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### The First Amendment versus BBS

Does the right to free speech extend to statements posted on a computer bulletin board? That's the basic question being probed in a lawsuit brought against Peter DeNigris, a Suffolk County, NY government worker, by Medphone, a medical equipment company based in Paramus, NJ. The company claims to have lost between $30 million and $40 million due to plummeting stock values as a direct result of a series of statements that DeNigris posted on the Prodigy online service. Prodigy was not named in the suit. Medphone claims that the statements were deliberate falsehoods intended to damage the company. DeNigris counters that his on-line statements were true and that they were protected by the First Amendment.

DeNigris, who lost $9000 on Medphone stock more than a year before he began using Prodigy, posted his first message about Medphone in July, 1992: "Medphone gets great publicity, but the stock will go nowhere. Having been a shareholder, I caution you against the hype the company manages to get out. That was followed by about 25 additional negative messages over the next 90 days. According to Medphone, some of the DeNigris' messages accurately predicted the stock's performance the following day, and the overall effect of the on-line statements caused the stock to drop from $1.75 to 37.5 cents a share.

Computer bulletin boards, which provide real-time, instant communications, fall somewhere between having a conversation between friends and reading a newspaper or magazine. This case will determine whether relatively uncensored BBS postings—which have potential audiences of more than two million people—have the same protection under the First Amendment as do spoken words and printed articles.

### Winning inventors

There were 41 winning high-school students in the Eleventh Annual Duracell/NSTA Scholarship Competition. The winning battery-powered inventions were chosen in March at Duracell headquarters in Bethel, CT, from a field of 100 finalist projects.

**PRIZE-WINNING DEVICES in the eleventh annual Duracell/NSTA Scholarship competition include the first prize Accelorometer (front) and, clockwise, the Portable Launch Base, the Electronic Precision Vise, the Katakana Blackboard, the Stoveguard, and the Car Jack Jinx.**

The $10,000 first-place scholarship went to Aaron James Passey, a senior from Bothell, WA, who designed and built an accelerometer, an electronic device that measures and visually displays acceleration and changes in acceleration in real time. Second place $3000 scholarships went to six students with interests in mechanics, electronics, engineering, and physics, whose inventions ranged from a portable launch base with the ability to individually or simultaneously launch multiple model rockets to the "Car-Jack Jinx," a remote-controlled device that lets a car owner turn off the engine to foil a thief. Ten more students received third place $500 scholarships, while 25 others received cash awards of $100 each.

The competition is open to U.S. high-school students, grades nine through twelve. They must build a battery-powered device that is educational, useful, or entertaining.

### Thermoelectric generator

Scientists at the GE Research and Development Center (Schenectady, NY) earlier this year demonstrated to officials of Rochester Gas and Electric Corporation (RG&E) the technological viability of a "continuous" gas furnace, a residential heating unit that would continue to operate even during a lengthy power outage. The technology centers on a solid-state thermoelectric generator that can directly convert heat from the combustion of natural gas into 100 to 300 watts of electricity, which is more than enough to operate the blower and other electrical requirements of a standard home-heating system. The breadbox-sized device could be built into new gas furnaces. Unlike gasoline- and kerosene-powered generators used as emergency backups, the thermoelectric system can run unattended, is maintenance free, and does not require the homeowner to store potentially hazardous fuel.

**GE PHYSICIST DR. LIONEL LEVINSON tests a thermoelectric generator used in prototype "continuous" gas furnaces.**

The RG&E-funded project included the construction of a small, 70-pound heater-generator system with thermoelectric output. The test unit directly converted the heat from the combustion of diesel fuel into 160 watts of electric power. Approx.

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*continued on page 90*
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• **Cable vs. TV sets.** Cable TV and consumer electronics products such as TV sets and VCR's are becoming less compatible as time goes by, and there's fear that the situation will become far worse with the development of digital transmission. The Cable Act of 1992 orders the FCC to improve the interfaces between cable and the products used in the home to receive them. The first results in the Commission's inquiry are not encouraging.

The two sides could agree on nothing except that the situation needs improving. The consumer electronics industry, through the Electronic Industries Association (EIA), said cable was to blame for virtually all the problems, while the National Cable Television Association (NCTA) put the onus on the manufacturers. Particularly targeted for censure by the EIA was cable systems' increasing tendency to scramble all channels, thereby rendering useless such TV features as picture-in-picture and wireless remote control, as well as ability to record one channel while viewing another.

NCTA, in turn, blasted TV manufacturers for poor tuners which it said make cable boxes necessary, and for telling consumers their sets are "cable ready," thereby needlessly raising their expectations. NCTA urged a return to a standard back-of-set baseband interface such as Multi-Port, developed by the two industries years ago. EIA retorted that its members spent millions of dollars installing Multi-Port connectors on the rear of their sets but the cable TV industry refused to go along. The end of the discussion is not yet in sight.

• **Channel mapping.** Complicating the problem of TV-cable interface is a new practice by cable systems, becoming increasingly widespread, known as "channel mapping." This is a system whereby channel numbers assigned by cable systems to the various programs they carry bear no relationship to the frequency the channel is supposed to occupy. A 10-year-old preliminary standard developed by the cable and TV industries assigns a specific frequency to each cable channel, from 1 through 99 (currently this standard is in the process of being amended to include channels above 99).

In channel mapping, the cable systems apply to each channel number a frequency that only their own converter boxes understand. For example, CNN might be listed as Channel 10 (whose standard frequency is 192–198 MHz), but it actually would be sent out on 240–246 MHz, which is Channel 27 under the standard. However, the set-top boxes provided by the cable system are "mapped" to tune to 240–246 MHz when Channel 10 is dialed. This naturally creates havoc with those cable subscribers trying to tune these channels on a "cable ready" TV without a box. In Manhattan, for example, more than 10 channels have been mapped to come in on changed channel numbers. Since pay-per-view programming is very profitable for cable systems, and a cable box is required to receive pay-per-view programs, a subscriber might think that channel mapping is simply designed to hassle him into using a cable box so that he can be sold pay-per-view programs.

Not so, say the cable operators. The re-mapping, they say is virtually required under the cable act, given the inadequate shielding in TV sets. The Act requires VHF broadcast stations to be carried on their broadcast channels, but that would result in direct off-air pickup interference in many sets if they were carried on their actual frequencies. Another advantage of channel mapping, the cable systems say, is that it permits uniform newspaper listing of programs by channel in any viewing area. The third advantage is that it makes pay programs easy to tune.

For example, the viewer can select a variety of movies and starting times on a single channel, but in reality, that channel covers a number of frequencies, which are changed with each selection. So far as the viewer is concerned, 11 pay movies are on Channel 35, for example, when in reality they may be on 10 different frequencies.

• **Measuring picture tubes.** The introduction of widescreen TV sets with 16:9 aspect ratio CRT screens is complicating the issue of measuring screen sizes. The subject was already complicated enough before the arrival of the new sets.

For example, do you know that if you ship a 27-inch TV set to Canada, it gains two inches when it crosses the border, and when you unpack it, lo and behold, it's a 29-incher? Similarly, a set shipped from Japan will shrink when it reaches American waters! That's because the U.S. TV industry measures screen size in a way that differs from the methods of all other countries.

The U.S. TV measurement method dates back from before commercial TV. The first significant use of cathode-ray tubes was in oscilloscopes. The size of the screen, which was circular, was measured as a diameter. The first monochrome TV sets also had round faces, and they were measured in diameter. With the introduction of the rectangular tube, the same method of measuring the screen was kept, but now it was from corner to corner.

In the 1950's, the Federal Trade Commission (FTC) ruled that this "overall" diagonal measurement was deceptive, because it included the thickness of the glass walls of the tube. It mandated that measure continued on page 90
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SOFTWARE RESET

I am using an IBM XT as a process controller, and I find that I often need to reset the entire system—both manually and automatically—under the control of the software I’m using. The motherboard I’m using is from a real IBM XT and it has no provision for resetting it. Is there some circuit I could build that will let me do this?—B. Schif, Jaipee, FL

A lot of people think that there’s nothing you can do with an outdated but still functional computer. This includes XT’s, Apple II’s, and even the prehistoric Timex Sinclair. I’m using one of those old timers as the "brains" of a home controller, so I’m glad to find that someone else out there has had more or less the same idea.

Any computer that gives you access to its bus through slots is a good candidate for long life—there’s more to a computer than just word processing, running games, and using other software.

Adding a reset capability to an XT is pretty simple—as long as it uses an 8284 IC as its main clock generator. Although I don’t have a schematic for the IBM XT, I know there’s an 8284 on the motherboard, so you won’t have any trouble adding a reset button to it. Once you know how to add manual reset, triggering it with software shouldn’t be difficult either.

Although I can’t be certain about the details, the clock circuit built around the 8284 is probably pretty close to the schematic shown in Fig. 1. I haven’t put in component values because they’re going to vary from motherboard to motherboard. What’s important here, however, is that simply grounding pin 11 will cause the 8284 to generate a reset pulse for the 8088. All you need is a normally open, momentary, SPST switch connected between pin 11 and ground and you’ve finished the installation of a manual reset switch. If the IC’s aren’t clearly numbered or, as is sometimes true, the IC’s are house-numbered, you can find the 8284 by tracing back from pin 21 of the 8088, its reset input. The location of the 8284 should be close to that of the 8088 on the board. Another clue for locating it is that it should be next to the 14-MHz crystal that’s used as the basis of the system clock.

You can’t connect a manual switch to the reset pin of the 8088 because the power-up sequence of the 8088 is really picky about variables like pulse width and shape. The 8284 takes care of all that for you, and one of its main jobs is to reset the 8088.

Resetting under software control is a bit trickier than doing it manually. You didn’t go into the specifics of your setup, so I don’t know what kind of I/O you have available. But if you’re using the XT as a controller, I imagine you have some hardware that decodes and responds to specific I/O commands. You must reserve one of them for reset.

The manual switch can be located in parallel with a small relay that is activated under the control of your software. Once you have the relay in place, resetting the XT is simply a matter of sending the appropriate word out the port, decoding it, and then using that to energize the relay. That’s the easiest way to do it and, if I had your problem, that’s the way I’d solve it.

Because the XT will be reset, you don’t have to worry about resetting the relay. The system bootstrap process performed by the BIOS will take care of that function for you.

MIXED FAMILIES

I know this is an elementary question, but I’ve just started studying logic design and I want to be able to use IC’s from different logic families in the same design. My problem is that the CMOS part of the design has to run on nine volts, but the TTL part has to run on five volts. Is there some conventional way to do this kind of thing?—T. Melvin, Darian, CT

From the moment that CMOS logic first appeared on the market, people have been mixing it with TTL logic. Some of the incentive for doing that disappeared when the 74CXXX CMOS equivalents of TTL chips were developed. However, if you have a reason for using the standard members of both logic families in the same design, you must take special measures to accommodate them.

The simplest way to handle your problem is shown in Fig. 2. The schematics there should tell you all you need to know about mixing the two families together—even if each side of the design is working off a different voltage. While there are no special requirements for the TTL IC’s, you should use a 4049 hex inverter/buffer on the CMOS side when unequal power-supply voltages are used.

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and it works a lot better as a voltage translator or current driver in this kind of application. If the logic inversion done by the 4049 is a problem for you, you can put two of the inverters together or replace it with the 4050, a noninverting version of the 4049.

I'm using the 4049 in the schematic for two reasons. The first is that spare inverters are usually handy to have available on the board. The second reason is that, in these days of dwindling numbers of suppliers who service the hobbyist market, it's often easier to find a 4049 than a 4050.

There are other ways to mix logic families. Some are more elegant and some are simpler, but none of them are easier and, for sure, none is cheaper.

MEMORY BOOST

I want to add more memory to my IBM compatible but, after going through some mail-order catalogs, I'm confused about the type of chips to buy. My motherboard uses SIMM's, and it seems that there are two different types available on the market. For instance, one kind is described as 1K X 8, and the other is described as 1K X 9. I know the extra bit has something to do with checking data but I'm not sure. What's the difference?—H. Bansh, Denver, CO

For reasons known only to the original hardware designers of the IBM PC, an entirely separate market was created for the people who manufactured memory for IBM's family of personal computers. I don't know why they did that, but then again, I don't know why the dinosaurs disappeared from the earth either.

Although the PC uses the same definition for a byte as every other computer ever made (8 bits), it was decided that each byte would have nine bits associated with it. Eight of them would store the data and the ninth would be known as the "parity bit." That extra bit is used as a check on the validity of its associated byte. If you've been using an IBM clone (or, to be kind, a compatible), the chances are that you've
had the computer come to a grinding halt with the somewhat mysterious message "Parity Error at XXXX:XXXX." That happens when the parity check fails, and the BIOS decides that everything you’ve been doing for the last couple of hours should be lost.

The parity check is one of the crudest forms of a validity check you can imagine. All it takes is one error to make the entire computer lock up.

A parity check is a form of addition that’s done on the eight bits making up each byte, and the result of the operation—either a one or a zero—is stored in the ninth (parity) bit. If the data bits have an even number of 1’s, the parity will be set to 1. If the number of 1’s contained in the data bits is odd, parity will be set to zero.

To understand why I call this a really crude check, just consider the odds of having a parity error caused by a real error in the data it’s supposedly checking. As a simple example, let’s see what kind of insurance we can get from a parity check when we’re dealing with a four-bit digit.

1. One possible value has none of the bits set high.
2. Four possible values have only one of the bits set high.
3. Six possible values have only two bits set high.
4. Four possible values have only three of the bits set high.
5. One possible value has all of the bits set high.

Because there are only sixteen possible values when dealing with a 4-bit digit, everything works well if we’re transferring a "0" or an "F," but the odds of having a parity check catch an error with the other 14 digits are only 62.5% in the worst case and 75% in the best case!

Although anybody with earlobes can see that a parity check is really no check at all, you’re still stuck with the fact that you need memory that has nine bits available for each byte—a × 9 part—in order for your machine to work properly.

The Macintosh doesn’t bother with parity checking, and uses only eight bits for each part—a × 8 SIMM. Maybe the folks at Apple know something we don’t.
LETTERS
Write to Letters, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

MPC-2 CORRECTION
A mistake appeared in the schematic for my MPC-2 article (Electronics Now, May 1993)—probably as a result of a recent change in the schematic-capture software that I've been using. The schematic is missing a connecting line between the phone-line side of C1 and the relay wiper on one side of C3. The error appears only on the schematic itself; the foil pattern is correct. The corrected schematic appeared in the June issue, as part of the “Phone Line AutoCoupler” project. I apologize for any inconvenience that might have resulted.
MIKE HAGANS

HAMFEST HAPPENING
The Zero-Beaters Amateur Radio Club will host its 31st annual hamfest on Sunday, July 18 at the Bernie H. Hilleman Park (Washington Fairgrounds) in Washington, MO, from 6 AM to 3 PM. There will be food and refreshments, flea-market bargains, seminars, dealer displays, and non-ham displays. Exams will be conducted by volunteer examiners on a walk-in basis starting at 10 AM; bring your original license and a photocopy. Admission and parking are free. Vendors can rent space for $4.00. For more information, write to me at P.O. Box 24, Dutzow, MO 63342; call 314-459-6581 or 314-239-0060; or talk-in at 147.240 + repeater.
ED SOUTHAL, WDOELL
Dutzow, MO

GET OFF THE MICROSOFT BANDWAGON!
Jeff Holtzman’s Computer Connections column has become little more than a Microsoft propaganda machine; it offers scant technical information and nothing else of any value. Even Don Lancaster occasionally interrupts his dogmatic tirades to offer some potentially useful information. Most of us understand that competition is good—not something to be discouraged as Mr. Holtzman does with his fatalistic disregard of anything that doesn’t come from Mother Microsoft.

It seems that Mr. Holtzman’s Microsoft bias is more than just pragmatic, though, when he bashes CD-I—the OS-9-based interactive multimedia standard from Sony and Philips—in favor of VIS. His reason seems to be that the Tandy system is based on a version of Microsoft Windows that has been retrofitted for embedded systems use.

But, as Mr. Holtzman himself said in his April 1993 column, “people buy cars, not engine, transmission, and chassis.” Consumers won’t buy a home-entertainment system just because it comes from Microsoft. OS-9 is much better suited to the task, being a time-proven preemptive multitasking embedded real-time operating system. I suspect that Mr. Holtzman really knows very little about CD-I and OS-9, and probably couldn’t care less. In light of the one-sidedness in Electronics Now’s computer section, I think it’s fair to request a little space for an alternative viewpoint.

An operating system like Microwave’s OS-9 would provide a solid foundation for operating systems of the future. OS-9 is composed of any number of discrete modules that link the kernel to the hardware. The interface between these “black boxes” is simple and well-documented, so any programmer can write new device drivers.

OS-9 is easily reconfigured because the modules are not compiled together. It can be stripped down to bare essentials for embedded systems, run on a desktop PC or a laptop, or blown up into a large multi-user system. Ethernet and Internet support are available. OS-9 uses the UNIX programming and I/O model, which, despite the existence of incompatible versions, has been standardized by the IEEE.
OS-9 offers the technical advantages of UNIX without the excess!

OS-9 runs on the Macintosh, Amiga, and Atari computers as well as others like the IMS MM/1, computers from Frank Hogg Labs, and the PT-68K4—an updated version of the computer featured in a series of articles in Radio-Electronics a few years back. And OS-9000, Microwave’s portable version of OS-9, runs on PC’s with 386 or 486 processors (and comes with Virtual PC that runs MS-DOS and Windows), as well as the 68020-68040 and several RISC processors. And that doesn’t even begin to exhaust the possibilities.
OS-9’s modularity means that it could very easily be cloned. Many vendors could offer OS-9 work-alikes—each coming with its own suite of device drivers and retaining software compatibility with other versions. Computer companies could offer everything from hand-held personal assistants to graphics workstations using OS-9 or their own clones.

Mr. Holtzman’s “might makes right” sentiment suggests that if it isn’t totally dominant it’s not worth talking about. That is, of course, a totally self-fulfilling prophesy. If we all ignore anything that isn’t firmly entrenched, nothing new will ever arise, and we will deserve the resulting stagnation.

The makers of the PT/68K are now working on a 68020-based computer that could be a good topic for another series of articles. For hobbyists who like to learn and do it themselves, the OS-9 operating system offers tremendous potential and opportunities. Electronics hobbyists, if anyone, can appreciate the technical merits of an operating system and, being intelligent people, should be above the bandwagon approach. Let’s cut the propaganda and get back to the nuts and bolts!
JOEL EWY
Derby, KS
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ANOTHER LOOK AT THE LIGHT

I must disagree with the opinions expressed in the letter from Stephen Schleick (Electronics Now, June 1992) regarding the relationship between lamp life and switching frequency.

We have all seen that flash of lamp death at turn on, but that occurs when a lamp dies, not why. Yes, there is a large in-rush of current—about ten times the steady-state value—for a millisecond or two at turn-on, but the filament reaches normal operating temperature only after many milliseconds.

Yes, the rapid temperature change temporarily stresses the lamp, encouraging burnout, but evidence suggests that “infant” lamps recover completely with no cold working or other harmful cumulative aftereffects.

It’s been proven empirically by many lamp-flasher manufacturers that lamp flashing extends lamp life as much as ten times normal. I am conducting an experiment in which, at the moment, all but one of the constantly-on lamps have burned out, while none of the flashing lamps have burned out. Aircraft fleets are installing landing light flashers because it has been determined that life increases.

An exhaustive search at the University of Wisconsin engineering library for some simple statement on lamp aging turned up only an indication that lamp life varies inversely with duty cycle, independent of frequency (MHz to kHz) and, with the thirteenth power of applied voltage.

All of this is in accordance with the anecdote told by Mr. Schleick’s “rocket scientist” friend, who had to replace his eight-year-old bulbs within days of normal operation. But to claim that, because the lamps burned out right away when switched, switching frequency ages lamps, is irrational.

DAVID PECK
Edgerton, WI

REEL-TO-REEL TAPE SOURCE

A question in the Q&A column (Electronics Now, January 1993) asked for a source for 10 1/2-inch reels of recording tape. Sound Investment Corp. (3586 Pierce Drive, Chamblee, GA 30341) is a small mail-order company that I have patronized for years without trouble. I own a 10 1/2-inch-capable Revox G77 MK II, a half-track model. It still delivers high-quality sound, especially if the tapes are recorded from CD’s.

RANDY L. RHTON
North Bend, WA

RATING OPERATING SYSTEMS

After reading Jeff Holtzman’s Computer Connections in the April issue of Electronics Now, I couldn’t repress a feeling of sadness and disgust. I have been using PC’s running MS-DOS, VAX’s (VMS), Unix boxes, Unix with X Windows, the Commodore Amiga, and MS-Windows daily for the past several years, in my professional career.

I can tell you that MS-Windows and MS-DOS would be in about third place if I were to rate the operating systems that I prefer to use.

It’s easy to speculate, as Mr. Holtzman has done, about the future of the computer industry: Just pick as the winner the biggest guy with the most money and the best marketing. In my opinion, the reason that Microsoft now dominates in the computer industry is really simple. The company’s first customers were inexperienced users of MS-DOS so they were able to get them to use an inferior graphics user interface (GUI).

In other words, the neophytes had very little choice. The bundling of MS-DOS and MS-Windows with nearly every IBM or compatible personal computer built around an Intel microprocessor certainly boosted Microsoft’s position.

Moreover, it makes sense that third-party application software houses will write software for the biggest market first—and that’s MS-DOS/MS-Windows.

Nevertheless, no one will argue the points made about the dominance of Microsoft and Intel in the computer industry. I am saddened and disgusted to see all that cash going to Microsoft to raise an inferior product to the same level of capability, performance, and functionality that was reached by alternative operating systems and GUI’s some time ago.

FRED HEITKAMP
Dayton, OH

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EQUIPMENT REPORTS
AVCOM PSA-37D Spectrum Analyzer and PTR-25A Portable Test Receiver

It's possible to install a satellite-TV system without any test equipment—but it's not recommended for any professional installer who intends to stay in business very long! Test equipment can help an installer adjust a satellite system for maximum performance. On strong satellite transponders, the improvement from fine tuning might not be noticed. But for marginal signals, every bit of tweaking can make a dramatic difference.

We recently had the opportunity to install a satellite-TV system using two tools made just for the job: the PSA-37D Portable Spectrum Analyzer and the PTR-25A Portable Test Receiver. Both are from Avcom of Virginia, Inc. (500 Southlake Blvd., Richmond, VA 23236).

Aiming a satellite antenna can be tricky business, and we can only sketch the details here. But it's worth noting that if your antenna aim is off a quarter of an inch, you can miss the satellite by hundreds of miles! In satellite TV, Signals are received from geosynchronous (apparently fixed) satellites located in an arc some 22,300 miles over the equator; the satellites are spaced at 2-degree intervals.

The first step in aiming a dish is to fix it on the highest satellite in the arc. That particular satellite varies with location, but it is always the satellite located closest to due south. Armed with a compass, protractor, and aiming data for the installation site, the installer aims the dish by adjusting its azimuth and elevation. The next step is to move to other satellites, and to fine tune the position of the mount such that the dish can track the arc properly.

Experienced installers can get a dish to track the satellite arc reasonably well without any test equipment. But it's virtually impossible to get a system operating to its maximum potential without making some measurements. As first-time installers, we relied heavily on Avcom's spectrum analyzer and portable test receiver. And thanks to that equipment, our installation was problem-free.

Unlike most spectrum analyzers, the battery-powered PSA-37D is designed specifically for satellite TV installation and servicing. It provides five operating ranges in 500-MHz blocks. The highest range is the C-band downlink frequencies, 3.7-4.2 GHz. Second is the 950-1400 MHz band, the output of standard LNB's or low-noise block downconverters. (The LNB is an amplifier that boosts the extremely weak signals collected from the dish, and converts them to a lower frequency so that they can be transmitted over standard coaxial cable to a satellite receiver.) A third range is the European standard block downconverter frequencies from 1250-1750 MHz. Two lower RF ranges, 1-500 and 500-1000 MHz, makes the analyzer useful for a wide variety of service applications including cable TV and cellular telephone. The analyzer can provide power to the LNB (+18 volts DC) through its BNC connector.

The main advantage of using a spectrum analyzer instead of a receiver when peaking a dish is that it's far more sensitive. Small changes that might not be noticed in a video image can be seen on the analyzer's CRT.

Another use for the analyzer actually comes before the dish needs to be aimed. The first step of any satellite installation is the site survey. For a successful installation, you must be able to "see" the satellites without obstructions such as trees or buildings. The site must also be free of terrestrial interference or Ti. The spectrum analyzer (used with either a standard feedhorn and LNB or a special feedhorn sold by Avcom), can quickly pinpoint sources of Ti.

As valuable as a spectrum analyzer is, there are some tasks that are easier with a satellite receiver. One example is targeting the first satellite. An error of a couple of degrees could cause the dish to receive signals from the wrong satellite, making all further attempts to align the dish onto the satellite arc frustrating. A spectrum analyzer can't identify the satellite the antenna is fixed on. But an installer armed with a receiver can quickly identify a "bird."

For example, on our initial aiming attempt, we were happy to find a signal with only minor adjustment. But when we looked at the picture on the PTR-25A portable test receiver, we knew something was wrong. Continued on page 93
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Fax: 909-629-3317

AC POWER-LINE TESTER. Extech’s 310115 AC Power-Line Analyzer is able to diagnose power problems as a stand-alone unit, or it can be connected to a PC or laptop to view events in real time. The analyzer is easy to use. Once it is plugged into a grounded outlet, it monitors the power for 24 to 74 hours, storing the data in internal RAM. The data can be transferred to a PC by connecting the analyzer to the computer’s serial communications port. Power Audit Software provides complete analysis of spikes, sags, surges, dropouts, power failures, true-RMS AC line voltage and frequency, common-mode noise, high-frequency noise, phase shift, and neutral line voltage. Each power audit chart contains the actual disturbance event data, indicates symptoms related to that type of disturbance, and recommends a specific solution. Power disturbances are presented in four easy-to-understand formats—detailed or summary reports, bar or pie charts, power-quality audit, or sinewave graphics. The analyzer comes with software, RS-232 cable, and a six-foot power cord.

The AC Power-Line Analyzer costs $595.

Extech Instruments Corp.
335 Bear Hill Road
Waltham, MA 02154
Phone: 617-890-7440
Fax: 617-890-7864

WORK-STATION ESD MONITORS. Two work-station monitors from 3M continuously test wrist straps, personnel, work surfaces, and ground connections for electrostatic discharge (ESD). Models 720 and 722 directly measure DC resistance of the grounding system, which means that changes in capacitance due to a person’s size, dress, posture, location, and the way the wrist band is worn will not affect the true resistance reading, as is the case with impedance monitors.

Unlike periodic testing devices, the 720 and 722 work-station monitors notify the user of static-control equipment failures as they occur, eliminating time-consuming, costly audits and record keeping. Continuous monitoring also detects intermittent failures caused by such things as improperly worn wrist straps or dry skin.

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The 720 and 722 work-station ESD monitors have suggested retail prices of $124 and $190, respectively.

3M Electronic Specialty Markets
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Phone: 512-984-6674

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TRAINER OSCILLOSCOPE. MCM Electronics’ Tenma Trainer Oscilloscope is aimed at students and entry-level electronic hobbyists. The low-cost instrument features high (5mV/div.) sensitivity, a smooth roll-off (exceeding 20 MHz), and a maximum triggering sweep speed of 0.2µsec/div. The Tenma Trainer comes with two probes, power cord, and owner’s manual. It’s covered by a two-year warranty. The Tenma Trainer oscilloscope costs $320.

MCM Electronics
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Centerville, OH 45459-4072
Phone: 800-543-4330

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FOUR-CHANNEL OSCILLOSCOPES. Two recent additions to Tektronix’ TAS 400 family of analog real-time oscilloscopes provide greater capabilities for tougher service applications where multiple channels must be displayed to troubleshoot circuit conditions, such as three-phase power or logic circuitry. The 100-MHz TAS 475 and the 200-MHz TAS 485 scopes both offer four channels with a full range of amplification and attenuation.

THOUGH TAILORED to the analog scope user, the TAS 400 scopes are based on the popular, streamlined TDS (Tektronix Digital Scopes) family’s interface, which makes operation virtually intuitive. The analog oscilloscopes offer a balanced combination of buttons, knobs, simple menus, and such features as autoset, save/recall setups, cursors, and set-to-50% triggering. The hybrid design houses the entire acquisition system for each input channel, drastically reducing the parts count, the calibration time, and the need for manual adjustments. The integrated design also boosts the instruments’ reliability—so much so that Tektronix will provide a free replacement if a TAS 400 oscilloscope fails within a three-year period.

