
- Cap. to 20µF
- AC/DC Voltage
- AC/DC Current
- Beeper
- Diode Test
- Transistor Test
- Meets UL-1244 safety specs.

Model M-2760 - $24.95 (9 functions)

Fluke 79III

$185

- Capacitance ranges from 99.99nF to 9999µF.
- Built-in frequency counter of voltage input from 1Hz to over 20kHz.
- Lo-Ohms range, a 40Ω range with Fluke's proprietary Zero Calibration, offers 0.01 resolution with increased noise rejection.

Series II (limited qty.) $179

Fluke 87III

$299

Features high performance AC/DC voltage and current measurement, frequency, duty cycle, resistance, conductance, and capacitance measurement.

Series II (limited qty.) $289

Elenco Model LCR-1810

$99.95

- Capacitance .1pF to 20µF
- Inductance 1µH to 20H
- Resistance .01Ω to 2000MΩ
- Temperature to 750°C
- DC Volts 0 - 20V
- Frequency up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

Elenco Model M-1005K

$14.95 Digital Multimeter Kit

- 18 Ranges
- 3 1/2 Digit LCD
- Transistor Test
- Diode Test

M-1000B (Assembled) $14.95

Dual-Display LCR Meter w/ Stat Functions

B&K Model 878

$219.95

Auto/manual range

Many features with Q factor

High Accuracy

Elenco Model 6100

$99.95

- True RMS of high speed signals
- Computer interface and software
- Frequency to 200KHz
- Capacitance to 40µF
- Large 3 3/4 LCD display
- Captures and displays max, min, & avg.
- Relative % to reference
- Three hold system
- Analog bar graph and pointer
- Audible continuity
- Auto power off
- Unit indicator
- Diode test

Oscilloscopes

Free Dust Cover and 2 Probes

S-1325	25MHz	Dual Trace	$325
S-1330	25MHz	Delayed Sweep	$439
S-1340	40MHz	Dual Trace	$475
S-1345	40MHz	Delayed Sweep	$569
S-1360	60MHz	Delayed Sweep	$749
S-1390	100MHz	Delayed Sweep	$995

DIGITAL SCOPE SUPER SPECIALS

DS-203	20MHz/10Ms/s Analog/Digital	$695
DS-303	40MHz/20Ms/s Analog/Digital	$995
DS-603	60MHz/20Ms/s Analog/Digital	$1295

TEKK Radios

Both Models Available In Yellow, Blue & Black

Pro-Sport FRS Two-Way Radio Model PRO-SPORT+

Talk up to 2 miles!

No License Required

Model PRO-SPORT
- 1/2 Watt Output, 14 Channels.
- TX LED Indicator.
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- Highly Water Resistant.
- Economy Type
- No License Required!

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Model PRO-SPORT +
- 1/2 Watt Output, 14 Channels.
- TX & RX LED/LCD Indicators.
- Large LCD Display.
- 38 Privacy (CTCSS) Tones.
- Plus All Features of Pro-Sport Model.

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Elenco Technician Tool Kit

Model TK-1500 $49.95

28 tools plus a DMM (M-1000B) contained in a large flexible tool case with a handle ideal for everyone on the go.

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G1492 $29.95 ea.

CORDLESS PHONE BATTERY

This 3 cell nicad button pack is rated 3.6V@280mAh. Size is 1" Tall x 1" Dia. has blue vinyl sleeve, flexible color coded wires and small female connector. Prime brand new. Sold for up to $9.00 each elsewhere.

G1508 $1.49 ea. • 5 for $7.00

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Compact module consists of 3 amorphous silicon solar cells connected in series, mounted on a glass epoxy board and then coated with a clear epoxy. Size only 4 1/2' x 2 5/8" x 1/16" but produces an incredible 1.6V open circuit voltage and up to 400ma short circuit current. These are great for powering small DC motors to make hundreds of unique solar powered cars, boats, fans, & electronic projects.

G1496 $14.95 ea.

SMALL EFFICIENT MOTOR & FAN BLADE

Works perfectly with the solar panell sold above, this motor features solder tinned connection posts and small 2" overall dia. push on fan blade.

G1495 $2.75 Wow!

FIBER OPTIC DISPLAY BUNDLE

Bundle of various length plastic fiber optics made for a multicolor light display. We didn't receive the light unit but we did get the fiber optic bundles that consist of about 70 small diameter plastic fibers cut at various lengths from about 3/4" up to about 8" long. The bundle terminates into a small metal crimp fitting which is where a multi colored light was to be connected.

G1134 ~~$2.95~~ Sale! $1.29 ea.

TEST LEADS WITH CLIPS

Package of 10 test leads with clips. You get 10 total test leads (2 red, 2 black, 2 green, 2 yellow, and 2 white). Each has a clip on each end and is 13 1/2" long.

G1498 PACKAGE OF 10 $2.49

We have over 150 kits! Call for Catlaog!

IR VISION ROVER ROBOT KIT

This incredible robot can actually see! As it explores, it emits invisible beams of IR (infrared) light which reflect off any obstacles in its path, including wall, rocks, humans, boxes, etc. Its' simple brain and sensor causes the IR Vision Rover Robot to turn backwards and then go forward in a different direction avoiding the obstacle it has detected up to one foot away. It can even be remotely controlled from up to 25 feet away by using any standard VCR/TV IR remote control that you have. Simply point and press almost any button on your remote and you will notice that your IR Vision Rover Robot will immediately back up and then go forward in a different direction. The Rover emits beeps and blinks bright colorful LEDs as it explores. Operates from only two AA batteries (not included). Features DC-DC converter circuitry, sensitive IR sensor module, 2 IR LEDs, 9 colorful LEDs, 2 powerful motors and reliable drive train. This entertaining robot will amaze everyone who sees it! It's a fun kit to build, and an excellent introduction to robotics. Size about 5 1/2" x 6 1/2". Complete with all parts, PC board and instructions. Skill level 2.

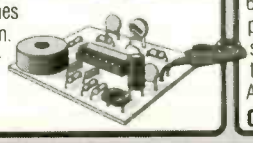
C6761 $46.99 ea. Unique

LIE DETECTOR KIT

Fun "poor man's lie detector"! Pitched tone varies if you are relaxed or nervous. Uses 9V battery (not included). Skill level 1.

C4657 $6.50

ELECTRONIC CRICKET KIT



This electronic cricket starts "chirping" every time it gets dark. Of course, if you turn on the lights to look for the "cricket" it becomes silent again. Loads of fun. Uses 9V battery (not included). Skill level 1.

C6707 $6.50

AIRPAX SERVO MOTOR

This is a prime 12VDC precision servo motor made by Airpax that produces an unbelevable amount of torque! Technical specs: Part number 8204 045 01211, Gear Ratio 150:4 ,23RPM. Perfect for high torque robot applications! Size of motor is 2 1/2" Long x 1 1/4" Dia. with a 1 5/8" square mounting base with 4 screw holes. Shaft size is 3/16" Dia. Sold in lots of two only.

G1497 2 MOTORS $19.95

ENERGIZER® RECHARGEABLE 650MAH 2.4V BATTERYPACK

This pack consists of two AA size batteries with individual white vinyl sleeves connected in series and then a black vinyl sleeve was placed over the pack. These were made for an electric tool and are new prime highest quality Energizer® nicads.

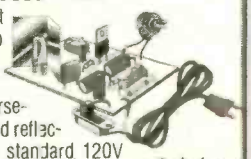
G1480 ~~$1.00/PACK~~ Sale! 79¢/PACK
10 PACKS for $6.00

15VDC 400MA ADAPTER

Special Adapter made for Sega Channel. Plugs into standard 120VAC outlet and features a 5mm female barrel plug with center (+). Has built in ferrite bead RF interference filter. Special blow-out price.

G1357M 99¢ ea. Sale

120VAC HIGH POWER STROBE LIGHT KIT



Deluxe strobe light kit has control to vary flash rate from 60 to 300 flashes per minute. Uses horseshoe strobe tube and reflector. Operates from standard 120V AC. Skill level 2.

C4162 $23.50 Wow!

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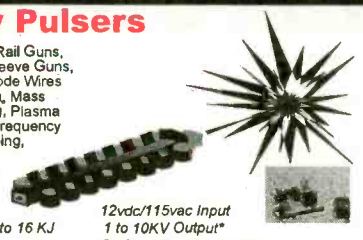

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JACK1 Plans.....$8.00
JACK1K Kit Minus Case.....$129.95
JACK10 Ready to Use.....$249.95

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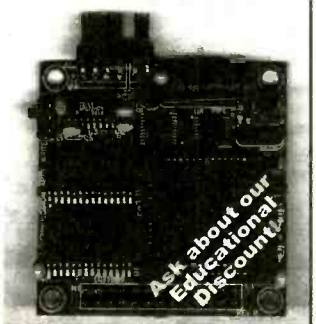

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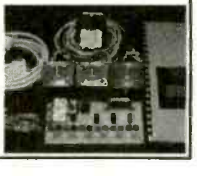

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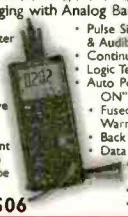

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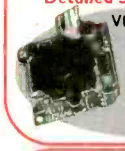

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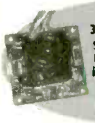

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Delay Sweep	YES	ALT-MAG	ALT-MAG	ALT-MAG
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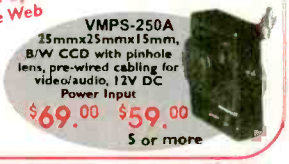

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THE POINT: Standard surge suppressors allow too much current to hit the computer. Standard surge suppressors divert surge current to the ground wire and disrupt data transfer. Standard surge suppressors eventually fail without warning. Modern computers have logic voltage levels (the signals that transmit the data) and power supply voltages that are dramatically lower than that of their recent predecessors. Modern computers use integrated circuits with transistors of ever decreasing physical geometries. Modern computers are virtually always interconnected to other computers or peripheral equipment. The bottom line; ***modern computers are much more sensitive and susceptible to powerline anomalies.***

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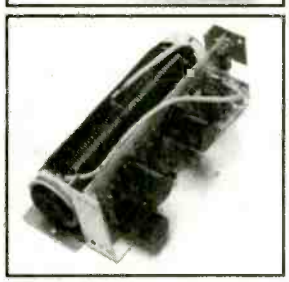

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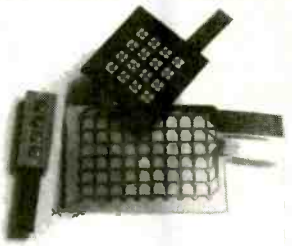

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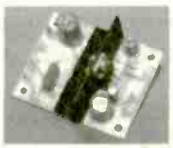

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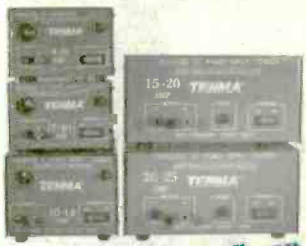

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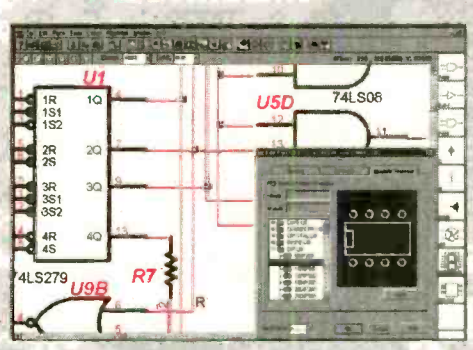

