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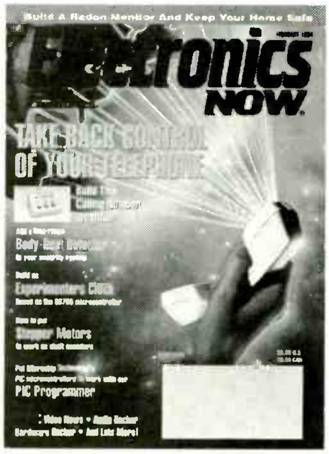

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WHAT'S NEWS

A review of the latest happenings in electronics.

Digital Dolby comes home

Dolby Laboratories (San Francisco) and Zoran Corporation (Santa Clara, CA) introduced integrated circuitry that they say is a giant step toward including Digital Dolby Surround Sound in consumer home-theater equipment. Their programmable, fixed-point, digital signal processor (DSP) and a related family of ICs are intended for installation in various types of audio and speech equipment.

Zoran's ZR38000 is the only single-chip DSP capable of encoding and decoding six-channel audio processed with Dolby's AC-3 low bit-rate surround-sound algorithm. It will be installed first in Dolby Laboratories' professional theater decoders. Consumer products that include the chips are expected to reach the market sometime during 1994.

The ZR38000 has a general-purpose register file, unified data address registers, single memory address space, and large on-chip memory. It is said to be easily programmable. Dolby's licensees can add custom features in addition to AC-3 decoding. The DSP is priced less than $25 each in large quantity purchases.

The first two user-programmable DSPs to be offered will be the ZR38000 and the ZR38001. They are intended for applications that need relatively large off-chip program or data memories, or for systems that permit the customer's programs to be incorporated into the on-chip ROM. The ZR38000 offers 8K words of program/coefficient ROM and 2K words of RAM for data storage.

The ZR38001 offers a 1K word on-chip program RAM, 2K words of on-chip data-storage RAM, and a 1.5K word ROM for coefficient storage. No external memory other than a single EPROM is needed to use the device.

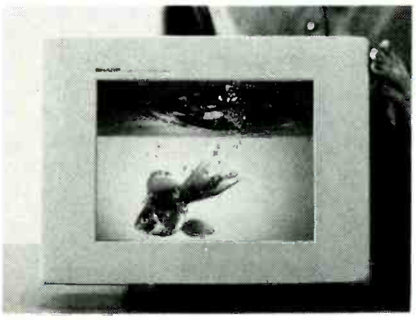
The two companies also announced three application-specific ICs and development software. The ZR38500 provides six-channel AC-3 decoding for home theater products, and the ZR38501 provides two-channel Dolby AC-3 decoding for cable television and computer multimedia. Both of the ICs can also perform Dolby Pro Logic decoding.

The ZR38511 is optimized for two-channel audio decoding for computer multimedia and CD-ROMs. The ZR38000 assembler, linker, and simulator software package gives the programmer with a Windows-based computer tools for developing and debugging algorithms written in ZR38000 assembly language.

Multimedia LCD panel

A liquid-crystal display panel that is compatible with multimedia has been introduced by Sharp Corporation (Osaka, Japan). It is capable of displaying text, graphics, and both broadcast and pre-recorded video images. Those images can be obtained from such sources as television, VCRs, and laser discs. Sharp expects the LCD panels to find applications in various equipment including business presentation systems, security monitors, and video-conferencing systems.

The 10.4-inch active matrix LC-10V1 display will display 24-bit color, which can form more than 16 million hues, the present industry maximum. The LCD panel's low-reflecting front face reduces ambient light glare to one-tenth the value of earlier Sharp products. This is said to permit relatively glare-free viewing even when viewed in brightly lit rooms.



Sharp's multimedia-compatible color liquid-crystal display panel displays video images as well as text and graphics.

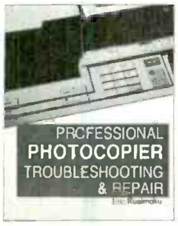
The LC-10V1 is compatible with, and can be connected directly to, Macintosh LC, II, and Quadra series personal computers, IBM PCs, and other makes. A microprocessor built into the display performs automatic centering, calibration, and screen control. In the RGB mode, it can automatically adjust for off-center images and for the variations in analog output levels expected from different PCs.

An on-screen, menu-driven display allows the user to set variables including switching between RGB and video inputs, selecting the PC display mode, adjusting the RGB level/gain, and controlling the serial port.

Hams in Nobel company

A 1993 winner of the Nobel Prize for physics credits much of his success in science to his participation in amateur radio. The winner, Dr. Joseph H. Taylor, K1JT, of Princeton University, said that he developed many of his scientific skills as an amateur radio operator while a student at Moorestown Friends Academy in New Jersey.

Dr. Taylor went on to earn a bachelor's degree from Haverford College and a doctorate in astronomy from Harvard University. He shared the Nobel Prize with Princeton colleague Dr. Russell A. Hulse. The physics prize was granted to the pair of scientists for their study of the gravitational forces exerted by pulsars. The results of their study are said to confirm the predictions of Einstein's General Theory of Relativity. Ω



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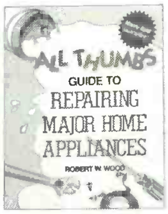

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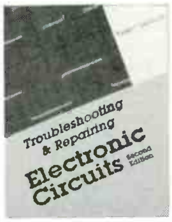

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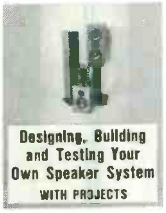

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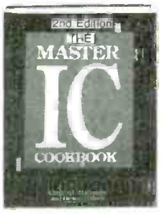

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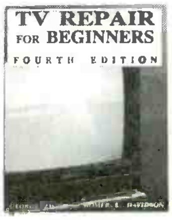

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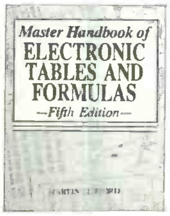

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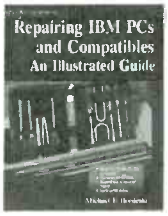

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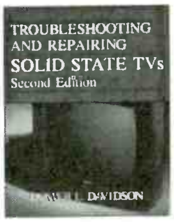

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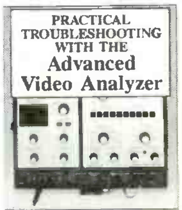

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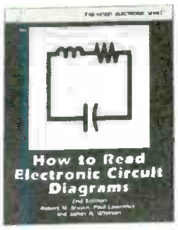

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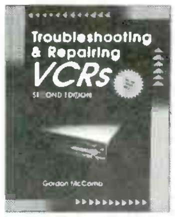

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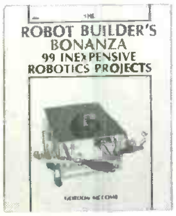

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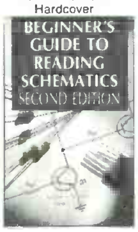

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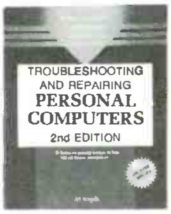

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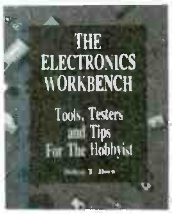

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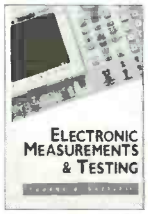

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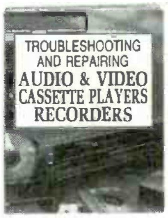

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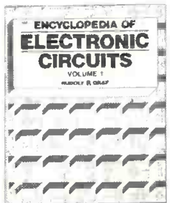

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VIDEO NEWS

What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• **For HDTV compatibility.** Still another change in the proposed parameters for high-definition television has been approved by the FCC's Advanced TV Advisory Committee (ATAC). ATAC approved an increase to 1080 active lines from the previous 960. That change is designed to enhance compatibility with computers and increase the likelihood that Europe and Japan will adopt compatible systems. Japanese broadcasting authorities, now transmitting an analog system of 1035 active lines, have already indicated a willingness to switch to 1080 lines when they adopt a digital system, and there is an indication that Europe will seriously consider dropping from 1125 active lines to 1080.

The ATAC also approved a proposal to permit both interlaced and progressive scan. Although that will increase receiver cost initially, it appears to be necessary because of the current unavailability of progressive scan technology and components. For digital audio, ATAC approved the incorporation of a Dolby system. The new moves will result in a four- to five-month delay in the testing schedule, with testing probably to start next October instead of June. The eventual goal is to allow the broadcasting of the 1986 Olympics from Atlanta in HDTV.

• **Million HDTV's in 1996.** Zenith Chairman Jerry Pearlman thinks that the American public will buy between one and two million HDTV sets in 1996, the first year of their availability. That is a far more optimistic view than has been expressed by other industry members, who have pointed out that it was 10 years from the start of color TV broadcasting to the first million-set year. In addition, Pearlman forecast that 10% of American homes would have HDTV four to five years after introduction.

Despite their added cost, Pearlman cited the versatility of HDTV sets, which should be able to provide at no charge many services for which consumers now pay. Among those enhancements are elimination of the $200–$300 cost of a digital cable box and a $50 digital data recorder, the existence of a built-in video adapter for the audio CD player, the capability of acting as a video telephone, and the incorporation of a deluxe digital audio system.

• **CD-ROM at Blockbuster.** If there was any question that CD-ROM has arrived as a successful medium, it was dispelled when the world's biggest video retailer, Blockbuster, announced plans to sell and rent digital interactive hardware and software. The company is now testing various types of interactive systems at its 52 stores in the San Francisco area, and plans to go nationwide after analyzing the results of that test. Blockbuster is renting software for IBM and Macintosh PC's and 3DO, CD-I, and Sega CD multimedia systems. Itis renting the hardware for the last three.

Blockbuster charges $4 for a three-evening software rental, and gives renters a $5 credit toward the future purchase of a program. Equipment rental at $19.95 includes three software titles along with the player. Blockbuster has been testing rental of CD-I hardware and software in 100 stores for the past year.

• **Who'll make the box?** Be prepared to witness a battle royal over the future home terminal in the digital age. With digital transmission of video on demand, video telephone service, and computer data over the so-called "information superhighway," computer, semiconductor, TV, cable-equipment, telephone, and video-game manufacturers will be vying to supply the consumer equipment. Each of those groups probably has some claim to the right to sell (or rent) the equipment.

Some cable-TV equipment manufacturers insist that the "TV set" of the future will be nothing but a box with a picture tube and a few video circuits. The idea, of course, is for cable systems to rent all of the additional reception equipment to consumers' homes. Having been stung in the past by exorbitant cable fees, consumers might feel wary of entrusting cable operators to supply virtually all of their equipment.

At the other extreme is the TV-set manufacturer, who naturally doesn't want to be relegated to the position of making nothing but a "tube in a box." TV manufacturers say that they hope to supply self-programming digital terminals, which can adapt to virtually any system entering the home. For scrambled programs, they hope that dealers or cable operators eventually will supply plug-in smart cards to decipher pay programming.

• **Apple enters TV.** Already the lines between computers and TV sets are blurring, with TV boards now available for many computers. The boldest stroke yet is Apple's Macintosh TV, which is a cross between a TV and a computer—or a combination of both. However, there's very little interaction between computer and TV sections—the computer can't be used to edit home videos, for instance. It can freeze a TV frame or it can let the user listen to TV sound while computing, but that's about it. It's hard to figure out the purpose of a Macintosh TV, but Apple suggests that it might be useful in crowded college dorm rooms where there's not room for both a TV set and a computer.

Is it possible that as a next step, a major TV manufacturer will bring out a computer with a 60-inch projection screen. Useful, maybe, for processing very long words or displaying very w-i-d-e spreadsheets. Ω

Q & A

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PARALLEL PROCESSING

I've heard a lot of talk about parallel processing in computers but I'm not sure exactly what the term means. Does it refer to a lot of stand-alone computers working on different parts of one problem at the same time, or does it mean something else?—F. Boffer, Procon, NY

Parallel processing is really not a new idea. Mainframe computer users are showing new interest in parallel processing because they are rapidly approaching a limit to the speed and processing power that can be obtained from a single central processor manufactured with existing technology. There have been incredible advances in microelectronic component density and in IC chip technology. However, when you are at the point where the width of internal IC traces are measured in terms of electron dimensions, you're up against a pretty formidable obstacle.

Your notion of parallel processing is correct in that it refers to the idea of having several microprocessors working on the same problem at the same time. However, those microprocessors are not the kind that you'll find inside a home computer, but specially designed RISC (reduced instruction set computer) chips. For an example of how RISC works, consider an Intel 386-based computer with a 387 numeric coprocessor. There's no reason to have the 386 do any floating point calculations because the 387 can do them. To go a step further, any of the 386's instructions intended specifically for floating-point calculations could be removed from the instruction set, simplifying it and making the chip more efficient.

To put parallel processing in perspective, back in the old Apple II days, you would add an 80-column card to expand the video display. An 80-column card had a dedicated microprocessor that handled all of the video memory. Since both the 6502 on the Apple's motherboard and the 6845 on the 80-column card had access to the same (video) memory, this was a "shared memory system"—one of the two main types of parallel processing architecture currently in use.

The second road being explored is a "distributed memory system" in which each microprocessor has its own array of memory and can, if the need arises, access any element of any other microprocessor's memory array.

The advantage of a shared memory system is that it's much easier to write the software needed to have each dedicated microprocessor work on that part of the problem for which it was designed. The difficulty with this setup is that the speed of the entire system is limited by the hardware network that connects it together. This limitation is similar to the one designers are confronting with single microprocessor computer designs.

In a distributed memory system, each microprocessor has its own set of memory, so the hardware problem is reduced. However, the software needed to let any microprocessor access any memory array in the system is incredibly complicated.

Most of the major computer manufacturers recognize the inherent limitations of a single-CPU computer design, and are experimenting with the idea of parallel processing for future machines. The final design will probably be some compromise between the two basic arrangements of memory and hardware. As things stand now, parallel processing is slowly creeping into the PC market. All the so-called "video accelerator cards" are smart cards with their own microprocessors—and the same is true of disk-controller cards. It's only a matter of time before the main processor is reduced to the role of a high-speed controller whose main job is to coordinate the activities of other special-purpose microprocessors on the motherboard.

FAN SHUT-OFF

I have a wood-burning stove with a fan that blows hot air. My problem is that when the stove cools off, the fan keeps blowing. Is there any simple solution that will turn the fan off when the stove cools down?—J. Rego, Pickering, Ont

I had a similar problem and spent several hours at the bench to arrive at a simple solution. It's not a terribly complex design problem, and I had a few possible approaches worked out on paper when my wife came up with the best one, which I used immediately.

Sometimes working on a problem and breaking it down to smaller parts blinds you to the obvious. The easiest and best way to handle your problem is to do exactly what I did—install a thermostat to control the fan. Any store-bought thermostat is designed to open and close a relay at a settable temperature, and that's exactly what you want to do.

The chances are that your fan motor is not the best designed piece of electrical machinery in the world, so rather than having the thermostat control the fan directly, it's a good idea to have it control a relay that will turn the fan on and off.

There are three other advantages to using a thermostat. The first is that it can be located anywhere you want in the room, and you can use very thin wire to connect it to the relay that's mounted near the motor. The third reason, more important to my wife, is that the thermostat isn't an eyesore.

DANGEROUS CLEANER

I have a small digital radio with pushbutton presets. When one of the buttons stopped working, I sprayed it with tuner

cleaner, but I oversprayed and now some of the elements of the LCD display aren't working. I've tried drying it with a hair dryer and other less direct methods but nothing has worked. Any ideas?—J. Brown San Mateo, CA

I hate to tell you this, but I think the problem is not that something is keeping the display from working, but that it's been damaged permanently by the spray. A similar thing happened to my friend's VCR controller and we spent uncountable hours trying to fix it. I found that the tuner cleaner he used was also a lubricant, and while the cleaner solvent evaporated pretty quickly, it left a residue of lubricant which, as you might suspect, was also a conductor. Even though we dried the unit before putting the batteries back in, the remaining lubricant caused shorts between some of the LSI chip pins, and when we turned it on, the display blinked a few times and then disappeared into hyperspace.

The VCR controller was toasted, but the important lesson here is that if we had cleaned off the lubricant before applying power no damage would have been done. While I don't hold out a lot of hope for your radio, it's probably worthwhile to see if there's any residue from the cleaner hiding between the pins of either the display or the IC that's controlling it.

The high price paid for designing the radio to sell for a low retail price is the old warning "No user serviceable parts inside." That warning is more important now than it ever was. This is why it's usually cheaper to replace a unit of consumer electronics rather than have it repaired.

Ni-Cd RESISTANCE

Can you suggest a simple circuit that could measure the internal resistance of a Ni-Cd battery?—T. Ng, East Irvine, CA

I can't imagine why you would want to do something like this and, to tell you the truth, I've never thought much about it. While the cell's internal resistance is one of the parameters given by the battery's manufacturer, I suspect it's a value that's measured indirectly rather than by doing something like putting an ohmmeter directly across the battery terminals (and possibly destroying the meter in the process).

If I wanted to know the internal resistance of the battery, I believe that the best way to measure it is to put a known load across the terminals, measure the voltage and current, and then use Ohm's law to calculate the total resistance of the circuit. Once this is done, the battery's internal resistance could be determined by simply subtracting the measured load from the total circuit resistance.

You could check the results indirectly by measuring the battery's voltage while it's under load, and using that number, along with the current flow, to determine the cell resistance.

Ni-Cds aren't cheap, so before you start messing around with them it's a good idea to contact a Ni-Cd battery manufacturer and ask him for some advice as well. I'll bet that what you'll hear is either that you need specialized equipment for the job or that there's a standard load figure you have to use. Ω

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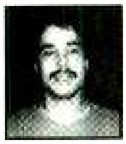

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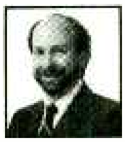

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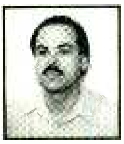

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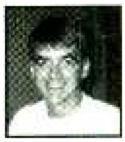

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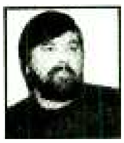

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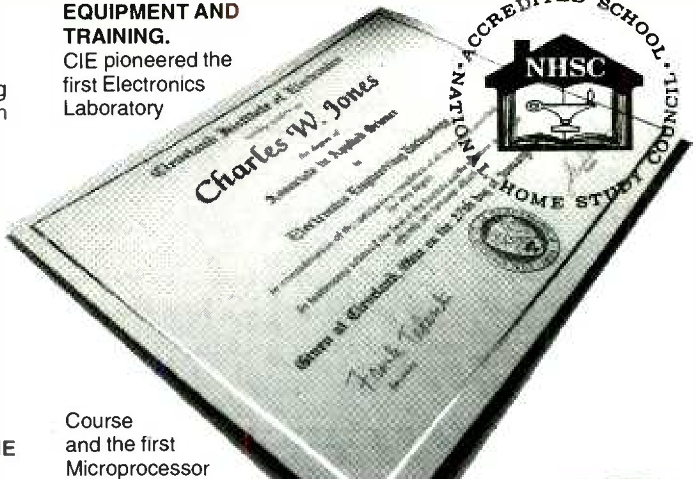

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TELEPHONE RING AMPLIFIER

In *Q&A* (**Electronics Now**, Page 12, September 1993), M. Mitchell of Kansas City was looking for an amplifier circuit that would boost the ring level on a telephone. However, the answer published did not include a circuit that a reader could build to perform that very same function.

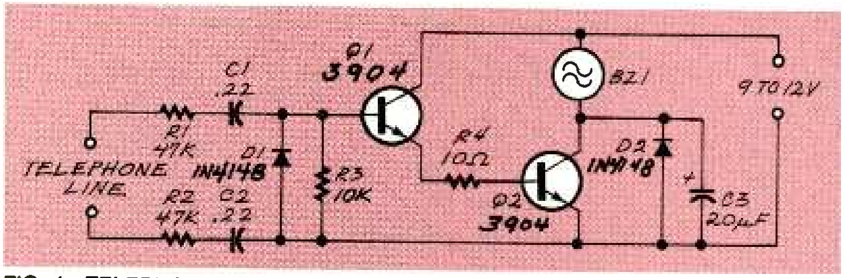


FIG. 1—TELEPHONE "BELL" amplifier circuit will let you hear (or see) an enhanced alarm if you are away from your telephone.

I designed the amplifier circuit shown in Fig. 1 so that I could hear my phone "ring" in my back yard. My "bell" is actually a horn of unknown origin that I found in my junk box. The power supply for this circuit can be any off-the-shelf 9- to 12-volt, 0.250-ampere wall outlet adapter.

If a higher powered signal is required, a relay or an optocoupler with a triac output can, with care, control a 120-volt AC horn, light, or both, replacing my "bell."

D.A. Butch
Tallahassee, FL

TESLA DEFENDED

I see that Don Lancaster continues to denigrate Nikola Tesla's. name. In a past column he referred to Tesla as a "lousy theoretician," and in the September 1993 column of *Electronics Now* he labeled Tesla "a superb con artist."

It appears that Lancaster paints all organizations with any connection to Tesla with one large, black paint brush. In one of his past columns, he listed our group, the Tesla Coil Builders Association, under "Resources at the Fringe," while in another we appear under "Free Energy" resources.

The Tesla Coil Builders Association is by no means a *fringe free-energy* organization. We resent these comments which, if directed at a living person, would be grounds for a libel suit. We request that Lancaster refrain from listing our group in future columns and that, if he does, our name be deleted before publication.

Judging from his bias on the subject of Tesla, I assume that Lancaster is unaware of tributes made to Tesla by such American electronics pioneers as Edwin H. Armstrong, John S. Stone, and L. W. Austin. In addition, his work was much admired by the French communications pioneer E. Girardeau and the German radio expert A. Slaby.

It is important that your readers be aware of the wide appreciation of Tesla's work and not be influenced by Lancaster's distorted opinions that were apparently formed in hindsight with a lack of knowledge.

HARRY GOLDMAN
Tesla Coil Builders Association
Queensbury, NY

LIGHTNING CONTROL UPDATE

On page 12 in the August 1993 *Q&A* column of **Electronics Now**, Fig.1 shows two simple circuits to that will debounce mechanical switch contacts—one with a positive and the other with a negative output pulse.

As a laboratory teaching assistant for a digital design class, I have seen those circuits in several textbooks. However, when my students actually built them, they failed to do what they were supposed to do—semester after semester. Moreover, when I built the circuit myself, it still did not work.

Figure 2-*a* is a copy of the earlier circuit, but the circuit shown in *b* is one that I designed. After building and testing it, I found that it works well.

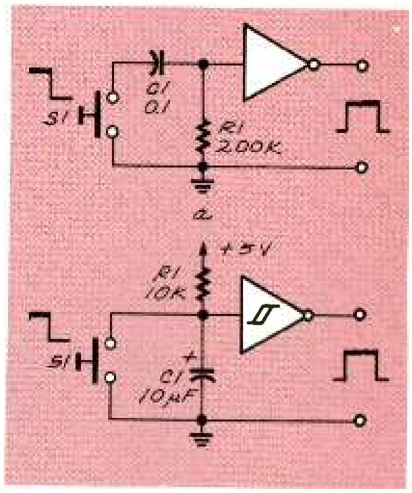


FIG 2—CONTACT DEBOUNCERS revisited. The switch contact debouncer circuit *a* appeared in the August *Q&A*. However, a reader reports that the Schmitt-trigger version shown in *b* really works.

The new circuit is similar to the one shown in *a* in that it uses the same filtering principle. However, in place of the inverter logic shown, it has a Schmitt trigger inverter (such as a TTL 7414), which helps to prevent retriggering from switch-contact bouncing.

K. F. YEE
Raleigh, NC

SOURCE CORRECTION

The article "The Photoresist Method" (**Electronics Now**, December 1993) listed *Skychaser* as a source in a list of circuit board manufacturers that provide prototyping and full production services for boards with up to 16 layers. We wish to advise you that Skychaser has changed its name to *Computerese*, and it has moved to 675 Sterling Drive, Charleston, SC 29412. The new phone number is 803-762-4809. We would like to apologize for any inconvenience that might have been caused by publishing an outdated name and address.—Editor

STORMY WEATHER

There were a few errors that found their way into my Weather Station article that appeared on page 40 in the November 1993 issue of **Electronics Now**.

First, I provided the wrong number for rain-gauge calibration. The number published was for a half gallon, *not* for one quart as stated. I'd like to point out that one quart of water through the rain gauge is equivalent to 1.15 inches of rainfall—and that amount is more than enough water for an accurate rain-gauge calibration.

Second, the anemometer and rain gauge connections shown in Fig. 4 on page 44 are incorrect. The anemometer connection should be between pins 8 and 21 on the J14 DB25F and the rain-gauge connection should be between pins 9 and 22.

Finally, Table 1, which was missing from the article, is presented here.
RONALD M. JACKSON

TABLE 1—BAROMETER CALIBRATION

PRESSURE INHG	CALIBRATION VOLTAGE
31.1	5.120
31.0	4.985
30.9	4.851
30.8	4.716
30.7	4.581
30.6	4.446
30.5	5.312
30.4	4.177
30.3	4.042
30.2	3.907
30.1	3.773
30.0	3.638
29.9	3.503
29.8	3.368
29.7	3.234
29.6	3.099
29.5	2.964
29.4	2.829
29.3	2.695
29.2	2.560
29.1	2.425
29.0	2.291
28.9	2.156
28.8	2.021
28.7	1.886
28.6	1.752
28.5	1.617
28.4	1.482
28.3	1.347
28.2	1.213
28.1	1.078
28.0	0.808
27.9	0.808
27.8	0.674
27.7	0.539
27.6	0.404
27.5	0.269
27.4	0.135
27.3	0.000

COMBUSTIBLE GAS ALARM WARNING

Dave Williams, in his article entitled "Combustible Gas Alarm" (**Electronics Now**, July 1993), describes how reducing gases, such as methane, butane, propane, and carbon monoxide, can be detected with a tin-dioxide sensor-based alarm.

In that article the reader is advised to position the alarm near the ceiling because methane is lighter than air, and would therefore collect near the ceiling. However, in giving that advice, Mr. Williams did not point out that many reducing gases are *heavier* than air. Carbon monoxide, propane, and butane, for example, can accumulate at floor level to reach dangerous concentrations well before a ceiling-mounted alarm would be triggered.

In the interests of personal safety and the prevention of fires and explosions, please advise your readers of this fact.

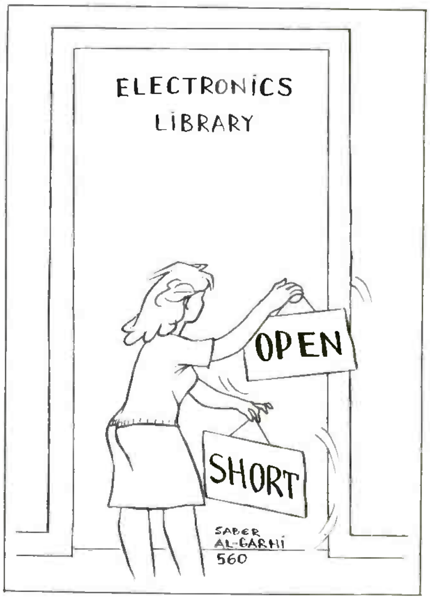
R.C.S.
Excelsior, MN

LOOKING AT IR SIGNALS

I enjoyed the article "Remote-Control Tester" (*Electronics Now*, March 1993), but I have an easier approach. Although infrared (IR) is invisible to the human eye, the IR used in most remote controls is detectable with a common camcorder, because CCDs are sensitive to IR. To test a remote control, simply point the remote control at the camcorder and say cheese. You'll see the IR LED flash in the view finder if the remote control is operating properly.

JAMES SIUNIAK
Santa Paula, CA

Ω



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Bugs of a very small size are easy to build and they can be placed quickly in a matter of seconds, in any object or room. Today you may have used a telephone handset that was bugged. It probably contained three bugs. One was a phony bug to fool you into believing you found a bug and secured the telephone. The second bug placates the investigator when he finds the real thing! And the third bug is found only by the professional, who continued to search just in case there were more bugs.

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This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

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EQUIPMENT REPORTS

ITT Pomona Logic Scope Probe

Turn your oscilloscope into a logic analyzer!

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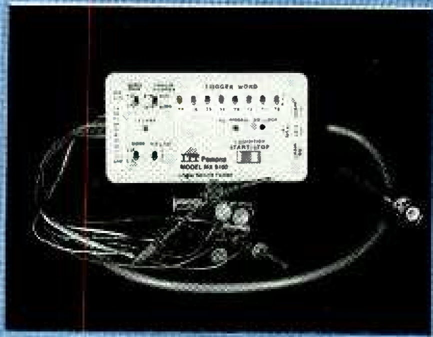

Many technicians and hobbyists need a logic analyzer occasionally, but not often enough to justify the purchase of a full-featured unit. That's just who the *Logic Scope Probe* is built for. The Logic Scope Probe, from ITT Pomona (1500 E. Ninth Street, Pomona, CA 91766) turns any analog oscilloscope into a simple logic analyzer.

The Logic Scope Probe is housed in a small, beige, plastic box that measures about 4½ × 2½ × 1½ inches. An eight-inch cable extends from the right side of the unit; a BNC connector on its end allows connection to an oscilloscope. Up to eight digital data lines can be connected to the unit through a special cable. That ribbon cable plugs into the bottom of the Logic Scope Probe; its other end is terminated in eleven small *Micrograbber* clips.

Eight of the clips serve as data inputs, one as a clock input, and the final two are used to supply power to the unit. Normally, the probe is powered from the unit under test. An external supply, which prevents the instrument from loading down the circuit under test, is available as an option.

The Logic Scope Probe has three modes of operation. First is the logic-analyzer mode in which the oscilloscope becomes an 8-channel logic analyzer with a memory depth of 16 words. Each channel is displayed as one horizontal line on the oscilloscope's screen in a timing-diagram fashion. Three independent memory banks are available, each with a depth of 16 words.

The second mode of operation is the trigger-probe mode, in which the unit generates a trigger signal whenever an 8-bit user-selected condition is met. Because the scope's signal inputs aren't connected to the Logic Scope probe in that mode, so the scope can be used to observe analog signals.

The third mode is the MUX or multiplexer mode in which the scope displays eight digital signals in real time simultaneously. No data is acquired and stored in memory, however.

Up to three Logic Scope Probes can be daisy chained in all modes, to provide a 16- or 24-channel system. However, one scope channel is required for each probe input; a three-channel scope would be required to view 24 channels simultaneously. If simultaneous viewing isn't imperative, the three units can be hooked up to the scope sequentially.

In the logic analyzer mode, the probe operates in two cycles: display and acquisition. First, data is acquired and stored in one of three 16-word memories. Then it is displayed on a oscilloscope with eight traces corresponding to the eight input channels. (A trigger signal is also provided for the scope.) A START/STOP pushbutton is used to switch the probe between its display and acquisition modes.

If the TRIGGER POSITION switch is set to BEGIN, the Logic Scope Probe will begin storing data when the data at its inputs correspond to the trigger word set by eight three-position switches on the top panel. Each switch can be set to logic high, low, or "don't care." When the input to the eight data lines matches the switch settings, a trigger is generated and the probe begins storing data in memory.

If the TRIGGER POSITION switch is set to END, the probe will stop storing data with the trigger condition is met. The Logic Scope Probe can be set to sample the data on either the rising or falling edge of the clock pulse.

The Logic Scope Probe can be used to capture data that occurs both before and after the trigger event. To do that, the acquisition would be repeated twice, once with TRIGGER POSITION set to BEGIN and once with it set to END. The first acquisition would be stored in memory position 1, and the second in memory position 2. Two probes could be used in a similar manner to capture the data simultaneously.

The Logic Scope Probe cannot replace a logic analyzer because of its limited functionality. For example, its operating frequency range is limited to 20 MHz. Its memory depth is limited to 16 words, and it has no provisions for saving the memory to disk. In the best case, only 24 data channels can be displayed.

However, the Logic Scope Probe is not intended to be a substitute for a full-function analyzer, but to provide a portable, easy-to-use instrument for quick troubleshooting in the field, and occasional use on the bench. It does all those things well, and at a suggested retail price of $330, it seems like a good buy. Ω

NEW PRODUCTS

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STAMP-SIZED SINGLE-BOARD COMPUTER. The *BASIC Stamp* miniature single-board computer from *Parallax, Inc.* runs BASIC. Not much larger than a postage stamp, the 1 × 2-inch computer board is intended for data acquisition, interfacing, and industrial control in systems where the low cost of components is an important consideration.

The *Stamp* is available separately or as part of a development kit that also includes a three-pin downloading cable, editor software, and a manual. The editor is used for developing programs for the *stamp* on a personal computer. Those programs can be converted into PBASIC tokens at the touch of a key, downloaded through the three-pin cable, and executed.

The *Stamp's* PBASIC program is said to be easy to learn. Instructions are provided for high-speed digital, analog, and serial input/output as well as for debugging, power control, table look-up, and on-board EEPROM access. Program size is limited to about 80 PBASIC instructions, but several *Stamps* can be connected to perform longer programs.

Each *Stamp* includes an 18-pin RISC microcontroller and an 8-pin EEPROM. The microcontroller interprets PBASIC and manages the I/O lines, while the EEPROM stores the tokens. About 2000 PBASIC instructions can be executed each second. A small prototyping area on the board allows circuitry to be added to the *Stamp's* eight general-purpose I/O lines.

A single *Stamp* is priced at $39, and the development kit sells for $139. PBASIC interpreter chips, which are used in custom circuits, are available for $6 each in minimum quantities of 25.

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VGA-TO-VIDEO CONVERTER. *JDR Microdevices' VGA–NTSC Converter* is a personal computer accessory that is capable of driving an NTSC monitor. The converter, when connected to the PC, allows presentations to be displayed on low-cost video monitors instead of large-screen VGA monitors. It is intended for use in seminars, lecture halls, or in video-tape production. Light in weight and small in size, it can be used "on the road" with notebook or laptop computers.


CIRCLE 17 ON FREE INFORMATION CARD

The converter output can be plugged into a standard or S-video VCR, permitting the production of custom training tapes. A built-in flicker filter is said to reduce eye fatigue, and TV auto blanking and brightness controls keep the displays sharp.

JDR Microdevices offers an optional video splitter/buffer capable of driving up to eight monitors from a single VGA card for presentations that require more than one VGA monitor.

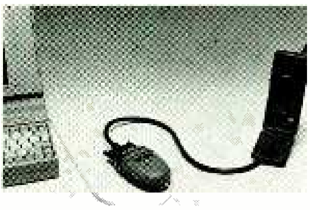
The *VGA–NTSC* converter is priced at $299.95.

JDR Microdevices
2233 Samaritan Drive
San Jose, CA 95124
Phone: 408-559-1200
Fax: 408-559-0250

CELLULAR/DATA LINK. The *Intelligent Data Equipment Adaptor (I.D.E.A.)* from *Ora Electronics* allows any modem or fax machine to be connected directly to a portable cellular phone. This "intelligent" cellular telephone data link permits data or faxes to be sent and received automatically when it is plugged into the cellular telephone.

The microprocessor-controlled *I.D.E.A* system generates a dial tone, controls the functions of the portable cellular telephone, and includes a standard RJ-11 interface for modem or fax connections. Completely transparent to the modem or fax machine, the system works with all popular communication and fax software packages. It is compatible with all modem-equipped computers or fax machines that have RJ-11 interfaces, without the need for purchasing additional software.