The TAS 475 and TAS 485 four-channel analog oscilloscopes cost $2395 and $3495, respectively. Tektronix, Inc.
Test and Measurement Group
P.O. Box 1520
Pittsfield, MA 01202
Phone: 800-426-2200

OHM EXTENDER. A portable, battery-operated unit called the Ohm Extender, when used with your digital multimeter, provides you with the equivalent of an expensive milli- and micro-ohmmeter. The battery-operated unit is based on the four-wire Kelvin configuration (two-sense/two-source), which measures the voltage drop directly at the resistance source. The Ohm Extender is easily adjusted to your own DMM, and allows you to read down through the milliOhm range into the lower portion of the micro-ohm range.

That allows you to measure shunt resistors, precisely determine wire length, verify circuit-board trace resistance, read motor and transformer values, and check switch and relay contacts.

The Ohm Extender costs $161, postpaid.
Micro-Ohm Measurements
P.O. Box 460
Brookshire, TX 77423
Phone: 713-934-4659

CABLE AND WIRE ORGANIZERS. Those who are confronted with confusing tangles of wires and cables could benefit from using Strap-Loc continuous-length cable ties from Advanced Cable Electronics. The product consists of a spool of cable tie and locking devices. Because it comes in continuous roll, it can be cut to find any different size and number of cables, and can be used to fasten and bundle large cables, to separate and space wires and cables, to fasten though panels, and to create multiple wrapings for extra-high tensile strength applications. Strap-Loc allows wire bundles to lie flat and pass through narrow openings, to be separated for easy tracing and termination, and to be fastened to guide wires for aerial support. It eliminates the need for "daisy-chaining" and for stocking a large inventory of assorted cable-tie lengths. The low-insertion-force locking device assures strength and stability. A stainless-steel grip-lock is recessed into the lock body to protect wires, and rounded edges on the strapping prevent damage to wire insulation.

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It doesn't matter how good your stereo components are, if you don't have decent speakers. This book shows do-it-yourselfers and technicians how to build quality speaker systems for use in the home and the car. With clear instructions and illustrated examples, the book details the construction of four home speaker systems—a compact bookshelf speaker, a small 2-way speaker intended for unobtrusive use in a living room, a large 3-way speaker, and a ported-reflex 3-way speaker—and a variety of automotive speaker installations. The book explains how speaker systems work, including the science behind the system; the effect of enclosures on sound quality; and the design factors behind various speaker types.

The book also covers the construction of speakers designed to fit specific areas and purposes and the addition of finishing touches for a professional look. Appendices are filled with design equation and conversion charts, and a glossary of audio and speaker terminology is included.

Even those who aren't interested in building their own speakers should glean enough information from reading this book to enable them to make more informed decisions when buying speakers.

The AutoCAD 3D Companion: The Illustrated Guide to AutoCAD's Third Dimension for Release 12; by George O. Head. Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515; Phone: 919-942-0220; Fax: 919-942-1140; $27.95; companion diskette: $49.95.

Mastering AutoCAD Release 12's powerful 3D capabilities doesn't have to be difficult. This book teaches everything needed to draw effectively in 3D. Special emphasis is given to the 3D Toolkit, with 52 ready-to-load AutoLISP programs designed for maximum 3D productivity. Those programs are also available on the companion diskette, which is available separately.

The first 14 chapters each take the reader step-by-step through the use of a specific tool. Those include 3D Preview, an overview of essential features; the User Coordinate System (USC) that is used to set up drawings, create new origins, rotate drawings, work with text and dialogue boxes, save and restore the USC, and use 2D commands; DView, which is used to operate the Camera; View Ports, used to divide up views as Tiles; Surfaces, including such things as extrusions, faces, meshes, complex shapes, and holes; Paper Space; and Shading and Rendering.

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Build the Experimenter, and put your personal computer to work doing interesting and useful real-time tasks.

THE EXPERIMENTER

JUST IMAGINE WHAT WOULD HAPPEN if your personal computer had the ability to sense real-world events taking place around it and was able to respond by controlling those events in some useful way. You would then have unlimited possibilities for building fascinating computer-based projects. With a variety of sensors you could build such projects as a computerized weather monitoring station, a sophisticated home-security system, or perhaps add voice recognition to your computer.

If your home computer could control electric motors, you could build a robot that could be programmed and operated from your PC. You might even consider a computer-controlled telescope that would automatically track star movements.

The Experimenter, a computer peripheral circuit described in this article, actually offers those capabilities. Its circuitry is built on a double-sided PC board that will work with most of the popular brands of personal computers available today that meet certain minimum performance requirements.

The missing link

The Experimenter is the missing measurement and control link between your personal computer and the outside world. It provides eight inputs capable of voltage measurement, four timer/counter inputs, and 24 digital input/output (I/O) terminals. The Experimenter features eight high-voltage, high-current outputs, and a power relay. The variety in outputs provides a wide range of capabilities for driving and controlling motors, solenoids, and alarms, as well as generating useful control signals. The Experimenter has its own power supplies and its circuit board includes unused space for adding circuitry and connectors for projects of your own design.

The Experimenter's measurement and control features were designed to be user-friendly. An on-board microcontroller interprets measurement signals and control commands sent from your PC. The microcontroller has enough built-in computing power to relieve your PC of any additional housekeeping burden. This "intelligence" permits your own PC to operate on standard software, making it quicker and easier to get your real-time projects up and running and put to use.

The Experimenter is connected to your computer through a serial port, so you can connect it to almost any brand of personal computer including IBM-compatible PCs, Macintosh, Atari, and Commodore. In the coming months we will present many projects based on the Experimenter. They will include an ultrasonic "radar," that can measure distances to objects as its transducer rotates, and a desktop meteorological station.

The necessary software to run these projects will be included. It will be written in Microsoft's QuickBASIC for DOS-based IBM PC and AT compatibles that are equipped with CGA, EGA, or VGA display boards. Most of the programs can also be adapted to the Macintosh. Owners of other personal computers, however, might have to modify the programs for the BASIC dialect that is compatible with their particular computer.
FIG. 1—EXPERIMENTER SCHEMATIC. Most of the measurement and control capability is embedded in the microcontroller, IC6.
The Experimenter schematic

Figure 1 is the schematic for the Experimenter. Its DC power requirement of 6 to 15 volts is introduced at coaxial jack J2. Because the center conductor of the power plug is positive on some power supplies and negative on others, jumper block J1 provides a convenient way to select between the two different configurations. Switch S1 is the main power switch for the Experimenter.

Voltage regulator IC1, an LM2940T-5.0, provides the regulated +5-volt logic supply which powers all of the logic circuitry as well as some other circuit functions. A special low-dropout voltage regulator, IC1 allows the Experimenter to run from a 6-volt battery.

Adjustable voltage regulator IC10 is an optional regulator that can be added to obtain a separate 5.12-volt supply to operate analog circuitry. This analog supply can provide an adjustable reference source, isolated from the relatively noisy logic supply. Its presence makes possible more accurate voltage measurements.

If you plan to build any analog circuitry that will be under the command of the Experimenter, this regulator will help you to avoid possible noise problems, and its presence will simplify circuit debugging. This option is recommended if you anticipate a need for the highest analog measurement accuracy that can be obtained from your Experimenter.

The “brain” of the Experimenter is IC6, an Intel 80C552 CMOS microcontroller with an 8-bit internal microprocessor, as well as many additional measurement and control functions. The microcontroller includes a serial port, baud-rate generator, clock oscillator, analog multiplexer, analog-to-digital converter, counters, timers, and pulse-width-modulators (PWM).

Your PC is connected to the Experimenter through J3, a standard 25-pin female “D”-style connector (DB-25). Because the EIA RS-232C accepts larger voltage swings than are obtained from standard logic devices, IC5 (a DS14C232CN RS-232 driver) is required to adapt the RS-232C interface to your processor. The device also contains a voltage doubler and inverter that, along with capacitors C5 to C8, provides the ±10 volts required by the RS-232C standard.

A 7.3728 MHz crystal is used in the microcontroller’s clock. The frequency is evenly divided into standard baud rates for RS-232C by the baud-rate generator contained in IC6. Three-position DIP switch S2 allows rates to be selected from 300 baud to 38.4 kilobaud.

The analog multiplexer in the microcontroller provides eight analog voltage-measurement inputs. The analog-to-digital converter can measure these inputs with 5-millivolt resolution (10 bits) over the range from 0 to 5.115 volts. That is a useful voltage for powering many sensors such as thermistors for temperature measurement and photo-cells for light sensing.

Capacitor C10 provides a reset signal for both microcontroller IC6 and the 82C55A parallel interface IC, IC9. That reset signal causes the microcontroller and parallel interface chip to initialize their internal registers when the logic supply is switched on. The lower eight bits of the address bus multiplex on the same lines as the data bus. The 74LS373 octal latch, IC2, holds the address value while data is on the bus.

Software for the microcontroller is stored in EPROM IC4. The contents of the EPROM, in Intel hexadecimal format, are available as file ELNOWO1.OBJ, which is part of a self-extracting ZIP file called EXPER.EXE on the Electronics Now BBS (516-293-2283, 1200/2400, 8N1).

The Experimenter can accommodate many different brands and bit densities of EPROM. Jumpers J4 to J7 organize the Experimenter for use with different EPROM’s. Although it was not included in the prototype, the Experimenter has space on its PC board, labeled IC3, for adding more memory; the space can accommodate an 8K byte static RAM.

The microcontroller has four counter/ timer inputs (TIN0–TIN3), at pins 16 to 19. The inputs can count pulses or measure time intervals for applications such as counting raindrops in a weather station, counting rotations of a motor shaft, or measuring distance with an ultrasonic rangefinder.

Timer outputs 0 to 7 appear at the microcontroller’s pins 7 to 14; they are available directly on the PC board at the pads labeled TOUT 0–7. The timer outputs are also buffered for higher voltage and current applications by SN754410 driver chips IC7 and IC8. The driver outputs (labeled DRIVER A, 0–3 and DRIVER B, 4–7 on the PC board) provide eight high-powered channels for controlling DC and stepper motors, solenoids, and other powered devices.

Each driver has its own power input (DRIVER A+ and DRIVER B+) which must be connected to an external power source of 4.5 to 36 volts DC. Each of the eight outputs can source and sink up to 1 amper. Separate high-current grounding points are also provided for the driver outputs.

A metal heatsink is mounted “piggyback” on top of each high-power driver IC to conduct heat from these devices. The heatsinks are soldered in place to pins 4, 5, 12, and 13 of each IC. If you elect to use sockets for positioning the driver IC’s on the circuit board rather than soldering them directly to the board, cooling will be less effective. If you make that decision, limit the maximum current that will appear at each output to about 700 milliamperes.

The driver IC’s are thermally protected, and they will shut down automatically if their internal temperature exceeds their threshold levels. However, they are not protected against current overloads or short circuits. Caution: if more than 1 ampere is drawn from any driver output, the driver could be destroyed.

Jumpers J8 and J9 permit
the drivers to remain continuously enabled, or permit them to be enabled under the control of the pulse-width-modulated outputs of the microcontroller (PWM0 and PWM1, pins 4 and 5). Those outputs provide a continuous stream of pulses of controllable frequency and duty cycle. Those outputs are also directly available on the PC board at the location marked PWM 0 and 1. By varying the duty cycle, the driver outputs will provide varying amounts of power to a load such as a DC motor. By varying the power, the rotational speed of the motor can easily be controlled.

The Experimenter has one relay, RY1, that can switch high-current loads up to 8 amperes. That is a useful value for actuating large alarm horns, switching the power supplies to the driver ICs, and handling other heavy-current loads. The processor controls the relay through buffer transistor Q1. Indicator LED2 lights when the relay's coil is energized. Diode D1 prevents inductive voltage spikes from damaging the relay coil when the transistor turns off. Again, connections to the relay terminals are directly available on the PC board next to the relay.

Digital input/output device IC9 (an 82C55A) provides 24 bits of digital input or output. Digital outputs can be timed with 1-millisecond resolution. Digital inputs are useful for such tasks as binary sensing (determination of the positions of door or window switches) in alarm systems. Digital outputs are also useful as low-current signals and as strobes for controlling circuitry such as would be included in an ultrasonic rangefinder.

A large grid along the lower edge of the Experimenter's PC board is available for wiring your own projects. The 5-volt logic supply and ground are wired to every fourth connection in the top and bottom rows of the grid. That corresponds to the standard power pin locations for most logic components—the upper right corner for \( V_{CC} \) and the lower left corner for \( V_{EE} \). Any IC devices that do not conform to that power-distribution pinout should be installed to the right or left of the power connections.

Below the wiring area are pads for mounting extra connectors: one high density, one DB-25, and two DB-9. You can add any of those connectors to suit your particular application. The connector locations are marked X1 through X4 on the PC board.

### Commands

The Experimenter recognizes a variety of measurement and control commands. To familiarize you with the commands, the Experimenter has a built-in, user-assistance system. If you send the Experimenter a question mark (?) at the start of a line, it lists all of its commands and their parameters. To determine the status of an individual command, enter the command name (or abbrevia-
Voltage measurement

The Experimenter has eight analog voltage measurement channels, again available directly from the PC board at the location marked "ANALOG, 0-7." (Separate analog power and ground connections are also provided.) Each channel measures from 0 to 5.115 volts with 5 millivolt (10-bit) resolution. If sent the command ANALOG 5, the Experimenter will quickly measure the voltage on channel 5, and return the result as a number expressed in millivolts. Commands can be abbreviated with the use of just the first letter, so the command "A 5" will produce the same result.

Suppose you were adjusting a potentiometer to monitor the angle between elements of a robot arm. The external connections of the potentiometer would be wired to the analog ground and power supply (AG and A+5), and the wiper would be wired to one of the eight analog inputs. By reading the voltage represented by the potentiometer’s wiper position, you can calculate the angle within a fraction of a degree!

### Measurements

The Experimenter provides four pulse-counting and time-measurement inputs (T_IN, 0-3). The counters have 16 stages and reach a maximum count of 65535. When a counter or timer reaches its maximum value, it stops. Table 1 lists the COUNTER/TIMER commands.

When used as counters, any of these inputs can make a count on rising edges of waveforms. Falling edges, or either edge, for that matter, depending on the function selected for each counter. The maximum count rate exceeds a kilohertz. The counters are well suited for mechanical monitoring tasks.
such as counting wheel rotations, motor-shaft rotation, or robot arm movements.

Experimenter's counters can run individually or simultaneously. The accumulated counts are reported on command, and can be set to do so either with or without stopping the counter. Take, for example, a raindrop detector that sends one pulse to the TIN0 input for each drop of rain it counts.

The command "C 0 1" will start counting pulses on this input (and report an accumulated count of 0). By periodically issuing the command C 0 1, Experi-
tions are listed in Table 2.

To read a digital input, use the DIGITAL-I/O command with only the port-number parameter. The experimenter will read the specified port and return a number from 0 to 255. The mode byte can only be written, and cannot be read.

To write to a digital output, use the DIGITAL-I/O command with both port number and output value parameters. The output value, from 0 to 255, will appear on the selected port.

The experimenter also has a built-in timer on its output ports. Up to three different output values can be specified, with time durations ranging from 1 to 65535 milliseconds between them. The first output value will appear on the port for the duration specified, then the second output value will appear on that port, and the progression will be continued. The last output value will remain on the port until a new DIGITAL-I/O command is issued.

**Driver commands**

As shown in the schematic, the eight timer-driven outputs (TOUT 0–7) are buffered for high-power applications (DRIVER A, 0–3 and DRIVER B, 4–7). The pulse-width modulators can control the duty cycle of the drivers. The drivers themselves can be controlled in a variety of ways with the H-BRIDGE and INDIVIDUAL-OUTPUT commands. Two commands are provided to make it easier for you to use these outputs for different applications.

Power-on default for all outputs is high (logic 1), with all outputs enabled by the pulse-width modulators. The ENABLE-PWM command controls the PWMs. When controlling a DC motor, the H-BRIDGE command can also adjust a pulse-width modulator.

The H-BRIDGE command combines the four channels on each driver to control either one stepper motor or two DC motors. Experimenters includes two driver IC’s (IC7 and IC8), so two stepper motors or four DC motors can be driven. The H-BRIDGE command permits the driving of 12 different DC and stepper motors. This includes all of the readily available commercial stepper motors and permanent-magnet brush-type DC motors. Table 3 lists the parameters for this command.

Stepper motor operation can be educational and a lot of fun. These motors are easily adapted for building computer-controlled mechanical gadgets that require precise position and speed control. A stepper motor is included in the forthcoming ultrasonic “radar” project.

Consider the example of a two-coil bipolar stepper motor. It can be connected to DRIVER A 0 to 3. A suitable power supply must be provided for the A+ and GND inputs. The stepper motor can be run in full steps or in half steps. Half stepping permits the greatest precision in object movement. (It gives the greatest angular resolution.) Table 3 shows half-stepping as drive type 10.

The command “H 0 1 100 50 10” will cause the stepper motor on DRIVER A (0) to move in the forward direction (1), for 100 half-steps: each half-step takes 50 milliseconds with a type-10 drive pattern. The command H 02 100, commands the motor to rotate in the reverse direction (2) for 100 half steps. Experimenters’ memory remembers the step duration and drive type data presented to it earlier.

The INDIVIDUAL-OUTPUT command creates a single pulse, specific number of pulses, or a continuous stream of pulses on any of the eight timed outputs. This is a useful output for many testing and control applications.

Table 4 shows the parameters for the INDIVIDUAL-OUTPUT command. For each channel, you can specify an initial state, the duration that the channel should remain in that state, the duration that the channel should remain in the complement state, and the number of cycles that should be repeated. For example, the command “I 6
110 50 200° will produce pulses on output 6, starting with a logic 1 for 10 milliseconds, then logic 0 for 50 milliseconds, repeating the cycle for 200 pulses.

To read the status of an INDIVIDUAL-OUTPUT command, issue the command with only the channel parameter. The experimenter will respond with three numbers: the current state of the channel, the remaining duration of the current state, and the number of cycles remaining to be output.

The INDIVIDUAL-OUTPUT command is usually limited to creating pulses of 255 milliseconds. Here is a clever way of getting longer time durations: When the complement-duration is 0, the total duration of the output pulse will be the duration multiplied by the number of cycles. Thus a pulse of up to 65,025 seconds (255 ms x 255) can be made.

The H-BRIDGE and INDIVIDUAL-OUTPUT commands share the same output drivers. Any command that affects outputs in use by another command will cancel that other command. For example, if an H-BRIDGE command is given, any INDIVIDUAL-OUTPUT commands using that four-bit data group will be canceled.

The ENABLE-PWM command lets you set duty cycle and frequency for the pulse-width modulators. Table 5 lists the parameters for this command. The power-on default is always on (logic 1). When DC motors are driven, unwanted resonances can occur between the PWM drive frequency and the rotation frequency of the motor. That situation can cause rough motor rotation. With the ENABLE-PWM command, the PWM drive frequency can be changed to obtain smoother DC motor operation. The frequency is adjustable from about 56 Hz to about 14 kHz.

Other commands
The FLIP-RELAY command lets you set, reset, or toggle the single-pole, double-throw relay, and to read and report the relay's state. The relay is useful for controlling large currents, such as those needed to drive large motors, actuate alarm horns, or provide system power. The format for the FLIP-RELAY command is shown in Table 6.

One final command, GENERAL-INFORMATION/CONTROL, is shown in Table 7. General information about the experimenter is reported and special functions are controlled. The special functions control data formatting to make experimenter's communications more readable. Manual-mode defaults enable those functions, while computer-control-mode defaults disable them for more efficient communication.

Next Month
That's it as far as experimenter operating theory and commands are concerned. Unfortunately you'll have to wait until next month to test the board. We will also provide the foil patterns at that time. In the meantime you can begin to acquire parts for the project.

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Most people today are aware of the dangers of a home fire, and depend on smoke detectors for an early warning. However, fires caused by combustible gases can be avoided by detecting the gases before they ever reach toxic levels or ignite. A combustible-gas detector can provide a much earlier warning than any smoke detector!

Theory of operation

The gas alarm is based on a semiconductor sensor element, shown in Fig. 1, that undergoes a change of resistance when exposed to gases that have an affinity for oxygen. Gases with that property are known as reducing gases and they include methane, butane, propane, and carbon monoxide. The sensor is composed mainly of tin dioxide on a ceramic base; it includes an internal heater coil which maintains the semiconductor at a constant temperature.

In normal air, and at a fixed temperature, the sensor is designed to absorb oxygen at a constant rate. Because the conductivity of the tin dioxide is related to the rate of oxygen absorption, it is also a constant in normal air. However, in the presence of a reducing gas, the sensor's internal resistance decreases in proportion to the gas-concentration level. By converting the sensor's resistance change to a DC voltage, the circuit can detect specific gas concentrations and trigger an alarm before the concentration reaches a dangerous level.

The circuit

The sensor is labelled SEN1 in the gas-alarm schematic of Fig. 2. The 9-volts DC from wall transformer T1 is regulated to 5 volts by an LM2940 regulator, IC3. Capacitors C1 and C2 provide filtering and stability to the regulator. The 5-volt output from IC3 is connected to the heater coil of SEN1 at pins 2 and 3.
5. The sensor's internal resistance element is connected in series with resistor R1 to form a voltage-divider circuit. Note that R1 is a calibrated resistor that has been specifically matched to each gas sensor by the manufacturer and is included with the purchase of each sensor. Do not substitute any other resistor for R1 or the alarm trip point will be incorrect.

The SEN1/R1 combination results in 2.5 volts across R1 in the presence of approximately 5,000 parts per million (ppm) of methane gas at a temperature of 20 degrees Celsius. That concentration level represents \( \frac{1}{100} \) the level at which methane becomes explosive in air. The trigger point is low enough to provide advanced warning of a natural gas leak, yet is high enough to avoid false alarms from common home vapors such as hair sprays or cooking fumes.

The output voltage from the SEN1/R1 divider goes to the positive input (pin 2) of an LM311 comparator (IC1). The negative input (pin 3) is set to a reference voltage determined by R2, R3, R4, and thermistor R8. Those components provide a 2.5-volt reference voltage at room temperature. Because SEN1's gas detection is based on the principle of chemical adsorption, its output voltage is affected by humidity and temperature changes, and that can cause variations in the alarm trip point. Therefore, a negative temperature coefficient (NTC) thermistor (R8) is used to effectively adjust the threshold voltage to compensate for those variations.

In the presence of a reducing gas, the resistance of SEN1 will drop and the voltage at pin 2 of IC1 will rise. When it reaches 2.5 volts or greater, the output of IC1 will turn on transistor Q2 which will in turn activate the buzzer, BZ1. Resistor R5 provides some hysteresis to IC1 and capacitors C5 and C6 provide noise filtering on the comparator inputs.

A flashing light-emitting diode (LED1) indicates that the sensor is operating with the correct supply voltage. An LM3909 low-power LED flasher (IC2) uses C3 to set the flash rate at approximately 1 hertz. A DS1233 voltage detector (IC4) monitors the 5-volt output from IC3. If the output falls below 4.75 volts, the DS1233 will turn off transistor Q1, which in turn will turn off IC2 and the LED.

A 9-volt battery (B1) and blocking-diode (D2) provide battery-backup operation for short power outages. The LM2940 is a low-dropout regulator that will give a regulated output with input voltages as low as 5.8 volts. (A normal regulator works properly only when the input voltage is above 7.5 volts.) Therefore, the LM2940 regulator allows for longer backup times as the battery voltage drops. The gas alarm draws approximately 170 milliamps during operation; that relatively high current draw is due to the heater element in SEN1. A fresh 9-volt alkaline battery will provide slightly over an hour of backup operation. If you want longer backup operation, you must replace B1 with a higher-capacity external nickel-cadmium or lead-acid battery.

**Construction**

The easiest way to build the gas alarm is with a PC board. Artwork is provided here; etched and drilled boards can be purchased from the source...

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**FIG. 1**—THE GAS SENSOR is mainly composed of tin dioxide on a ceramic base; the resistance of the sensor varies depending on the concentration of reducing gases in the air.

**FIG. 2**—THE SENSOR'S RESISTANCE ELEMENT is connected in series with resistor R1 to form a voltage-divider circuit; R1 is specifically matched to each gas sensor by the manufacturer.
PAR T S L I S T

All resistors are ¼-watt, 5%
R1—Calibration resistor, included with sensor (see text)
R2, R4—10,000 ohms
R3—6800 ohms
R5, R6—330,000 ohms
R7—1000 ohms
R8—5000-ohm thermistor

Capacitors
C1—470 µF, 16 volts, electrolytic
C2—22 µF, 10 volts, electrolytic
C3—330 µF, 6 volts, electrolytic
C4—0.1 µF, ceramic

Semiconductors
IC1—LM311 voltage comparator
IC2—LM3909 LED flasher
IC3—LM2940CT-5.0 (or 7805T) voltage regulator
IC4—DS1233 power monitor
Q1—2N3904 NPN transistor
D1, D2—1N4001 diode
SEN1—TGS813C gas sensor (Figaro)

Other components
B1—9-volt battery
T1—9-volt DC, 300 mA wall transformer
BZ1—12-volt DC buzzer

Miscellaneous: PC board, 9-volt battery connector, enclosure (SERPAC #231-1, or similar), hardware, two 8-pin IC sockets, wire, solder

Note: The following items are available from LNS Technologies, 20993 Foothill Blvd, Suite 307R, Hayward, CA 94541-1511 (510) 885-9296:
- SEN1 gas sensor, 6-pin socket, and calibration resistor (R1)—$24.00
- Complete kit of parts for the gas alarm, including PC board, all parts, and plastic enclosure—$49.00
Please add $5.00 S&H to all orders. California residents must add local sales tax. MC/VISA orders accepted.

mentioned in the Parts List. Figure 3 is the parts-placement diagram.

Two wire jumpers must be installed on the PC board at the locations marked “J.” Next, install resistors R1 through R6. Note that the calibration resistor (R1) has a solid gray body with no color bands. Install diodes D1 and D2, paying close attention to their polarity.

Sockets are recommended for IC1 and IC2, and they can be installed now. (Don’t insert the IC’s yet.) Next install ceramic capacitors C4, C5, and C6, and thermistor R8. The voltage monitor (IC4) and the transistors (Q1 and Q2) look very similar, so pay careful attention to their identity, and to their orientation. Install electrolytic capacitors C1, C2, and C3, and the voltage-regulator IC3.

Note that LED1 and SEN1 (both shown with dashed outlines) are mounted on the foil side of the circuit board. That arrangement allows the parts to fit through openings in the top cover of the plastic enclosure.
When soldering the LED to the foil side of the PC board, make sure that its bottom edge is \(\frac{1}{4}\)-inch from the board. The sensor has a 6-pin socket that should be installed on the foil side of the board.

Next attach the wires for the battery connector, making sure that the red wire goes to the positive pad. It is also necessary to observe the correct polarity when attaching the wires from the 9-volt DC wall transformer to T1. You can check the output of T1 with a DC voltmeter to determine which wire is positive if you're not sure. Then unplug the transformer and solder the wires in the proper locations.

The last step is to attach the buzzer to the PC board with a metal bracket and screws (included in the kit). The bracket is necessary only if you are using the same case that is supplied in the kit. Figure 4 shows the dimensions of the bracket in case you have to make one. Otherwise you can mount the buzzer anywhere off-board, or hot-melt glue the buzzer in place.

**Final assembly**

If you use the same enclosure as the prototype, drill the three holes in the top cover as shown in Figure 5. (Note that the case included with the kit comes pre-drilled.) Figure 6 shows how the buzzer mounts to the metal bracket and how the final assembly fits into the plastic enclosure. Be sure to solder the two wires from the buzzer to the locations shown in Fig. 3. Position the PC board so that the LED, the gas-sensor socket, and the buzzer can be seen through the holes in the top of enclosure. (The sensor should not be in its socket yet.) The PC board should lie flat against the four plastic standoffs in the case, and held in place with four \#4 \(\times\) \(\frac{1}{4}\)-inch self-tapping screws. Figure 7 shows the inside of the prototype.

Cut or file a slot in the bottom edge of the case for the transformer wires to fit through when the case is closed. Screw the two halves of the enclosure together with the four remaining screws.

**Operation**

Plug the gas sensor into its socket (polarity is unimportant), and plug the wall transformer into an AC outlet. The red LED should flash to show that the unit is powered up. 

*continued on page 93*
PRECISION DIGITAL SCALE

An easy-to-read precise scale with a liquid crystal display (LCD) will permit you to put the right postage on your letters and packages, carry out experiments that require precise measurements, and maybe even improve your cooking because you'll be able to measure just the right amount of ingredients. Now you can build your own solid-state electronic scale and make measurements in grams and ounces with ounce accuracies to hundredths of an ounce.

This small, light, and easy-to-build digital scale is completely portable. It is based on a sophisticated component called a load cell and it includes a monolithic analog-to-digital converter. The load cell for the prototype described here was selected to give readings up to 19.99 ounces in increments of 0.01 ounce and readings up to 600 grams in increments of 1 gram, a fairly wide range for a desktop scale.