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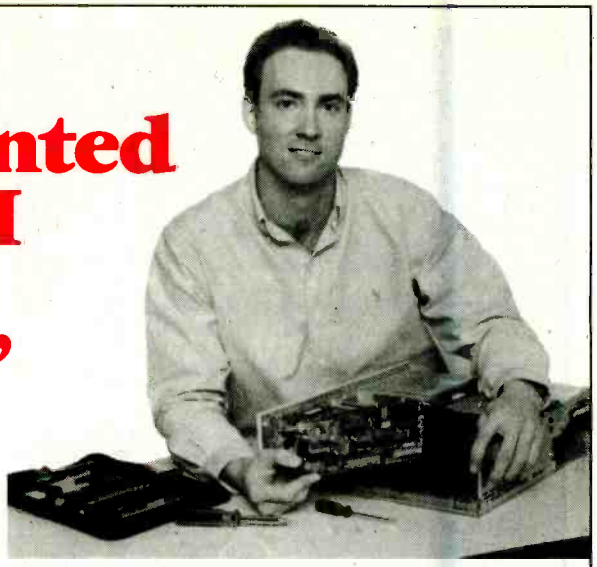

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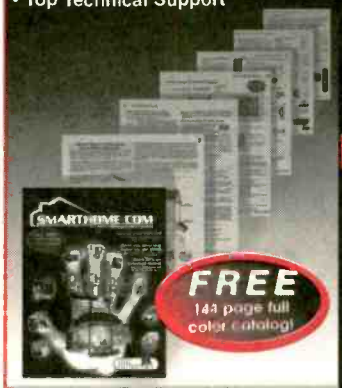

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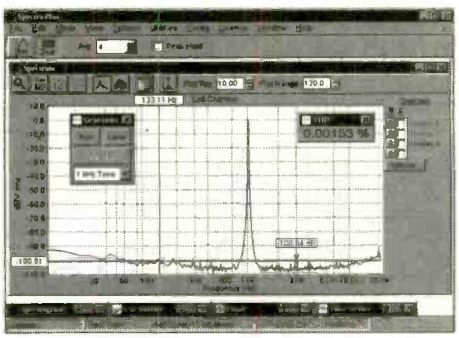

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PROGRAM MEMORY	768 OTP	1K FLASH
MATH REGISTERS	1	32
MAX INSTRUCTIONS / SEC	5M	20M
MAX COUNTER BITS	16	18
INPUT / OUTPUT BITS	12	15
A TO D COMPARATOR	NO	YES
HARDWARE INTERRUPTS	NONE	3

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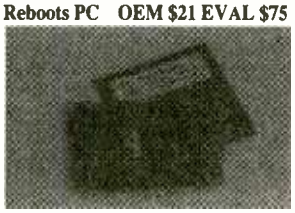

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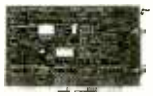

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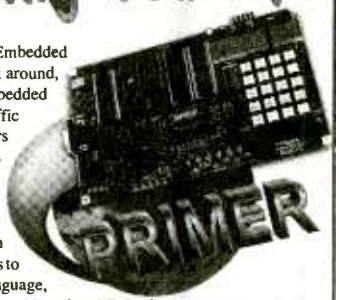

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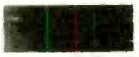

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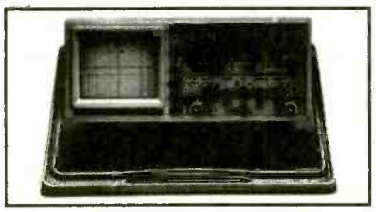

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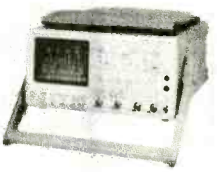

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HP 3325A SYNTH./FUNCTION GEN....$1295
HP 3577A NETWORK ANALYZER.....$8950
HP 3488A SWITCH CONTROL UNIT....$495
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CIRCLE 217 ON FREE INFORMATION CARD

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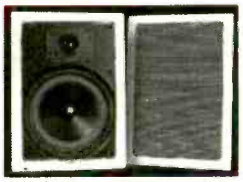
6-1/2" Two Way System



This is our most popular in-wall. You won't believe how good these really sound. Big enough to produce great home theatre sound and still fit everyone's budget. Put a pair in every room of your house. Great for front or rear speakers in your surround system. The 6-1/2" polypropylene woofer and 1" textile dome tweeter were specially designed with home theatre in mind. The crossover network utilizes a mylar capacitor for crisp clean highs. 3 piece design make installation in new or existing walls a snap.
Specifications: ◆6-1/2" polypropylene cone woofer with poly foam surround ◆1" textile dome tweeter/midrange ◆8 ohm impedance ◆3 component L/C crossover network ◆Frequency response: 50-20,000 Hz ◆Power handling capability: 60 watts RMS/85 watts max ◆Sensitivity: 89 dB 1W/1m ◆Overall dimensions: 8-1/2" W x 12" L x 3-1/2" D ◆Hole size: 7-1/4" x 10-3/4" ◆Fits into standard 2" x 4" wall ◆Net weight: 12 lbs. per pair.

#300-036 ..... **$89.90**$_{(1-3\ PRS)}$ **$79.50**$_{(4\ PRS-UP)}$

Satellite Speaker Stands

These quality speaker stands are perfect for mini or rear surround speakers. The heavy die cast base provides stability. Textured black satin finish blends in well with any decor. The height is adjustable from 26-1/2" to 47-1/2" and the speaker wire can be run inside the pole for a better appearance. The top base is adjustable from 4-1/8" to 7-1/2" to accommodate most mini speakers. Includes foam pads to prevent marring of speaker cabinet. Sold in pairs. Net weight: 12 lbs.

#240-762 ..... **$39.80**$_{(1-3\ PRS)}$ **$35.50**$_{(4\ PRS-UP)}$

5 Function Remote

◆Operates five devices (TV, VCR, Cable, Satellite, A/V Receiver) ◆Lighted component keys which indicate what device is currently being used ◆Preprogrammed, 621 codes that work over 6,400 models ◆New ergonomic design features a contoured case, index finger grooves, and keys grouped in clusters for easy operation ◆Satellite cursor control is tailored for use with a Home Theatre system, keypad design allows movement through menus with ease ◆Retains codes when replacing batteries ◆New flat back design for easy operation ◆Money back guarantee ensures customer satisfaction ◆Toll free customer service number provides the customer with friendly, knowledgeable assistance ◆Requires 2 AAA batteries (#140-150 not included)

#180-806 ..... **$29.95**$_{(1-3)}$ **$26.35**$_{(4-UP)}$

3M 3/4" Temflex™ 1700 Vinyl Electrical Tape

General purpose 7 mil electrical tape. UL listed and CSA approved. 3/4" x 60' rolls.

#350-052 ..... **75¢**$_{(1-9)}$ **59¢**$_{(10-UP)}$

Gold Plated A/V Cables

A super quality, "siamesed" type cable. Two RCA cables for stereo (audio) signal from VCR to receiver/stereo TV and one low noise coaxial type cable for video.

Part #	Length	Price (1-9)	Price (10-UP)
180-120	3 ft.	$4.25	$3.95
180-118	6 ft.	4.90	4.50
180-121	12 ft.	8.95	7.95
180-124	20 ft.	12.75	11.50

6-1/2" Round Coaxial System

Designed for the home and office, these 6-1/2" round in-walls are ideal for ceiling installations, or for use as rear channel surround speakers. Adding music to the kitchen, den, bath, or patio has never been easier! System features a weather resistant 6-1/2" treated paper cone with poly foam surround, coaxially mounted 1/2" polymer dome tweeter, and built-in crossover with a mylar capacitor in the tweeter feed. Retrofit design allows installation in both new and existing construction in just minutes. System includes removable steel mesh grills, built-in mounting bracket, hardware, and installation instructions.
Specifications: ◆Impedance: 8 ohms ◆Frequency response: 60-20,000 Hz ◆Power handling capability: 30 watts RMS/45 watts max. ◆Sensitivity: 89 dB 1W/1m ◆Dimensions: 9" round x 2-7/8" deep. ◆Net weight: 5 lbs. per pair.

#300-408 ..... **$69.95**$_{(1-3\ PRS)}$ **$62.75**$_{(4PRS-UP)}$

3 Amp Power Supply

This fully regulated power supply is perfect for powering CBs, car radios, and other 12 VDC devices that draw up to 3 amps. Heavy duty steel housing with front mounted switch and binding posts. Short circuit and overload protection!
Specifications: ◆Output Voltage: 13.8 VDC (fixed) ◆Output Current: 3A (cont), 5 amps (surge) ◆Ripple Voltage: Less than 3mV at rated output ◆Input Voltage: 120 VAC, 60Hz ◆Dimensions: 5-1/2" x 3-1/2" x 6-1/2" ◆Weight: 5 lbs.

#120-530 ..... **$19.95**$_{(1-3)}$ **$18.50**$_{(4-UP)}$

DMM and LCR Meter

In addition to functions found in regular DMM's, this meter can also measure inductance in 5 ranges (4mH, 40mH, 400mH, 4H, 40H), capacitance in 5 ranges (4nF, 40nF, 400nF, 4uF, 400uF), frequency in 4 ranges (4KHz, 40KHz, 400KHz, 4MHz), TTL logic test, diode test and transistor hFE test. 5 AC/DC ranges up to 1000V (AC750V), 3 AC/DC current ranges up to 20A and 7 resistance ranges up to 4000 M ohms. Includes test leads, battery, spare fuse, and manual. Net weight: 1 lb.

#390-513 ..... **$85.90**$_{EACH}$

2.5W Mini Audio Amplifier

This amp contains both pre-amplifier and power amplifier on a super small board measuring only 1-5/8"x1-1/4". Maximum output power is 2.5W into 4 ohms with 12VDC input power. No adjustments required. Short circuit protected.

#320-215 ..... **$9.95**$_{EACH}$

Weller WLC100 Soldering Station

The Weller WLC100 solder station is ideal for the professional, serious hobbyist, or kit builder who demands higher performance than usual of a standard iron, but without the high cost of an industrial unit. Power is adjustable from 5 to 40 watts. Includes 40 watt pencil iron. UL approved. Net weight: 1-3/4 lbs. Replacement sponge #372-119.

#372-120 ..... **$39.95**$_{EACH}$

"44" Solder

Kester "44" rosin core solder is designed for electronic and electrical work. It uses a fast acting, instant wetting, non-corrosive, and non-conductive flux for faster soldering and a strong, long lasting bond.

Part #	Alloy Lead/Tin	Spool	Dia.	Price (1-3)	Price (4-UP)
370-080	60/40	1 lb.	.031"	$8.50	$7.95
370-090	60/40	1 lb.	.050"	8.50	7.95
370-098	60/40	4 lb.	.031"	33.90	31.80
370-088	60/40	1/2 lb.	.020"	6.95	5.75
370-072	63/37	1 lb.	.020"	14.90	13.50
370-086	63/37	1/2 lb.	.031"	9.95	8.50
370-074	63/37	1 lb.	.031"	12.50	11.50
370-087	36/37	1/2 lb.	.031"	7.95	6.75

Pro Wick

Pro Wick's advanced fine braid design provides wicking action that is second to none.