The *I.D.E.A.* system is available for most popular



CIRCLE 18 ON FREE INFORMATION CARD

cellular telephones, such as those offered by AT&T, Motorola, NEC, and OKI. However, an optional cellular-telephone adaptor cable allows it to be used with other portable cellular telephone brands. The system includes the *I.D.E.A.*, a cellular-phone-specific cable, a modular telephone cord, a 9-volt battery, and a user's guide.

The *Intelligent Data Equipment Adaptor* system is priced at $249.95.

ORA Electronics
9410 Owensmouth Avenue
Chatsworth, CA 91311
Phone: 818-772-2700

DIGITAL SYNTHESIZER CARD. *Novatech's DDS3 PC* direct digital synthesizer is a 12-MHz precision signal source for IBM and compatible personal computers. It has a stated 5-ppm accuracy and 10-ppm/year stability. *Novatech* claims that it offers spectral purity comparable to that of its earlier and more costly digital synthesizers.

CIRCLE 19 ON FREE INFORMATION CARD

Phase noise is specified as less than −90 dBc at 1 KHz offset, spurious signals are specified as below −45 dBc, and harmonics are specified as less than −40 dBc. Output amplitude is 12 volts peak-to-peak into an open circuit, and this can be attenuated in 10-dB steps to 70 dB.

The *DDS3 PC* can generate sine and TTL- and HCMOS-compatible clock signals simultaneously from 2 Hz to 12 MHz in 2-Hz steps. The card includes a C-language program that runs under DOS to make the setting of frequency and attenuation easier. The program also permits users to set or to sweep through a set of frequency, attenuation, and dwell time settings. A driver for a Windows-based ATE program is available as an option.

The *DDS3 PC* direct digital synthesizer card is priced at $399.

Novatech Instruments, Inc.
1530 Eastlake Avenue East
#303
Seattle, WA 98102
Phone: 206-328-6902
Fax: 206-328-6904

AUDIO ANALYZER SYSTEM. *Liberty Instruments'* new *IMP Audio Analyzer* is a full-featured fast Fourier transform spectrum, impedance, and network analyzer. It is intended for use with IBM- or compatible personal computers.

The *IMP Audio Analyzer* connects to the PC through the PC's printer port. The analyzer has inputs for two clip probes and one microphone which are included. The instrument has an output for rectangular pulses or optional maximum-length-sequence (MLS) test signal.

The *IMP's* graphically-based software package allows the extraction of quasi-anechoic acoustic measurements, transient response analysis in three-dimensional "waterfall" format, and correction for microphone response. It permits the merging of data taken from multiple measurements, delay compen-

FAX DIRECTORY LISTING

COMPANY	FAX NUMBER
Alfa Electronics, Inc.	(609) 275-9536
All Electronics Corporation	(818) 781-2653
A.M.C. Sales, Inc.	(303) 494-4924
B.G. Micro	(214) 271-2462
Caig Laboratories, Inc.	(619) 451-2799
Chemtronics, Inc.	(404) 717-2111
Communications Specialists, Inc.	U.S. – (800) 424-3420 Int'l – (714) 974-3420
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Danbar Sales Company	(909) 592-2940
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Gateway Electronics	(314) 427-3147
Global Specialties	(203) 468-0060
Goldstar Precision Co. Ltd.	(310) 921-6227
Hameg Instruments	(619) 630-6507
Interactive Image Technologies Ltd.	(416) 368-5799
Jameco Electronic Components & Computer Products	(800) 237-6948
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MCM Electronics	(513) 434-6959
Mondo-Tronics, Inc.	(415) 455-9333
Moody Tools, Inc.	(401) 885-4565
Mouser Electronics	(817) 483-0931
MWK Industries	(909) 278-4887
Northeast Electronics	(508) 695-9694
Number One Systems Ltd.	011 44 480 494042
PC Boards	(205) 933-2954
People's College of Independent Studies	(407) 847-8793
Print Products International	(800) 545-0058
Howard W. Sams & Company	(317) 298-5604
Sencore, Inc.	(605) 339-0317
Sibex, Inc.	(813) 726-4434
Startek International, Inc.	(305) 537-5577
Suncoast Technologies	(904) 596-7599
The Engineers Collaborative, Inc. (TECI)	(802) 525-3451
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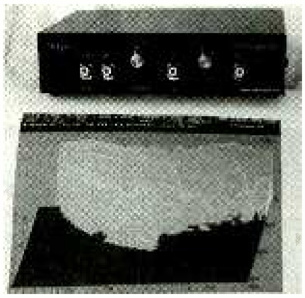


CIRCLE 20 ON FREE INFORMATION CARD

sation, and inductor- or capacitor-value measurement.

Automated macro operations can be performed, and the analyzer is capable of extracting loudspeaker parameters from their impedance curves. Measured data can be saved to and retrieved from disk, and all screen graphics can be printed out. Version "M" of the software provides on-line help, mouse interface, overlay plots, on-trace markers, and it can support the MLS hardware option. Both dynamic range and noise immunity can be enhanced while measurement time can be reduced with an IMP/MLS enhancement board that is an option.

The *IMP Audio Analyzer* with "M" 2.0 software and the MLS enhancement option is priced at $599. A basic kit version without an enclosure sells for $275.

Liberty Instruments, Inc.
P. O. Box 1454
West Chester, OH 45071

FUNCTION GENERATOR. The new *Fluke PM 5135* function generator is a benchtop instrument suitable for many different general-purpose applications. These include education and training, audio and electronics servicing, production testing, and product development.

According to *Fluke*, the *PM 5135* is easy and fast to set up because of its clean, logical front panel control layout. Frequency is selected by pushbuttons in four decade ranges, a logarithmic dial, and a Vernier control with a range of ± 20% of the dial setting. The standard sine, triangle, and square waveforms are also pushbutton selected. The function generator's duty cycle is a standard 50 %.

Frequency sweeping can be single or continuous, with a logarithmic characteristic and a continuously variable sweep ratio from 1 to 2000. The sweep range is 3.5 decades, and the sweep period is continuously adjustable over a range of 10 to 150 seconds. It can be triggered with a pushbutton or from an external source.

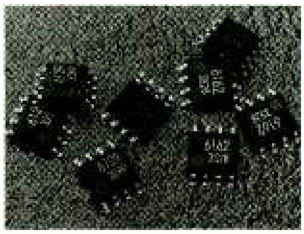
CIRCLE 21 ON FREE INFORMATION CARD

The attenuation range of the *PM 5135* is 0 to 60 dB in 10-dB increments, or it is continually variable over a 0 to 20-dB range. Both modes are pushbutton selectable. The function generator's output is protected from short circuits.

Fluke PM 5135 function generator is priced at $795.

Fluke Corporation
P. O. Box 9090
Everett, WA 98206
Phone: 800-44-FLUKE
Fax: 206-356-5116

VOLTAGE-MONITORING IC'S WITH BATTERY BACKUP SWITCH. *Rohm Corporation* is offering the *BA6129F* and *BA6162/F*, new voltage-monitoring integrated circuits. Each includes two factory-set thresholds. The circuits



CIRCLE 22 ON FREE INFORMATION CARD

monitor the voltage to external devices such as volatile RAM memories in memory cards, palmtop computers, and scanners.

If the host equipment's supply voltage falls below the first threshold, the voltage monitor switches to a standby mode. If the second threshold is reached, the monitor IC automatically switches demand from the primary power supply to a battery backup supply.

The detection voltage for the *BA6129F* is 3.5 volts for the standby mode and 3.3 volts for the backup mode. The detection voltage for the *BA6162/F* is a higher 4.2 volts, but its backup mode switching voltage is also 3.3 volts. Internal circuitry provides hysteresis to prevent circuit instability during power supply switching.

Both voltage-monitoring IC's are available in 8-pin surface-mount, small-outline IC (SOIC) packages, and the *BA6162/F* is also packaged in an 8-pin DIP.

The *BA6129F* and BA6162/F voltage-monitoring ICs are priced at $.50 each in 1000-piece quantities.

Rohm Corporation
3034 Owen Drive
Antioch, TN 37013
Phone: 615-641-2020
Fax: 615-641-2022

TEMPERATURE SIMULATORS. Two new hand-held temperature simulators from *Wavetek* can be adjusted in 1° and 0.1° increments over a wide range. Both Models *473* and *475* can measure a 4- to 20-milliampere signal while simulating temperature. The simulators are intended for calibrating temperature transmitters and signal conditioners.

Both temperature simulators can simulate four different sensors for calibration purposes and measure their output for display on an LCD digital temperature indicator. The LCD readouts and a user-friendly keypad are said to make the simulators easy to read and use. Their compact size and long battery life make them suitable for field servicing.

CIRCLE 23 ON FREE INFORMATION CARD

The *473* is intended for thermocouple calibration. It directly emulates type K, J, and T thermocouples, and it will source up to 100 millivolts DC to simulate other thermocouples. The *475* simulates resistance temperature detectors (RTD). It will directly simulate both 0.00385 and 0.00392 type platinum 100-ohm RTDs and copper 10-ohm RTDs. It will also source up to 1000 ohms for the calibration of other RTDs, and it can also calibrate standard potentiometer settings.

The *473* temperature simulator is priced at $795 and the *475* is priced at $895.

Wavetek Corporation
9145 Balboa Avenue
San Diego, CA 92123
Phone: 619-279-2200

TINY VOLTAGE-CONTROLLED OSCILLATOR. *Z-Communications* claims its new *Model SMV2500 VCO* is the world's smallest voltage-controlled oscillator (VCO) integrated circuit. It was developed for wireless local-area networks (LAN). Small package size was emphasized to minimize its "footprint"on the "credit-card-" size circuit boards that fit in laptop personal computers.

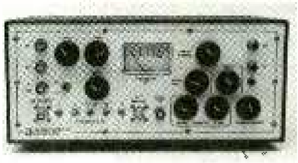
The *SMV2500 VCR* will oscillate in the 2.4 GHz to 2.485 GHz frequency range. It operates from a 3-volt DC supply voltage, and typically draws only 16 milliamperes. Phase noise is specified at −85 dBc/Hz at a 10 kHz offset, and its second harmonic minimum is −20 dBc. The VCO package measures 0.3×0.3×0.117 inch.

CIRCLE 24 ON FREE INFORMATION CARD

The *SMV2500* voltage-controlled oscillator is priced at $5.75 each in 100,000 quantities. Samples are priced at $150 each.

Z-Communications, Inc.
9939 Via Pasar
San Diego, CA 92126
Phone: 619-621-2700
Fax: 619-621-2722

RF SWEEP GENERATOR. *Lurie Instrument's* new *LI10A* radio frequency sweep generator has two built-in channel amplifiers. It can permit the frequency responses of two S-parameters to be monitored on a two-channel oscilloscope.



CIRCLE 25 ON FREE INFORMATION CARD

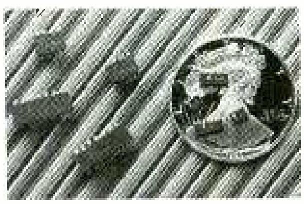
The benchtop 1.2-GHZ sweep generator offers fast continuous sweep, marker grids with single crystal time base, and stepped and continuous level adjustment. Sweep width is variable from 2 MHz to full range. The 50- and 75-ohm accessories available include a detector head, a reflection bridge with built-in detector, and a signal divider. Also available from *Lurie* are a bias tee, a 20-dB attenuator, and a 50/75-ohm minimum loss pad.

The *LI10A* RF sweep generator is priced at $1685.

Lurie Instruments
2738 Orange Avenue
La Crescenta, CA 91214
Phone: 818-957-7714
Fax: 818-957-2208

DUAL AND QUAD VIDEO OP AMPS. The *EL2210* and *EL2211* dual video operational amplifiers and *EL2410* and *EL2411* quad versions of those op-amps from *Elantec* are made with the complementary bipolar (BiCMOS) process. The op-amps were developed specifically for consumer video equipment.

The*EL2210* and *EL2211* dual op-amps operate from ± 5-volt supplies with a gain of +1 with 50-MHz bandwidth. Both the dual op-amps will drive a 150-ohm load to +2 volt and −1 volt with a 100-MHz bandwidth. Slew rate is 130 volts per microsecond.



CIRCLE 26 ON FREE INFORMATION CARD

EL2410 and *EL2411* quad versions operate at ± 5 volts at a gain of +2 with 100 MHz of bandwidth. Differential gain for the quad op-amps is specified at 0.07%, and differential phase at 0.15°.

The dual op-amps are available in 8-pin plastic DIP packages and 8-lead small-outline transistor (SOT) packages. The quad versions are available in 16-pin plastic DIP and 16-lead small-outline packages.

The pricing for the video op-amps begins at $2.40 each in 100 quantity.

Elantec, Inc.
1996 Tarob Court
Milpitas, CA 95035
Phone: 408-945-1323
Fax: 408-945-9305

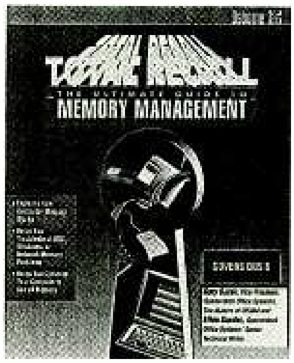
Ω

NEW LITERATURE

Use The Free Information Card for fast response.

Total Recall: The Ultimate Guide to Memory Management; by Gary Saxer and Ellen Sander. Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Phone: 510-549-6600; Fax; 510-549-6603; $19.95.

This book will give you a clear understanding of personal computer memory—both concept and actual hardware. It's information you'll need to make informed purchasing decisions and solve any problems related to memory that you might encounter.



CIRCLE 40 ON FREE INFORMATION CARD

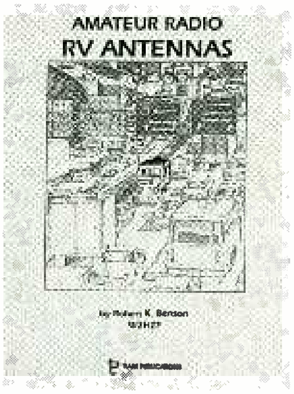
This guide by Saxer and Sander delves into the history of computer memory, and explains how and why the various kinds of computer memory evolved. You'll find a straightforward explanation of how the memory in your personal computer works, how your applications software finds the memory it needs, and how to provide more memory for those applications. You'll also find out how to master memory management with DOS 6 and other memory mangers, and you'll learn how to troubleshoot problems in DOS and Windows operating systems and local-area networks (LAN).

You'll find the information you need to install and configure memory, and you'll learn how memory works in the multitasking environment. The guide also tells you how to determine how much memory your computer is using. A special question-and-answer section is devoted to many common memory problems and their solutions, including how to respond to memory error messages and how to solve hardware conflicts that can prevent your PC from booting or cause it to crash.

Amateur Radio RV Antennas; by Robert K. Benson, W2HZF. Tiare Publications, P. O. Box 493, Lake Geneva, WI 53147; Phone: 414-248-4845; $14.95 plus $2 shipping and handling.

This is the book for amateur radio operators who want to take their avocation along with them when they take off on their vacations. Existing amateur radio equipment makes it practical to take your radio gear with you in a recreational vehicle or set it up at a campground. You can even operate from a yacht, if you so desire.

The author cautions that the right antenna is essential for good communications with a ham station in the field. The book explains what to look for in antennas—construction, materials, size and directivity—if you want to purchase a factory-built antenna for field use. It also gives you guidance on how to build and install suitable antennas if you elect the do-it-yourself route.



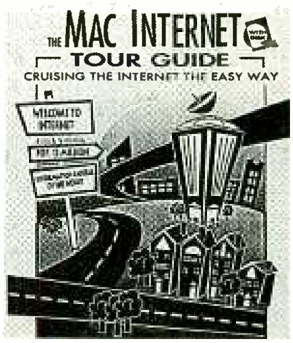
CIRCLE 39 ON FREE INFORMATION CARD

The special operating conditions found on a wide variety of recreational vehicles such as motor homes, campers, trailers, and even boats are described. This book will help the amateur match his antenna system to the RV of his choice to obtain maximum communications efficiency.

Benson's book describes the antennas best suited for receiving and transmitting while you are driving, and it identifies those best suited for operating at a fixed location such as a campground. The recommended mounting positions and procedures are detailed. Tips are provided on the selection and installation of ancillary equipment for an efficient mobile ham station.

The Mac Internet Tour Guide: Cruising the Internet the Easy Way; by Michael Fraase. Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Phone: 919-942-0220; Fax: 919-942-1140; $27.95, including diskette.

This combination book and disk will help Mac computer users master the Internet. It does this by replacing obscure Unix commands with the icons and boxes familiar to Mac users. The book explains how to get connected and make use of Internet in a simple, step-by-step format that allows readers to proceed at their own pace.



CIRCLE 38 ON FREE INFORMATION CARD

Fraase's book will be a roadmap to Internet's information resources for both novices and experienced Mac computer users. It explains network benefits, and it provides an overview of the history and growth of Internet with predictions about its future growth. Fraase also explains how the Internet is organized and its networking protocols. He also discusses the requirements for good networking "manners."

The disk contains file-transfer software that lets users visit remote sites quickly and easily to download desired programs and files. Included are E-mail

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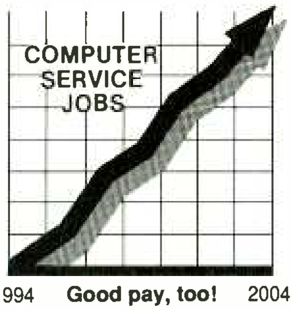

Jobs for computer service technicians will almost double in the next 10 years, according to the latest Department of Labor projections. For you, that means unlimited opportunities for advancement, a new career, or even a computer service business of your own.

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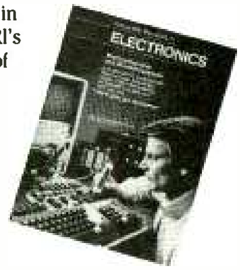

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Accredited Member, National Home Study Council 3-0194 software that converts Internet's Unix commands to a form that is easier for Mac owners to use and decompression software that decodes files from most personal computers.

30th Anniversary Catalog. Jensen Tools Inc., 7815 South 46th STreet, Phoenix, AZ 85055-5399; Phone: 800-426-1194; Fax: 800-366-9662; free.

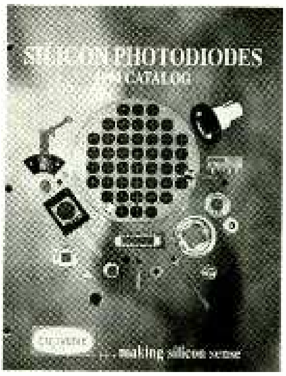
Jensen's 256-page master catalog describes the company's product line. Photographs and pricing information accompany each item described. The catalog includes tool kits, cases and carts, personal computer accessories, telecommunications equipment, and test equipment for local-area networks and fiber optics. It also includes wire, cable, crimpers, wire-wrap tools, and soldering equipment.

CIRCLE 37 ON FREE INFORMATION CARD

For the workplace there are workbenches, tools, boxes and containers that prevent damage from electrostatic discharge, circuit boards, lighting fixtures, and cleaning equipment. The catalog contains color-coded pages to simplify the search for desired products, a table of contents, and a detailed index.

Silicon Photodiodes 1994 Catalog. Centronic, Inc., 2088 Anchor Court, Anchor Business Park, Newbury Park, CA 91320; Phone: 805-499-5902; Fax: 805-499-7770; free.

This full-color, 50-page catalog from Centronic includes product photographs and specifications for the company's standard and application-specific photodiodes. Included are charts and data that will help buyers select the right photodiode for any given application.

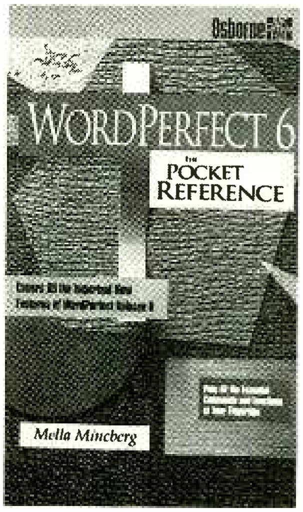


CIRCLE 36 ON FREE INFORMATION CARD

The catalog includes a handy photodiode selection guide and a six- page technical tutorial on photodiodes. It covers structure, theory of operation, and spectral response. The text explains temperature effects and key parameters, and includes typical circuit diagrams and commonly used abbreviations. The catalog includes outlines of photodiode dies, package outlines, and precautions for handling photodiodes.

WordPerfect 6: The Pocket Reference; by Mella Mincberg. Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Phone: 510-549-6600; Fax; 510-549-6603; $9.95.

This pocket-sized reference book is said to contain all the information



CIRCLE 35 ON FREE INFORMATION CARD

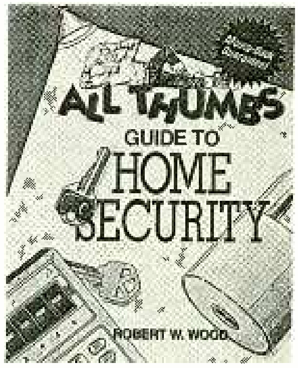
needed to guide WordPerfect 6 users to expert-level proficiency in a step-by-step format. It is arranged to give readers the answers they need as fast as possible, and it contains an alphabetical listing of all the important WordPerfect 6 functions and features. This version includes such features as desktop publishing, mail-merging, changing styles, and preparing tables and columns.

An overview section covers such general topics as cursor movement, codes, and blocking. A handy pull-out command card consolidates the most important commands and features. The book is said to be more streamlined than a manual, but far more detailed than a command card.

Hands-on exercises allow novices to work at their own pace as they build their skills. All the basic features from typing and editing to retrieving, saving, and printing documents are described. The reader with experience in word processing who is upgrading to WordPerfect 6 from an earlier version will find all the information needed to switch over and become productive quickly.

All Thumbs Guide to Home Security; by Robert W. Wood. Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Phone: 1-800-233-1128; $9.95.

This illustrated guide is offered with the claim that it will provide homeowners and renters with all the information they'll ever need to safeguard their homes against burglary and fire. Moreover, it is sold with a money-back guarantee that novices will be able to complete the projects successfully without outside help.



CIRCLE 34 ON FREE INFORMATION CARD

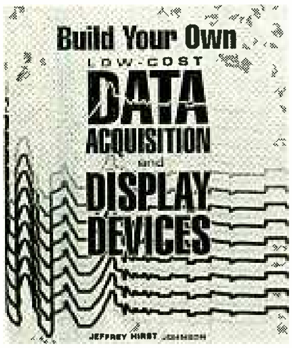
According to its author, Bob Wood, you don't need formal training in wiring and electricity to carry out the inexpensive security measures he discusses. Wood claims that, if organized effectively, the projects detailed in the book can reduce the risk of fire and intrusion significantly—and they might even help to reduce insurance rates.

It includes easy-to-follow directions on how to install burglar alarms, smoke detectors, outdoor lighting, and indoor and outdoor motion sensors. You'll find instructions on the installation of deadbolt, anti-slide and other security locks on doors and windows. It even explains how to position shrubs and plants around a house to deter unwanted intrusion.

Build Your Own Low-Cost Data Acquisition and Display Devices; by Jeffrey Hirst Johnson. Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Phone: 1-800-233-1128; $19.95.

Here is a book that explains how to make flexible and affordable data-acquisition and display devices for any IBM-compatible computer. It includes all the information that you'll need to turn a personal computer into a high-performance data-acquisition system.

Johnson's book includes circuit designs and step-



CIRCLE 33 ON FREE INFORMATION CARD

by-step instructions for building a wide variety of portable plug-in devices that allow fast, effective data communication in many different situations. After presenting the basic principles of data transmission, Johnson tells you how to program interfaces for serial and printer ports. He also explains how to design circuits for parallel and serial interfacing and digital sensing and measurement.

Included in the book is a complete project for building a versatile digital voltmeter and writing a simple data-acquisition program. Also included are software routines to support the hardware and information on data formats and rates, cabling and connectors, and troubleshooting. Ω

TAKE BACK CONTROL OF YOUR TELEPHONE

Know who's calling you before you pick up the phone with this easy-to-build Caller-ID circuit.

TERRY J. WEEDER

HAVE YOU EVER BEEN TOO BUSY TO answer your phone but afraid of missing an important call? Are you tired of spending your dinner time brushing off annoying telephone salesmen? Build our caller-ID circuit and you will see the telephone number of the calling party *before* you answer. *You* can decide whether or not you want to talk to the caller. The caller ID system can also retain in memory the phone number of the five most recent calls, and the time of day that they were received.

About caller ID

The service that makes it possible to display the number and time of incoming calls is known as CND (calling number delivery). This service is now available in most major communities. Check with your local telephone company to see if it is available in your area. CND is a subscriber feature that transmits digital data that indicate the date, time, and number of the calling party during the silent period between the first and second ring. You must subscribe to the service to receive the data, which will be received whether the caller subscribes or not. (Most phone companies, however, provide a means for a caller to block the transmission of his number.) The fee for the Caller-ID service is about $6.50 per month.

The date and time information is sent on all calls, but the actual calling number will be available only from parties who are calling from within your area. At the present time your area consists of local calls that originated from where the CND is available. The number can be blocked by the calling party, in which case a special code is sent in place of the number indicating that this is the case. A special code is also sent if the call originated from outside your area.

The data is transmitted serially with the least-significant bit first, at a rate of 1200 bits per second. The data is modulated using frequency-shift keying (FSK), with 1200 Hz being a logical 1 (mark) and 2200 Hz being a logical 0 (space). Each 8-bit word is preceded by a start bit (space) and followed by a stop bit (mark). In addition, up to 10 mark bits can be added between words.

The portion of the message that contains the calling number is preceded by a "type code" of 04 hex. The first word to follow is a "length" word, which is the number of words in the message. That is followed by the date, time, and number in ASCII format, and a "check sum." For example, the data for a call made at 1:30 PM on February 12 would be sent as follows:

typelength
02129413305135551212
checksum

Note that the time is in the 24-hour format.

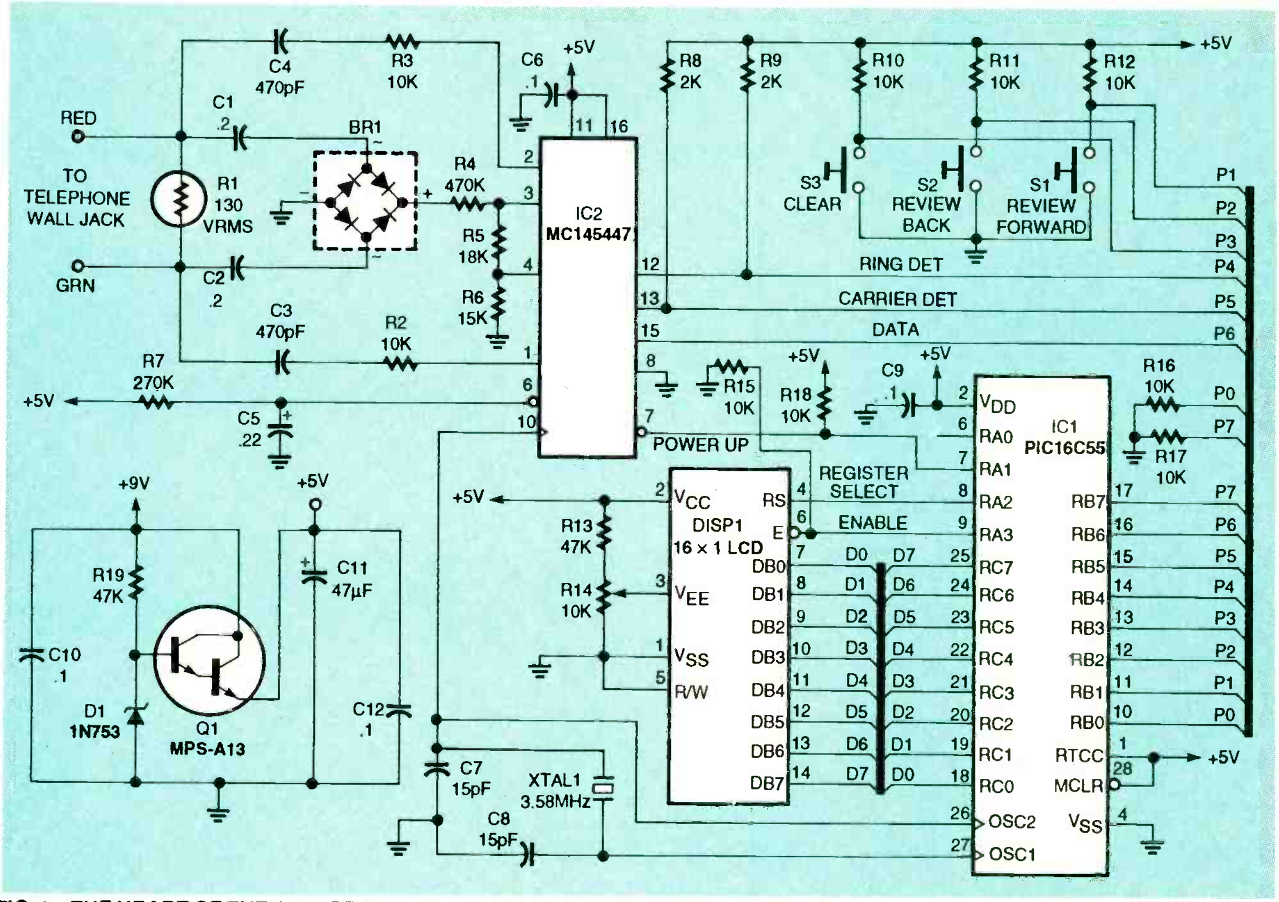


FIG. 1—THE HEART OF THE CALLER ID circuit is microcontroller IC1 which processes the serial data from IC2, outputs ASCII characters to DISP1, and monitors switches S1–S3.

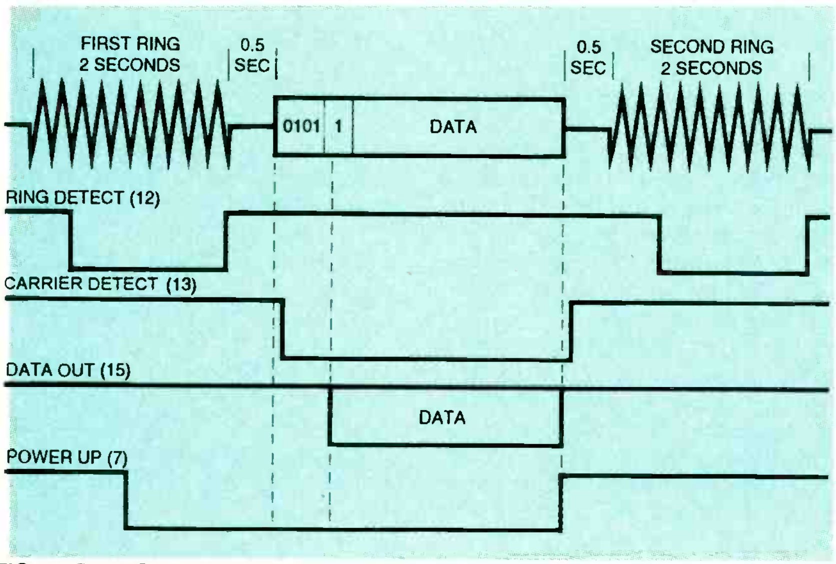


FIG. 2—TIMING RELATIONSHIPS between the data present on the phone line (top), and the output pins of IC2.

Circuit theory

A schematic diagram of the Caller-ID circuit is shown in Fig. 1. Motorola's new MC145447 calling line identification receiver chip (IC2) strips the FSK tones from the telephone line and converts them to TTL-level data. The tones are coupled through C3, C4, R2, and R3 to the input pins 1 and 2 of IC2. Bridge rectifier BR1 converts the ring voltage to DC and applies it through attenuator R4-R6 to the RING-DETECT inputs (pins 3 and 4) of IC2. Figure 2 shows the timing relationship of IC2's output pins when the data is being received.

The heart of the circuit is IC1, a PIC16C55 EPROM-based 8-bit CMOS microcontroller manufactured by Microchip Technology, Inc. This microcontroller has two 8-bit I/O ports and one 4-bit I/O port. An internal EPROM memory holds the program that decodes the data output by IC2, controls the LCD display, and senses any input from three switches. A preprogrammed PIC16C55 is available from the supplier listed in the Parts List. Code for programming the chip yourself is available on the *Electronics Now BBS* (516-293-2283, 1200/2400, 8N1) as a file called CID.ZIP.

Figure 3 is a flowchart of the operating software. The RING DETECT pin of IC2 is constantly monitored by IC1. When a low is detected on this pin (indicating a valid ring pulse on the telephone line) IC1 pulls pin 7 of IC2

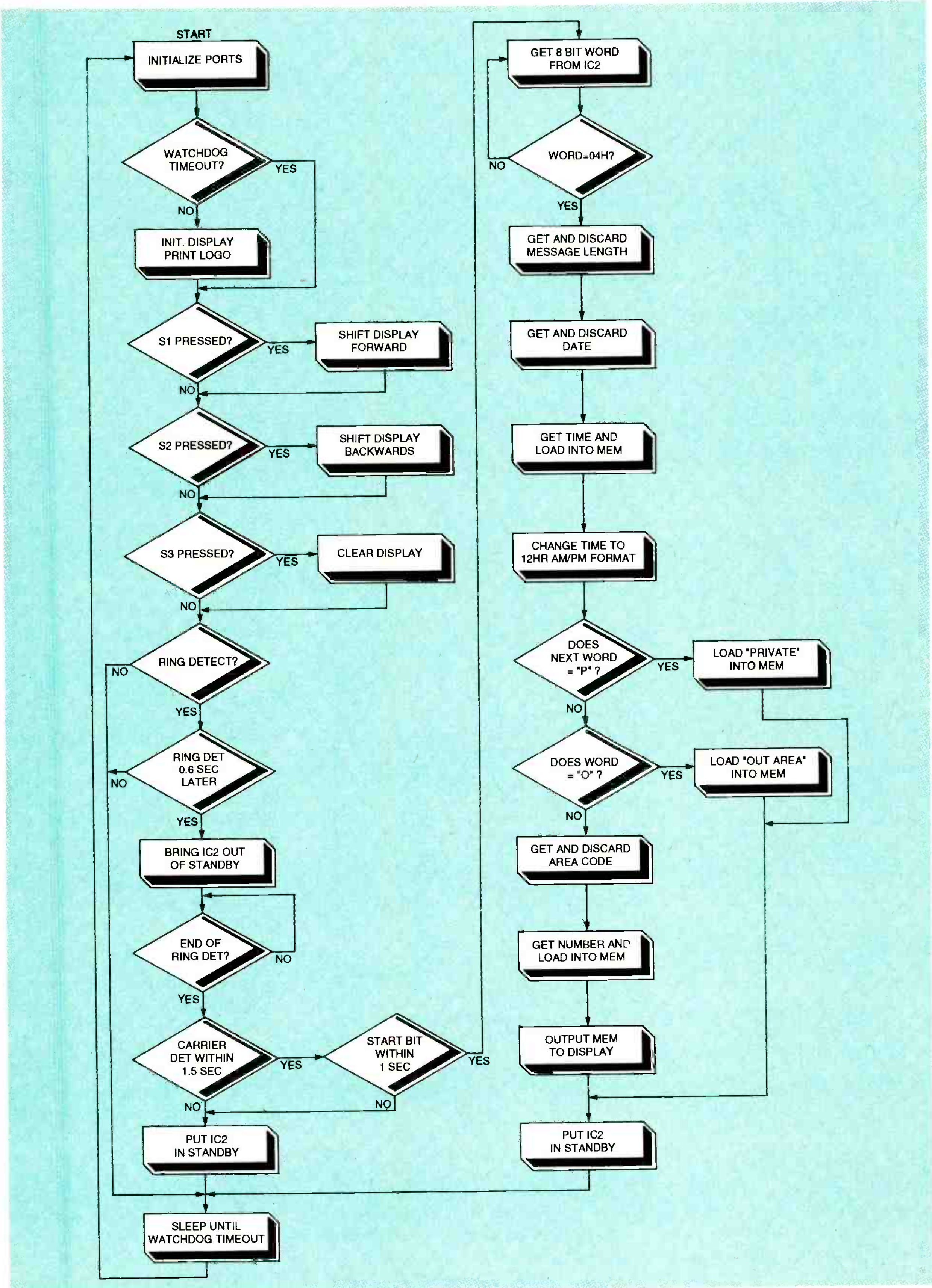
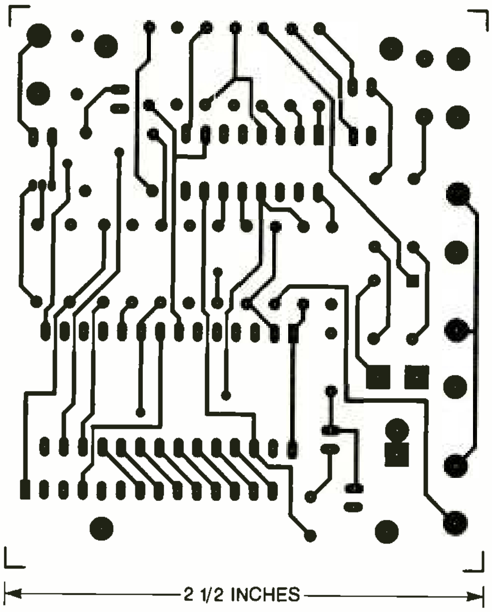
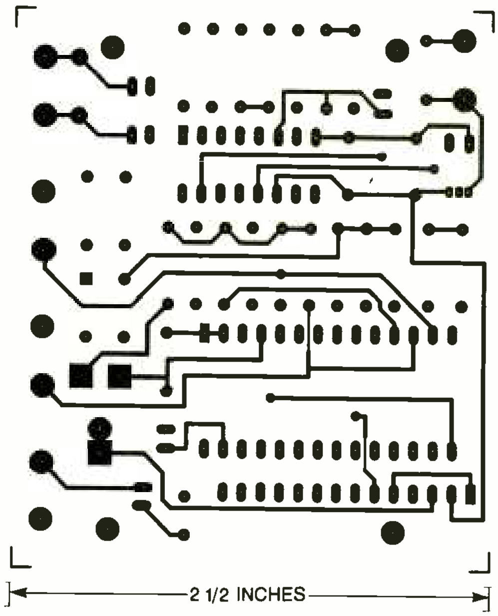


FIG. 3—FLOWCHART of the operating software for the microcontroller. A pre-programmed microcontroller is available from the source mentioned in the Parts List.