The accuracy and resolution of this digital scale are far greater than are needed for weighing letters and packages to determine their postage. It has all of the performance needed to make it suitable as a high school or college science lab measuring instrument. It will also be a valuable tool for the chemist, the biologist or other scientists. Its accuracy and resolution will be appreciated by hobbyists, experimenters, gourmet chefs, and just about anybody who needs to weigh things precisely.

Front-panel switches permit the selection of either ounce or gram modes. Weight is shown on a large 3½-digit LCD with ½-inch high characters. The scale features automatic decimal-point placement when it is operated in the its ounce mode.

The scale can also provide tare weight, the weight of a container deducted from the total weight to yield the weight of the contents of a container. The scale automatically offsets the reading by an amount equal to the weight of the container. This form of measurement is especially useful if you want to weigh a large number of small objects that must be contained in a cup or dish.

Two standard 9-volt alkaline transistor batteries power the scale for many months of intermittent use. A built-in battery-monitoring circuit automatically displays a low-battery (BAT) legend when the batteries must be replaced.

How does it work?

Figure 1 is a simplified functional block diagram of the scale. It consists of a precision platform load cell, followed by an instrumentation amplifier (consisting of two differential input operational amplifiers), which increases the relatively low output voltage generated by the load cell when a weight is placed on the scale platform. An analog-to-digital converter converts the amplifier's analog output voltage to digitally coded signals that drive the 3½-digit LCD.

Figure 2 is the schematic for the electronic scale. It is powered by a pair of standard 9-volt alkaline transistor batteries connected in series to produce 18 volts. The MC78L10 fixed voltage regulator IC1 provides a stable 10-volt output to power the circuit. The two batteries in series have sufficient capacity to ensure the scale's accuracy stability even as the batteries terminal voltages decline. Internal circuitry determines when the voltage has dropped to the threshold level and a low battery indication is presented on the display.

Load cell

Figure 3 is a simplified schematic of the load cell, the key component in the scale. It contains four variable resistive strain-gauge elements that are connected as a Wheatstone bridge, powered by the regulated 10-volt supply. The four color-coded wires are brought out of the load cell assembly in a shielded cable.

When the cell is at rest (no weight applied) the values of all four resistors are equal, and the bridge is balanced. As a result, the differential output voltage of the bridge, taken between the blue and green wires, is essentially zero. However, even without a weight on the scale, there can be some residual offset of the load cell that shows up on the LCD display because of the

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Build this electronic scale and weigh objects precisely in the 0 to 1.3 pounds (0 to 600 grams) range.

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weight of the scale’s load platform. Moreover, the load cell itself might have some built-in zero offset due to minor manufacturing imperfections.

The total voltage offset of the bridge circuit, including the effect of the platform weight and a container, can be cancelled out by with zero-adjust potentiometer R11 in the LM324N instrumentation amplifier circuit. It can be adjusted with a control knob mounted on the front of the case. The same control can null out the effect of an empty container placed on the scale platform for tare measurements when needed.

When a true weight is placed on the scale, two of the resistors in the Wheatstone bridge circuit increase in value while the other two decrease in value. This unbalances the bridge, generating an output voltage. Full-scale (1.3 pounds/600 grams) output voltage of the load cell is 10 millivolts.

The prototype scale was designed to measure weights that are generally less than 1 pound (0.453 kg), but the upper limit of the load cell can be exceeded under certain conditions that will be discussed later.

Scale circuitry

Refer to the schematic in Fig. 2 and see that sections a and b of IC2, a quad differential-input operational amplifier, form a differential instrumentation amplifier. This circuit amplifies the output voltage of the load-cell bridge circuit and provides a differential output voltage that is sent to analog input pins 30 and 31 of IC4, an ICL7106 analog-to-digital converter.

The gain of the differential amplifier is determined by the values of resistors R4 through R9, and is about 48. A feedback network composed of potentiometer R4 and resistor R5 allows circuit gain to be adjusted to compensate for variations in load cells.

Operational amplifier IC2-c is essentially a voltage follower that is driven by the green output wire of the load cell. The output of this op-amp section feeds the negative differential input of IC4, the A/D converter. The 100-ohm feedback resistor R14 permits the voltage-follower circuit to add a zero offset to the output of op-amp IC2-c from the control potentiometer R11 so that the LCD will show zero when no weight is on the scale.

The 3½-digit A/D converter IC4 contains the necessary circuitry to drive the LCD. This IC includes seven-segment decoders, display drivers, a clock, and the backplane square-wave signal generator.

The differential analog input voltage required for a full-scale display of 1999, applied between pins 30 and 31 of IC4, is twice the reference voltage fed between pins 35 and 36. That voltage is provided by the 10-volt regulated supply discussed earlier and a voltage divider consisting of resistors R16, R17, R18, R19, and R20. When the scale is operated in its ounce mode, R18 and R19 are shorted out by front panel switch S2-b. The reference voltage fed to pins 35 and 36 of IC4 then has a fixed value of 0.232 volts.

When the scale is in the grams mode, the reference voltage is increased to about 0.817 volts as S2-b is opened. This increase in reference voltage causes the display reading to decrease in magnitude by a factor of 3.52, which is the conversion of the full scale display of 1999 ounces (neglecting the decimal point) to 566.7 grams. When in the grams mode, the display permits weight readings greater than 567 grams. Up to 1800 grams (1.8 kilograms can be handled by the load cell on that scale without damaging it.

Section d of EXCLUSIVE OR gate IC3 provides the decimal point in the OUNCES mode. An EXCLUSIVE OR gate produces a high logic output only when the logic levels fed to the input terminals oppose each other.

Section d of IC3 is connected as a conditional inverter. The backplane signal generated by IC4 is fed to input pin 12 of IC3-d, while the logic level fed to pin 13 is either 0 or 1 as determined by switch S2-a. When operating in the OUNCES mode, the positive voltage at pin 13 makes the output at pin 11 the inverse of the backplane signal. This is the requirement for actuation of any LCD segment.

The inverted backplane signal, fed to pin 12 of the LCD, causes the decimal point to be activated in the OUNCES mode. When S2-a is set to GRAMS, the backplane signal is not inverted; this removes the decimal point.

Section d of IC2 functions as a voltage comparator (it has no feedback resistor) to warn the user when the battery is near the end of its service life and must be replaced. The positive input of the comparator is connected to the 10-volt regulated bus. The negative input is connected to the output of a voltage divider made up of resistors R1 and R2.

When the battery terminal voltage is above 12 volts, the output of the comparator remains low. However, when the battery is almost depleted, its terminal voltage falls below 12
volts, and the output of the comparator goes high.

Section c of IC3 functions as a conditional inverter in a manner that is similar to IC3-d. When the output of comparator IC2-d goes high with falling battery voltage, IC3-c inverts the backplane signal fed to pin 9 of IC3-c. This in turn is fed to the "BAT" segment of the LCD, displaying it when the batteries need replacement.

**Building the scale**

Building this scale calls for both circuit board assembly and discrete point-to-point wiring as well as mechanical fabrication. The electronic components are inserted and soldered to two circuit boards and later those boards are interconnected by wires and assembled in a stack to the front panel.

![Schematic Diagram of the Electronic Scale](image)

The project also calls for drilling and forming holes in the aluminum case cover and plastic project case. A rigid base is required for mounting the load cell inside the case to take full benefit of the load cell's performance. A suitable platform must also be provided for the scale. The wiring between circuit boards and from the circuit boards to the panel-mounted controls should be done only after the mechanical work is complete. The electronics assembly is discussed here first.

The electronic circuitry is on two printed-circuit boards: main and display. The full-scale foil patterns defining the copper laminated circuit conductors (solder side) for both boards are included here if you want to make your own boards. Alternatively you can purchase them from the source listed in the Parts List. There are no critical component arrangements in the circuitry, so it can also be made by point-to-point wiring on perforated phenolic board.

![Schematic for Load Cell](image)

**Figure 3—Schematic for Load Cell.** The cell in this scale is rated for 1.3 pounds or 600 grams.
The Parts List specifies most of the resistors as 1% metal-film units for the analog circuitry. The stability of the circuit will depend on those tight tolerance values. Do not substitute carbon-film resistors because they are unstable with respect to ambient temperature changes.

**Parts List**

All resistors are 1/4-watt, 1%, metal-film, unless otherwise specified.

- R1—22,100 ohms
- R2—107,000 ohms
- R3, R21—47,000 ohms, 1/4-watt carbon resistor
- R4—200 ohms, cermet potentiometer, PC mount
- R5—357 ohms
- R6, R7, R8, R9, R18—10,000 ohms
- R10, R12—475,000 ohms (See text)
- R11—100,000 ohms potentiometer, panel-mount
- R13, R16, R20—100,000 ohms
- R14—100 ohms
- R15—1 megohm, 1/4-watt, carbon composition
- R17—4,750,000 ohms
- R19—5 megohm cermet potentiometer, PC mount
- R22—10,000 ohms, 1/4-watt, carbon

**Capacitors**

- C1—10µF, 25-volt, radial-leaded electrolytic
- C2, C7—0.1µF, 50-volt ceramic disc
- C3—4.7µF, 25-volt radial-leaded electrolytic
- C4—0.01µF, 50-volt ceramic disk
- C5—0.22µF, 50-volt metal-film
- C6—0.47µF, 50-volt metal-film
- C8—100 pF, 50-volt ceramic disk

**Semiconductors**

- LC1—Load Cell Model C2G1 (1.3-pound/600-gram) NMB Technologies, Inc., Chatsworth, CA 91311 (see text)
- IC1—AN78L10, fixed 10-volt regulator, Motorola or equivalent
- IC2—LM324N quad operational amplifier, Motorola or equivalent
- IC3—CD4030B quad two-input exclusive OR, Harris or equivalent
IC4—ICL7106CPL, analog-to-digital converter, Harris or equivalent

**Other components**

- B1, B2—9 volt alkaline transistor radio batteries
- DSP1—3½-digit LCD display, Digikey LCD002 or equivalent

**Miscellaneous:** two circuit boards: main and display, project plastic case with aluminum cover (see text), IC sockets for all DIP ICs and display (see text), battery clips, project case with cover (see text), baseplate for mounting load cell LC1 (see text), three-inch square micarta or phenolic platform, four 3-mm screws, sets of standard screws, nuts and spacers as required, flat washers with ½-inch I.D. (see text), stranded insulated hookup wire in a variety of colors, solder wire, and solder wicking.

**Note:** The following parts are available from A. Caristi, 69 White Pond Road, Waldwick, NJ 07463:

- Etched and drilled set of two PC boards—$19.95
- LC1—load cell, 1.3 lb/600 gm—$71.50
- IC1—AN78L10, 10-volt regulator—$2.00
- IC2—LM324N quad operational amplifier—$2.00
- IC3—CD4030B quad two-input exclusive OR—$2.00
- IC4—ICL7106CPL, analog-to-digital converter—$15.75
- DSP1—3½-digit LCD display—$11.75
- Set of 15 metal-film resistors—$8.00

Please add $5.00 postage and handling. New Jersey residents please add 6% sales tax.

Figure 4 shows the three jumper wires needed to complete the circuit. These are: pin 4 of IC2 to the plus side of capacitor C1 (JU1); pin 26 of IC4 to the minus side of capacitor C1 (JU2); and pin 37 of IC4 to pin 7 of IC3 (JU3). The jumpers should be made from standard insulated hookup wire (24 to 28 AWG) inserted on the component side of the board with care taken in their placement so they do not interfere with the insertion of other components.

When all the components have been soldered to the boards, inspect all soldered joints for open circuits, short circuits or "bridging," and cold solder joints, which will appear as dull blobs of solder without smooth fillets.

If any of these faults are located, remove the solder by re-heating the joints with a soldering pencil and applying a desoldering wick. Then resolder the joints and trim any excess lead lengths close to the board.

Carefully insert IC2, IC3, and IC4 in their sockets. Be sure they are properly oriented in accordance with the reference notches shown Figs. 4 and 5. Check to see that all pins fit securely in their sockets and that none has been accidentally bent under a DIP.

The glass-covered, 40-pin LCD DIP module is fragile and must be handled carefully. Figure 5 shows how the LCD DIP is located on the display circuit board. Be sure that the key pins (1, 20, 21 and 40) are located as shown. Figure 5 also gives the
alphanumeric pin identifications for subsequent interboard point-to-point wiring.

The LCD DIP can be soldered directly into the display board as illustrated, but it is recommended that 20-pin headers be made to act as a socket.

**Hole forming steps**

The prototype scale is housed in a plastic project case with inside dimensions of 7¼ x 4¾ x 2¼-inches deep as shown in Fig. 6. It has an aluminum cover that measures 7⅛ x 4⅛ and serves as the scale's front panel. Figure 7 is a template for drilling and forming the holes in that cover. Drill or punch all holes and openings in the aluminum cover as shown. If you use a larger case, center the template in the larger panel area.

Drill a hole in the front center of the plastic case as shown in Fig. 6 to accommodate the threaded bushing of zero-effect potentiometer R11. Assemble R11 to the case, and fasten it in position with its locknut and lockwasher.

Figure 8 is an exploded view of the front panel/cover assembly showing how the circuit boards are fastened together with screws, spacers, and nuts to form two separate decks. Position the switches S1 and S2 in the slots cut for them in the cover and mark the locations of their holes on the panel. (The switches selected for the prototype have tapped holes in their brackets so no nuts are needed.) Drill the holes and insert and fasten the switches to the aluminum panel.

Refer to Fig. 8 and cut a 3 by 3-inch square from 0.030 to 0.040-inch thick phenolic laminate or other suitable thin, rigid board. After deburring its edges and rounding its corners, drill two holes at its center for two flathead 3-millimeter screws as shown in Fig. 6. (The hole spacing must be the same as the spacing between the two tapped holes in the top surface of the load cell.) Countersink the holes slightly for the flathead screws.

The load cell, shown in Fig. 6, has two through-drilled and tapped holes at each end, spaced ⅝-inch apart. Caution: the holes are tapped to accommodate 3 millimeter screws so that the substitution of non-metric screws will strip the threads in the load cell. The end marked with an arrow identifies the load-bearing side.

Figure 6 shows the one-inch high extruded aluminum channel that was fastened to the bottom of the plastic case of the prototype to function as a rigid base for the load cell. Four holes were drilled in the bottom of the case and four matching holes were drilled and tapped in the bottom of the channel to fasten it to the case. Two holes were also drilled in the far end of the channel to accommodate two more 3-millimeter screws for mounting the load cell to the rigid base from the underside.

The composition and size of the rigid base are not critical, and alternatives can be used if a six-inch length of thick-wall aluminum channel is not avail-
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Subjects covered include microprocessors and their register sets; interfacing serial, parallel, monitor, games and MIDI ports; numbering systems, operating systems and computer graphics. While the book is aimed at the computer hobbyist, it should also prove useful to anyone who intends to use a computer to follow their interests.

INTERNATIONAL RADIO STATIONS GUIDE—BP255—$9.95
Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed as a guide for the complex radio bands.
Includes coverage on Listening to Short Wave Radio, ITU Country Codes, Worldwide Radio Stations, European Long Wave and Medium Wave Stations, Broadcasts in English and more.

FURTHER PRACTICAL ELECTRONICS CALCULATIONS—BP144—$9.00
450 pages crammed full of all the formulae you are likely to need.

WIRELESS & ELECTRICAL CYCLOPEDIA—ETTI—$5.75
A slice of history. This early electronics catalog was issued in 1918. It consists of 176 pages that document the early history of electricity, radio and electronics. It was the "bible" of the electrical experimenter of the period. Take a look at history and see how far we have come. And by the way, don't try to order any of the merchandise shown, it's unlikely that it will be available. And if it is, the prices will be many times higher.

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P.O. Box 240, Massapequa Park, NY 11762-0240

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Address__________________________
City______State______Zip________

SHIPPING CHARGES IN USA AND CANADA

<table>
<thead>
<tr>
<th>Range</th>
<th>Charge</th>
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<tr>
<td>$0.01 to $5.00</td>
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<td>$1000.01 and above</td>
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SORRY No orders accepted outside of USA & Canada

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<th>Description</th>
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<td>Total price of merchandise</td>
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<td>Total Enclosed</td>
<td>$</td>
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</table>

All payments must be in U.S. funds

EN793

www.americanradiohistory.com
Build BORIS the miniature motorless walking machine with Muscle Wires! They contract up to five percent when powered. Remove power and they relax, ready for millions more cycles. Create direct linear action without heavy gears, balls, or motors. Use Muscle Wires in robots, models, planes, railroads — anywhere you need small, strong, all-electric motion.

What Are Muscle Wires?

Muscle Wires are highly processed strands of a nickel-titanium alloy called nitinol. At room temperature they are easily stretched by up to 5% of their length. When conducting an electrical current they return to their original unstretched shape with a force thousands of times their weight.

How strong are Muscle Wires?
The force a wire pulls with varies with size, from 35 to 335 grams. For more strength, use several wires in parallel.

How fast can Muscle Wires activate?
They contract as fast as they are heated — as quickly as 1/1000 of a second. To relax, the wire must cool again. Rates of many cycles per second are possible with active cooling.

Flexible Muscle Wire Specifications

<table>
<thead>
<tr>
<th>Wire Diameter</th>
<th>50 µm</th>
<th>100 µm</th>
<th>150 µm</th>
<th>200 µm</th>
<th>300 µm</th>
<th>500 µm</th>
<th>1000 µm</th>
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</thead>
<tbody>
<tr>
<td>Resistance</td>
<td>510 Ω/m</td>
<td>1020 Ω/m</td>
<td>1530 Ω/m</td>
<td>2040 Ω/m</td>
<td>3060 Ω/m</td>
<td>4080 Ω/m</td>
<td>6012 Ω/m</td>
</tr>
<tr>
<td>Contraction</td>
<td>5 mg/m</td>
<td>10 mg/m</td>
<td>15 mg/m</td>
<td>20 mg/m</td>
<td>30 mg/m</td>
<td>40 mg/m</td>
<td>60 mg/m</td>
</tr>
<tr>
<td>Typical Current</td>
<td>50 mA</td>
<td>100 mA</td>
<td>150 mA</td>
<td>200 mA</td>
<td>300 mA</td>
<td>400 mA</td>
<td>500 mA</td>
</tr>
</tbody>
</table>

How much power does Muscle Wires need? Power varies with wire diameter, length, and surrounding conditions. Once the wire has fully shortened, power should be reduced to prevent overheating.

What are the advantages of Muscle Wires?
Small size, light weight, low power, very high strength-to-weight ratio, precise control, AC or DC activation, long life and direct linear action and much more!

Get our new 112 page Book and Deluxe Sample Kit with plans for BORIS and 14 other motorless motion projects. Includes one motor each of 50, 100 and 150 µm diameter Muscle Wire — everything you need to get moving today!

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50A2

Heart Attack. Fight it with a Memorial gift to the American Heart Association.

THE AMERICAN HEART ASSOCIATION MEMORIAL PROGRAM

American Heart Association

This space provided as a public service.

www.americanradiohistory.com
Enclosed in shelter that is fully insulated with aluminum exterior and plywood interior. 741 x 577 x 605½ H, 620 lbs. Has two sliding windows and is louvered for ventilation, which is filtered. A 400 watt, radio frequency communications transmitter. It is used for voice or transmission of beacon signals to aircraft in the frequency range of 190 to 500 KC. Power requirements are 230 VAC. Units are unsited and in excellent condition. Units are complete with all accessories including cables, antenna, controls and many other parts and accessories. Fits into 6' commercial truckbed.

Price: $1595.00

HEWLETT PACKARD#4808-OPT 322 SOLID STATE SIGNAL GENERATOR

Two synchronized frequency range: 63 kHz to 500 kHz, to 100 kHz with external frequency doubler optional. Ten frequency bands in octave increments from 500 kHz to 11 kHz. Band 11 for doubler use. Accuracy: ±5 kHz. Stabilty: ±0.1 ppm. Output power: ±45 dBm to +10 dBm terminated 10 MHZ, 120ohms. Impedence ±500 ohms. SWR < 1.2:1. Frequency range 0 to 10000 MHz.

Price: $2150.00

CURRENT Hewlett-Packard

Prices: $22,000.00

GENERAL MICROWAVE 476 THERMALLY ELECTRIC POWER METER

With type 4240A power head. Power range: 30n watts to 10m W (-45 to +10 dBm). Frequency range: 0.01 to 10 GHz. VSWR: 1.3 from 0.01 to 0.015 GHz. 1.35 from 0.015 to 10 GHz. 1.6 from 10 GHz to 18 GHz. Connector: Type N. Size: 4.5 inches. Accuracy: ±1.5% of full scale on all ranges. Built in 10 kHz calibration signal. Power Requirements: 115V, 230V, 50-60000 Hz 4 watts. Size: 6.17 x 5.17 x 11.3"D. Weight: 7 lbs. Includes 4 Attenuators: DC to 18 GHz.

Price: $275.00

L.R. TANK PERISCOPE

Type M-24. Rugged military construction. Contains two independent infrared image converter tubes plus correction lenses, prisms, and eyepieces. The binocular viewing system is directly connected to a prism-type periscope. The image tube have dynamic focus provided by a built-in adjustable voltage divider. This unit requires 10 to 15 KV at low current for operation. Unable to supply power supply. Dimensions: 18"H x 9"W x 4"D. Weight: 17 lbs. Stock #MP9001.

Price: $200.00

(818) 787-3334
(800) 235-6222
FAX (818) 787-4732
PC-BASED OSCILLOSCOPES OUTPERFORM STAND-ALONES IN COST AND PERFORMANCE

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- Store and Retrieve WaveForms from Disk.
- Built-in Functions include Ave,Freq,T<sub>r</sub>,T<sub>f</sub>,PW,Env,FFT
- Professional Scope Software works with virtually all CGA, EGA, VGA, or Hercules compatible monitors.

CHASSE SCIENTIFIC INTRODUCES 4 NEW PC-SCOPES

By Staff Writer

Chase Scientific Company has currently introduced 4 new PC-based Digital Storage Oscilloscope boards with useful bandwidths of 20, 40, 60, and 100MHz. Each ChaseScope™ System is completely self-contained on a single mid-size (10") add-on board (for IBM PC-compatible only), at prices that will make the competition cry. Just plug the board in and load the ChaseScope™ System software (free with board) and you're on your way.

These boards have 2 completely independent vertical channels, each with their own 25 or 40 megasample/sec 8-Bit A/D converter, 8K/32K/128K static ram, and 10 vertical gain settings (in 1.25 steps) standard. This gives you the same high performance whether you are using one channel by itself or multiple channels simultaneously (not a common feature among other add-ons). Also, there are 27 timebase settings in 1.25 steps.

Post- and Pre-Triggering are available for time reconstructed waveforms as well as one-shot waveforms due to the board's ability to use random interleaved sampling.

These PC based scopes are designed with the latest in Surface Mount Technology, providing better performance, reliability, and features than any other board on the market today.

Actual Screen Output on HP LaserJet III at 150dpi

COMPARISON CHART OF CHASE SCIENTIFIC PC-OSCILLOSCOPES

<table>
<thead>
<tr>
<th>MODEL #</th>
<th>CS100-40*</th>
<th>CS60-25</th>
<th>CS40-25</th>
<th>CS20-25</th>
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<tr>
<td>PRICE</td>
<td>$795</td>
<td>$695</td>
<td>$595</td>
<td>$495</td>
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<tr>
<td>BANDWIDTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Repetitive (-3dB)</td>
<td>100 MHz</td>
<td>60 MHz</td>
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<tr>
<td>Single-Shot (Sample Rate/4)</td>
<td>10 MHz</td>
<td>6.2 MHz</td>
<td>6.2 MHz</td>
<td>6.2 MHz</td>
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<tr>
<td>MAXIMUM DIGITIZING RATE</td>
<td>40 Ms/sec</td>
<td>25 Ms/sec</td>
<td>25 Ms/sec</td>
<td>25 Ms/sec</td>
</tr>
<tr>
<td>(Two-Channel Simultaneous)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUMBER OF CHANNELS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME BASE RANGE **</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAXIMUM TIME RESOLUTION</td>
<td>20ns/2.56ns/div</td>
<td>50ns/2.56ns/div</td>
<td>50ns/2.56ns/div</td>
<td>50ns/2.56ns/div</td>
</tr>
<tr>
<td>VERTICAL RESOLUTION</td>
<td>250 pe</td>
<td>400 pa</td>
<td>400 pa</td>
<td>1 ns</td>
</tr>
<tr>
<td>MEMORY (Standard)***</td>
<td>32K words</td>
<td>8K words</td>
<td>8K words</td>
<td>8K words</td>
</tr>
</tbody>
</table>
| * = Available 2nd Qtr 93
| ** = Screen display can zoom up to 10X
| *** = 32K option available (128K for CS100) |

All Scopes have 10mV/div - 10V/div input sensitivity in 1,2,5 steps (20pF, 1Mohm)

FOR INFORMATION PACKAGE CALL 1-800-866-7899, FAX (408) 479-8572
OR WRITE TO CHASE SCIENTIFIC, 7960-B SOQUEL DRIVE, SUITE 191, APOTOS, CA 95003

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MARCONI SYNTHESIZED SIGNAL GENERATOR

Model 2018
Freq range 80Khz-520Mhz with calibrated output levels from -1.27 dBm to +13dBm. Resolution 10Hz. It can be freq, phase or amplitude modulated from ext or int modulation sources. RF output resolution is 0.1dB, reverse power protection of up to 50Watts possible without damage to the intrument. This instrument is microprocessor controlled and very easy to use, a must for any serious repair or development lab.
Price: $1500.00 Checked

IFR 1000SA

COMMUNICATIONS MONITOR
FM/AM-1000SA is a synthesized AM/FM/SSB receiver/signal generator. Frequency range is 300Khz-1Ghz, it contains a 60 watt rf power meter, deviation/modulation meter, oscilloscope, tone generator and internal high stability freq standard. Its a radio repair shop in one cabinet.
Price: $2750.00

HEWLETT PACKARD

8640B SIGNAL GENERATOR
Industry Standard sig-gen 500Khz-512Mhz features internal phase lock/synchronizer and digital freq readout. +190 to -145 dbm output.
AM, FM external and Pulse modulation.
Price: $2295.00 OPT 001 add $100.00 OPT 003 add $150.00

TEKTRONIX 577/177 CURVE TRACER............$2395.00
-HP 3580A SPEC-ANALYZER 5Hz-50KHz........$3470.00
-HP 8443A 110MHz TRACKING GENERATOR........$900.00
-HP 8160A OPT-20 PROG PULSE GEN............$5500.00
-HP 4260A LCR BRIDGE...............................$385.00
-HP 3551A TRANSMISSION TEST SET............$1275.00
-EXACT 566 SWEEP/FUNCTION GEN...............$345.00
-IFR 1000A COMMUNICATIONS MONITOR............$2675.00
-IFR 1000S COMMUNICATIONS MONITOR.............$4250.00
-IFR 1100S COMMUNICATIONS MONITOR.............$5750.00
-BOONTON 82AD AM/FM MOD-METER..............$1275.00
-GEN-RAD 1662 RES-LIM BRIDGE.................$325.00
-HP 3585A SPECTRUM ANLYZER......................$7250.00
-TEKTRONIX 1502 TDR w CHART-REC..............$3795.00

COLLINS 30L-1 POWER AMPLIFIER
One of the finest mid-size linear amplifiers ever produced specifically for the Premier Ham Radio Operator. It covers the 80,40,20,15 and 10 meter bands in either SSB, CW, RTTY or SSTV modes. Input drive power is 70-100 watts for full output. Power input is 1200 watts, @ 115/230 vac 60 Hz. Output power is 650 watts RF (1000w @ reduced duty cycle). These units are in excellent condition complete with cables and connectors. If your looking for the amp opportunity of a life time, you've just checked-in. So check it out!!
Price: $595.00 winged. $695.00 round.

COLLINS 30S-1 POWER AMPLIFIER
The 30S-1 is a completely self contained AB-1 class linear amplifier for ham radio use. It uses the commercially popular Eimac4CX1000A power tube, modes of operation are SSB,CW, RTTY or SSTV . Power Output is 1000w SSB and 1000w for CW at a 50% duty cycle. Power requirements are 115/230 VAC 50/60 Hz 1Ph , drive power 70-100 watts RF.
Freq Range 80-10 meters. Ship wt. 160 lbs.
Price: $995.00 ea. Incl 4CX1000.

"MANUALS AVAILABLE AT ADDITIONAL COST."

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Please include (telephone/fax) number with mail-in orders.
Orders must be prepaid by guaranteed Instrument. ***
**Auto Trigger & Hold**

now, for the first time, available on inexpensive, portable counters with our new ATH™ Series. This feature is the most significant improvement ever made to the pocket-sized counters! It allows "Hands Free" operation to automatically read & hold a signal as quick as 80 ms or 8% of a second.