Part #	TS #	Size	Length	Price (1-9)	Price (10-UP)
341-415	1802-5	.06"	5'	$1.40	$1.25
341-416	1803-5	.08"	5'	1.45	1.30
341-417	1804-5	.10"	5'	1.60	1.45
341-424	1802-10	.06"	10'	2.75	2.50
341-425	1803-10	.08"	10'	2.80	2.55
341-426	1804-10	.10"	10'	2.95	2.70
341-440	1802-25F	.06"	25'	6.80	6.30
341-441	1803-25F	.08"	25'	6.85	6.35
341-442	1804-25F	.10"	25'	7.60	7.00
341-418	1802-100	.06"	100'	21.90	20.50
341-419	1803-100	.08"	100'	21.90	20.50
341-423	1804-100	.10"	100'	23.90	22.50

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INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

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

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

WHAT WE DO

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

RATES

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

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

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

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

DEADLINES

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

CONTENT

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

AD RATES: $2.50 per word. Minimum $37.50

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

CATEGORIES

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

CLASSIFIED AD COPY ORDER FORM

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

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00
17 - $42.50	18 - $45.00	19 - $47.50	20 - $50.00
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00
25 - $62.50	26 - $65.00	27 - $67.50	28 - $70.00
29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00

Total words _____ $2.50 per word = $_____

Bold Face _____ $0.40 per word = $_____

Special Heading _____ $30.00 = $_____

Other _____ = $_____

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Signature _____

Name _____ Phone _____

Address _____ City State Zip _____

World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture! Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Audio units include sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Any of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air!

C-2000, Basic Video Transmitter Cube..... $89.95
C-3000, Basic Video & Audio Transmitter Cube..... $149.95
C-2001, High Power Video Transmitter Cube..... $179.95
C-3001, High Power Video & Audio Transmitter Cube... $229.95

CCD Video Cameras

Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infra-Red) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80º) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for audio sound pick-up and super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens..... $69.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens..... $69.95
CCDCC-1, Color CCD Camera, wide-angle lens..... $129.95
IR-1, IR Illuminator Kit for B&W cameras..... $24.95
IB-1, Interface Board Kit..... $14.95

Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast which has handy SCA output. Add our snazzy matching case and knob set for that smart finished look.

AR-1, Airband 108-136 MHz Kit $29.95
HFRC-1, WWV 10 MHz (crystal controlled) Kit $34.95
FR-1, FM Broadcast Band 88-108 MHz Kit..... $24.95
FR-6, 6 Meter FM Ham Band Kit..... $34.95
FR-10, 10 Meter FM Ham Band Kit..... $34.95
FR-146, 2 Meter FM Ham Band Kit..... $34.95
FR-220, 220 MHz FM Ham Band Kit..... $34.95
SR-1, Shortwave 4-11 MHz Band Kit $29.95
Matching Case Set (specify for which kit)..... $14.95

Tiny FM Transmitters

Gosh, these babies are tiny - that's a quarter in the picture! Choose the unit that's best for you. FM-5 is the smallest tunable FM transmitter in the world, picks up a whisper 10' away and transmits up to 300'. Runs on tiny included watch battery, uses SMT parts. FM-4 is larger, more powerful, runs on 5-12 volts, goes up to a mile. FM4,5 operate in standard FM band 88-108 MHz. FM-6 is crystal controlled in 2-meter ham band, 146.535 MHz, easily picked up on scanner or 2 meter rig, runs on 2 included watch batteries. SMT (surface mount) kits include extra parts in case you sneeze & loose a part!

FM-4MC, High Power FM Transmitter Kit..... $17.95
FM-5, World's Smallest FM Transmitter Kit $19.95
FM-6, Crystal Controlled 2M FM Transmitter Kit $39.95
FM-6, Fully Wired & Tested 2M FM Transmitter $69.95

Super Pro FM Stereo Transmitter

Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. *We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.*

FM-100, Pro FM Stereo Transmitter Kit..... $249.95
FM-100WT, Fully Wired High Power FM-100..... $399.95

FM Stereo Radio Transmitters

No drift, microprocessor synthesized! Excellent audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit $129.95

Lower cost alternative to our high performance transmitters. Great value, tunable over FM band, plenty of power and manual goes into great detail about antennas, range and FCC rules. Handy kit for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit $34.95
CFM, Matching Case and Antenna Set $14.95
FMAC, 12 Volt DC Wall Plug Adapter..... $9.95

RF Power Booster

Add muscle to your signal, boost power up to 1 watt over a freq range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat finished look, add the nice matching case set.

LPA-1, Power Booster Amplifier Kit..... $39.95
CLPA, Matching Case Set for LPA-1 Kit $14.95
LPA-1WT, Fully Wired LPA-1 with Case..... $99.95

FM Station Broadcast Antenna

For maximum performance, a good antenna is needed. Properly tuned and matched antenna is fully PVC enclosed for weather protection and rugged use. Vertical or horizontal mounting, 'F' style connector, 5' long.

TM-100, Tru-Match FM Station Antenna Kit.....$39.95

AM Radio Transmitter

Operates in standard AM broadcast band, set to clear channel in your area. AM-25 'pro' version is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 has tunable transmit oscillator, runs FCC maximum 100 mw power, expected range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set for a finished, professional look. High level modulation for low distortion.

AM-25, Professional AM Transmitter Kit..... $129.95
AM-1, Entry level AM Radio Transmitter Kit $29.95
CAM, Matching Case Set for AM-1..... $14.95

RAMSEY

Binocular Special

Wow, did we nab a deal on these first rate binoculars! Absolutely identical to a famous big name brand here in Rochester, NY - but without 'their' name. Well made with fully coated optics, super nice rubber armored housing over hi-alloy aluminum, includes lens cleaner cloth, neck lanyard and carry case. 4 styles: roof prism 10x25 (10 power, 25 mm), 10x25 high performance roof prism ruby coated objective lens model for demanding use in bright sun, 10x25 high-end BAK-4 lens porro prism ruby coat with TacGrip housing, and Ultra-View 10x50 porro prism ruby coats. First quality, yet at a close-out price on the exact same units as the 'Trademarked' units - but at half price!

BNO-M, 8x21 Mini Monocular $14.95
BNO-1, 10x25 Roof Prism Binoculars..... $24.95
BNO-1EX, 10x25 Ruby Coated Porro Prism $29.95
BNO-2, 10x25 TacGrip Ruby Coat Porro Prism..... $59.95
BNO-6, 10x50 Ultra-View Ruby Coat Porro Prism... $69.95

World's Smallest FM Radios

Everyone who sees one of these babies says they just gotta have one! Super cute tiny FM radios have automatic scan/search tuning, comfortable ear bud earphones and we even include the battery. The pager style unit looks like a shrunken pager and even has an LCD clock built-in. You will be amazed at the crystal clear amazing sound! That's a quarter in the picture for size comparison - pretty tiny, huh?

MFMT-1, World's Smallest FM Radio..... $11.95
PFMR-1, Pager Style LCD Clock & FM Radio $12.95

Speech Descrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. Speech inversion technology is used, which is compatible with most cordless phones and many police department systems, hook it up to your scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC. Our matching case set adds a professional look to your kit.

SS-70A, Speech Descrambler/Scrambler Kit..... $39.95
CSS, Custom Matching Case and Knob Set $14.95
SS-70AWT, Fully Wired SS-70A with Case..... $79.95
AC12-5, 12 Volt DC Wall Plug Adapter..... $9.95

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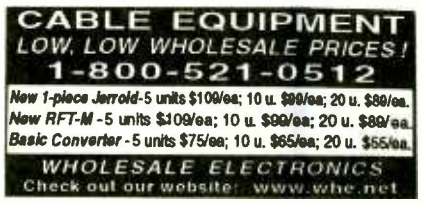

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PIC ASSEMBLY LANGUAGE

(continued from page 38)

have specified; w means the result should go in the W register.

Looping. Obviously, the main program will be an endless loop—shift the bits of Port A, delay a few milliseconds, and then go back and do the whole thing again. That's taken care of by the mloop label at the beginning of the main loop and the goto mloop instruction at the end.

The time delay loop is more complicated because it requires counting. In BASIC, it would look roughly like this:

```
FOR J=50 TO 1 STEP -1
   FOR K=50 TO 1 STEP -1
      REM do nothing
   NEXT K
NEXT J
```

That is, waste time by counting 50 × 50 = 2500 steps.

But we're not programming in BASIC. In PIC assembly language, the time delay loop looks like this:

```
        movlw   D'50'
        movwf   J
jloop:  movwf   K
kloop:  decfsz  K,f
        goto    kloop
        decfsz  J,f
        goto    jloop
```

Here's how it works: First, note that counting down is easier than counting up because it's easier to test whether a byte equals 0 than whether it equals some other number. So we stuff decimal 50 into variables J and K at the beginning of the loop. The value 50 is stored in W, which doesn't change during the whole process; thus it can be copied into K fifty times.

The crucial instruction here is:

```
decfsz  K,f
```

which means, "Decrement (that is, subtract 1) and skip the next instruction if it is zero." Thus, a decfsz followed by a goto means "Subtract 1 and go back *unless* the result of the subtraction was 0." Two decfsz loops, nested, produce the time delay we need. On the last pass through the loop, the value of J or K respectively is 1; then, when it reaches 0, the program exits the loop.

Defining Variables. But wait a minute: Where did we get the variables J and K? Those aren't the names of file registers, are they?

Actually, they are names *now*, because we defined them. At the beginning of the program, the pseudo instructions:

```
J       equ H'1F'
K       equ H'1E'
```

define J and K to be abbreviations for two hex numbers, 1F and 1E, which are the addresses of two suitable file registers. These registers were chosen by looking at the memory map in the PIC16F84 manual; it's entirely up to the programmer to choose a suitable address for each variable.

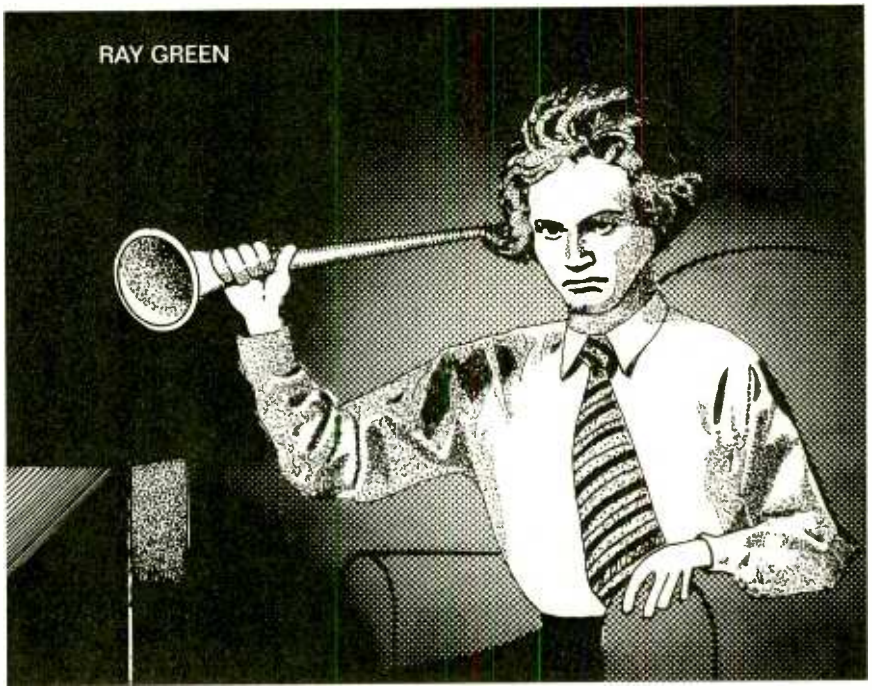
Debugging Your Programs. Finally, a few words about debugging your own programs. Any program should be designed so that you can build and test it in stages, as we did with the two programs in this article: First figure out how to turn on one LED, then get all eight blinking in the proper sequence. In real life there would probably be several stages in between, in which you turn on various LEDs and test the time delay loop. Because the PIC16F84 can be reprogrammed instantly, there's no need to implement the whole program before you test any of it.