CALLER ID COMPONENT SIDE.



CALLER ID SOLDER SIDE.

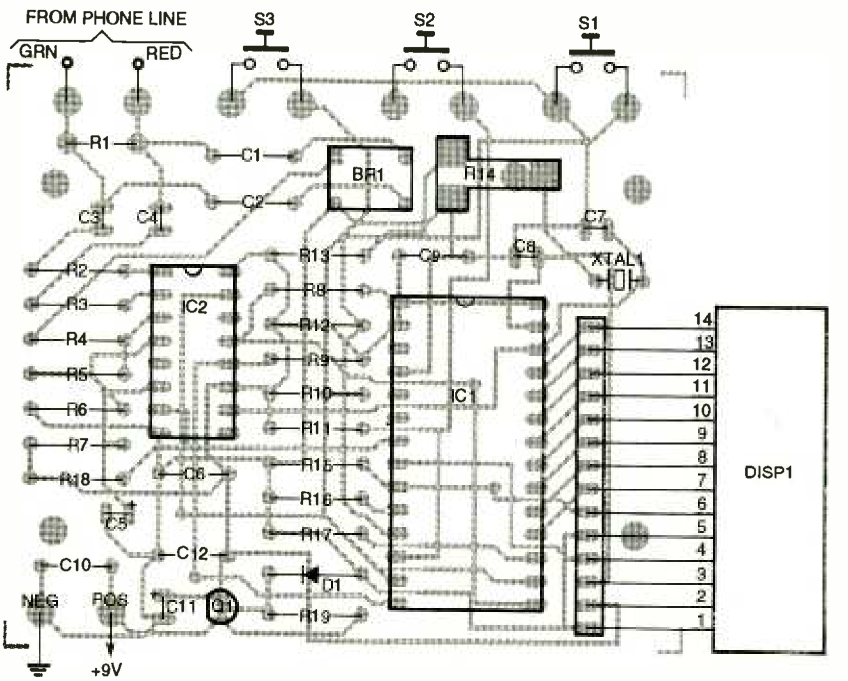


FIG. 4—PARTS-PLACEMENT DIAGRAM. The 14-conductor ribbon cable that should be used to connect the display module to Pin 1 on the main board is indicated by a rectangular pad instead of a oval one.

low, placing the chip in the active mode. IC1 then waits for a low on the CARRIER DETECT pin. If a low is not detected within 1.5 seconds, IC1 aborts the process and resumes monitoring RING DETECT. If a CARRIER DETECT does occur within this time period, IC1 looks for the first start bit on IC2's DATA pin. If the start bit does not occur within 1 second, the process is again aborted. This "find or abort" process of monitoring the outputs of IC2 ensures that IC1 knows exactly when the data is going to be sent and is not fooled by glitches on the telephone line (such as those caused by lifting the receiver), or by the detection of any ring pulses after the first one.

The microcontroller does not have an I/O port specifically designed for serial input, so the programming software converts the serial data output from IC2 into 8-bit parallel data. When a start bit is detected on IC2's DATA line, IC1 waits for a time period equal to 1.5 bits before it reads the data line. That ensures that the DATA line is midway through the first bit after the start bit when being read. The most-significant bit of IC1's receive register is initially set to equal the state of the data line. The register then shifts one place to the right, waits for a time period equal to 1 bit (placing it mid-way through the second bit), and then reads IC2's DATA line. IC1 again sets its receive register's MSB equal to IC2's DATA line and then shifts the register one place to the right. After eight cycles of reading and shifting, IC1 holds one 8-bit word in its receive register. After IC1 verifies that there is a stop bit, it either stores the 8-bit word in a separate register or discards it as depicted in the flowchart.

The first word of the calling number stream is 04 hex. When that word is received, IC1 knows that the data that follows is calling-number data. As IC1 receives the data from IC2, it identifies the characters which will be sent to the 16-character LCD readout (DISP1) and stores them in 16 internal registers (one register for each character space in the display). After receiving all the calling-number

PARTS LIS'

All resistors are ¼-watt, 10%, unless otherwise specified
R1—130 volts RMS varistor
R2, R3, R10–R12, R15–R18—10,000 ohms
R4—470,000 ohms
R5—18,000 ohms
R6—15,000 ohms
R7—270,000 ohms
R8, R9—2000 ohms
R13, R19—47,000 ohms
R14—10,000 ohms, trimmer potentiometer
Capacitors
C1, C2—0.2 µF, 100 volts, Mylar
C3, C4—470 pF, 50 volts, ceramic disc
C5—0.22 µF, 35 volts, tantalum
C6, C9, C10, C12—0.1 uF, 50 volts, Mylar
C7, C8—15 pF, 50 volts, ceramic disc
C11—47 uF, 35 volts, electrolytic
Semiconductors
BR1—1-amp, 200-PIV, full-wave bridge rectifier
D1—1N753, 6.2-volt Zener diode
IC1—PIC16C55, 8-bit microcontroller (Microchip)
IC2—MC145447, calling line identification receiver (Motorola)
Q1—MPSA13, NPN Darlington transistor
Other components
DISP1—16 × 1 LCD module
XTAL1—3.58-MHz TV colorburst crystal
S1–S3—SPST momentary pushbutton switch
Miscellaneous: Enclosure, PC board, IC sockets, 9-volt alkaline battery or 9-volt AC-to-DC wall adapter, telephone cord with modular plug, battery clip, ribbon cable, wire, solder, etc.
Note: The following items are available from Weeder Technologies, P.O. Box 421, Batavia, Ohio 45103:
• Double sided PC board (WTCID-B)—$9.50
• Kit of all board-mounted components including pre-programmed PIC16C55 (WTCID-C)—$24.50
• LCD display module (DISP16X1)—$18.50
All orders must include an additional $3.50 for shipping and handling. U.S. and Canadian orders only. Ohio residents must add 6% sales tax.
Note: Call your local telephone company to verify that Caller-ID service is available in your area before ordering.

data and changing the time from a 24-hour format to a 12-hour format, IC1 outputs the contents of its 16 registers to the LCD display through port C. The LCD display is wide enough to display only the time of day and the 7-digit telephone number, so the date and area code is discarded.

If the calling party is blocking the transmission of his number, a letter "P" will be received immediately after the date and time. In this case IC1 loads—along with the time—the word "PRIVATE" into its registers in place of a telephone number. Similarly, if the calling

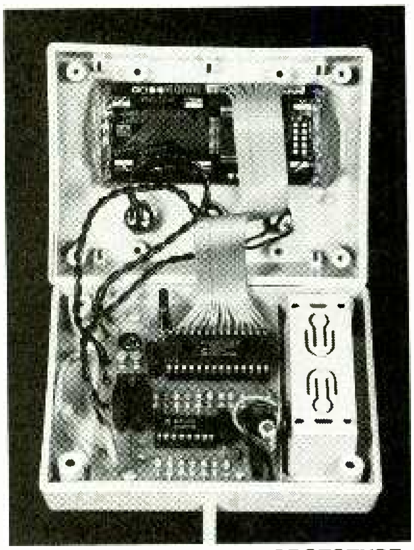


FIG. 5—THE COMPLETED PROTOTYPE. The small project case is the perfect size to place next to your telephone.

party is outside your area, a letter the letter "O" is received instead of the telephone number. IC1 then loads, along with the time, the message "OUT AREA" in its registers.

The LCD has its own internal memory which holds five 16-character messages. Each time a call comes in, IC1 addresses and writes to the next 16-character block, returning to the first block after reaching block number 5. Therefore DISP1 will always be holding the last five calls in memory. If IC1 detects an input from switch S1 or S2, it sends the instructions to DISP1 to shift the display backward or forward; it still remembers the address of the last block written to, however, and returns the display to this block when a new call comes in. If IC1 detects an input from S3, it clears the display and erases all contents in the display memory.

The circuit can be powered by either a 9-volt battery or DC wall adapter. A regulator is formed by Q1, D1 and R19, which drops the 9 volts down to 5 volts. The regulator is specifically designed to draw low current for longer battery life. The circuit draws only about 1 milliampere in the standby mode, and about 12 to 14 milliamperes when a call comes in.

Construction

The circuit is assembled on a 2.5- × 3-inch double-sided PC board. The foil patterns for the PC board are provided for those who wish to etch their own board. A pre-made PC board is also available from the source mentioned in the Parts List. Follow the parts-placement diagram shown in Fig. 4. Start by mounting IC sockets for IC1 and IC2. Pay particular attention to the pads on IC1 which have traces running between them. It is very easy to create a bridge of solder between those pads and the traces if you're not very careful.

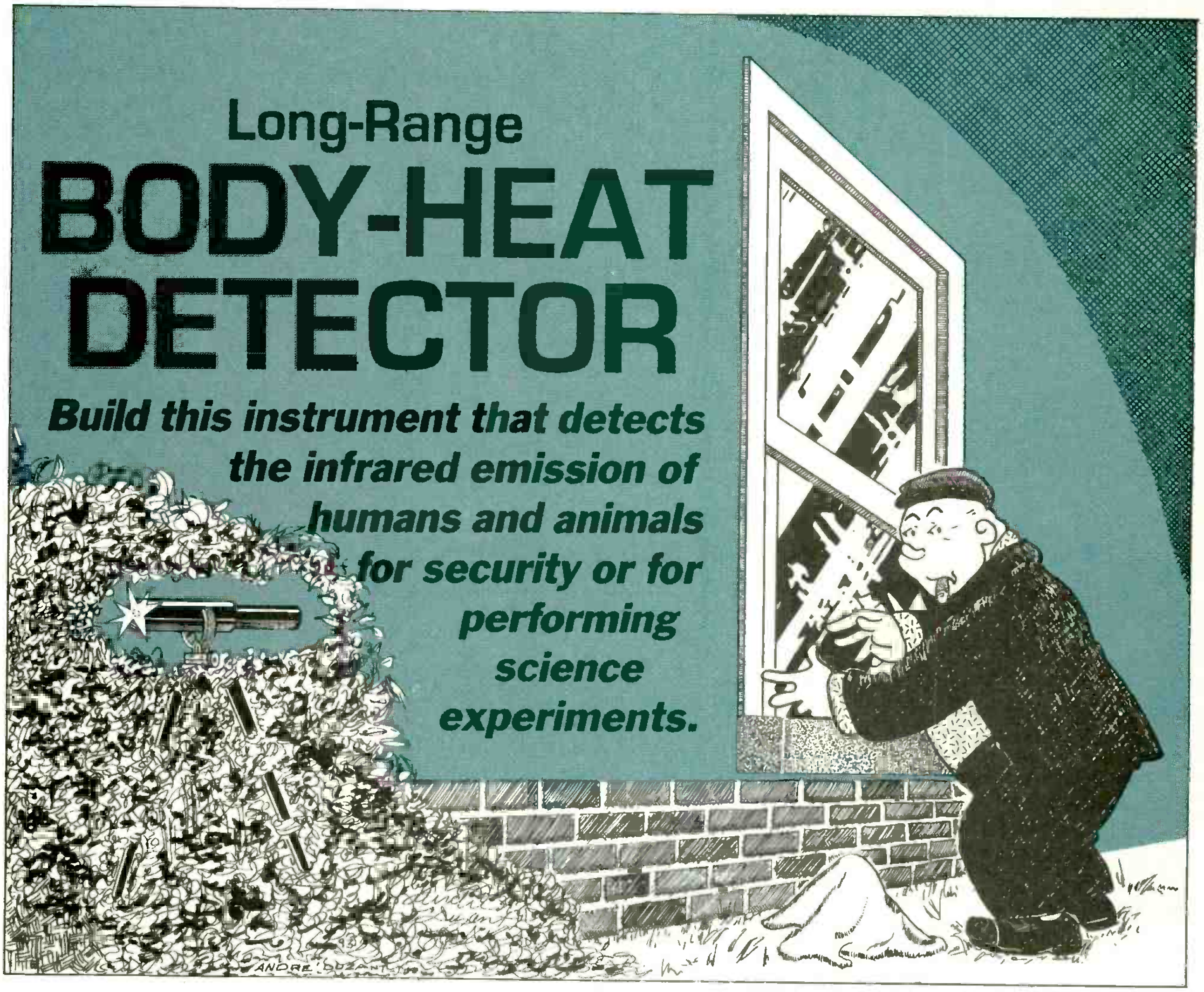
Mount the resistors, capacitors and all other components. Pay attention to the orientation of the polarized components such as C5, C11, and D1. The pad spacing for Q1 is very tight, so extra care should be observed when soldering this component. Crystal XTAL1 should not be seated all the way down onto the board when soldering it because there is a chance that the metal case of the crystal will short the pads together. Use twisted pairs of insulated hookup wire to connect the switches as shown. However, make sure the switches are installed in the case cover before you solder the leads to them.

Use a length of 14-conductor ribbon cable to connect the display module to the board. Separate the wires on each end of the cable for a length of about 1 inch to make it easier to solder them to the PC board and the display

Continued on page 84

Long-Range BODY-HEAT DETECTOR

Build this instrument that detects the infrared emission of humans and animals for security or for performing science experiments.



ROBERT IANNINI

A PYROELECTRIC DETECTOR IN THIS battery-portable instrument detects the presence of animal or human intruders night or day by sensing their body heat. The detector can supplement your home security system, or you can monitor animals for nature study or find sources of heat loss.

This project will introduce you to the fundamentals of infrared emission and detection. The instrument could help you locate hidden or buried heat sources that could be wasting heat in your home. Detectors capable of "seeing" in the non-visible infrared region have proven themselves extremely useful in nighttime law enforcement and in military operations on land and in the air around the clock.

This instrument can detect the presence of humans or animals up to several hundred feet away by sensing their body heat, which corresponds with a specific wavelength emission. Its narrow 8° field of view makes it suitable for detecting intruders passing through doors or moving along corridors inside a building. In addition, it can detect the presence of persons or animals entering the defined sensitive zone along roads or paths outdoors.

The best results will be obtained if the instrument is mounted on a camera tripod or other rigid support. When securely mounted, it can be panned manually or by electric drive over a wide sector to obtain a wider field of view. That makes it easier for the user to discriminate between true and false targets.

Pyroelectric detector

The heat sensitive elements in this instrument are two lithium tantalate ($LiTaO_3$) crystals within the TO-5 metal transistor case of the pyroelectric detector. The metal case has a rectangular silicon window in its cap for admitting infrared energy as well as a high-value resistor, and a low-noise field-effect transistor (FET).

The pyroelectric detector and pinout are shown in Fig. 1-*a*, and Fig. 1-*b* is a simplified schematic of the sensor circuit. Thermal compensation within the case prevents errors due to ambient temperature variations. The detector has a spectral range of 6 to 14 microns centered on 10 microns in the infrared band. This range is determined by the characteristics of the silicon window at the end of the TO-5 case.

The infrared emission from human and animal body heat is in the 10 micron infrared (IR) band that corresponds to the "black body" temperature of 100°F (300 K) and a frequency of 30,000 GHz. All objects whose temperature exceeds absolute zero (0 K) radiate energy as a function of the fourth power of temperature.

When the pyroelectric detector is exposed to infrared radiation in the 6 to 14 micron band, the temperatures of its lithium tantalate crystals change, unbalancing the charges on each crystal's surface. This unbalanced condition, which shows up as a voltage variation at the output of the sensor, indicates that infrared energy has been detected. The dual crystals in the detector cancel signals obtained from sunlight, open fires, or radiators because the crystals in the device are oppositely polarized.

To detect infrared emission, either the heat-emitting target must be moving or a shutter must periodically break or "chop" the path between the target and sensor. In this detector, the path is chopped by a motor-driven shutter whose speed can be controlled.

Although a moving source will produce a changing signal, a rapidly moving object could be missed because of the instrument's narrow viewing angle and relatively slow detector response. As a result, you will probably want to operate the chopper motor for most object detection.

The infrared energy is focused on the sensitive rectangular window at the end of the detector case with a translucent plastic Fresnel lens, which has a focal length of approximately 5 centimeters. This translucent lens is transparent to infrared energy in the 10 micron region.

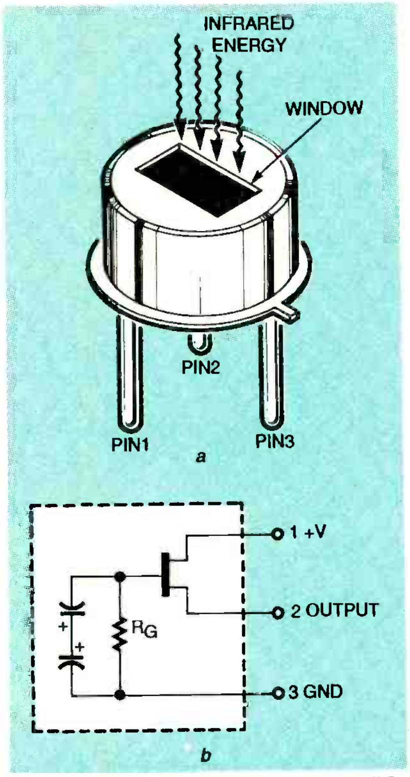


FIG. 1—DUAL-ELEMENT PYROELECTRIC detector pinout arrangement (*a*) and simplified schematic (*b*).

Operating modes

The thermal detector operates

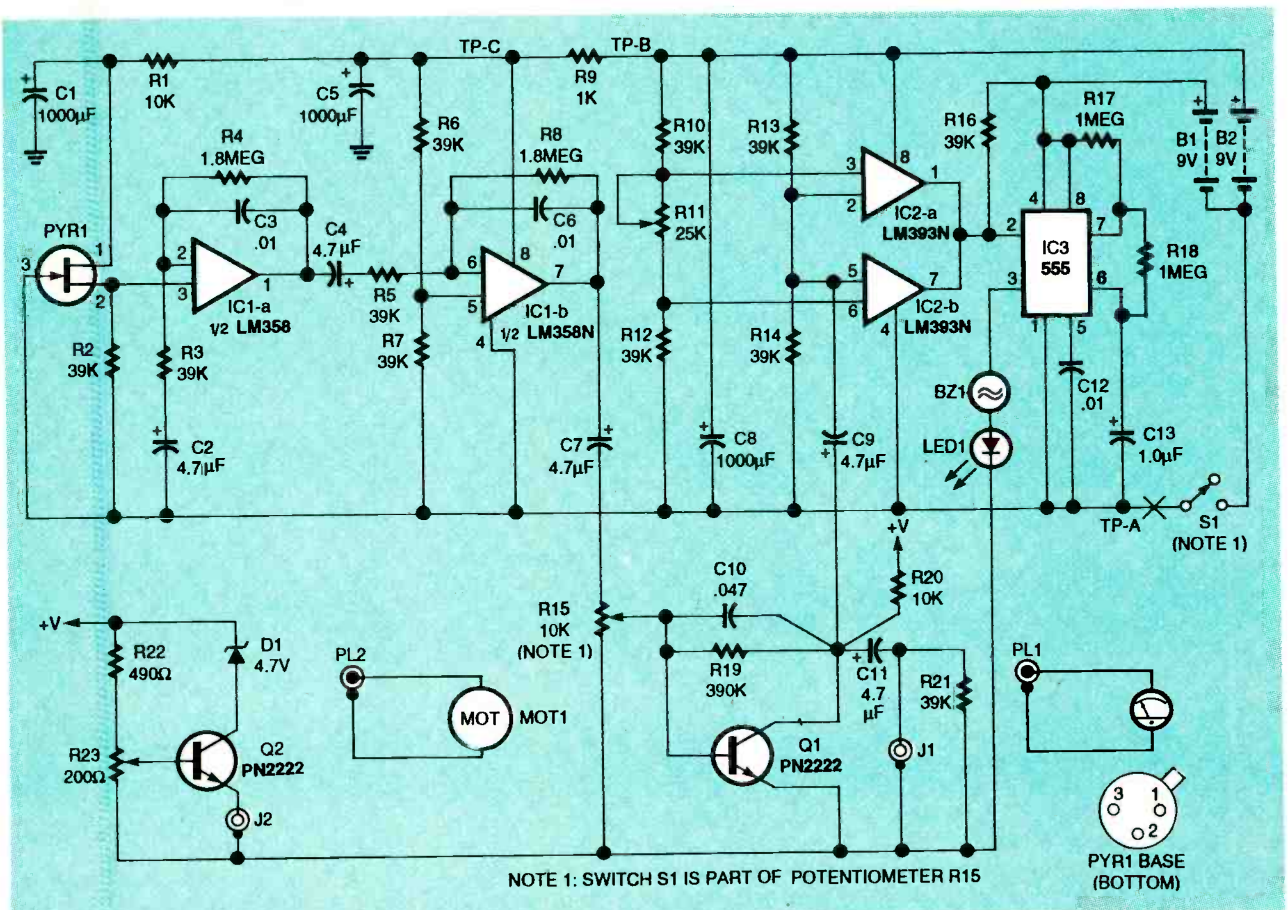


FIG. 2—SCHEMATIC FOR THE INFRARED DETECTOR CIRCUIT. Panel potentiometer R15, J1 and J2, and LED1 are located on the end cap of the amplifier section.

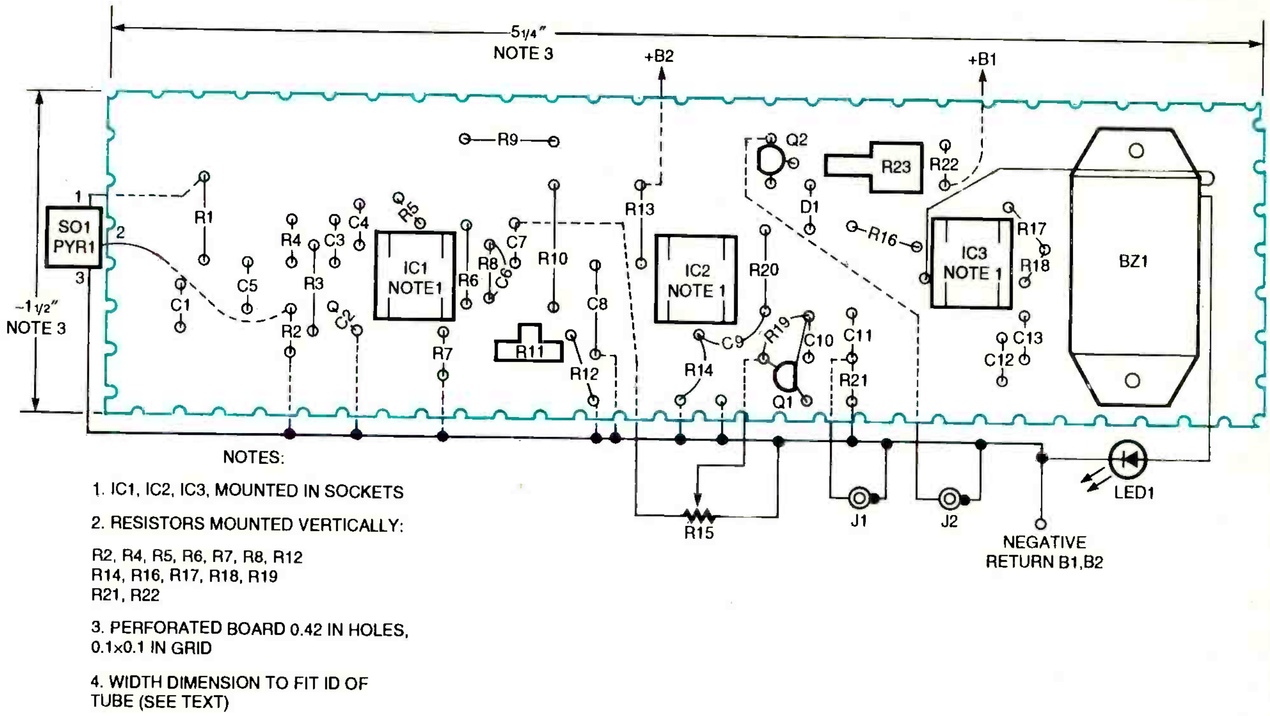


FIG. 3—LAYOUT OF THE CIRCUIT BOARD showing optimum component placement for point-to-point wiring. The circuit board width is determined by the inside diameter of the housing tube.

All resistors are ¼-watt, 10% unless otherwise specified.
R1, R20—10,000 ohms
R2, R3, R5, R6, R7, R10, R12, R13, R14, R16, R21—39,000 ohms
R4, R8—1,800,000 ohms
R9—1000 ohms
R11—25,000 ohms trimmer potentiometer, 8 mm vertical PC mount, Mouser Electronics 32RM403 or equivalent
R15/S1—1000 ohms control potentiometer, miniature panel mount, Mouser Electronics 31CT301 or equivalent
R17, R18—1,000,000 ohms
R19—390,000 ohms
R22—470 ohms
R23—200 ohms, trimmer potentiometer, 8 mm horizontal PC mount, Mouser Electronics 32RH202 or equivalent.

Capacitors
C1, C5, C8—1000 µF, 16 volts, aluminum electrolytic
C2, C4, C7, C9, C11—4.7 µF, 25 volts, aluminum electrolytic
C3, C6, C12—0.01 µF ceramic disc
C10—0.047 µF, 100 volts
C13—1 µF, 50 volts

Semiconductors
PYR1—dual pyroelectric detector, 3-pin TO-5 case, P2288 Hamamatsu Corp.
IC1—LM358N, dual operational amplifier, 8-pin DIP, National Semiconductor or equivalent
IC2—LM393N, dual comparator, 8-pin DIP, National Semiconductor or equivalent
IC3—NE555N timer, 8-pin DIP, Signetics or equivalent
Q1, Q2—N2222 NPN transistor
LED1—Light-emitting diode, T-1, yellow
D1—1N5230 Zener diode, 4.7 volts

Other components
BZ1—Piezoelectric buzzer, 6 volts, Mouser 25MS060 or eqivalent
J1, J2—Jack, 3.5 mm ID
PL1, PL2—Plug, 3.5 mm OD
MOT1—DC motor, 0 to 12 volts, low-torque , slow speed, MCM Electric No. 58-500 or equivalent.
SO1—transistor socket, 3-pin (for PYR1)

Miscellaneous: Fresnel lens, polyethylene, 0.77 focal length, 1½-inch, Fresnel Technical No. IR2 or equivalent, perforated circuit board, 0.1-inch grid (see text), plastic or metal tubing, end cap and inserts (see text), two sockets for 8-pin DIP ICs, T-1 LED snap-in holder, 28 AWG insulated tinned copper wire (nine-strand ribbon cable (see text), two 9-volt battery clips with insulated wires, two 9-volt alkaline transistor batteries, tinned copper wire, plastic adhesive, plastic screw, solder.

Note: The pyroelectric detector is available from Hamamatsu Corp. Bridgewater, NJ (201) 231-0960. The Fresnel lens is available from Fresnel Technical, 101 Morningside Drive, Ft. Worth TX 76110, (817) 926-7474.

The following items are available from Information Unlimited, Box 716 Amherst, NH 03031 (603)-673-4730, fax 603 672-5406;
• A kit of all parts including tubing cut to length, circuit board, pyroelectric detector, motor and all active and passive components except batteries—$69.50

• Pyroelectric detector and motor—$12.50
Please add $5.00 for shipping and handling. Allow 4 to 6 weeks for delivery.

in two detection modes: moving or stationary target. The moving detection mode permits the user to detect intrusions by *moving* people or animals. The detector's field of view in this mode is narrow enough to be able to sense intrusions in restricted spaces, and its detection range is about 100 meters. In this mode it rejects constant background thermal energy.

The stationary mode permits the detection of stationary "hot spots" against a "cold" background such as a back yard or open space at night. Preferred in a search for hidden persons,

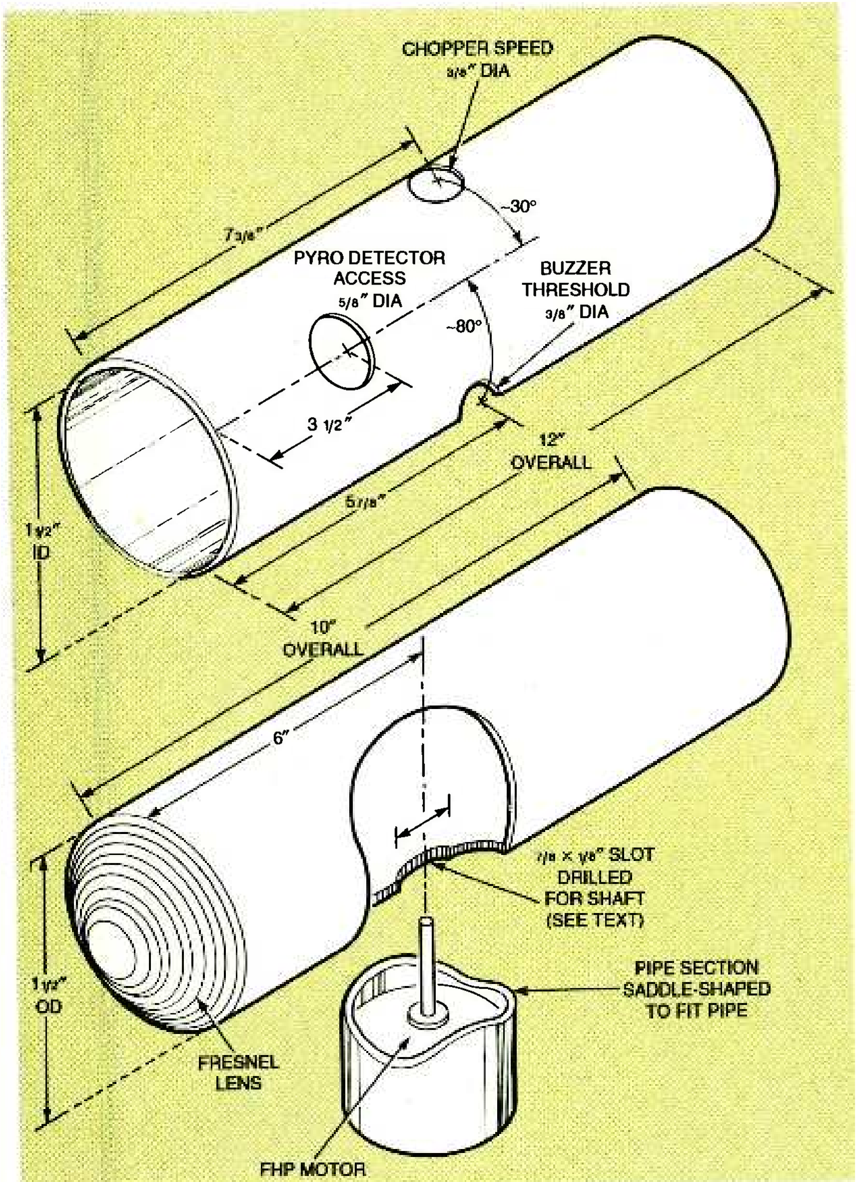


FIG. 4—CUTTING AND FORMING DIRECTIONS for the plastic or aluminum tubes for housing the sensor/amplifier and shutter/lens assemblies.

animals, or heat sources, this mode is so sensitive that some valid responses might seem to be false alarms.

System operation

Refer to the schematic, Fig. 2. The output of pyroelectric detector PYR1 is fed to the input of the low-frequency, dual-stage amplifier and filter IC1. The LM358N amplifier IC1-a, with a gain of about 2500, responds to a frequency of 0.1 to 10 Hz, peaking at about 1 Hz. This range matches the response of PYR1 to the infrared spectrum commonly generated by humans or large animals that is centered at about 10 microns.

The changing output of the filter IC1-b is further amplified by a factor of about 40 by PN2222 transistor Q1. This output can be capacitively coupled to an AC meter through EXTERNAL AC METER JACK J1. The output of J1 is an analog indication of signal strength, which should be between 20 and 100 millivolts.

The AC output of Q1 is also fed to IC2-a and b, an LM393N dual plus or minus "window" comparator. Trimmer potentiometer R11 sets the threshold activation level for buzzer BZ1. The output of IC2-a and b is sent to an AND gate, and its output is sent to the pin 2 TRIGGER input of the NE555N timer IC3.

The output of IC3 can activate buzzer BZ1 and LED1 that are connected in series. LED1 illuminates when a target has been detected. Buzzer BZ1's on time is controlled by the 1-megohm timing resistors R17 and R18 across pins 8, 7 and 6, and capacitor C13 at pin 6. Panel potentiometer R15 (located on the end cap of the case) adjusts system temperature range and response to anticipated target size and temperature.

An optional chopper motor speed control consists of PN2222 transistor Q2 and trimmer potentiometer R23. Zener diode D1 provides a positive turn-on signal. Jack J2 provides DC drive for the shutter motor MOT1 through PL2.

