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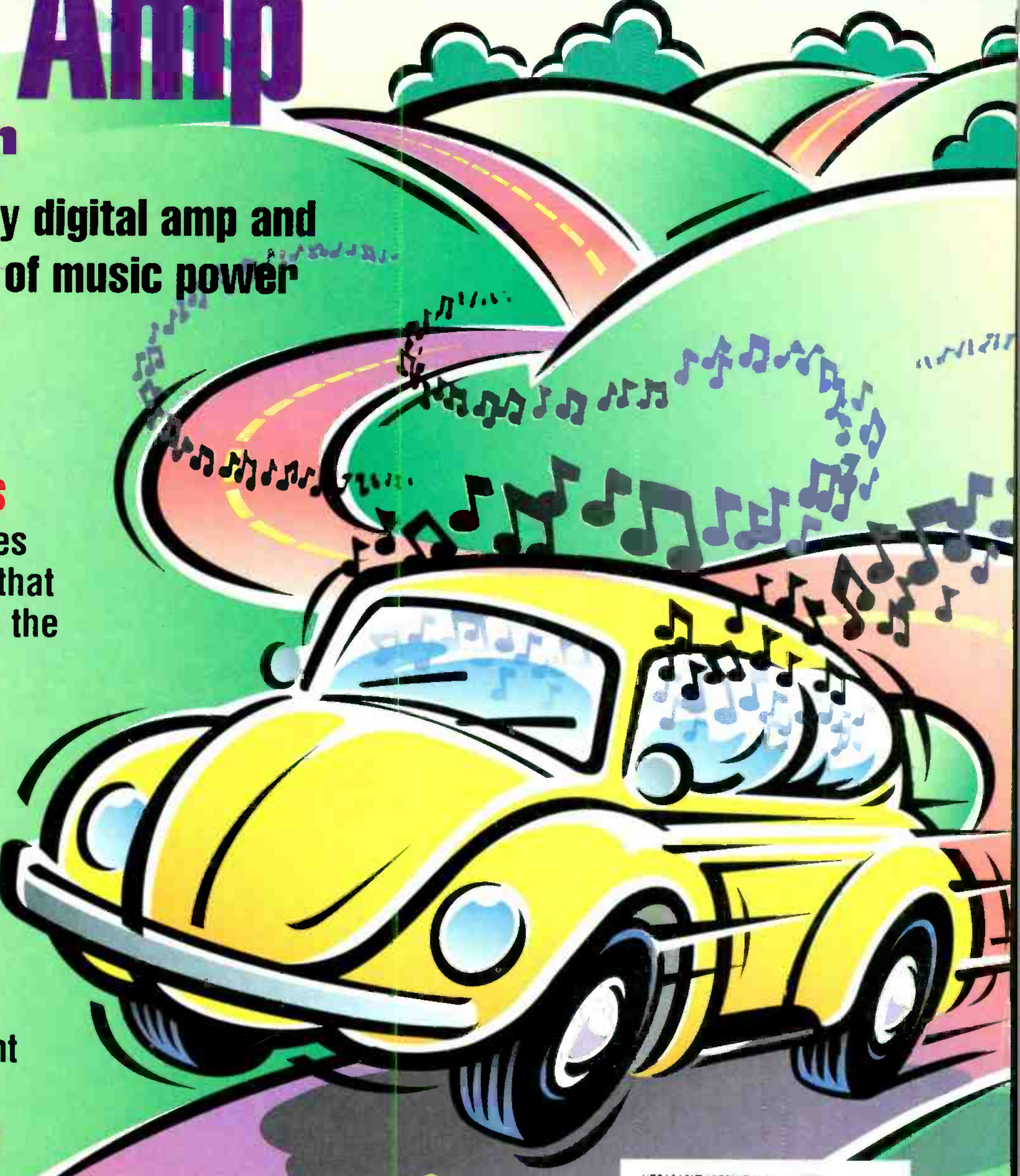

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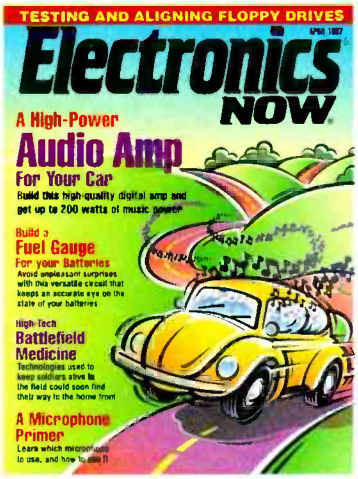

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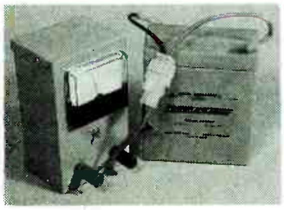

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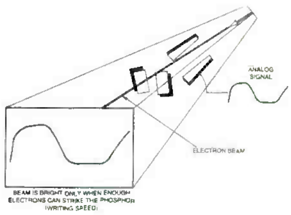

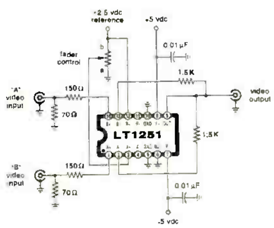

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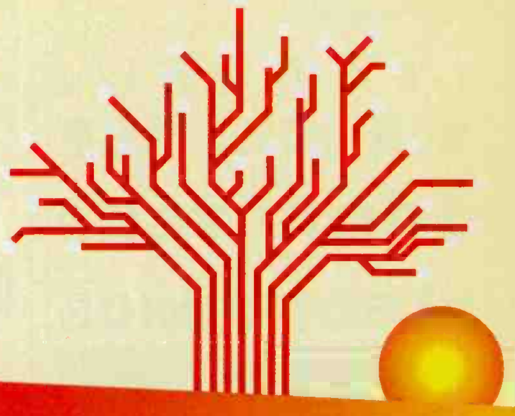

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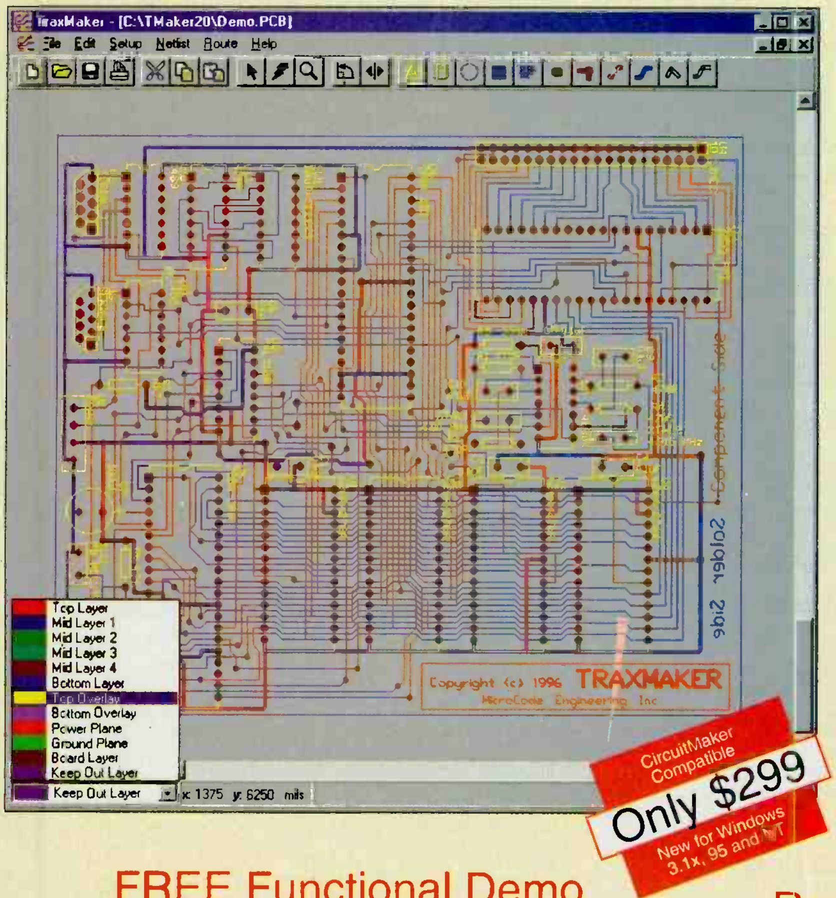

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EDITORIAL

Out of the Closet

While doing some spring cleaning, we came across some older software titles, most still sealed in their original packaging, in the darkest recesses of one of our storage closets. As they were of little use to us, we were about to toss them when we realized they might be of use to some of our readers.

The titles, along with the systems they run under, are listed below. If you want one of these items, send us a self-adhesive shipping label with your name and address on it, our description of the item, and a check or money order for $4.00 payable to CLAGGK Inc. to cover the cost of shipping one item via Priority Mail. We regret that we can't accept telephone requests or any questions. All items are "as is."

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WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

On-Line Research Tools

The Institute of Physics (IOP) and the Institution of Electrical Engineers (IEE) have announced that, beginning this spring, users of IOP's Electronic Journals on the World Wide Web will be able to select any journal reference and receive the INSPEC abstract instantly, at no extra cost.

INSPEC is the information services division of IEE, the largest professional engineering society in Europe. The not-for-profit organization, with worldwide membership of more than 130,000, publishes over 20 primary journals, as well as the INSPEC bibliographic database. The London-based Institute of Physics, a professional society with more than 20,000 members worldwide, is a leader in the electronic publishing of scientific research journals. IOP's publishing branch produces research journals and graduate-level texts, as well as popular science books, magazines, and reference titles.

The IOP/IEE project uses IOP Publishing's HyperCite service and INSPEC's database of scientific and technical journal abstracts, which date back to 1969. It will explore the efficiencies of combining primary and secondary information services in a hypertext environment, and is expected to become the platform for a more extensive scheme in which HyperCite service will link IOP Publishing references to all 32 of its full-text electronic journals. The second phase of the project, planned for this summer, will extend the concept to other important physics publishers.

"This is an ambitious project which should have substantial tangible benefits for researchers in physics," said Anne Dixon, electronic publisher at Institute of Physics Publishing. Jim Ashling, director of sales and marketing at INSPEC, added, "We believe that integration of electronic journals with quality secondary information services is just what is needed to create the value-added features that are so essential in navigating the Internet. Institute of Physics Publishing and INSPEC are certainly a perfect fit in this respect."

Electronic Delivery Of Chinese Research Documents

Aided by the University of Pittsburgh Library System, the Peking University Library became the first Chinese academic library in the People's republic to be able to electronically deliver research materials to libraries in the west. This marks one of the first such services between a North American library and a library in China.

The Pitt University Library System and Peking University Library successfully completed a test in which full-text documents were transmitted on the Internet using Ariel software. Document delivery through cyberspace provides scholars at each university with access to the vast information resources of the other.

Pitt University Library System director Rush Miller, who initiated the international project while visiting Beijing last August, said, "the successful establishment of an Internet linkage between the [two] libraries ... is a milestone in the long history of cooperation between the academic institutions of both countries. Now that we have demonstrated for the first time that this technology can be utilized for resource sharing with libraries in China, we plan to extend our partnership to other major libraries in China."

Battling Heat-Induced PC-Board Warpage

During manufacturing, printed-circuit boards are vulnerable to heat-induced warpage. Boards that warp after expensive components have been added can mean thousands of dollars in losses. An experimental technique known as Thermoire, developed at the Georgia Institute of Technology and licensed by Electronic Packaging Services (EPS) Ltd. Company, provides real-time data about PCB warpage. Research sponsors, who were brought together through Georgia Tech's Manufacturing Research Center (MARC), include Motorola, MICOM, Ford Electronics, IBM, DEC, and AT&T.

Thermoire developer Dr. Charles Ume, an associate professor in the School of Mechanical Engineering, explains, "Electronic packaging companies can use the warpage information to make changes in their PCB design early. That way, there's no mass production of a product that has a problem."

Temperatures of up to 230° Celsius are an integral part of PCB processing. The relatively minor heat generated by computers and other devices that contain printed-circuit boards can also cause warpage. Small, thin, densely populated boards are particularly susceptible to the problem. According to EPS manager Dirk Zwemer, "It's not uncommon to see losses of one to three percent in a mature product, and it can be much higher for some designs."

A special oven with a glass grating top is used for the new process. A white light shines through the glass grating onto the PCB, and an inexpensive, compact, charge-coupled device (CCD) camera captures warpage digitally as it occurs.

Equally spaced parallel lines are etched on the flat glass grating. When the beam of light is directed at a specific angle, the etched lines create a shadow on the surface of the board. If warpage occurs, a moire pattern is produced by the geometric interference between the etched lines on the glass and the shadow of those lines on the PCB's surface. The more the board warps, the greater the

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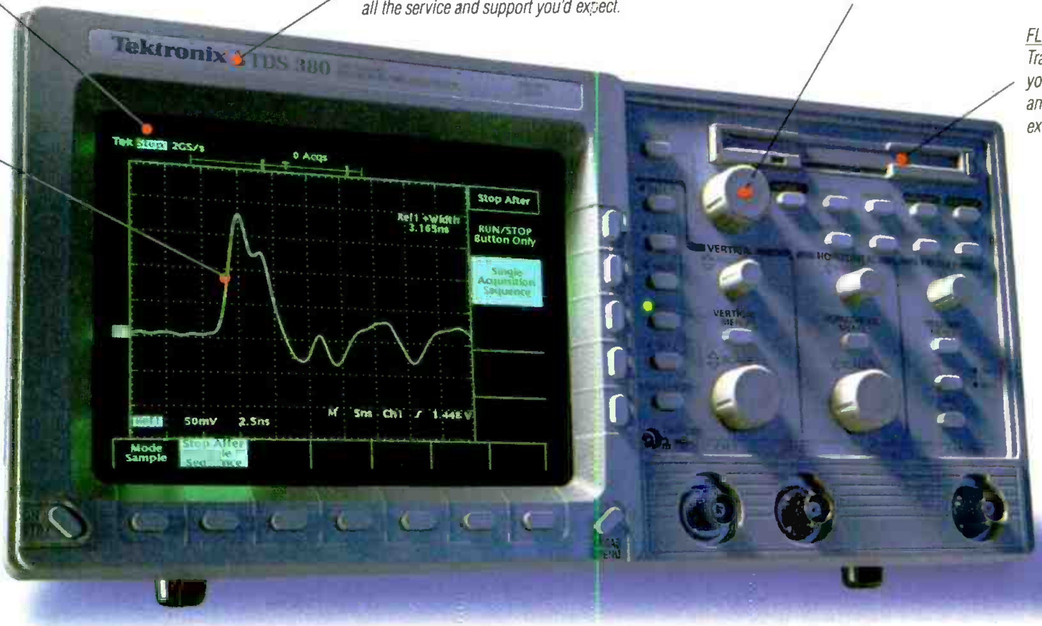
Overpowered.



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You'll see things the other scopes can't even capture. The new TDS 300 Series also offers FFT and Disk Drives – features others charge hundreds of dollars more for, or don't even have.

The biggest breakthrough, though, is in the number on the price tag. The TDS 300 Series starts at $2,995.* For this price, you get a level of performance you'd expect only in scopes twice as expensive. Contact your Tektronix Authorized Distributor for details, or call 1-800-479-4490, Action Code 311. Or find us on the World Wide Web at http://www.tek.com/mbd/w311.

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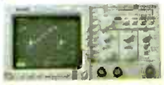

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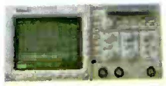

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Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

AC Current Mystery

Q *Recently, I was measuring the currents in a simple rectifier circuit and found an anomaly. The circuit was a bridge rectifier with resistive load. I measured the AC current before the rectifier and got 195 mA; the DC current through the load was only 175 mA. I asked several technicians and then a Ph.D. in electrical engineering, who told me the discrepancy was due to the fact that the meter responds to average current but is calibrated in rms. Is that correct?—D. J. B., Uvongo, South Africa*

A Figure 1 shows a circuit we breadboarded that demonstrates the same effect, but the discrepancy is even bigger (216 vs. 145 mA in our case). We used a true-rms multimeter.

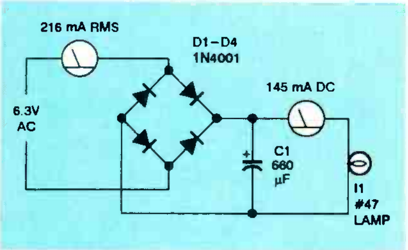

FIG. 1—WHEN USING A TRUE rms measuring meter, the AC current is considerably higher than the DC current in this circuit.