Unused output lines can be put to good use for debugging. If your program is complicated, make it send some signals out one or more spare port pins so that you can use a voltmeter or oscilloscope to tell what part of the program is running. If nothing else, output a "heartbeat" bit that toggles every time the program goes through its main loop.

Where To Go From Here. Now all that's left is to learn the rest of the assembly language and the art of microcontroller software development—not something you'll do in one weekend, but at least your career has been launched. A good book to start with is *Easy PIC'n*, by David Benson, published by Square One Press (www.sq-1.com; you can special-order it through any bookstore). Together with its sequels, *PIC'n Up the Pace* and *PIC'n Techniques*, it takes you through PIC programming from the very beginning. These books use the PIC16F84 or its software-compatible twin, the PIC16C84, for most of the projects. More advanced books about PICs include *Programming and Customizing the PIC Microcontroller*, by Myke Predko (McGraw-Hill, 1998), and *Design with PIC Microcontrollers*, by John B. Peatman (Prentice Hall, 1998). The last of these is a very professional guide based on the PIC16C74A. Ω

TV AUDIO HEARING WONDER

Enjoy listening to television once again with this adapter for the hearing impaired.



If you're hard of hearing, you know the difficulty in trying to listen to television. Hearing aids help but just don't "cut the mustard" when you're trying to discriminate between similar-sounding words that are coming from your TV set. What is it about hearing aids that seem to work perfectly fine in normal conversation but fall short in the seemly simple task of listening to television?

What is needed is a circuit that has a large treble boost to compensate for the audio region where most hearing loss occurs. If you have lost the enjoyment of watching movies, sports, or news because of hearing problems, then the Television Hearing Adapter presented here is a "must have" for you! Whats more, the circuit is easy to build and the parts are available at any local RadioShack (and most other electronics suppliers) for about $30.

Television and the Hard of Hearing. As we grow older many of us lose our ability to hear the higher frequencies that help us to discriminate between words. Live speech produces frequencies across the entire audio spectrum, most of which is lost when recorded and played back. Even the telephone, with its 300–3000-Hz frequency response can be a problem. An interesting historical oddity on the subject of the telephone is that it was a byproduct of Bell's research to help the deaf—including both of his parents.

Because the human ear loses sensitivity to higher frequencies, we need to compensate for that loss. What is needed then is a circuit that increases its gain at higher frequencies. A plot of such a gain-to-frequency relationship is shown in Fig. 1. That type of plot happens to be the mirror image of a hearing-loss curve for most common forms of deafness. For whatever reason, the best and most expensive hearing aids don't seem to be able to produce the clear rich-sounding audio that the Television Hearing Adapter is capable of.

How It Works. The schematic diagram for the Television Hearing Adapter is shown in Fig. 2. As you can see, the circuit is built around IC1, an LM386 audio amplifier. That chip was originally designed for use in battery-operated audio systems like radios, cassette players, and small portable sound systems. Audio from a television is connected to J1. The signal is attenuated by volume control R2. Note that R2 and S1 are integrated as a combination on/off switch and volume control. Light-emitting diode LED1 indicates whether the Television Hearing Adapter is on or off—a handy reminder not to leave the unit on when you're not using it. The output of IC1 is connected through C4 to J2; suitable headphones are connected to that jack. A feature of the LM386 is that it can (with the help of C4) drive an 8-ohm load directly.

The secret to the treble boost is in C2. Connected between pins 1 and 8 of IC1, the induced negative feedback increases amplification as the input frequency increases. A feature of IC1 is that ability to change the frequency response with pins 1 and 8. During the development of the Television Hearing Adapter, many different feedback configurations were tried, up to and including T-Pad filters. It was found that to achieve a response that would offset typical hearing losses, using the 1-μF capacitor worked best. After all, simplicity is the keynote of good engineering design.

The frequency range of critical speech understanding falls between 500 Hz and 6000 Hz; most hearing tests are conducted in that range. Persons with moderate hearing loss typically have a frequency-response degradation of 10 dB to 20 dB over

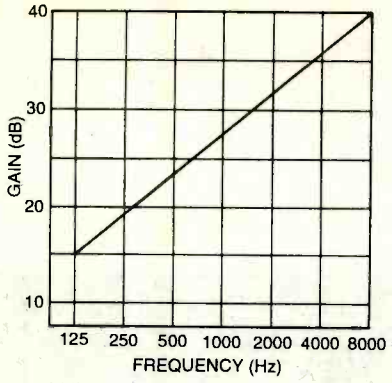


Fig. 1. This is a plot of the change in amplification gain versus a change in frequency input for the Television Hearing Adapter. Note that the higher the frequency, the louder that frequency is amplified—much like a "souped-up" treble control.

that range, so the gain of the Television Hearing Adapter is set to about 15 dB, offsetting that condition nicely. Persons with extreme hearing loss might want to decrease the value of C2 to about 0.47 µF. That will increase the gain to about 20 dB. Although you might find that the recommended value works well, some programs have too much bass boost in their audio; increasing the treble gain might improve your ability to understand what is being said. As a modification, both values of capacitor can be placed in parallel and selected one at a time with a small switch.

Construction. Building the Television Hearing Adapter is as simple as its schematic diagram suggests. The unit can be built on a small piece of perfboard using standard construction techniques; the author's prototype shown in Fig. 3 is an example of that method of construction.

Drill holes for mounting the jacks, controls, and LED in a suitable enclosure. The locations are not critical; the layout should suit your personal tastes; use Fig. 3 as a guide. Note that the lid of the unit was not used for mounting any components. That way, you don't have to worry about stretching or breaking any wires when you open the unit to replace the batteries. Mount the controls and jacks in the holes. A battery holder is glued to one end of the case. Set the case aside.

Cut a piece of perfboard to an appropriate size. Note the terminal strips mounted to each end of the perfboard. With several terminals easily reachable, it is a simple matter to wire up the external components to the circuit after the board has been mounted in the case. Drill holes in the perfboard and mount the two terminal strips with screws and nuts. Using an 8-pin IC socket for IC1 is suggested to prevent damaging the chip during construction. Do not plug the IC in until the unit is completely finished. Mount the other components and wire the circuit together using insulated wire.

The board is mounted next to the battery holder using double-sided tape, hot-melt glue, rubber adhesive, or any other suitable method. Wire and solder the connections between the board and the case-mounted components. If you are using an integrated potentiometer/switch, check to be sure which terminals are for the switch with an ohmmeter. Also note that the anode lead of LED1 is longer; that lead should be connected to S1.

Use a piece of shielded wire for the connection from J1; that signal is not amplified and is susceptible to noise and interference.

Check your work for any errors. When you are satisfied, plug IC1 into its socket and put a fresh set of batteries into the battery holder. With the case closed up, the Television Hearing Adapter is ready to go!

Using the Television Hearing Adapter. While the Television Hearing Adapter is simple to set up and use, a few notes and pointers might help.

The one drawback to the Television Hearing Adapter—though in some cases it might be a strong point instead of a weakness—is the fact that it must be connected directly to the headphone jack of your TV set or VCR. Check both your

PARTS LIST FOR THE TELEVISION HEARING ADAPTER

SEMICONDUCTORS

IC1—LM386 audio amplifier, integrated circuit
LED1—Light-emitting diode, red

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—33,000-ohm
R2—10,000-ohm panel-mounted potentiometer with single-pole, single-throw switch
R3—1000-ohm

CAPACITORS

C1—0.001-µF, ceramic-disc
C2—1-µF, 50-WVDC, non-polarized electrolytic
C3, C4—220-µF, 35-WVDC, electrolytic
C5—0.047-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

B1—6-volt battery
J1—RCA audio jack
J2—Miniature ⅛-inch headphone jack
Case, IC socket, five-lug terminal strips, battery holder, knob for R2, wire, hardware, etc.

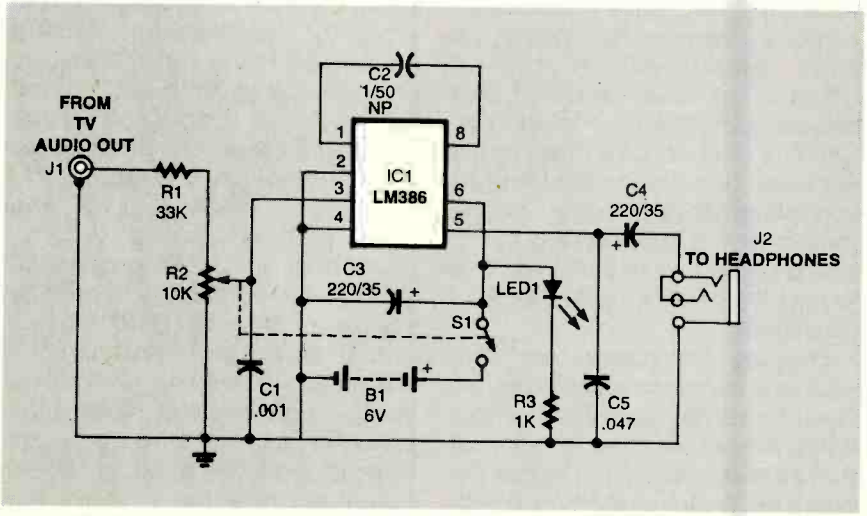


Fig. 2. The Television Hearing Adapter is a simple amplifier circuit built around an LM386. The value of C2 gives the unit its "magic" in helping the hard-of-hearing to enjoy television again.

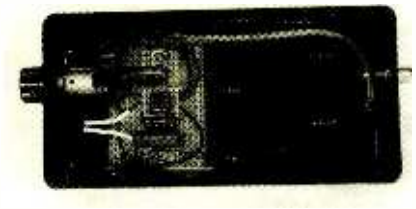


Fig. 3. The Television Hearing Adapter fits into a standard-sized project case. Note the use of terminal strips on the perfboard; that makes it easier to wire the external components to the board after installation in the case.

TV set and your VCR. If you have either a headphone jack, or an RCA-type jack labeled "Audio Out" or "Audio to Hi-Fi", then you are in luck. On a stereo TV, connect to the left channel only. Depending on the type of TV that you have, the audio jack might have a constant-volume output designed for recording regardless of where the TV's volume control is set. Plugging the Television Hearing Adapter into that output jack will give you the advantage of controlling your volume separately from the TV. Imagine the joy of being able to listen to television with family and friends without "blasting" the audio!