External controls

Three access holes are formed in the tubular enclosure for the detector. One access port permits the lens position to be adjusted and the angle of PYR1 to be aligned for optimum results when the finished instrument is being set up. (This port is covered with an opaque band or tape to keep out ambient light when the instrument has been adjusted.)

Two other access holes are formed in the case to permit the two trimmer potentiometers R11 (buzzer threshold) and R23 (chopper motor speed adjust) to be set by a small insulated screwdriver or plastic trimmer adjusting tool. Panel-mount control potentiometer R15 can be set by a knob fitted on its shaft.

Chopper motor MOT1 speed can be set for optimum shutter chopping speed for detecting stationary objects by trimmer potentiometer R23. It produces the necessary "step function" in the infrared input signal.

Case material

Obtain a 12-inch length of aluminum or plastic tubing with an inner diameter of approximately 1.5 inches and a wall thickness of approximately 0.060 inch. Obtain a suitable plastic or aluminum cap with an inside diameter that will fit

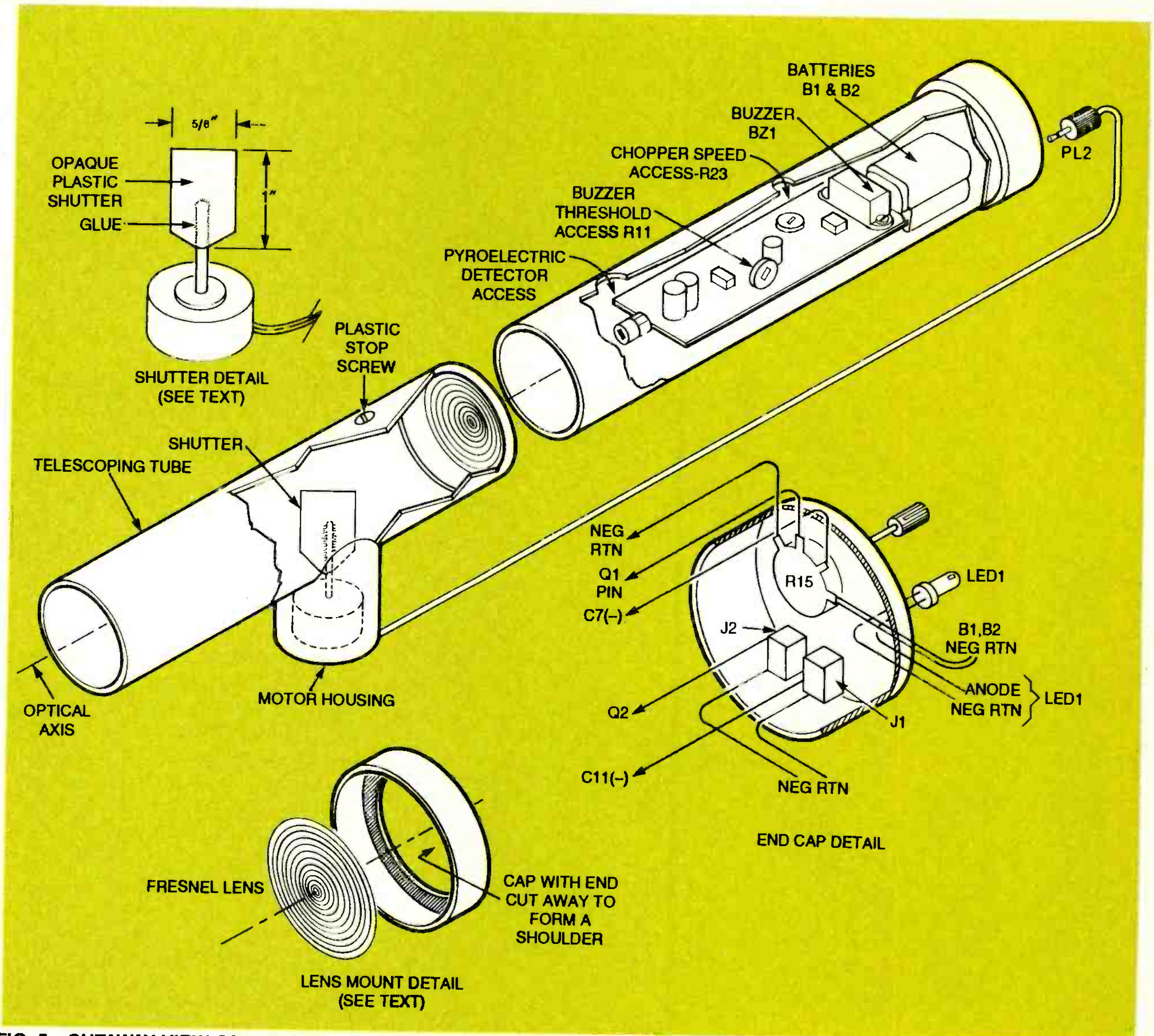


FIG. 5—CUTAWAY VIEW OF THE INFRARED BODY HEAT DETECTOR with details for making the shutter, lens mount, and end-cap assemblies.

snugly over the end of the tube.

Also obtain a 10-inch length of aluminum or plastic pipe with an exterior diameter of about 1.5 inches and a wall thickness of about 0.060 inch that telescopes snugly inside the larger tube. Then obtain an aluminum or plastic cap or cup about 1 inch deep that will fit snugly inside the smaller diameter tube.

Circuit board assembly

Refer to the electrical schematic Fig. 2 and the parts layout diagram Fig. 3. The amplifier circuit board was dimensioned to contain all of the electronic components and be able to slide inside the tubular case. The prototype circuit board was cut from perforated board with a 0.1 inch grid to a length of 5¼ inches by 1½-inches, the approximate inside diameter of the housing tube. The width of the board should be cut slightly oversize. It can be sanded or ground down so that it can be press fit snugly inside the tube.

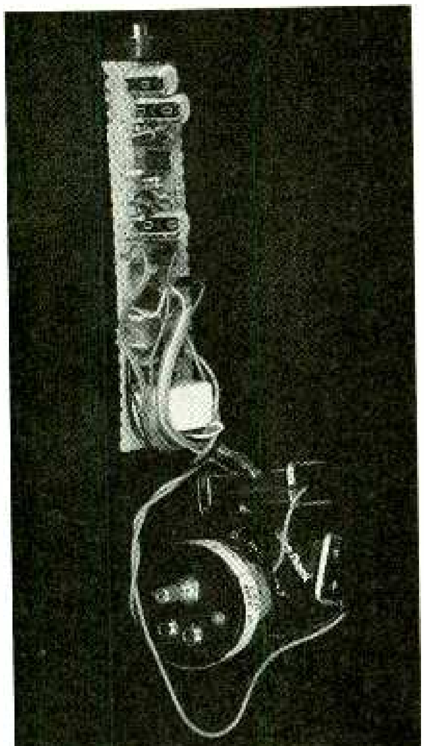
The parts layout as shown in Fig. 3 is intended to keep interconnection leads as short as possible. All connections are made with untrimmed component leads except for a bare wire bus that runs along the edge of the board on the wiring side. However, it might be necessary to solder tinned wire extensions on the ends of some sockets.

With Fig. 3 as your guide, insert the socket for pyroelectric detector PYR1 on the centerline of the board at the edge as shown. Then position the electronic components in the punched holes in the approximate positions shown in Fig. 3. In the prototype, resistors R2, R4, R6, R7, R8, R12, R14, R18, R19, R21 and R22 were all mounted vertically to conserve board space. One lead of each was bent back 180° to form a radial-leaded component.

Pay particular attention to the positions of the polarized devices and the pin 1 positions on the IC sockets. Bend the excess lead lengths on the wire side to form mechanical connections before doing any soldering.

Note the ground bus wire that connects pin 3 of SO1 with the negative sides of resistors R2, R7, R12, R14, R15, R21 and R23, as well as the negative sides of capacitors C2, C8, C12 and C13. In addition, this bus connects pin 4 of both IC1 and IC2 and the cathode of LED1 with one side of S1 (R15).

After completing all component insertion and soldering, check the circuitry visually against the schematic to be sure that all component placement is correct. Check for cold solder joints (dull gray color without evidence of solder flow), inadvertent solder bridges, or excessive solder on joints. Make all corrections before proceeding.



CIRCUIT BOARD AND END CAP assembly with batteries. The pyroelectric detector is at the top.

Mechanical assembly

Form the access holes in the 12-inch length of tubing as shown in Fig. 4. Then cut a slot that measures approximately ⅝-inch by ⅛-inch wide in the 10-inch tube as shown. Cut a small section of pipe that will accommodate the outside diameter of the DC shutter motor. Form a hole in the side of the section to accept the twin-wire power cord, and shape the upper edge of the motor housing to form a saddle so that it will fit snugly against the pipe section.

Refer to the end cap detail in Fig. 5, and form the necessary holes in the tube cap to accommodate the two jacks J1 and J2, the light-emitting diode LED1 in a snap-in holder, and the combined potentiometer R15 and switch S1. Assemble those part in the cap and fasten them with the ring nuts provided.

End cap wiring

Cut approximate ten-inch lengths of No. 28 AWG insulated copper hookup wires required to connect the circuit board with the end cap components. The wires should be long enough to permit the end cap to be removed for replacing batteries B1 and B2 without removing the circuit board. In the prototype, nine-wire 28 AWG, multicolored flat-ribbon cable was used to make the nine connections from the circuit board to the cap.

Separate the individually color-coded insulated wires on both ends as necessary to make the appropriate connections. (If about an 8-inch length of flat cable remains bonded, it is easier to fold the cable back into the housing after final assembly.) Cut the black and red insulated wires from the 9-volt battery clips to about 10-inch lengths. Strip all wire ends, and twist all related pairs of wires before making the connections and soldering them.

Recheck the complete assembly looking for short circuits, cold solder joints, and improper location and orientation of polarized components. The circuitry can now be tested.

Electrical test

Install IC1 and IC2 in their sockets. Preset all potentiometers full counter clockwise with the pyroelectric sensor PYR1 out of its socket. Connect the 9-volt batteries B1 and B2 to their battery clips. Connect an ammeter on the 0 to 100-milliampere scale in series with the common leads of both batteries across switch S1 at test point A (TP-A) and measure the current. It should be between 15 and 20 milliamperes.

Turn the control knob of potentiometer R11 clockwise until the buzzer sounds. Expect to read a current of 60 milliamperes when LED1 is lit simultaneously. A voltage reading of 9 volts should be obtained at test point B (TP-B) and a voltage reading of 8.5 volts should be obtained at test point C (TP-C). Back off R11 slightly until the buzzer sound stops.

Insert pyroelectric detector PYR1 in its socket and slowly turn panel potentiometer R15 clockwise until the buzzer sounds. Keep PYR1 focused on a cold stationary background to prevent the detector circuit from responding erroneously to any movement. Make trial adjustments of R15 to verify the presence of a valid signal by passing your hand near the detector. Maximum sensitivity should be obtained when R15 is full clockwise and R11 is set to the critical activation point.

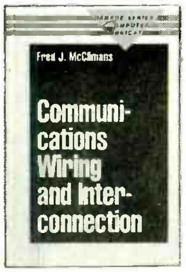
Connect a sensitive AC millivoltmeter set to the 500-millivolt range to jack J1, and watch for a response as an object or hand is placed in front of the detector.

Instrument housing

Refer to the lens-mount detail on Fig 5. Cut out the end of the aluminum or plastic cup that fits inside the 10-inch tube so that a shoulder about 1/16-inch wide is left as a retainer for the lens. Insert the lens in the aluminum sleeve and fasten it with one or two drops of a suitable adhesive. Then insert the lens assembly in the end of the tube as shown. Cement the assembly in place with an additional one or two drops of adhesive.

Refer to the shutter detail on Fig. 5. Assemble the chopper motor in the prepared housing. Then cut a thin piece of opaque plastic to the approximate dimensions shown, and glue it with suitable adhesive to the motor shaft as shown. After the adhesive has set, insert the shutter into the tube as shown in Fig. 5, and clamp the motor

Continued on page 87



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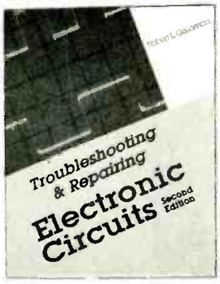

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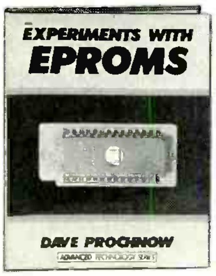

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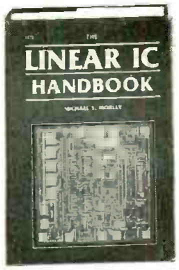

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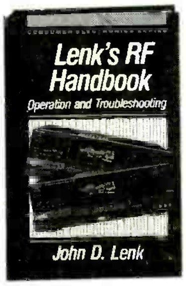

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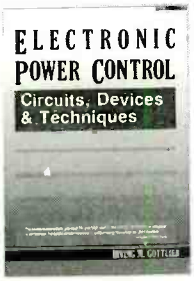

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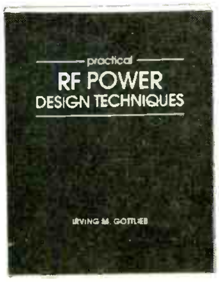

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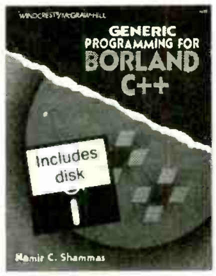

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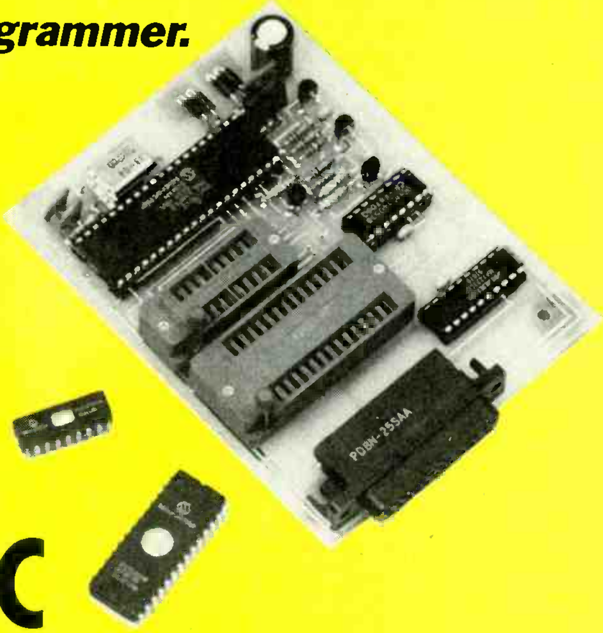
We hope you PICed up all the parts you need because it's time to build the PIC programmer.



PIC MICROCONTROLLER PROGRAMMER

FRED EADY

LAST MONTH THE OPERATING THEORY of a PIC programmer was covered. This month, complete construction details are provided, along with details on a programmer for use with PIC17C42 devices.

Programmer construction

The PIC programmer can be assembled with point-to-point wiring, but assembly time and the possibility of wiring errors can be reduced dramatically by using a PC board. If you do not have the facilities to create the double-sided PIC programmer board (the foil patterns are presented here), you can obtain a professionally manufactured one from the source mentioned in the Parts List. To guarantee that the PIC16C5X programmer will operate properly once it's complete, we will simultaneously assemble and test the PIC programmer components as we proceed. Use the parts-placement diagram in Fig. 4 as a guide.

First, build and test the power supply. Install diodes D1–D4, paying attention to the orientation of the cathode bands on the diodes. Next, install bypass capacitors C2 and C10. Install the 7805 voltage regulator, IC6, with the metal tab facing the diodes. Finally, install capacitor C6, being careful to orient the positive lead as noted in Fig. 4. Temporarily attach the 18-volt AC transformer leads to the pads marked "AC" and apply power. You should measure +27-volts DC across C6 and +5 volts DC on pin 3 of the 7805. If all is well, install the remaining capacitors, XTAL1, and all of the resistors.

Apply power and check the +27- and +5-volt points again. If the voltages are correct, disconnect power and install IC5. Apply power again and check for +5.9 volts at the output (pin 2) of IC5. Then remove power, and jumper pin 24 of IC2 to ground. (The 7805's metal tab is a good ground point.) Apply power and check for +4.9 volts at pin 3 of IC5.

If all the voltages are obtained, you have successfully installed the +5-volt supply and the switchable target V_{CC} voltages. Now remove power and install transistor Q1. Jumper IC2 pin 23 to ground, apply power, and check for 0 volts at pin 14 of target socket ZIF1. Remove the jumper from IC2 pin 23 and the voltage at IC4 pin 14 should rise to +5.5-volts DC. Remove power before continuing.

Install voltage regulator IC4, apply power, and check for +13.5 volts at pin 2. If it checks out, remove power and install transistor Q2 and IC3. You can solder ICs directly to the PC board, but IC sockets are recommended. Apply power and check for +13.5 volts DC at pin 15 of IC3. Remove power and jumper IC2 pin 28 to +5 volts DC. The voltage at IC3 pin 15 should be 0 volts with the jumper installed and +13.5 volts with the jumper removed. Remove power and install the remaining IC sockets and DB-25 connector J1. Do not install any other ICs at this time.

After all of the IC sockets are soldered in place, check for +5 volts at pin 7 of the IC1 socket and pin 1 of the IC2 socket. Recheck your work, looking for solder bridges and cold solder joints. Once you are satisfied that everything is correct, install the remaining ICs in their sockets and permanently connect the transformer leads to the board.

For the final test, apply power to the completed PIC programmer board, but do not install any target PICs at this time. Check all components for overheating or any other obvious malfunctions, and correct any problems. Connect the PIC programmer to the serial port (COM1 or COM2) of an IBM-standard computer. Run the PICPROG terminal program (it is available on the Electronics Now BBS, 516-293-2283, 1200/2400, 8N1, as a file called PICPROG.ZIP) by typing PICPROG and pressing the enter key. You should get a screen full of descriptive text explaining how to use the PICPROG program. Enter "PICPROG B 54 1" if you are using COM1. Enter "PICPROG B 54 2" for COM2. Press the enter key. You should get a banner followed by "PIC IS NOT BLANK" or "PIC IS BLANK." This verifies that the serial port and PIC17C42 on the PIC programmer are functioning. At this point you can install ZIF (zero insertion force) sockets into the target IC sockets. They allow for easy insertion and extraction of target PICs during the program-development process. Your PIC16C5X Microcontroller Programmer is now ready for use. Figure 5 shows what the completed programmer looks like.

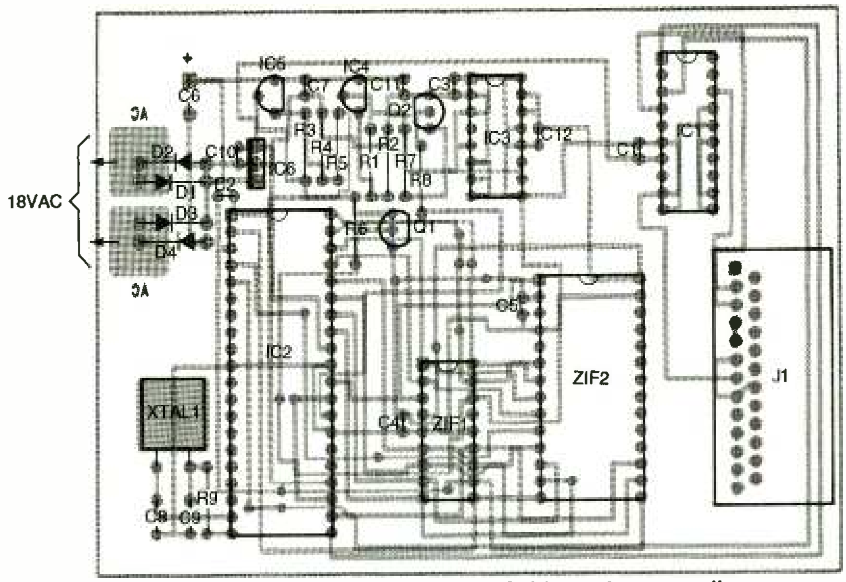


FIG. 4—PARTS-PLACEMENT DIAGRAM for the PIC16C5X microcontroller programmer. You can make your own board or you can obtain one from the source mentioned in the parts list.

Using the programmer

To use the PICPROG terminal, simply type "PICPROG" which will display a command syntax screen with an example entry. The PICPROG terminal program is designed to help you use it automatically. For example, if you enter "PICPROG B," an incomplete blank-check command, the program will respond with an error message informing you that you left out a parameter. The correct blank-check command syntax is displayed, and an example blank-check entry is offered to help you enter the correct command. There is very little left to chance when using PICPROG. To make it even easier, many of batch files are included to simplify the PIC programming process. For instance, to blank check a PIC16C54, execute B54.BAT. Likewise, P54.BAT is used to program a PIC16C54 and R54.BAT will read the same device. You can custom tailor the batch files to match your system parameters.

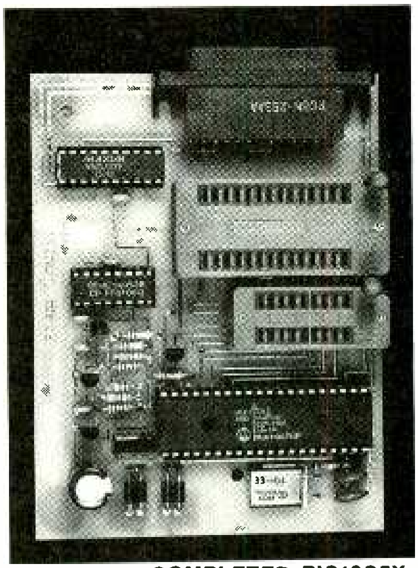


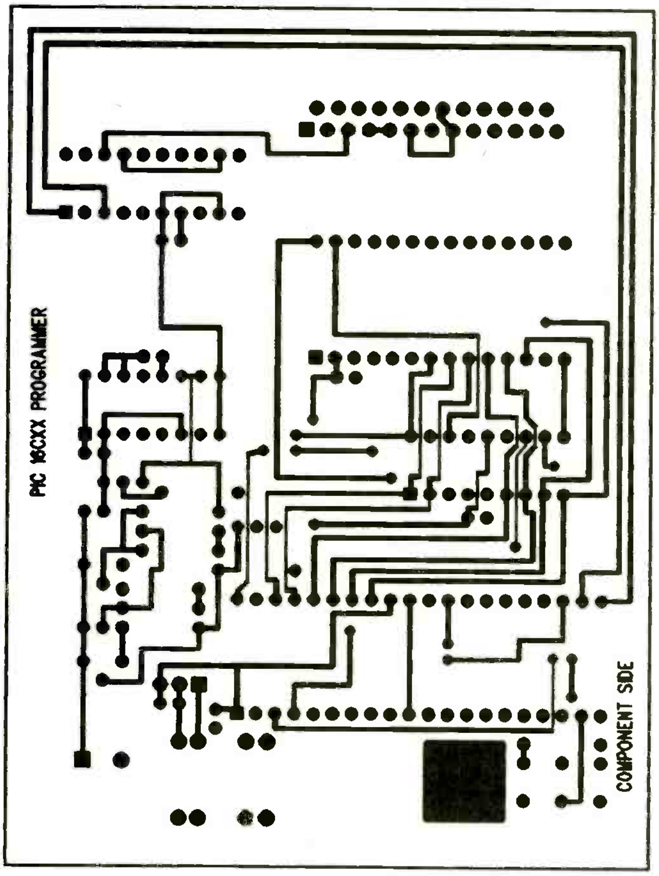
FIG. 5—THE COMPLETED PIC16C5X programmer. The ZIF sockets allow for easy insertion and extraction of target PICs during the program development process.

TABLE 1—FUSE DETAILS

Fuse	S1 Position	Address	Function
FOSC0 FOSC1	1 2	FE00h FE01h	FOSC1, FOSC0: 00 : LP oscillator mode 01 : RC oscillator mode 10 : XT oscillator mode 11 : EC (external clock mode)
FWDT0 FWDT1	3 4	FE02h FE03h	FWDT1, FWDT0: 10 : WDT prescale is 256 01 : WDT prescale is 64 11 : WDT prescale is 1 00 : WDT is a normal timer
FPMM0 FPMM1	5 7	FE04h FE06h	FPMM1, FPMM0: 00 : Microcontroller mode (code protected) 10 : Micrcontroller mode 01 : Extended microcontroller mode 11 : Microcontroller mode
FGLWP	6	FE05h	FGLWP: 0 Global write protection on 1 Global write protection off

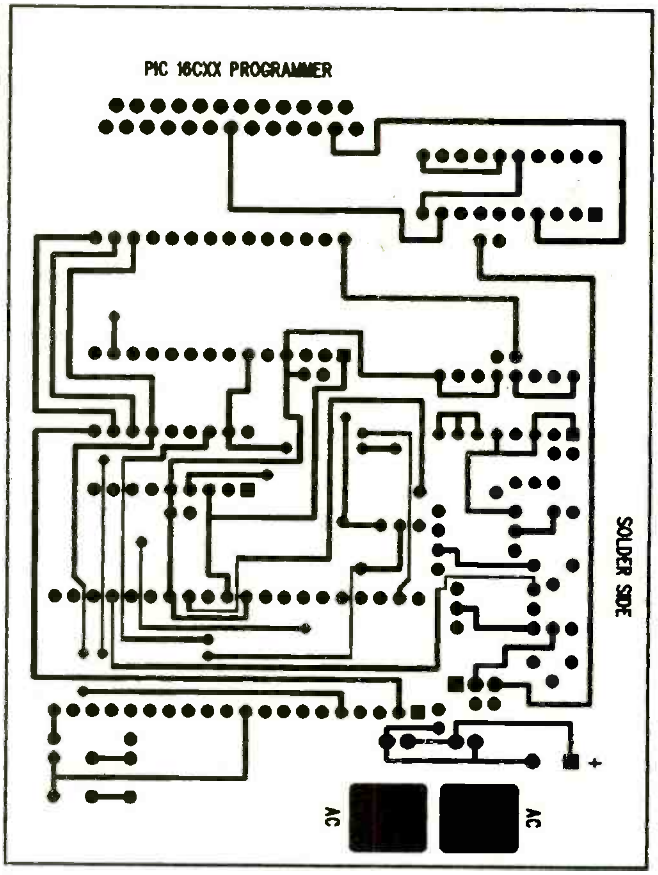
PIC17C42 programmer

For those of you who want to build the programmer entirely from scratch, Fig. 6 is a schematic for a PIC17C42 programmer module. All of the 8749H microcode and the PIC17C42



3 3/8 INCHES

COMPONENT SIDE for the PIC16C5X programmer PC board.



3 3/8 INCHES

SOLDER SIDE for the PIC16C5X programmer PC board.

PIC16C5X PROGRAMMER PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted
R1, R3—237 ohms, 1%
R2—2320 ohms, 1%
R4—866 ohms, 1%
R5—3090 ohms, 1%
R6–R8—10,000 ohms
R9—430 ohms

Capacitors
C1–C5, C7, C10–C12—0.1 µF, 25 volts, monolithic
C6—330 µF, 35 volts, electrolytic
C8, C9—27 pF, 5 volts, NPO

Semiconductors
IC1—MAX233 RS-232 transceiver (MAXIM)
IC2—Pre-programmed PIC17C42 microcontroller (Microchip)
IC3—CD4053B CMOS multiplexer
IC4, IC5—LM317LZ voltage regulator
IC6—7805 5-volt regulator
D1–D4—1N4002 diode
Q1, Q2—PN2222A NPN transistor

Other components
ZIF1—18-pin zero-insertion-force socket for PIC16C54/56 target microcontroller
ZIF2—28-pin zero-insertion-force socket for PIC16C55/57 target microcontroller
XTAL1—10 MHz crystal
T1—18 VAC transformer, 500 mA
J1—PC-mount female DB-25 connector
Miscellaneous: PC board, IC sockets, 25-conductor ribbon cable, etc.

Note: The following items are available from E D Technical Publications, P.O. Box 541222, Merritt Island, FL 32954, Phone/Fax 24 hours 407-454-9905:
- **Complete PIC16C5X kit including PC board, transformer, female DB-25 connector, and all electronic parts (no ZIF sockets or cables)—$69.95**
- **PC board only—$30**
- **Programmed PIC17C42—$30**
- **Software on diskette—$10**

Please add $7.50 shipping for the full kit and $3.00 shipping for parts and software. Check, money order or COD only.

terminal program, both source and executable code, can be obtained from the Electronics Now BBS (516-293-2283) or from the E-D Technical Publications BBS (407-454-3198).

The prototype for this programmer was assembled with wire-wrap techniques. The power system and serial I/O subsystem contained on the PIC16C5X board were used, and the power, data, and control connections were jumpered, via a 40-pin header and matching socket, across to the PIC17C42 programmer module. That makes for quick and easy assembly. You can also build up all the power system and other components on one breadboard if you wish. A 7407 open-collector buffer (IC5) emulates the open-collector pins on the PIC16C5X programmer.

Be sure to provide adequate heatsinking for the LM7805 regulator (IC6) as it is supplying power for most of the non-CMOS parts. Bypass capacitors C2–C5 are a must. Although parts placement is not critical, it is recommended that you stick close to the prototype layout shown in Fig. 7.

An 8749H (IC2) controls the programming process, and an 8255 (IC3) provides the extra I/O pins that are necessary to accommodate the 16-bit data bus

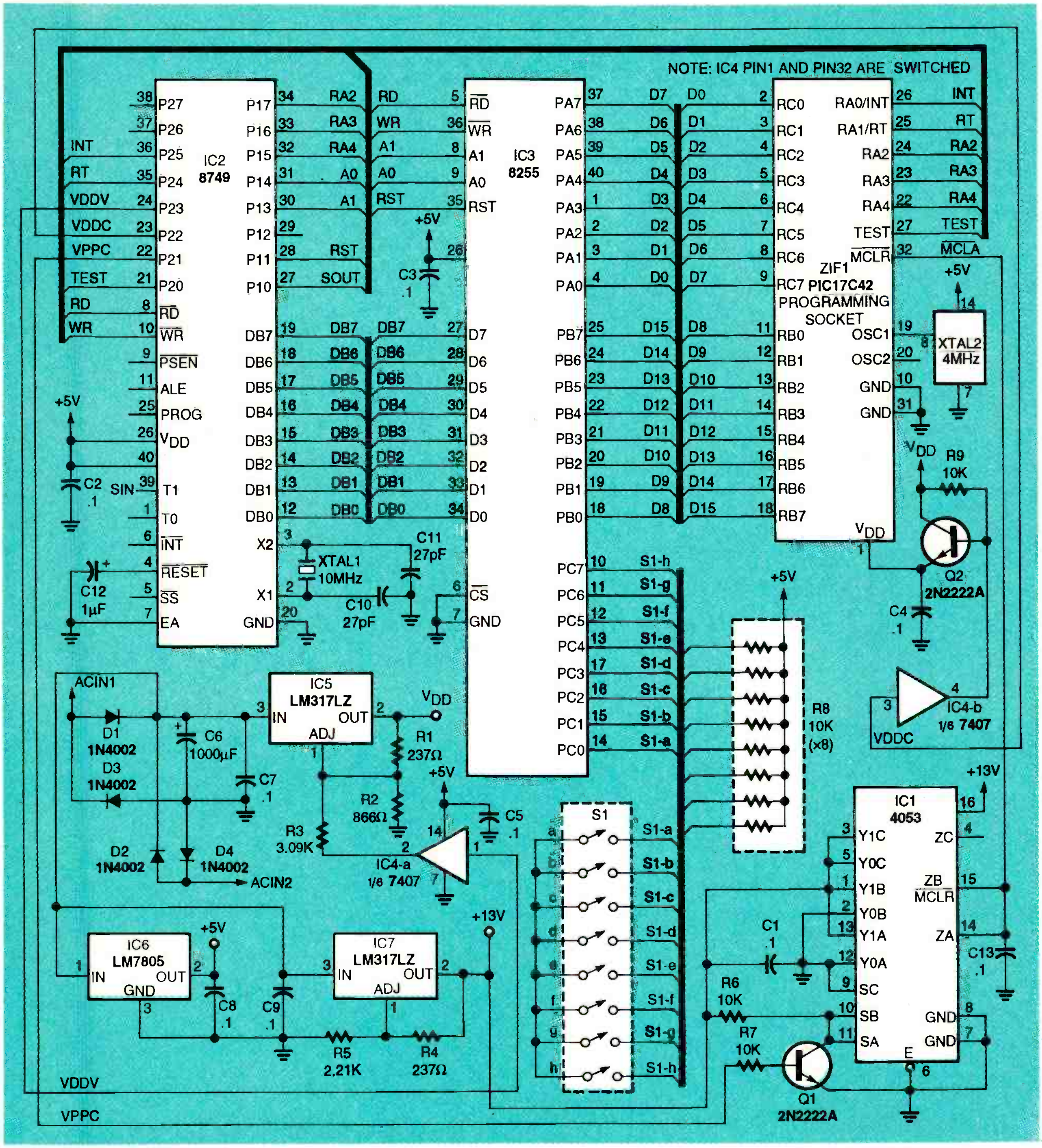


FIG. 6—PIC17C42 PROGRAMMER MODULE. The PIC16C5X programmer uses a pre-programmed PIC17C42, and this module will let you program it yourself.

of the PIC17C42. Most of the control functions are provided by the on-board I/O of the 8749H. The completed PIC17C42 programmer communicates via a serial connection to the terminal program. You can use the same MAX233 serial I/O circuit that was used on the PIC16C5X programmer. Also note that T1 is the input pin on the PIC17C42 programmer.

The PIC17C42 is programmed like other PIC16C5X MCUs, with the exception that an internal ROM-programming routine built into the PIC17C42 eliminates much of the programming overhead that is usually required for such devices. Data is transferred via the 8749H data bus to the data bus of the 8255 I/O subsystem. The 8255 passes the 16-bit programming between the target PIC17C42 and the 8749H. The 8255 also reads the configuration fuse settings that are set up by DIP switch S1. Table 1 gives the fuse details. Setting a switch to read "0" at the 8255 input port pin will blow (set to "0") that particular fuse.

The PIC17C42 requires that a clock signal be fed into CLKIN (pin 19) for programming, and

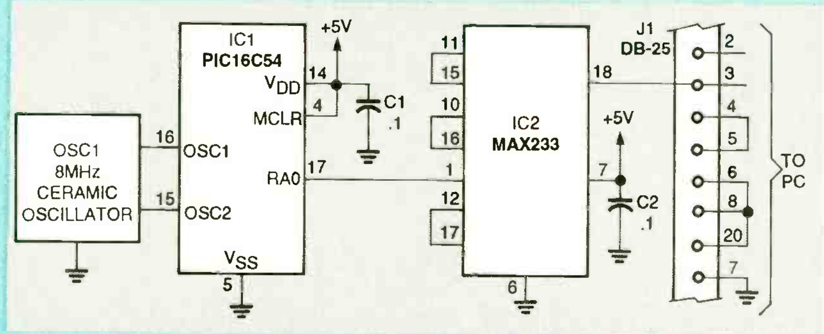
SEEPIC

The author has developed a simple program and hardware combination (shown here) for the PIC16C5X Microcontroller Programmer called SEEPIC. It will execute a PIC instruction or set of PIC instructions and display the resulting PIC register file contents on your terminal or PC with a 9600 BPS serial link. To use SEEPIC insert your small test program into the skeleton SEEPIC code and program the resulting compiled code into a PIC16C54. A MAX233 allows a connection to be made to your PC's serial port. Run whatever communication software you are comfortable with, and you should get a binary display of all of the PIC16C54 registers including the W register on screen. SEEPIC runs your test program only once, so you must remove and apply power to the programmed test PIC to run the program again. SEEPIC is designed as a learning tool. Writing code and seeing a result is the best way to learn how any microcontroller works. SEEPIC provides examples of a 9600 bps serial routine and many common functions you will use when you apply the PIC in your projects.