Why is the AC current larger? A quick answer is that there's AC but not DC current in the filter capacitor. Thus, not all the AC current goes through the resistive DC load.

But that's almost too quick an answer; the question deserves a little more thought. First let's review what we mean by rms. Because an AC voltage or current is constantly changing, the only way to assign it a constant value is to use some kind of average.

The rms value is a special kind of average with the following property: the power (wattage) computed with rms AC is the same as with DC. For example, 6-volts rms AC will light a light bulb to the same brightness as 6-volts DC, and when it does so, the rms AC current through the bulb will be the same as the DC current would have been.

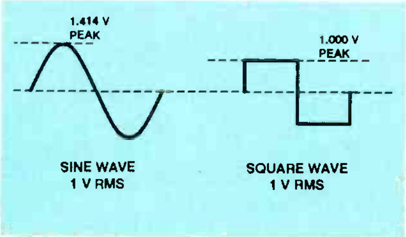

FIG. 2—THE RELATIONSHIP between peak and rms voltage or current greatly depends on the shape of the waveform.

Because wattage depends on the square of voltage of current (P = E2/R = I2R), the rms value is obtained by squaring the voltage, averaging the square, and then taking the square root. The abbreviation rms stands for root of the mean of the square. The average (mean) of the voltage itself is somewhat lower.

The relation between rms, average, and peak voltage depends on the waveform (see Fig. 2). With a squarewave, all three are the same. With a sinewave, which isn't at maximum voltage all the time, the peak, rms, and average values are in the ratio 1.414:1.0:0.9. If the waveform consists of narrow spikes, the discrepancy is even bigger. Current works exactly the same way as voltage.

Now back to the bridge rectifier. Although the AC voltage at the input is a sinewave, the AC current waveform is not. We sampled it by inserting a 1-ohm resistor and connecting an oscilloscope across it, and what we found is shown in Fig. 3. Current flows only briefly at the peaks, when the AC voltage is higher than the voltage on the filter capacitor. At those times, the current flow is heavy (about 800 mA) because the capacitor has to make up all the charge it has lost since the last peak.

Because of the strange waveform, only a true-rms meter will give you the correct rms value. Some multimeters are "average responding, rms reading," which means that they actually measure the average voltage or current and then multiply it by 1.1 on the assumption that it's a sinewave. A few meters are "peak responding, rms reading." Both kinds read correctly only with sine waves.

The moral? The rms current into a rectifier can be considerably higher than the DC current out, and the peak current going in can be even greater. Remember that whenever you choose a power transformer; the current rating of the transformer secondary generally needs to be higher than the DC current to be delivered to the load.

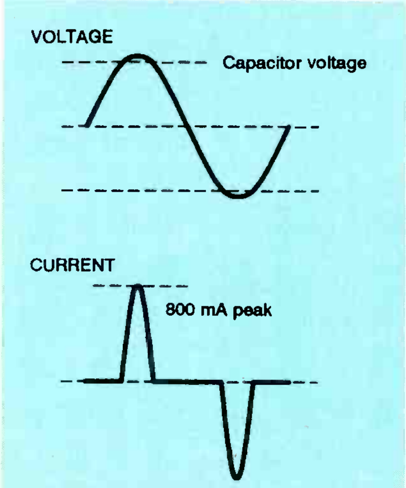

FIG. 3—AC VOLTAGE IS A SINEWAVE, but current only flows at the peaks where the AC voltage exceeds the voltage already on the capacitor.

Finally, note that no energy is lost, because the DC voltage out is higher than the AC rms voltage in. Except for diode drop and resistive losses, you get back in volts everything that you lose in amps.

Tube Substitution

Q *I need advice about replacing a 7199 tube with a 6EA8 to revive my Williamson all-tube amplifier built many years ago. According to the* RCA Receiving Tube Manual, *the 6EA8 is about the same as the*

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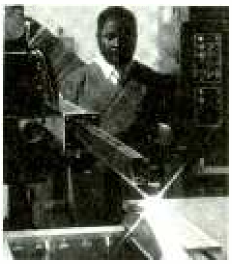

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Many electronic component manufacturers have web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online.

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

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

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

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

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, Box 637, Spanaway, WA 98387.

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

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

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

7199, except that the pin-out is different and the 6EA8 is designed for RF, not audio. Is there a danger of feedback or oscillations?—E. C., Miami, FL

A It's worth a try; as you noted, the two tubes are quite similar except for the pin-out. Each consists of a triode and a pentode in a single envelope, and the characteristic curves are almost indistinguishable. The main difference is that the 7199 is specified for low hum.

There is no particular danger of oscillations when using an RF tube in an audio application; the frequency response of the two tubes is actually about the same. The internal capacitances of RF tubes tend to be lower, but that won't harm audio performance.

You can probably find an original 7199, cheap, at a hamfest (ham-radio swap meet). For information about hamfests in your area, contact the American Radio Relay League, Newington, CT 06111.

Two Kinds of IDE

Q *My computer is a clone PC XT with a Miniscribe 8225XT IDE hard disk drive. I have purchased a Miniscribe 8051A IDE drive but can't get it to work in this machine. Thanks in advance for whatever help you can supply me with.—R. McG., St. Laurent, P. Q., Canada*

A As you note in your letter, an IDE hard disk is one whose controller is built into the drive itself; it connects to an IDE host adapter, which provides a communication path between the drive and the bus of your computer.

Most IDE drives, including your new 8051A, are designed for computers that have a 16-bit PC AT type (ISA) bus. Your computer has an 8-bit bus and the Miniscribe 8225XT is one of the relatively few IDE drives that will work in it. As far as we know, there is no way to get your new drive to work in an XT computer.

Touch-Tone Decoding

Q *I am trying to design a circuit that will decode Touch-Tone frequencies and interface with a Z80 microprocessor or a computer. How can I do that?—F. S., Newark, NJ*

A There are a number of ICs on the market that accept DTMF (Touch-Tone) tones and output 4-bit data indicating which number is being received. One of them is the CD22202E, which you can get, along with data sheets, from JDR Microdevices, 1850 South 10th Street, San Jose, CA 95112 (Tel: 408-494-1400). For more on DTMF decoding, see the May 1995 installment of this column.

My Pool Runneth Over

Q *During rainy season, the water level in my pool rises to where I have to pump it out manually. I would like to have a system that senses the water level and activates the pump, and at the same time opens the faucet so that the water drains outside of the pool. Can I use a Triac controller?—S. C., Clearwater, FL*

A Maybe, but this is more a plumbing problem than an electronic one. The very simplest solution is to add some kind of overflow drain to the pool so the water will automatically flow out when it rises above a certain level.

If that won't do, a simple alternative is to add a second pump that is used only for draining overflow and is triggered by a float switch—something along the lines of a sump pump. That way, you don't have to open and close faucets electrically, nor modify the controls of your main filter pump.

Tape Recorder Quandary

Q *My father, who is now physically handicapped, would love to hear his wedding, which was recorded on reel-to-reel tape in 1958.*

I've searched pawn shops for years to find a reel-to-reel tape recorder, but so far every one I have purchased either does not play at all or plays at the wrong speed (too fast). Can I modify my Akai 4000 DS to play slower?—T. G., Denham Springs, LA

A The standard recording speeds in 1958 were 15/16, 1-7/8, 3-3/4, 7-1/2, and 15 inches per second (ips). We're guessing that the wedding was recorded at 3-3/4 or 1-7/8 to save tape, but high-fidelity tape decks often have only the higher two speeds, 7-1/2 and 15 ips.

The circuit you describe in your letter, a Triac-type speed controller, won't work with a synchronous motor. In fact, it's not practical to make large changes in the speed of a tape recorder by purely electronic means. What you'd need to do is change the size of drive wheels somewhere in the mechanism.

But what you really need is a service, not a piece of equipment. Is there a radio station or recording studio in your town that would, for a price, copy your old tapes onto cassettes? Look for an older radio station that still has some equipment from the 1950s.

Pager Conversion

Q *I have a Motorola Bravo pager from 1987, which operates on 43.6 MHz. The paging services here use the 150-MHz band. Can the receiver components in the pager be changed so that I can receive the frequencies in this area without having to purchase another pager?—W. M. R., Indianapolis, IN*

A Converting from 43.6 to 150 MHz is not a small change. Minimally, the built-in antenna and front-end components would have to be replaced. That's about half of the pager. If the data format or bandwidth is different, the rest of the pager will have to be changed also. It's cheaper to get another pager.

Intelligent LED Displays

Q *Would you explain how the Texas Instruments TIL 311 LED indicator could be put to use? I want to cascade several of them and build a 100-MHz digital frequency counter.—B. P., Yonkers, NY*

A Texas Instruments makes several "intelligent LED displays" that contain one red digit plus the circuitry to drive it. The TIL 311 contains a latch, decoder, and driver; you give it 4 bits of data and it displays a hexadecimal digit (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, or F).

The TIL 306 and TIL 307 are even smarter; they contain a decade counter along with a one-digit display. You supply pulses to the "clock" pin; it counts them and displays the count. To cascade them, connect the "maximum count output" of one chip to the clock input of the next higher digit. At $13 per digit, this isn't the cheapest way to build a counter, but you can't beat it for simplicity. The maximum counting rate is about 15 MHz, so your 100-MHz counter will need a divide-by-10 prescaler.

Data sheets on the TIL 306, 307, 311, and related products are available from Texas Instruments, P.O. Box 655303, Dallas, TX 75265, and on the Web at http://www.ti.com.

Programming the 8748

Q *I need to be able to read and write to the EPROM portion of an Intel 8748H microcontroller. It seems like that should be possible by building a 28- to 40-pin adapter for my present EPROM programmer. Can you give me any help on this? The cheapest programmers I've seen are about $600!—R. A. M., Kane, PA*

A The programming requirements of an 8748 are fairly similar to an EPROM, but without more details it's hard to make a specific recommendation. (Your EPROM programmer might be using any number of different algorithms and timings; no two seem to be quite the same, even for the same EPROM.) If you can determine exactly what your EPROM programmer is doing, and match it up with the specifications in the 8748 data sheet, you should be able to make an adapter that works.

An alternative is to use an Intronics "Pocket Programmer" and its 8748 adapter. That programmer connects to the parallel port of your PC, and the whole setup, including adapter, costs about $220. It also programs EPROMs and EEPROMs up to 8 megabits, and adapters are available for programming many newer microcontrollers, including 8751s and PICs. Contact Intronics at 612 Newton Street, Edwardsville, KS 66113 (Tel: 913 422-2094).

Still another alternative is to look for a used 8748 programmer, cheap. Since the 8748 is obsolete, that may be a good strategy. A wide selection of new and used programmers is available from General Device Instruments (Tel: 408 241-7376, BBS: 408 983-1234).

CB to 10 Meters

Q *I have an old Teaberry CB rig that has SSB for the 27-MHz Citizens' Band. What I am interested in is converting the rig to 10 meters (28 MHz) for amateur use. I have found a supplier of crystals but have no idea what frequencies to order. The crystals in the synthesizer range from 11.4 to 11.750 MHz. Can you give me any information I might be able to use?—M. McG., Macks Creek, MO*

A Because the 10-meter ham band and the Citizens' Band are right next to each other (at 28 and 27 MHz respectively), converting a transceiver from one band to the other sounds like a simple job. As you've noted, hams use SSB (single sideband), so only an SSB CB would be worth converting.

The trouble is, since the late 1970s, most CBs have used frequency synthesizers rather than simple transmitter crystals, and it's not always easy to reverse-engineer a synthesizer. We are aware of one CB circuit (using a PLL02A synthesizer) that can be converted simply by connecting pin 8 of the PLL02A to ground instead of +5V. This tells the digital circuitry to make all frequencies 1.28-MHz higher than they previously were. A full alignment, with frequency counter,

continued on page 29

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

A Grateful Reader

First of all, I want to commend you on an excellent magazine, both in content and presentation.

The article "Build a TV transmitter" (*Electronics Now*, May 1996) was not only outstanding, but entertaining as well. As a regular reader and one who is interested in this field of study, the article was invaluable and appeared at just the right time to help me.

IWUAGU OBI
Rotterdam, Holland

Simpler Frequency Doubler

I'm surprised that your circuit gurus didn't catch the fact that a much simpler circuit for frequency doubling exists than the one from Bobby Smith ("Letters", **Electronics Now**, September 1996). Here are two versions.

Figure 1 uses only a single exclusive-OR gate and a couple of passive components. The width of the output pulses are determined by the time constant of the RC network, and the maximum input frequency cannot exceed ½RC. If very high frequency operation is needed, or if very narrow output pulses can be tolerated, the circuit shown in Fig. 2 can be used. In that case, the output pulse width is determined by the propagation time delay of the exclusive-OR gate, and the input frequency cannot exceed ½[delay]. Neither circuit has a low-frequency limit.

MAX CARTER
Wheatland, WY

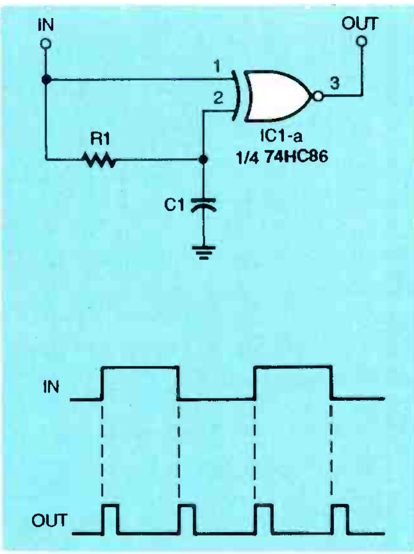

FIG. 1

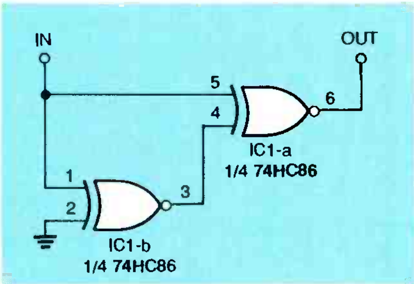

FIG. 2

JamMix Suggestions

I found William Hendry's JamMix (Electronics Now, October 1996) to be a fun application and a professional-looking unit. However, I was surprised at the selection of the MC1458C op-amp for the mixer circuitry. I believe that high noise, low performance op-amps such as the MC1458C are not really suitable for accurate audio reproduction, even for the modest requirements for guitar amplification. Of course, Mr. Hendry did mention his preference for a small amount of distortion, and that might be why he decided to use that particular op-amp.

To do justice to the bandwidth of the JamMix, a low-noise, higher performance dual op-amp can be directly substituted. I would recommend the TL072 or the NE5532. Of the two, the 5532 has higher bandwidth and slew rate, lower distortion, and can drive 600-ohm loads. But its higher supply current will run the batteries down faster. The TL072, with less than half the supply current of the MC1458C, would conserve battery power better.

The problem with using the 1458C is that when the device is configured as a unity-gain inverter, the input level has to be reduced below 1-volt peak-to-peak at 10 kHz in order to get down to 1% THD+N at the output. At a 3-volt peak-to-peak input (not unusual for a guitar pickup), the THD+N is over 4%. Viewed on an oscilloscope, the output waveform shows the typical 741 non-symmetrical slew-induced distortion as well. Above 10 kHz, the THD increases dramatically.

The 741-type devices (741, 747, 1458, 308, 358, 4136, *etc.*), and especially the LM324, are not a good choice for audio use. Given the availability and low price of devices with vastly higher performance, they are not even cost effective. You can buy an NE5532 or TL072 for about 40 cents more than a 1458 and you can hear the difference.

As another suggestion, the unused section of IC4 should be connected as a grounded voltage follower (pin 5 to ground, pin 6 connected to pin 7). Leaving the unused inputs unterminated invites oscillation. That uncontrolled oscillation can degrade the sound by coupling into the other op-amps via the power supply rails, and can draw enough power to run the batteries down much faster than normal. The performance can be further improved by connecting 1-µF ceramic decoupling capacitors from pins 4 and 8 to ground at each op-amp, as is recommended for linear devices.

CHARLES HANSEN
Tinton Falls, NJ

EN

Write To:
Letters,
Electronics Now Magazine,
500 Bi-County Blvd.,
Farmingdale, NY 11735

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

EQUIPMENT REPORTS

A MAGNETO OPTICAL DISK DRIVE FROM OLYMPUS

Transport large files from computer to computer with ease, with the Olympus SYS.230 Magneto Optical drive.