Our ATH™ circuitry is super fast because it does not require the time for multiple readings, like digital filtering techniques.

The ONE-SHOT ATH™ feature is standard on the ATH-30. Using controls and indicators on top of the unit, it will hold the first reading until manually reset. (The ONE-SHOT feature is a $40 option on the ATH-15.)

**Say goodbye to random counting & false readings with the ATH™ Series**

ATH™ Series features include:
- Easy to use - simple controls
- Ultra fast response time - 900% faster
- Extra bright LED digits
- 3-5 hour battery operation
- Automatic clean dropout
- Maximized sensitivity, <1mv typical
- 4 GHz signal strength Bar Graph
- 2 ranges - 6 fast gate times
- 9-12V auto-polarity power jack
- StarCab™ aluminum cabinet

**NEW WARRANTY**

5 years all parts
1 year labor
ALL MODELS

**ALL MODELS MADE IN U.S.A.**

**In Stock...Same Day Shipment**

- Ultra high sensitivity, Bar Graph
- 2 ranges - 6 fast gate times
- 9-12V auto-polarity power jack
- StarCab™ aluminum cabinet

**频率计数器**

<table>
<thead>
<tr>
<th>型号</th>
<th>频率范围</th>
<th>特性</th>
<th>价格</th>
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<tbody>
<tr>
<td>ATH-15</td>
<td>1-1500 MHz</td>
<td></td>
<td>199</td>
</tr>
<tr>
<td>ATH-30</td>
<td>1-3000 MHz</td>
<td></td>
<td>259</td>
</tr>
<tr>
<td>HHT-15</td>
<td>1-3500 MHz</td>
<td>Ultra high sensitivity, Bar Graph</td>
<td>249</td>
</tr>
</tbody>
</table>

**配件**

- A: CC-90, Case for all models (12)
- B: TA-90, Telescope BNC antenna (12)
- C: TA-90L, Telescope elbow antenna (16)
- D: RD-2750, 27.50 MHz rubber duck (28)
- E: RD-800, 800 MHz rubber duck (28)
- F: M-207-C, Interface cable for MFJ-207 (10)
- G: P-110, 200 MHz, 1x, 10x probe (39)
- H: LP-22, Low Pass, audio usage probe (25)
- I: DC-10, Direct, 50 OHM probe (20)

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Unbeatable Discount Prices

1 YEAR WARRANTY
15 DAY MONEY BACK GUARANTEE

Four Instruments in One Instrument

<table>
<thead>
<tr>
<th>Instrument</th>
</tr>
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<tbody>
<tr>
<td>MT-100</td>
</tr>
<tr>
<td>Reg. $395.</td>
</tr>
<tr>
<td>$399.00</td>
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</tbody>
</table>

- **Function Generator**
  - Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
  - 0.02 Hz – 2MHz

- **Power Supply**
  - 3-1/2 Digit LCD
  - Triple output: #1, 0-50V, 0.5A MAX
  - #2, 15V, 1A
  - #3, 5V, 2A

- **Frequency Counter**
  - 6 Digital LED
  - 1 Hz – 100MHz
  - 1 (Hz + 1 digit + Time Base Error)

- **Digital Multimeter**
  - 3-1/2 Digit LCD
  - DCV, ACV, Ω, DCA, ACA
  - ± (0.5% ± 2 digits)

---

**BEST BUY! O’SCOPES**

<table>
<thead>
<tr>
<th>Oscilloscope</th>
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</thead>
<tbody>
<tr>
<td>FG-150</td>
</tr>
<tr>
<td>Reg. $395.</td>
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<tr>
<td>$229.00</td>
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- 2MHz Sweep / Function Generator
- w/Built-in Frequency Counter

<table>
<thead>
<tr>
<th>Oscilloscope</th>
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</thead>
<tbody>
<tr>
<td>RF Signal Generator, SG-310</td>
</tr>
<tr>
<td>100KHz - 150MHz</td>
</tr>
<tr>
<td>Reg. $595.</td>
</tr>
<tr>
<td>$119.00</td>
</tr>
</tbody>
</table>

- 100KHz – 150MHz, 6 Ranges.
- Accuracy: ± 5%
- RF Output: 100 m Vrms (Up to 30MHz Unloaded)
- Modulation: Int. 1KHz (AM) 30%
- Ext. 50KHz – 20KHz
- Audio Output: 15KHz Mm 2 Vrms

<table>
<thead>
<tr>
<th>Oscilloscope</th>
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<tbody>
<tr>
<td>DC Power Supply, PS-500</td>
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<tr>
<td>0-30VDC, 0-3A</td>
</tr>
<tr>
<td>Reg. $249.</td>
</tr>
<tr>
<td>$159.00</td>
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</tbody>
</table>

- 0 - 30VDC Continuously Variable
- Regulation: ± 0.01% ± 3mV
- Ripple Voltage: p-p ≤ 2mV Vrms; ≤ 1mV
- 0.1A – 3A Constant Current
- Regulation: ± 0.2% ± 3mA
- Ripple Current: ≤ 3mA Arms
- Short Circuit Overload Protection w/Indicating Lamp

<table>
<thead>
<tr>
<th>Oscilloscope</th>
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<tbody>
<tr>
<td>Auto Bargraph w/ Holster</td>
</tr>
<tr>
<td>DM3200</td>
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<tr>
<td>Reg. $599.</td>
</tr>
<tr>
<td>$59.00</td>
</tr>
</tbody>
</table>

- Auto & Manual
- 3-1/2 Digit
- 32 Seg. Bargraph
- Diode Test
- Continuity Beep
- Data Hold
- Auto Power Off
- Low Battery Mark
- Over Range Mark
- Holster

<table>
<thead>
<tr>
<th>Oscilloscope</th>
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</thead>
<tbody>
<tr>
<td>Multimeter Multi-Function w/Holster</td>
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<tr>
<td>DM3000</td>
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<tr>
<td>Reg. $499.</td>
</tr>
<tr>
<td>$44.00</td>
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</tbody>
</table>

- 3-1/2 Digit
- 1.5" Big LCD
- Heavy Duty, 20A
- Capacitance
- TR-nFE Diode
- Low Battery Mark
- Over Range Mark
- Protective Holster
- Till Stand

<table>
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<th>Oscilloscope</th>
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<td>DM3050</td>
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<td>$54.00</td>
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<table>
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<td>DM3100</td>
</tr>
<tr>
<td>Reg. $599.</td>
</tr>
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<td>$54.00</td>
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- Temperature w/ Optional Probe
- Continuity Beep

---

**GoldStar Oscilloscopes**

<table>
<thead>
<tr>
<th>Oscilloscope</th>
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<tbody>
<tr>
<td>OS-7020A, 20MHz Dual</td>
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<td>Reg. $325.</td>
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<td>$399.00</td>
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<table>
<thead>
<tr>
<th>Oscilloscope</th>
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<tbody>
<tr>
<td>OS-9020B, 20MHz</td>
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<tr>
<td>Reg. $395.</td>
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<tr>
<td>$595.00</td>
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<table>
<thead>
<tr>
<th>Oscilloscope</th>
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<tbody>
<tr>
<td>OS-9040D, 40MHz Delay</td>
</tr>
<tr>
<td>Reg. $395.</td>
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<td>$695.00</td>
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<table>
<thead>
<tr>
<th>Oscilloscope</th>
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<tbody>
<tr>
<td>OS-8100, 100MHz 8 Trace</td>
</tr>
<tr>
<td>Reg. $1,145.</td>
</tr>
<tr>
<td>$52,95</td>
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</tbody>
</table>

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**DESCRAMBLERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>40+</th>
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<tr>
<td>SUPER 7 (DIGITAL IMPULSE)</td>
<td>$109.00</td>
<td>$99.00</td>
<td>$79.00</td>
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<tr>
<td>TB - 3 OR 2</td>
<td>$ 65.00</td>
<td>$ 50.00</td>
<td>$40.00</td>
<td>CALL</td>
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<tr>
<td>FTB - 3 OR 2</td>
<td>$ 79.00</td>
<td>$ 55.00</td>
<td>$50.00</td>
<td>CALL</td>
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<tr>
<td>SA - 3B</td>
<td>$ 65.00</td>
<td>$ 45.00</td>
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<td>SA - 3D-F</td>
<td>$ 99.00</td>
<td>$ 94.00</td>
<td>$89.00</td>
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<td>SB - 3 OR 2</td>
<td>$ 55.00</td>
<td>$ 43.00</td>
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<td>SP-200 (SPECIAL PIO)</td>
<td>$145.00</td>
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<td>*OAK N-12 (WITH VARI-SYNC)</td>
<td>$ 54.00</td>
<td>$ 49.00</td>
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<td>*HAMLIN 1200 CH. 3</td>
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*REFURBISHED AS NEW.

**CONVERTERS**

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<td>PANASONIC TZPC 145</td>
<td>$80.00</td>
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<td>T P550 (550 MHZ WPARENTAL)</td>
<td>$80.00</td>
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<td>*JERROLD DQN-5</td>
<td>$80.00</td>
<td>$70.00</td>
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<td>*JERROLD DQN-V7 w/volume</td>
<td>$85.00</td>
<td>$75.00</td>
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<tr>
<td>*JERROLD DRZ-450</td>
<td>$59.00</td>
<td>$49.00</td>
<td>$45.00</td>
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<td>*Sylvania Texscan 4040 (CH. 2, 3 OR 4)</td>
<td>$55.00</td>
<td>$45.00</td>
<td>$36.00</td>
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*REFURBISHED AS NEW. CONVERTERS AVAILABLE IN CHANNEL 2 OR 3.

**COMBINATION UNITS**

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<th>CALL FOR AVAILABILITY AND PRICING</th>
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<td>*Scientific Atlanta</td>
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<td>*Zenith Models</td>
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<tr>
<td>JERROLD BASEBAND</td>
<td>$329.00</td>
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<td>JERROLD DPV7-212</td>
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<td>*JERROLD DPS-DPV5</td>
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<td>JERROLD DRX-3DIC</td>
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<td>*Sylvania Texscan 4040-DIC (CH. 2 OR 3)</td>
<td>$ 79.00</td>
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<td>*OAK M35B (WITH VARI-SYNC)</td>
<td>$ 49.00</td>
<td>$ 44.00</td>
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<td>*OAK RTC56</td>
<td>$145.00</td>
<td>$125.00</td>
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*REFURBISHED AS NEW.

**OTHER PRODUCTS AVAILABLE:** REMOTES: JERROLD, PANASONIC, HAMLIN, TOCOM, SCIENTIFIC ATLANTA. INTERFERENCE FILTERS: CHANNELS 2 OR 3 / VIDEO TAPE ENHANCERS. AC ADAPTERS: 12 & 18 VOLT / ADULT INSULT BOXES / MORE. FULL SERVICE TECHNICAL SUPPORT.

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3) 2 H sweep, 4) IGC sweep.
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<tr>
<th></th>
<th>PANASONIC-145 CONVERTER</th>
<th>$62</th>
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<td>NEW</td>
<td>TVT-3 DIGITAL TRIBI ADD-ON</td>
<td>51</td>
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<td>For most Jerrold systems</td>
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<td>NEW</td>
<td>SCIENTIFIC ATLANTA 8580-338 CALL</td>
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<td>Converter/Descrambler</td>
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<td>NEW</td>
<td>SCIENTIFIC ATLANTA 8590 CALL</td>
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<td>JERROLD STARCOM 6 (DPV5) CALL</td>
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<td>REFUR</td>
<td>HAMLIN 6600 or 6000-3-M 65 55</td>
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<td>MLD1200 Built-In Converter/Descrambler</td>
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<td>PIONEER Add-on 100 95</td>
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<td>For all Pioneer Systems</td>
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<td>SCIENTIFIC ATLANTA Add-on 90 85</td>
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<td>NEW</td>
<td>For 8580 Systems</td>
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<td>NEW</td>
<td>JERROLD STAR 7 Add-on 90 85</td>
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</table>

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<td>Zip</td>
<td>Phone No.</td>
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SM-302 A A A

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<td>12A DC Power Supply</td>
<td>$289</td>
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<td>B+K 1666</td>
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<td>Model 70II</td>
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<td>Model 93</td>
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<td>Model 97</td>
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**Digital Triple Power Supply**

<table>
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<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>XP-620</td>
<td>Assembled</td>
<td>$49.95</td>
</tr>
</tbody>
</table>

**ELECTRONIC LEARNING**

**EDI-65-250**

- AM-FM Transistor Radio Kit
  - Model AM-FM 108
  - $27.95
  - 14 Transistors
  - Easy to build because schematic is printed right on the PCB
  - 13 Diodes
  - Model AM 550 AM Only $17.95

**Digital Multimeter Kit**

- With Training Course
- $49.95
- Fun & Easy to Build
- Ideal School Project

**Digital Multi-Function Counter**

- Elenco F-1300
- 1.2GHz
- $229

**AM-FM Transistor Radio Kit**

- Model AM-FM 108
- $27.95
- 14 Transistors
- 3 Diodes
- Easy to build because schematic is printed right on the PCB
- Makes a great school project
- Model AM 550 AM Only $17.95

**C&S SALES INC.**

1245 ROSEWOOD, DEERFIELD, IL 60015
FAX: 708-520-0085 • (708) 541-0710

- 15 DAY MONEY BACK GUARANTEE
- FULL FACTORY WARRANTY
- WRITE FOR FREE CATALOG

**CIRCLE 286 ON FREE INFORMATION CARD**
**ELENCO & HITACHI & B+K SCOPES AT DISCOUNT PRICES**

**ELENCO S-1325**

- 25MHz 2 Channel
- S-1340 40MHz Dual Trace Oscilloscope
- High luminance 6" CRT
- 1mV Sensitivity
- 10KV Acceleration Voltage
- 5ns Rise Time
- X-Y Operation

**$495**

**S-1360 60MHz Dual Trace - Delayed Sweep**

- Automatic Beam Finder
- Built-in Component Tester
- 1mV Sensitivity
- Dual Time Base
- Illuminated Internal Gradicule

**$775**

**DS-203 20MHz, 10MS/s Digital Storage Oscilloscope**

- 2K Word Per Channel
- Plotter Output
- 8 Bit Vert. Resolution
- 2048 Pts Hor. Resolution
- Much More

**$775**

**B+K 2120**

- 20MHz $395 Model 2125 $539.95 2 Channel Delayed Sweep
- 40MHz DUAL-TRACE Model 1541B
  - 1mV/div sensitivity
  - Video sync separators
  - Z axis input
  - Single sweep
  - V mode displays two signals unrelated in frequency
- 60MHz DUAL-TRACE Model 2160
  - 1mV/division sensitivity
  - Sweep to 5 ns/div
  - Dual time base
  - Signal delay line
  - V mode displays two signals unrelated in frequency
  - Component tester
- 100MHz THREE-TRACE Model 2190
  - 1mV/division sensitivity
  - Sweeps to 2ns/division
  - Dual time base
  - Calibrated delay time multiplier
  - Signal delay line
  - 19Kv accelerating voltage
- 20MHz ANALOG WITH DIGITAL STORAGE Model 2522
  - 20MHz analog bandwidth
  - 10MS/s sampling rate
  - 2k memory per channel
  - 20MHz equivalent time sampling
  - Pre-trigger capture
- 1.0GHz PORTABLE SPECTRUM ANALYZER Model 2610
  - AC/DC operation (battery included)
  - 70dB dynamic range
  - Resolution bandwidth of 10kHz
  - 50Ω and 75Ω input impedance (switch selectable)
  - Fixed bandwidth setting for viewing TV signals
  - Field calibratable with internally generated 100MHz, 80dB signal

**$2,595.95**

**SPECIAL BUY HITACHI V-212**

- 20MHz 2 Channel

**$409**

**Hitachi Popular Series**

- V-525 - 50MHz, Cursors $975
- V-523 - 50MHz, Delayed Sweep $949
- V-522 - 50MHz, DC Offset $849
- V-422 - 40MHz, DC Offset $749
- V-222 - 20MHz, DC Offset $625

**Hitachi Compact Series Scopes**

- V-660 - 60MHz, Dual Trace $1,095
- V-665A - 60MHz, DT, w/cursor $1,325
- V-1060 - 100MHz, Dual Trace $1,375
- V-1065A - 100MHz, DT, w/cursor $1,649
- V-1085 - 100MHz, QT, w/cursor $1,995
- V-1100A - 100MHz, Quad Trace $2,195
- V-1150 - 150MHz, Quad Trace $2,695

**Hitachi RSO Series**

- RSO's feature: roll mode, averaging, save memory, smoothing, interpolation, pretriggering, cursor measurements
- VC-6023 - 20MHz, 20MS/s $1,650
- VC-6024 - 50MHz, 20MS/s $1,950
- VC-6025A - 50MHz, 20MS/s $2,350
- VC-6045A - 100MHz, 40MS/s Call
- VC-6145 - 100MHz, 100MS/s Call

**Logic Analysers**

- 32 channels (VC-3120) or 48 channels (VC-3130)
- 25MHz synchronous operation on all channels
- 100MHz asynchronous operation (8 or 12 channels)
- 5ns glitch capture capability
- Multi-level trigger sequencing
- Non-volatile data and set-up memories
- Disassembler options for popular uPs
- Very low cost - Call
- 9 inch LCD screen

**Special Buy**

- Much More

**$539.95**

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- PROBES INCLUDED IN ALL SCOPES & METERS

- WRITE FOR FREE CATALOG

www.americanradiohistory.com
### RF POWER TRANSISTORS — TUBES

**SUBSTANTIAL SAVINGS ON RF SERVICE PARTS FOR NEW & OLDER COMMUNICATIONS EQUIPMENT**

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Price</th>
<th>Stocked By</th>
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<tr>
<td>KENWOOD</td>
<td>UNIDEN</td>
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<td>RF-Parts</td>
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<td>MOTOROLA</td>
<td>MIRAGE/KLM</td>
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<td>RF-Parts</td>
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<td>COLEMAN</td>
<td>GALAXY</td>
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<tr>
<td>RF CONCEPTS</td>
<td>ICOM</td>
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<td>YAESU</td>
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<tr>
<td>GE</td>
<td>AZDEN</td>
<td>39.95</td>
<td>RF-Parts</td>
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<tr>
<td>ALCINO</td>
<td>RCI</td>
<td>99.95</td>
<td>RF-Parts</td>
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<tr>
<td>JOHNSON</td>
<td>PALOMAR</td>
<td>229.</td>
<td>RF-Parts</td>
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<tr>
<td>ATLAS</td>
<td>TEMPO</td>
<td>299.</td>
<td>RF-Parts</td>
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</table>

AND SIMILAR AMATEUR, MARINE, LAND MOBILE & CB EQUIPMENT

### TRANSMITTING TUBE & TRANSISTOR SPECIALS

<table>
<thead>
<tr>
<th>Model</th>
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<td>3CX150A07</td>
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<td>4CX250B</td>
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<td>4CX250R</td>
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<td>8560AS</td>
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**TRANSMITTING TUBE & TRANSISTOR SPECIALS**

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<td>2SC2509</td>
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**PHONE ORDERS**

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<td>MOTOROLA</td>
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<td>COLEMAN</td>
<td>ICOM</td>
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<tr>
<td>RF CONCEPTS</td>
<td>RANGER</td>
<td>49.95</td>
</tr>
<tr>
<td>YAESU</td>
<td>GE</td>
<td>119.95</td>
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<tr>
<td>GE</td>
<td>AZDEN</td>
<td>39.95</td>
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<tr>
<td>ALCINO</td>
<td>RCI</td>
<td>99.95</td>
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<tr>
<td>JOHNSON</td>
<td>PALOMAR</td>
<td>229.</td>
</tr>
<tr>
<td>ATLAS</td>
<td>TEMPO</td>
<td>299.</td>
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### PRICE & AVAILABILITY SUBJEC TO CHANGE WITHOUT NOTICE QUANTITY PRICING AVAILABLE

**SHIPPING METHOD & CHARGES**

<table>
<thead>
<tr>
<th>Method</th>
<th>Minimum Charge</th>
<th>Rate</th>
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</thead>
<tbody>
<tr>
<td>UPS</td>
<td>$20.00</td>
<td>Per box</td>
</tr>
</tbody>
</table>

**PAYMENT METHOD**

- **PREPAID** with check or money order
- **VISA/MasterCard** accepted
- **C.O.D.** Add $5 to UPS charge
- **Cash, Checkers**
- **Money Order** or the approved Company

**WE STOCK A FULL LINE OF RECEIVING & TRANSMITTING TUBES, TRANSISTORS, RF POWER MODULES, CAPACITORS, SOCKETS, RELAYS, ETC. ALSO BOOKS ON THE DESIGN, MODIFICATION AND SERVICING OF POPULAR TRANSMITTERS, TRANSCEIVERS, AND LINEARS. WRITE FOR FREE CATALOG OR CALL OUR CUSTOMER SERVICE LINE AT (619) 744-0750.**

**MONDAY - FRIDAY 7:00 A.M. - 5:00 P.M. PST 10:00 A.M. - 8:00 P.M. EST**

**FAX**

435 SOUTH PACIFIC ST.
SAN MARCOS, CA 92069

CIRCLE 268 ON FREE INFORMATION CARD

---

**TOTAL COST FOR INSURED AIR MAIL OR FEDERAL EXPRESS SHIPPING OF ANY ONE OR AS MANY OF THE FOLLOWING ITEMS IS $15**

**ALL PRICES ARE IN US DOLLARS**

**68705 DEVELOPMENT SYSTEM**

- **80DPC5K** Disc ceramic $3.50 Ea
- **20K** Pin-5mA A/1A Pk
- **30K** Pin-300mA A/50A Pk
- **50K** Pin-50mA A/100A Pk
- **400** Disc ceramic $1.30 Ea
- **4000** Disc ceramic $1.30 Ea

**IMAGE INTENSIFIER TUBE AND NIGHT VIEWER KIT**

- **$340** tube only

**MINIATURE FM TRANSMITTER**

- **$25**

**SOME DIFFERENT COMPONENTS**

- **100PF/5KV** Disc ceramic $3.50 Ea
- **20K** Pin-5mA A/1A Pk
- **30K** Pin-300mA A/50A Pk
- **50K** Pin-50mA A/100A Pk
- **400** Disc ceramic $1.30 Ea
- **4000** Disc ceramic $1.30 Ea
- **680pF/5KV** Disc ceramic $1.30 Ea

---

**PHONE ORDERS**

- **ORIENTAL ELECTRONICS**
  - East Coast between 7 pm and 2 am West Coast between 4 pm and 11 pm
  - 011 612 579 4985
  - FAX ORDERS
  - 011 612 570 7910

**FAX ORDERS**

011 612 570 7910

---

**OATLEY ELECTRONICS**

5 LANDSOWNE PARADE, OATLEY
SYDNEY NSW AUSTRALIA 2223

---

**CONTACT**

- **R. F. PARTS**
  - 435 SOUTH PACIFIC ST.
  - SAN MARCOS, CA 92069

- **FAX**
  - 619-744-1943

- **E-MAIL**
  - info@rfparts.com

---

**IF POSSIBLE INCLUDE YOUR PHONE OR FAX NUMBER**
## MIKE NELSON'S MOVIE VIEW SALES, INC.

WHERE YOU'RE TREATED POLITE AND GIVEN INDIVIDUALIZED ATTENTION!

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Call C.S.T. Monday thru Friday 9:00 - 6:00 • Sat. 10:00 - 2:00
Friendly Courteous Service • 12 Yrs. Experience • 6 Mo. Warranty

### JERROLD

<table>
<thead>
<tr>
<th>QTY.</th>
<th>ITEM</th>
<th>PRICE EA.</th>
<th>TOTAL PRICE</th>
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</thead>
<tbody>
<tr>
<td>1-3</td>
<td>NEW TRU/B1 COMBO (FTB)</td>
<td>130.00</td>
<td>125.00</td>
</tr>
<tr>
<td>4 or more</td>
<td>NEW TRU/B1 PAN</td>
<td>75.00</td>
<td>60.00</td>
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<td>110.00</td>
<td>NEW SB-3 COMBO</td>
<td>60.00</td>
<td>55.00</td>
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<td>85.00</td>
<td>NEW SB-3 PAN</td>
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<tr>
<td>CALL</td>
<td>DPB-7212</td>
<td>75.00</td>
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<tr>
<td>CALL</td>
<td>DPBB-7212</td>
<td>60.00</td>
<td>55.00</td>
</tr>
<tr>
<td>110.00</td>
<td>NEW HAMLIN COMBO(CH 2 OR 3)</td>
<td>110.00</td>
<td>105.00</td>
</tr>
<tr>
<td>50.00</td>
<td>NEW HAMLIN MLD-1200</td>
<td>50.00</td>
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<td>50.00</td>
<td>MLD-1200-2</td>
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Price effective 1/1/93 (Subject to change without notice)

### PIONEER

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<td>*NEW SA-PIO-COMBO</td>
<td>155.00</td>
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<td>4 or more</td>
<td>NEW SA-PIO-PAN W/switch</td>
<td>80.00</td>
<td>75.00</td>
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<tr>
<td>CALL</td>
<td>NEW ORIG. BA-6100 PAN</td>
<td>CALL</td>
<td>MIKE</td>
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### SCIENTIFIC ATLANTA

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<td>*NEW SA-3 COMBO (SA-3B)</td>
<td>130.00</td>
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<td>4 or more</td>
<td>NEW SA-3 PAN</td>
<td>75.00</td>
<td>60.00</td>
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<tr>
<td>CALL</td>
<td>8550</td>
<td>175.00</td>
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<tr>
<td>CALL</td>
<td>8556</td>
<td>210.00</td>
<td>205.00</td>
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### OAK

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<td>1-3</td>
<td>NEW OAK N-12 COMBO(Vari Sync)</td>
<td>130.00</td>
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<td>4 or more</td>
<td>NEW OAK N-12 PAN(Vari Sync)</td>
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<td>60.00</td>
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<tr>
<td>M-35-B</td>
<td>50.00</td>
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### PANASONIC-VIEWSTAR

<table>
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<tbody>
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<td>20 LOT</td>
<td>PANASONIC</td>
<td>75.00</td>
<td>CALL</td>
</tr>
<tr>
<td>100 LOT</td>
<td>VIEWSTAR</td>
<td>220.00</td>
<td>CALL</td>
</tr>
</tbody>
</table>

### NOTCH FILTERS

- *All Combos come with new Panasonic or Viewstar converter.
- (Parental lockout units: No extra charge.)
- Volume control units available

(WAIVER) - MUST BE SIGNED FOR OUR RECORD

☐ Yes, I am paying for full service. This is only to be used as a second unit.

DECLARATION OF AUTHORIZED USE - I, the undersigned, do hereby declare, under penalties of perjury, that all products purchased, now and in the future, will only be used on cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws. FEDERAL AND VARIOUS STATE LAWS PROVIDE FOR SUBSTANTIAL CRIMINAL AND CIVIL PENALTIES FOR UNAUTHORIZED USE.

ABSOLUTELY NO ILLINOIS SALES

VISA-MASTER ☐ C.O.D. ☐
CASHIER'S CHECK ☐ MONEY ORDER ☐

ORDERS ONLY: 1-800 735-5912

Card # ☐ Exp. Date ☐
Name ☐
Address ☐ State ☐ Zip ☐
City ☐ Phone ( )

If for any reason you are not satisfied with any item purchased, you may return it within 30 days of delivery for a full refund.

July 1993, Electronics Now

50A29
DYNAMIC MICROPHONE

Good quality mike with professional appearance. Made for use with digital voice synthesizer. Microphone is 7" long, black with black wire element cover. 4 ft. long cord with gold plated 3.5mm mini phone plug. CAT# MIKE-13 $4.50 each

COMMUNICATIONS SPEAKER

Extension speaker for Ham, CB, marine or business communications. Black, break-resistant case and grill with adjustable mounting bracket. Improves the sound quality of mobile and hand-held transceivers especially in noisy environments. Speaker dimensions: 3.15" X 2.55" X 2.15" deep. Four foot cord with 3.5 mm mini-phone plug. 8 ohms.

CAT# SH-2 $10.00 each

JUMBO LED'S

Big, bright 10 mm diameter LED's will attract attention in any display or panel. Twice the diameter of regular LED's, stand about 10 mm above panel.