The author has also written a PIC cross-assembler that is included with the PIC programmer PICPROG software package. You can obtain all the batch files, PICPROG, SEEPIC, and the PIC cross-assembler from the Electronics Now BBS as the file called PICPROG.ZIP.

PARTS LIST FOR SEEPIC

IC1—PIC16C54
IC2—MAX233
C1, C2—0.1 µF bypass
8-MHz ceramic oscillator, DB-25 shell connector, perforated construction board, serial cable, wire, solder, etc.



SEEPIC SCHEMATIC. This simple hardware/software combination for the PIC16C5X Microcontroller Programmer will execute a PIC instruction or set of PIC instructions, and display the resulting PIC register file contents on your terminal or PC with a 9600 BPS serial link.

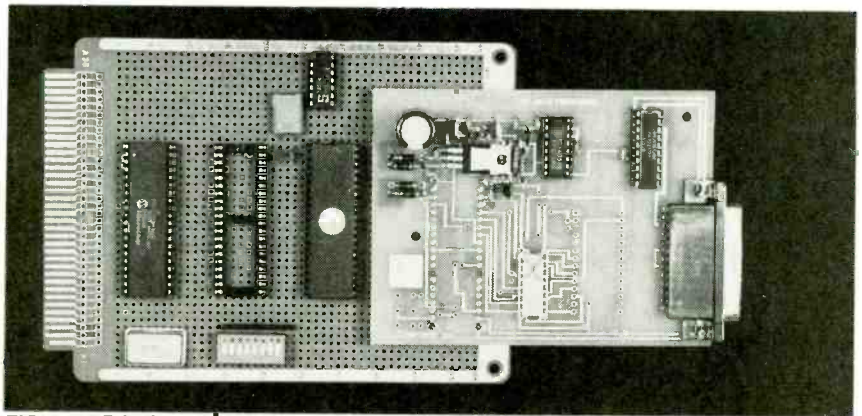


FIG. 7—PROTOTYPE PIC17C42 PROGRAMMER. The circuit is point-to-point wired.

PIC17C42 PROGRAMMER PARTS LIST

Resistors
R1, R4—237 ohms, 1%
R2—866 ohms, 1%
R3—3090 ohms, 1%
R5—2320 ohms, 1%
R6, R7, R9—10,000 ohms, 5%
R8—10,000 ohms × 8, 9-pin SIP
Capacitors
C1–C5, C7–C9, C13—0.1 µF, bypass
C6—1000 µF, electrolytic
C10, C11—27 pF, ceramic
C12—1 µF, Tantalum
Semiconductors
IC1—CD4053B CMOS multiplexer
IC2—8749H microcontroller
IC3—82C55 programmable peripheral interface
IC4—7407 TTL hex buffer
IC5, IC7—LM317LZ adjustable regulator
IC6—LM7805 5-volt regulator
D1–D4—1N4002 diode
Q1, Q2—PN2222A NPN transistor
Other components
XTAL1—10 MHz crystal
XTAL2—4 MHz oscillator
S1—8-position DIP switch
ZIF1—40-pin zero-insertion-force socket for PIC17C42 target microcontroller

XTAL2, a 4 MHz oscillator, is provided for this purpose. For a detailed bit-by-bit account of how the PIC17C42 programmer works, study the fully commented source code.

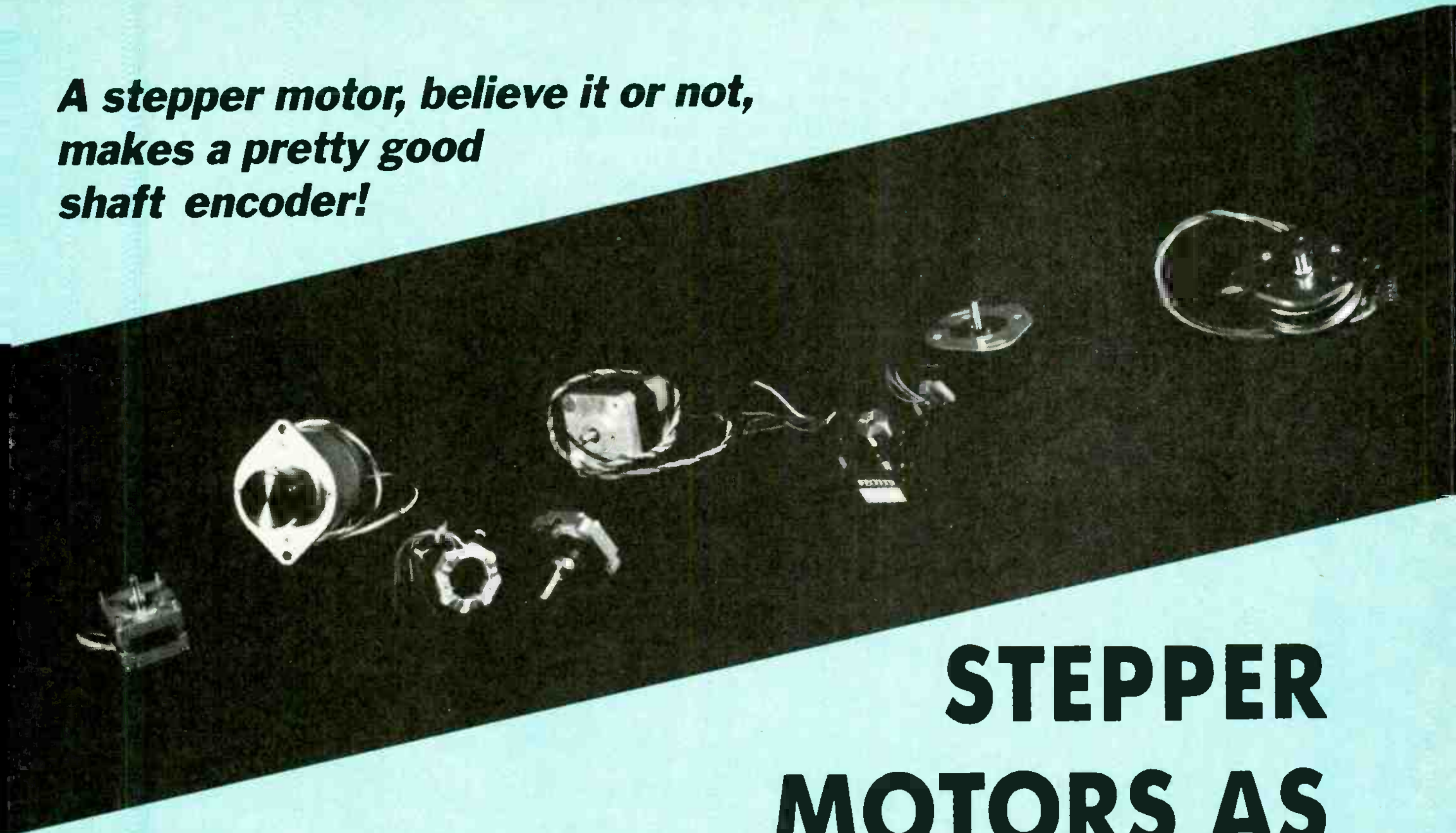
Using the PIC17C42 programmer should be a snap. There is only one caution to observe: never apply or remove power to the programmer module with a target PIC17C42 socketed. It could damage the target device. With that in mind, apply power to the programmer module and start the terminal program (17C42.EXE). A "READY FOR COMMAND" should be displayed as a flashing message indicating that the terminal program has made contact with the programmer module. Load the binary image of what is to be programmed (PICPRGR.BIN if you want to build the PIC16C5X project), insert a blank target PIC17C42. and press P to program. The programming algorithm will execute and end successfully with a "VERIFY OK" message. The PIC17C42 is then ready for service.

Conclusion

We hope you have "PICed" up enough information to realize what fantastic devices PIC microcontrollers really are, and how easy they are to use. For more PIC details, get your hands on the Microchip Data Book and the Microchip Embedded Control Handbook (Microchip Technology, Inc., 2355 W. Chandler Blvd., Chandler, AZ 85224-6199, 602-963-7373).

The author is always happy to offer readers any assistance he can, so you should feel free to PIC up the phone and direct your PIC-related questions to the HELPLINE at 407-454-9905. Ω

A stepper motor, believe it or not, makes a pretty good shaft encoder!



STEPPER MOTORS AS SHAFT ENCODERS

NEIL W. HECKT

SHAFT ENCODERS ARE USUALLY OPtoelectronic devices that produce quadrature (90-degree) signals in response to the rotation of a shaft. The phase relationship of the signals depends on the direction of rotation, and the pulse rate depends on the speed of rotation.

Shaft encoders are difficult to build, because they require mechanical construction. They are also somewhat expensive, starting at about $30, and rarely seen on the surplus market. This article describes how to use stepper motors as replacements for optical shaft encoders. Stepper motors are commonly found on the surplus market. The small permanent-magnet (PM) motors used in floppy-disk head positioning can be purchased for as little as $2 each.

Stepper motors are also quadrature devices. This means quadrature-related drive signals cause the shaft to rotate a precise amount. As in a shaft encoder, the phase relationship of a stepper motor's drive pulses determines its direction of rotation, and the rate of pulses determines its speed of rotation. Just as a standard electric motor can also be used as a generator, a stepper motor can generate quadrature phased output pulses in response to mechanical rotation of its shaft.

Figure 1 is a simplified diagram of stepper motors construction. The PM stepper motor consists of a rotor and a stator. The rotor is fabricated from a cylindrical permanent magnet, or more precisely, a spool-shaped permanent magnet. Teeth, like those found on gears, are ground into the north pole of the magnet, and an identical set of teeth, offset by ½ the tooth pitch, are ground into the south pole of the magnet. This can be seen in Fig. 1. Since the rotor in Fig. 1 has 5 teeth, the tooth pitch is 360/5, or 72 degrees. In actual stepper motors, there are usually a lot more than five teeth used. Figure 2 is a photo of a disassembled 200 step/revolution stepper motor that has 50 teeth in each row.

The stator consists of an iron-core electromagnet whose poles have the same spacing as the teeth on the gears less one tooth. Figure 1 shows that there are four poles. In a practical stepper motor there are several windings for each phase, and each winding has teeth ground on its surface to provide the effect of many more stator poles.

Stepper motor operation

Operation of the stepper motor (as a motor, and not a shaft encoder) is shown in Figs. 3 to 7. Currents are induced in the stator windings to produce magnetic poles, north (N) and south (S), as indicated on the stator pole pieces. The flux polarity of the rotor's magnetic poles are fixed by the permanent-magnet core, and each tooth possesses that flux density. The teeth are numbered to help the reader keep track of each tooth during rotation.

Figure 3 shows an arbitrary initial position (called state 0), in which the stator has a north pole at the top and a south pole

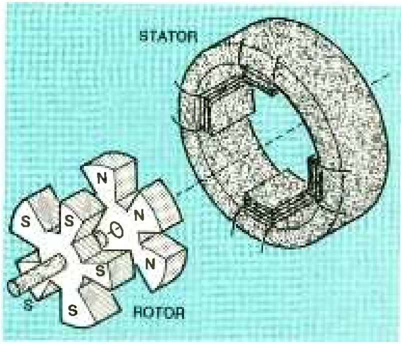


FIG. 1—A SIMPLIFIED DIAGRAM shows how stepper motors are built.

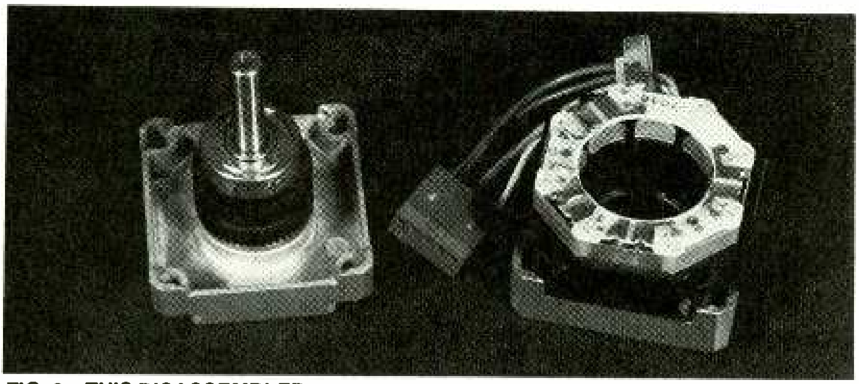


FIG. 2—THIS DISASSEMBLED 200 step/revolution stepper motor has 50 teeth in each row.

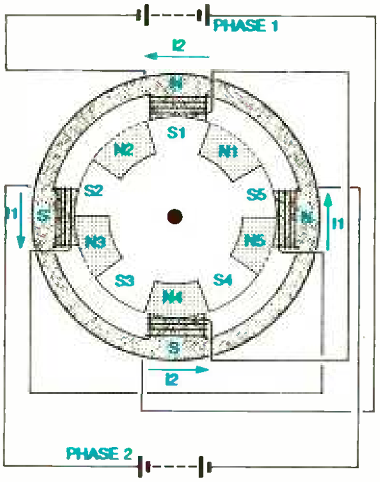


FIG. 3—THE INITIAL POSITION (state 0) results from the stator with a north pole at the top and a south pole at the bottom. They are opposite a rotor south pole (S1) at the top and north pole (N4) at the bottom.

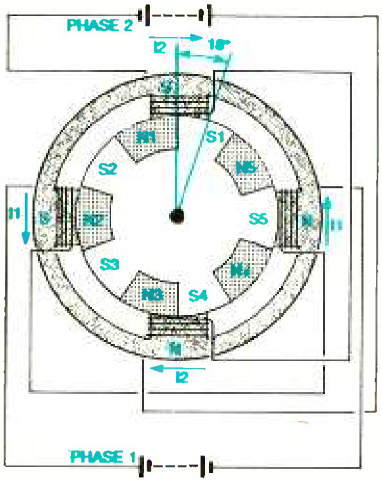


FIG. 4—STATE 1. The rotor has moved clockwise one quarter of the tooth pitch (72/4), or 18°.

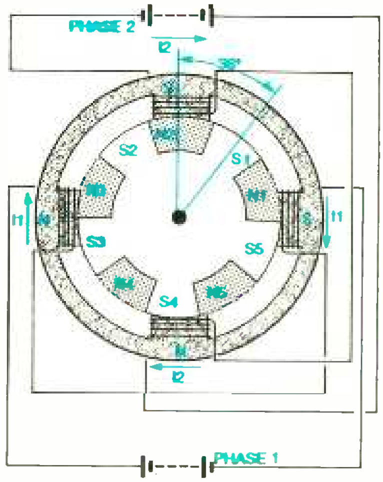


FIG. 5—STATE 2. Here the polarity of phase 1 is reversed, causing the left stator pole to become north and the right pole to become south. The motor then finds a new stable position clockwise an additional 18°, for a total of 36°.

at the bottom, and the rotor has a south pole at the top (S1) and a north pole at the bottom (N4). Because opposite magnetic poles attract, the rotor is held in this position. The left and right poles of the stator are half way between rotor teeth, so the net force is nearly neutral.

If the polarity of the current in phase-2 is reversed, the top pole of the stator will become a south pole and the bottom pole will become north. That relationship repels the rotor flux, freeing the rotor to seek a new stable position. The nearest stable position is determined by the left and right stator poles. Because the left pole is south and the right pole is north, the nearest stable position can be reached if a rotor's north pole (N2) aligns with the stator's left south pole, and a rotor's south pole (S5) aligns with the stator's right north pole. This position is one-quarter tooth pitch clockwise of the initial position as shown in Fig. 4.

In Fig. 4 (the position for state 1), the rotor has moved clockwise one quarter of the tooth pitch (72/4), or 18°. The top and bottom stator poles are now half way between rotor poles and have a neutral force. The motor has now found a new stable position.

In Fig. 5 (state 2), the polarity of phase 1 is reversed, causing the left stator pole to become north and the right pole to become south. The motor then finds a new stable position an additional 18° clockwise, and has now rotated a total of 36°. In Fig. 6 (state 3), the polarity of phase 2 is reversed, causing the top stator pole to become north and the bottom pole to become south. Again the motor finds a new stable position at an additional 18° clockwise, and has now rotated a total of 54°.

In Fig. 7 (state 4), the polarity of phase 1 is reversed, causing the left stator pole to become north and the right pole to become south. Again the motor finds a new stable position an additional 18° clockwise, and has now rotated a total of 72°. Because 72° is equal to one tooth pitch, the motor is again in state 0 but it is replaced one tooth clockwise. By repeating the sequence of phase reversals in the stator, the motor will continue to rotate clockwise.

By reversing the order of phase reversals, the motor will rotate counterclockwise. The effective currents in the stator are shown in Fig. 8 for both clockwise and counter-clockwise rotations. The current

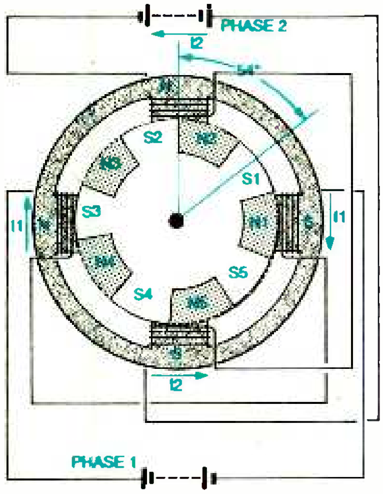


FIG. 6—STATE 3. Here the polarity of phase 2 is reversed, causing the top stator pole to become north and the bottom pole to become south. The motor has now rotated a total of 54°.

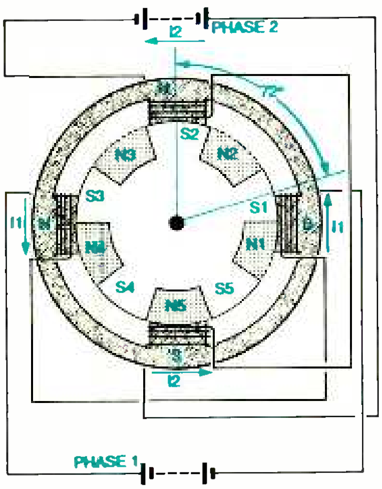


FIG. 7—STATE 4. Here the polarity of phase 1 is reversed causing the left stator pole to become north and the right pole to become south. It has now rotated a total of 72°, which is equal to one tooth pitch so the motor is again in state 0 but one tooth clockwise.

waveforms for the stepper motor are essentially square waves as shown.

Stepper generator

When a stepper motor functions as a generator, the voltage waveforms will essentially be sinewaves as shown in Fig. 9. The sinewaves constitute a "step" signal derived from phase 2 and a phase-leading (clockwise) or phase-lagging (counter clockwise) "direction" signal derived from phase 1. This permits continuous rapid rotation of the shaft.

When a stepper motor is at rest, it has a "magnetic detent" resulting from residual magnetism in the core of the stator reacting to the flux of the rotor's permanent magnet. In single-step operation, the rotor is moved from one magnetic detent to the next. The voltage waveforms for single-step rotation are similar to those in Fig. 10.

When single stepping, the maximum output amplitude is typically 30 to 500 millivolts, and for rapid rotation it can be several volts peak-peak, although it varies with the type of motor used. As with all generators, the output voltage is a function of the strength of the magnetic flux, the rate of rotation, and the number of turns of wire on the stator. Larger motors and/or higher-voltage motors will produce greater output voltages.

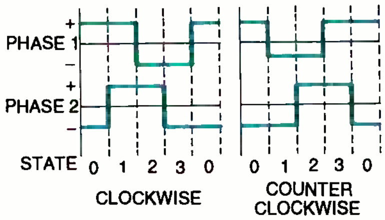


FIG. 8—STATOR CURRENTS for both clockwise and counter-clockwise rotations.

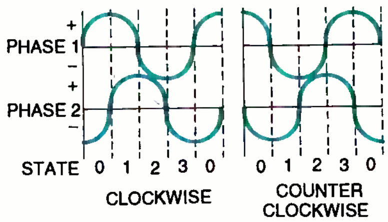


FIG. 9—WHEN A STEPPER MOTOR functions as a generator, the voltage waveforms will essentially be sinewaves with continuous rapid rotation of the shaft.

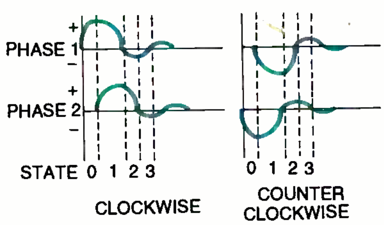


FIG. 10—THE VOLTAGE WAVEFORMS for single-step rotation are similar to these.

Stepper shaft encoder

For stepper shaft-encoder operation only the timing relationships between the pulses are important. The voltages are of interest only as a means for detecting their timing relationships and protecting the detector from excessive input voltage.

To obtain a complete set of pulses describing both rate and direction, the stepper shaft must be rotated through four of its motor positions. That is typically the distance from one magnetic detent to the next. Unfortunately the number of output-pulse sets per revolution of the shaft is one quarter the specified number of positions of the motor. A 200-step per revolution motor will therefore produce only 50 encoder output pulse sets per revolution.

To use the stepper shaft encoder, the output signals must be converted to square waves to drive logic circuits. A pair of voltage comparators, with hysteresis, convert the sinewaves to square waves (see Fig. 11). If

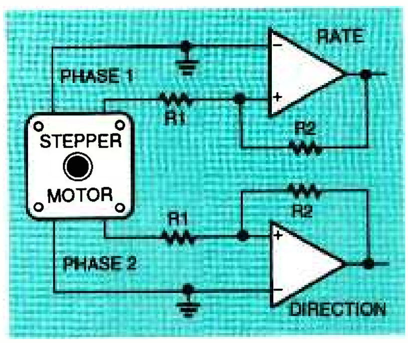


FIG. 11—TO USE A STEPPER as a shaft encoder, the output signals must be converted to square waves with a pair of voltage comparators.

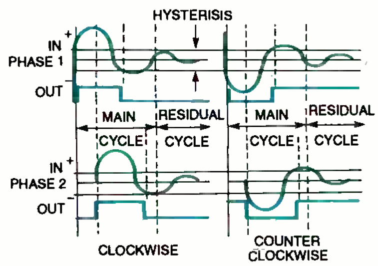


FIG. 12—COMPARATOR WAVEFORMS. The hysteresis trip points are set to less than the peak amplitude of the main cycle of the sinewave, but greater than the peak value of the residual cycle.

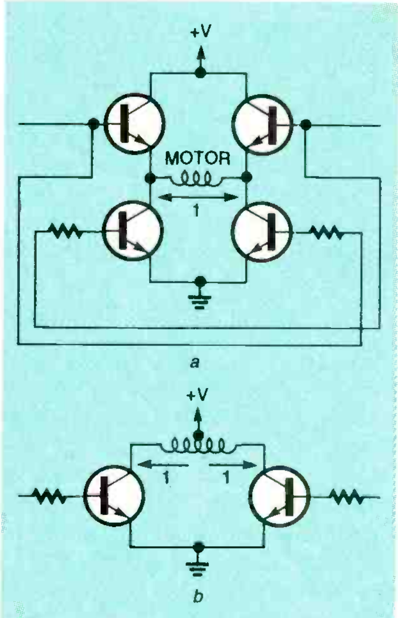


FIG. 13—BIPOLAR STEPPER MOTORS have a single winding for each phase. Unipolar units provide the bidirectional current flow when the winding is center-topped. Shown in *a* is a bipolar drive and in *b* is a unipolar drive.

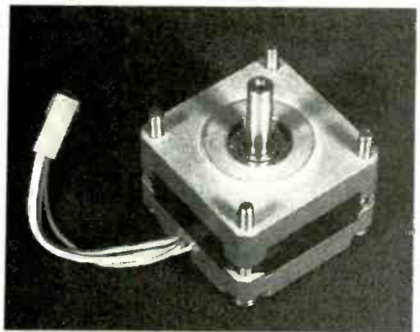


FIG. 14—THIS STEPPER provides 50 pulses per revolution.

the hysteresis is properly set, one can obtain reliable pulses even under single-step conditions.

Figure 12 shows the voltage-comparator waveforms. The hysteresis trip points are set to less than the peak amplitude of the "main" cycle of the sinewave but greater than the peak value of the "residual" cycle. The main cycle is generated by rotating the shaft from one magnetic detent to the next. The residual cycle is obtained from the overshoot past the detent and the rocking of the shaft as it settles into the detent. The residual cycles are much lower in amplitude because the rate of rotation is much slower.

Types of stepper motors

There are basically two kinds of stepper motors: unipolar and bipolar. Bipolar motors have a single winding for each phase. Because current must flow in both directions, the bipolar motor requires a double-pole, double-throw driver such as four transistors connected in a bridge. Unipolar motors are center-tapped to provide the bidirectional current flow as shown in Fig. 13.

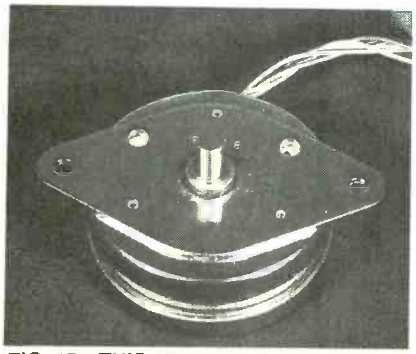


FIG. 15—THIS UNIT has a step angle of 3.6°.

Most of the author's experiments were performed on four-wire bipolar stepper motors. However the unipolar motors should also work if one end and the center tap or both ends are used. The 5-wire stepper motors have a common wire for power. With those motors it is necessary to use the common wire as neutral and one end of each winding for the signal. For the 6-wire stepper motors, the power is not common, and the two ends of the windings can be used to double the output voltage.

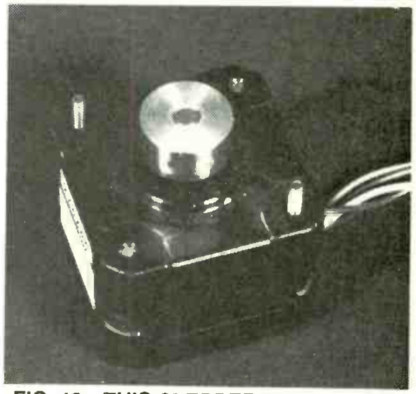


FIG. 16—THIS STEPPER WORKS WELL and provides 25 pulses per revolution. It seems to have more magnetic detent positions than output pulses.

Stepper motors are available with operating voltages from about 1.5 to 24 volts. For shaft-encoder use, the operating voltage is not important except that the output voltages will be higher for the higher-voltage motors. The most important specification is the step angle, or steps per revolution. Typical motors range from 15° (24 steps/revolution) to 0.9° (400 steps/revolution) with 1.8 degrees (200 steps/revolution) ratings quite common. As mentioned earlier, the number of output pulses is one quarter of the number of steps per revolution. The 200- and 400-step units that produce 50 or 100 pulses per revolution are those most suitable for shaft-encoder applications.

Figures 14–16 show several examples of stepper motors that were obtained from the list of suppliers contained in this arti-

TABLE 1—STEPPER MOTOR SPECIFICATIONS

Motor	Manufacturer	Part Number	Degrees Step	Rated Voltage	Type	Single-Step Output	Rapid-Spin Output
Fig. 14	Astrosyn	14PM-K203-01	1.8	-	Bipolar	0.5Vp-p	4.0Vp-p
Fig. 15	Airpax	LA82702-C	7.5	12	Unipolar	2.0Vp-p	12Vp-p
Fig. 16	Howard	1-9-4201	3.6	24	Unipolar	2.0Vp-p	6.0Vp-p

cle. Their specifications are listed in Table 1. Two are of particular interest. The one shown in Fig. 14 provides 50 pulses per revolution. The motor in Fig. 16 works well and provides 25 pulses per revolution, although it has more magnetic detent positions than output pulses. The magnetic detent is very light and might be ignored.

Designing an interface

Designing an interface to permit a stepper motor to act as a shaft encoder consists mainly of selecting a value for R3 in the circuit of Fig. 17. Two of those circuits are required for each encoder. An LM339, LM2901, or MC3302 quad voltage comparator or LM393 or LM2903 dual-voltage comparator can be used. To operate it from a single 5-volt supply biasing the comparators at one half the supply voltage is required. That can be accomplished with the voltage divider consisting of two 1K resistors (R5 and R6) and a fairly large bypass capacitor (C1) at the node; this network can be shared by both comparators. The input resistance is split in half between R1 and R2 with back-to-back diodes clipping the peak levels to protect the voltage comparators from high-voltage inputs during rapid rotation of the shaft. For lower-voltage motors, the diodes can be eliminated and R1/R2 replaced by a single 10K resistor.

The value of R3 sets the hysteresis trip points. Assuming that R3 is much greater than R1+R2, the trip points are approximately:

$V_{p-p} = (V_{CAP}R3)/(R1+R2)$

R3 should be between 100K and 1 megohm, with 1 megohm producing the highest sensitivity. A typical value is 470 kilohms.

BEcause it is difficult to evaluate the performance of a stepper shaft encoder with just an oscilloscope, the author built the test circuit of Fig. 18. It incorporates an ICM7217IJI four-digit up/down counter display-driver chip and a 4-digit common-anode LED display. The voltage comparators have 100K fixed resistors in series with 1 megohm potentiometers to set the hysteresis levels. The goal is to find a value of hysteresis that provides adequate sensitivity for single-step operation without being too sensitive and producing extra pulses. Adjustment is not critical, and steps of about 100K will lead to the correct value.

The test circuit allows a complete evaluation of the performance of the interface circuit.

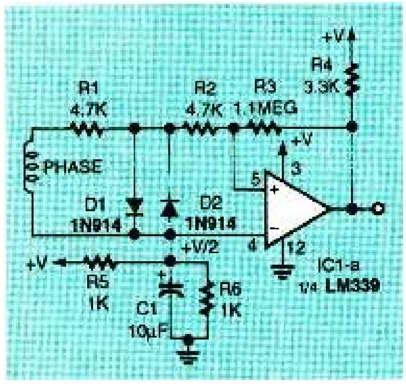


FIG. 17—TWO OF THESE CIRCUITS are required for each encoder.

For the two most applicable motors, the test results were excellent. It was very easy to set the count to any desired value and very easy to increment or decrement the count by one pulse. It is important that the frame of the motor be grounded to prevent noise pickup from your body. Figure 19 shows a photo of the test fixture.

Interesting results were discovered when the author inadvertently connected two motors in parallel. The circuit continued to perform well and either motor could be used to tune it. This suggests that two motors with different numbers of steps per revolution could be connected in parallel to provide course and fine tuning. One might use a 0.9° (400 steps/rev-

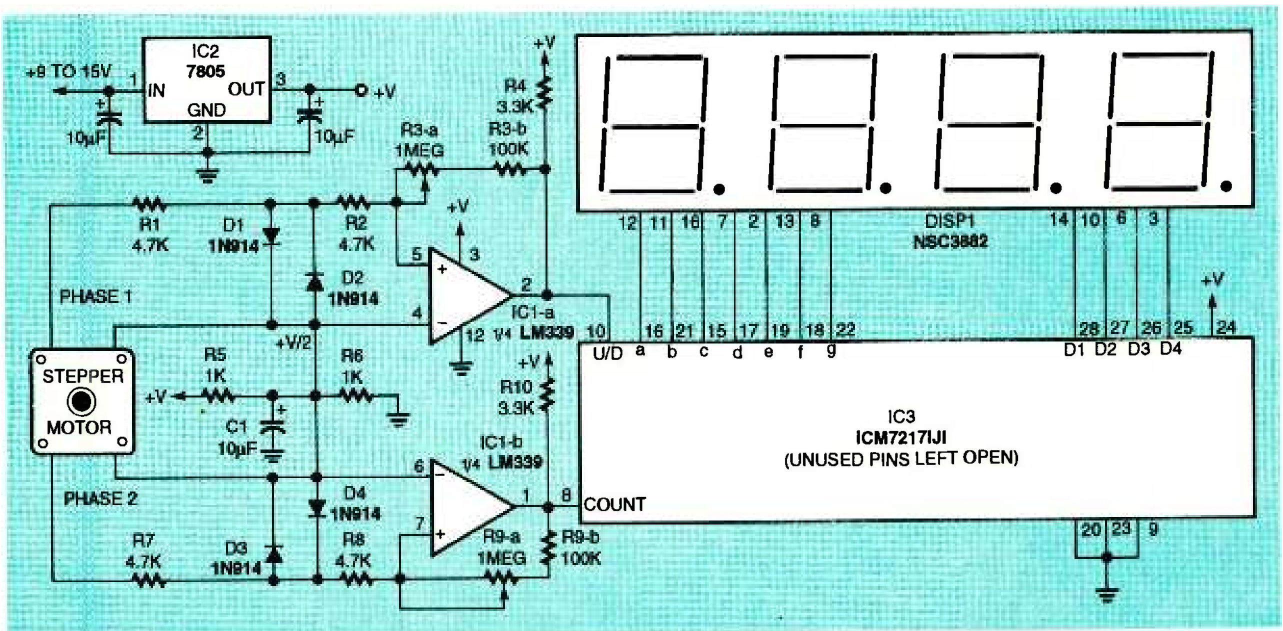


FIG. 18—THIS TEST CIRCUIT incorporates an ICM7217IJI four-digit up/down counter display-driver chip and a 4-digit common-anode LED display.

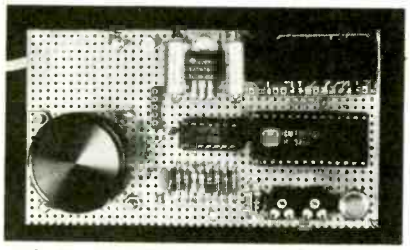


FIG. 19—PROTOTYPE TEST FIXTURE. It is important that the frame of the motor be grounded to prevent noise pickup.

olution) motor to provide 100 pulses per revolution course tuning and a 3.6° (100 steps/revolution) motor to provide 25 pulses per revolution fine tuning by connecting them in parallel.

The polarity of the two phases and their timing relationship depends on the application. Because there are two phases, there are four possible ways to connect the windings, one of which will meet any requirement. Most of the stepper motors have 3/16-inch diameter shafts. These cause a minor problem when fitting a knob. A piece of ¼-inch copper or brass tubing can be used as a bushing for a better fit. Holes opposite the set screws must be made in the bushing. Insert the tubing into the knob, tighten the set screws to mark their location, and scribe the tubing to mark the depth of the knob insert. The tubing is then removed, the holes made, and the piece cut to length.