CIRCLE 15 ON FREE INFORMATION CARD

Anyone who has used a computer for some time surely knows what a pain in the neck it can be to transport large files—ones that are too big to fit on a conventional floppy. Sure you can compress large files using archive software, and there are programs that let you chop up big files into ones small enough to fit on floppy disks, but none of that is at all convenient. Even if you have a lot of little files that total 10 or 20 megabytes, it's still a real chore to put it all on floppies and it takes a long time. It's also ridiculous to consider using floppy disks to back up a decent-sized hard drive. Fortunately, we don't have to rely on floppy diskettes anymore, because magneto optical, or MO disks, offer an attractive alternative.

An MO drive combines magnetic and optical technologies on disks that hold a lot more data than floppy disks, and they're rugged, can be rewritten, and are relatively cheap. For example, the *Olympus SYS.230* drive uses disks that are about the same size as regular floppy diskettes, but they hold 230 megabytes and cost around $10 apiece. (Olympus Image Systems, Inc., Two Corporate Center Drive, Melville, NY 11747. Tel: 516-844-5000, 800-347-4027, Fax 516-844-5339, http://www.olympusamerica.com)

MO Disks and the SYS.230

MO disks are different than magnetic media. An MO drive uses a laser to heat special magnetic media on an MO disk to the point where the data can easily be rearranged, or rewritten, by a magnetic head. Once the laser is removed and the material cools, the data is basically permanent and more or less impervious to stray magnetic fields. The laser isn't used when data is being read.

The basic Olympus SYS.230 is available as an internal model for $299, and as an external SCSI model for $359 (plus the cost of a SCSI controller if your PC does not already have one). There's also an external "Universal" model that adds a special adapter cable for use with any standard parallel port; its list price is $389 (street prices are, of course, much lower). Pack the Universal drive in your travel bag and you can load files onto just about any system wherever you go.

The SYS.230 has a 256 KB cache and spins at 4200 RPM. Olympus specifies a seek time of under 27 milliseconds and a data transfer rate of 1.72 MB per second. The drive measures 8 × 6 × 2 inches and weighs about 2 pounds, so it's easy to pack and carry. It's about the same size as an external modem. The drive is backward-compatible with 128 MB MO disks.

Olympus' disks are rated for 30 years of archival quality storage; the disks are available from other manufacturers as well. Each 230 MB disk is equivalent to 175 floppies; at $10 apiece, that works out to be just a little more than 4 cents per megabyte.

We tested the external SCSI SYS.230 with a Pentium system running Windows 95 both by connecting it directly to a SCSI adapter and to a parallel port with the special adapter cable. Of course, you'll get better performance if you connect the drive to a SCSI controller, so that's the preferred method. The drive can sit flat or stand vertically on its side in an included cradle. An AC adapter provides power.

Installing the SYS.230 is the easiest job you'll ever do if you're connecting it to a SCSI controller. The SYS.230 has two SCSI connectors on the back so you can connect other SCSI devices to the chain. A SCSI cable is included with the drive. A small rotary switch on the back of the SYS.230 sets it to an unused SCSI ID. Another switch provides built-in SCSI termination (you must terminate the drive if it's the last device on the SCSI chain). Windows 95 does the rest by automatically detecting the drive when it boots. The installation procedure is slightly harder if you're using a parallel port because you'll also have to install the parallel-port adapter software that's included with the Universal model.

The 230 MB disks are ready for use after a quick formatting procedure, accessed by a right mouse click on the drive icon in the My Computer folder. To test the drive's data-transfer rate, we copied a 31 MB file to the drive and timed it at 1 minute and 40 seconds. That worked out to a transfer rate of 310 KB per second—about the same as a 2× CD-ROM drive.

Fortunately the SYS.230 can read faster than it writes. The same 31 MB file copied back to the hard drive in 35 seconds, which is equivalent to a transfer rate of 886 KB per second. That's about the same speed as a 6× CD-ROM drive. The measured ratings aren't as fast as those specified by Olympus, but the drive is still fast enough for practical use. You can carry the drive from machine to machine, or send disks to someone else who has a 230 MO drive.

For more information on the Olympus SYS.230 MO drive, contact the manufacturer directly at the address given earlier in this article, or circle 15 on the Free Information Card. EN

NEW LITERATURE

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The Whole Spy Catalog: A Resource Encyclopedia for Researchers, PIs, Spies, and Generally Nosy People

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Intelligence Incorporated
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Fax: 415-851-5403
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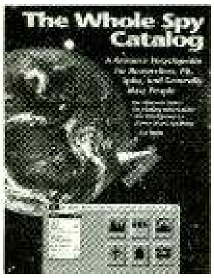

CIRCLE 338 ON FREE INFORMATION CARD

Intended to serve as *The Whole Earth Catalog* of spying, this book makes readily available to the general public the tricks, techniques, and secrets of espionage experts including the CIA, KGB, and other major spy agencies. It provides do-it-yourself pointers for amateur snoops, shows how to turn nosiness into a career in espionage, and explains where to go to hire ex-CIA or -KGB agents for jobs that might be too difficult or dangerous for you to tackle yourself.

Whether you want to find out if your date has a police record (or a decent bank balance), track down an old friend, or find out if your spouse is really working late so often, this book provides the resources and know-how to do so. It shows you how to access mail-forwarding, warranty-card, magazine-subscription, reverse-directory, and credit information to build a dossier on anyone. You can uncover a person's real property, bank accounts, stocks, bonds, off-shore accounts, and cars.

The book provides tear-out fax forms to help you get quickly started in your search. It shows you how to create a real-time chart that begins with a name and ends with a complete personal history. It reveals a $5 phone call that can instantly locate 90% of the population. The book also reveals the best on-line resources for locating and researching just about everything, including free federal databases, the Library of Congress, and organizations and associations that conduct searches.

The book shows how to apply for a job with the CIA, mingle with other "young intelligence professionals" in a national social club, and legally subscribe to the FBI's in-house newsletter and a variety of other publications. It explains how to order aerial or high-resolution satellite photos of anyplace in the world; hire the best private detectives; locate and bug anyone with the latest electronic surveillance devices—including a source where you can buy actual KGB surveillance equipment; tap any phone; set up video surveillance systems; and use countermeasures such as scrambling and encryption to protect your own privacy from other would-be spies.

The New Internet Navigator

by Paul Gilster
John Wiley & Sons, Inc.
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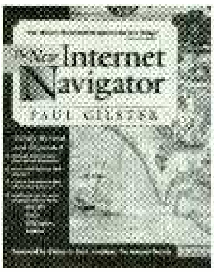
New York, NY 10158-0012
Tel: 1-800-225-5945
Web site: http://www.wiley.com
$24.95



CIRCLE 339 ON FREE INFORMATION CARD

This comprehensive Internet tutorial clearly charts unknown territory for newcomers and experienced Net travelers alike. It has been completely updated to reflect the changing boundaries and newly discovered territories of the continually evolving Internet.

Readers learn everything they need to know to access the Internet from anywhere in the world. The book shows them how to set up and get the most out of their Internet connections through Prodigy, CompuServe, and America Online. It explores the World Wide Web, and explains how to optimize Web browsers such as Netscape and Mosaic. The book discusses a whole new generation of Internet tools and provides practical examples of how to perform searches. It reveals how the Internet actually works and explores the underlying technologies, including TCP/IP, that make it work.

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These two data books feature more than 60 new high-performance and mixed-signal solutions. They also provide complete product descriptions, applications tips, performance graphs, detailed specifications, and ordering information.

In its more than 1300 pages, the *Linear Products* data book gives designers over 35 high-performance linear solutions. Highlighted new products featured in the data book include op amps, instrumentation amplifiers, isolation products, power op amps, optical sensors, references and regulators, and demonstration boards.

The *Mixed Signal Products* data book has more than 1100 pages of high-performance data conversion solutions for every design project. New products include A/D and D/A converters for industrial, instrumentation, and communications applications; data-acquisition components; digital audio converters; sample/hold amplifiers; V/F converters; multiplexers; and demonstration boards. EN

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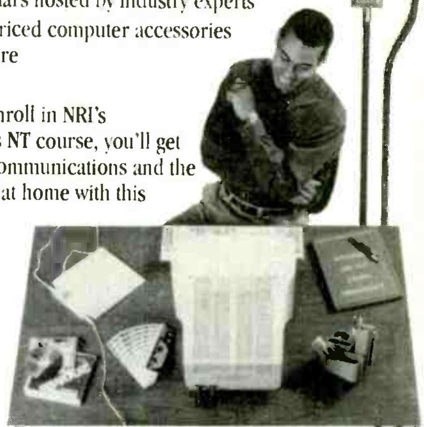

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NEW PRODUCTS

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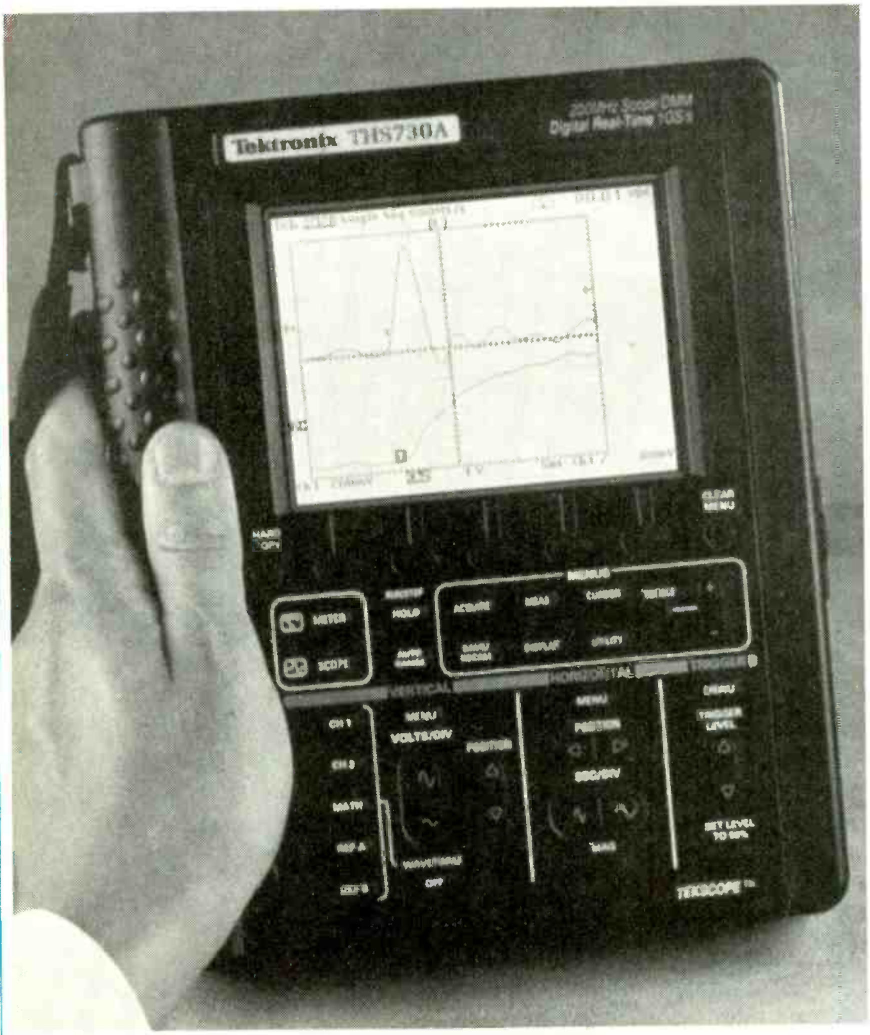
200-MHz TekScope

The THS730A handheld oscilloscope/digital multimeter represents the top of the TekScope line from Tektronix. The THS730A operates at 200 MHz, with an industry-leading 1-gigasample-per-second (GS/s) digital real-time (DRT) sampling rate. Textronix' exclusive IsolatedChannel architecture ensures the best possible safety for the user and the circuit under test, as well as uncompromised bandwidth.

Aimed at design and test engineers responsible for electronic circuit design and debugging, and for troubleshooting in the field, the TekScope offers high-speed, dual-channel/dual-digitizer measurement and triggering capabilities for quick timing-error detection. It features an easy-to-understand graphical user interface (GUI), comprehensive and advance triggering, glitch capture, and dB and dBm measurements. Battery trickle-charge time is only nine hours.



CIRCLE 20 ON FREE INFORMATION CARD

The THS730A 200-MHz TekScope, complete with two 200-MHz P6117 probes, costs $2995.

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Data-Acquisition and -Analysis Software

Two improved 32-bit data-acquisition and -analysis software programs from Fluke are designed specifically for use in research and development, as well as for industrial applications.

NetDAQ Logger for Windows offers the full advantage of Windows 95 and Windows NT operating systems while using the higher speed data-transfer capabilities of the NetDAQ data-acquisition products. Enhancements include view menus, tool and status bars, longer file names, and support for direct connection to a PC or general networks.

CIRCLE 21 ON FREE INFORMATION CARD

The updated version of the Trend Link For Fluke software package offers an advanced trending and analysis 32-bit configuration. It presents real-time data and recorded data in a chart recorder format for easy recording and analysis. The enhanced version includes the ability to reference real-time data to an historical trend for comparison. A multiple-document interface and display allow users to analyze and compare real-time and historical data from multiple sources. The program can be used with Fluke's entire line of portable and networked data-acquisition products, including the NetDAQ, Hydra, and Wireless Logger.

The NetDAQ Logger for Windows has a suggested list price of $795; upgrades are free to registered users. Trend Link for Fluke is available for a suggested list price of $895, or as an upgrade for $300. Full-featured demo disks are available at no charge for both packages.

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Field-Strength Meter

Palomar Engineers' Model PFS-1 field-strength meter is intended for serious antenna work. It features a detector that is linear over a nearly 30-dB range, an accurate step attenuator with 30-dB range, and a 25-dB RF amplifier. High-Q tuned circuits suppress out-of-band local signals. Its panel meter is readable to 0.1 dB.

CIRCLE 22 ON FREE INFORMATION CARD

The PFS-1 covers 1.8 to 150 MHz and is powered by 9- or 12-volt batteries. An SO-239 jack on the back of the aluminum cabinet is available for antenna connection.

The Model PFS-1 field strength meter is priced at $195.

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BOB OBLACK*

Blending the Best of Analog and Digital

DIGITAL STORAGE OSCILLOSCOPES (DSOS) ARE HOT. YET A SMALL POCKET OF ANALOG-SCOPE USERS ARE STILL LOYAL TO ANALOG TECHNOLOGY. SOMETIMES, THAT IS BECAUSE THEIR APPLICATION CAN ONLY BE SERVED BY ANALOG TECHnology. More often, it is because these users feel that DSOs lack the real-time event-display capability that their analog scopes provide. For analog-scope owners, and anyone else considering purchasing a new DSO, there is an excellent new choice.

Imagine an oscilloscope that combines the best qualities of an analog oscilloscope—real-time signal capture (a complete record in a single sweep)—combined with the characteristics of a digital storage oscilloscope (the ability to store, recall, manipulate, and digitally analyze waveforms). Now, think about the same scope with bonus benefits such as PC data compatibility and high-end features such as FFT (Fast Fourier Transform). Sound too good to be true? Sound totally out of your price range? Five years ago, we might have agreed with you.

Today, however, a significant new technology—*Digital Real-Time*—puts the best of analog and digital signal acquisition right at your fingertips—and at a fraction of the cost of equivalent capabilities five years ago. Digital Real Time technology (we'll refer to it as DRT from here on) is a natural evolution of both analog and conventional digital acquisition technologies. This exciting technology is available today in select DRT scopes priced below $5,000 and sometimes for as little as $2,500.

DRT technology solves the majority of waveform viewing and measurement limitations you found in earlier scope technologies. For analog scopes, those include the inability to capture single-shot signals and save and manipulate all kinds of waveforms; for conventional DSOs, it includes the limitations of real-time sample rates and display-update rates.

DRT Described

DRT is a waveform-acquisition technology that uses high-speed sampling (oversampling) or very fast digitizing rates to acquire a complete waveform record in one trigger (or sweep). Those sampling rates must be at least four times the analog bandwidth of the oscilloscope to qualify as a DRT. That gen-

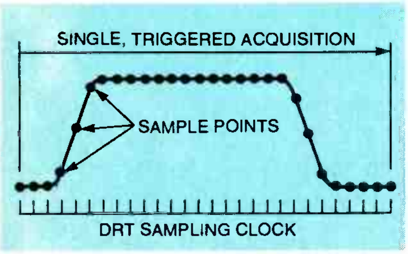

FIG. 1—IN DRT SCOPES, a high-speed sampler takes samples in sequential order and fills the waveform record from beginning to end in a single, triggered acquisition.