RED MAXI LED
CAT# LED-22R 3 for $1.00
GREEN MAXI LED
CAT# LED-22G 3 for $1.00

12 VDC 500 MA WALL TRANSFORMER

Panasonic # KX-A11
WHITE - U.L. listed. 12 Vdc wall transformer. 2.1 mm co-ax plug with center negative.
CAT# DCTX-125W $4.50 each
10 for $30.00 • 100 for $265.00

AUTOMOBILE ALARM

Protect your car and its contents with the Anes PRO-500 alarm system. The electronics and speaker of this passive anti-theft system are combined into one assembly making it easy to install, easy to operate. Automatically turns itself on and provides a 60 second exit delay when the ignition is turned off. Upon re-entry of the vehicle, you have 10 seconds to turn on the ignition and disarm the system. The alarm is triggered if any change in battery voltage occurs (courtesy lights, brake lights, dash lights). Sounds a high-pitched, high-low siren. Battery back-up feature protects even if battery cables are cut. Includes all necessary wiring, parts, window stickers and instructions. Not included but recommended is a single pole "valet switch" for disarming the alarm. Originally sold for $65.00 or more. These units were removed from store shelves, and some of the packages show signs of wear. The alarms, however, are fully functional and guaranteed.
CAT# AL-500 $20.00 each

UV "INVISIBLE" INK PEN

When the ink dries the writing of these felt tip pens is visible only under UV light. Originally for marking personal belongings and grill with permanent UV ink. lent for marking personal belongings

When the ink dries the writing of these felt tip pens is visible only under UV "black light". Originally for marking personal belongings in case of theft, these pens might also be used for writing secret messages or marking merchandise for inventory control.

CAT# UVP 3 for $1.00
100 for $25.00

CABLE TIES

<table>
<thead>
<tr>
<th>Size</th>
<th>Approx. Length</th>
<th>Min. Tensile Strength</th>
<th>Color</th>
<th>Max. Bundle Dia.</th>
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<tbody>
<tr>
<td>TR-400</td>
<td>4&quot;</td>
<td>18 lbs</td>
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<td>15/16&quot;</td>
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<tr>
<td>TR-400B</td>
<td>4&quot;</td>
<td>18 lbs</td>
<td>black</td>
<td>15/16&quot;</td>
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<td>TR-600</td>
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<td>TR-600B</td>
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<td>30 lbs</td>
<td>black</td>
<td>1 1/2&quot;</td>
</tr>
<tr>
<td>TR-800</td>
<td>8&quot;</td>
<td>50 lbs</td>
<td>neutral</td>
<td>1 3/4&quot;</td>
</tr>
<tr>
<td>TR-800B</td>
<td>8&quot;</td>
<td>50 lbs</td>
<td>black</td>
<td>1 3/4&quot;</td>
</tr>
<tr>
<td>TR-1100</td>
<td>11&quot;</td>
<td>50 lbs</td>
<td>neutral</td>
<td>3&quot;</td>
</tr>
<tr>
<td>TR-1100B</td>
<td>11&quot;</td>
<td>50 lbs</td>
<td>black</td>
<td>3&quot;</td>
</tr>
<tr>
<td>TR-1500</td>
<td>15&quot;</td>
<td>50 lbs</td>
<td>neutral</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Heavy-duty 15&quot; cable tie.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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DIODES

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SOLDER BREADBOARDS ON-A-CARD

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<td>8 bit card</td>
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<tr>
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SOLDERLESS BREADBOARDS

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WIRE-WRAP PROTOTYPE CARDS

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PORTABLE IC TESTER

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UNIKRAFT HAND TOOLS

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<tr>
<td>High-quality, stainless steel tools</td>
<td>$4.95</td>
</tr>
<tr>
<td>Spring-loaded, insulated grip handles</td>
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<td>Semiconductor Curve Tracer Generator</td>
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<td>LCG 409</td>
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<td>LCR 740</td>
<td>LCR Bridge</td>
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<td>LMV 186A</td>
<td>2 channel AC Millivoltmeter</td>
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<td>LDM 171</td>
<td>Semi-automatic Distortion Meter</td>
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<td>5860C</td>
<td>NTSC Wave-Form Monitor</td>
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<td>710</td>
<td>Thermal Printer for 300</td>
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<td>.015</td>
<td>100</td>
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<th>RF300T</th>
<th>150' Range Transmitter</th>
<th>24.95</th>
<th>19.95</th>
<th>15.95</th>
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<tbody>
<tr>
<td>Qty</td>
<td>RF300XT</td>
<td>300' Range Transmitter</td>
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<th>Receiver, Fully Assembled</th>
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<tbody>
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<td>Receiver, Complete Parts Kit</td>
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<tr>
<th><strong>HEWLETT-PACKARD 3314A</strong></th>
<th><strong>TEKTRONIX 465B</strong></th>
<th><strong>HEWLETT-PACKARD 141T W/ 8555A AND 8552B</strong></th>
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</thead>
<tbody>
<tr>
<td>Function Generator provides sine, square, and triangle waveforms from 0.01 Hz to 19.99 MHz with an amplitude range of 0.01 mV to 10 V p-p into 50 ohms.</td>
<td>Portable Oscilloscope, 100 MHz dual trace, 5 mV/div sensitivity, 2 nS/div sweep rate with 10 mag, trigger view, versatile trigger selection, alternate sweep.</td>
<td>Spectrum Analyzer mainframe with broadband RF Section, 01 to 18 GHz and high resolution IF section.</td>
</tr>
<tr>
<td><strong>$3000.00</strong></td>
<td><strong>$825.00</strong></td>
<td><strong>$3200.00</strong></td>
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<tr>
<th><strong>WAVETEK 178</strong></th>
<th><strong>HEWLETT-PACKARD 182T/85588 SPECTRUM ANALYZER</strong></th>
<th><strong>HEWLETT-PACKARD 3336B</strong></th>
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<tbody>
<tr>
<td>Programmable waveform Synthesizer, 1uHz to 50 MHz frequency range, synthesized 8 digit accuracy trigger, gate, burst, lin/log sweep, 20 volts peak-to-peak output into 50 ohm. Sine, triangle, square, ramps, and DC.</td>
<td>Spectrum Analyzer, 100 kHz to 1500 MHz plug-in with the 182T cabinet style mainframe, resolution BW from 1 kHz to 3 MHz, simple knob operation.</td>
<td>Synthesizer Level Generator is an excellent precision source from 10 Hz to 20.9 MHz, frequency resolution of 001 Hz, level accuracy within 15 dB over full range, AM and phase modulation. Programmable over HPIB, harmonics down more than 5 dB. Options available.</td>
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<tr>
<td><strong>$2100.00</strong></td>
<td><strong>SPECIAL $2450.00</strong></td>
<td><strong>SPECIAL $650.00</strong></td>
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<tr>
<th><strong>HEWLETT-PACKARD 8568A</strong></th>
<th><strong>FLUKE 8050A</strong></th>
<th><strong>HEWLETT-PACKARD 8568B</strong></th>
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<tbody>
<tr>
<td>100 Hz to 1.5 GHz frequency range, 10 Hz resolution BW, trace markers with amplitude and frequency readout.</td>
<td>Digital Multimeter, 45 digit LED, relative reference, dB, dBm, dBi, dBW, conductance, diode test, 03% basic dc accuracy, true RMS from 20 Hz to 50 kHz.</td>
<td>100 Hz to 1.5 GHz frequency range, amplitude range -135 to +30 dBm, direct plot, HP-IB.</td>
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<td><strong>$11750.00</strong></td>
<td><strong>$200.00</strong></td>
<td><strong>$19750.00</strong></td>
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<tr>
<th><strong>TEKTRONIX 7L5/L3</strong></th>
<th><strong>TEKTRONIX 475</strong></th>
<th><strong>TEKTRONIX 2445</strong></th>
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</thead>
<tbody>
<tr>
<td>Spectrum Analyzer plug-in, 20 Hz to 5 MHz, digital storage and averaging, reference level selection in 1 dB steps, Option 25 provides tracking generator. Comes with L3 plug-in module.</td>
<td>Portable Oscilloscope, 200 MHz bw, dual trace, 2 mV/ div sensitivity, 5 ns/ div sweep rate, delaying timebase, trigger view, and beam finder.</td>
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<tr>
<td><strong>$3950.00</strong></td>
<td><strong>$925.00</strong></td>
<td><strong>$1850.00</strong></td>
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<th>USED BY:</th>
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<tbody>
<tr>
<td>881/6L6WGC</td>
<td>$7.25 each</td>
<td>Fender, Soldano, VTL</td>
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<tr>
<td>12AX7/12AT7/GZ34</td>
<td>7.50</td>
<td>Matchless</td>
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<tr>
<td>6AQ5</td>
<td>6.90</td>
<td>Mesa Boogie Dual Rectifier</td>
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<td>3006</td>
<td>6.90</td>
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### SINO, CHINA

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<tr>
<td>2A3</td>
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<td>6.90</td>
</tr>
<tr>
<td>12AX7/ECC81</td>
<td>3.90</td>
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<td>EL34</td>
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### EL, YUGOSLAVIA

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### SIEMENS, GERMANY

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<tr>
<td>7025/12AX7a</td>
<td>$13.90 each</td>
</tr>
<tr>
<td>2SC7</td>
<td>6.90</td>
</tr>
</tbody>
</table>

### TESLA, CZECHOSLOVAKIA

<table>
<thead>
<tr>
<th>Tube Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>5U4GB</td>
<td>$12.50 each</td>
</tr>
<tr>
<td>6650a</td>
<td>25.00</td>
</tr>
<tr>
<td>6CA7/EL34</td>
<td>14.90</td>
</tr>
<tr>
<td>6L6G</td>
<td>13.90</td>
</tr>
<tr>
<td>6L6F</td>
<td>20.00</td>
</tr>
</tbody>
</table>

### GE, USA

<table>
<thead>
<tr>
<th>Tube Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6CA4</td>
<td>$4.50 each</td>
</tr>
<tr>
<td>6X4</td>
<td>5.00 each</td>
</tr>
<tr>
<td>6J1</td>
<td>5.00 each</td>
</tr>
<tr>
<td>6K6</td>
<td>3.50 each</td>
</tr>
<tr>
<td>6N1</td>
<td>6.90 each</td>
</tr>
<tr>
<td>6N4</td>
<td>5.90 each</td>
</tr>
<tr>
<td>6N5</td>
<td>5.90 each</td>
</tr>
<tr>
<td>6N5A</td>
<td>5.90 each</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Tube Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2K25</td>
<td>$28.00 each</td>
</tr>
<tr>
<td>5749</td>
<td>2.90</td>
</tr>
<tr>
<td>(6BA6W industrial)</td>
<td>6AU6</td>
</tr>
<tr>
<td>5859</td>
<td>8.90</td>
</tr>
<tr>
<td>5C22</td>
<td>60.00</td>
</tr>
<tr>
<td>5R4</td>
<td>4.90</td>
</tr>
<tr>
<td>5847</td>
<td>1.45</td>
</tr>
<tr>
<td>6287/EF86</td>
<td>3.60</td>
</tr>
<tr>
<td>6973</td>
<td>14.90</td>
</tr>
<tr>
<td>6AL5</td>
<td>2.40</td>
</tr>
<tr>
<td>6AN8</td>
<td>5.50</td>
</tr>
<tr>
<td>6AQ5A</td>
<td>4.90</td>
</tr>
</tbody>
</table>

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TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for the additional ads (a photocopy of this form works well). Choose a category from the list below and write that category number into the space at the top of the order form. If you do not specify a category, we will place your ad under Miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO
The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES
Our classified ad rate is $1.25 per word. Minimum charge is $18.75 per ad per insertion (15 words). Any words that you want set in bold or caps are 20¢ each extra. Bold caps are 40¢ each extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

CONTENT
All classified advertising in the Electronic Shopper is limited to electronics items only. All ads are subject to the publisher’s approval. We reserve the right to reject or edit all ads.

DEADLINES
Ads received by our closing date will run in the next issue. For example, ads received by April 1 will appear in the July, 1993 issue that is on sale in June 3. Shopper ads will appear Jan., Mar., May etc. No cancellations permitted after the closing date. No copy changes can be made after we have typeset the ad. NO REFUNDS, advertising credit only. No phone orders.

AD RATES: $1.25 per word, Minimum $18.75.

Send your ads with payment to:
Electronic SHOPPER, 500-B Bi-County Blvd. Farmingdale, NY 11735

CATEGORIES

<table>
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<td>270 — Computer Equipment Wanted</td>
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<tr>
<td>130 — Audio-Video-Lasers</td>
<td>300 — Computer Hardware</td>
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<td>690 — Music &amp; Accessories</td>
<td>710 — Test Equipment</td>
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<td>720 — Test Equipment</td>
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CLASSIFIED AD COPY ORDER FORM

Ad No. 1—Place this ad in Category # __________

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[ ] Check [ ] MasterCharge [ ] Visa ($18.75 minimum credit card order)

Name ____________________________
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City State Zip ______________________

Electronic Now, July 1993

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**Liquid Crystal Displays**

<table>
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<tr>
<td>40 x 4</td>
<td>$25.00</td>
</tr>
</tbody>
</table>

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

**5"COLOR MONITOR $79.00**

Flat Face Panel: 640 x 200 Dot Resolution • CGA & Hercules Compatible • 13 VCD Operation • 1575 KHz Horizontal, 60 Hz Vertical, 80 Hz Sync • Open Frame Construction • Excellent Image Quality & Contrast • Built-in Cable • Price includes 5 V power supply or upper part of the unit.

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**ADAPTEC 4070A (RLL) or 4000A (MFM)**

SCSI Controller, your choice $60.00

**FLOPPY DRIVES**

5.25" bracket for 720K or 1.44Mb drives $7 extra

**Proton ProNet-4 Model P1347**

Token Ring Board $79.00

16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • interoperable with IBM Token Ring network

**OVER 6 YEARS AND 22,000 CUSTOMERS LATER, WE'RE STILL GROWING! THANK YOU!!!**

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480 Dot x 128 Dot, (80 x 16 line) 15.6" each, or 2 for 20.00 Driver board available: $75.00

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**Portable Micro Terminal**

• Flip up LCD display (9-16 VDC) Can communicate with any computer having RS-232 port • Can communicate with another Microterminal • Use itself as electronic notebook • Onboard microprocessor, data RAM (32K) and Video RAM (64K) • Complex built in diagnostics and setup capabilities. Original intention for POS applications, display size 40 x 40 (256 x 128 pixels.) Dim. 6.3" 11, 2.0". (With LCD up height is 7.1")

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Includes: • 20 character dot matrix display with full alpha-numeric capability • keyboard with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-fan speaker

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Horizontal or vertical mounting. As seen in supermarket checkout counters.

**LASER DIODE: Sharp part#: LT022MC**

5mW at 780 nm, single transverse mode $10.00

**MagnaVox EGA Color Monitor $150.00**

9 dot pitch. Model: 9SCM53. EGA card available.

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9" Green BNC composite 115V/230V $109.00

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**GRAPHIC & ALPHANUMERIC LIQUID CRYSTAL DISPLAY**

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1728 element CCD $15.00

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7.2 V WATT SWITCHING $10.00 or 2 @ $20.00, (2) 6 power connection inputs • 115/230 Volt, Dim: 8.5 x 4.5 x 2.5 in. $8.00 each • 24 V $12.00 each • 48 V $14.00 each

**HENe Laser Tube**

10 mW max. output TEMMO, 15.5" long, MFG:NEC $99.00

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(for HENe tube) $100.00

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9 inch (Amber)....... $29.95

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**Laser diode with collimator**

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**101 KEY XT KEYBOARD**

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**IBM 370 OPTICAL AND AT EMULATION BOARDS**

$50.00

**FIBER OPTIC PROJECT**

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**HP BAR CODE WAND (HBCS300)**

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**IBM 370 OPTICAL XT AND AT EMULATION BOARDS**

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**9" AMBER NON ENCLOSED COMPOSITE MONITOR**

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- PB114C - 1.583" x 3.875" x 2.938" $2.75
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ECONOMICAL SURGE PROTECTOR
Six-outlet power strip, circuit breaker protected.

(92T041) $7.95 each

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Electret condenser type. This versatile microphone may be wired for Handy Talkie, telephone, base station, audio, CB radio, motorcycle intercom, etc. A transistor radio type earphone may be installed in either or both muffs. The microphone unit can be easily removed and installed on another helmet or helmet. (92A001) $4.95 each

- MINIATURE SPEAKER - This 1" speaker is an ideal companion for installation in our Boom Mike featured above. (93A000) $4.95 each

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8.75" x 10". (93C008)

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Two for $49.95

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Size 6.25" x 7.125", approx. 1300 gold pins at .035" spacing. 500 pieces of new stock. (92W001)

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CIRCUIT WORKS CONDUCTIVE PEN
Makes instant silver conductive traces on most surfaces. Drives in minutes at room temperature. Valved pen tip for easy application. Solderable at low temperatures. Use with conductive electronic traces are needed. (92W307)

$8.49 each

EVEREX 14" FLAT SCREEN TST AMBER MONITOR
Reconditioned. Slight screen burn. (93C009)

$24.95 each

360K 5.25" FLOPPY DRIVES
Used. (93C005)

$17.95 each

Dow Corning 340 Silicone HEAT SINK COMPOUND
5-oz. tube. (92U004)

$2.99

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High quality, thermally protected, 115VAC, 60 Hz, 88W, 6.875" x 6.875" x 4.25". Rotron model #T33A2. (93F001) $12.95

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12 VDC @ 0.4A. 2.575" x 2.575" x 11". (93F002)

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SUPER STRANGE MEASUREMENT THING
Contains the following: Peltier Effect Device with Sixteen Junctions. Overall 0.6" x 0.75" x 0.2"; Cu/Con Thermocouple; Ultra-Fast Thermistor; and Optical Measurement Chamber. New, removed from equipment. (92W106) Only $49.95

ROBOT KITTY
This fan feline with an internal microprocessor control system is a marvel of state of the art technology. Featuring DUAL DC DRIVE MOTORS with GEAR REDUCTION and two-inch diameter RUBBER TREAD DRIVE WHEELS that provide excellent mobility and traction. Special integrated sound analysis and recognition circuitry allow you to command your Robot Kitty with simple hand claps. When your Robot Kitty hears your commands, it moves, moves and paws, and its eyes light up! If you ignore it, it will "go to sleep" and awaken at your command. Original retail price over $100.00. (92T020) $29.95

RESISTOR RIOT
1/8, 1/4, 1/2, 1/3 Watt, precision, fixed, adjustable, etc. Thousands of pieces. (92F004)

5 lbs. for $4.95

DB25 TO MODULAR ADAPTOR
4-6- or 8-pin modular plug will fit this jack. Specify male or female. Quantity pricing available. (93E004) 79¢ each

INDUCTORS GRAB BAG
100 popular value chokes. Fixed and adjustable. (92P004) $4.95

CAPACITORS
All new types, tanta, discos, computer grades. All kinds of caps. A good variety. (92P008)

5 lbs. for $5.00

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Also Visit:
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Reno, NV 89431
(702) 355-8822

www.americanradiohistory.com
A base can be formed from steel channel if it is thick enough to be rigid, or it can be constructed as a channel from ¼-inch or thicker glass fiber or other suitable rigid plastic laminate. Wood is not recommended as a base construction material. All bases must be one inch high if a case with the same height dimensions as the prototype is used.

Carefully drill two holes in the base with the proper spacing to accommodate the two 3-millimeter screws for cantilever mounting the load cell. Use the template, Fig. 7, for reference. The front set of drilled holes in the load cell will be directly under the center line of the ½ X ¾-inch cutout in the aluminum cover plate.

Position the load cell as shown in Fig. 6 above the holes previously drilled in the base. Find two flat washers with inside diameters of at least ½-inch that are approximately 0.040-inch thick, and locate them over the holes in the base to act as shims. Fasten the load cell to the base with two 3-millimeter screws from the underside of the base. The flat washers permit a clearance space of about 0.080-inch under the cantilevered load end of the load cell.

The base plate with load cell can then be fastened to the bottom of the case. It can be seen that any weight impressed upon the load end of the cell will cause it to deflect. This action generates the electrical output signal that is amplified and converted to provide the digital readout.

**Electrical interconnection**

With the cutting and drilling complete and the load cell mounted on its base, which is secured to the bottom of the case, the off-board interconnection wiring should be completed next. Use standard stranded 24 to 28 AWG insulated hookup wire to make all connections. Different colored insulation will simplify the wiring task and make any troubleshooting and signal tracing easier.

Cut all wires to lengths that will leave enough slack to permit the circuit boards to be stacked as shown in Fig. 8, but not long enough to interfere with cover closure. Strip the insulation back about ⅛ inch from both ends of each insulated hookup wire.

Refer back to Figs. 2, 4, 5, and 8 and complete all of the wiring between the main circuit board and the display board. Then complete all off-board wiring as shown in Figs. 4 and 6, again making sure that the wire lengths are long enough to permit opening the cover, yet not long enough to interfere with cover closure. When the wiring is complete, bundle related groups of wires with thin cable ties or bind them with cord to relieve stress on individual wires and improve the appearance of the wiring.

Sufficient space was allowed in the prototype between the side of the load cell base and the wall of the case to permit the two 9-volt batteries to fit snugly in position without clips or clamps. Terminate the red and black wires by soldering snap-on caps for the appropriate battery terminals. Also make up a jumper from insulated hookup wire with caps soldered on each end for the series connection as shown in Figs. 2 and 6.

As the last step, connect the four color-coded leads from the load cell's shielded cable as shown in Figs. 2, 4, and 6, observing the color coding shown. Twist a short length of the braided shielding at the end of the load-cell cable to form a solid wire, and tin it with solder. With a hand drill, form a hole about 0.060-inch in diameter in the copper foil border of the main circuit board, which acts as a ground bus. Push the twisted and tinned braid end through
that hole and solder it to the copper ground bus.

Final assembly
Position the circuit boards as shown in Fig. 8, and with the appropriate spacers and screws, fasten them to the cover plate. The spacers between the panel and display board must be cut precisely so that the LCD module is flush with the underside of the cover but not under stress. The spacers between the display and main boards should be approximately 1/8-inch long.

The 3/8 x 5/8-inch cutout cut into the cover allows the scale platform to be mounted to the load cell with screws and a pair of spacers when the scale is completely assembled. The length of the spacers will depend on the desired distance between the top of the mounted load cell and the underside of the scale platform, but they should be kept less than 3/4-inch long. (The spacers in the prototype are 1/2-inch long.)

Assemble the cover panel with attached circuit boards to the case, and fasten it with screws at four corners. Then assemble the platform with the two 3-millimeter screws and spacers. After satisfying yourself that the mechanical phase is complete, remove the platform and cover, and proceed with the electrical tests.

Electrical tests
A digital or analog voltmeter with an input resistance of at least 1 megohm will be needed for the electrical test of the digital scale. A filtered, regulated DC power supply able to provide +15 volts DC to power the circuit under test will also be needed. An oscilloscope will be useful if the circuit does not function correctly when the power is switched on.

Limit the current from the external power supply to about 40 milliamperes after connecting the supply with the proper polarity. (The scale will normally draw about 30 milliamperes.)

Set potentiometers R4, R11, and R19 to their midpositions. Switch S2 to OUNCES. Apply power to the circuit and measure the output of voltage regulator IC1 between the 10-volt bus and circuit ground. The voltmeter reading should be between +9.5 and +10.5 volts.

If you do not obtain voltage in that range, do not proceed until the circuit fault is found and corrected. The most likely causes of improper voltage are: 1. incorrect input voltage polarity, 2. a short circuit in the wiring, or 3. a polarized component incorrectly located on the circuit board.

Recheck to be sure the DIP-packaged IC's: IC1, IC2, IC3, and IC4 are properly oriented as is the polarity mark on electrolytic capacitor C1. Measure the voltage and its polarity at the input of IC1 to be sure that it is at least +12 volts DC. Recheck the wiring of the main circuit board for any possible shorts or cold solder joints. Check the wiring to switches S1 and S2-a.

After you have verified that voltage regulator IC1 is delivering the proper voltage, proceed with the test. Display DISP1 should show a number, positive or negative. If it is blank, there will probably be a fault with IC4 or DISP1.

Check the orientation of DISP1, IC4 and all of its associated components. Check pin 21 of IC4 with an oscilloscope for the presence of the 100-Hertz backplane squarewave signal. If no waveform is present and no fault can be found in the wiring, replace IC4.

Rotate the knob of the zero-adjust panel-control potentiometer R11 over its range while observing the display. If the circuit is wired correctly, negative numbers should appear on the display when the control knob is set at its maximum counterclockwise position, and the negative sign should drop out as the knob is turned clockwise to its maximum position.

If the potentiometer is wired incorrectly and the knob does not cause the changes previously described, correct this fault by interchanging the two outer wires from the lugs of control potentiometer R11. If the display reading cannot be adjusted through zero because of the effect of the weight of the platform, reduce the value of either resistor R10 or R12 by at least 10% in increments until the operating range of the control is centered.

If the segments or complete digits of the display are not correctly formed, there is either a wiring error between IC4 and DISP1, or there is a short or open circuit in one of the conductors on either of the circuit boards. Identify the incorrectly formed digits and, by referring to Fig. 2, find the faulty connections.

When you are satisfied that the display readings are correct as the knob of zero-adjust potentiometer R11 is rotated over its range, the scale can be calibrated. Reassemble the cover and platform, and make these adjustments with the platform attached to the load cell because its weight must be nullled out by zero-adjust potentiometer R11.

Calibrate the circuit first in the OUNCES mode because the grams calibration depends on the final setting of potentiometer... continued on page 87
Let your fingers do the tapping with the ThumbDrum.

JOHN SIMONTON and KENT CLARK

Last month we went over the theory on how the ThumbDrum operates. Now let's build it and get it working.

Getting it together

Step 1 is to decide what you're going to build. You must build the sensor board and either the MIDI computer or the analog tone board. Remember that MIDI does not produce sound, so if you build that version you will need a MIDI keyboard, sound module, or MPC (Multimedia PC) to produce the actual sounds. If you're after a system that generates those funky drum sounds, you'll need the sensor board and the tone board.

When assembling any circuit board, remember that polarized components such as electrolytic capacitors, diodes, and IC's must be installed with the proper polarity. Do not use a solder gun; when you release the trigger, the powerful magnetic fields it generates can damage some IC's.

Although the circuits can be assembled with wire-wrap or other common prototyping techniques, printed circuit boards provide the best results. Foil patterns were provided last month, and ready-to-use boards are available from the source mentioned in the Parts List. If you don't use PC boards, make wire runs as short as possible on perforated board.

Since the sensor board is common to all configurations, it makes a good starting point for assembly. The sensor-board circuitry is built on a single-sided circuit board, and its parts-placement diagram is shown in Fig. 4. Even though it is a single-sided board, the piezoelectric discs (PZ1-PZ8), their associated trimmer resistors (R1, R2, R5 R8, R11, R17, R20, and R23), and the power/overload indicator LED1 mount on the solder side of the board—which ends up facing the top side of the ThumbDrum so that these parts will be able to peek out through holes in the top of the case. (Note that all of the parts that mount on the solder side of the board are shown with dashed outlines.)

It's best to start the sensor board assembly by installing the parts on the component side of the board. When inserting voltage-regulator IC1, press it down against the board because there won't be room for it to stand up when the computer or tone board is in place.
mechanical isolation, the striking force on the sensor can be transmitted through the board to other sensors, resulting in a mechanical "cross-talk" that might cause unintended drums to sound. Keeping cross-talk to a minimum effectively increases dynamic range.

Tin the three mounting pads for each piezo disc and the corresponding points on the circumference of each disc with small solder bumps. (The silver face of each sensor points away from the PC board.) Mount the discs by remelting the solder (see Fig. 5). Be aware that the brass disc of the sensor will quickly soak up heat. A typical 25-watt soldering iron must be held in place for some time before the disc accepts solder. That's permitted, because the discs are not temperature sensitive—but your fingers are, so let them cool a little bit before touching them. Temporarily space the disc off the board with shims made of narrow strips of thin cardboard (about 5 business cards worth) while re-melting the solder connections. Pull the shims out when the solder has cooled.

Make the connection between the active face of the sensor and the circuit board with the smallest diameter wire you can find: 30-gauge wire-wrap wire is ideal. Solder one end of the wire to the indicated pad on the board and the other end directly to the silver face of the sensor. Pre-tin the wire before soldering, and do it quickly. Soldering to the brass disc takes lots of heat, but the thinly deposited tin-lead coating in the center of the disc doesn't require much heat at all. If you blow it the first time and wind up with a small hole in the silver and the wire not attached, just solder to another place. A small hole won't effect the operation of the sensor much. After the jumper wire is in place, a round foam-rubber cushion should be mounted on each piezo disc as shown in Fig. 6. The cushions are included in the ThumbDrum kit, but you can make them by cutting out circles from an old computer peripheral mouse pad.

The piezoelectric discs that mount on the solder side of the board must be raised off the board slightly. That not only prevents the brass disc from shorting out traces underneath, it also provides a suspension mount for the disc that mechanically isolates it from the circuit board. Without that
Solder the trimmer resistors and LED1 to the solder side of the board. The pads for those components are made larger than normal to make soldering easier, and to give more mechanical strength where the pads adhere to the board. Allow about ¼-inch of space between the bottom of the LED's base and the circuit board.