At this point it's up to you to come up with interesting applications for using stepper motors as shaft encoders. Availability of low-cost stepper motors on the surplus market and the simplicity of the interface circuits makes their use as shaft encoders very attractive to the hobbyist. Ω

STEPPER MOTOR RESOURCE LIST

All Electronics
P.O. Box 567
Van Nuys, CA. 91408
800-826-5432

American Design Components
400 Country Ave.
Secaucus, NJ 07094
800-776-3700

American Science and Surplus
601 Lindon Pl.
Evanston, IL 60202
708-475-8440

C&H Sales
P.O. Box 5356
Pasadena, CA 91117-9988
800-325-9465

Fort Apache
31902 Hayman St.
Hayward, CA 94544
510-429-1060

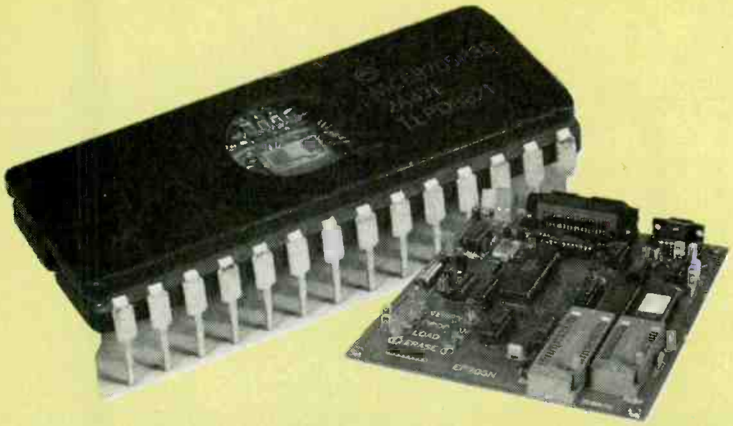
Herbach & Rademan
P.O. Box 122
Bristol, PA 19007-0122
800-848-8001

MECI
340 East First St.
Dayton, OH 45402-1257
800-344-1165

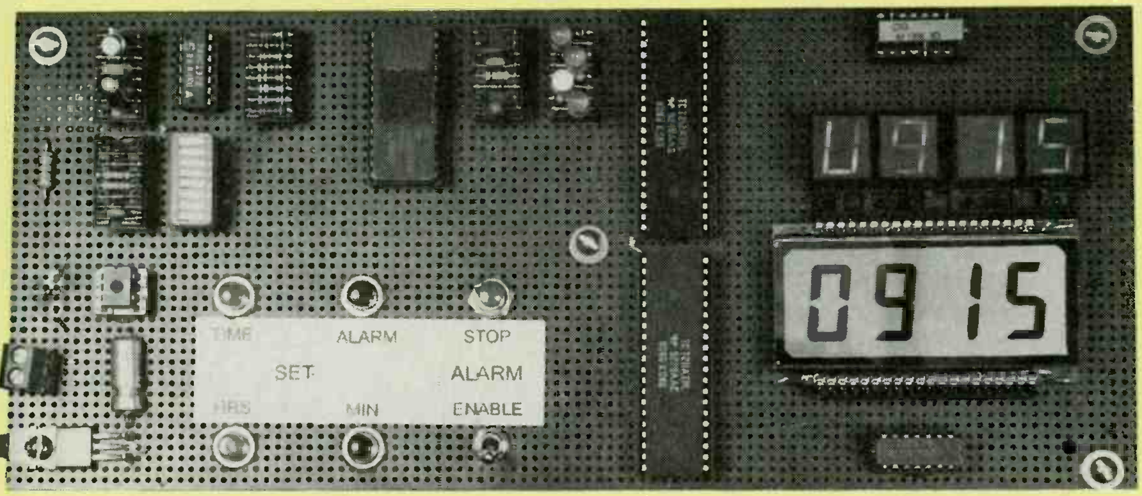
Marlin P. Jones & Assoc.
P.O. Box 12685
Lake Park, FL 33403-0685
407-848-8236

R&D Electronics
1224 Prospect
Cleveland, OH 44115
216-621-1121

Digi-Key
(for the ICM7217IJI)
701 Brooks Ave. S.
P.O. Box 677
Thief River Falls, MN 56701-0677
800-344-4539



68705-BASED



EXPERIMENTER'S CLOCK

Now that you know how to program 68705 microcontrollers, and have built the equipment to do so, you can put one to use in a clock circuit.

BRIAN BEARD

LAST MONTH THE DESIGN OF A PROgrammer for Motorola's HMOS 68705 family of microcontrollers was presented. This month a digital alarm clock based on one of those parts, the 68705P will be described. Motorola has published a power-line interrupt circuit and interrupt software for clocks in its M6805 Family User's Manual. Motorola also has a Freeware BBS (512-891-3733, 300/2400, 8N1) that wil permit you to download assemblers

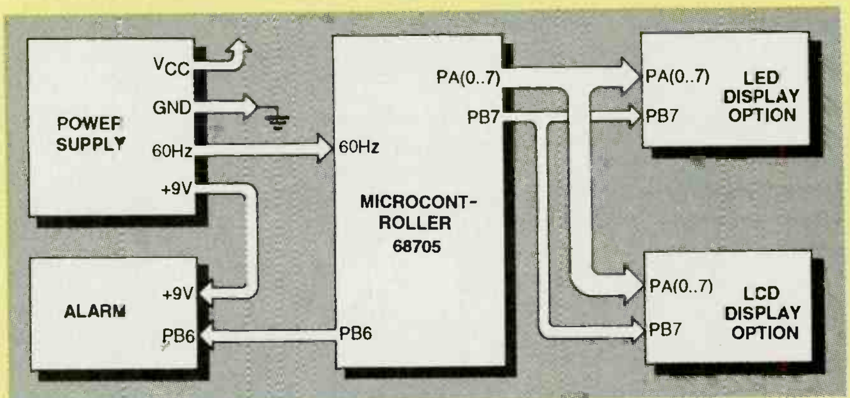


FIG. 1—CLOCK CIRCUIT BLOCK DIAGRAM. You can build the clock with an LED (light-emitting diode) or LCD (liquid-crystal) display.

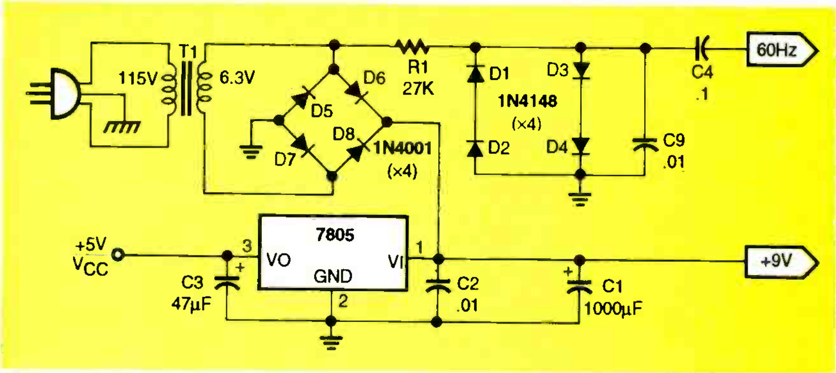


FIG. 2—POWER SUPPLY. The alarm circuitry uses an unregulated +9 volts while the rest of the clock needs a regulated +5 volts provided by 7805 regulator.

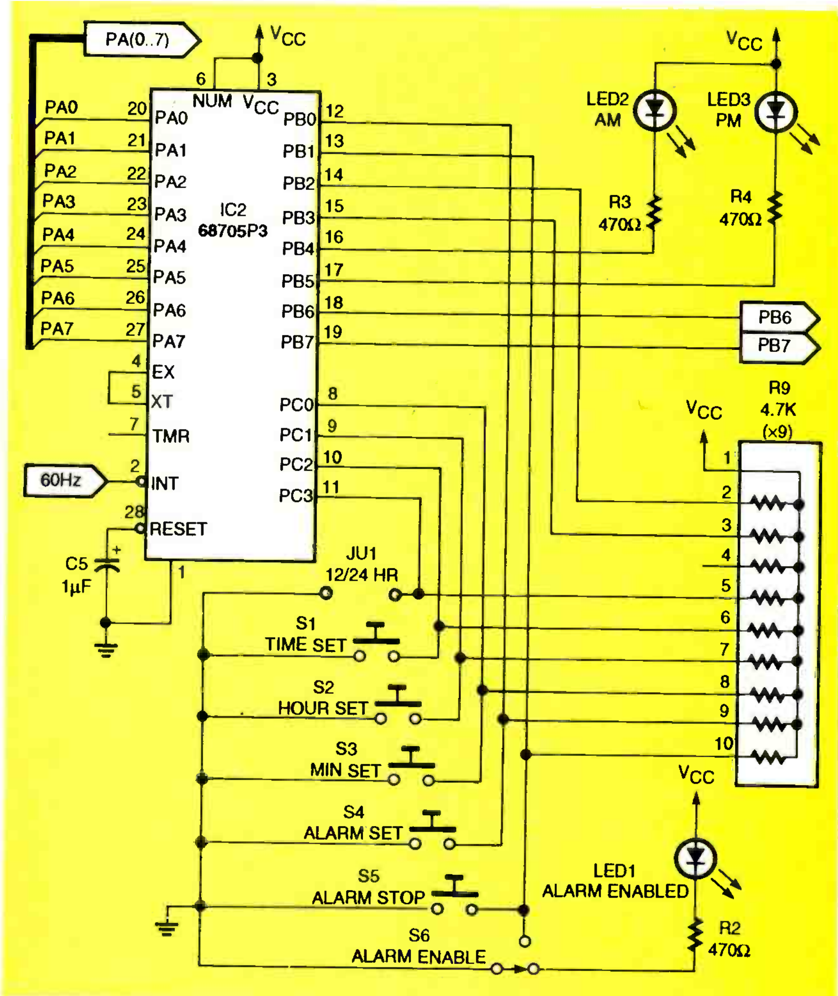


FIG. 3—68705 CIRCUITRY. With the crystal inputs tied together, the oscillator circuit can free-run, providing an internal clock cycle of approximately 1.25 microseconds.

and user libraries, at no cost, for all of its 8-bit micro-controllers. The code for this project was compiled with a free assembler from the BBS.

Hardware design

The clock contains the basic features found in most digital alarm clocks, but it can be customized to suit your needs. Figure 1 is a block diagram of the clock circuit. There are only four parts to the clock: power supply, alarm, microcontroller, and display. As the figure shows, you can display the clock output with an LED (light emitting diode) or LCD (liquid crystal) display. The prototype shown here includes both.

Figure 2 shows the power supply. The alarm circuitry needs an unregulated +9 volts while the rest of the clock is powered by a regulated +5 volts provided by 7805 regulator IC1. One side of the transformer secondary provides a 60-hertz timebase. The 60-hertz line frequency is constantly monitored and corrected by the power company, and its average frequency is maintained as close to 60 hertz as possible. By using the 60-hertz timebase, the need for a crystal timebase is eliminated. The AC voltage is clipped by resistor R1 and diodes D1–D4, filtered by C9, and capacitively coupled by C4 to the external interrupt pin of the 68705. Interrupts are triggered on every negative-going zero crossing of the AC signal.

The 68705 is shown in Fig. 3. Notice that the crystal inputs (pins 4 and 5 of IC2) are tied together. That allows the oscillator circuit to free-run, providing an internal clock cycle of approximately 1.25 microseconds. Port-A lines PA0–PA7 are output to the display, which will be discussed shortly. Port-B lines PB4 and PB5 control the AM and PM indicators, PB6 controls the alarm, and PB7 controls the colon display. Ports PB2 and PB3 are not used. The remainder of port-B and all of port-C accept inputs from the circuit control switches.

The switch connections are very simple. The port lines are pulled high (logic 1) by a resistor until a switch is closed which grounds the port line (logic 0). All of the switches are normally-open momentary pushbuttons. The TIME SET button allows you to set the time of day. Pressing it together with the HOUR SET button will increment the hours digit until one of the buttons is released. Similarly, the TIME SET and MIN SET buttons will increment the minutes digit. When you press and hold the ALARM SET button, the display will show the alarm time. While the alarm time is displayed, it can be changed with the HOUR SET and MIN SET buttons.

The ALARM STOP button and

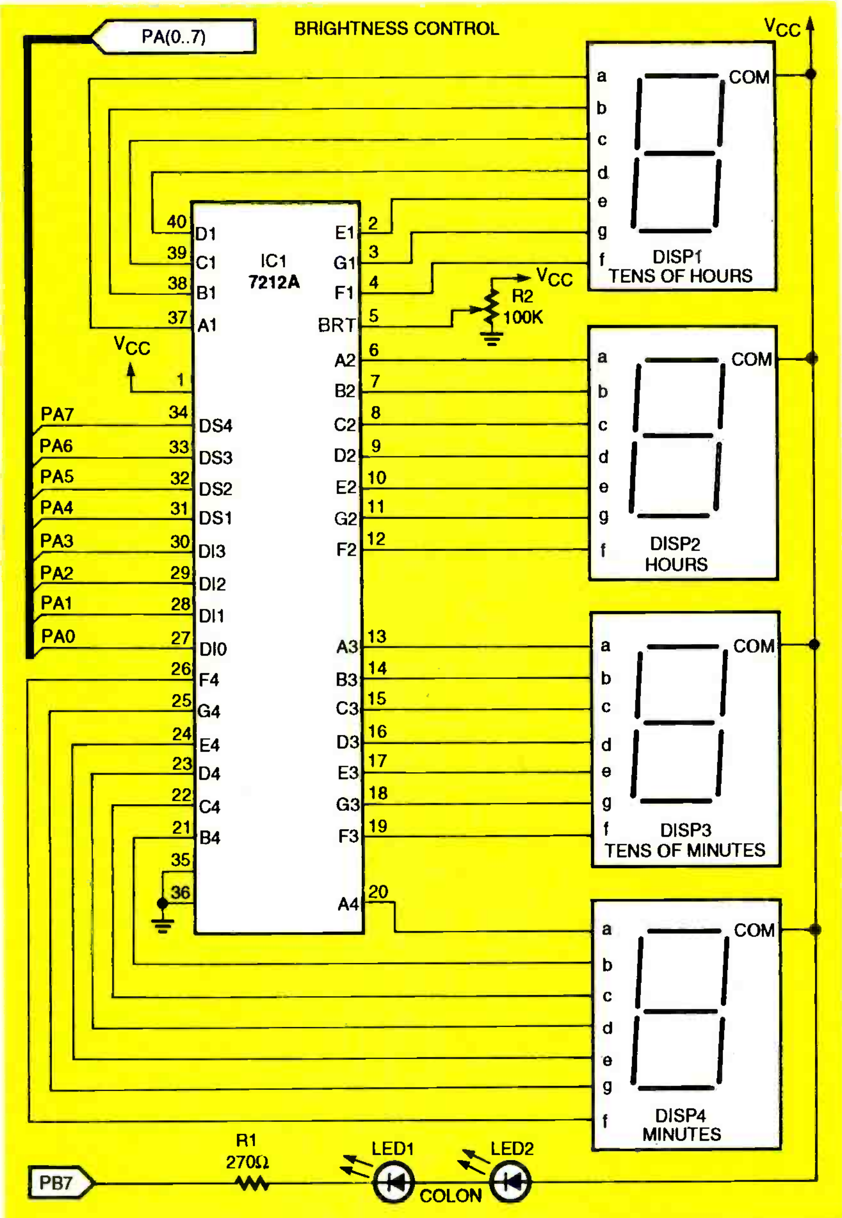


FIG. 4—LED DISPLAY CIRCUIT. The 7212A can drive four 7-segment common-anode digits.

ALARM ENABLE switch both connect to PB1. When the alarm is enabled, the ALARM ENABLE LED will be lit and PB1 will be high. When the time of day first equals the alarm time, the 68705 checks the state of PB1. If PB1 is high, the alarm is turned on; then, as soon as PB1 goes low, the alarm is turned off.

If there were only a pushbutton in the circuit, the alarm would turn on *every* morning at the set time. Conversely if there were only a switch, you would have to remember to enable the alarm every night.

The final input (PC3) selects a 12- or 24-hour display. Grounding PC3 (closing jumper JU1) will give you the 12-hour display. The function is controlled by a jumper, because most people have a definite preference, but a switch can be used if you want to be able to switch between display modes. If you hardwire the 24-hour display, the AM/PM indicators (LED2 and LED3) will never come on, so you need not even install them.

The display is the part of the clock you'll see most often, so it should have the display style you like. That's why the clock was designed for either LCD or LED displays. In fact, the prototype clock pictured here has both! This is made possible by the use of display controller chips. A 7211A (an LCD controller) and a 7212A (an LED controller) can both accept multiplexed BCD inputs. The 68705 program simply sends out hour and minute data as multiplexed BCD. The type of display that is connected to the circuit makes no difference.

The LED display circuit is shown in Fig. 4. The 7212A (IC4) will drive four 7-segment common-anode digits. The brightness control input to IC4 (pin 5) can be tied to +5 volts for maximum brightness, or potentiometer R11 can be connected as shown in Fig. 4 for adjustable brightness. With the colon indicator (LED4 and LED5) connected to PB7, it will flash at 1 hertz. If you want the colon to stay on constantly, connect it to ground instead of PB7.

The LCD circuit is shown in Fig. 5. The 7211A (IC4) generates the required AC drive signals for a 4-digit 7-segment liquid-crystal display. The oscillator input (pin 36) can be left open, which results in a backplane frequency of approximately 125 hertz. The colon will flash at 1 hertz as long as IC5-a pin 2 is connected to PB7. If you want the colon to remain on, connect IC5-a pin 2 to ground instead of PB7. On the other hand, if you don't want the colon to appear at all, tie the LCD's colon pin directly to the backplane and omit IC5-a.

Figure 6 shows the alarm circuit of the prototype. The circuit is basically two gated oscillators and an output transistor. The first oscillator (IC3-a and -b) runs at about 1.6 hertz, gating the second oscillator (IC3-c and -d), which runs at about 720 hertz. The resulting tone bursts are shrill enough to wake almost anyone. The alarm is controlled by the state of PB6; a high turns the alarm on and a low turns it off.

Software

There isn't enough space to print the entire assembly language source code in this arti-

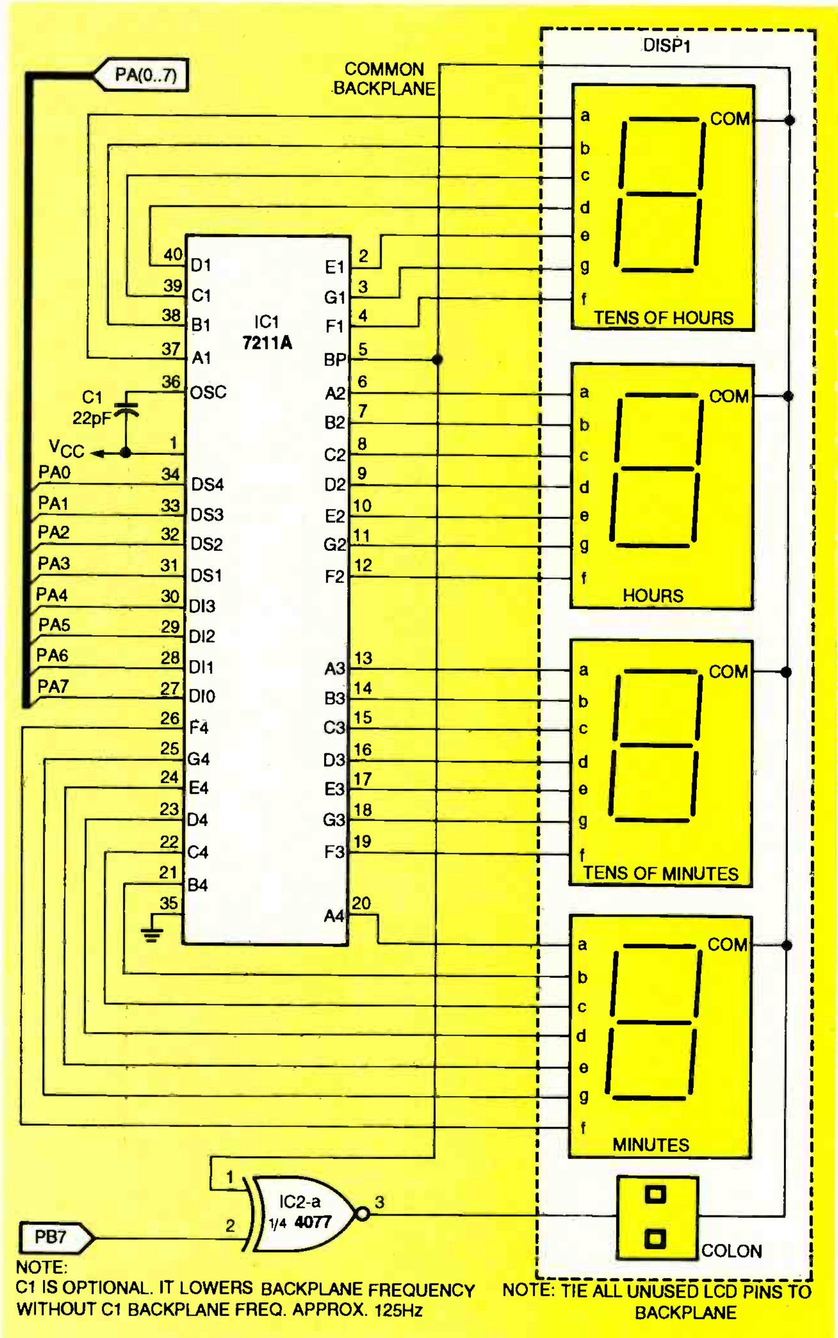


FIG. 5—LCD CIRCUIT. The 7211A generates the required AC drive signals for a 4-digit, 7-segment liquid-crystal display.

MAIN CLOCK PARTS

All resistors are ¼-watt, 5%, unless otherwise noted.
R1—27,000 ohms
R2–R4—470 ohms
R5—270 ohms, ½-watt
R6—100,000 ohms
R7—220,000 ohms
R8—820 ohms
R9—4700 ohms ×9, 10-pin SIP (pin 1 common)

Capacitors
C1—1000 µF, 25 volts, electrolytic
C2, C7, C9—0.01 µF
C3—47 µF, 15 volts, electrolytic
C4—0.1 µF, ceramic
C5—1 µF, 15 volts, electrolytic
C6—10 µF, 15 volts, electrolytic
C8—47 µF, 35 volts, electrolytic

Semiconductors
IC1—7805 5-volt regulator
IC2—68705P3 microcontroller
IC3—74HC132 CMOS Schmitt-trigger quad NAND gate
D1–D4—1N4148 diode
D5–D8—1N4001 diode
Q1—2N2222 NPN transistor
LED1–LED3—light-emitting diode, any color

Other components
SPKR1—8-ohm speaker
T1—6.3-volt AC, 1-amp transformer
S1–S5—Normally-open pushbutton switch
S6—SPDT switch

Miscellaneous: Heatsink for 7805 regulator, IC sockets, perforated construction board, wire, solder.

LCD DISPLAY PARTS

IC4—7211A LCD driver (ICM7211AIPL or TC7211AIPL)
IC5—4077 CMOS quad exclusive-NOR gate
DISP1—4-digit 7-segment liquid crystal display module
C10—22 pF, ceramic
40-pin socket—for the 7211A
14-pin socket—for the 4077

cle. However, it is available on the *Electronics Now BBS* (516-293-2283, 1200/2400, 8N1) as a file called 687CLK.ZIP. The source code is well-commented and highly modular, so it should be easy to understand.

The code begins with a large block of comments that explain the memory map and functioning of all the ports. Next, understandable names are assigned to the various registers and memory locations that will store variables by the use of equate definitions. These definitions make the difference between readable code and indecipherable hieroglyphics.

The subroutines come next in the program. One of the subroutines converts the time to 12-hour format, another converts binary values to BCD, and another sends the BCD to the display. Internally, all times are kept in a 24-hour format, so the alarm will go off only once a day, even if you select the 12-hour display format.

Two other subroutines are responsible for setting the time of day and alarm time. Both of these subroutines call a delay subroutine that monitors how long you hold the "set" pushbuttons depressed. For example, if you press the TIME SET and MIN SET pushbuttons, the minutes will increase by one immediately. If you keep both buttons depressed, the next increment will occur after 0.8 seconds; the interval between increments will then get smaller and small-

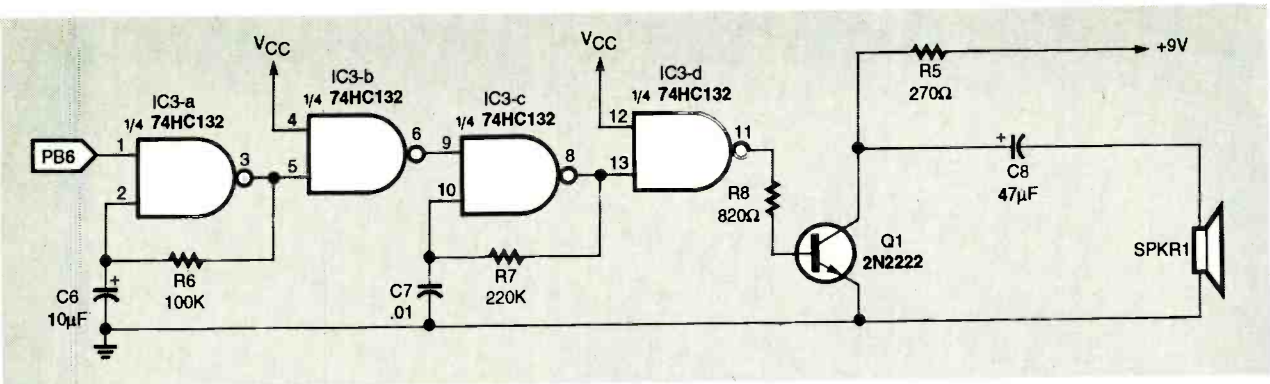


FIG. 6—ALARM CIRCUIT. The first oscillator (IC3-a and -b) runs at about 1.6 hertz, gating the second oscillator (IC3-c and -d) which runs at about 720 hertz.

er until it reaches a rate of five per second. This way you can rapidly change a value by holding both buttons. Note that when the TIME SET button is released, the seconds counter is cleared so that timekeeping resumes from the start of the displayed minute.

At power-up, control is transferred to the address stored in the reset vector. In this case, it is the label "RESET." This portion of code initializes all the variables and control registers. It then starts flashing the message "HELP" on the display and it sounds the alarm until the TIME SET button is depressed. If there is a power outage you won't know with most alarm clocks until you are already late for work. This clock will wake you up so you can reset the time and alarm. If you don't want to hear the alarm every time the power is interrupted, one line from the source code will delete that feature.

The main program is a continuous loop beginning at the label "LOOP." It checks the TIME SET and ALARM SET switches, flashes the colon every second, updates the display every minute, and starts the alarm when necessary. If the alarm is sounding and you don't turn it off, it will automatically shut off after 30 minutes.

Finally we come to the external interrupt service routine. Program control is transferred here, to the label "TICK," with every tick of the 60-hertz interrupt. The time-of-day counters are increased by 1/60th of a second and control returns to the routine that was interrupted.

Construction and checkout

First decide on the type of display you want for the clock. Remember, LCDs cannot be read in the dark because they do not emit any light. However, a small incandescent bulb, mounted in front of and to the side the LCD, will make it readable at night. Backlighting is also possible if you install a transmissive or transflective LCD module with a built-in light source.

Collect the required parts for the clock and display of your choice. The parts are available from many mail-order companies including ones that advertise in this magazine. Burn the program into the 68705P's internal EPROM; you can use the programmer discussed last month or buy a preprogrammed 68705P from Lucid Technologies (see the Parts List).

The prototype was built using a combination of wirewrap and point-to-point construction. Be sure to install sockets for all the ICs. After everything is assembled, check for wiring errors, shorts, opens, and loose connections. Before installing the ICs in their sockets, apply power and check for +5 and +9 volts. Also check the IC sockets to be sure that +5 volts and ground are on the correct pins. If everything is okay, remove AC power, install the ICs, and reapply power. The "HELP" message should now be flashing on the display, and the alarm should be beeping. Press and release the TIME SET button; the alarm should shut off and the display should now show 1:00 AM (0100 when displayed in the 24-hour format).

LED DISPLAY PARTS

IC4—7212A LED display driver (ICM7212AIPL or TC7212AIPL)
DISP1–DISP4—Common-anode 7-segment LED display
R10—270 ohms
R11—100,000 ohms, trimmer potentiometer
LED4, LED5—Colon-indicator LEDs
40-pin socket—for 7212A

Note: The following items are available from Lucid Technologies, 7439 Highway 70 South, Unit 297, Nashville, TN 37221:

- **EP705N programmer kit (includes PC board, programmed 2764 EPROM, MC145411 bit-rate generator, UA78S40 switching regulator, 5.25-inch 360K documentation disk, and schematics)—$48**
- **EP705N programmer kit (same kit as above, less PC board)—$28**
- **Clock kit (includes 68705P3 programmed with the clock software for 60-hertz power, documentation, source code and S19 file on a 5.25-inch 360K disk, and schematics)—$25**

Other options

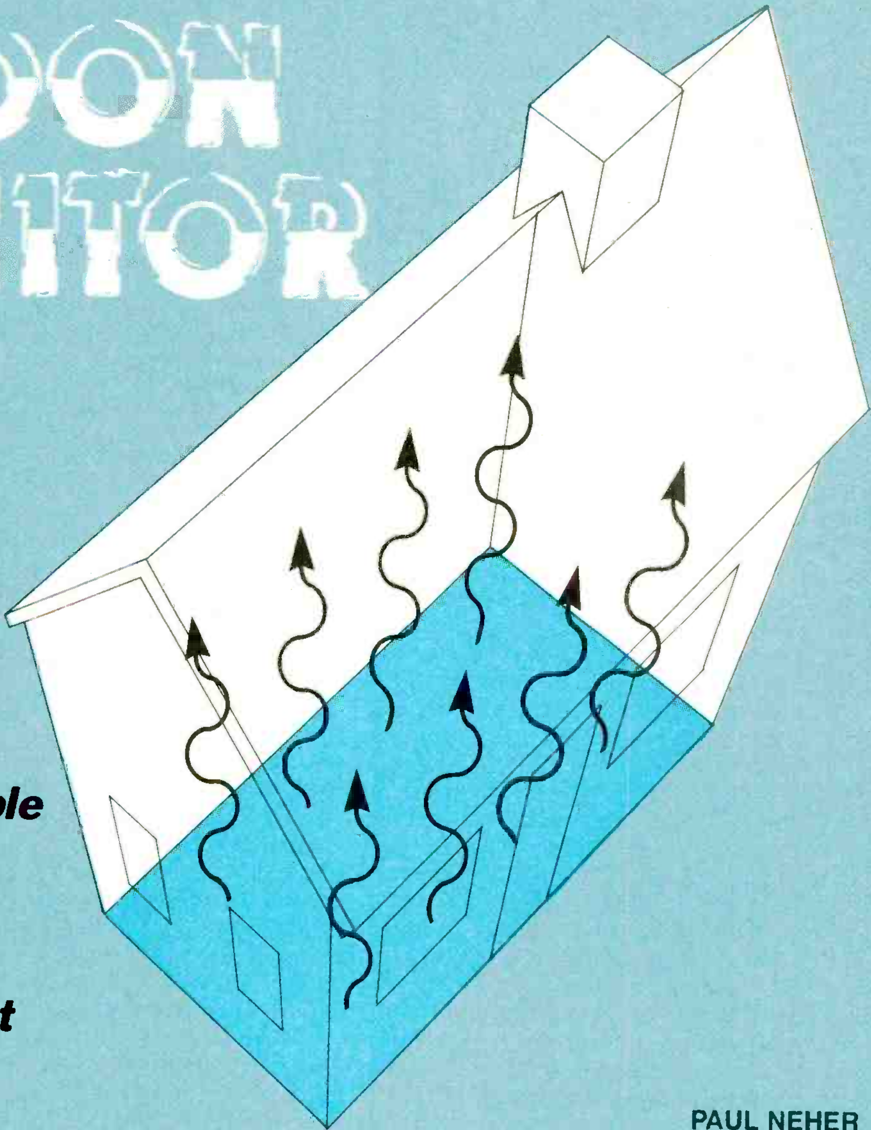
The options included in the digital alarm clock design should satisfy most hobbyists. However, there are some additional things you could try.

The LED brightness control (pin 5 of the 7212A) can be driven by a digital signal. It is possible to build a light-sensing circuit that varies the duty cycle of a pulse train applied to that pin. Then, as the room becomes darker, the display will dim.

The alarm circuit shown is only one of many that are possible. You can change the time constants of the oscillators to get different effects. Actually you can use any noise-generating circuit that can be digitally controlled (PB6 = 1 for alarm on, 0 for alarm off). Try experimenting with a sound-generator chip. Ω

RADON MONITOR

Build this radon monitor to detect a possible health threat in your home and, while doing it, learn more about radioactivity.



PAUL NEHER

THIS IS THE SECOND PART OF A TWO-part article on the design, construction and use of a simple, inexpensive environmental radon gas monitor that you can build. It is called the beverage can environmental radon monitor or BERM because the ionization chamber sensor is made from a readily available aluminum beverage can. The first part of this article explained radon and described the construction of BERM's ionization chamber and amplifier circuitry.

As was explained in the first part of this article, most people are exposed to environmental radon in excess of the natural rate because of the time they spend indoors. The article explained what radon is, why it is a health hazard, and the importance of knowing the level of radon in the rooms of your house where you spend most of your time while indoors. It also included the information needed to build the ionization chamber and its amplifier circuitry, and alternative circuits for charging an internal high-voltage capacitor to 500 volts.

The second part of this article covers such subjects as calibration and the measurement of events or rates. It offers alternative methods and circuitry for performing these functions.

Counting techniques

To determine picoCuries per liter of activity, it is necessary to count the number of pulses over a period of time, say an hour, and determine the average count per minute. It will be necessary to divide this count by the effective volume of the chamber and factor in the effect of radon daughters, which also produce alpha ionizations, to come up with an estimate of the radon concentration.

Because this count is a random process, any estimate is meaningful only when accompanied with some indication of probable error. This indication of error includes the statistical uncertainty of the count as well as uncertainty in the volume of the chamber and other factors. Later in this article, formulas will be given for the conversion of BERM's pulse counts to specific activity units.

Rate meter

A count-rate meter will meet your requirements for counting and averaging. The circuit schematic for a count-rate meter is shown in Fig. 6. The components on the left side of the schematic function as the basic pulse-rate count circuit, while those on the right side condition the output of the analog voltmeter M1.

When the amplifier comparator IC1 (IC1-b) pulls the input to ground, capacitor C5 in the rate meter discharges through emitter-base diode D2 (Q2). Then, when the comparator goes high, resistor R8 charges C5 through emitter-base diode D3 (Q3) and accumulation capacitor C6. These components form a simple "charge pump" which charges accumulation capacitor C6 at a rate determined by the pulse rate.

The current flowing out of C6 through R9 is proportional to the accumulated charge and, at equilibrium, equals the current flowing in. In other words, the pulse rate determines voltage V_R across 100-megohm resistor R9. The equation for this response is :

$V_S = r \times R9 \times C5 \times (V_S - 2V_D)/(1 + r \times R9 \times C5)$

Where r = the pulse rate in counts per second, V_S = the supply voltage, and V_D = the diode forward voltage drop (0.5 volt).

This function is approximately linear as long as the product $r \times R9 \times C5$ is small compared to unity. If, for example, the circuit is designed so that the maximum count rate develops a voltage across R9 that approaches 10 % of the supply voltage, the maximum nonlinearity error will be 2 %.

With a regulated 9-volt supply, this circuit develops about 120 millivolts (V_R) with an input rate of 20 counts per minute where (r = 20/60 counts per second).

The value of accumulation capacitor C6 doesn't enter into the previous equation. Time constant (C6×R9) must be sufficiently long with respect to the pulse interval to produce a reasonable average. The uncertainty of the count rate, as a function of this time constant, is given by:

$U_r = \sqrt{(r/2RC)}$

This circuit has an RC time constant of 1000 seconds. This means that it will take about an hour to settle to within 3% of its final value. It has a half-scale uncertainty (10 counts per minute) of ± 5 %.