Many VCRs have an audio-output jack for playback to another VCR or a stereo system; that can also be used for the Television Hearing Adapter. Using a jack on the TV is better because you don't have the added annoyance of fiddling with another piece of equipment, detracting from the joy of listening to television.

If your TV gear lacks an appropriate audio output, you are not completely out of luck. One alternative is to connect the unit to your TV's loudspeaker through an isolation transformer such as a RadioShack 273-1380. Connect the 8-ohm secondary winding to the speaker and the 1000-ohm winding to J1. If you don't have an audio-output jack on your TV or VCR, and you don't want to make a connection to your TV's loudspeaker, then the only solution is to buy a new TV!

The Television Hearing Adapter is very sensitive. If you are near a radio station, you might experience radio interference; C1 generally eliminates that problem. If you cannot correct it in any other way, use a metal box instead of a plastic one to house the circuit.

The Television Hearing Adapter has been tested with audio cables up to 24 feet in length. That length should be more than enough for most installations.

Almost any pair of headphones will work well. If you don't own a pair, most electronics stores have a wide selection to choose from. While the author prefers the lightweight types, try more than one model or type—some sound better than others.

Four AA-size batteries will last from six months to a year in normal use if you don't forget to turn the unit off. A smaller unit can be constructed using a 9-volt battery, but at a usable life of only three to four months before needing a replacement battery. If you decide to go that route, the value of R3 should be changed to 4700 ohms. The author's preference leans toward the four-AA battery version as that yields a longer battery life.

The author would be interested in hearing from anyone who builds the Television Hearing Adapter by sending mail in care of the **Electronics Now** editorial office or by e-mail at raygreen@juno.com. Build the Television Hearing Adapter if you have a hearing problem, and it will give you a whole new outlook on life! Ω

GRAVITY WAVES

(continued from page 44)

changes without ruining our signal-to-noise ratio. However, when we consider the size of the wavefronts we'll be encountering, you'll soon see that this method offers no directional selectivity. Gravity waves generated by every object in the Heavens will be affecting the mirrors from every angle, possibly "swamping out" any usable results. Perhaps by arranging a string of mirrors in a certain manner, we could obtain some directional selectivity—assuming that wave propagation isn't beyond light-speed, where just possibly nothing at all may happen to the dimensions of solid objects!

That's why the heterodyne method appears to be the best bet: It offers excellent directional selectivity, tunable frequency, and tolerance to wavefront size. However, considering the wavelengths we have to deal with, the interferometer will need an extremely long baseline to function. Remember our one-millisecond pulsar? It would produce the shortest wavelength we could expect to see: 186 miles. That means that if we use a one-quarter wave-length laser spacing, our baseline would be at least 46 miles! Don't forget, most gravity waves that we can expect to detect would have much longer wavelengths than that. The most promising method appears difficult to implement by any practical means.

But that does not mean impossible. Please remember that while some of the concepts presented are a shade radical, they are based on current mainstream theory. It is the author's hope that the above discourse has got you thinking and wondering. And who knows, perhaps one of you may actually be able to build a working gravity-wave detector! Ω

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ET11

BY DON LANCASTER

A Low-Cost PC Board Drilling System, and More

AS MIGHT HAVE BEEN MENTIONED A TIME OR TWO BEFORE, I AM UTTERLY FASCINATED BY ALL THE WEB'S BIZARRE "FREE ENERGY" SITES. THESE ARE PLACES WHERE WEIRDNESS APPEARS TO REIGN SUPREME. EXAMPLES INCLUDE JERRY DECKER'S Keely Net Mail List at keelynet.com/interact/archive/date.htm and Bill Beaty's Freenrg-l mailing list at www.eskimo.com/~bilb/freenrgl/fnrga.

Once you get past all of the scams, urban lore, or wishful thinking, most of pseudoscience quickly classifies itself into labwork so mesmerizingly awful that it is not even wrong or as having proponents with such an utter disdain for scientific principles that they are not even hopeful of working up to total cluelessness, that suffer from a large medical problem (such as acute recto-crainial inversion), or that have some other hidden agenda.

I strongly believe that finding a new source of unlimited free energy would be one of the most heinous imaginable crimes against humanity for the binge that is sure to result clearly would turn the planet into a cinder. Fortunately, this flat out "ain't gonna happen."

Further, it appears to me the key point these folks all completely miss about free energy is simply this: The conservation of energy and thermodynamic "laws" are much more than "laws." They are also theorems.

It turns out that a theorem is an unavoidable consequence of initial principles. As such, the thermodynamics and related "laws" absolutely guarantee us that there is no possible over-unity combination of ordinary motors and magnets. Nor is it possible using any mechanical arrangement of balls, wheels, slides, weights, or levers, any fully accounted heat pump, or any miracle carburetors. And nothing special will happen to a wire if you happen to make it a lot longer than usual, outside of needing to understand fancier math.

Thankfully, these theorems free us up to spend all our time researching more useful stuff. Two key points are that an hour in the library is worth a month in the lab and that "real science" progresses by standing on the shoulders of giants. Plus, of course, that extraordinary claims demand extraordinary proof.

Now, yes, those fundamental first principles could be challenged. But because they're verified over and over again in zillons of ways each day, any exceptions are likely to be at extremes of pressure, size, temperature, or time, if they even exist at all.

The whole trick when evaluating pseudoscience is to carefully separate the useful adjuncts towards porcine wholebody cleanliness from the total hogwash. Lots more on this subject is up at www.tinaja.com/pseudo01.html.

NEED HELP?

Phone or write all your US Tech Musings questions to:

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US email: don@tinaja.com
Web page: http://www.tinaja.com

A New Printed-Circuit Drill

Gordon Robineau has developed an ultra low-cost way to plot and drill hobby and prototype printed-circuit boards. It is the PCD100, and systems, kits, and consulting are available; prices start at $200. While not particularly rugged, fast, or very precise, these solutions certainly are exceptionally innovative and elegantly simple.

The general scheme is shown in Fig. 1. As you can see, gravity plays a big role! The concept works by leaving the pen or drill centered and stationary while moving the printed circuit board in suitable X and Y directions.

A solid base is supported on a steep 60-degree angle. There is one single brass tube "monorail" going down the board center. This monorail supports a fixed combination pen and drill holder. The custom electric drill is miniature and self-advances on power; the pens also "pen down" on applied power. A plain old relay contact replaces any need for a solenoid.

A full-width horizontal aluminum bar rides up and down under the monorail. A smaller slider goes back and forth on this horizontal bar. The printed circuit board is taped to this slider. The X-board motion is done by sliding back and forth. The Y board motion is done by lifting or lowering the horizontal bar.

Two smallish steppers control the motions by way of plain old fishing-line strings, while gravity keeps the needed tension on everything. The strings go through end rollers on the horizontal bar and connect to slider ends. The steppers always will work together. When

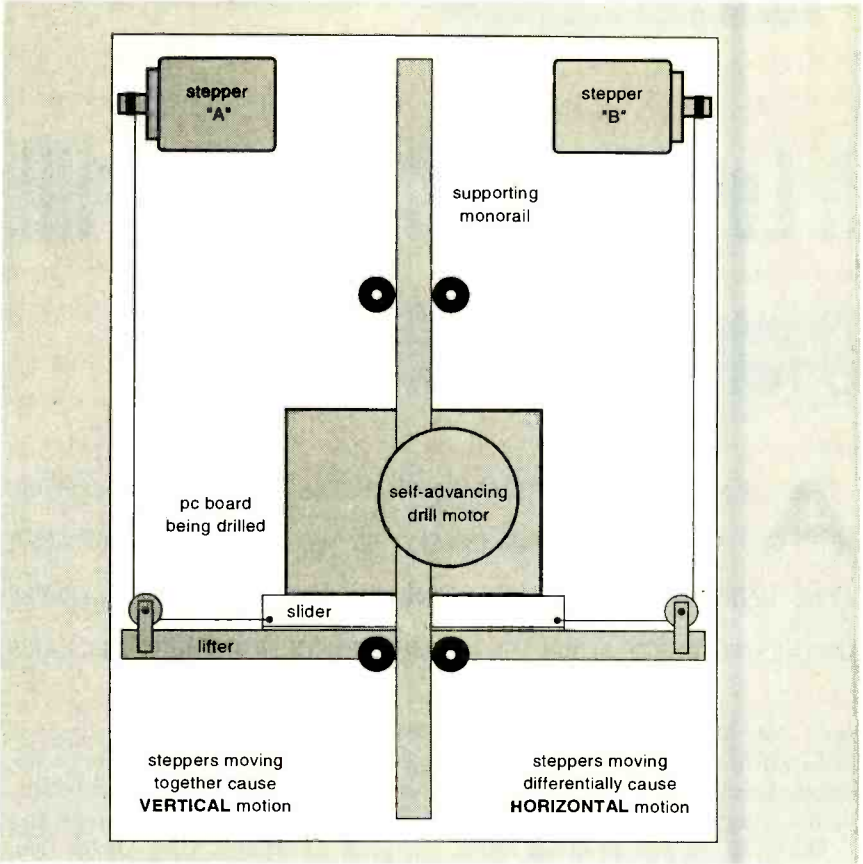

FIG. 1—THIS NEW PCD100 PRINTED CIRCUIT DRILL is largely gravity powered! Differential stepper motions move a PC board under a fixed self-advancing drill or a plotting pen.

both step in the same direction, the board raises or lowers.

Should both step in the opposite direction, the board moves left or right. Combined motions are easily done by selecting the needed number of differential steps.

The schematic of the interface is shown in Fig. 2. All the hard work is done by the PC host. The interface is about as simple and as dumb as you can get. One chip "amplifies" the parallel-port signals to control the stepper phases. A power supply and NMOS driver transistor controls the self-advancing drill motor or the pen up-down Z motion.

Sadly, the software is DOS based. The included floppy-disk software accepts simplified Gerber or HPGL files and converts them into needed stepper, drill, or pen motions. A slide-down "boresight" alignment target automatically does alignment to make sure that board edges are truly parallel to the desired foil pattern. A seventy-cent baby PIC added to the interface sure would add bunches for independence and compatibility with newer operating systems.

Now, Make it Speak PostScript

Sure thing; trivial even. While PC drills and such can use Gerber file formats or Hewlett-Packard HPGL plotting languages, I've found that PostScript is far more flexible and way more powerful, particularly if lots of fancy fonts or exotic transformations are involved.

The trick is to send your PostScript code to a special utility that is sent to Adobe Acrobat or GhostScript. This utility accepts the normal PostScript vector commands and reduces them to elemental horizontal and vertical steps by using PostScript's powerful pathforall and flattenpath procs. The output can be a simple and elemental meta language such as the ASCII numerals "0" through "7" for east through northeast on through southeast, "H" for home, "U" for pen up, "D" for pen down, "X" for your debugging break, and "Q" for quit. Modifications to this utility can directly generate PCD100 commands.

What a possible three-inch circle might look like is shown in Fig. 3. Full source code, tutorials, and other insider

details can be found at www.tinaja.com /flut01.html. More on PostScript is downloadable from my www.tinaja.com/post01.html. Consulting services are offered per www.tinaja.com/consul01.html or at www.tinaja.com /info01.html.