In the prototype, a four-inch long, 14-conductor ribbon cable terminated in DIP headers makes the connections between the sensor board and computer or tone boards. The sensor end of the cable can be soldered directly into the DIP pattern at J1. Make sure that the pin-1 conductor of the ribbon cable (usually marked with a color stripe) corresponds to pin 1 of J1.

When you've finished assembling the sensor board, do the following tests: Temporarily apply +12-volts to the circuit board pads “A” (+) and “G” (−), and make sure that LED1 lights. Turn all of the sensitivity trimmers fully clockwise and tap each pad— you should see the LED brighten very briefly with each tap. If you use a voltmeter, set it to its 10-volt DC scale across the outputs of the individual sensors (pins 1-8 of J1). You should see no voltage until you hit the pad, and then you'll see an upscale swing. If you turn off the power to the sensor board, and put the assembly aside while you build either the MIDI computer or the tone board.

**MIDI computer**

The MIDI computer is built on a double-sided board as shown in Fig. 7. One component, DIP switch S1, mounts on the solder side of the board, so that it will be accessible through an opening in the bottom of the case. The author is not a big fan of IC sockets, because the only re-
liable ones seem to be more expensive than the components that go in them. But microprocessor ROM chips are an exception and using sockets for IC3 and IC4 is recommended.

There are locations for some components on the circuit board that are not used in this application. Those components were marked with an asterisk (*) in Fig. 2 last month. The board is designed so that PCB-mount DIN jacks can be used for the MIDI jacks, but in the ThumbDrum panel-mount jacks with leads going back to the circuit board are used. The REMAP button, S2, is also mounted off-the-board. One side connects to the circuitboard pad "B" and the other side connects to any convenient ground trace.

A 14-pin DIP socket is used for J5, which is the connector for the sensor board. When you install crystal XTAL1, position it on its side. Once all the parts are mounted and you've inspected your work carefully for solder bridges and bad joints, it's time to test the system.

Set DIP switch S1 as shown in Fig. 8. Plug the ribbon cable from the sensor board into J5 on the MIDI board, and make sure that the pin 1 positions on each side correspond. Turn on power to the sensor board and make sure the power LED lights. Tapping the percussion pads should cause the Send/Active LED to blink.

If the LED doesn't blink, check for solder bridges and misplaced parts. Check the voltage at the supply pins of the IC's (not at the socket).

For the final test, connect a MIDI cable from the Computer Board's J2 (MIDI OUT) to the MIDI input of your favorite keyboard, sound module, or MPC, and set this receiving device for MIDI Channel 1. As you strike percussion pads, you should hear sounds from the audio output of the receiving device. The specific sounds are largely immaterial at this point; you'll learn to select them as you use the ThumbDrum. Now install the electronics in the case, close the cover, and celebrate. The two boards are joined together and secured to the bottom of the case with standoffs and hardware (see photos).

FIG. 8—FOR TESTING, set DIP-switch S1 as shown here. The four least significant switches (1-4) set the MIDI channel, switches 5-7 select one of eight "maps" assigning different drum sounds to different pads, and the Log/Linear switch (8) selects a logarithmic or linear response.

FIG. 9—THE MIDI JACKS allow keyboard/controllers to be daisy-chained into sound modules as shown here.

**MIDI SOUND MODULE**

**MIDI KEYBOARD/CONTROLLER**

**MIDI THUMBDRUM**

**AMPLIFIER**

**SOLDER SIDE OF MIDI BOARD**

**FIG. 8**

**FIG. 9**

**TONE BOARD PARTS LIST**

**All resistors are 1/4-watt, 10%.**

- R1—1000 ohms
- R2, R5, R9, R16, R23, R31—10,000 ohms
- R3, R4, R10, R11, R13, R17, R18, R24, R25, R32, R33, R39, R47, R6, R20, R27, R35—3.9 megohms
- R7, R14, R21, R28, R36, R51—100,000 ohms, trimmer potentiometers
- R8, R15, R45, R60—33,000 ohms
- R9—15,000 ohms
- R19—68,000 ohms
- R22, R30—33,000 ohms
- R26, R29, R44—1 megohm
- R34—39,000 ohms
- R37, R43—680,000 ohms
- R38—2200 ohms
- R40—R42, R46, R48, R50—2.2 megohms
- R49, R52—R57—47,000 ohms
- R58, R59—22,000 ohms
- R61—10,000 ohms, potentiometer

**Capacitors**

- C1, C13, C18, C26, C9—0.01 µF, ceramic disc
- C2, C6, C10, C14, C19, C22—0.01 µF, Mylar
- C5—0.05 µF, Ceramic
- C7, C8—4700 pF, Mylar
- C3, C4, C11, C12, C15, C16, C20—0.001 µF, Mylar
- C17—0.22 µF, Mylar
- C23, C24, C27—C29—560 pF, Mylar
- C25—0.1 µF, Mylar
- C30—0.005 µF, Ceramic
- C31—10 µF, 15 volts, electrolytic

**Semiconductors**

- IC1, IC2—LM324 quad op-amp
- IC3—5532 dual low-noise op-amp
- D1—D5—1N914 diode
- Q1—PNP silicon transistor (selected for noise, see text)

**Other components**

- J1—14-pin input connector
- J2—16-pin DIP Socket
- J3—1/4-inch phone jack

**Miscellaneous:** PC board, ribbon cable, solder

---

[Diagram showing the connection of MIDI channels and modules]

[Table of parts list with resistors, capacitors, semiconductors, and other components]
Using the MIDI ThumbDrum

Setting the sensitivity trimmers is very important. Trigger pulses greater than 5 volts produce unpredictable results that will probably sound like all the drums going at once. Remember, the power LED on the sensor board provides an indication of an overload condition. If the power LED glows brighter, briefly, when a sensor is struck, it's an indication that the sensitivity is set too high.

A common way to use the ThumbDrum is in the configuration that we used to test it: simply plug it's MIDI Out into the MIDI In of a keyboard or sound module. The receiving device must be set to receive MIDI on the channel that the ThumbDrum is using for sending (from 1 to 16) as set by the four least significant switches of S1. (The DIP switches should be set to the MIDI channel number minus 1, in binary—channel 1 is 0000, channel 2 is 0001, channel 3 is 0010, and so on.)

The Log/Linear DIP switch number 8 (see Fig. 8) selects a logarithmic or linear response. If there seems to be a lack of dynamic range (the sounds are not soft enough) try turning that switch off to select a logarithmic response.

DIP Switches 5–7 select one of eight "maps" assigning different drum sounds (actually MIDI notes) to different pads. There are a few instrument-specific maps and general MIDI maps of different drum kits. There's a "Latin Kit" with claves and maracas and a "Rock Kit" with symbols and snares. They're too lengthy to include here, but they're part of the self-extracting ZIP file called EN-DRUM.EXE on the Electronics Now BBS (516-293-2283, 1200/2400, 8N1). The maps are provided with special thanks to Charles Fischer who configured them.

You're not stuck with just those eight drum maps: the ThumbDrum allows for remapping. Remapping requires that a keyboard—or some other source of MIDI note data—be plugged into the MIDI In jack. To change the MIDI note assigned to a pad, push the remap button and play a note on the keyboard. Release the remap button, and within five seconds hit the pad to which you want to assign the note. If you decide you don't want to make a change after hitting the remap button, just release it and wait five seconds.

If you haven't installed any RAM on the MIDI computer board you will be able to change only map number 8, and the change will be lost when power is turned off. If you installed a 6116 RAM chip as IC11, you can change all maps but the data is volatile. If you've installed an MK48Z02 (a battery backed-up RAM), all maps can be altered and changes will not be lost when power is turned off.

The ThumbDrum's MIDI In jack provides a "merging" function that allows data appearing there to be combined with information from the sensors to form the final MIDI output. That allows keyboard/controllers...
**MIDI COMPUTER PARTS LIST**

All resistors are 1/4-watt, 10%.

- R1—4700 ohms
- R2, R3, R6, R9—220 ohms
- R4, R13—680 ohms
- R5, R8—3300 ohms
- R7, R10, R11—100,000 ohms
- R12—3900 ohms

**Capacitors**

- C1, C2—33 pF, ceramic disc
- C3—10 µF, electrolytic
- C4—C11—0.1 µF, Mylar
- C12—1 µF, electrolytic
- C13—100 pF, ceramic disc
- C14—100 µF, electrolytic
- C15—C19—0.01 µF, ceramic disc

**Semiconductors**

- IC1—7805 5-volt regulator
- IC2—74HC373 octal latch
- IC3—8031 8-bit microcontroller
- IC4—2764 EPROM
- IC5—6116 static RAM
- IC6—74HC04 hex inverter
- IC7, IC9—TIL111 optoisolator
- IC8—74HC138 1-of-8 decoder
- IC10—74HC02 quad NAND gate
- IC11—AD5809 8-input ADC

**Miscellaneous**

- D1—not used
- D2, D3—1N914 diode
- LED1, LED2—red light-emitting diode

**Note:** The following items are available from PAIA Electronics, Inc., 3200 Teakwood Lane, Edmond, OK 73013, Phone (405) 340-6300, Fax (405) 430-6378:

- Sensor PC board only (item # 9301pc) $16.50
- MIDI PC board only (item # 9201pc) $27.25
- Tone PC board only (item # 9302pc) $19.25
- Sensor board kit (item # 9301k, includes PC board and parts) $54.25
- MIDI computer kit (item # 9201k, includes PC board, DIN jacks, and PROM with firmware) $69.50
- Tone board kit (item # 9302k, includes PC board and parts) $34.75
- Complete MIDI ThumbDrum kit (item # 9300m, includes case, PC board, all parts, and firmware in PROM) $165.00
- Complete audio ThumbDrum kit (item # 9300a, includes case, PC board, and all parts) $99.00
- Case only (item # 9300c, includes wood side panels) $28.50

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**THE SENSOR BOARD AND EITHER THE MIDI OR TONE BOARD are held together and mounted to the case with screws and spacers.**

(which, like the ThumbDrum, has no sound-producing capabilities) to be daisy chained into sound modules as shown in Fig. 9.

**Tone Board**

The tone PC board, shown in Fig. 10 has, in addition to the normal component-mounting holes, a 1/8-inch hole drilled under each trimmer so the trimmer can be adjusted from the bottom of the board (and from the bottom of the case when the unit is finished).

All of the components for the Tone Board mount on the component side of the board. Sockets can be used for the IC's if you wish, as there is sufficient room for them. Use a 14-pin DIP socket for J1.

The DIP pattern marked J2 on the tone board is a jumper area where pads from the sensor board are connected to drum sounds. A DIP header can semi-permanently provide this mapping. A 16-pin socket is recommended here.

After you have assembled the board and have checked your work, plug the sensor board's ribbon cable into the socket at J1 on the tone board. Make sure pin 1 of the cable corresponds to pin 1 of the socket. Turn on the power and make sure the power LED lights.

The first test of the tone board is simply listening to it. So either connect the audio output to an amplifier or plug in a pair of headphones. Begin by setting all trimmers on the tone board fully counterclockwise. You should not hear any output from the tone board. As you slowly adjust the trimmers, you should hear a tone that begins to swell and then stay constant. When you hear the tone, back off on the trimmer and go on to the next one.

When you have confirmed that all the oscillator circuits work, jumper drum-sound circuits to finger pads one at a time at J2. (An eight-position DIP switch temporarily inserted in socket J2 makes it easy to test pads and oscillators one at a time.) Hit a pad and adjust the trimmer of the drum circuit connected to that pad. As you strike the pad while adjusting the trimmer, you'll first hear a dull pop, then a more of a drumlike tone, and finally sustained oscillation. Back the trimmer off from the sustained oscillation until you have a sound that most closely resembles a specific drum.

Setting the sensitivity trimmers on the sensor board is not as critical with the tone board as it is with the MIDI Board. Trimmers for pads driving the snare drum should always be fully clockwise.
Build this versatile printer power controller.

PRINTER-MINDER

DO YOU DEBATE WHETHER TO TURN your printer on and off—or do you simply leave it on all the time? Perhaps you’ve got a remote data-logging or control application in which the printer need be on only occasionally.

Either way, Printer Minder can help. Printer Minder is an inexpensive printer controller that applies power to a printer whenever it receives a print request, and subsequently removes power following a one-hour delay after the printer has accepted the last character.

You can build Printer Minder from a kit for about $150. In case you wish to roll your own, we publish complete PC board patterns; in addition, bare boards are available separately.

Overview

You install Printer Minder between your computer and your printer, as shown in Fig. 1. When you first apply power to Printer Minder, it will prevent power from being applied to the printer. The reason is to protect the printer in the case of brownouts or power failures. Printer power remains off until the host CPU actually starts sending data. While in the power-off state, Printer Minder takes the signals the computer needs to make it think that the printer is on and ready. That allows the computer to begin sending data without thinking there is a printer error. As soon as Printer Minder receives a character, it asserts a control signal to make the computer wait until Printer Minder gets through its power-up sequence.

When the printer does become ready, Printer Minder presents data to it, along with the necessary control signals. After the printer acknowledges the first character, Printer Minder drops out of the loop, and data simply flows through directly to the printer.

A retriggerable one-shot keeps power on to the printer for about one hour after the last character has been received. After the time limit expires, power turns off automatically. To help protect the printer from power-line transients, Printer Minder also includes several metal-oxide varistors (MOV’s).

How it works

Printer Minder consists of two main sections: AC Power Control and Logic Circuit. We describe each in turn.

Referring to Fig. 2, Printer Minder uses a relay (RY1) to control the power to the printer. Transistor Q1 drives the relay to handle the necessary current. The relay is a normally-open type; it is on only when IC8-a (the retriggerable one-shot) is active. The time constant of the one-shot is approximately one hour. What triggers the one-shot is a strobe signal from the computer, labelled "BUF STR" in Fig. 2. After an hour passes, IC8-a times out, which de-energizes the relay, which in turn disconnects power to the printer. To indicate power status, LED1 lights up.

The one-shot also has a clear input that is driven by a power-up signal (pup), which is generated by C3, R13, and IC10-b; its purpose is to ensure that IC8-a remains clear (hence the printer remains off) when power is first applied to Printer Minder.

FIG. 1—PRINTER MINDER controls the flow of data and AC power to your printer. After a one-hour time-out, Printer Minder turns the printer off; as soon as data starts flowing again, it turns the printer back on.
FIG. 2—RELAY RY1 controls AC power to the printer; it in turn is driven by Q1, which is driven by one-shot IC8-a.

FIG. 3—OCTAL LATCH IC1 buffers data between Printer Minder and your printer. The latch is enabled by IC4-b.

Other components include three MOV's (MOV1–MOV3) that protect Printer Minder—and, more important, the printer—from voltage transients.

The power supply provides a regulated +5-volts DC (Vcc) for the logic circuit, and unregulated +12-volts DC (Vdd) to drive the relay and LED1.

**Logic circuit**

Let's discuss the simple case first; refer to Fig. 3. When printer power is on, Printer Minder simply routes the various control signals straight from the computer to the printer (for the strobe signal), and from the printer to the computer (for the ACK, BUSY, PAPER OUT, and SELECT signals). Octal latch IC1 buffers the data lines, and should be sufficient in most cases. Buffer IC9 is optional; its purpose is to provide extra "oomph" when driving long or noisy transmission lines. The data inputs and outputs are shorted together on the PC.
FIG. 4—MULTIPLEXER IC5 drives the printer’s control lines with either actual signals (B inputs) or Printer Minder’s simulated signals (A inputs) during power up.

board; if you want to use IC9, you must cut those traces. Printer Minder does not process the FAULT and PRIME signals at all.

When the printer is powered down, the control logic has to “fake” the appropriate control signals, making it appear to the computer that the printer is online and ready, even though it’s not.

Normally, when the printer is powered up and on-line, latch IC1 is “open,” thereby allowing data to flow through. However, its function is different when the printer is powered off. OR gate IC4-b allows two signals, POWER ON LOW and FIRST CHARACTER DELAY, to enable IC1. POWER ON LOW comes from the one-shot (Fig. 2); it remains on continuously after the initial character has been received. FIRST CHARACTER DELAY is asserted only after the printer has come on-line and released its busy line.

Figure 4 shows how Printer Minder buffers and processes the four printer-status signals (ACKNOWLEDGE, SELECT, BUSY, and PAPER OUT). All four are routed through multiplexer IC5, which selects between the “live” signals (B inputs) coming from the printer and the “fake” signals (A inputs) generated by
**PARTS LIST**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resistors</strong></td>
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</tr>
<tr>
<td>R1, R3-R7</td>
<td>10,000 ohms</td>
</tr>
<tr>
<td>R2</td>
<td>1500 ohms</td>
</tr>
<tr>
<td>R8-R12</td>
<td>470 ohms</td>
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<tr>
<td>R13</td>
<td>1 megohm</td>
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<tr>
<td>R14</td>
<td>100,000 ohms</td>
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<tr>
<td>R15, R18</td>
<td>1000 ohms</td>
</tr>
<tr>
<td>R16, R17</td>
<td>4700 ohms</td>
</tr>
<tr>
<td>R19-R26</td>
<td>1000 ohms, 10-pin SIP</td>
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<tr>
<td><strong>Capacitors</strong></td>
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<tr>
<td>C1</td>
<td>1000 µF, 16 volts, Mylar</td>
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<td>C2, C5-C13</td>
<td>0.1 µF</td>
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<tr>
<td>C4</td>
<td>330 µF, 25 volts, electrolytic</td>
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<tr>
<td><strong>Semiconductors</strong></td>
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</tr>
<tr>
<td>IC1</td>
<td>74LS373, octal three-state latch</td>
</tr>
<tr>
<td>IC2</td>
<td>74LS05, open-collector hex inverter</td>
</tr>
<tr>
<td>IC3</td>
<td>74LS00, quad two-input NAND gate</td>
</tr>
<tr>
<td>IC4</td>
<td>74LS32, quad two-input OR gate</td>
</tr>
<tr>
<td>IC5</td>
<td>74LS258, quad three-state 2-to-1 data selector</td>
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<td>IC6</td>
<td>74LS240, three-state octal buffer</td>
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<tr>
<td>IC7</td>
<td>LM7805, 5-volt regulator</td>
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<td>IC8</td>
<td>74HC123, dual retriggerable monostable multivibrator</td>
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<td>IC9</td>
<td>74LS244, three-state octal buffer (optional, see text)</td>
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<td>IC10</td>
<td>74LS14, hex inverter</td>
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<tr>
<td>D1-D3</td>
<td>1N4001 diode</td>
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<tr>
<td>LED1</td>
<td>standard red light-emitting diode</td>
</tr>
<tr>
<td>MOV1-MOV3</td>
<td>120-volt metal-oxide varistors</td>
</tr>
<tr>
<td><strong>Other components</strong></td>
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<tr>
<td>F1</td>
<td>10A, 125V, slow-blow fuse</td>
</tr>
<tr>
<td>RY1</td>
<td>SPST relay, 12 volts, 10 amp contacts</td>
</tr>
<tr>
<td>T1</td>
<td>Dual 8-volt winding power transformer (PSS2-16 or equiv.)</td>
</tr>
</tbody>
</table>

**Notes:**
- Component notes are included to ensure proper setup.
- The circuit is designed for a permanent print, so components must be durable and reliable.

---

**Assembly and testing**

This circuit is moderately complex, so we recommend the use of a PC board. Suitable patterns appear here; you can also purchase a commercially prepared board from the source listed in the Parts List.

Figure 5 shows how to stuff the board. Except for off-board AC power connector J4, all components mount on the component side of the board. Use sockets for the IC's and check all connections carefully, especially those around the AC power section. Use care when working on this project, as it contains an exposed source of 120 VAC! Because of the height restrictions of the enclosure, AC output cannot be PC-mounted, so we used a snap-in, panel-mount device with push-on connectors. Take care to properly connect the AC neutral line and safety ground to the printer's select output. The latch consists of two cross-coupled NAND gates, IC3-a and IC3-b, as shown back in Fig. 3.

---

**Returning to Fig. 4,** that portion of the circuit also handles the strobe signal that latches each byte of data into the printer. After buffering by IC6-a, strobe drives the oneshot (IC8-a, Fig. 2) that keeps Printer Minder awake for one hour following the last character received.
Learn how to multiply, divide, square, and get square roots of analog variables with an analog multiplier, and put that skill to work in your experiments and projects.

MONOLITHIC ANALOG MULTIPLIERS can multiply, divide, square, and extract the square root of analog inputs that represent various arithmetical values. Multiplier IC’s can accept one or two inputs, and calculate analog outputs with few external components. These analog “math blocks” play important roles in data acquisition, automatic control, and instrumentation circuits. It’s all a matter of how the input signals are connected to the multiplier.

Most popular IC multipliers perform what is called variable-transconductance multiplication in which the emitter currents of matched pairs of bipolar transistors are controlled. The calculations are represented by variations in gain. The results are then linearized and converted from differential to single-ended values.

Along about now you are probably saying to yourself: Who needs analog multipliers when there are so many low-cost digital computation techniques? The answer is that analog multipliers are appropriate where the factors needed for arithmetical calculations are analog signals representing “real-world” variables such as voltage, frequency, temperature, pressure, or flow rate.

The analog multiplier can perform the arithmetical calculations at or near the sensors or transducers that produced the variables. Moreover, the result will reflect instantaneous changes in the variables. If it is necessary to transmit the arithmetical solution to a remote computer, data logger, or display, only one channel will be needed, not the two or three that would be required if all variables were transmitted separately. Today that single analog result can easily and economically be converted to a binary code for more reliable transmission over long distances.

Analog multipliers are components in voltage-controlled amplifiers and video mixers. They are also found in radar receivers where they process radar returns, and they are in sonar receivers where they are located in automatic gain control circuits.

Specific applications for “math blocks” are:

- An analog multiplier can modulate or demodulate signals, make remote gain adjustments, measure power, or assist in curve fitting and linearizing.
- An analog divider can compute ratios of efficiency, attenuation, or gain, and then measure those ratios. It can also make remote gain adjustments.
- An analog squarer can double frequencies or measure the power of constant loads.
- An analog square rooter can compute vectors, root-mean squares (RMS), or linearize a flowmeter.

Don’t be surprised if these “math blocks” are unfamiliar to you. Most readers of this magazine have studied such basic analog circuits as the operational amplifier and the linear circuits like active filters that include op-amps. But it’s safe to assume that most have not studied analog “math blocks” unless they work in the analog instrumentation field.

Introductory electronics texts usually don’t mention analog multipliers although they do describe the voltage multiplier, a different kind of circuit entirely. Moreover, most electronic engineering handbooks limit their coverage of analog multipliers to a paragraph or so. It turns out that IC manufacturers’ data books and applications sheets and analog circuit design textbooks remain the best sources of information on those analog products.

Analog multipliers, like op-amps, had their origins back in the days when analog computation was the only game in town. Multipliers have evolved from discrete-component modules to
hybrids since the 1960's—and they are now available as monolithic IC's with differing levels of complexity and on-chip support circuitry.

Figure 1 is a simplified block diagram of a single-ended multiplier that includes a gain-conditioning op-amp. The block, labeled "M," represents the multiplier "core," and the triangle represents the op-amp. The input signals are labeled X and Y. The circuit represented by this diagram can multiply, divide, square, or extract square roots if the proper external connections are made.

**FIG. 1—FUNCTIONAL BLOCK DIAGRAM of a typical multiplier/divider.**

**FIG. 2—DIAGRAM OF FOUR quadrants for multiplier shows how output polarity relates to input polarities.**

**Quadrants of operation**

It will be useful to review the concept of quadrants before discussing multiplier circuitry: single quadrant-, two-quadrant- and four-quadrant-operation. Refer to Fig. 2 and notice the differences in the polarity symbols at the dual inputs and single output of each of the four five-sided symbols that represent a multiplier. The four quadrants are defined by Cartesian coordinates—right out of your old trigonometry book.

It can be seen that:

- In Quadrant 1 both horizontal and vertical axes are positive, and that X and Y inputs to the multiplier are both positive, so its output is positive.
- In Quadrant 2 the horizontal axis is negative but the vertical axis is positive. The X input to the multiplier is negative and the Y input is positive, so its output is negative.
- In Quadrant 3, both the horizontal and vertical axes are negative. Because both X and Y multiplier inputs are negative, its output is positive.
- In Quadrant 4, the horizontal axis is positive but the vertical axis is negative. The X input to the multiplier is positive and the Y input is negative, so its output is going to be negative.

A one quadrant multiplier can handle either positive or negative inputs but not inputs that are either positive or negative. As a result, the output of a one-quadrant multiplier will always be positive.

Figure 3 is a functional block diagram of a four-quadrant multiplier connected for multiplication. The VZ terminal is connected to the VOUT terminal. The values of VX and VY can be either positive or negative. The transfer function for the multiplier is:

\[ V_{OUT} = \frac{(V_XV_Y)}{10V} \]

Where VX and VY are limited to ±10 volts.

If VX and VY = 10 volts, VOUT = 10 volts.

Figure 4 shows the same four-quadrant multiplier connected as a divider. The VX input is connected to the VOUT terminal. VX is limited to 0 to -10 volts, and VZ can be ±10 volts. For a numerator input VZ, a denominator input VX, and a constant of 10V, the equation for division with a multiplier is:

\[ V_{OUT} = \frac{10VZ}{V_X} \]

VOUT will be 10 volts or less for VZ equal to or less than VX. VX has a single polarity and will not provide a meaningful result if it is close to zero. If VX can be either positive or negative, the device is a two-quadrant divider, and the output will reflect the polarity of VX.

Figure 5 shows the four-quadrant multiplier connected as a squarer. VX and VY are tied together to form a new VX, which is limited to ±10 volts. The VZ terminal is again tied to VOUT. The equation for a squarer is:

\[ V_{OUT} = \frac{(V_X)^2}{10V} \]

A four-quadrant multiplier, used as a squarer, will have an output that is positive whether VX is positive or negative.

Figure 6 shows the four-quadrant multiplier organized as a square rooter. Terminals VX and VY are tied together and connected to anode of diode D1 at the VOUT terminal. The value
FIG. 7—FOUR-QUADRANT MONOLITHIC modulator is basically two two-quadrant transconductance multipliers.

Commercial multiplier IC's

Commercial IC multipliers are typically four-quadrant extensions of the basic two-quadrant concept. A simplified four-quadrant monolithic multiplier circuit is shown in Fig. 7. The circuit can be viewed as a pair of cross-connected differential pairs (Q1 and Q2 with Q3 and Q4) fed by controlled emitter current (from Q5 and Q6). Each half is single differential pair, the basis for the two-quadrant multiplier.

The operation of this transconductance analog multiplier IC will not be explained in detail here because of space limitations. You don't need to know exactly how the circuitry works to be squared (within a range of 0 to +10 volts) is connected to terminal \( V_Z \). If the constant is 10V, the equation for determining the square root is:

\[
V_{OUT} = -\sqrt{10VZ}
\]

\( V_{OUT} \) will be in the range of 0 to 10 volts.

A square rooter works in one quadrant: Figure 6 shows an external diode that prevents latchup if the input polarity changes, even momentarily.

FIG. 8—FUNCTIONAL BLOCK DIAGRAM of an Analog Devices AD532 showing its differential inputs. Note the single \( Z \) input and the \( V_{os} \) input.

You just want to make practical use multipliers. However, there are many excellent references available on the core circuitry of this multiplier, known as the Gilbert "gain cell." (as shown in Fig. 7) in manufacturers' applications notes and analog circuit design texts.

However, notice that the output signals at \( I_{O2} \) and \( I_{O1} \) are differentially multiplied currents. A differentcurrent to-voltage converter is required to convert the current back to a voltage.

Now, to move this discussion from theory to practice, consider the Analog Devices' AD532, a ready-to-use complete multiplier IC. It multiplies in four quadrants, divides in two quadrants, and square roots in one quadrant. In addition to these basic functions, its differential \( X \) and \( Y \) inputs provide a lot of operating flexibility for both algebraic computation and transducer output conditioning.

The functional block diagram of the AD532 is shown in Fig. 8, and the complete schematic diagram is shown in Fig. 9. The AD532 IC has 28 transistors, a big increase from the six transistors in the basic Gilbert "gain cell" shown in Fig. 7. The
AD532 has pretrimmed adjustments for scale factor and offset. The product of the two inputs is resolved in a "gain cell." In the multiplying and squaring modes, the Z terminal is connected to the output to close the feedback around the output op-amp. (In the divide mode, the terminal is used as an input terminal.)