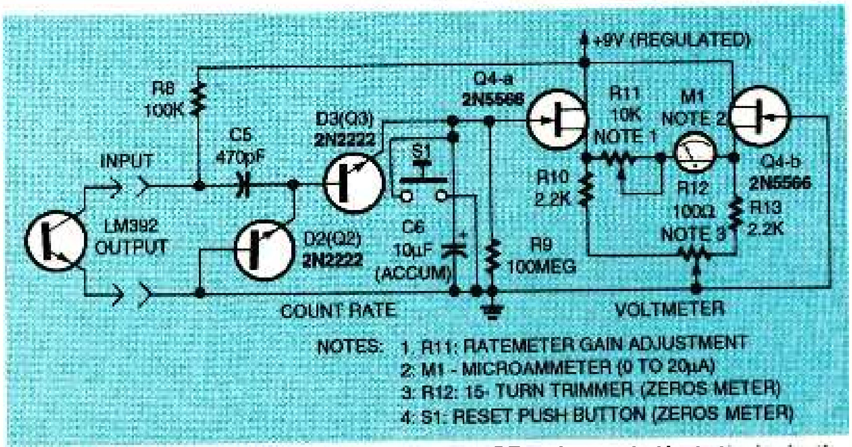


FIG. 6—THIS PULSE-COUNT RATE circuit for the BERM is coupled by to the ionization chamber with a three-wide cable.

Voltmeter

The right half of the Fig. 6 schematic is an analog panel voltmeter with a very high input resistance so that it does not load the rate circuit. Figure 6 shows a 20-microampere meter, but if you want to save money, the lower cost 50-microampere meter will work as well.

Alternatively, if you do not want a permanent system, you can substitute a bench volt-ohm milliammeter (VOM) in place of resistor R11 and the microammeter, and modify the circuit accordingly to match your meter's lowest scale. With this approach, the meter need only be connected when you want a reading.

Meter zero-adjustment resistor R12 can compensate for ± 6 millivolts of differential offset voltage in dual FET Q2. With that compensation in addition to the mechanical adjustment on the meter movement, you should be able to zero the meter with accumulation capacitor C6 discharged. If this does not happen, recheck the circuitry for possible errors.

Component selection

The leakage of diodes D2 and D3 of Fig. 6 (formed with the emitters and bases of 2N2222 transistors) as well as capacitor C6 must be low if this rate meter circuit is to work properly. The emitter-to-base junctions of a 2N2222 transistor has three orders of magnitude lower reverse current than a 1N914 switching diode.

Test electrolytic capacitor C6 for leakage before using it in the circuit. Select one that has an internal leakage resistance that is at least ten times greater than resistor R9. An effective capacitor will have a self-discharge time constant greater than three hours. Most capacitors tested by the author held at least 1 volt for 24 hours.

Don't forget the memory effect of electrolytic capacitors, especially if they have been recently operated at a voltage higher voltage than a few hundred millivolts. Some electrolytic capacitors recharge themselves to a small fraction of their operating voltage after being temporarily discharged.

Another alternative

You can also use a digital voltmeter with a constant 10-megohm input resistance and the pulse-rate circuit shown in Fig. 7. The five components of the rate circuit in Fig. 7 will fit on the amplifier circuit board with careful layout.

Typically, a full-scale count

rate of 20 counts per minute will be suitable for most indoor air environments, so the values shown in Fig. 7 were selected to produce 200 millivolts into a 10-megohm resistance. Select the value of capacitor C5 to calibrate the circuit. In contrast to the previous approach, however, the DVM must remain connected at all times.

Rate meter calibration

To calibrate any of the rate meters, you will need a data point to adjust the gain or scale factor. You can build a pulse circuit based on the 555 silicon monolithic timer IC (e.g., NE555N or MC1455N) as shown in Fig. 8. It produces about 10 pulses per minute to establish the slope of the rate meter's response when input counts per minute are plotted against the rate meter output scale.

Calibrate the pulser's rate by counting oscillations for 10 minutes so it will be within 1% accurate. Connect this auxiliary pulse circuit to the rate meter and let it settle for at least an hour before adjusting gain potentiometer R11. It might be necessary to substitute an alternative value for capacitor C5, depending on which version of the rate meter you build. You should be able to calibrate the meter to within a few percent in this way.

Combine the two

The rate meter shown in Fig. 6 and the amplifier together draw a supply current of about 3 milliamperes. They will both work from a standard 9-volt transistor battery. If you want a portable radon monitor, you can put both circuits together in a common enclosure.

Reset pushbutton switch S1 across capacitor C6 will be useful if you should accidentally bump the ionization chamber against a solid object. The large number of false readings will overload the meter which will take a long time to settle unless switch S1 is pressed.

Periodically check the rate meter zero setting by resetting capacitor C6. Do not apply any input pulses to the rate meter circuit for about an hour to check capacitor C6 for memory effects.

Alternative counters

An electromechancial counter is capable of accumulating a raw count. The LM392 (IC1) cannot drive the solenoid directly, but it can trigger a 555 timer IC that provides both a sufficiently wide pulse and enough current to drive a low-voltage counter.

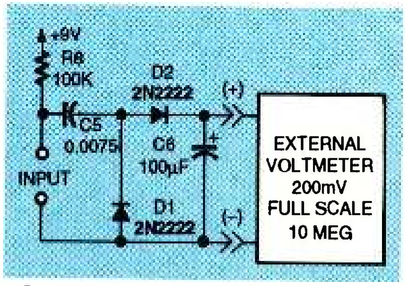


FIG. 7—AN ALTERNATIVE CIRCUIT for pulse-count determination if an an external voltmeter is be used in place of the meter.

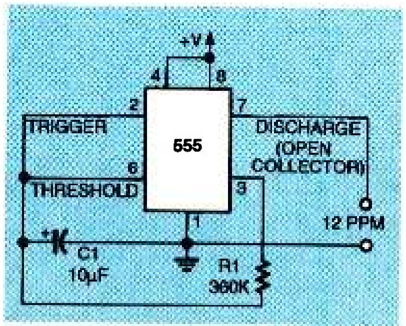


FIG. 8—THIS PULSE COUNT reference circuit can be used to calibrate the pulse-count rate circuit.

Some benchtop frequency counters include a scaler setting that will allow you to make a direct connection to the ionization chamber so you can accumulate counts. Alternatively, you can build a digital counter with an LSI counter/display driver IC.

Computer interface

If you are a computer enthusiast you might want to use your PC to count the pulses, compute a running-time average, and display the results graphically. The interface to your computer probably makes use of a latched interrupt request. A separate RS flip-flop board, set by the active-low, open-collector output, can provide the latch that is reset by the interrupt handling routine. The count rate will typically be less than 10 counts per minute, so processing speed is not critical.

An advantage of the open-collector output from the ionization chamber is that it can be pulled up by the computer logic supply (5-volts, 10 kilohms) without the requirement that the noise-sensitive amplifier circuitry share a common (electrically noisy) positive supply voltage. The chamber ground should be connected to the computer ground.

The largest calibration error relates to the proper determination of the ionization chamber's effective volume. Compared with that uncertainty, most of the other contributing sources of error in the BERM are small—approximately 10%.

Gain equation

The specific activity of radon, a(Rn), as a function of system variables is given by the following equation:

$a(Rn) = r \times k/(n \times VE)$

where a(Rn) is in units of picoCuries per liter

r = the count rate in counts per minute

k = a conversion factor from disintegrations per minute to picoCuries

n = the number of alpha counts per radon atom

VE = the effective volume in liters = physical volume × efficiency.

The constants $k/(n \times VE)$ equal 1.9 for a chamber equipped with a radon progeny filter. At 5 counts per minute, the radon concentration is 9.5 pCi/l.

If the construction instructions given in part 1 of this article were followed, the result should be a BERM that will have the same calibration factor as the author's prototype. The basic accuracy of your instrument will be ± 25%, which accounts for the probable mechanical variations, the statistical uncertainty in the author's calibration, and any rate meter error.

Radon progeny error

Refer to Fig. 9. The conversion factor n, number of alpha emissions per radon atom, has a theoretical value of 3 because, for every radon disintegration, two more alpha particles are emitted from polonium 218 and polonium 214 (See Table 1) under equilibrium conditions.

As radon decays, the number of progeny atoms increases until their radioactive decay balances their rate of production. After radon is introduced into the chamber, the alpha production rate will stabilize in about two hours.

If the ionization chamber is open to the air so that radon and radon progeny can enter the chamber freely, there is a reading uncertainty caused by their unknown equilibrium state. Researchers have found wide variations in the ratio of short-lived daughter products compared to radon in indoor air.

This factor has been estimated to average 20 ± 14 %. A simple progeny filter made from a plastic or paper bag eliminates this source of error. However, even with a filter in place, radon diffuses slowly through the paper or plastic, and it might take up to eight hours for the reading to stabilize. The installation of a simple BERM filter is described later.

Rate meter error

Because rate meter gain is directly proportional to the power supply voltage, you should know that the calibration shifts with decreasing battery voltage. The voltage of a typical 9-volt battery will fall approximately 20% over its useful lifetime. This has been found to permit about three days of continuous operation.

The rate meter, with a time constant (RC) of 1000 seconds, has an uncertainty that depends on the rate r, assuming the background rate is negligible, and as stated earlier, has a ± half-scale error. If the count is accumulated by other means, the statistical uncertainty in N counts is $\sqrt{N}$.

Summary of errors

The BERM has a total probable error of ± 25% plus a calibration drift caused by the battery. However, the total probable error can be reduced to about ± 13% under the following conditions:

- A progeny filter is installed.
- A highly stable power supply is in use.
- The BERM is calibrated against a standard instrument with a ± 10% error.
- Background rate adjustments have been made.

Application

The discussion on errors assumes that the BERM is in equilibrium with the surrounding air. A number of factors affect the time required for the BERM to reach this equilibrium.

Filters

As discussed earlier, the installation of a simple radon progeny filter will limit the particles entering the ionization chamber to radon. Find a polyethylene plastic bag sealed on three sides that is large enough to hold the ionization chamber. Inflate it with air and tie it off at the neck with several turns of a wire tie. Observe the inflated bag over a period of about an hour to make sure that it has no pinhole leaks.

After you are satisfied that the bag is free of pinholes, open it and place the ionization chamber inside. Then inflate the bag again and again tie it off with several turns of the wire tie around cable this time. Attempt to hold as much air as possible inside the bag while you tie it off.

PARTS LIST

Figure 6 ratemeter circuit.
All resistors are ¼-watt, 5%.
R8—100,000 ohms, carbon composition
R9—100,000,000 ohms, carbon composition
R10, R13—2,200 ohms, carbon composition
R11—5000 to 10,000, 15-turn trimmer
R12—100 ohms, 15-turn trimmer
Capacitors
C5—470 pF silvered mica, selected (see text)
C6—10 µF, 15 volts, aluminum electrolytic, radial-leaded, value tested (see text)
Semiconductors
Q2—2N5566 dual JFET
D2, D3—diodes formed from 2N2222 transistors
Other components
M1—0 to 20µA analog moving-coil panel meter (see text)

Response time

Theoretically, if a constant concentration of radon could be introduced into the chamber, the alpha count rate would increase over a few hours before reaching a stable rate. Figure 9 is a plot of short-lived radon progeny dynamics, which affect alpha count ratio until equilibrium conditions are reached. The BERM's ionization chamber will typically stabilize in a few hours. The shortest time constant of the rate meter is 17 minutes.

Background rate

Even when BERM is taken outdoors where radon concentration is very low, it is likely that there will be some alpha activity in the chamber. It will be caused by the materials in the chamber itself as well by residual isotopes from the surrounding air which have attached themselves to the chamber walls.

Because this background activity is variable, it is advisable to check the background rate after cleaning the chamber. This is done by discharging high-voltage capacitor C1 and flushing the chamber with clean outside air. If possible, allow the chamber to remain outdoors for a day before performing the indoor measurement.

The background rate of the chamber is typically 20 to 60 counts per hour. Use the net counting rate—gross indoor rate minus outdoor rate—to calculate radon concentration, especially if the rates are similar.

Making a measurement

Although the BERM has an assumed large scale factor or calibration error, the instrument is still sensitive enough to detect even small amounts of radon, perhaps only a few times greater than that in outdoor air. It has sufficient dynamic range to remain linear up to several hundred counts per minute. Without a filter which improves accuracy but slows down its measurement, the BERM can be used anywhere in a house to identify the highest levels of radon concentration and the conditions that cause that level.

Vibration effects

As stated in Part 1 of this article, the BERM's ionization chamber is a very sensitive vibration sensor that will also respond to loud, low-frequency noises. Be suspicious of any unusually high readings if the chamber had just been inadvertently bumped against a solid object. After you have gained experience with BERM while it is connected to an oscilloscope, you will be able to see for yourself what level of vibration causes false detections.

Natural background

You can modify the BERM so that it will be capable of measuring radon concentration in the soil. To do this the radon monitor must be capable of measuring up to 200 counts per minute. This is done by replacing resistor R9 with one having a value that is only 10 % of the specified R9 value. Then:

- Place the ionization chamber in the plastic filter bag as previously described. (In this test the filter will act as a moisture barrier. The BERM is insensitive to changes in relative humidity, but condensation can provide a leakage path between the cathode lining and ground.)
- Dig a hole about 15 inches deep in dry ground.
- Place the bag-covered ionization chamber at the bottom of this hole to collect radon gas emitted from the soil and cover it with an inverted bucket. Then backfill the soil around the bucket to act as a seal.

This test should show that radon concentration in the ground is at least 100 times greater than that found in outdoor air. Compare the outdoor readings with those measured indoors with the same rate meter. If you have been unable to calibrate your BERM against a professional instrument, the readings taken in the ground will act as a useful reference. *If the amount of radon collected indoors is as much as 10 % of the level determined from the soil test, it is probable that a radon hazard exists.*

Line power circuit

If you want to experiment with your BERM indoors or perform long-term testing, you might want to power it from the AC line rather than depend on disposable 9-volt batteries. An off-the-shelf AC-to-DC adaptor is not suitable for this application because it lacks the necessary filtering to eliminate noise interference. The circuit shown in Fig. 10 includes the necessary filtering. Ω

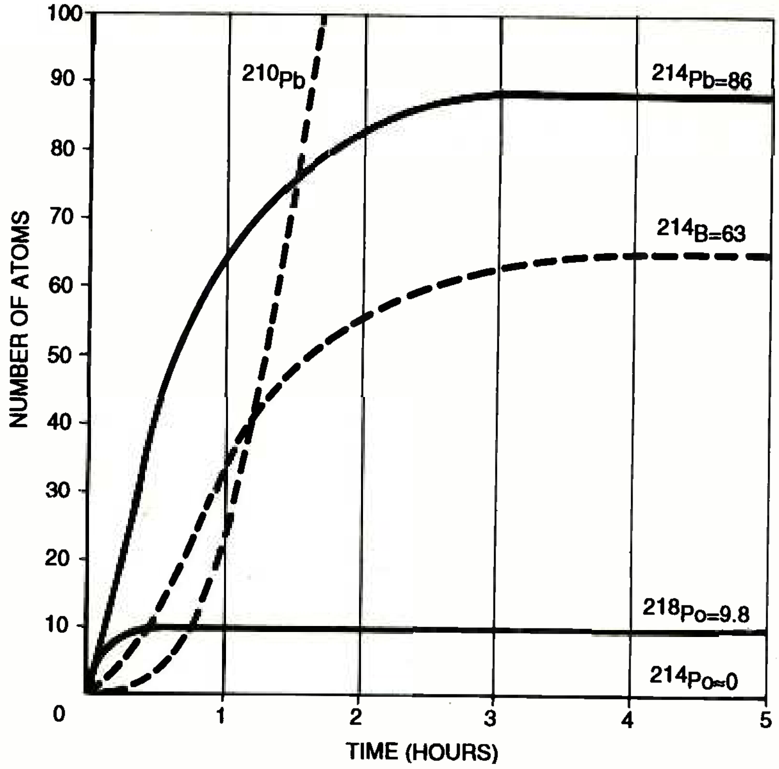


FIG. 9—PLOT OF RADON 222 PROGENY EMISSION OVER TIME VS. number of atoms.

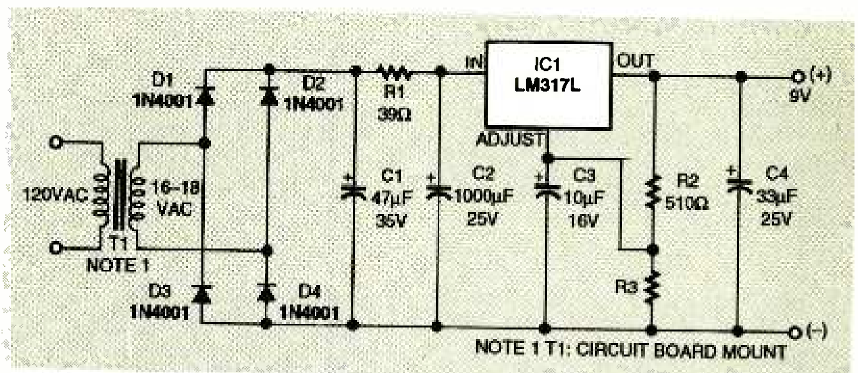


FIG. 10—THIS FILTERED POWER SUPPLY can replace a 9-volt transistor battery for powering the radon monitor.

References

1. Brookins, Douglas G.: "The Indoor Radon Problem," Columbia University Press, New York, NY, 1990.
2. Lao, Kenneth: "Controlling Indoor Radon," Van Nostrand Reinhold, New York, NY, 1990.

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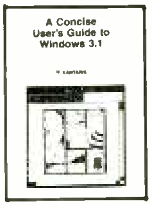

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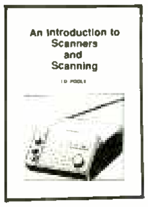

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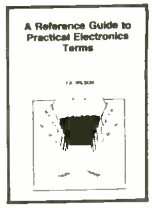

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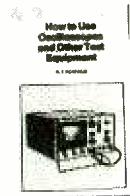

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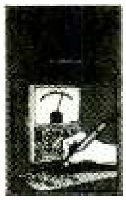

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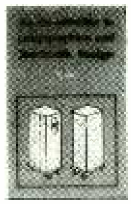

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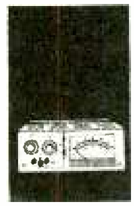

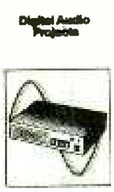

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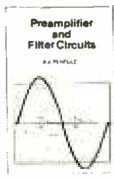

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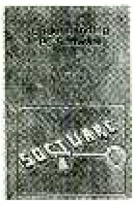

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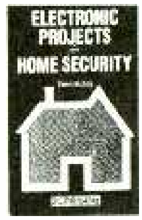

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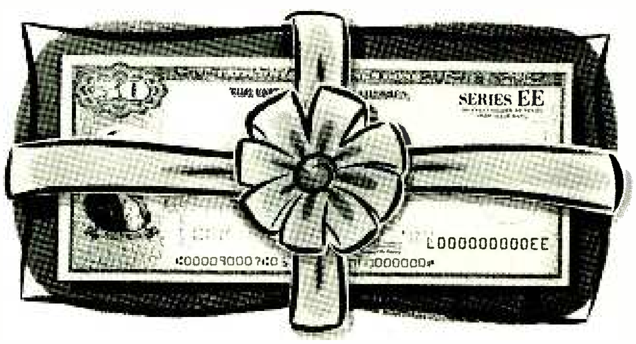
SERIES EE

HARDWARE HACKER

Hacker's data exchange, the Adobe Acrobat system, a new pseudoscience magazine, voice messaging circuits, and special-effects resources.

DON LANCASTER

Let's start with an announcement that a superb video on the use of car alternators as low-cost, high-power stepper motors for such tasks as CAD/CAM is now available from *John Rees*. Included is a demo of his sign routing system and step-by-step rewinding details. The cost of the video is $19.50.

One hardware hacking topic that has generated more than its share of helpline calls lately is...

Voice messaging

At one time, analog tape recorders were the only reasonable way to record and play back voice messages. But these days, we've got compact, low-power, reliable electronic solutions—solutions that require no mechanical parts or moving media. Uses? Everything from voice E-mail systems to robotics and talking cards.

There are a lot of different options here. They trade quality and message time against costs, ease of recording, and compressibility.

Many older systems are based on *Toshiba* or OKI speech chips. Those systems basically include an A/D converter for recording, some digital storage, and D/A circuits for playback. The digital storage can be permanent (ROM) or else easily changeable (RAM). Otherwise a large EPROM can store messages that are to be changed only every now and then.

Typical low-cost hacker systems include the *Quik Voice* from *Eletech Electronics* and various offerings from *Ming Engineering*. Pricing is in the $20 to $40 range. These systems are usually a small circuit board holding a speech chip, a message EPROM, some analog circuits, and an output amplifier.

Everything from telephone- to CD-quality audio is available simply by changing the sampling rates. But memory requirements tend to get out of hand when recording messages longer than a minute or so.

Two good starting points for this approach are the *Voice Synthesis LSI* data book from *OKI* and various data books and application-notes from *Toshiba*.

But there is a new kid on the block that offers a true single-chip solution to electronic messaging. This one is called DAST, short for *direct analog storage technology*. Instead of going the A/D-D/A route, this new technique uses special circuitry that *directly* stores *analog* samples in a nonvolatile array.

The pioneer here is an outfit called ISD, which is short for *Information Storage Devices*. Its current offerings are the ISD2500 family that give up to 90-second playback at selected quality levels. As many as several hundred different messages can be stored. You could easily record a vocabulary of words and combine them as needed under external computer control.

Its analog storage capability is 480K bytes, or just under a half megabyte. But note that this is equivalent to many megabytes of pure digital storage.

ISD has also released a simpler and older ISD1000A chip for sale through *Radio Shack* (No. 276-1325 voice recorder chip). This one costs around $20 for the chip alone and holds 128,000 analog speech samples. Figure 1 shows the chip in an ultra-simple playback-only circuit, while Fig. 2 shows what's needed to record and play back messages.

While there's no reason why you can't also use this for recording tones, sound effects, or music, the lower sampling rates of the DAST system generally limit you to telephone-quality audio.

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A hacker data format

Wouldn't it be nice if there were some sort of data standard for getting *exact size* printed-circuit artwork for construction projects, as well as ready-to-use panel art and dial plates? Well, I've been doing this for years with all of my more recent *Hardware Hacker*, *Ask the Guru*, *Resource Bin*, and *Blatant Opportunist* columns by way of my *GEnie* PSRT. But that's just me. The key question is which data format could be used so that *all* authors for *all* technical publications could provide the same service?

There are several obvious goals for such a data format. The files should be totally device independent. The same file should run identically on *any* computer—a PC, Mac, IBM, C-64, Amiga, Sun, or Cray. The files should consist of ordinary printable ASCII characters that can be sent over a non-transparent 7-bit data channel. There should be absolutely *no* need for any special end-user hardware or software. Files should be printable on all popular printers.

The files should be more or less readable by humans and easy to edit. No royalties, costly software, limits, use licenses, or other restrictions should be involved. No trace should remain of any of the proprietary code used to generate the actual text and graphic images. All the files should also lend themselves to full *book-on-demand* publishing.

And, of course, the files should all be super compact, run quite fastand be self-collating at the maximum possible mechanical feed speed of the printer with *zero* setup time. A reasonable goal is a file size o 10 kilobytes per camera-ready page, uncompressed.

After working on this problem for several years, I've concluded there are three routes to the hacker data format that seem reasonable. These are fax, *PostScript*, or Adobe's new *Acrobat* document system.

I don't like fax. I never use it. Special costly equipment is often needed. Compared with camera-ready PostScript, fax quality is putrid. The exact size is never guaranteed. And most fax files end up much longer than PostScript files and transmit much more slowly.

It turns out that fax compression is just about the worst possible way to squash photos or fancy technical

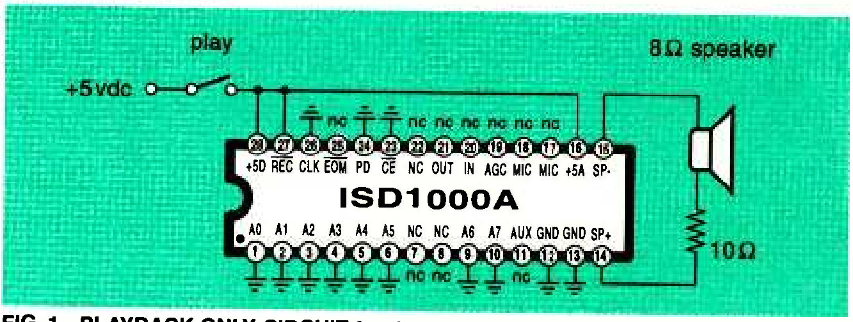

FIG. 1—PLAYBACK-ONLY CIRCUIT for the ISD1000A. The ISD chip has an innovative on-chip analog data-storage system.

illustrations. See Adobe's note No. 5115 for unbiased comparisons. And it is still fairly tricky to store, edit, and reuse fax code. And they are usually black-and-white only. Yet there are lots of sources now offering automatic fax services. For instance, Dan Poynter has some outstanding free resource information on self-publishing available by way of his auto fax. And most of the electronic trade journals now have lots of auto fax ads showing up.

On the other hand, PostScript can meet all hacker data goals. As I have mentioned before, I use PostScript as a totally *general purpose* computer language. I use it for everything from formal engineering design to stock-market analysis. Plus, of course, dirtying up otherwise clean sheets of paper.

More and more hackers have easy access to a PostScript laser printer. If you do not, the *GhostScript* shareware is widely available for downloading. This lets you run a fake PostScript over any popular printer, plotter, or phototypesetter. And yes, the full GhostScript source code is included so you can work from any recent host computer system.

One subtle but super important feature of PostScript: You can easily do *microsizing*. That let's you adjust precisely the final size on printed-circuit art and compensate for paper stretch or mechanical feeding errors. PostScript, of course, works beautifully with the new direct-toner printed-circuit processes offered by *DynaArt Designs* and *Techniks*. And, yes, PostScript can be converted back into older and more klutzy *Gerber* or HPGL vector formats.

Adobe Acrobat is brand new. This is intended to let Fortune-500 firms achieve "paperless offices," whatever those are. Their fancy document files include global searching, nonlinear Hypercard access, and thumbnail sketches for each page. The system is quite expensive.

Sadly, Acrobat document files can *not* be printed without special viewer software. Acrobat files generally demand the use of genuine PostScript level 2. The final files are also much larger and run much more slowly than I believe is really necessary.

Because nearly all of those more powerful PostScript commands are disallowed in the files, some simple graphic constructs will often generate unbearably long code. For instance, a circle needs hundreds of bytes.

Something vastly better is clearly needed for a hacker file-interchange standard.

The solution

Why not combine the best features of PostScript and Acrobat? Acrobat contains a useful but grievously flawed *distillery* that can take any PostScript input from any source and reduce it to essential core commands only, usually in a fairly efficient manner.

Sadly, the new distillery does all of its work in the host, rather than the printer. Any selected fonts must be available in host format. The file must be in one continuous piece, since persistent downloads and *run* support are appallingly absent.

Nonetheless, the distillery is the key to converting any code that was generated on a proprietary CAD/CAM, page-making, or illustration program into license-free and royalty-free distribution format.

Each page appears in the Acrobat document as an *object*. It is very

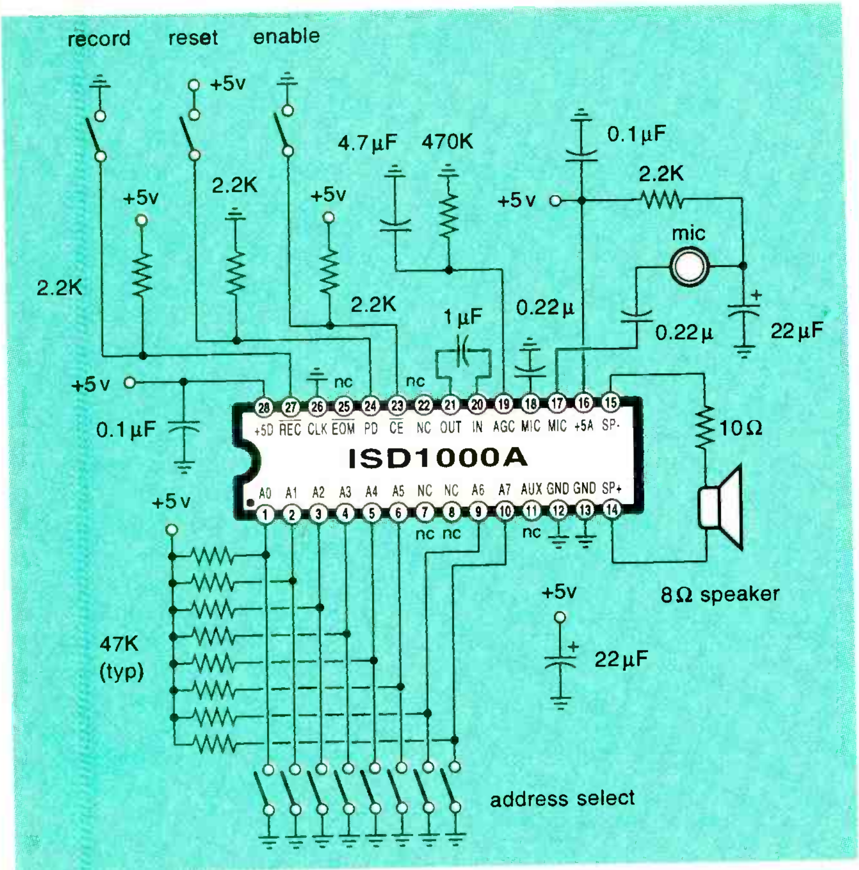

FIG. 2—A MULTI-MESSAGE COMBINATION playback and record circuit based on the ISD1000A. An electret microphone is shown.

easy to extract each page object, add some simple header code, and make it into a stand-alone PostScript file.

But I believe that raw Acrobat page output is much too long and runs far too slowly. It is also hard to read and harder yet to edit.

So, I have come up with a *triple distilling* process that dramatically improves extracted Acrobat files. The files are first split into their graphics and text portions. Then the graphic portions are shortened and simplified by permitting additional PostScript commands. The tricks used here will depend largely on how the original code was first generated. But such operators as *arcto*, *translate*, and *repeat* can play a big role here.

The text is sorted so that *each font size only is used once* and it is defined so that *each text line stands on its own*. Unneeded characters (such as leading zeros, trailing spaces, and extra precision) are also eliminated to further shorten the files. The speed and size gain here can be very impressive to the extent that an *uncompressed* triple-distilled file is often shorter than a compressed Acrobat file!

With some care, triple distilling can leave you with level 1 commands only, so that older PostScript printers can still be used. This will continue to be an important hacker feature for the next several years or so.

Figure 3 shows a fragment of Acrobat text output, while Fig. 4 shows the double-distilled results. The Acrobat code is typically 65% longer and 43% slower. In addition, it is harder to read and edit. Since many casual PostScript users end up baud-rate limiting themselves, a 65% length penalty can also become a 65% speed penalty. More details appear in SPEEDUP.PS.

The triple-distilling process can be fully reversible. The end user could always use the Acrobat distillery to get himself right back where it all started, or to import into packages that accept only limited PostScript commands. This use would normally be very rare.

Custom or exotic fonts could be

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handled one of five ways: (1) Ignore them and default to *Courier*. (2) Ask your end user to get all of his own fonts. (3) If only a few characters are involved, you can use a *font eliminator* that substitutes the actual font paths (this is great for logos—see FONTELIM.PS). (4) Use *multiple master* fonts for a lookalike approximation. Or, (5) You can internally tow along a copy of the needed font. Yes, much of the triple-distilling process can be fully automated.

If you do not have any access to Acrobat, there's an older DISTILL.PS file available for downloading. This older program has lots of bugs that eliminate clipping, scaling, and subscripting. But it can be run in any PostScript printer or emulator. It also supports persistent downloads, allows run commands, and has no host font restrictions.

I strongly believe that triple-distilled PostScript is the ultimate solution for a compact and low-cost hacker file interchange. I've got scads more on this on *GEnie* PSRT, including lots of source code and examples.

Naturally, I'd be most happy to help you create your own distribution files in hacker data format. You can call or write for help on this.

Two contests

As the first of two contests this month, just tell me your thoughts for a new hacker data-format standard. There will be the usual *Incredible Secret Money Machine II* prize going to the best dozen or so entries, with an all expense paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all. As usual, send your written entries directly to me here at *Synergetics* and not to **Electronics Now** editorial.

Special effects

How would you like to build your own T-Rex? or shoot a custom version of *Godzilla versus the Night Nurses* as a home video? What you'll require here, of course, are *special effects*. As you might guess, there is a low-profile and little-known special-effects industry that can supply all of your needed bits and pieces, either off-the-shelf or custom.

The special-effects supply sources can be a treasure trove for hardware hacking. Included are materials for plastic, rubber, and resin molding. There's special hardware, unusual materials, "claymation" supplies, fur and hair, armatures, control cables, remote controls, unusual lighting, fog and smoke machines, and lots more.

As a sidebar for this month, I thought we'd gather together a few of the better special-effects resources. The center of the industry appears to be a great quarterly magazine called *Cinefex*. A recent issue showed the insider secret plans to all the Jurassic dinosaurs, as well as the Andean plane crash. A second useful magazine on this subject is *Film & Video*.

Two of the more intriguing entries on our list are the *Sword & Stone*

```
/F8 1 Tf
9.75 0 0 9.75 60 427.5 Tm
0.029 Tc
0.032 Tw
(The tone frequencies are)Tj
/F9 1 Tf
10.9 0 Td
(subaural)Tj
/F8 1 Tf
3.7 0 Td
( in)Tj
-14.7 Te
0.021 Tc
-0.013 Tw
(that most phone or mobile comm gear)Tj
0 Te
0.043 Tc
0.115 Tw
(sharply attenuates audio below)Tj
9 0 0 9 200.4 406.5 Tm
0.046 Tc
0.124 Tw
(300)Tj
9.75 0 0 9.75 215.2 406.5 Tm
-15.9 Te
0.026 Tc
0.016 Tw
(Hertz or so.)Tj
1.025 Te
0.030 Tc
0.038 Tw
(The)Tj
9 0 0 9 89.1 385.5 Tm
0.032 Tc
0.041 Tw
(MX365A)Tj
9.75 0 0 9.75 125.4 385.5 Tm
0.030 Tc
0.038 Tw
( is a typical chip that)Tj
-6.7 Te
0.032 Tc
0.053 Tw
(can be be used either as the encoder)Tj
0 Te
0.032 Tc
0.053 Tw
(of Figure 2 or the decoder of Figure)Tj
0 Te
0.035 Tc
0.068 Tw
(3. This circuit offers your choice of)Tj
0 Te
0.048 Tc
0.148 Tw
(hardwire programmable tones or a)Tj
0 Te
0.038 Tc
0.084 Tw
(serial computer control. I've shown)Tj
```

FIG. 3—TYPICAL ADOBE ACROBAT OUTPUT used to distribute high-quality text and graphic documents. A special reader is required before the file can be printed.

and *National Hair Technologies*. The first for medieval armor, and the second for fake fur and strange wigs.

There are a lot more where those came from, so be sure to let me know your favorites or anyone I missed. In fact, let's make a second contest out of it.