More on Scanner "Photographs"

Last month, we saw how creative use of a better-quality scanner can give you ridiculously better "photos" than a digital camera. Resolution can be hundreds of times higher. To do this, you carefully support and align an object, scan it, and then "airbrush" edit it using Paint, PhotoShop, or your choice of anything in between.

Complete details can now be found in www.tinaja.com/blat01.html and in my http://www.tinaja.com/glib/imagimag.pdf Dozens of astounding results can now be viewed by going to my www.tinaja.com/barg01.html. Your only tiny downside is that the process is incredibly addictive. After playing with these techniques for a while, I've come up with several additional insider secrets:

Use pixel locking—Try to get exactly horizontal and vertical lines. Use a mechanic's combination square for initial subject alignment. Then you'll "normalize" a small portion of some edge and "chase" it along as far as you can. Wholesale move the rest of your image up or down a pixel as needed for perfect alignment.

Crowd all shadows—Shadows almost always will be way too large, way too many, and way too dark. Expand the "brighter" portions of the subject so that the last "brown" line moves well over most of the "black" ones, or eliminate shadows entirely if they do not add to your effect. Similarly, the darkest grays on a meter face can usually be replaced with fewer and significantly lighter ones.

Don't retouch lettering—The results will almost always be bad enough to call attention to themselves. Instead, make only the most minor and most essential adjustments. Take half and leave half. If the lettering is really bad, replace it entirely. I will often write new lettering in raw PostScript using a multiple master font that has adjustable size and weight. I'll then let Acrobat Distiller color, size, and anti-alias the callouts, lift them with a screen grabber, and then paste it on back into Paint.

Brighten and sharpen selectively—If something is too dark or too fuzzy, I will slide it on over into the Arcata ImageViewer, and then selectively deal with it there. What the photo folks call dodging and burning. But note that a little sharpening goes a very long way. Stay on the fuzzy side or the final results may have garish "sugar" in them.

Invent if really needed—Create any essential fine detail from scratch if you have to. Pixel locked and totally controlled stuff such as thermometer gradiations, edge-thread details, or complex sensor structures. A hand-done antialiased 3 × 5 or 5 × 7 lettering can sometimes work wonders. But a little of this goes a very long way.

Work in pieces—First to get an object to fit the scanner, and second to get your lettering as close to the glass as possible. For instance, on a squirrel cage blower, I took it all apart and scanned the motor separate from the cage. Two other scans were used to optimize the look of the wiring, and a portion of the

GPS BOOKS

Aviator's Guide to GPS... (Bill Clarke)
GPS for Everyone: How the Global Positioning... (L. Larijani)
GPS for Geodesy (Peter J. G. Teunissen)
GPS for Land Surveyors (Jan Van Sickle)
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GPS Made Easy : Using Global Positioning ... (Lawrence Letham)
GPS Satellite Surveying (Alfred Leick)
Simple GPS Navigation; Sea, Air, Land... (Mik Chinery)
Understanding GPS: Principles and Applications (Elliott D. Kaplan)
Using GPS (Conrad Dixon)
Using GPS: Finding Your Way With the... (Bruce Grubbs)
Wilderness Navigation : Finding Your Way... (Bob Burns)
Yachtsman's GPS Handbook... (Colin Jones)

For more details, see www.tinaja.com/amlink01.html

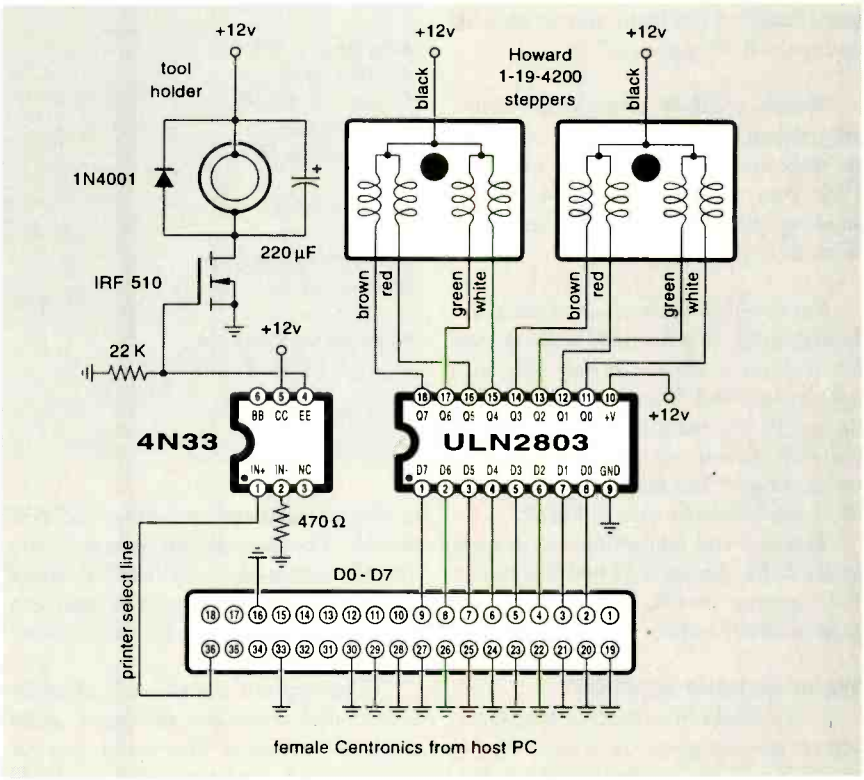

FIG. 2—THE ELECTRICAL INTERFACE for the PCD100. A parallel port and DOS software is currently used.

label was selectively sharpened as an overlay. If removing knobs takes you closer to the glass, do so. Then scan the knobs later.

Use symmetry and repetition—Once you have got one corner of an object looking the way you want it to, flip it horizontally and then vertically to take care of the other three. If your lighting on something cylindrical is poor, expand the "good" side of the best lines, duplicate them vertically, and then mirror the entire result.

Experiment on the side—The greatest ideas have a way of turning sour, so always tow a copy of any detail you are working on to a background area, improve it, and tow it back. Be sure to save often. Save any details that you can reuse, such as screws, knobs, line cords, other fasteners, fuses, or feet.

Avoid the "Barney Oldfield" Effect—Early photos of moving race cars had elliptical wheels, which was caused by the camera's focal-plane shutter seeing the top of the wheel after the bottom. Moving scanners could also have a disconcerting habit of showing only one "side" of a knob, support, or whatever. Get around that by taking the good "half" of the knob, mirror copy it, and make it "straight on."

Watch shadow directions—Similarly, scanners tend to "throw" shadows on only one side of knobs or supports. Pick your scanning direction so the shadows all stay out of the lettering. This saves you lots of grief.

But the ultimate key test of your airbrush work is that it should seem to vanish without a trace. Leaving you with appropriate and "accurate" results that do not in any manner call attention to themselves. Your whole goal here is not to be noticed! I've summarized some of these guidelines for you in Fig. 4.

Training and consulting services are available for this exciting new technique. For ongoing details, refer to www.tinaja.com/info01.html.

Water Soluble Plastics

In my surplus wanderings I have come across a great heaping pile of water-soluble plastic film. These are intended for hospital laundry bags and are resold by M.D. Industries. They are easily cut with scissors or a paper cutter and are "somewhat" heat sealable. They are mildly translucent—you can tell roughly what is in them but cannot read print through them. Thickness is a mil or two—somewhere between delicate and sturdy.

These cry out for all sorts of oddly unintended uses—hot-tub-guest swim suits, for instance. You could also tie some around a microswitch for a flood alarm or a rain detector, or perhaps use it as packages for bath salts or some dye.

Thinking about it further, a dozen or more "magic" tricks come to mind. Maybe there are a few possible greenhouse or other agriculture uses. Perhaps it could be useful places where you don't want to handle something. I'm not sure if you can dissolve the films and then reuse the solution somehow.

Cost is quite low, especially when you only use a few square inches. What uses can you think up for these that give new depth of meaning to "diabolically

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www.gspinc.com

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www.ihspubs.com

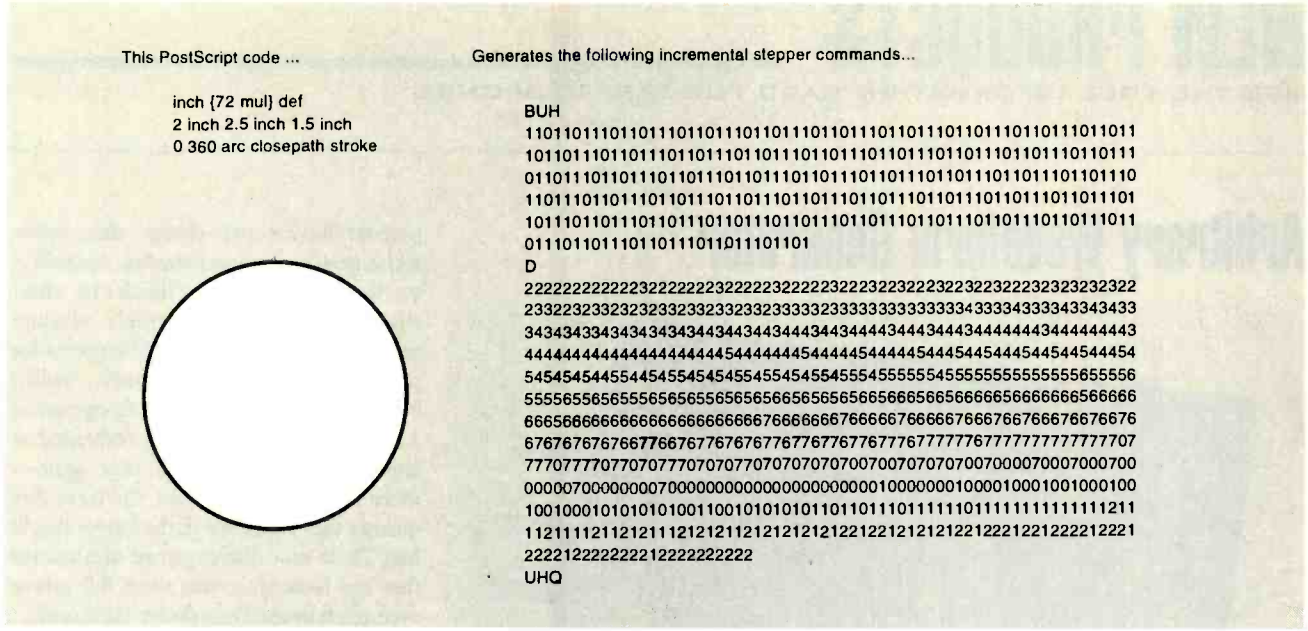


FIG. 3—POSTSCRIPT CAN EASILY CONTROL ANY PLOTTER or XY table by sending a special utility to Acrobat Distiller. Here is a three-inch circle example. See www.tinaja.com/flut01.html for full details.

fiendish"? Contact me via e-mail at don@tinaja.com should you want to play with any of this neat stuff. Or see www.tinaja.com/bargos01.html.

Some GPS Books

GPS is an acronym for the Global Positioning System, a collection of 24 wandering satellites that give you navigation, altitude, time, and speed information anywhere in the world to 80-foot accuracy with lower-cost techniques. Fancier schemes let you hit aircraft-landing precision and sub-centimeter surveyor accuracy.