The X and Y inputs are fed to high-impedance differential amplifiers with low distortion and good common-mode rejection. The input voltages are converted to current, and the currents are multiplied together and then divided by a reference. The output current, \( I_x \times I_y \), is converted to voltage by feedback around the output multiplier. The AD532 has a stated maximum multiplying error of ±1.0%, and offers a 10-volt output. It is powered by a ±15-volt power supply.

The built-in op-amp provides low output impedance and makes self-contained operation possible. The residual output voltage offset can be zeroed as \( V_{OS} \) in critical applications. (The \( V_{OS} \) terminal should be grounded when not used.)

Figure 10 is the pinout diagram for an AD532 packaged in a TO-116 14-pin DIP. However, it is also available in a hermetically-sealed TO-100 metal can and in a leadless chip-carrier package.

**Multiplier**

Figure 11 shows the AD532 multiplier organized as a multiplier. Its differential inputs change its transfer function from that given in Fig. 3 to:

\[
V_{OUT} = \left( \frac{V_x - V_y}{V_{Y1} - V_{X2}} \right) \times 10V
\]

The inputs can be fed differentially to the X and Y inputs, or single-ended by grounding the unused input. Connect the inputs according to the desired polarity in the output. The Z terminal is tied to the output to close the feedback loop. The offset adjust \( V_{OS} \) is optional, and it connecting the multiplier cell in the feedback loop of the op-amp and using the Z terminal as a signal input, as shown in Fig. 12. The transfer function when \( X1 \) is greater than \( X2 \) is:

\[
V_{OUT} = 10V \times \frac{V_x - V_y}{V_{Y1} - V_{X2}}
\]

To avoid positive feedback, Analog Devices recommends that the X input be restricted to negative values. Thus for single-ended negative inputs (0 volts to -10 volts), connect the input to X1 and the offset null to X2; for single-ended positive inputs (0 volts to +10 volts), connect the input to X2 and the offset null to X1.

**Squaring**

The squaring circuit of Fig. 13 is a variation of the multiplier circuit. The transfer function for squaring is:

\[
V_{OUT} = \left( V_x - V_y \right)^2 / 10V
\]

The differential input capability of the AD532 can be used, however, to obtain positive or negative output response to the input.

**Square rooting**

The connections for square rooting are shown in Fig. 14. Similar to the divide mode, the multiplier cell is connected in the feedback of the op-amp by connecting the output back to both the X and Y inputs. The diode D1 is connected as shown to prevent latchup as \( I_{in} \) approaches 0 volts. The square rooting transfer function is:

\[
V_{OUT} = -\sqrt{10V_z}
\]

Here the \( V_{OS} \) adjustment is made with \( Z = 0.1 \) volts DC, adjusting \( V_{OS} \) to obtain -1.0 volts DC in the output. \( V_{OUT} = -\sqrt{10V_z} \),

continued on page 90
Learn how inductive capacitive filters work.

RAY MARSTON

THE PRIMARY APPLICATION FOR RESONANT INDUCTIVE CAPACITIVE (LC) FILTERS THESE DAYS ARE IN HIGH-FREQUENCY CIRCUITS. THESE FILTERS, LIKE RESISTIVE CAPACITIVE (RC) FILTERS CAN EASILY BE DESIGNED TO PERFORM LOW-PASS, HIGH-PASS, BANDPASS, OR NOTCH FILTERING, BUT THEY HAVE THE ADDITIONAL BENEFIT OF OFFERING AT LEAST 12 DB PER OCTAVE OF ROLLOFF COMPARED TO THE 6 DB PER OCTAVE OF RC FILTERS, WHICH MEANS SHARPER CUTOFF CHARACTERISTICS AT ALL OPERATING FREQUENCIES.

The series- and the parallel-resonant LC filters are the two "watershed" LC designs from which all others are derived. Figure 1-a shows a circuit for a series-resonant filter, and Fig. 1-b shows its simplified equivalent circuit. The R represents the resistance of the coil.

Series-resonant filter

The fundamental response of the series filter is that capacitive reactance C decreases with increased frequency, while inductive reactance decreases. The inverse relationship also holds. The filter's input impedance is equal to the difference between these two reactances, plus the value of resistor R.

At some specific frequency, the reactances of C and L could be 10 kilohms and 1 kilohm, respectively. Therefore the filter's input impedance (ignoring the value of R) will be 9 kilohms at that frequency. Many other similar examples can be given.

The key point to be made here is that at resonant frequency, \( f_c \), the reactances of C and L will be equal (but 90° out of phase), and the filter input impedance will equal the value of R, as indicated by the dotted line at the bottom of the impedance vs. frequency characteristic curve Fig. 2-a. For example, if this occurs when the reactances of C and L are both 1000 ohms, and R equals 10 ohms, the input impedance would be 10 ohms, and the entire signal voltage would be generated across R.

The signal currents through effective resistance R flow through C and L, which both have reactances 100 times greater than the value of R in ohms. Consequently, the signal...
voltage generated across C and L is 100 times greater than the actual input signal voltage, as shown in Fig. 2-b, the curve of voltage vs. frequency. This voltage amplification, indicated by the sharp peak, is known as the circuit's Q.

Notice in Fig. 2-b that the inductive and capacitive voltages are 90° out of phase, and the voltage generated across the series LC combination is effectively zero. The impedance of the filter at \( f_c \) is known as the filter's characteristic impedance, \( Z_o \), and it equals \( \sqrt{LC} \).

Figure 3 shows two ways to make practical use of a series-resonant LC filter: In Fig. 3-a, 2.2 kilohm resistor \( R_x \) and the filter act together as a frequency-selective attenuator that gives high attenuation at the resonant frequency \( f_c \), and lower attenuation above or below that resonant frequency. (The filter is a notch rejector.)

In Fig. 3-b, the input signal is applied directly to the filter, and the output is taken across the inductor L. This filter circuit acts as a notch acceptor that provides high gain at resonant frequency \( f_c \) and low gain above or below that frequency.

Table 1 lists the principal formulas that can be applied to both series- and parallel-resonant LC circuits.

**ParalleI-resonant filters**

Figure 4-a shows the schematic for a parallel-resonant filter, and Fig. 4-b shows its equivalent circuit. The inductor's resistance is represented by \( R \). In this filter, capacitive reactance decreases with increasing frequency, and inductive reactance increases with increasing frequency. The reciprocal relationship also holds.

Each component draws a signal current that is proportional to its reactance, but the two currents are 90° out-of-phase, so the total signal current is equal to the difference between the \( L \) and \( C \) currents. At resonance, \( L \) and \( C \) are equal so the total current falls nearly to zero.

As a result, the filter acts as a near-infinite impedance. In practical filters, the presence of equivalent resistance \( R \) modifies the response by reducing the impedance at the resonant frequency \( f_c \), \( Z_c \), to \( Z_o \sqrt{R} \). For example, if \( Z_o \) equals 1 kilohm and \( R \) equals 10 ohms, the value of \( Z_c \) will be 100 kilohms.
come this drawback are illustrated in Fig. 5.

One way to obtain output coupling is to consider the primary winding of an RF transformer as the filter's inductive component, and to take the output from the transformer's secondary, as shown in Fig. 5-a. This approach provides a fully floating output. If the transformer has a 10:1 turns ratio, the output signal will have an attenuation factor $a$ of 10.

In a second method, the coil can be tapped as shown in Fig. 5-b, to obtain an output by autotransformer action. In the third method, as shown in Fig. 5-c, the required tuning capacitance is obtained from two series-connected capacitors. An output can be obtained across the larger capacitor by capacitive divider action.

In these schematics each circuit has arbitrarily been given an attenuation factor $a$ of 10. Each has an output impedance of $Z_o/a^2$. Thus, if $Z_o$ equals 100 kilohms and $a$ equals 10, the $Z$ output equals 1 kilohm.

**LC oscillators**

Figures 6 through 10 illustrate the different schemes for using a parallel-resonant filter as the tuning element in transistorized LC oscillators. The simplest of the LC oscillators is the tuned-collector feedback form shown in Fig. 6.

Transistor Q1 is connected as a common-emitter amplifier. L1 and C1 form the tuned collector filter, and L2 provides the collector-to-base feedback. Inductor L2 is inductively coupled to L1, providing transformer action. By adjusting the phase of this feedback signal, the circuit will give zero phase shift at the tuned frequency so that, if the loop gain (determined by T1's turns ratio) is greater than unity, the circuit oscillates. With the component values shown, oscillation frequency can be varied from 1 MHz to 2 MHz by trimmer capacitor C1.

Figure 7 is the schematic for a simple Hartley oscillator. The turns of collector load inductor L1 are tapped at a point 20% down from the top of the coil, and the circuit's positive power supply is connected to this tap point. As a result, L1 acts as an autotransformer so that the signal voltage appearing at the top of L1 is $180^\circ$ out of phase with the voltage at its low end (nearest Q1's collector).

The signal voltage at the top of the coil, which is $180^\circ$ out of phase with the signal at Q1's collector, is coupled to the base of Q1 base by isolating capacitor C2. In this arrangement the circuit oscillates at a center frequency.
Gouriet oscillator offers excellent frequency stability. With the component values shown in the schematic, it will oscillate at about 80 kHz.

Figure 10 is a schematic for a Reinartz oscillator. Its tuning coil has three inductively coupled windings. Positive feedback is obtained by coupling the collector and emitter signals of the transistor through coils L1 and L2. Both windings are inductively coupled to L3. The Reinartz oscillator oscillates at a frequency determined by the values of L3 and C1. The col-turns ratios are typical for a circuit designed to oscillate at a few thousand kHz.

Low-pass and high-pass

Figure 11-α is a schematic for a "false" L-type low-pass filter. Inductor L and capacitor C act together as a frequency-dependent attenuator. At low frequencies the reactance of L is low and the reactance of C is high, so the circuit offers negligible attenuation. At high frequencies the reactance of L is high and that of C is low, so the circuit offers high attenuation.

Consequently, the circuit acts like a low-pass filter. It is called it a "false" filter because the circuit will only function correctly if it is driven from a source impedance equal to $Z_0$. (This is not shown in the diagram.) The circuit is actually a series-resonant filter (like Fig. 1) with its output taken from across capacitor C.

If the circuit is driven from a continued on page 89
As I might have mentioned a time or two before, I am the sysop of GEnie PSRT, and I have bunches of reprints of my Hardware Hacker, Ask the Guru, Blatant Opportunist, Resource Bin, and LaserWriter Corner columns. I also have hundreds of files on hacking, PostScript, and my book-on-demand publishing. Typical file downloading costs are around twenty one cents. I've just made an arrangement with GEnie to provide you with a new, fast modem-access startup. Just autodial (800) 638-8369 and then type HHH. When prompted, enter your top-secret access code of XTX99005, SCRIPT. Whatever you do, keep this secret password carefully hidden and do not reveal it to anyone else. GEnie has many thousands of local access lines across the country. But if you live in a really remote area, it now offers a brand new (800) number service. It has also improved its Mac graphic interface. We might start off with a pair of back-to-the-basic fundamentals...

Maximum power transfer

Suppose you're using an electrical or electronic generator and that it happens to provide a one-ohm source impedance and is outputting a one-volt signal. What is your "best" load resistance? As Fig. 1 shows you, there is no "best" choice. Only compromises that depend entirely on exactly what you are trying to do. If you make your load resistance fairly high, you'll get high efficiency and good regulation. But you will be unable to get the maximum possible power from your generator. Your AC power utility is an example of where generator impedance is made as low as possible to minimize all possible losses.

If you make your load resistance equal to your source resistance, you should extract the maximum possible power from your generator. But the efficiency will be a mere fifty percent and your regulation will be poor.

Video and RF transmission lines are important circuits in which you want to precisely match the load to the source. Besides delivering maximum power, you'll also minimize reflections and standing waves. Other areas where "make load equal source" is important are older power audio amplifiers driving speakers, car batteries when cold cranking, and solar cells trying to deliver as much power to the load as possible.

You also have the choice of using a very low load resistance. That will give you horrible efficiency and terrible regulation. It also will deliver only a tiny fraction of the possible generator power. But there are few lower-level uses where you want your generator to look and act like a current source.

For instance, a current-source load for a transistor amplifier can offer an enormously high voltage gain. Those unusual applications sometimes justify the low power and bad efficiency.

Note what this maximum power transfer curve is telling us: You can deliver the most power to a load by throwing half of the generated power away in your source!

The maximum power transfer curve is surprisingly broad. Double or halve your load and the power that gets delivered drops by only about twelve percent or so. Thus, an exact match might not be that important for maximum power transfer. A precise match just might be needed for other reasons: for example to eliminate standing waves and reflections.

If you are going to cause a mismatch, it usually pays to do so on the high side. That way overall efficiency will be better, even if delivered power drops a tad.

Let's look at several examples of how a bad source-to-load mismatch can severely impair efficiency. In Fig. 2, let's take a piezo striker and see what we can get out of it. Let's assume the striker has a source impedance of 10 megohms and outputs a peak of 1600 volts. We will also disable the spark gap to prevent their breakdown.

Into an open circuit, we get zero power. For maximum power transfer, use a 10-megohm load. Half the voltage will appear across the load, and power will end up as 640 milli-watts. This is in accordance with the $P = E^2/R$ formula.

That's over half a watt, so we should be able to light a lamp with it. Right? Wrong. As Fig. 2-b shows us, a flashlight bulb offers a resistance of about 10 ohms. With a 10-ohm load and a 10-megohm source, you can deliver only 256 nano watts! Efficiency is essentially zero. Ergo, no light.

Can you do better? Substituting a neon lamp for a flashlight bulb would help bunches. Instead, you can place a transformer with a 1000:1 turns ratio between the striker and the bulb, as shown in Fig. 2-c. A 1000:1 turns ratio gives you a 1,000,000:1 impedance ratio. Your
bulb now "looks" like a 10-megohm load to the source. And you should get nearly the full maximum power when flashing the lamp.

Remember, of course, that all piezoelectric devices are AC-only generators.

Most small impedance mismatches between source and load are not that big a deal. But bad ones (especially with high-value sources driving low-value loads) will severely degrade circuit efficiency.

Several columns back, we found several good reasons why any piezoelectric power production hacks were likely to end up a bad scene. Some of you helpline callers pointed out that there is an even more fundamental gotcha.

Most power generators are either E-field machines or H-field machines. An H-field machine uses a changing magnetic field to induce current into a conductor. An E-field machine will use a changing electric field to induce a voltage across an insulator.

All E-field machines are inherently high-impedance devices. The power density of all known E-field machines is extremely low. E-field machines tend to operate at the inefficient extreme left of the maximum power transfer curve of Fig. 1. That is precisely where you don’t want to be.

The current state of the art in both materials science and high-vacuum techniques simply will not allow the construction of any economical, high-power E-field machine.

There never has been any E-field machine ever produced commercial "nickel-per-kilowatt-hour" AC power. I’ll give you my book an Incredible Secret Money Machine if you can prove me wrong on this.

And while any piezoelectric generator is obviously an E-field machine, it is only a "fair to middlin" one at its very best. Sigh...

Maximums and minimums

There are a number of fairly ob-
ious ways you could verify the maximum power transfer curve of Fig. 1. Being lazy, I just told the incredibly superb general-purpose PostScript computer language to plot it for me. The short and simple Fig. 1 code appears in HACK65. PS on my GEnie PSRT RoundTable. As we have seen before, PostScript is now the ultimate hacker’s language.

Or, you could go into the lab and use a wattmeter and a variable load resistor. That should give you the same curve, again with its maximum value matching your source.

Let’s try using some math instead. There’s this ugly rumor going around that electrical circuits obey math rules and that you can predict what they will do simply by doing the underlying math.

In Fig. 1, there is a voltage divider that attenuates a 1-volt input by...

$$e_{OUT} = \frac{R}{(1 + R)}$$

The output power should be this voltage squared, divided by the load resistance. That simplifies to...

$$P_{OUT} = \frac{R}{(1 + R)^2}$$

You or a computer can then plot the curve for different values of $R$ to generate the maximum power curve.

By the way, this stunt of using 1-volt generators with 1-ohm source impedances is called normalization. If you can ever analyze something using easy numbers instead of hard ones, it will usually pay to do so. Anything that can be scaled can also be normalized. Much more on this in my Active Filter Cookbook.

But there is a much better way to find the maximum power transfer point. There is a math process called max-min theory that easily lets you find maximum or minimum points for any reasonable curve. Figure 3 shows the key secret.

Any reasonable curve will also have a slope. A slope is simply the “steepness” or the “rise over run” of any tiny portion of the curve. One crude way to find the slope of any section on a curve is to pick a point just before and one just beyond the section and create a tiny triangle out of it. The rise/run (or tangent) of the triangle will equal the slope of the curve.

As Fig. 3 shows, there are only three possible conditions where you can get a zero slope on a curve. These happen only at a local maximum, at a local minimum, or, more rarely, at an inflection point.

1. At a local MAXIMUM, the slope (or the first derivative) will be ZERO and the rate-of-change of slope (or the second derivative) will be NEGATIVE...

2. At a local MINIMUM, the slope (or the first derivative) will be ZERO and the rate-of-change of slope (or the second derivative) will now be POSITIVE...

3. At an INFLECTION POINT, the slope (or the first derivative) will be ZERO and the rate-of-change of slope (or the second derivative) will also be ZERO

FIG. 2—MAX-MIN THEORY is a branch of differential calculus that lets you quickly and easily find a maximum or a minimum of any reasonable curve.

With an OPEN CIRCUIT, 1600 volts is routed to an infinite resistor. The total delivered load power is ZERO.

With a MATCHED LOAD, 800 volts is delivered to a 10 meg resistor. Total delivered power is a fairly respectable 640 MILLIWATTS.

With a BADLY MISMATCHED LOAD, 1.6 millivolts is delivered to a 10 Ohm incandescent lamp. The total delivered power is a useless 256 NANOWATTS.

With a MATCHED LOAD, nearly 640 MILLIWATTS can be delivered to the incandescent lamp by using a 1000:1 turns ratio matching transformer.

With an SHORT CIRCUIT, 0 volts get sent to an 0 Ohm resistor. The total delivered power will be ZERO.

FIG. 3—GROSSLY MISMATCHING your source and load impedances can severely reduce your total available delivered power. Here are several examples that try to use a piezo striker as a power generator.

a maximum, a minimum, or an inflection point?

How can you tell which is which? Often, it will be completely obvious. If not, go one step further and find the slope of the slope. If you are at a local maximum (3-a), the rate of change of slope will be negative. At

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a minimum (3-b), the rate of change of slope will be positive. And if you are now at an inflection point, the rate of change of slope will be zero.

The "correct" and "exact" way to determine the slope for any curve is known as finding the derivative, and this whole field is called differential calculus. You could find a full set of rules in any college-level calculus 101 text. A good listing of calculus rules also appears in the Mathematical Tables that can be found in the Handbook of Chemistry and Physics.

I've shown how you use max-min theory to prove the maximum power transfer theorem in Fig. 1. Sure enough, the maximum is exactly at a load impedance that matches the source. Taking most derivatives is quite simple. For instance, a parabola, \( y = x^2 \) has a slope everywhere of 2x. Good old u' and friends.

Advanced math can be neat stuff. And very valuable, too.

**SETI resources**

NASA has recently started a new and very aggressive SETI (search for extraterrestrial intelligence) program. In the first few hours of its operation, more frequencies have been observed in more ways than they have in the entire history of all previous ET watching.

One prominent researcher in SETI is Frank Drake. He is famous for the "Drake Equation" which accurately predicts the number of intelligent civilizations that are likely to be lurking in the universe at any given time. Frank has recently authored a new and highly readable book titled *Is Anybody Out There?* published by Delacorte.

So, I thought it might be a good time to do a resource sidebar on SETI. I've included the names of several associations and a listing of the better books.

Besides the three groups Frank mentioned in his book, I've added the *Amateur Radio Astronomers* who also publish a *Radio Observer* newsletter. But note that their main focus is on radio astronomy fundamentals, and they distance themselves from both ET watching and the UFO crowd.

For several reasons, I strongly feel that the odds for an imminent SETI contact are quite high. One reason is that our signal detection, processing, and computing abilities have skyrocketed in the last several years. And they should continue to do so.

Shortly after World War II, our sun suddenly turned into a radio star. Captain Video, Roller Derby, and Kukla, Fran, & Ollie became our first goodwill ambassadors to outer space. Those signals are now 45 light years away from us, and have now swept through nearly a third of a million cubic light years of space.

Within that humongous volume are several hundred probable candidate star systems. Our own signals are easily detectable at this range with our present state of the electronic art. In another 45 years, eight times more volume will be swept out with eight times more star systems watching Your Hit Parade. At a further signal strength drop of less than six decibels!

We are now in transition between irritating hundreds of candidate star systems to annoying thousands more.

On the other hand, I do not believe that looking for obviously modulated narrow SETI signals in the expected "water hole" frequency band will not be the swiftest way to go. If Earth is an even remotely typical example, all the *unintentional* radiated signals swamp those *intentional* ones by at least a zillion to one.

And we have recently discovered spread-spectrum communications. If you really want to punch any signal through very high noise over great distances, spread spectrum is a very good way to go. The chances are that you could step up to multiple dimensions of spectrum spreading using, say, frequency, time, and some sort of a trellis modulation type of overlay.

Perhaps a "multi-level marketing scheme" in which the unsniffed could figure out that something unusual was happening, the fairly bright could receive useful information, and the superintelligent could grab the full set of plans. That surely would beat sending out prime numbers forever.

The signals might be there, but we just might not be smart enough to recognize them just yet. Perhaps the fundamental question to ask is: "What spreading and modulation scheme would give us the most bang for the buck?" And then start looking for something similar heading our way.

Let's have your thoughts on this.

**New opto chips**

Infrared data communications has recently become much simpler, thanks to a pair of *Sharp* circuits. Figure 4 shows details.

Those devices look like a transistor with a built-in lens. Their RY5AT01 transmitter outputs a burst of 500-kHz modulated infrared square waves if fed a logic one, and outputs nothing with a logic zero. This is a form of modulation that's called Amplitude Shift Keying.

The RY5AR01 receiver accepts an infrared signal and converts it back into digital logic levels. An internal digital filter rejects most interfering signals or noise.

The modulation scheme largely
ignores ambient light. Signals from most interfering TV or VCR remotes are also strongly rejected. Data rates up to 19,200 baud are supported. The beamwidth is a somewhat narrow ten degrees, and the recommended range is from 1 to 36 inches.

Obvious hacker uses include safety isolation, data communication, aids for the handicapped, virtual reality, robotics, and for wireless mice.

Because of their narrow beamwidth, the two devices must point directly at each other at all times. While there is good rejection of ambient light and many random IR signals, the circuits offer no selective coding. This means that you will have to strictly isolate each optical linkup from any potentially interfering neighbors. This turns into an especially sticky problem in full duplex (two-way) data communication.

Sadly, Sharp’s $10 intro price for these is in the “What are they on, and where can we get some of it?” range. These will be superb products when their prices fall to 60 cents each.

**Short-haul telemetry**

There are all kinds of emerging new uses for shorter-range wireless data communication. I’d like to apply the generic term short-haul telemetry to any of the newer methods that tries to send information a few inches or a few feet without any wires.

We’ve discussed one possible need in a previous column and in my ongoing Hardware Hacker book-on-demand reprints.

An *isopod* is a tennis-ball shaped beastie that you glomp onto an AC power wire. The isopod automatically measures and transmits the current to a nearby receiver. This can greatly simplify home energy management. No rewiring, no electricians, and no code hassles need be involved.

Another new demand is for a wireless pulse-rate sensor for use...
on an exercise bicycle computer. And there are thousands more. How about an "optical mouse" that senses where you are looking? Or new ways to get data onto or off of a rotating shaft or moving vehicle. Or how about ground-loop-free alternatives to data communications?

But why don't you tell me instead? For this month's contest, either (a) show me a use for the RY5AT01 and the RY5AR01, or else (b) dream up a brand new application for short-haul telemetry.

There will be dozens of the usual Incredible Secret Money Machine II book prizes awarded, along with an all-expense paid (FOB Thatcher, AZ) tinaja quest going to the best of all.

Be sure to send your written entries to me here at Synergetics, not to Electronics Now editorial.

New tech lit

From Signetics, there's a new and thick Desktop Video Data Handbook chock full of A/D, D/A and DSP chips. Also included are its genlocking video encoders.

From NEC there's a large packet of data sheets on Infrared Control IC's. Yes, these definitely include the fancy new teachable versions.

RF Design is a magazine that covers radio communications in the VHF and UHF range. Lots of ads for specialized IC's and components here. And Wired is a brand new magazine out of Multimedia Gulch that is quite interesting but hard to describe. The stories so far have included ones on cellular hacking and virtual reality.

Plotter codes appear in the Plot Data Format Reference Book from Gerber.

From Cerac, there's a freebie pocket-size periodical chart of the elements.

For the fundamentals of most digital integrated circuits, be sure to check into copies of my TTL Cookbook and CMOS Cookbook. Both are available per my nearby Synergetics ad.

Most of the items that I've mentioned appear in our Names & Numbers or SETI Resources sidebars. Be sure to check here first before calling our helpline. Let's hear from you.

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Some reader suggestions concerning our SSAVI descrambler and something completely different.

ROBERT GROSSBLATT

Over the years, a lot of the projects we've worked on together have needed oddball decoders. I've said over and over again that my preferred solution is an EPROM. I've used EPROM's for everything from custom character generators to state detectors for weird numbers. If you've got the time and patience to work out a gates-only solution, you might improve your logical thinking skills, but it will take you a lot longer to get something working, it will make PC board layout a lot more complicated, and it will lock you into a particular design. EPROM's are more versatile because any modifications to the hardware in the design can be accommodated simply by programming some new code in the EPROM.

When you're in the middle of designing some hardware, a gates-only decoder might seem more attractive if you can't program an EPROM right then and there. But if you do a lot of hardware design, an EPROM programmer is just as essential as an oscilloscope.

I'm mentioning this because since we went through the basics of a SSAVI descrambler, I've received a lot of mail with alternatives to the EPROM decoding scheme I used to detect lines 24 and 257. Since it seems that a lot of you out there either prefer to do stuff with gates or don't have access to EPROM programmers, I'm going to pass along some of the decoders I've received.

All the decoders that were sent in are built with standard gates, so you should have no trouble getting the parts. Even though I have the greatest faith in my readers, I'd be a bit remiss if I didn't tell you that I haven't tried these circuits myself. You should experiment with them before you lock them into your decoder design.

The first one is from David Siegel of Livonia, Michigan and the schematic is shown in Fig. 1. It's a pretty slick design in that it's built with only three chips: two dual 4-input NOR gates and one dual 4-input AND gate.

The second decoder is from Chris Carson of Ottawa, Ontario. His design is a bit more complicated, but that's ok. Remember that more complexity makes a design more interesting. As you can see in Fig. 2, one nice feature is that only one pin is used for the line indicator. That can be handy if the rest of your descrambler wants the start and end of the vertical interval to be indicated on a single line.

Most of the circuits I received came from people in the northern part of the U.S. and Canada, so I can only guess that having to spend more time indoors during cold weather must have advantages. My apologies to the rest of you who sent me solutions—there are limits to the room I have here. My special thanks to both Chris and Dave for their designs—I know from my own experience that they took a lot of time to produce them.

Something completely different

One of the considerations I use to choose the topics for this column is the amount of good material available on the subject. After a bit of

FIG. 1—MANY READERS SENT IN ALTERNATIVES to the EPROM decoding scheme I used to detect lines 24 and 257. This one uses only three chips.
searching, it occurred to me that there has been virtually nothing published on the "underground" subject of "unprotecting", software.

Some years ago I did a basic tutorial on the subject for the Apple but, alas, that computer has all but vanished from the face of the earth. The Apple IIgs had a lot of promise but, even though I think Apple is still making the computer, it's been all but abandoned by the software development community. And, unfortunately, I know a lot of people who whined about an extraordinary amount of money to buy them. Oh well.

My primary interest is in the PC family and I suspect that the same is true for the majority of you people. Although software protection has pretty much disappeared in business software, it's still used extensively to protect computer games. The advent of inexpensive hard disks as well as the growth of game sizes has changed the nature of copy protection in the last several years. Original disks are always readable and the files are easy to copy.

The trend in protection these days is the infamous document, or "doc" check. You know what I mean—the manual has some pages that are columns of numbers from which you have to get the right one to proceed with the game. Those pages, by the way, are often printed in some color combination that makes it virtually impossible to duplicate them on a copying machine.

Getting rid of that kind of copy protection differs from the old methods in that you have to find the place in the code that's calling the document check and eliminate it. Since manufacturers don't provide the source code for the software, you have to work your way through pages and pages of unannotated source code and raw hex.

Before we start on this, let me warn you that our discussion has a working knowledge of DOS and some familiarity with computer programming in general. Although there are some good debuggers around that make the job easier, don't forget that "easier" is a relative term. If you can't understand the information that's being displayed, it doesn't matter how informative it is (or isn't).