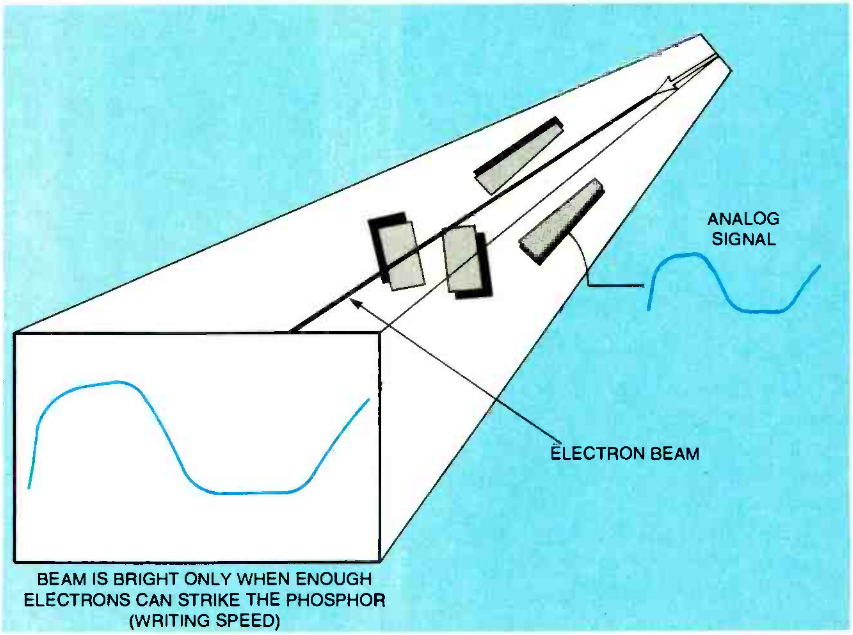

FIG. 2—ANALOG DISPLAYS, created by driving an electron beam across the phosphor on the CRT screen, are woefully inadequate for viewing low-repetition-rate signals at fast sweep speeds, single-shot events, or slowly changing waveforms.

*Tektronix, Inc.

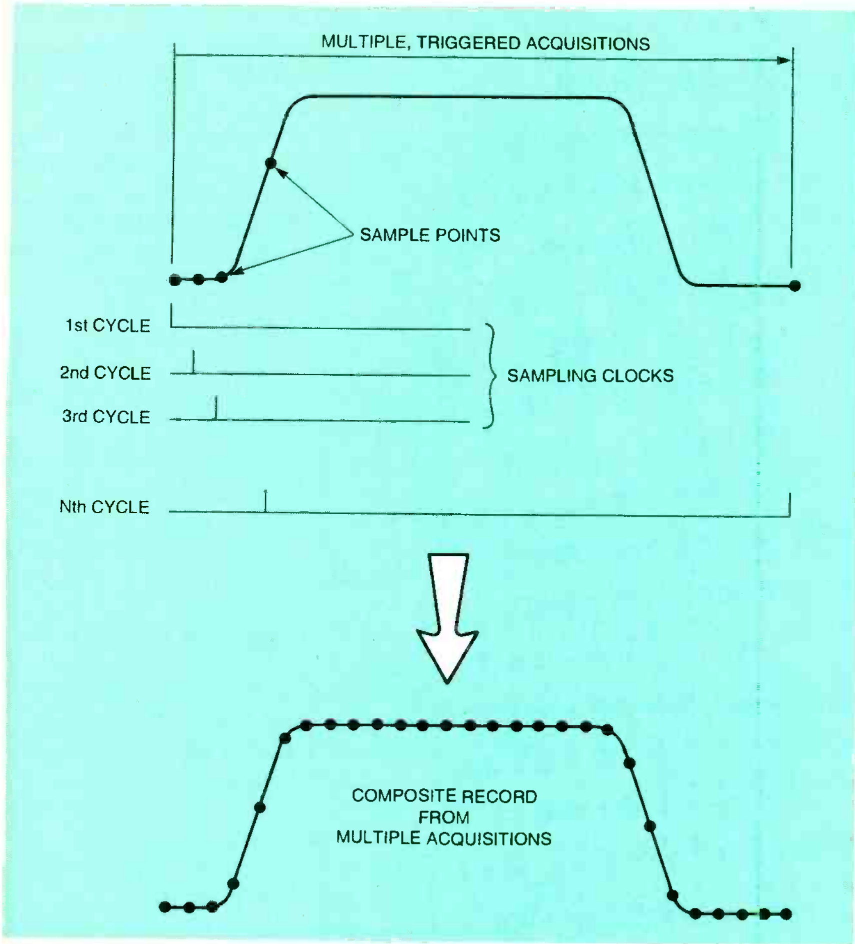

FIG. 3—IN EQUIVALENT-TIME DSOs, low-speed sampling is used to take one or more samples from each triggered acquisition. The samples from numerous triggered acquisitions must be combined over time to fill the waveform record with a composite representation of the waveform.

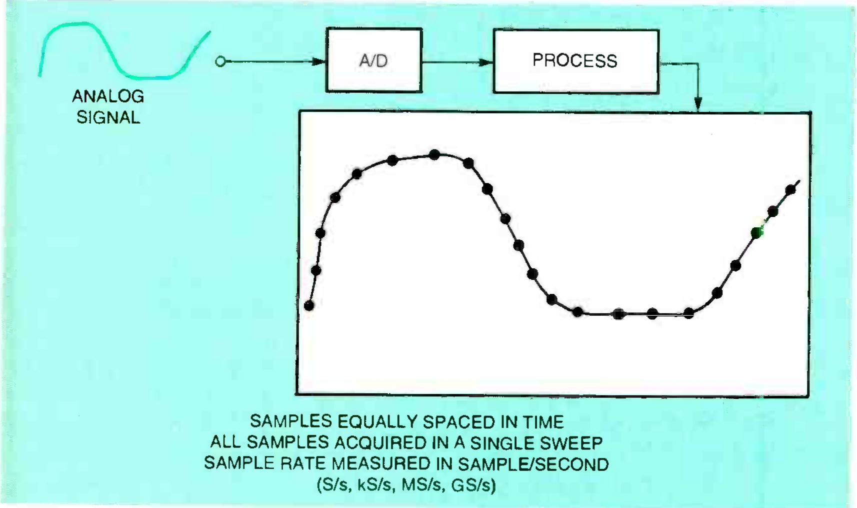

FIG. 4—DRTs ENABLE THE CAPTURE of fast, low-repetition rate signals from a single, triggered repetition. You can acquire the narrow, fast pulse at any time/division setting without having to wait through the multiple acquisitions needed to build a full display with equivalent-time methods

erally places the sampling rates of DRT scopes in the gigasample/second range. High-speed CMOS integrated circuits enable DRT scopes to acquire enough sample points to create a full record (Fig. 1) in one acquisition. The DRT scope also uses "fast in, slow out" (FISO) technology that samples the analog signals at a very fast rate, stores them inside the CMOS circuit, slowly reads them out as analog, and uses high-speed digitizers to process them for display on the CRT.

Another distinguishing characteristic of DRT scopes is that they have a separate real-time sampler for each input channel, with the same high sample rate available simultaneously on each. This eliminates the speed tradeoffs of shared sampling in conventional DSOs when more than one channel is in use.

Faithful Reproductions Instantaneously

The primary benefit of DRT is that it gives you a faithful and instantaneous reproduction of the time and amplitude values of each waveform. In contrast, conventional DSOs show composite displays of captured waveforms.

Analog displays are created by driving an electron beam across the phosphor on the CRT screen (see Fig. 2) to create a visible trace. That real-time technique is fine for viewing most repetitive waveforms, but is woefully inadequate for viewing low-repetition rate signals at fast sweep speeds, elusive single-shot events, slowly changing waveforms, and fast transitions.

Conventional DSOs typically use equivalent-time sampling methods (see Fig. 3). That means repetitive triggering to build a full record of waveform samples over many waveform cycles. Because the equivalent-time waveform is a composite of many repeated acquisitions, the ability to capture single-shot waveforms is limited. In addition, there can also be a notable delay between the waveform acquisition and its display. That display-update rate delay can be annoying, especially when you are trying to make circuit adjustments.

DRT scopes, on the other hand, allow you to capture single-shot waveforms with the same methods you'd use with an analog oscilloscope—in real time, up to the analog bandwidth of the scope. You'll not only capture the waveform to full bandwidth and resolution, but because you are capturing it with a digital scope, you can store it for easy viewing, in-depth processing, and analysis. Moreover, DRT oscilloscopes provide the same measurement advantages of traditional DSOs, *i.e.*, signal averaging to reduce noise, peak detection to catch glitches, and enveloping to track waveform changes over time.

DRTs also enable capture of fast, low-repetition rate signals from a single, triggered repetition. You can acquire the narrow, fast pulse at any time/division setting without having to wait through the multiple acquisitions needed to build a full display with equivalent-time methods (see Fig. 4).

Bonus Capabilities

As mentioned, DRT oscilloscopes offer all of the benefits that you associate with conventional DSOs. But you also get some important bonus capabilities. Since DRTs incorporate leading-edge technology at a decreased cost, you can have a number of advanced capabilities that were only available in very high-end scopes a few years ago. For example, with DRTs you get PC diskette and data compatibility and Fast Fourier Transform algorithms.

Some DRTs come with a standard 3½-inch disk drive, a feature that less than a decade ago was found only in scopes costing over $10,000. That capability allows you to save test setups and reference waveforms on a diskette and use them for ongoing test procedures—up to 700 test files can be saved per diskette. You can also save display screens in a variety of formats (BMP, TIFF, PCX, PostScript, etc.) for use in test reports or presentations.

Because the diskettes on which you've saved your data are PC-compatible, you can also import the data into your computer for further use and analysis. For example, waveform data can be converted into word-processing documents, spreadsheets, even *MathCAD* formats for mathematical modeling and analysis.

Another bonus capability is Fast Fourier Transform (FFT), a feature that five years ago was found only in scopes at the $25,000 price range. FFT is an algorithm that can be applied to waveform data to obtain frequency information. That is useful in such applications as amplifier testing for sound quality, where you need to look at sinewaves and squarewaves on a frequency-domain display. With FFT, you will be able to detect subtle changes in the waveform that would not otherwise be visible on your display.

A New Paradigm

Five years ago, an oscilloscope based on DRT technology would have cost you around $30,000. Today, these scopes range from $2,500-$5,000. At such an affordable price, does it really make sense to use outdated analog technology for the majority of test and measurement applications? From acquiring signals in real-time, to all the advantages of digital storage, to advanced bonus capabilities such as FFT, your money simply buys so much more in a DRT oscilloscope.

It's interesting to note that the first analog oscilloscopes went on the market in the mid 1940s. Digital storage oscilloscopes were introduced in the late 1970s. Today, DRTs culminate 50 years of scope technology, offering users the best of both analog and digital storage in an exciting new paradigm of oscilloscope technology. **EN**

BY JEFF HOLTZMAN

How Not To Be A Bad Coder

I WISH I COULD SAY THAT THE EVENTS RELATED BELOW WERE PART OF SOME ELABORATE APRIL FOOL'S JOKE. UNFORTUNATELY, THEY'RE NOT. AS A CONSULTANT, I FREQUENTLY GET CALLED IN TO HELP OUT ON PROJECTS THAT ARE BEHIND schedule and up against a serious deadline. Sometimes it's stressful, but I enjoy it. Recently I worked on a project with a team of people who were putting together a set of programs to model use of health-care facilities by the U.S. military. The model ran on a huge UNIX server to which Windows-based clients would attach, via the Internet. The clients gathered data from users, submitted it to the server, and presented results when they became available. The server portion was written in POSIX-based C running against an Informix database, and the client portion was written in Delphi. I worked on the Delphi client.

(Aside: When Delphi first came out, I couldn't interest clients in it. Now they are coming to me. This is a "Good Thing.")

As it turned out, the most interesting part of the experience for me was not the health-care model, not even the Delphi development, but what was really a personnel issue. One member of the team was not pulling his share of the load. He certainly tried, but just wasn't capable. Eventually management saw that he was not cutting it, and really needed to find another line of work. In the meantime, the rest of the team suffered.

Part of my job in this case was to analyze what Mr. X had been doing, and either fix it or re-do it from scratch. In the process, I worked closely with Mr. X. Watching him work, and trying to work with him, was a massive experience in frustration. To ease the frustration, I decided to make it a learning experience. I hoped that by trying to understand exactly how he was going wrong, observing his mistakes, and cataloging them, I could thereby develop a smorgasbord of tips for how to be a better programmer. Of course, much of the advice is negative ("Don't do this, don't do that."). But that seems to be mostly how we learn anyway.

The Scenario

The project had been undergoing development for about six months when I joined, with about eight weeks left until a major milestone and beta delivery to the client were to occur. Most parts of the application were in good shape, and delivery was set to occur on schedule.

Shortly before I joined, the project manager (PM) realized that Mr. X's area had problems. It was a complex area from several points of view. The underlying concepts were complex, the required user interface was complex, and the coding necessary to make it all work was complex. When I first arrived, the PM held several meetings to review Mr. X's plans, and subsequently decided—with the tacit agreement of the rest of the team—that Mr. X was on top of things and would be able to complete his portion of the application on time. I was assigned to work on other less-visible areas of the application.

An interesting twist was that since delivering the original requirements, the client's real interest and focus had shifted to Mr. X's portion of the application. In other words, the thing most important to the client was being developed by the weakest member of the team.

As the deadline approached, everyone was wondering about Mr. X's portion, but he kept reassuring us that things were on schedule. No one forced him to prove that he really was on target.

Next, he blew past several intermediate deadlines, and it was down to the last few days before the due date. Then it became apparent that he was behind. It

HOW NOT TO BE A BAD PROGRAMMER

Know your requirements: If you don't know what you're supposed to be doing, your only chance of succeeding is through blind luck.

Know your tool set: If it's new to you, learn it piece-wise, but learn each section well. You'll be much more valuable to your team-and yourself-if you're expert in some areas than half-fast overall.

Work on one thing at a time: Resist all temptation to jump around. Sure, in software the ankle bone's connected to the thigh bone, and so on, but if the individual bones are weak, the skeleton as a whole will never stand up.

Know underlying theory and techniques cold: You wouldn't expect an MD to practice his trade without a thorough grounding in anatomy and in giving injections. Software is no different.

Don't make fundamental errors: If you repeatedly do, you're almost certainly in the wrong job.

Strive for clarity and concision: When logic starts getting convoluted, you almost certainly need to rethink the problem.

took a few more days to discover just how far behind he was, and how deeply his code missed the mark. He was pulled from the project. We all worked several 18 and 20 hour days.

At that point, it became apparent that even if we worked around the clock, we would never be able to make up the loss. So then it became a question of cutting features. Which features were we contractually bound to provide? Which did the client really need? Which could we provide given the time constraints?

The PM made some decisions, we disabled numerous items in the user interface, and quickly tried to get enough up and running to meet the terms of the contract. Despite the lacking features, the client was happy, and the project was viewed (externally) as a success. Unfortunately, things don't always work out as well.

People Not Technology Issues

Working with Mr. X. was difficult for several reasons, not the least of which was that he was a nice guy. If he had been a total jerk, it would have been easy to write him off. But he was a nice guy, and he sincerely tried to help.

Ultimately, working with him was difficult because of his lack of technical competence. He was simply in over his head. How he managed to go unnoticed so long is a mystery.

One lesson I learned early on was not to ask him too many questions, because he would get diverted, and start down a trail of digression that was almost impossible to trace. After getting intimately familiar with his code, I believe that's how he worked as well. At one point I called his "methodology" a hypertext nightmare. Everything seemed to lead to everything else, with no priority or emphasis or structure.

The project manager was also nice—unfortunately, too nice. She did not exert enough control and authority. She did not hold people accountable, and did not force certain issues (such as having code reviews) until it was too late. That worked fine for the team members who were producing, but not so well in the other case. She had excellent technical understanding of the project, and she acted with good intentions. However, she lacked experience, and some team members felt that her inexperience gave them leave to refuse to submit to code reviews. Ironically, the biggest excuse was that there wasn't time.

The lesson here is: You can't be a project manager and be a nice guy. Conversely, if you want to be a nice guy, project management is probably not a profession in which you will excel.