I've gathered together a listing of some of the better GPS books for you as this month's resource sidebar. Tutorials on GPS can be found in www.tinaja.com/resbn01.html and at www.tinaja.com/glib/resbn90.pdf.

Updates

A curious update to last month's column on hot-tub economics: Most conventional hot-tub thermometers have a large thermal slug in them to prevent their temperature changing much while you're reading them. The fifteen minute or so delay can cause underreporting during warm-up. If you do not allow for this, the tub may appear to do its last few degrees of heating much faster than you'd expect and may overheat.

Also, the SETI-at-home project seems to be smashing most records for distributed computing. As of this writing, twenty millennia (!) of prime computing time has been devoted to this project. As we saw last month, you can participate or pick up details at setiathome.ssl.berkeley.edu/stats/totals.html.

New Tech Lit

From Standard Microsystems comes a new CD-ROM product catalog that focuses on local-area networking, data communications, and I/O controllers. New from Hewlett Packard is their latest Test and Measurement catalog. From Physik Instrumente, there's a catalog on piezo and other micropositioning mechanisms. From Pericom, comes application notes on their bus switches, with emphasis on video switching applications.

USGS topographic maps are finally free online at greenwood.cr.usgs.gov. Many of these are newly available in Acrobat PDF format. Low-cost collections of maps on CD-ROM are offered by Tom Oliver's Map One at, of all places, www.mapone.com.

From SiRF Technology there's a white paper on their new GPS technology that seems to effectively solve certain "urban canyon" problems.

By way of Dan Michael's Oricom Technologies, there's an assortment of One Hour Protoboards. These seem well suited for most PIC and similar-size projects. A number of ready-to-go designs are also available on their www.sni.net/~oricom Website.

Free samples of sleeving and heat shrinkable tubing are offered from INSULTAB. A free graphic-instrument programming LabVIEW Evaluation Package is available from National Instruments.

Our featured trade journals include *Security Systems Integration* plus *Vacuum & Thin Film*.

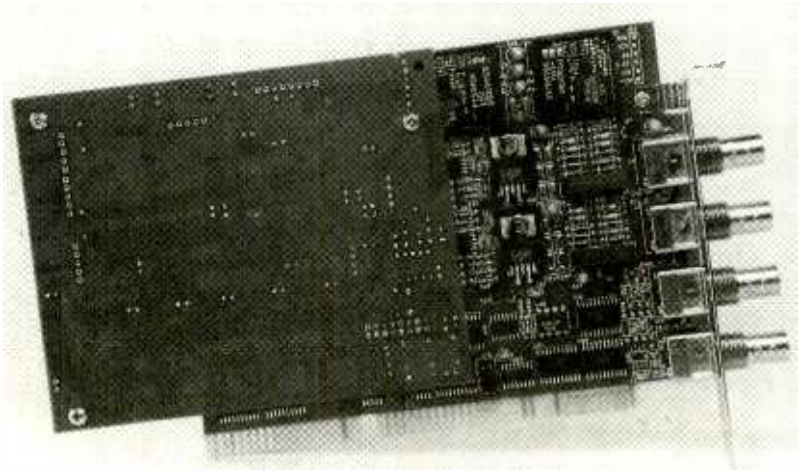
The latest "new-old" books from Lindsay Publications include *Early Die*

(Continued on page 85)

1. Seek exact horizontal and vertical pixel locking.
2. Reduce, eliminate, or crowd all muddy shadows.
3. Avoid retouching lettering. Replace if needed.
4. Brighten and sharpen selectively. Do not oversharpen.
5. Invent fine detail from scratch when appropriate.
6. Consider scratch 3×5 and 5×7 antialiased lettering.
6. Work in pieces for maximum sharpness and convenience.
7. Use symmetry and duplication to ease repetitive work.
8. Do all experiments and detail work on the side,.
9. Mirror any scanner "Barney Oldfield" effects.
10. Pick your shadow directions very carefully.

FIG. 4—MY SECRETS for improving scanner "photographs."

Arbitrary Waveform Generator



CIRCLE 20 ON FREE INFORMATION CARD

THE PCI-344 DUAL-CHANNEL ARBITrary Waveform Generator combines the performance of advanced stand-alone generators with the convenience of the personal computer, and it occupies one PC expansion slot. It is designed for test and production engineers building instrument sets for communications, video, ATE, process control, power line disturbance tests, laser positioning, frequency response analyzers, power supply testing, and component testing.

The unit provides 0.01% frequency accuracy, three selectable output filters, independent gain and offset controls, and software functions for nine standard waveform shapes. Waveforms can be created using the Waveform Builder in the included *BenchTop* software; they can be imported from spreadsheets or math programs; or they can be transferred from one of the company's oscilloscope cards. Waveform editing is also provided via the mouse or a text entry dialog box.

The PC-344 provides an on-board waveform memory sequencer that creates complex waveform sequences by looping and linking memory segments. Each step (up to a maximum of 255) in a sequence can address a memory segment and can repeat the segment from 1 to 32,767 times.

Two new features that are very useful are the Loop Unit Trigger Mode and the Multi-Sequencer Mode. The Loop Unit Trigger Mode loops on one waveform segment indefinitely until a trigger event is recognized. The Multi-Sequencer Mode provides storage of 16 different sequences, and the sequence number can be changed by the PC or by an external event, thereby providing interactive waveform generation useful in creating digitally modulated communications signals.

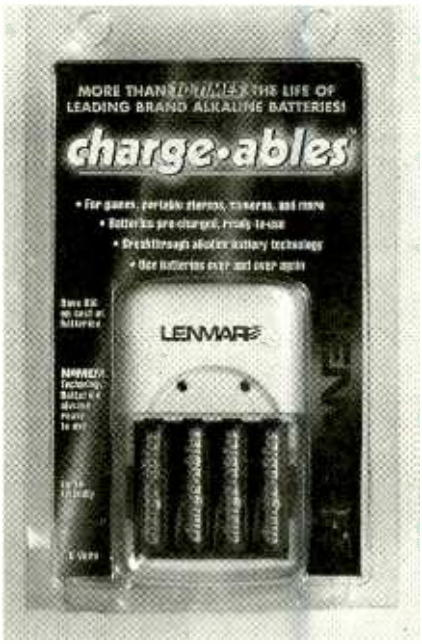
Complementing the extensive memory control features are a suite of high-performance analogy specifications: 12 bits of vertical resolution at rates up to 50 million samples per second, output amplifiers with 24 volts peak-to-peak, standard memory of 32,000 samples/channel, and DDS-based internal and external clock sources.

The PCI-344 Dual-Channel Arbitrary Waveform Generator has a suggested retail price of $2495.

PC INSTRUMENTS, INC.
526 South Main Street
Akron, OH 44311
Tel: 330-762-8500
Fax: 330-762-8855
Web: www.pcinstruments.com

Rechargeable Alkaline Battery

The Charge•ables line of rechargeable alkaline batteries supplies power 20 to 30 percent longer per charge than other rechargeable alkaline batteries, according to the manufacturer, thank to their advanced RAM (rechargeable alkaline manganese) technology. Charge•ables provide a full 1.5-volt capacity, unlike NiCd rechargeables, which only operate at 1.2 volts. They can be fully recharged at any power level over and over again—more than 25 times. In fact, the more frequently they are charged, the longer they'll last. Their slow discharge rate also assures that the batteries retain their full power even if left unused in a device for months.



CIRCLE 21 ON FREE INFORMATION CARD

Charge•ables are especially suited for use in high-tech consumer products such as cell phones, portable CD players, portable games, remote controls, beepers, pagers, and toys. The system includes AA and AAA size batteries, plus two AC chargeable charging stations. The CH2 is a two-cell capacity charger, and the CH4 has a four-cell charging capacity, with a flip-up/flip-down AC plug.

The Charge•ables are available in several configurations: as charging stations with batteries in either 4 Cell AA/AAA Chargepal with 4 AAs or 2 Cell AA/AAA Chargepal with 2 AAs; or as batteries only in either AA/AAA 4-pack

or AA/AAA 2-pack. The suggested retail prices are $24.95, $14.95, and $6.95 and $3.95, respectively.

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31328 Via Colinas, #102
Westlake Village, CA 91362
Tel: 800-424-2703 or 818-879-2700
Fax: 800-336-2703 or 818-879-2703
Web: www.lenmar.com

Computer Monitor Training Course

The Advanced Computer Monitor Service Training CD-ROM (TC100CD) contains 11 sections partitioned around the major circuits of a computer monitor. Each section delivers theory information, defect symptoms, practical troubleshooting guides and tips, plus alignment procedures. The material is geared specifically for beginning, intermediate, and advanced service technicians; and it can be immediately applied on the bench.

CIRCLE 22 ON FREE INFORMATION CARD

The course teaches fast, efficient computer monitor repair and servicing techniques, using practical troubleshooting knowledge. The TC100CD comes complete with section checks and tests to track the learning progress of the technicians. Topics include: safety, scan frequencies, pixels, blanking times, switch mode power supplies, vertical deflection, horizontal deflection/high voltage, sync, video amplifiers, CRT circuits, component testing, and more.

The Advanced Computer Monitor Service Training CD-ROM (TC100CD) has a list price of $495.

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3200 Sencore Drive
Sioux Falls, SD 57107
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Fax: 605-339-0317
Web: www.sencore.com

Microwave Alarm

The MicroAlert Radio/Microwave Alarm is ideal for trying to find out what's emitting microwave or radio signals, whether in hiding or in plain sight. It detects cellular phone towers, analog/digital cell phones, and microwave ovens (in use). As you move closer to the radio/microwave source, the beep tone sounds more frequently, ultimately becoming a solid tone.

CIRCLE 23 ON FREE INFORMATION CARD

The top switch powers the unit and selects the sensitivity level. It chirps once when powered on to indicate that the battery is good. The side control raises or lowers the sensitivity selected. Compact enough to easily fit into a shirt pocket, the alarm is the size of a small pager (2.25 by 1.6 by .75 inches) and comes with a 3-volt lithium coin battery and a pocket clip.

The MicroAlert Radio/Microwave Alarm costs $81.50, plus S & H.

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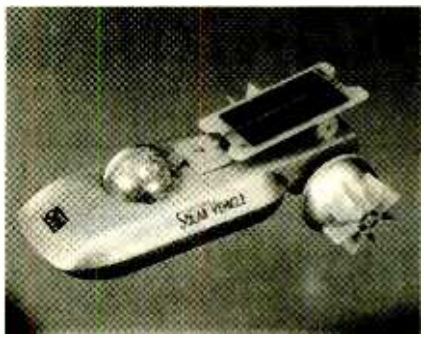
Amphibious Solar Vehicle

The Amphibious Solar Vehicle kit teaches and introduces the fundamentals of solar power through hands-on experiments. Hobbyists and kids of all ages can discover the world of alternative energy by learning what materials solar batteries are made from, characteristics of solar batteries, and advantages and disadvantages of solar.



CIRCLE 24 ON FREE INFORMATION CARD

The Amphibious Solar Vehicle kit has a suggested retail price of $39.95.

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TECH MUSINGS

(continued from page 83)

Casting and *Hot Air Engines Vol 2*. For fast access, click the banner on my Website. A new engineering book catalog is available from Butterworth Heinemann. Instant information on bunches of books that I've personally recommended is up at www.tinaja.com/amlink01.html.