The basics of doc-check removal are simple. The program is looking for one piece of information from the manual that you have to enter at the keyboard. It then checks that data against data either read in from disk or already in memory. If the check is successful, you go on to save the earth—or whatever. If not, instead of blowing into space you get blasted back to DOS.

If you're lucky, the comparison is made with the actual string you type in. All you have to do is find the table in the program with the stored strings and you're almost home free. That technique, however, isn't too common now because it's too easy to get around, and large tables can waste a lot of space. It's more common to have a table of checksums for the numbers in the manual and do the verification with them.

If you don't know what checksums are, you have a lot of homework to do if you want to make sense of the discussions we're going to have in the future.

No matter how familiar you are with programming or how much time you've spent hunting for bugs in a jungle of code, you'll find that making sense out of uncommented source code is to put it mildly, a difficult task. When you're going through your own code, you know why each line is there. You also know the order in which things are supposed to happen, and when each routine is supposed to be called. That makes it relatively easy to trace the flow of a program and hunt for glitches.

When you're looking through someone else's source code, no matter how well commented, regardless of the language, or how logical the structure, it's always difficult to get to the point where you really understand how the whole thing works. When you're working your way through pages of unlabelled op codes, it takes longer to figure out what's going on, and it's virtually impossible to get a complete handle on every aspect of the program.
Breaking into someone else's code, especially when they've taken measures to make it as difficult as possible for you to do, means you have to have a systematic approach to the job and know exactly what you're looking for. If a program is looking for something from the disk or the keyboard, there are a limited number of instructions that can be used. The op codes are the sign posts that will help you figure out where the copy protection comes into play and how to get around it.

If you're going to be successful in removing the copy protection from a piece of software, you have to deal with the problem in a logical manner. The steps to follow are:

1. Be familiar with the software. The instructions that make up a piece of software are there to make things happen on the screen. Make sounds come from the speaker, and get things from the keyboard. Even before you look at the code, you can get a good idea of how the code is structured by carefully noting the order in which things are happening.

2. Be familiar with your tools. No one, not even the person who wrote the code, can read the kind of un-commented source code produced by a debugger and follow it like the plot of a cheap novel. Comments and labels must be added to explain things normally understood only by computers. Each debugger has its own unique way of interpreting hex and deciding how it should be translated into source code. An ASCII string can be decompiled into some of the strangest source code imaginable, but if you know the behavioral quirks of your debugger, it's easier to understand.

3. Be familiar with the operating system. Programmers are free to do whatever they want as long as they limit their activity to data that's already in memory. When they want to get something from the keyboard or disk, however, there are only a few commands they can use. The 80XXX series of microprocessors are interrupt-driven. That means any
DIGITAL SCALE

continued from page 54

or R4. If you have a set of standard apothecaries' weights, they will save you time in the calibration process. An alternative is to obtain a set of new (or at least unworn) quarters (U.S. currency). One quarter weighs about 0.2 ounces. There are 40 quarters to a roll. Remove the wrappers from two rolls and stack the 80 coins on the platform. They weigh 15.82 ounces or 448.5 grams. This method of calibration is surprisingly precise.

With nothing on the scale platform and the unit set to ounces mode, set the zero-adjust potentiometer R11 for a display of 0.00, with the minus sign deleted. Place the calibrating weight on the scale and adjust R4 for the correct reading. Remove the weight, recheck zero, and repeat the calibration adjustment of R4. This completes the ounce calibration.

The ounces calibrating weight can be used for calibrating grams. Refer to Table 1, a handy English and metric weight equivalent reference and Table 2, a list of English to metric conversion factors. Convert the weight in ounces (avoirdupois) to grams. For example, if the set of 80 quarters was used for calibration, its weight of 15.82 ounces converts to 448.5 grams.

Trimmer potentiometer R19 calibrates the scale in grams mode. Set S2 to the grams position and, if necessary, set the display to read 000 with the minus sign extinguished and no weight on the platform. Place the calibrating weight on the scale and adjust R19 for the correct reading in grams. Remove the weight and recheck zero. Place the weight back on the scale and reset R19 if necessary. This completes the calibration of the digital scale.

The low-battery function of the display can be checked by substituting the filtered adjustable DC power supply for the battery. Caution: Observe the proper polarity when making this connection. Start with the power supply set at +15 volts DC as measured by a DC voltmeter, and slowly reduce the voltage until the "BAT" indicator on the display appears. This should occur when the supply output voltage approaches +12 volts DC. If the low-battery indicator does not perform as described, check IC2-d, IC3-c and all related components.

Scale operation

To operate the scale, first select weight mode—ounces or grams, and then turn the power on. Zero the display by adjusting the knob of the control potentiometer R11 on the front of the case. Be sure the minus sign is not displayed. The scale now is at your service.

For maximum sensitivity, select the ounces mode because with that setting, the display can resolve 0.01 ounce (0.283 grams), as compared with 1 gram in the grams mode. If a display of weight in grams is desired, and a resolution of 1 gram is satisfactory, set the ounces/grams switch to grams. To convert grams to ounces, refer to conversion Table 2.

Loads greater than 19.99 ounces will drive the ounces display off-scale. Weights as great as 3 3/4 pounds (1.8 kilograms) can safely be measured by taking advantage of the safe overload capability of the load cell. To obtain a weight measurement greater than 19.99 ounces, switch to the grams mode which can handle up to 1800 grams without damaging the load cell.

Caution: Do not place any object with a weight greater than 3 3/4 pounds or 1.8 kilograms on the scale or the load cell will be damaged.

To obtain net weight readings (tare), place an empty container on the scale before zeroing the display adjust control.

Turn the power on only when actually making a measurement of weight, and don't forget to turn it off after you have finished. This will ensure long battery life. When the bat indication is visible, replace the batteries.

I/O operation (such as keyboard and disk access) has to include a particular set of op codes. Those are the Achilles heel of any copy-protection scheme because their presence indicates the possible location of code that's part of a protection scheme.

These days, most software is written in a high-level language such as a variety of C or Pascal. The days of assembly language seem to be coming to a close. There are lots of reasons for that, and the main one seems to be economic. It's much easier to move software from one type of computer to another (IBM to Mac, for example), if the code is written in a high-level language. And being able to make the software available for a wide range of computers means that the market grows that much larger.

For someone involved in the fine and gentle art of code cracking, the presence of a high-level language has certain consequences. While the programmer might be writing

continued on page 96
E
verything that I said last
month about tweeter power
ratings also applies, to some
degree, to midranges and woofers.
Except, unlike the situation with
tweeters, the heat dissipation
problem of the larger drivers is eased by
heavier voice coils and the forced-air
cooling provided by the greater
diaphragm movement. This ad-
vantage is negated somewhat by the
fact that most musical energy oc-
curs in the midrange. An octave-
band real-time analyzer clearly
shows an energy hump centered
around 500 Hz for classical music,
and perhaps an octave or so higher
for pop and rock.
In general, the lower the fre-
cuencies a midrange driver must deal
with, the greater the applied me-
chanical and thermal stress. A mid-
range unit intended to perform at
typical crossover frequencies
to shift, its operating
range unit
is run-
ning with a low-
range driver.

To minimize mechanical stress,
the crossover frequency and its
slope are carefully adjusted in low-
crossover three-way systems to
safely limit the amount of low-fre-
cuency energy reaching the mid-
ranger. An over-stressed midrange sounds raspy or other-
wise distorted. If it continues to
sound that way when the program
volume is reduced, it has been
pushed beyond recovery, and re-
placement is in order.
Woofers usually give you plenty
of early warning when they are run-
ing into trouble, which is usually
more mechanical than thermal. That
wasn’t always so, but improved
cone and voice-coil materials and
better cements have led to greater
resistance to thermal meltdown.
But at the mechanical end, the laws
of acoustic physics still hold. For
every additional lower bass octave
that you want to reproduce, four
times the speaker-cone excursion is
required. For that reason, there are
very few speakers that can reach
loudly down to 20—or even 30—
Hz, despite what the ads would
have you believe.

The outer cone suspension (the
surround), the inner cone suspen-
sion (the spider), the cone itself,
and the voice coil are all mechan-
ically at risk when a speaker is over-
driven at low frequencies. A really
whopping overdrive situation (such
as would occur if a speaker were
plugged into an AC outlet—some-
thing that should never be done) can
tear the cone out of a speaker.

Speaker distortion
As a prelude to destruction
comes distortion, which serves as
an early warning to back off the vol-
uume. In general, the harder any
component, electronic or mechani-
cal, is driven, the higher its distor-
tion. But distortion usually does
not become obvious until the compo-
nent approaches its mechanical or
electrical limits. And operating at
these limits is risky.

There is a kind of little-recognized
distortion that occurs when a
speaker is consistently run close to
overload. It happens because cop-
per wire increases its resistance as
it heats up. The effect is so con-
sistent that engineers can directly
calculate the operating tempera-
ture of a voice coil by its rise in resis-
tance above its room-temperature
reference.

The voice-coil resistance shift is
far from innocuous for several rea-
sons. It not only can cause the
crossover frequencies to shift, but,
when reflected back to the ampli-
fier, it also results in signal compres-
sion. An amplifier putting out, say, 12.5
watts into a speaker system with a
measured 8-ohm impedance will de-
deliver 10 watts into 10 ohms, and less
than 7 watts into 15 ohms. Note that
this is a dynamic effect in that the
degree of compression varies with
the varying temperature of the voice
coil.

As is evident, the drivers in
speaker system react differently
to being pushed too hard. An over-
driven woofer will "double" or "triple" at low frequencies, mean-
ing that as the cone and voice coil ap-
proach their mechanical and mag-
netic limits, the cone motio-
becomes nonlinear, no longer track-
ing the electrical audio waveforn
fed it. The result is second-
and third-harmonic distortion. If pushed
too hard at 50 Hz, for example, a
woofer will produce large amount
of spurious 100- and 150-Hz energy,
in addition to the original 50-Hz
tone.

Other sonic artifacts also result
from cone flexing (breakup), and rat-
tling or snapping noises may be
heard as the rear of the woofe
voice coil strikes the back of the
speaker’s magnetic structure. A
long-term overload (such as migh
to cause the compression mentioned
above) that is not quite large enough
to cause mechanical problems can
overheat a voice coil sufficiently for
it to warp, throw off its windings, or
char.

In the past dozen years, ad-
vances in the cements and voice-
coil materials have eliminated many
of the thermal problems. That’s why
mechanical stress remains the pri-
mary woofer killer.

Minimum power
We can assume that the "mini-
mum power" rating that appears on
spec sheets is derived by determin-
ing how much amplifier power is re-
quired to achieve a reference sound
pressure level of "x" dB. As men-
tioned earlier, most speakers have a
minimum power rating that is easily
met by virtually any available re-
ceiver or amplifier. But what hap-
pens when an amplifier runs out of
voltage and/or current before it can
drive the speakers to a desired vol-
ume level?

When an amplifier is pushed
beyond its limits in an effort to pro-
ence a required sound-pressure level from a given loudspeaker, it is possible to calculate the impedance of the musical waveforms. However, audible clipping will occur if longer overloads are frequently perceived as level compression, rather than distortion. However, clipping will occur if the circuit is overloaded, which can result in damage to the amplifier.

Proper power ratings

Arriving at a speaker system's power rating is a complex task, even for its design engineer. Ideally, a manufacturer designs for the highest power capability that can be achieved without compromising the circuit's performance.

Figure 12-a shows how Fig. 11-a can be modified to show the circuit's behavior as a true L-type low-pass filter. Resistor $R_X$ is placed in series with the circuit's input so that the sum of $R_X$ and $R_S$ (the input signal's source impedance) and $R$ (the equivalent resistance of L) equals the circuit's characteristic impedance $Z_0$. The addition of this resistance reduces the circuit's Q to unity, but it results in a clean low-pass filter output shape as shown in Fig. 12-b.

Figure 13 illustrates how the principle just discussed can be applied to make an efficient L-type high-pass filter. The output is taken across inductor L, but informative, power-handling capability specification, such as that used by Allison Acoustics: "At least 15 watts continuous at any frequency. Over most of the frequency range, at least 350 watts for 0.1 second, 125 watts for 1 second, 60 watts for 10 seconds."

Note the distinctions Allison makes between continuous and transient wattage levels. The difference between them is what allows you to play very loud music without problems, even though the continuous sinewave at the time peak level would certainly damage your audio equipment. In other words, your 100-watt (or even 200-watt) amplifier is certainly safe to use with typical speakers rated at 50 watts maximum so long as you don't feed continuous tones or pink noise to them, drive the amplifier into hard clipping, drop a tone arm, or lose a cable ground at high volume. In short, you have to abuse your speakers (and your ears) before disaster is likely to strike. If you don't ask for trouble, it probably won't happen. 

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**Figure 15**

**T-SECTION POWER LINE FILTER**

Input filter rejects interference on the power line to about 25 MHz.

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last month we discussed how the computer, telecommunications, entertainment, publishing, and consumer electronics industries are converging. One way to view this convergence is to think of society as a big information-crunching machine (ICM). The purpose of this machine is to process information. Information in, information out. Figure 1, a variation on a theme initiated last month, indicates the idea.

"So what," you might say; "What's the big deal?"

The big deal is that the ICM is going—indeed, already has begun—to radically alter all aspects of life, such as how we work, how we play, and how we interact with other people. The ICM view of society says that both unsophisticated goods and labor-intensive services will soon become extinct, to be replaced by information-intensive goods and services produced by a computer-based infrastructure and operated by information workers. Maybe they won't become extinct—but they'll certainly be on the endangered species list.

Look at how we work now, and how we will work in the future. Right now many of us spend much of our time in front of computer screens. But there is still a significant number of people that perform manual labor in manufacturing and service industries (e.g., restaurants). However, these jobs are evaporating. No, they're not going south of the border, or to Korea or Japan. Because of a steady and increasing trend toward complete and total automation of most processes, these jobs are simply becoming unnecessary.

So be leery of government-sponsored jobs programs. No company in its right mind wants to increase the number of jobs involving manual labor. That type of job consistently provides the most expensive, least reliable link in the production chain. And any company that can't decrease cost, increase quality, and increase its ability to respond to a chaotic, rapidly evolving global economy... well, I sure wouldn't want to own stock in such a company—nor work for one.

Back to the ICM.

Anything, anywhere, anytime

A widely shared goal among computer visionaries is being able to access any kind of information, anywhere, anytime. Until recently, this type of vision reigned more in the realm of science fiction than fact. However, trends in the semiconductor and computer industries have in amazingly short order made available a set of building blocks powerful enough to start implementing the first tentative structures of this global network. A future in which your house has a bit meter next to the gas and electric meters is not far off.

For example, it is now possible—not necessarily easy or effective or efficient—to exchange email messages among all important services (AT&T Mail, BIX, CompuServe, Internet, MCI Mail, and more). However, these messages seldom carry more than ASCII text; binary file transfer is available only sporadically; and full multimedia data transfer (i.e., real-time audio and video) is still a long way off. What services there are still force people to spend a major fraction of their online time learning to use and tweaking the computer tools, rather than just seeking and capturing the information they want.

Information and hype

The computer industry has been slow to recognize and respond to growing demands for universal connectivity and data access. Attention has instead been shunted from meeting user needs to increasingly great hype and marketing warfare concerning operating systems, CPU's, graphical user environments, and the like. The technology-driven computer market continues to supply what it can (and what it finds interesting to build), rather than carefully ferreting out and responding to exactly what users need.

The fad-driven and haphazard way in which vendors rushed to add icon bars to Microsoft Windows applications is only one recent example of how much remains to be learned. Building solutions that correspond to no real-world problems has been a way of life at many technology concerns, large and small, for years. However, those days are over. Careful needs analysis and usability testing, rather than simply heaping feature upon feature upon feature, will certainly define the successful computer company of the 90's.

That statement applies to both hardware and software. For example, computers today are sold as daredevil items. No one buys a car expecting to pay extra for brakes; people consider them a built-in part of the system. But what sort of data-safety features does the average PC (or Mac or workstation) come with? To protect our data we must spend extra on peripherals (e.g., tape backups, redundant disk controllers, and uninterruptible power supplies) and utilities (virus scanners, disk repair software). Of course, if those problems ever are fixed, those of us in the consulting business may have to look for other lines of work.

Content, creativity, and capital

Now let's look at the entertainment industry (e.g., movie studios, record companies, and megacorporations like Time-Warner). That
industry is in an extremely strong position in the emerging world of universal digital access to multimedia data. Even Bill Gates talks to Hollywood.

The entertainment companies have content (records and films), creativity, and capital. In some cases, these companies have major interests in all stages of the process. Time-Warner, for example, owns significant content, both print and film; the company is also the second largest cable-TV distributor. With control over all stages of the information creation and distribution process, TW’s ability to monopolize, control, and censor the flow of information is frightening; it makes old fears about AT&T’s domination pale by comparison. One currently circulating rumor concerns a possible TW/AT&T merger.

The entertainment industry is using new multimedia technologies in irresistible ways. Witness recent films like Terminator 2 and The Lawnmower Man, the virtual-reality chambers built by Disney, 3D video parlors, and the special-effects companies set up by the film studios. The entertainment industry understands user interfaces, how to make the technology transparent, and how to draw people into compelling alternate worlds. To the extent that it is going to survive as a separate entity, the computer industry had better pay attention to what’s going on.

The computer industry is in imminent danger of being subsumed by Hollywood and the other points in the information-distribution chain. In this scenario, computer technology will drop to the level of plumbing—the shading in Fig. 1. Indistinguishable varieties of hardware will be mass-produced by robots for next to nothing. A friend talks about the time, probably within the next decade, when an entire computer, with a gigabyte of RAM and a megapixel full-color display will fit on a single chip that costs less than $3. Where will Intel, Motorola, and even IBM be then?

Conclusions
Since the dawn of the industrial age, western society has defined itself by producing material goods; this type of production defined the overall economy, as well as how people worked, learned, and lived. Nowadays, there is less and less emphasis on physical production, and more and more emphasis on the “soft” side, on style, on intangibles, and on form rather than just on function.

So how does today’s computer technology fit in a view of society as an information grinder? It’s clear that the hardware side of the industry is headed for pure commodity status, which spells bad news for U.S. manufacturers—and workers.

On the other hand, the software side has much to learn, but through partnerships with Hollywood and the like, has much opportunity to learn it. If it blows these opportunities, the computer industry per se will disappear; to be replaced by a hybrid consisting of companies that understand the ICM model.

Either way, opportunities will make the explosive growth of computers in the 80’s seem minuscule by comparison. However, it will also mean excruciating pain for the manufacturers of “hard” goods. Over the long term, I wouldn’t buy stock in any company that makes things you can put your hands on—unless it’s the packaging for multimedia software.

News bits
Intel finally released two versions (60- and 66-MHz) of the Pentium, the successor to the 80486. Systems that use the Pentium should be released in early summer, and they’ll be expensive, but early betas indicate less of a performance jump than with the corresponding switch from the 386 to the 486. Could this be the beginning of the end of Intel’s hegemony in microprocessors?

Microsoft officially released MS-DOS 6.0; the product might perhaps be more accurately known as a better suite of utility programs for DOS 5; DOS itself has changed very little. DOS 6 is mostly a power-user’s update that improves the bundled utilities (e.g., the 386 memory manager and backup programs), but hardly pushes the envelope. One nice feature is the configuration manager, which allows you to keep several boot configurations in one CONFIG.SYS, and select among them at boot time. You can also press hotkeys to bypass boot files altogether, or selectively execute lines in CONFIG.SYS. Overall, DOS 6 is more interesting for what it doesn’t include than what it does. There is still no multitasking; no networking; no email; and only a mediocre graphical shell. Rumor has it that DOS 7 will really push the memory and file-system limitations we’ve lived with for more than a decade.

I’ve been playing with several beta releases of OS/2 2.1. Although there are still bugs, this time IBM really seems to have done its homework. Speed of Windows applications running under OS/2 is now acceptable, i.e., comparable to simply running them in Windows. And the OS/2 Workplace Shell does have a habit of growing on you after you’ve used it for a while. One of my favorite features is still the Boot Manager, which allows you to boot to any one several previously defined partitions or extended disk drives, each of which may contain a totally different operating system.

Unix operating-system vendors have fought continually during the past decade over relatively insubs-
tential issues. In recent years, vendors coalesced around two groups of standards, those promulgated by the Open Software Foundation (which includes IBM, DEC, HP, and others), and those by a combination of AT&T and Sun. At long last, the walls have come tumbling down. HP, IBM, SCO, Sun, Univel, and Unix Systems Laboratories (formerly of AT&T, but recently purchased by Novell) announced the Common Open Software Environment (COSE, pronounced cozy), a global application programming interface that hopes to eliminate inter-platform portability problems. With Microsoft’s Windows NT due to be released this spring, this is clearly an act of desperation.

Think HDTV is something? Then check out Ultra Definition TV (UDTV), a new project sponsored by the Japanese Government and 100 of Japan’s largest electronics firms. This may be a tacit admission of defeat in the HDTV wars, so the Japanese are leapfrogging to the next generation.

Remember the switch from 256K to 1Mb DRAM’s? Maybe you noticed increased usage of 4Mb devices? The industry is about to make the next jump: 16-megabit DRAM’s. Toshiba, Fujitsu, and NEC are already producing on the order of 500,000 units per month, and promise to double or triple that quantity over the next year. Not to be outdone, NEC has introduced 16-megabit synchronous DRAM’s, which provide 10-ns access times; initial production rates will be 30,000 units per month. The ultimate is Hitachi’s recent break-through announcement: the so-called single-electron memory, which would allow construction of power-effective gigabyte semiconductor memories. But give it about ten years to reach commercial status.

Bell Atlantic has built a demo Intelligent Home, which is prewired with fiber optic cables and features extensive multimedia communications. Using a TV, users can access telephone, cable TV, shopping, and other information services. This is the kind of forward-thinking use of technology that we should see more of.

---

**EQUIPMENT REPORT**

continued from page 22

wrong because the picture we were viewing, SportsChannel, was not on Galaxy 2 (our highest satellite), but on one satellite to the east!

The receiver also offers an handy audio “Squawk” that provides an audio indication of signal strength. It’s a easy way to peak the dish position because it allows an installer to keep his eyes on his work instead of on a signal meter or spectrum analyzer.

The PTR-25A portable test receiver has a list price of $1395. The PSA-37D portable spectrum analyzer has a list price of $2475. Thanks to the time they can save an installer, they should pay for themselves in short order. And the improved performance they can potentially bring to a dealer’s installed systems should keep his customers happy—and coming back for more!

**COMB. GAS ALARM**

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When power is first applied, the alarm will sound for several seconds as the heater element brings the sensor to the correct operating temperature. After the alarm stops, it takes approximately 2 minutes for the sensor to stabilize before accurate gas concentrations can be measured. After the warm-up period, you can test the alarm by using alcohol instead of methane. Dip your fingers into some rubbing alcohol and rub them together directly in front of the sensor element. The alcohol vapors should trip the alarm and the buzzing should stop once the alcohol has dissipated.

To use the backup feature, install a fresh 9-volt alkaline battery and repeat the alcohol test with the wall transformer unplugged. Remember to remove the battery whenever the unit is not in use to prevent discharge. Your gas sensor alarm is now ready to use. Remember that methane gas rises in normal air, so the alarm should be mounted near the ceiling.

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**PRINTER MINDER**

continued from page 64

this connector. Perform the following tests before installing the board in a case:

1. With no power applied, use an ohmmeter to verify that there is more than 20 ohms resistance between +5 volts and ground.
2. Apply AC power and ensure that the +5-volt source is accurate. It’s convenient to measure across pins 20 and 10 of ICl.
3. Without connecting the printer, verify that LED1 (Printer On) is off. Attach one end of a test lead to pin 1 of J1 (STROBE IN). Momentarily ground the other end of the lead (e.g., to pin 19 of J1). The LED should illuminate, and should remain on for about one hour. While it’s on, there should be 120 VAC across power connector J4.
4. With the LED still on, verify the power-fail feature by momentarily removing input power. The LED should go out, and J4 should lose power.

If any of those tests fail, correct the source of the trouble before proceeding.

The last step is to mount the board. If you use a case like our prototype, slide it in the tracks extruded into the wall of the case, and then seal the case with two end caps.

**Hooking up**

Now you’re ready to connect Printer Minder between your computer and your printer. To understand the wiring scheme, refer back to Fig. 1, and perform the following steps:

1. Unplug the AC cable from your printer: it will be used later.
2. Unplug the data cable from your printer and connect it to J1 of Printer Minder.
3. Now connect another data cable from J2 of Printer Minder to the input port of your printer.
4. Connect an AC extension cable from J4 of Printer Minder to the printer’s AC input.
5. Now apply power to Printer Minder by connecting the AC cable removed from the printer in Step 1 to J3.
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You know that the Russians secretly installed countless microphones in the concrete work of the American Embassy building in Moscow. They converted

The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of voice scrambling telephone communications. In fact, do you know how to look for a bug, where to look for a bug, and what to do when you find it?

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 places 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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MAR-8 2.15

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RAM-2 4.95 4.95 4.95 4.95 4.95 4.95 4.95
RAM-3 4.95 4.95 4.95 4.95 4.95 4.95 4.95
RAM-4 4.95 4.95 4.95 4.95 4.95 4.95 4.95

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MAR-3 1.50 +MAV-3 1.50 +VAM-3 1.60 +MAV-3
MAR-4 1.50 +MAV-4 1.50 +VAM-4 1.60 +MAV-4
MAR-5 1.50 +MAV-5 1.50 +VAM-5 1.60 +MAV-5
MAR-6 1.50 +MAV-6 1.50 +VAM-6 1.60 +MAV-6
MAR-7 1.50 +MAV-7 1.50 +VAM-7 1.60 +MAV-7
MAR-8 1.50 +MAV-8 1.50 +VAM-8 1.60 +MAV-8

Output Pwr. +dBm
-5 0.5 1.5 5 1.8 10 10 10
-10 2 5.5 12.5 12.5 12.5 12.5 12.5
-20 2.0 5.5 12.5 12.5 12.5 12.5 12.5
-30 3.0 6.5 12.5 12.5 12.5 12.5 12.5
-40 4.0 7.5 12.5 12.5 12.5 12.5 12.5
-50 5.0 8.5 12.5 12.5 12.5 12.5 12.5
-60 6.0 9.5 12.5 12.5 12.5 12.5 12.5
-70 7.0 10.0 12.5 12.5 12.5 12.5 12.5
-80 8.0 10.5 12.5 12.5 12.5 12.5 12.5
-90 9.0 11.0 12.5 12.5 12.5 12.5 12.5
-100 10.0 11.5 12.5 12.5 12.5 12.5 12.5

Gain: dB
-10 1.0 1.40 1.50 1.55 1.60 1.65 1.70
-20 2.0 1.45 1.55 1.60 1.65 1.70 1.75
-30 3.0 1.50 1.60 1.65 1.70 1.75 1.80
-40 4.0 1.55 1.65 1.70 1.75 1.80 1.85
-50 5.0 1.60 1.70 1.75 1.80 1.85 1.90
-60 6.0 1.65 1.75 1.80 1.85 1.90 1.95
-70 7.0 1.70 1.80 1.85 1.90 1.95 2.00
-80 8.0 1.75 1.85 1.90 1.95 2.00 2.05
-90 9.0 1.80 1.90 1.95 2.00 2.05 2.10
-100 10.0 1.85 1.95 2.00 2.05 2.10 2.15

Notes:
- Frequency range DC-1500MHz
- Gain: dB less than shown
- Designers' kit, KH-1 available only $5.95 includes:
  10 MAR-1, 10 MAR-2, 10 MAR-3, 10 MAR-4, 10 MAR-5
  100 CAPACITORS* 50 100 pf 50 1000 pf 50 10000 pf
  740 page RF/IF DESIGNERS' HANDBOOK
  - MIXERS, POWER SPLITTER/COMBINERS, AMPLIFIERS, ELECTRONIC ATTENUATORS
  - RF TRANSFORMERS, DIGITAL ATTENUATORS, PHASE DETECTORS
  - SAVES up to 60%

Typical Circuit Arrangement:

designer's kit, KH-1 available only $5.95 includes:
40 AMPLIFIERS * 10 MAR-1, 10 MAR-2, 10 MAR-3, 10 MAR-4, 10 MAR-5
150 CAPACITORS* 50 100 pf 50 1000 pf 50 10000 pf
740 page RF/IF DESIGNERS' HANDBOOK
- MIXERS, POWER SPLITTER/COMBINERS, AMPLIFIERS, ELECTRONIC ATTENUATORS
- RF TRANSFORMERS, DIGITAL ATTENUATORS, PHASE DETECTORS
- SWITCHES/DRIVE

Typical Circuit Arrangement:

Values or models may be substituted without notice, depending on supplies.

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