Mr. X

Following summarizes the traits exhibited by Mr. X. If you ever find yourself experiencing anything like these, a little alarm should go off in your head, and you should fix the problem.

He was never exactly sure what he was trying to accomplish. He didn't have a good grasp of the requirements of the application we were trying to build.

He didn't stick to what he was trying to do. He constantly jumped from one thing to the next without ever completing anything. His code was littered with half-finished routines and unused variables.

He didn't have a good grasp of the tool set (Delphi). He lacked a good grasp of important underlying concepts including object-oriented and relational database theory.

He didn't have a good grasp of programming fundamentals. He repeatedly made basic errors like indexing strings from the wrong position, using lots of global variables, not initializing variables, and hard-coding string and numeric constants.

He created highly convoluted logic flows that were hard to understand and harder to debug. To me, that indicated that he really didn't think through the problem carefully, because if he had, he would have developed a more straightforward solution.

Given all that, you may wonder how Mr. X. ever got into a position that demanded so much technical knowledge, when his qualifications were so lacking. That indeed is a mystery of the political sort, and out of my arena.

Conclusions

So how can you become a good programmer? Even if you avoid the types of mistakes made by Mr. X, you won't necessarily become a good programmer. But by avoiding those mistakes, you can avoid being a bad programmer, and will undoubtedly become a better programmer. If you're lucky, perhaps you'll even become a good programmer. More likely, though, you were born that way . . . or not.

That's all for this month; until next time, you can contact me via e-mail at jkh@acm.org. EN

Q & A

continued from page 13

is then required in order to get the transceiver to perform properly. (In the worst case, you might tune to the wrong side of the VCO and end up on 24 instead of 28 MHz.) Other circuits require changing crystals, but again, you have to align the transceiver after converting it. In the past, specific CB conversion plans have been available from 73 Magazine, WGE Center, Hancock, NH 03449.

Bear in mind that even after doing this, your transceiver will still have 40 discrete channels; you won't be able to tune the frequencies in between.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information. If you are asking about a circuit, please include a complete diagram. Due to the volume of mail, we regret that we cannot give personal replies. EN

EDITORIAL

continued from page 4

Deadline (IBM PC)

Tele-Talk (Atari 400/800)

Miner 2049er (Apple II or IIe)

Flight Simulator II (Apple II, II+, IIe, IIc)
Word Vision Writing Tool (IBM PC or compatible, PC-DOS 1.0 or 1.1)

Rendezvous (Apple II)

The Word Handler II (Apple II+, IIe)

EasyWriter II (IBM DOS 1.1/2.0)

SAT Word Attack Skills (Apple II, II+, IIe, Franklin Ace, DOS 3.3)

Household Finance Cartridge (Commodore VIC 20)

Pipes Cartridge (Commodore VIC 20)

Shamus (Cartridge for Commodore VIC20)

Home Office (Commodore VIC 20)

Peachtree Accounting Software
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- Sales Invoicing (IBM PC, IBM PC XT, IBM PC AT, or compatible)
- Fixed Assets (IBM PC, PC XT, or com patible)
- Accounts Payable (8-inch CP/M)
- Accounts Payable (IBM PC, PC XT, PC AT, or compatible)
- Job Cost (8-inch CP/M)
- Job Cost (IBM PC, PC XT, PC AT)
- Back to Basics Accounting System — General Ledger, Accounts Receivable, Accounts Payable (IBM PC or compati ble)
- Peachpak 4 — General Ledger, Accounts Receivable, Accounts Payable (Apple II, II+)
- General Ledger (8-inch CP/M)
- General Ledger (IBM PC, PC XT, PC AT, or compatible)
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- Inventory Control (IBM PC, PC XT, PC AT, or compatible)
- Payroll (8-inch CP/M)
- Payroll (IBM PC, PC XT, PC AT, or compatible)

EN

WHAT'S NEWS

continued from page 6

number of moire fringes that appear. Ume counts the number of fringes and puts them into an equation; a computer then determines how much warpage has occurred. The warpage process is displayed in real time on a TV screen and recorded in video and on computer.

The Thermoire technique can be used to simulate the three major kinds of soldering processes—infrared reflow, convective reflow, and wave. The oven system can reproduce any given soldering-temperature history used in producing a board, while measuring PCB warpage at any specified time interval or temperature. That allows the system to pinpoint which processes or designs might cause the most warping.

Manufacturers can use the results to make design or process changes before production—perhaps changing soldering temperature profiles, reducing or extending processing times, relocating key components, and changing the types of materials used in assembling the PCB. The Thermoire technique can also be used by manufacturers to validate their numerical warpage predictions. If a certain amount of warpage is allowable, the new process lets manufacturers measure initial warpage (rather than assuming that the board is flat before components are added) and then determine how much additional warpage develops as components are added. The technique also allows manufacturers to measure the warpage of the different materials that are sandwiched together to make a board—F-4 laminates, fiber (prepreg), several varieties of copper foil, and newly developed materials.

Future Thermoire users could include manufacturers of foil, tape, resin, glass fibers, and aviation equipment. Other possibilities include putting Thermoire on an assembly line to make it more automated for the average worker. "The technical applications are larger than the original sponsors knew it would be when they started," said Zwemer. "We want to be a good example of technology transfer."

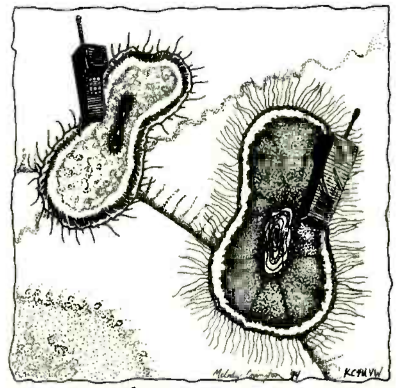
Thermostat Recycling Encouraged

With the support of the National Electrical Manufacturers Association (NEMA), Honeywell, General Electric, and White-Rodgers have formed the Thermostat Recycling Corporation, a private corporation established to facilitate the recycling of used mercury-switch thermostats. There are currently more than 50 million mercury-switch thermostats installed in American homes.

A pilot program, which has regulated the recycling of mercury from more than 13,000 thermostats, has been in operation since 1994 in Minnesota. The Minnesota program will serve as a model for other states. Before the program can be implemented in a state, that state must individually adopt the federal Universal Waste Rules or give appropriate approval. The rules are designed to remove unnecessary regulatory impediments to the safe and efficient management of hazardous wastes.

According to NEMA president Malcolm O'Hagan, Thermostat Recycling Corporation's efforts will focus on heating and air-conditioning contractors and wholesalers because they sell and install the majority of thermostats. In addition, the industry already has in place the infrastructure to support an effective recycling program. (Only a small percentage of replacement thermostats are installed by do-it-yourselfers; those presumably can be handled by the local government's hazardous waste collection program.)

When they install new thermostats, professionals can drop off the old mercury-switch thermostats that they removed—no matter what brand—at their wholesaler. Wholesalers will collect the thermostats in a protective bin supplied by the Thermostat Recycling Corporation. When the bin is full, it will be sent to the corporation's recycling center where the switches will be removed and forwarded to a mercury recycling facility. EN



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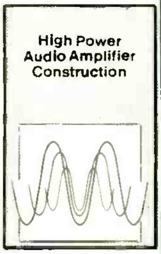

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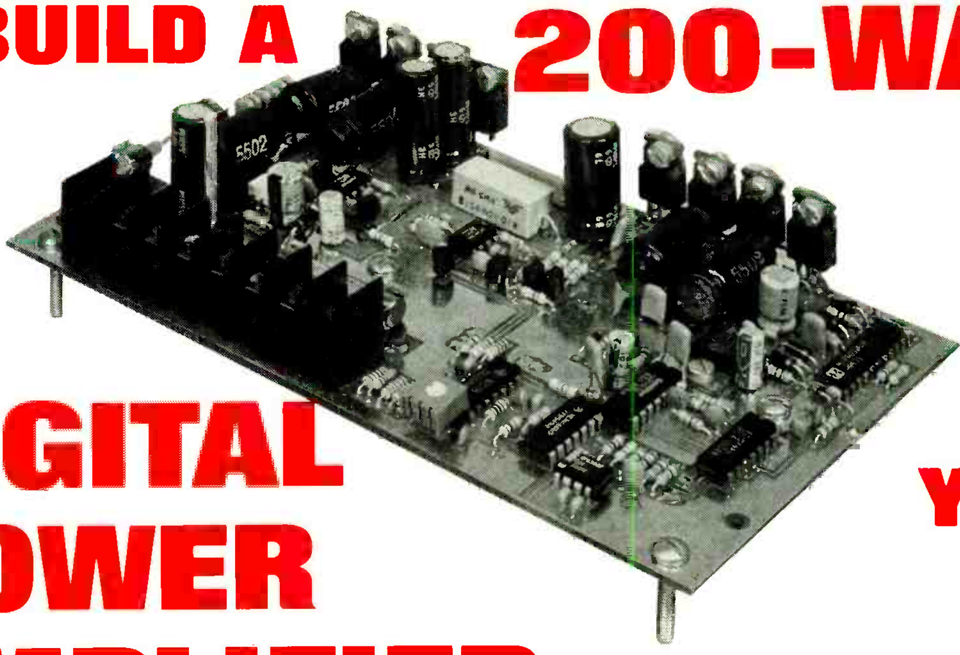


ALAN BAYKO

Here's a project that will add zip to your driving experience—a low-cost, high-end amplifier that's equally at home in your car, boat, or home!

Most audio power amplifiers currently available on the market are some kind of analog design. That seems perfectly reasonable since sound is an analog signal. Unfortunately, high-powered amplifiers tend to be somewhat wasteful in power consumption, making them very hot when operating and fairly bulky due to their large heatsinks.

In the same way that switching-type power supplies are used in computer equipment for their compact size and efficiency, digital amplifiers have become a practical alternative to analog amplifiers. The 200-watt digital power amplifier presented here is designed to take advantage of that type of circuitry, especially in the areas of size, power usage, and heat dissipation.

The 200-watt digital power amplifier presented here is a class-D, single-channel, audio power amplifier that can output 200 watts rms into a 4-ohm load, or 100 watts rms into an 8-ohm load. For stereo applications, two amps will be required. The amplifier will deliver that output power at a 96% efficiency with a distortion value under 1% at 1 kHz, all in a package that measures 7 × 4 × 2 inches. The supply voltage can be between 10 and 18 volts, making it an ideal car stereo amplifier.

How It Works. In analog amplifiers, the output transistors are biased to operate somewhere in the transistor's linear-operating range. That means that some current is always flowing through the transistor, as the transistor is rarely either fully on or fully off. Current flowing through a transistor when there is a sizable voltage difference between the collector and emitter terminals causes the transistor to dissipate heat. Class D amplifiers, on the other hand, pulse-width-modulate the input signal. The analog input signal is converted to an on-off pulse of a single, steady frequency. The width of the pulses depends on the voltage of the input signal. For example, one cycle of a simple sinewave will generate a train of pulses that start with a 50% duty cycle (the ratio of on to off in a pulse train). As the sinewave rises, the duty cycle will increase as the pulses get wider, then decrease as the sinewave returns to zero volts. When the sinewave dips below zero volts, the process is reversed, with the pulses getting narrower then returning to a 50% duty cycle.

The conversion process will be easier to understand with the help of Fig. 1. A high-frequency triangle wave is used as a reference signal, and is compared digitally to the audio signal to be converted (Fig. 1A). If the voltage level of the audio signal is higher than the triangle-wave reference signal, the output is switched on. Naturally, when the audio signal is lower in voltage than the reference signal, the output turns off. That results

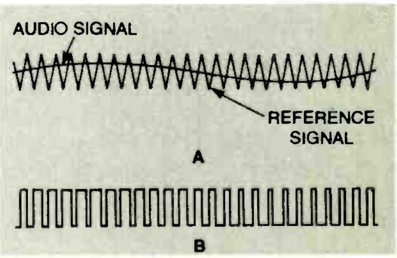


Fig. 1. Comparing an audio signal to a high-frequency, triangle-wave, reference signal (A) results in a series of high-frequency pulses whose widths track the original (B). That is how a class-D amplifier works.

in a pulse train similar to the one shown in Fig. 1B.

Pulses are easily amplified by a switching circuit. Switching circuits do not dissipate as much heat as their analog counterparts because there will be little or no voltage across the transistors when they are switched on, and no current flow when they are switched off. In either state, no power is consumed, so there will be little or no heat given off. The major cause for loss of power in switching circuits is the dumping of the stored charge in the circuit while the circuit changes state. While the transistors are switching, they are passing through their linear operating region, which is where most (if not all) of the heat generated by the amplifier comes from. Switching circuits, therefore, are very similar to CMOS logic circuits.

After the signal has been amplified, it is changed back to an analog signal by a low-pass filter. That removes the high-frequency signals introduced by pulse-width modulating the original signal. The result is an amplified version of the original input signal. If only inductive/capacitive filters are used for the output filter, losses will be very low.

Supply voltages for the 200-Watt Digital Amplifier are generated by a pair of DC-DC converters. Those converters are set up as current-mode controllers. In a current-mode controller, the amount of current flowing through a switching transistor is monitored. Knowing how much current is flowing allows the converter to

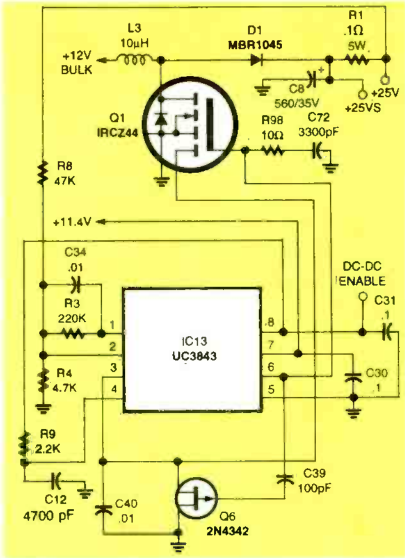


Fig. 4. The positive DC-DC converter creates a 25-volt power source from the 12-volt supply. An enable signal tells the rest of the circuit to shut down if the converter is having a problem.

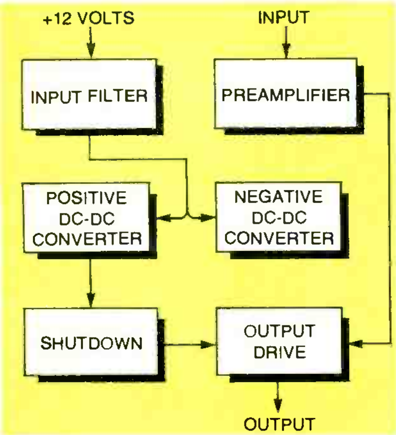


Fig. 2. The design of the 200-watt Digital Amplifier is quite straightforward. Most of the circuitry involved is connected with supply-voltage generation and fault detection.

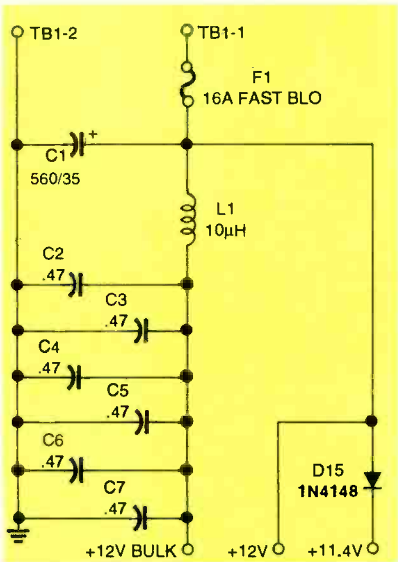


Fig. 3. The input filter for the 200-watt Digital Amplifier smoothes out any supply voltage spikes—either from the power supply or from the amplifier.