New tech lit

Untapped Technology in Review is a new labor-of-love pseudoscience journal. Uh, this one seems midway between the *Skeptical Inquirer* and the *Borderlands Quarterly*. Included are commented critical reviews of some popular free-energy and antigravity schemes, the current contents for the other pseudoscience magazines, and off-the-wall patent listings.

A brand new book on buying and using older *Tektronix* oscilloscopes is titled *Oscilloscopes: Selecting and Restoring a Classic*. This one costs $19.95 from *Stan Griffith*.

Olympus has just introduced its *Videoimagescope* system. This is a full-color video camera, a *quarter inch* in diameter, at the end of a 70-foot (!) strobe-illuminated and fully steerable snake-like probe. While this dude looks outrageously expensive, it just might make a really dandy cave-survey and exploration tool, especially if it could be made self-cleaning and waterproof to a depth of twenty feet.

The horse's mouth source information on SCSII disk communication is known as ANSI X3.131-1986. It is available for $50 directly from the *American National Standards Institute*.

```
/Times-Roman 9.75 ss
.31 .29(The tone frequencies are)60 427.5 hH
( in)203.9 427.5 H
-.13 .21(that most phone or mobile comm gear)60 417 h
1.12 .42(sharply attenuates audio below)60 406.5 h
.16 .26(Hertz or so.)60 396 h
.38 .3(The)70 385.5 hH
( is a typical chip that)125.4 385.5 H
.52 .32(can be be used either as the encoder)60 375 hH
(of Figure 2 or the decoder of Figure)60 364.5 H
.67 .35(3. This circuit offers your choice of)60 354 h
1.45 .47(hardwire programmable tones or a)60 343.5 h
.82 .37(serial computer control. I've shown)60 333 h

/Times-Italic 9.75 ss
.31 .29(subaural)166.9 427.5 h

/Times-Roman 9 ss
1.12 .42(300)200.5 406.5 h
.38 .3(MX365A)89.2 385.5 h
```

FIG. 4—TRIPLE DISTILLING can make the Acrobat output faster, shorter, and far more hacker friendly. No expensive software or special printer is required.

Sound Practices is a hands-on magazine that concentrates on vacuum tube audio circuits with only high-voltage linear triodes. The preferred tube these days seems to be the 211. To me, that mythical "tube sound" is simply so much hum, noise, and distortion added to an otherwise clean audio channel. You

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can easily remove any amount of hum, noise, and distortion with a digital signal-processing chip and a decent DSP algorithm.

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AUDIO UPDATE

Audiophile Silliness: Absolute Sounds Off

LARRY KLEIN

The editor of *The Absolute Sound*, who signs himself "HP," has finally responded (in his Summer 1993 issue) to my repeated cage rattlings. In a fit of dudgeon, he quotes my comment that his publication includes "a witch's brew of pseudo-science and unabashed subjectivism" and that its reviews "are essentially unreliable, influenced by price, fads, technical ignorance, and unfettered egos." (You know, if I had it to write all over again, I couldn't have said it better.)

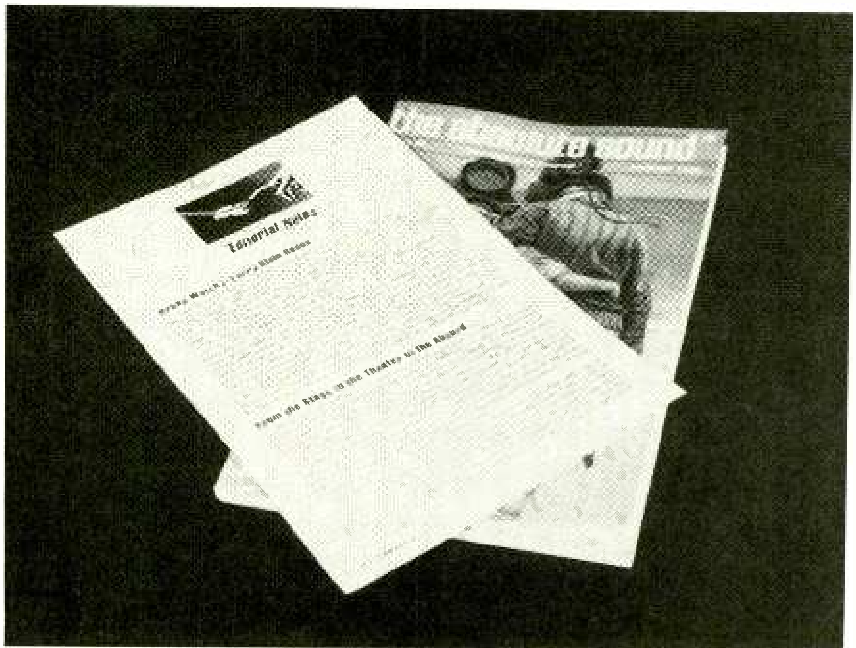
Since I've been crusading for years against the silliness and bad science that appears in most audiophile magazines, one might question why HP suddenly chose to respond—however inadequately—to my ongoing criticisms. The answer, I suspect, is that HP's ire was triggered by my praise and plug in the January 1993 issue of **Electronics Now** of his hated competitor, *The Audio Critic*.

HP's editorial was surprisingly weak, if only because of its several factual errors and the childish "nyaah, nyaah, nyaah" quality of his counterattack. It seems to me that if I go to the trouble of phrasing a literate assault, the least that HP could do is reply in kind.

Let's take his comments in order: For some reason, HP believes that I've gone from my "perch" as Technical Editor (actually, I was Technical Director) at *Stereo Review* to *Popular Photography*, where he thinks my column criticizing his publication appeared. (I haven't written for *Popular Photography* for at least 20 years.) He then attempts to invalidate my thinking, or hearing, or character—or all of the above—with a misquote that he's attributed to me before.

I did not write in *Stereo Review* that I did "not have to listen to music to know what it sounds like." During a 1977 six-page interview in *The Boston Phoenix* I said that "I'm not really sure how the process works, but I think I have an image in my head of what live sound is. So I really don't need an A/B comparison against live sound usually."

Obviously, HP and other audiophiles must also have an image (memory) of live music stored in their heads; otherwise there would be no way to audition components critically, given the absence of a concert-hall performance available as an immediate live reference for comparison purposes.



THE SUMMER 1993 ISSUE of The Absolute Sound starts out with an attempt to bash Larry Klein's approach to audio issues.

TAS test reports

HP supposes that I've not read *Stereophile* and *The Absolute Sound* in quite some time because "Both magazines are dramatically better in technical accuracy and solid judgments than they once were." Really? In HP's current issue there's a test report on the T4, a $7450 (!) power-line isolator that purports to improve audio performance by "isolating components from the power grid and from each other." In case you're wondering, all those thousands of dollars don't buy an extra-high current capacity; the T4 can handle a maximum of 2 amperes at each of its four AC sockets.

Now, because the report is appearing in *The Absolute Sound*, it would be silly to expect them to do any kind of reality-based testing of the T4. For example, they apparently never thought of something as simple as using a digital storage scope to look at and measure the device's ability to suppress injected power-line noise signals of various types and frequencies. Instead, all the reviewers did was listen to their audio systems with and without the isolator in series with the AC line.

One reviewer found that, at first the T4 seemed to clear haze from the highs, multiply the layers of stage depth, open up more space between the instruments, and maybe clarify the bass notes. But after listening for a few days, he became aware of an "unmusical glassiness in the upper midrange" and a diffusion of image focus. All that improvement, mind you, was from using a power-line isolator!

Elsewhere in the same issue, reviewers extol the virtues of 6-inch-long "cable jackets" at $70 each, which they find work sonic wonders when wrapped around line cords and system cables. One reviewer was so impressed that he said he added seventeen of them to his system at a list price (which I doubt he paid) of $1190.

Then we have the RFA-78 room-tuning devices. They are soft, fuzzy, adhesive-backed discs about the size of a quarter. They cost $595 for a box of 16; two boxes are recommended for a typical installation. HP's reviewers heard "enormous" improvements in their listening room acoustics when the discs were cemented on their walls. Needless to say, no before and after acoustic room measurements were made, nor were the operating principles of the devices explained in any way.

In that connection, I find it fascinating that not one of HP's equipment reviewers was moved to dissect one of the little fuzzy $37 discs in an attempt to understand how it works. Perhaps they thought that violating its integrity would break the magic spell. We must assume that something metaphysical is involved, because the discs appear to operate somewhere in an audio tweak Twilight Zone, outside the realm of conventional acoustic physics.

I'm truly flabbergasted to find that HP regards that sort of audiophile blather as demonstrating a dramatic improvement in technical accuracy and judgments. My God, what kind of evaluations were they making five or ten years ago?

One final note: HP closes his editorial comment with the suggestion that the sort of "irresponsibility" that prevents me from recognizing the technical improvements in his magazine has led to my shameful purported position at *Popular Photography* instead of an audio magazine. (Oh, the embarrassment of it all!) He goes on to imply that my plug for *The Audio Critic* was attempt to get hired by them. How silly can one get? My answer, in regard to HP, is: Very!

AES

Last October I attended the 95th Audio Engineering Society Convention held in the Jacob Javits Center on Manhattan's far-west side. There was a plethora of programs, papers, and exhibits but, unlike some previous conventions, I found that there was very little of home-audio interest.

A couple of typical paper titles will illustrate my problem: "A Perceptual Gain-Control Technique for Bioacoustic Transient Detection" and another one called "Idle Channel Tones and Dithering in Delta-Sigma Modulators."

There were special sessions on psychoacoustics and subjective assessment, auralization (which I understand refers to the accurate simulation of acoustic room environments), digital signal processing, multichannel and HDTV sound, and so forth.

In any case, I found most of the papers and sessions somewhat obscure and not particularly relevant to my concerns. Next month I'll discuss a few of those papers that I did find interesting. Ω

DRAWING BOARD

Our automotive power supply comes to life.

ROBERT GROSSBLATT

Adding homemade electronics to a modern car can be a complex business. Open the hood of your car and you might get the impression that there's more electrical wiring there than hoses, pipes, and other more traditional kinds of automotive hardware. Although it's hard to believe, once upon a time the only wire under the hood that was less than 14 gauge was for the lights, the charging system, and a handful of relays.

Eventually manufacturers added electronics that, in theory, would keep an eye on various aspects of engine operation. Unfortunately, those electronics don't tell the driver how well the car is running.

My favorite is the "oil" idiot light. While your owner's manual wants you to believe that it lights when the oil pressure becomes too low, the truth is really quite different. The oil-pressure light is more likely to let you know that the reason your car has stopped running (at 3:00 AM on an unmarked road) is that it ran out of oil, the engine has seized, and it's going to cost you a year's salary to get it repaired.

The first step in adding meaningful electronic monitoring to your car is to design a power supply, and the most important aspect of that is to get rid of the steep voltage spikes and gullies that are caused primarily by the high-voltage side of the ignition system. In a typical car you can expect to see voltage transients that are well over 20,000 volts! The electrical load we'll put on the supply is very small—certainly a lot less than a half ampere at either output voltage—so there's no need to get overly sophisticated in the choice of voltage regulators.

Considering the state of the hobbyist market, the shrinking number of suppliers who will sell in single quantities, and the needs of the circuits we'll be working on, the best choice for a voltage regulator is any member of the 78XX and 79XX family. These parts are easy to get, can supply the current we'll need, and are extremely reliable.

The simplest power supply you can build is the standard 78XX design shown in Fig. 1. I've left the regulator unspecified because the circuit layout is exactly the same for any member of this family and, since several of these regulators are required, the complete power supply circuit will be cloned from this layout—one for each regulated voltage. This layout has appeared a number of times here in the past, so you should be familiar with it.

About the only component you might find mysterious in Fig. 1 is the diode straddling the input and output of the regulator. The diode is sometimes referred to as the "quench" diode. It comes into play whenever the input to the regulator sees either a short circuit or a voltage drop that causes the input voltage to fall below the regulated output voltage. The second of these situations is a real possibility when you consider what can happen to the battery voltage when you're starting your car on a cold winter morning.

While all 78XX regulators are protected internally against output shorts, they have virtually no protection against input shorts. If there's an output short, the regulator will immediately attempt to supply the required current, although the shock will be somewhat smoothed because the 100-microfarad capacitor at the output will discharge and feed its own stored energy into the short circuit. Ultimately the current drawn from the regulator will cause it to overheat, the device will exceed its thermal overload point, and the regulator will turn itself off.

In the case of an input short, however, the situation is much more dangerous. Whenever there's either an input short or a severe drop in the input voltage, there will be a higher voltage at the output of the regulator than at the input. This means that the energy stored in the 100-microfarad capacitor is going to be discharged into the internal output circuitry of the regulator. Depending on the circuit parameters, this will probably reverse-bias the regulator's internal pass transistor and the IC will be toast.

The way to keep this from happening is to use the quench diode. In normal operation, the diode is going to be reverse biased and won't have any effect on the operation of the regulator. This will be true even if an output short occurs because, even then, the output voltage will be less than the input voltage. If, however, the input voltage falls below the output voltage, the diode will begin to conduct, and the energy

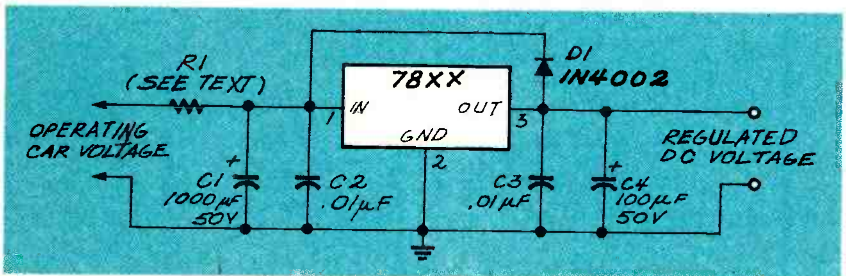


FIG. 1—THE STANDARD 78XX REGULATOR is in the simplest power supply we can build. The circuit layout is exactly the same for any member of this family.

from the capacitor will be shunted through the diode and it will prevent the regulator's output stage from being completely destroyed. The diode rating depends on the circuit but, since we're not extending the standard limits of the 78XX, a diode rated for 2 amperes should be more than adequate. Keep in mind that having the diode there doesn't mean that you can be more casual than usual in designing the circuits that are going to be powered by the supply.

Other than that diode, our power supply is pretty straightforward. All that's needed are a few capacitors, diodes, and a separate 78XX regulator for each of the voltages you want available. Since the supply will be providing both 5 and 12 volts, a 7805 and a 7812 are needed. (I made a mistake last month when I said I would use 9 volts as the design criteria for the supply—I meant 5 volts—sorry about that.)

The last serious bit of business we have to cover regarding the power supply is the issue of isolation. From a practical point of view, isolating the power supply from the car's electrical system requires only a single resistor. The value of the resistor is determined by calculating the maximum amount of current the supply will be drawing. For most applications, the amount of current drawn by the supply is the same as the amount of current the supply is expected to deliver—in this case that number is half an ampere per regulator. All that's left to determine, in order to calculate the value of the resistor, is the voltage available to the power supply.

Since the supply will usually be used while the car is running, it is reasonable to assume that 13.5 volts will be present at the input of the supply. The resistor's value, as a simple application of Ohm's law (I = V/R) reveals, is 13.5/0.5 or 270 ohms.

Adding a 270-ohm resistor to the supply leg of each regulator subsection as shown in Fig. 1 will help isolate the different sections of the supply from each other as well as from the hostile electrical environment of an automobile. Decoupling capacitors and isolation resistors are good things to include in the

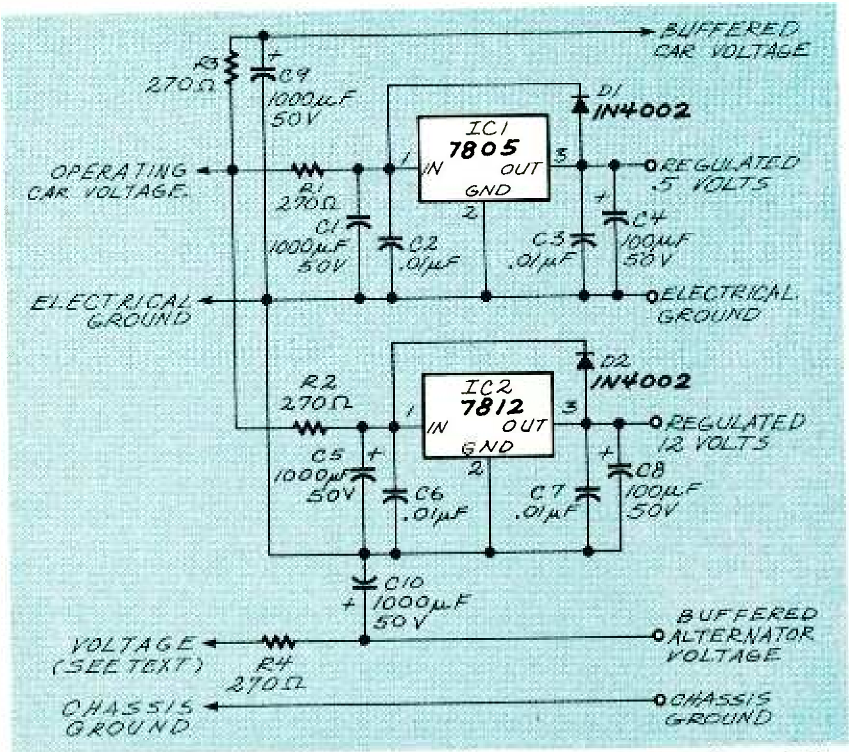


FIG. 2—FINAL POWER-SUPPLY DESIGN. Electrical ground connects the car battery and chassis ground to some convenient bolt on the body of the car. The operating voltage is the battery voltage.

design of any power supply, especially non-switching ones. As you'll see later, each circuit powered by the supply will get the same treatment as well, because you want to ensure that glitches in the car's electrical system will have a minimum effect on the circuits that will be added to the car.

The final design of the power supply is shown in Fig. 2. It incorporates all the refinements discussed and has a few other things added that are needed to meet the list of criteria I drew up last time. Electrical and chassis ground are simply made by hooking up wires to the appropriate points—the former should come from the battery, and the latter can come from the body of the car.

The operating voltage of the car is just the battery voltage, and you'll notice that I've used isolation and decoupling components there as well. More than likely, the only use you'll ever have for the battery voltage is to feed it to a voltmeter, but it's a good idea to buffer it before feeding it to any other circuitry.

You will need access to the alternator voltage. Although this is also buffered, your car characteristics will determine how useful it will be. My car has a separate alternator and voltage regulator, so I also brought the field voltage to the power supply board. That lets me keep an eye on the operation of both the regulator and alternator, but if your car has its voltage regulator built into the alternator, the value of alternator voltage will be considerably less informative because it will usually be a duplicate of the car's operating voltage.

Probably the best thing for you to do now is find the service manual for your car and see how your alternator/generator and voltage regulator are set up. This will show you which power lines are the most useful for extending to the power-supply board.

In the interests of saving money (for the manufacturers, that is), some important voltage test points in newer cars are being hidden from the probing eyes of owners. A service manual will at least give you some clues about where the lines are, so owning the manual is well worth the cost. Next month I'll begin designing a versatile tachometer that will not only function as a tach, but will also add goodies such as rpm averaging. Ω

CALLER ID

continued from page 37

module. Pin 1 on the PC board is indicated by a rectangular pad instead of an oval one. Be sure to match this pad with the pad labeled 1 on the display module board.

The size of the PC board and the location of the mounting holes are arranged so it mounts directly into a 3- × 4- × 2-inch plastic enclosure (it's manufactured by Serpac, and available from Digi-Key as part no. SR232G-ND).

If you are mounting the board in a different enclosure, do not use metal standoffs. The standoffs could short against one of the traces on the bottom side of the board. Position the display and the three pushbutton switches on the bottom side of the top cover, and, being very careful, mark it for drilling and cutting.

Mount the switches and display to the cover and make the appropriate connections to the board. Label S1 "REVIEW FWD," S2 "REVIEW BCK," and S3 "CLEAR." Hook up the 9-volt power supply to the positive and negative terminals as shown in Fig. 4.

Use a telephone cord with a modular jack on one end and run the cord through a small hole in the case, tie a knot in the cord for strain relief, and solder the red and green wires to the correct pads. After all connections have been made to the board, place the board at its mounting location and mark the spot on the enclosure directly below the slot in potentiometer R14. Remove the board and drill a hole at that spot just big enough for a small screwdriver, and then re-mount the board in the enclosure. The hole will allow you to make adjustments to R14 without removing the case. Last, install the two ICs in their sockets. Figure 5 shows the completed caller-ID prototype.

Operation

Adjust R14 to its mid-position and apply power. If everything is wired up correctly, a logo will appear on the LCD display. While viewing this message you can adjust R14 to change the contrast of the display. If the message does not appear, there is an error in the wiring and you should remove power and closely examine the board. A prime spot for error would be the ribbon cable that connects the main PC board to the display module. Check for solder bridges on both ends of the cable, and verify that the pin numbers on the main board and on the display board correspond with each other.

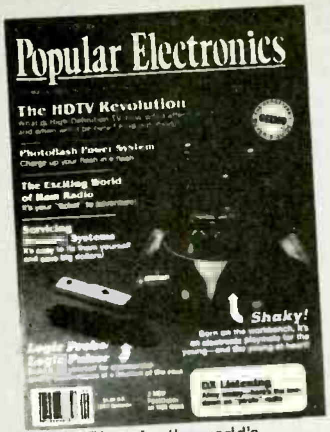
At the end of the logo display the word "Ready" will be displayed and will remain for about 20 seconds before the display clears. Note that this will work without being plugged into a phone line.

The Caller ID unit is now ready to be hooked up to the telephone line and receive data. Use a modular duplex jack so that the unit can share the same wall jack with your telephone.

Remember that you must subscribe to the Caller ID service before your unit will work. It might take several days to be hooked up, depending on your local telephone company, so it is a good idea to do this in advance.

When each call comes in, the display shows the time of day on the left side and either the telephone number, the word "Private," or the word "Out Area" on the right side. Pressing S2 "REVIEW BCK" shifts the display to view previous calls and pressing S1, "REVIEW FWD" shifts the display back to the most recent call. Holding down either one of the review buttons causes the display to scroll through the calls, stopping at either the most recent or oldest call, depending on which direction you are scrolling.

You do not have to shift back to the most recent call before receiving a new one. The display automatically returns and adds the new call directly after the most recent call, knocking out the oldest call if five calls already exist in the unit's memory. Ω



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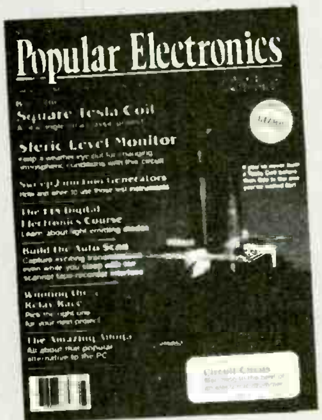

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HEAT DETECTOR

continued from page 43

housing assembly to the focus tube with plastic electrical tape. Then insert the focus tube in the larger circuit tube as shown in Fig. 5.

Operating instructions

Be sure to allow the detector to "soak" in the ambient temperature in which it will be operated until it becomes temperature stabilized. For example, if it is to be used outdoors in the winter or summer when the temperature is significantly lower or higher than room temperature (22°C), allow the unit to remain in that environment for at least one hour and possibly as long as two hours before attempting to detect objects.

The ability of the detector system to discriminate a heat-producing stationary object from its background environment will depend on chopper-motor speed. Maximum sensitivity is achieved with one-tenth chopper revolution per second, but a chopper speed of 1 to 3 rps is recommended.

However, if you elect not to use the chopper for some application or experiment, look into the open end of the tube and move the shutter so that it is aligned in the focal plane to minimize interference with the incoming infrared emission.

The field of view of this instrument with the Fresnel lens and pyroelectic detector specified is approximately 8°. Larger objects can be detected by panning the unit horizontally after mounting it on a rigid tripod.

After you are satisfied that the focus tube has been adjusted to the optimum focal length, mark the location of the end of the larger diameter tube on the smaller diameter tube. Drill a small hole in the end of the smaller diameter tube and insert a small plastic screw to act as a stop, as shown in Fig. 5. Either apply a patch of black plastic electrician's tape or slide an opaque plastic sleeve over the detector access port to keep out ambient light. Ω

COMPUTER CONNECTIONS

The National Information Infrastructure

JEFF HOLTZMAN

One good thing about the Clinton administration: It seems to value technology.

Nowhere is the administration's acceptance of technology more apparent than in its Agenda for Action regarding the National Information Infrastructure (NII). NII has become the umbrella concept for uniting a disparate collection of technologies, including computers, networking, and wireless communications, to provide anytime anywhere access to anything. This time I'll talk about the nature of the NII agenda, as well as critical industry response to it. Many aspects of this agenda are still under debate, so things might have changed and probably will by the time you read this.

Why NII?

The agenda outlines three basic reasons why the NII is necessary: flexible employment, targeted education, and intelligent health care.

The first is a person's ability to live anywhere, without foregoing the opportunity for intellectual and economically rewarding employment. The idea is that information workers could telecommute to their jobs via high-bandwidth data links.

Second is a person's ability to learn anywhere, without being hampered by the lack of local resources or a physical disability. Bright kids in rural districts would be able to link to virtual electronic classrooms at leading schools, thereby having access to quality instruction.

Third is a person's ability to obtain appropriate health care when and where needed. Much health care might be unneeded or inappropriate. Trying to cure severe diseases after they have taken hold is more expensive than catching them at an early stage. People with on-line access to expert medical resources might pay more attention to preventive health care.

What is the NII?

The Agenda defines it this way: "A seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips."

By contrast, what we have now are sets of building blocks that don't fit together very well—if at all. Our communications networks include multiple, unconnected webs and subwebs. These include the telephone networks, the cable-TV networks, the Internet, 50,000 electronic bulletin board systems (BBSs), and the local-, metropolitan-, and wide-area networks (LANs, MANs, and WANs) that are proliferating in corporate America and worldwide.

The cable-TV networks have high bandwidth and connectivity to most of urban America, but the industry has an extremely poor service record. The phone companies have less bandwidth, but equally broad connectivity, and a fairly good service record. However, their inability to implement even low-bandwidth (128K bps) ISDN (integrated services digital network) over the past decade does not reassure us about the future. The Internet was originated for scientists, engineers, and researchers, but its use is rapidly spreading to corporations and individuals. Nonetheless, navigating the Internet is still too difficult and expensive for average users. BBSs have evolved in an ad hoc way to support computer-user communications, but there is precious little of value for professionals. Its bandwidth is low, but its connectivity is flexible.

Our computer systems are just as varied, as they include PCs, Macintoshes, Unix boxes, and numerous minicomputer and mainframe systems. These are being supplemented by new technological systems including cellular telephone/modem systems and pen-based personal digital assistants. Those devices give us the promise of simpler, more efficient means for interacting via digital technology with remote systems. But right now, it's still only a hope.

The most important factor is the data. There is already a tremendous

TABLE 1—NII OBJECTIVES

1.	Promote private sector investment, through appropriate tax and regulatory policies.
2.	Extend the "universal service" concept to ensure that information resources are available to all at affordable prices.
3.	Act as a catalyst to promote technological innovation and new applications.
4.	As the NII evolves into a "network of networks," promote seamless, interactive, user-driven operation of it.
5.	Ensure information security and network reliability.
6.	Improve management of the radio frequency spectrum.
7.	Protect intellectual property rights.
8.	Coordinate with other levels of government, with other nations, with industry, with labor, with academia, and with the public.
9.	Provide access to government information and improve government procurement.

amount of data in digital format in data bases, and it seems to be growing exponentially. One priority of the Agenda is making the vast quantities of data created by various government agencies accessible to the taxpayers who paid for it. Making data available is half of the problem; the other half, one that will require gargantuan technological innovation, is providing tools that help the taxpayers find what they want.

NII objectives

The NII Agenda has nine objectives, shown in Table 1, that guide it. The following are a few notes about each:

1. At one time, Vice President Gore advocated direct government involvement in building and operating the NII. Wisely, he has retreated from that position. Now the administration advocates a government role limited to leadership and coordination, leaving implementation to industry.

2. The Communications Act of 1934 articulated in general terms a national goal of Universal Service for telephones, which called for widespread availability of a basic communications service at affordable rates. A major objective in developing the NII will be to extend the Universal Service concept to the information needs of the American people in the 21st Century. As a matter of fundamental fairness, this nation cannot accept the division of our people into telecommunications or information "haves" and "have-nots."

3. The Clinton/Gore administration plans to invest $1 to 2 billion annually in deploying NII technology. This investment will be applied to both computing and communications. U.S. industry, by contrast, has been investing about $50 billion annually on communications alone in recent years.

4. User-driven information tools will be a hot area of development. User interfaces must improve by an order of magnitude—maybe two—before the common man or woman will be able to make effective use of NII.

5. Security and reliability are crucial. The network must be impervious to, or at least tolerant of, natural disasters, war, and hacking/phreaking.

6. Wireless connectivity plays a key role in the anytime/anywhere portion of the NII goals. The technology here goes by the name Personal Communication Services (PCS); it typically includes spread-spectrum cellular radio transmission, but with higher reliability and more flexibility than current systems. Frequency spectrum allocation thus becomes critical. Recently, the National Telecommunications and Information Administration (NTIA), a division of the U.S. Department of Commerce, advocated a scheme allowing both "large" (30 MHz) and "small" (10 to 15 MHz) chunks of spectrum to be auctioned. The hope is that smaller, more innovative firms would be able to bid on the smaller chunks; in addition, spectrum space could be used more efficiently in smaller chunks.

7. Digital technology, with its ability to capture and modify information in just about any form, has created a morass of moral and legal issues regarding copyrights. Several current projects (e.g., Plexus and Project Gutenberg) seem to advocate a copyright-free world in which everything is available to everyone without obligation. But commercial publishers and media corporations will never go for that, nor will most individual authors be willing to assign their intellectual property rights over to the public domain. Thus a system for tracking the use of copyrighted materials, and compensating authors accord-

ingly, is required.

8. The Agenda clearly recognizes the need for coordinated action between Federal, state, and local governments, and their agencies, particularly the Congress, the FCC, and the Executive branch, as well as foreign governments. This is a big problem; half-cocked attempts are bound to fail and even harm efforts through loss of credibility, much as NASA has suffered in the past few years. It's critical that this job be done right, from the beginning.

9. "Information is the currency of democracy," said Thomas Jefferson; never was that statement more true than it is today. The federal government produces unbelievable quantities of information, some of which could be valuable, were it accessible at low cost and with ease. Some information is currently placed on expensive on-line services (e.g., Dialog), which can cost hundreds of dollars per hour to access. Other information is recorded on CD-ROMs, but then sold for exorbitant rates. Clearly, we the people—the taxpayers—paid for this information once; there is no reason why we should have to pay for it twice.

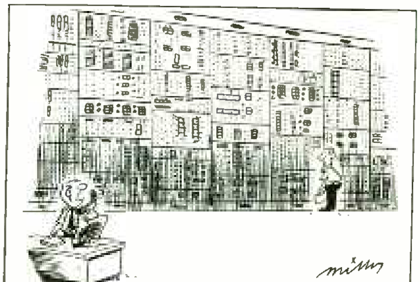
Convergence

People have been talking about convergence among the computing, communications, and publishing industries since the mid 1980s. (See my June and July 1993 columns for a more complete discussion of these concepts.) What's new now is that there is high-level political recognition of the importance of this trend, of the importance of not being a follower but a leader.

The Clinton administration has taken several steps to ensure follow-through on this initiative. It has convened an Information Infrastructure Task Force (IITF) for the purpose of pursuing the nine goals outlined above. The IITF has already spawned three subcommittees that are attacking various aspects of the problem, including telecommunications policy, information policy, and applications. The President is also expected to sign an executive order creating an advisory council, from industry, whose primary concern is NII matters. The administration is also encouraging, within government agencies closely allied with NII matters, the use of E-mail and other information technologies now taken for granted at most corporations. Perhaps after experiencing the productivity gains made possible by advanced computers and communications firsthand, the bureaucrats will learn to accomplish something.

Some in American industry will undoubtedly decry any kind of government involvement, but I think it's a good thing—as long as the government doesn't try to exert too much control or impede progress by over-bureaucratizing efforts. The problems of integrating our diverse digital information systems are just too great for industry to sort out by itself within a reasonable amount of time. We need strong leadership and a process for working out compromises among the many headstrong players in this game. We as citizens need to insist that the processes do not become bogged down in haggling over trivia, because Europe and the Pacific are working on similar initiatives, and getting there first will certainly provide strategic global advantage.

The ideal situation would allow anytime, anywhere access to anything, regardless of provider, platform, or transport. We're a long way from that now, so the current initiatives will encourage experiments covering various portions of the problem. Some of these experiments will be performed by IBM, AT&T, and Time-Warner, TCI. Others will be performed by small startups that do not yet exist. Indeed, the government has budgets earmarked expressly for the purpose of funding startups untainted by big-company thinking. You might want to get in on some of that. Ω



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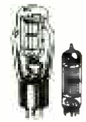

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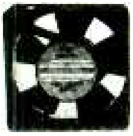
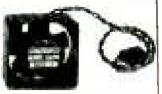
2R100976  2R100917  2R100896 

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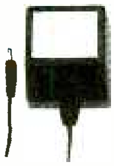 2R15392

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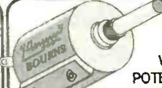

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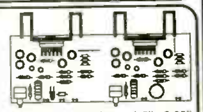

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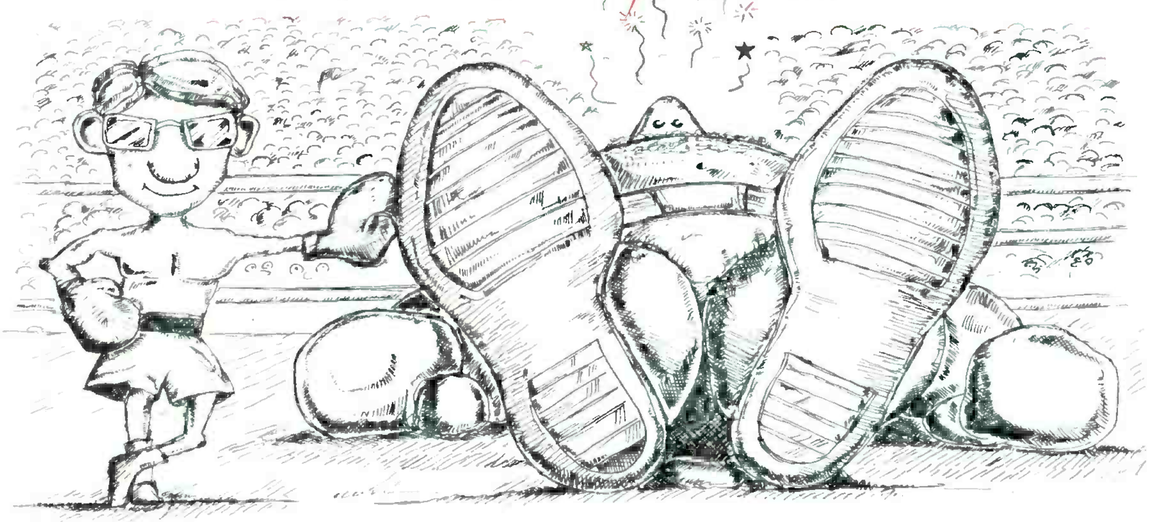

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