For all the fundamentals of digital integrated circuits, check into my *CMOS* and *TTL Cookbooks*, either by themselves or as part of my bargain priced Lancaster Classics Library as per my nearby Synergetics ad.

Some of the really wild new stuff up at www.tinaja.com/barg01.html now includes hospital-grade physical therapy machines, premium-quality flags from odd countries you never heard of, precision airflow meters, several superb pressure and humidity sensors, immersion thermocouples, and great heaping bunches more. Catalogs about our products and services can be downloaded directly from www.tinaja.com/synlib01.html.

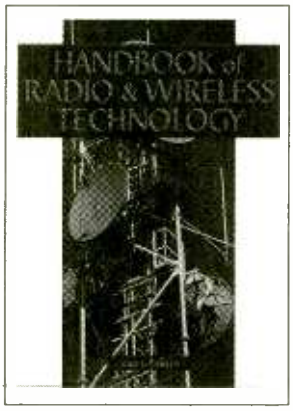
As usual, most of the mentioned items are in our "Names and Numbers" or "GPS Books" sidebars. A no-charge US technical help line is offered per the nearby box. Be sure to include your e-mail address if you expect a personal reply. Let's hear from you.

NEW LITERATURE

Handbook of Radio & Wireless Technology

by Stan Gibilisco
McGraw-Hill
1221 Avenue of the Americas
New York, NY 10020
Tel: 800-2MCGRAW
Web: www.tabelectronics.com.
$49.95

A comprehensive, plain-English compendium on the entire field of radio and wireless technology, this book contains more than 1000 concise articles. It provides blanket coverage of one of the fastest growing areas in communications.



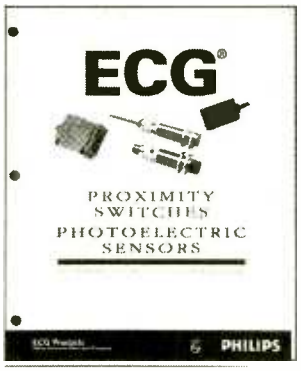
From antennas and transmission lines; to analog and digital modulation techniques; to satellite, space, and laser communications; this handbook can help readers master terminology, understand technology and theory, and form an overview of specific topics or the entire field—including new trends and developments. With hundreds of clarifying illustrations, tables, and charts, and extensive cross-referencing, this sourcebook is ideal for both professionals and hobbyists.

Proximity Switches & Photoelectric Sensors (ET-2869)

from Philips ECG
1001Snapps Ferry Road
Greeneville, TN 37744
Tel: 800-526-9354
Web: www.ecgproducts.com
Free

This catalog features 51 proximity switches and 23 photoelectric sensors. Inductive proximity switches are precision, solid-state, metal-sensing devices that are capable of sensing at distances from 1.5mm to 15mm. Available in four sizes and several styles, the switches operate from 10 to 30 volts DC and 35 to 250 volts AC, and they will switch from 10 Hz to 1000 Hz.

Photoelectric sensors are ideal for

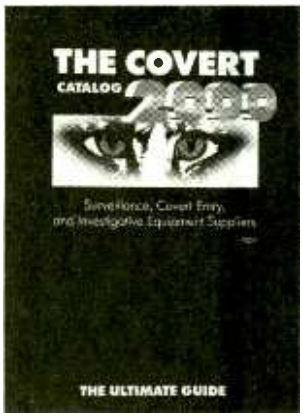


applications requiring precise "no-touch" detection of objects, ranging from solid to opaque and even to transparent items. Sensors are available in thru-beam types, with ranges up to 32 feet; self-contained reflective types with a range up to 16 feet; and fiber optic types for sites where space is limited.

The Covert Catalog 2000

from Intelligence Incorporated
3555 South El Camino Real, #309
San Mateo, CA 94403
Tel: 650-559-0020
Fax: 650-728-0525
Web: www.intelligence.to
$34.95

Because you never know when the need for a cell phone interceptor (or neutralizer), laser eavesdropping system, phone tap, or room bug will arise, this up-to-date, hands-on supplier and source guide has come to the rescue. Its more than 200 pages are dedicated to the procurement of products, such as electronic surveillance equipment, covert video cameras and transmitters, electronic tracking systems, and computer surveillance and remote viewing devices. This catalog contains items that are not available elsewhere, including receivers and code grabbers.

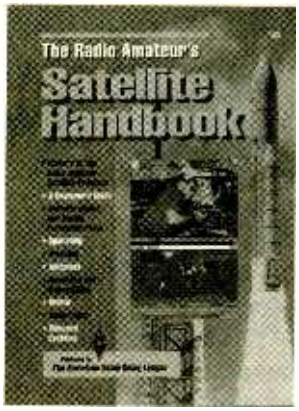


It features exact addresses and ordering information on suppliers in the U.S., Canada, Germany, Japan, Russia, Taiwan, Peoples Republic of China, The Netherlands, United Kingdom, and Korea.

Radio Amateur's Satellite Handbook

by Martin Davidoff, K2UBC
American Radio Relay League
225 Main Street
Newington, CT 06111-1494
Tel: 888-277-5289
Fax: 860-594-0303
Web: www.arrl.org
$22

Aimed at ham radio operators who want to contact other stations through orbiting spacecraft, this is a comprehensive and informative handbook. Its fifteen chapters cover tracking, station equipment and antennas, and operating tips and techniques. The unique aspects of the analog and digital ham satellites and complete details on current and future satellites, including AMSAT's Phase 3D, are discussed. In addition, the handbook also covers the SAREX (U.S. Shuttle amateur in space) program and opera-



tion from the Mir space station.

Appendices provide useful information on spacecraft history, profiles of active satellites, Internet sites, relevant FCC regulations, and graphic tracking aids. There are also sample problems that involve satellite orbits and tracking.

Electronics Components Catalog

from North American Capacitor Company
7545 Rockville Road
Indianapolis, IN 46214
Tel: 317-273-0090
Fax: 317-273-2400
Web: www.nacc-mallory.com
Free

This 268-page, fully illustrated, customer-friendly, catalog features the

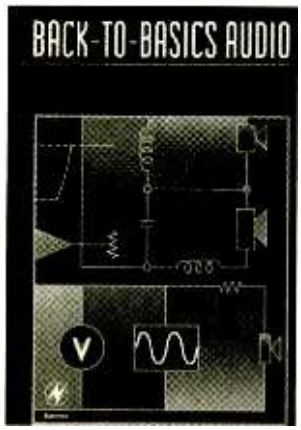
complete product line, as well as application and technical information. An extensive table of contents and a complete product index arranged alphabetically by type make it easy to locate specific product categories. Included among the new products are extended range, hermetically sealed wet tantalum electrolytic capacitors, long-life and non-polar axial leaded aluminum electrolytic capacitors, and numerous radial-leaded and surface-mount DC film capacitors, as well as a wide variety of transducers, indicators, and sirens.

There is an extensive lineup of sound devices, including the Sonalert and Sonalert II product lines. In addition, DC voltage rotary fans, control products, and hardware are also covered. Each product type includes a photo and/or drawing, product specifications, and a variety of charts and tables. A technical information section with cross-reference charts and conversion charts, completes this comprehensive catalog.

Back-To-Basics Audio

by Julian Nathan
Newnes, Butterworth Heinemann
225 Wildwood Avenue
Woburn, MA 01801
Tel: 800-366-2665 or 781-904-2500
Fax: 800-446-6250 or 781-904-2620
Web: www.bh.com/newnes
$39.95

Written for hands-on technicians and



others who want to learn the basics of audio and electrical principles without taking a college course, this is a thorough and approachable handbook on audio theory, practice, and allied electrical theory. The subject is audio and how systems are put together and calibrated. A basic idea of how things work is also given to enable the reader to make loss path, passive equalizer networks, power supplies and relay systems—the interface and support units for the major parts of a sound system.

Chapters on drawing and construction show how to design racks and panels, understand complex systems, prepare working diagrams, and communicate design ideas. Aspects of movie soundtrack recording, signal processing, and acoustics are discussed in detail. EN

ANTIQUE RADIO

(continued from page 25)

Save Those Radio Verifications!

Radio verifications, or QSL cards, are mailed out by broadcast and shortwave stations to acknowledge reception reports sent by radio listeners. QSLs are also routinely exchanged by radio amateurs to document contacts they have made. Many collections of QSL cards are misplaced or discarded when their owners pass on or leave the hobby. This is unfortunate because QSLs are not just souvenirs of individual accomplishments, but also represent important documentation of the history of radio.

The Committee to Preserve Radio Verification is an official committee of North American Radio Clubs (ANARC)—which was founded in 1964 as a unifying organization for radio-listening clubs in the US and Canada. It is a five-person group whose goal is to preserve QSLs belonging to hobbyists who are no longer active. The CPRV collection is part of the Broadcast Pioneers Library of American Broadcasting located at the University of Maryland. This library, devoted exclusively to the history of broadcasting, also contains a wide-range of other materials, including recordings, books pamphlets, periodicals, photographs, and scripts.

The current collection includes many thousands of QSLs, principally from shortwave and medium wave broadcast stations. There is a computerized index, with all QSLs fully identified with their original owner. If you are interested in donating a collection for preservation by this organization, contact Jerry Berg, Chairman CPRV, 38 Eastern Ave., Lexington, MA 0241; Tel: 781-861-8481. CPRV also has a "registered collections" program for those who wish to donate at a later date. Stickers are provided to be pasted into the QSL albums identifying CPRV as the eventual recipient. EN

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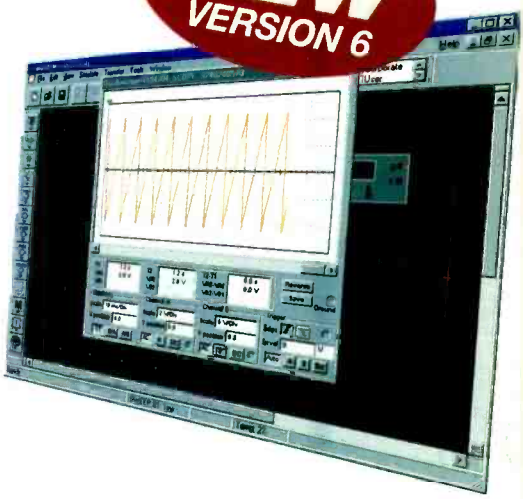

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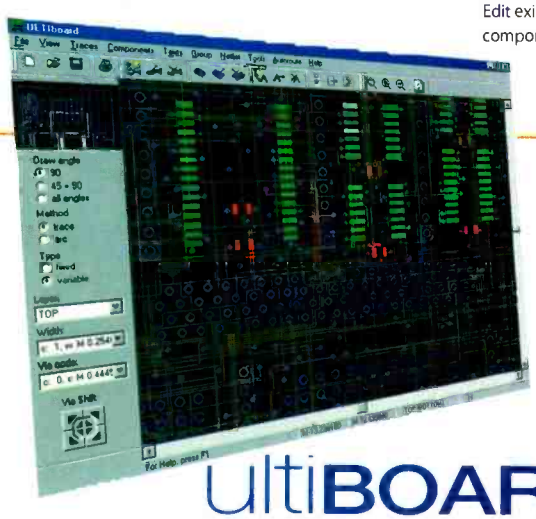

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