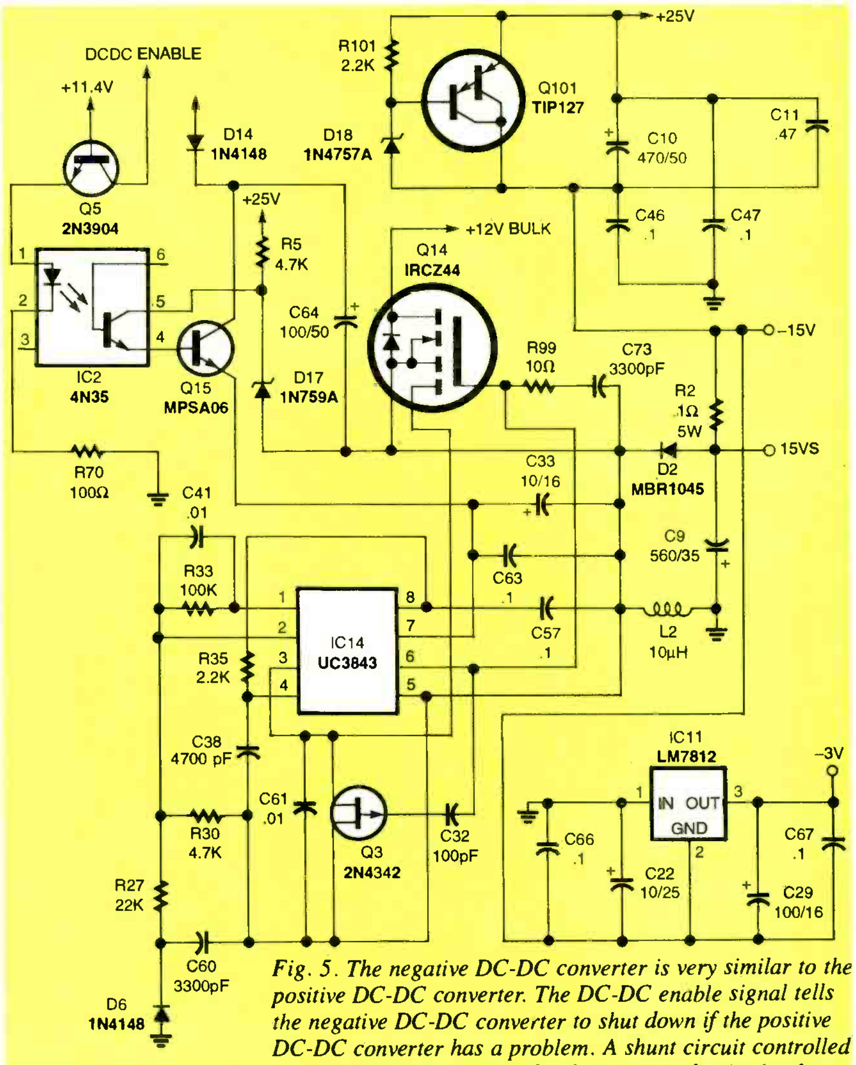


Fig. 5. The negative DC-DC converter is very similar to the positive DC-DC converter. The DC-DC enable signal tells the negative DC-DC converter to shut down if the positive DC-DC converter has a problem. A shunt circuit controlled by Q101 protects the amplifier from very inductive loads at low frequencies and high volume settings.

control how much energy is being converted by turning the transistor off at the right time. By increasing the current allowed through the transistor, the total energy converted by the circuit can be controlled. The current shut-off point is controlled by an error amplifier that monitors the output voltage. If the output voltage drops, the current through the transistor is increased until the voltage returns to the control-circuit reference.

The power amplifier circuit can be divided into the following sections: input filters, positive and negative DC-DC converters, unbalanced-load shutdown circuit, preamplifier, ramp generator, output drive, and output filter. Those sections and their interconnections are shown in Fig. 2. Each section will be described in order.

Input Filters And Converters. The input filter (Fig. 3) smoothes out any ripples that might appear in the supply voltage. The positive and negative DC-DC converters (Figs. 4 and 5) are both current-mode controllers. In both DC-DC converter circuits, the current is monitored using the voltage drop across the drain-source resistance of Q1 and Q14.

When Q1 is on, 12 volts is applied across L3, which causes current flow to build up through L3. The longer Q1 is on, the more current flows. When the error-amplifier portion of IC13 reaches the proper cutoff point, Q1 is turned off. The current in L3 continues to flow and is forced through D1 to the higher potential of the 25-volt supply. The current through L3 will decay because of the reverse potential across L3. After a preset time, Q1 is again turned on and the current through L3 will increase again. The current through L3 does not need to drop to zero before Q1 is turned on.

The negative DC-DC converter is very similar. The only difference is that Q14 and L2 are exchanged, and the polarity of D2 is reversed.

The positive DC-DC converter also generates an enable signal. In the event of a low-voltage condition, the positive DC-DC converter shuts down first. The positive DC-DC converter sends a signal to the negative DC-DC converter telling it to shut down, too.

Shutdown Control. The shutdown circuit of Fig. 6 is used to control

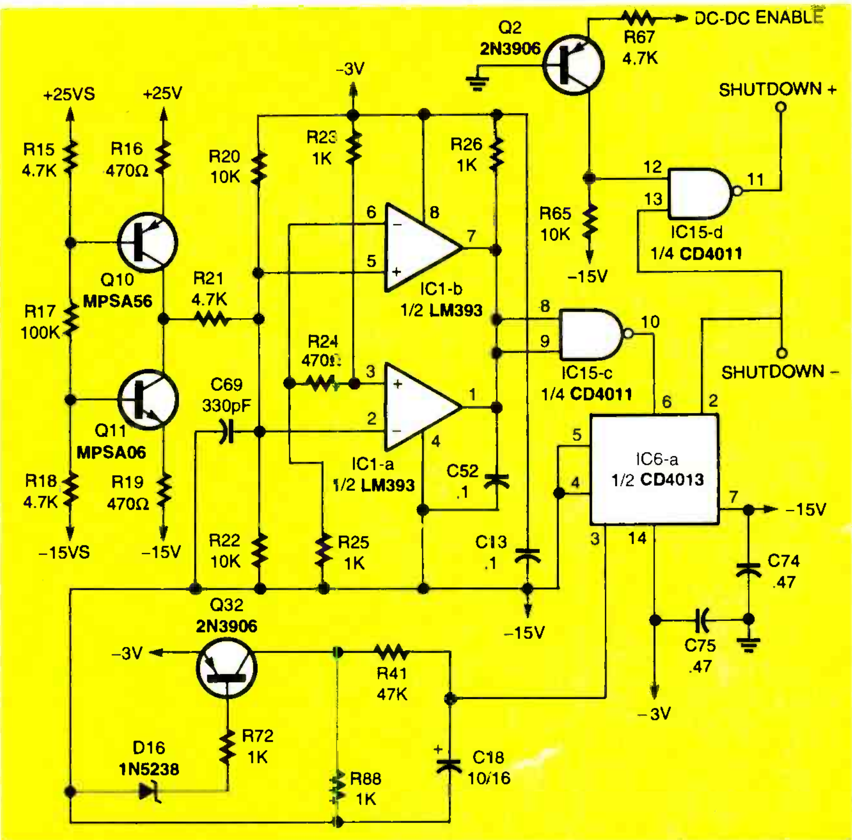


Fig. 6. The unbalanced-load shutdown circuit detects fluctuations in the supply voltages which would indicate a failure in one of the output transistors.

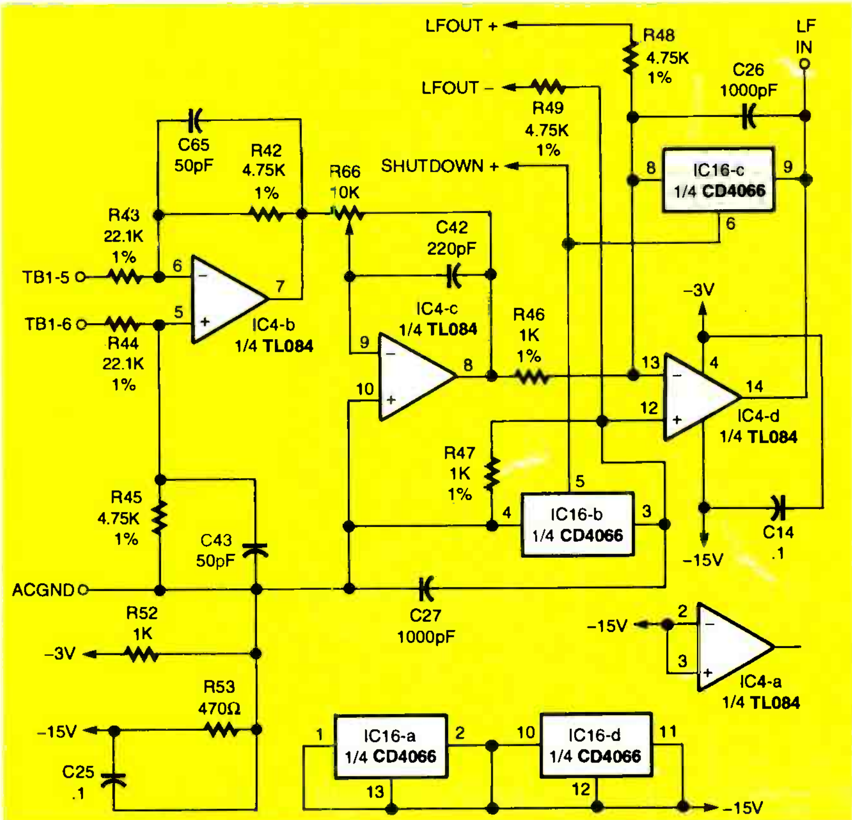


Fig. 7. The preamplifier conditions the input signal for pulse-width modulation.

whether the output transistors are active or shut down. Three conditions under which the output transistors should be shut down are when the power supply is starting up and the voltages are not stable, the input voltage is dropping and the power supply is shutting down, and when the amplifier output is shorted.

To allow the power supply to stabilize on startup, the output transistors are not enabled for ½-second after the difference between the −3-volt and −15-volt supplies reaches 12 volts. By tying C52 to the −15-volt supply, IC6-a starts up in the shut-down state. That prevents a startup pop in the speaker.

The enable signal from the DC-DC converters overrides the output of IC6-a by combining both signals using IC15-d. The enable signal goes low when the power supply is shutting down. That will temporarily shut off the output transistors until power voltages return to normal. The shutdown is temporary because it is possible for a signal spike to cause the external supply voltage to drop below 8 volts for a very short amount of time. When the amplifier is being turned off, a shutdown pop in the speaker is also prevented.

The final cause of shutdown is detected by monitoring the current in the positive and negative supply lines with Q10, Q11, and IC1. If the current in the negative supply is not the same as current in the positive supply, then there is a fault to ground. If that occurs, the output will be shut down and not restarted until power is removed and restored. There can be up to a 1-amp difference in the monitored currents before the amplifier is shut down to make up for component tolerances. A ground-fault shutdown is latched because it only occurs when there is a fault of some type in the wiring. If the shutdown is not latched in that condition, the amplifier would eventually damage itself.

Preamplifier. The preamplifier, shown in Fig. 7, is used to remove noise and condition the input signal for the drive circuit. It is also a part of the control loop for the output-drive circuit, and will be discussed later in this article.

The input signal is applied to both inputs of IC4-b. That method, called differential-input amplification, lets

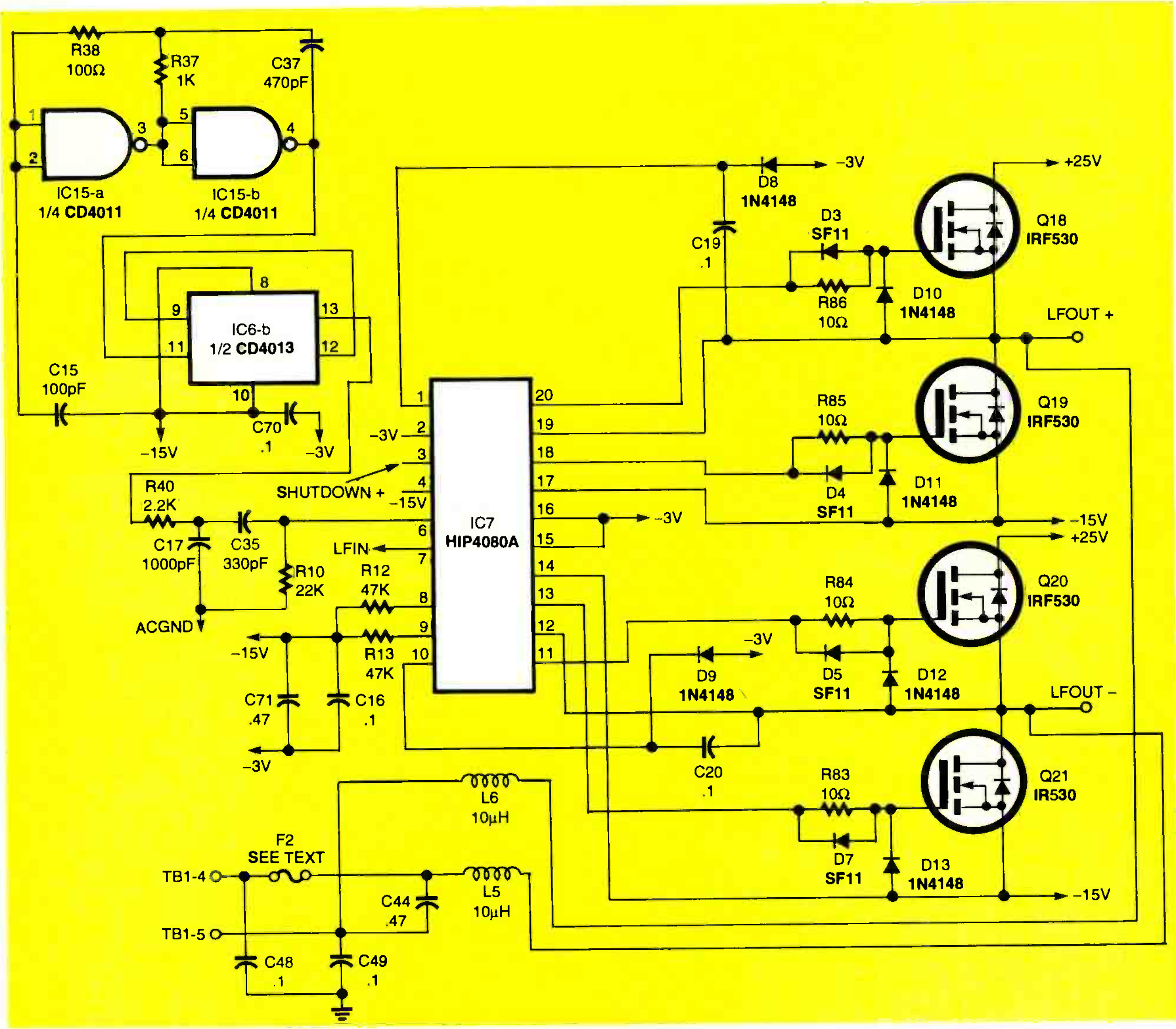


Fig. 8. The output drive circuit pulse-width-modulates and amplifies the signal. A pair of LC filters remove the high frequencies generated by pulse-width modulation.

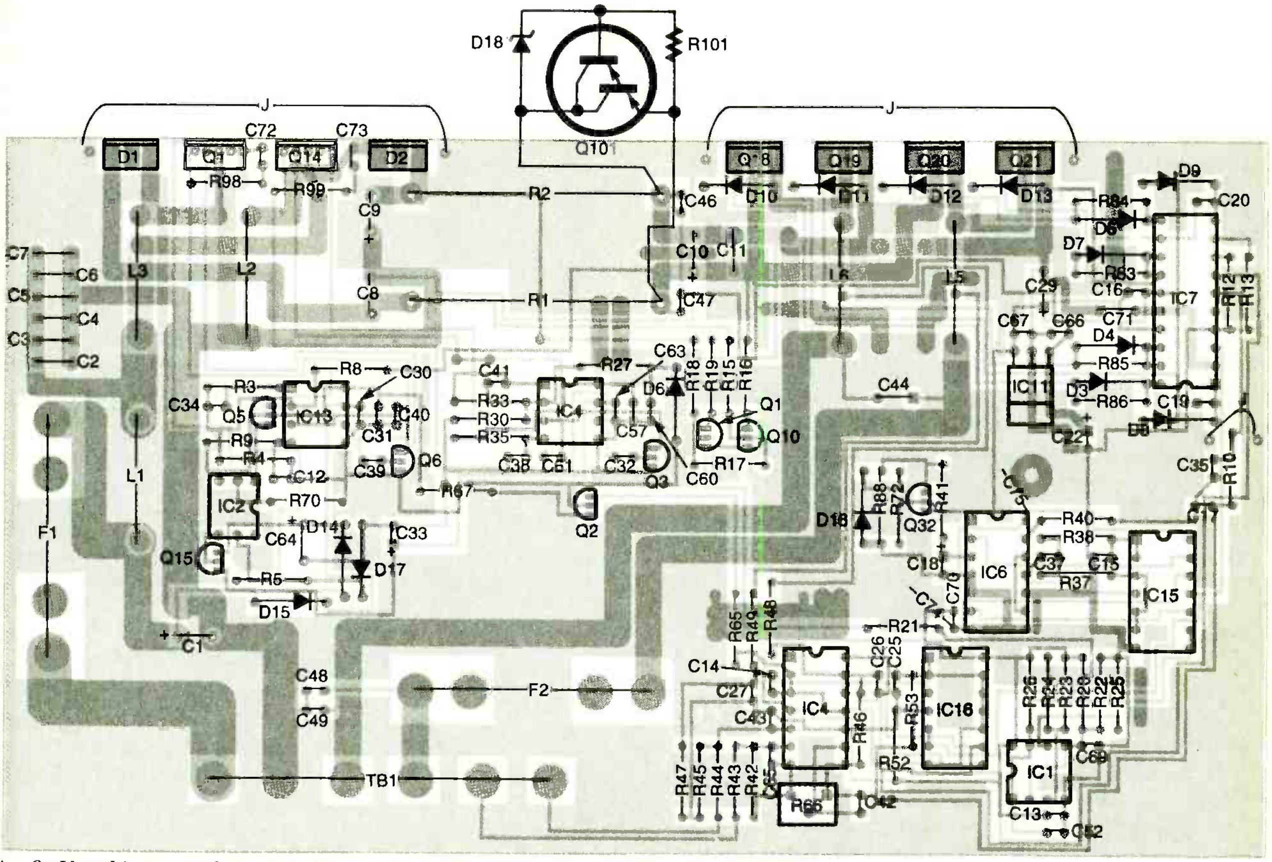


Fig. 9. Use this parts-placement diagram to locate where the various parts of the 200-watt Digital Amplifier are mounted on the PC board. Be careful when handling static-sensitive components such as IC7. Mount Q101, R101, and D18 on the case and connect them to the amplifier with insulated wire.

IC4-b remove any common-mode noise between the local AC ground and the signal-source ground. An added advantage of using differential inputs is that the entire amplifier can be powered from an AC-isolated source, therefore preventing interference with other electronic devices. The amplifier gain can be set to any level between 0.125 and 125, with a gain of about 1.25 when R66 is set to its midpoint.

Output Drive. The actual amplification is done by the output drive and support circuitry in Fig. 8. The audio signal is pulse-width modulated and the resulting pulses amplified. The ramp generator circuit for the triangle-wave reference signal is a simple oscillator using two gates of IC15. That oscillator generates a fixed frequency of about 1 MHz. That frequency is divided in half by IC6, resulting in a perfect squarewave. Resistor R40, along with C17 and C35, forms an integrator that changes the squarewave into a triangle wave.

The triangle wave is applied to IC7, where the actual pulse-width encoding is done. The encoder is placed in a control loop with the preamplifier. That reduces any distortion and noise. The distortion is caused by a less than perfect ramp and the bridge-drive dead time (when no output transistors are on). The control-loop error amplifier is IC4-d in the preamplifier. It has a high-frequency roll off to keep the loop stable and make it immune to high-frequency switching noise.

The additional support circuitry in the output drive controls the turn-on speed of Q18–Q21 and prevents ringing. The turn-on speed of Q18–Q21 needs to be controlled in order to prevent current spikes. Those spikes originate from a freewheeling current (the speaker drive current) that turns on the body diodes of Q18–Q21. In order to prevent the stored charge in the diode from discharging too fast, the rise time of the gate voltage is limited. That discharge current is limited to about 30–50 amps.

If a short occurs across the outputs, then the fuse F2 should blow before any damage occurs. That fuse is also used to protect the speaker in the event of a transistor failure. Selecting the proper size is very important in order to properly protect the speaker. The recommended maximum size for F2 is 16 amps.

Construction. Important—The high-frequency, high-current switching used in the 200-watt Digital Amplifier might cause interference in radio equipment. The layout of the printed-circuit board is designed to limit RF radiation and prevent destructive ringing in the circuit. Component placement is important, so *do not* attempt to build the amplifier on perfboard.

Building the 200-watt Digital Amplifier is quite straightforward. Simply install the components in the board and solder them in place, following the parts placement diagram in Fig. 9. However, installing certain components before others will make construction much easier.

PARTS LIST FOR THE 200-WATT DIGITAL AMPLIFIER

SEMICONDUCTORS

D1, D2—MBR1045 silicon diode
D3–D5, D7,—SF11 silicon diode
D6, D8–D15—1N4148 silicon diode
D16—1N5238 Zener diode
D17—1N759A Zener diode
D18—1N4757A Zener diode
IC1—LM393 dual comparator, integrated circuit
IC2—4N35 optoisolator, integrated circuit
IC3, IC5, IC8–IC10, IC12—not used
IC4—TL084 quad op-amp, integrated circuit
IC6—4013 dual D-type flip-flop, integrated circuit
IC7—HIP4080AIP full-bridge driver, integrated circuit
IC11—7812 12-volt regulator, integrated circuit
IC13, IC14—UC3843 current-mode controller, integrated circuit
IC15—4011 quad NAND gate, integrated circuit
IC16—4066 quad bilateral switch, integrated circuit
Q1, Q14—IRCZ44 N-channel field-effect transistor
Q2, Q32—2N3906 PNP transistor
Q3, Q6—2N4342/J175 P-channel field-effect transistor
Q4, Q7–Q9, Q12, Q13, Q16, Q17, Q22–Q100—not used
Q5—2N3904 NPN transistor
Q10—MPSA56 PNP transistor
Q11, Q15—MPSA06 NPN transistor
Q18–Q21—IRF530 N-channel field-effect transistor
Q101—TIP127 PNP Darlington transistor

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R2—0.1-ohm, 5-watt, 10%
R3—220,000-ohm
R4, R5, R8, R12, R13, R15, R18, R21, R30, R41, R67—4700-ohm
R6, R7, R11, R14, R28, R29, R31, R32, R34, R36, R39, R50, R51, R54–R64, R68, R69, R71, R73–R82, R87, R89–R97, R100—not used
R9, R35, R40, R101—2200-ohm
R10, R27—22,000-ohm
R16, R19, R24, R53—470-ohm
R17, R33—100,000-ohm
R20, R22, R65—10,000-ohm
R23, R25, R26, R37, R52, R72, R88—1,000-ohm
R38, R70—100-ohm
R42, R45, R48, R49—47,500-ohm, 1/4-watt, 1%, metal-film
R43, R44—22,100-ohm, 1/4-watt, 1%, metal-film
R46, R47—1,000-ohm, 1/4-watt, 1%, metal-film
R66—10,000-ohm, variable (BOURNS 3386P-1-103 or similar)
R83–R86, R98, R99—10-ohm

CAPACITORS

C1, C8, C9—560 μF, 35WVDC, electrolytic, low ESR-type
C2-C7, C11, C44, C71—0.47 μF, ceramic disc
C10—470 μF, 50WVDC, electrolytic, low ESR-type
C12, C38—4700 pF, ceramic disc
C13, C14, C16, C19, C20, C25, C30, C31, C46–C49, C52, C57, C63, C66, C67, C70—0.1 μF, ceramic disc
C15, C32, C39—100 pF, ceramic disc
C17, C26, C27—1000 pF, ceramic disc
C18, C33—10 μF, 16WVDC, electrolytic
C21, C23, C24, C28, C36, C45, C50, C51, C53–C56, C58, C59, C62, C68—not used
C22—10 μF, 25WVDC, electrolytic
C29—100 μF, 16WVDC, electrolytic
C34, C41—0.01μF, ceramic disc
C35, C69—330 pF, ceramic disc
C37—470 pF, ceramic disc
C40, C61—0.01 μF, ceramic disc
C42—220 pF, ceramic disc
C43, C65—50 pF, ceramic disc
C60, C72, C73—3300 pF, ceramic disc
C64—100 μF, 50WVDC, electrolytic
C74, C75—0.47 μF, ceramic disc

ADDITIONAL PARTS AND MATERIALS

L1–L3, L5, L6—10-amp, 10 μH coil (Miller 5502 or similar)
L4—not used
F1—16-amp fast-blow fuse
F2—see text
TB1—Terminal strip, 6-terminal, PC-mount
Printed-circuit board, case, PC-mount fuse clips, 4-40 × 1/4-inch screws, 4-40 washers, 4-40 nuts, 8-32 × 1/2-inch screws, 8-32 × 3/4-inch screws, 8-32 nuts, TO-220 mica insulators, no. 8 × 1/4-inch spacers, etc.

Note: The following items are available from: Radical Electronics, Inc., 115 Hall Cr., Saskatoon, SK S7L 7G7, Canada, Tel./Fax: 306-384-8777: Kit of all parts less case, $100. Circuit board only, $23. IC7, $12. Add $4 for shipping charges. Prices for other parts are available on request. Prices listed are in US dollars.

Before soldering any components to the PC board, drill the various mounting holes in a suitably-sized enclosure. The enclosure should be made of steel and should be large enough to hold the PC board without the board touching any sides of the enclosure. The hole sizes and locations in Fig. 10 are measured from the inside of the case. Since it is easier to mark and drill the holes from the outside of the case, measure the thickness of your case's walls and add that measurement to the information given in Fig. 10.

The case will also act as a heatsink for the transistors and diodes in the TO-220-style package. It is best to begin by installing D1, D2, Q1, Q14, Q19, and Q21. The remaining transistors, Q18 and Q20, will be installed later during testing. Put five 8-32 × ¾-inch screws into the top side of the board and secure them in place with hex nuts. Temporarily slip ¼-inch long spacers over the screws and mount the PC board in the case with additional nuts. Make sure that the board does not touch any sides of the case, although is should come close to the side where the TO-220 transistors and diodes will be mounted.

Mount the transistors and diodes onto the case with 8-32 × ¼-inch screws and nuts. Solder each lead of the components to the top side of the board. Remove the PC board from the case, turn the board over, and solder each lead on the bottom side of the board. Do not solder two leads in a row on the same component—skip from component to component. That will allow each solder joint to cool enough that it will not melt again, possibly allowing the component to shift position. If that happens, the component will not line up properly with the mounting hole in the case when the board is reinstalled in the case. Due to the size of the components and PC board layout, C46 and C47 interfere with C10, and will be very difficult to place on the top side of the board. Those components should be mounted on the solder side of the board. Be sure to solder on both sides of the board for all components if your board does not have plated-through holes. Circuit traces on both sides of the board must be connected together, including any unfilled holes.

You might want to install IC4 before

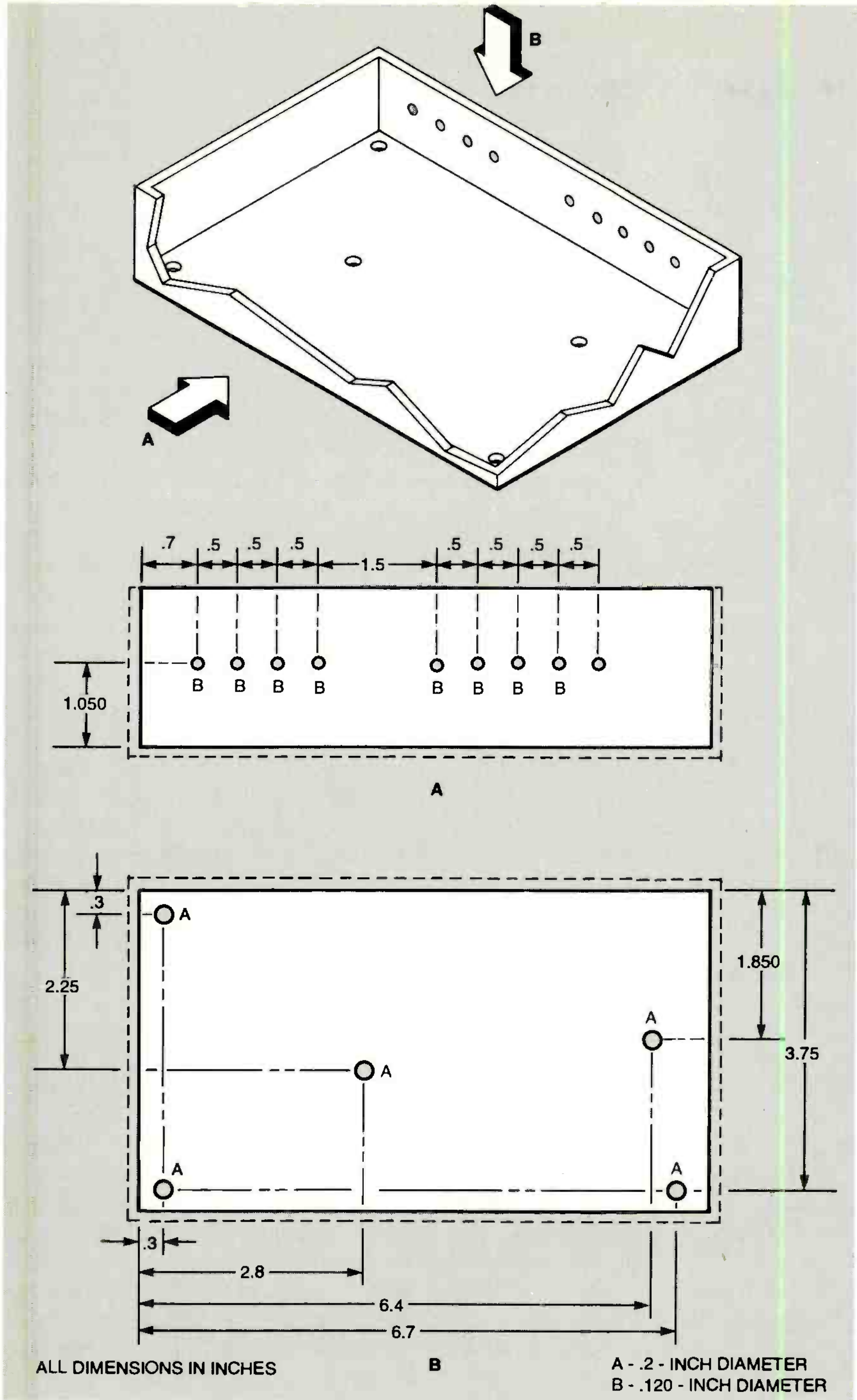


Fig. 10. The hole locations for the amplifier are shown from the outside of the case. The case should be made of steel. Not only is it used as a heatsink for the output transistors, the steel is an effective shield against radio-frequency interference.

R66, depending on the size of the trimpot's case. If needed, you can mount R66 on top of IC4, standing R66 up off the board. Capacitors C74 and C75 should be installed after IC6 is installed. Tack solder one lead of C74 to pin 7 of IC6, and the other lead to the ground plane. Install C75 the same way to pin 14 of IC6.

When installing IC11, be sure to use a mica insulator and insulated washer. The PC board's ground plane is used as a heatsink for IC11. Any contact between IC11's tab and the ground plane will short it.

There are 3 jumpers on the board that do not affect the circuit, but are required to reduce any radio-frequency interference (RFI) generated by the amplifier. They connect sections of the ground plane together. The jumper by R10 and C35 can be a scrap piece of resistor lead, but the two jumpers by the TO-220 transistors are much longer and should be insulated. Lengths of wire-wrap wire will do nicely. They should be dressed neatly along the edge of the board so they will not be pinched when the PC board is mounted in the case later.

Transistor Q101 is mounted in the unused hole in the case next to Q18. Bend the leads of Q101 so that the length of the entire component is no more than 1 inch in length from the center of the mounting hole to the bend in the leads. That will ensure that Q101, R101, and D18 will fit in between Q18 and D2.

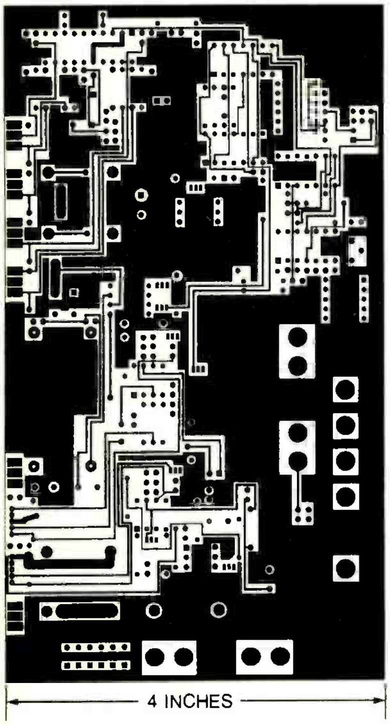
Cut two lengths of insulated wire. One wire will be about 1 inch long and the other will be about 2 inches long. Strip about ¼-inch of insulation from each end. Trim one lead of R101 and solder that lead to the emitter lead of Q101. The same is done with the anode of D18, only solder D18 to the collector lead of Q101. Carefully bend the other lead of R101 so that it crosses the cathode lead of D18, and solder it to the base lead of Q101. Wrap the cathode lead of D18 around the lead of R101 that is connected to the base lead of Q101, and solder the two leads together.

Carefully tack-solder the longer insulated wire to the emitter of Q101 and the shorter wire to the collector of Q101. The shorter wire is wrapped around the right-hand lead of R2 and the longer wire around the right-hand lead of R1. Solder those two connections.

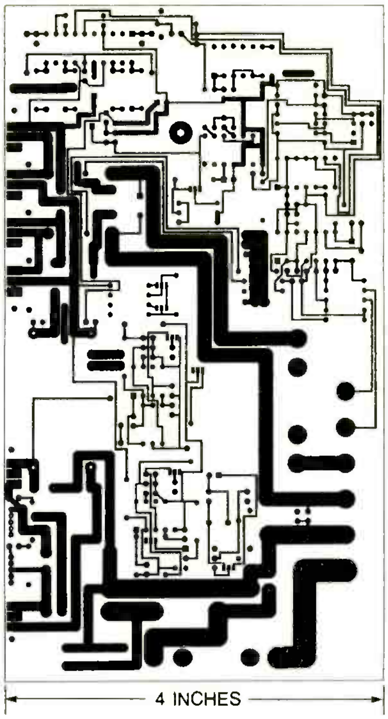
Since IC7 is *very* sensitive to static damage, it should be installed last. When installing IC7, make sure that you, your soldering-iron tip, and the circuit board are all properly grounded.

When all components except for Q18 and Q20 are installed, the amplifier is ready for testing. Be sure Q101 and its attached components are not touching any other components or the PC board.

Testing. Some of the voltages being measured during testing can only be measured when IC7 is disabled. Noise introduced into the circuit by measur-



Here is the component side of the board. It is shown half size for space reasons.



Here's the solder side of the board. It is shown half size for space reasons.

ing instruments can cause the circuit to malfunction. To measure the waveforms that do not have a return reference requires differential probes.

Connect the amplifier to a 12-volt power supply with a 4-amp capacity. If one is not available then use a supply with a 4700-µF capacitor across its outputs. Place a jumper across R24 to induces a shutdown. Apply power to the amplifier. It should not use more than 1 amp of current with an input of 12 volts.

Using ground as a reference, you should measure between 25 and 38 volts at the cathode of D1, and −15 volts ±20% at the anode of D2. The DC-DC enable signal (pin 8 of IC13) should measure somewhere between 4 and 6 volts.

Remove your voltmeter's negative probe from ground and connect it to pin 2 of IC11 (−15 volts) for the following measurements. Pin 3 of IC11 should read 12 volts with a 10% tolerance. Pin 3 of IC6 and the shutdown signal at pin 11 of IC15 should both read between 8 and 12 volts. Pins 7, 8, and 10 of IC4, along with pin 9 of IC16 should all read 4 volts ± 10%.

The triangle wave is best checked with an oscilloscope. Connect the oscilloscope's probe to pin 6 of IC7, and the ground to pin 2 of IC11. The frequency of the triangle wave should be 1 MHz with a 40% tolerance and a 3-volt peak-to-peak level sitting 4 volts above the −15-volt reference.

Now remove the jumper across R24. Place a jumper across C26 and C27 to disable the preamplifier. Again, using pin 2 of IC11 as a reference, pin 3 of IC7 should be between 0 and 4 volts. On IC1, pin 6 should read 4.8 volts, pin 3 should read 7.2 volts, and pin 5 should read 6 volts ± 10%.

Replacing the voltmeter with an oscilloscope, a 12-volt squarewave at 1 MHz should be present at pins 11, 13, 18, and 20 of IC7. Those measurements are referenced to pin 2 of IC11.

Remove power from the amplifier and install Q18 and Q20. Use the holes in the case to align the transistors in the same way as done for the other TO-220 components. Because of the other components on the board, you may use the holes from the outside of the case to align Q18 and Q20. Be sure to detach the case from the transistors before continuing the tests.

Re-apply power, and connect an oscilloscope's probe ground to TB1-2. A 1-MHz squarewave swinging between −15 and 25 volts should be present at pins 12 and 19 of IC7. The speaker outputs at TB1-4 and TB1-5 should both measure between 3 and 9 volts with a 3-volt ripple.

Now remove the jumpers across C26 and C27. With no input, the speaker outputs at TB1-4 and TB1-5 should both measure between 3 and 9 volts with a 3-volt ripple, referenced to pin 2 of IC11. Connecting the oscilloscope probes between the speaker outputs should measure between −0.25 and 0.25 volts including ripple. If all the voltages are correct, then a signal source and speaker can be attached to test out the entire amplifier. Keep the audio test at a low volume until the board is permanently mounted in the case.

If everything checks out OK, install the PC board permanently with the ¼-inch spacers and nuts on the 8-32 screws mounted on the PC board. Use insulators, shoulder washers, and heatsink grease to attach the transistors to the case with appropriate screws and nuts.

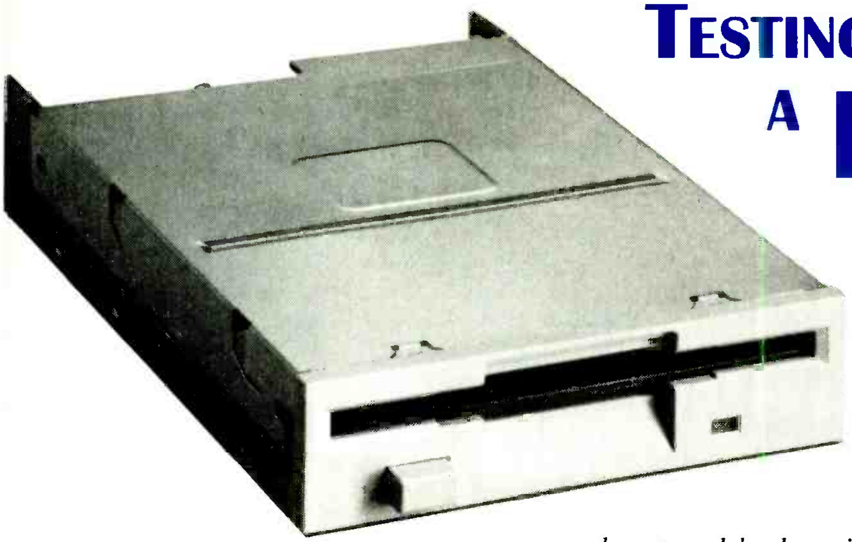
If one of the FETs should burn out, it will usually destroy the other FET in that side of the bridge. It can also destroy IC7. Replace the FETs in pairs. When installing the new FETs, IC7 can be tested by placing a jumper across C26 and C27, installing the low-side drive FET, and checking for the squarewave gate drive from IC7. If the squarewave is not present on both FETs, then IC7 should be replaced. Once both gate drives are working, the high-side drive FET can be installed and the jumpers removed.

Using The Amplifier. When installing the amplifier, make sure that the input impedance of the 12-volt supply is less than 1 ohm. If the amplifier is to be installed in a home setting, or other location in which power will be drawn from a 117-volt wall socket, be sure that the 12-volt supply output has adequate isolation in order to avoid any shock hazard.

The differential inputs are very useful since the amplifier ground does not have to be at the same potential as the signal source ground. The negative input may be hooked to the source ground, using the positive input for the signal.

If you are driving the amplifier with an output that was meant to be connected directly to a speaker, you might need to add an 8-ohm resistor across the input terminals in order to reduce noise. Ω

TESTING AND ALIGNING A FLOPPY DRIVE



STEPHEN J. BIGELOW

Today's alignment software makes troubleshooting a balky floppy drive easier than ever before. Here's how it's done.

The basic nature of a computer floppy-disk drive has changed very little since its introduction in the 1970s: A circular disk coated with magnetic media is inserted into the drive and spun at a fixed rate while clamped between two electromagnetic "read/write" heads. Those heads can be positioned across the disk to read or write data to any desired location on the media.

While the media itself (the "diskette") is remarkably simple and cheap to produce, floppy drives themselves are largely mechanical devices composed of motors, lead screws, sliders, levers, clamps, and a myriad of other assorted linkages. Over time and regular use, those mechanical elements will eventually wear out and cause the floppy drive to malfunction. In most cases, floppy-drive problems can be traced to a mechanical problem rather than an electronic failure. Fortunately, whether you fix PCs for a living, or tinker with your own system as a hobby, you can often recover a failing floppy drive with a few basic tools and some alignment software.

Knowing Your Way Around. Before you can work with a floppy drive, you need to know what all the major parts are, and how those parts are put together. Figure 1 is an exploded diagram of a typical 3.5-inch floppy drive. The diagram may appear confusing at first glance, but there are really only six parts you need to know; the spindle motor, the head-stepping motor, the read/write (R/W) heads, the electronics board, the frame, and the clamp/eject plates.

The spindle motor is a low-profile motor (and PC board) mounted to the bottom of the frame. It is the spindle motor that spins the disk. The head stepping motor carries the R/W heads back and forth along the radius of your diskette—that is what allows the heads to reach each concentric track on the disk. When the diskette is inserted into the drive, it is held in place by the clamp/eject plates. After pressing the eject button, the plates separate and allow the diskette to pop out. Finally, the electronics board operates the drive motors, checks the drive's sensors, and manages communication between the drive and the floppy-drive controller in the PC.

You can see how everything works together in the block diagram that is shown in Fig. 2. Figure 2 also shows the major control signals used by the floppy drive interface (that 34-pin ribbon cable that connects the drive to your floppy drive controller).

Recognizing Floppy Problems. Next, you will need to understand when a floppy drive is showing signs that might be related to alignment errors. There are three tell-tale signs of alignment problems:

- Files and data become lost or corrupted when saving to diskette (that might also appear as an intermittent or occasional problem).
- Files and data cannot be read from the diskette—usually resulting in a DOS "General Drive Error" (that might also occur as an intermittent or occasional problem).
- Files and data can be written and read from a diskette in one PC, but may have trouble being used in other PCs (suggesting that the original drive might be out of alignment).

The Cleaning Check. Unlike hard drives, where R/W heads float above the disk platters on a microscopic cushion of air, floppy R/W heads actually contact the diskette media. Over time, particles of media will rub off the diskettes and accumulate on the R/W heads. As accumulations develop on the heads, the dimensions of the heads change, and that can cause floppy errors similar to alignment problems.

Whenever you suspect a floppy-drive problem (especially on older drives with lots of running time), your first step should always be to clean the drive, then re-check it. Cleaning

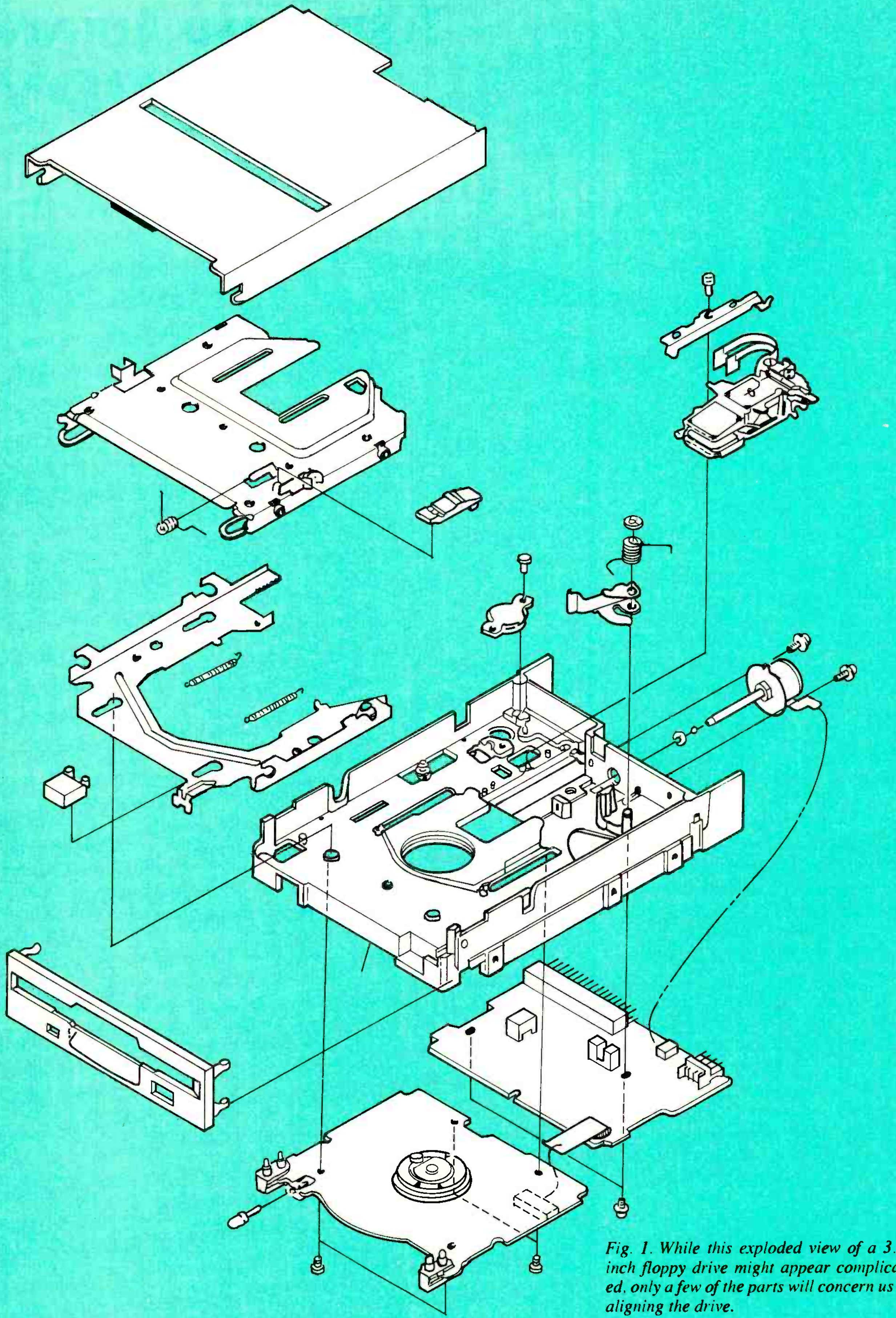


Fig. 1. While this exploded view of a 3.5-inch floppy drive might appear complicated, only a few of the parts will concern us in aligning the drive.

is also important because oxide deposits on the R/W heads are more abrasive than the heads alone, so running with "dirty" heads can actually shorten diskette life. More on the actual cleaning procedure can be found later on in this article. If problems persist after cleaning the drive, check its signal cable.

The Cable Check. Floppy drives depend on a reliable cable connection between the drive and floppy-controller card in the PC. In virtually all PCs, that connection is established through a single 34-pin ribbon cable. The cable may be terminated with "card edge" connectors or "IDC" (insulation displacement connector) sockets, but either way, those connectors must be attached cleanly and completely.

However, the contacts involved in the connection could eventually become oxidized from exposure to everyday air and moisture. Before replacing the drive or realigning it, it makes sense to check the cable to eliminate it as the source of your problems. Making sure computer power is off, try removing and reinserting the connector (once or twice) at each end of the 34-pin ribbon cable. If problems persist after checking the cable connections and cleaning the heads, it is time to decide whether to repair or replace the drive.

Repair vs. Replace. Floppy-drive alignment continues to be a matter of debate. The cost of a floppy-drive alignment package is often as high as the cost of a new drive, so many technicians question the practice of drive alignment when new drives are readily available; in fact, most professional technicians would not choose to align a misbehaving drive.

Even so, testing software has an important place in any toolbox. At the very least, test software can confirm a faulty drive and eliminate the guesswork involved in drive replacement. For enthusiasts and technicians who have a volume of drives to service, alignment tools offer a relatively efficient means of recovering drives that might otherwise be discarded. Ultimately, one of your most vital troubleshooting tools is an open mind—you can repair or replace the drive depending on what makes the most economic sense to you.

Using the Tools. Drive alignment is

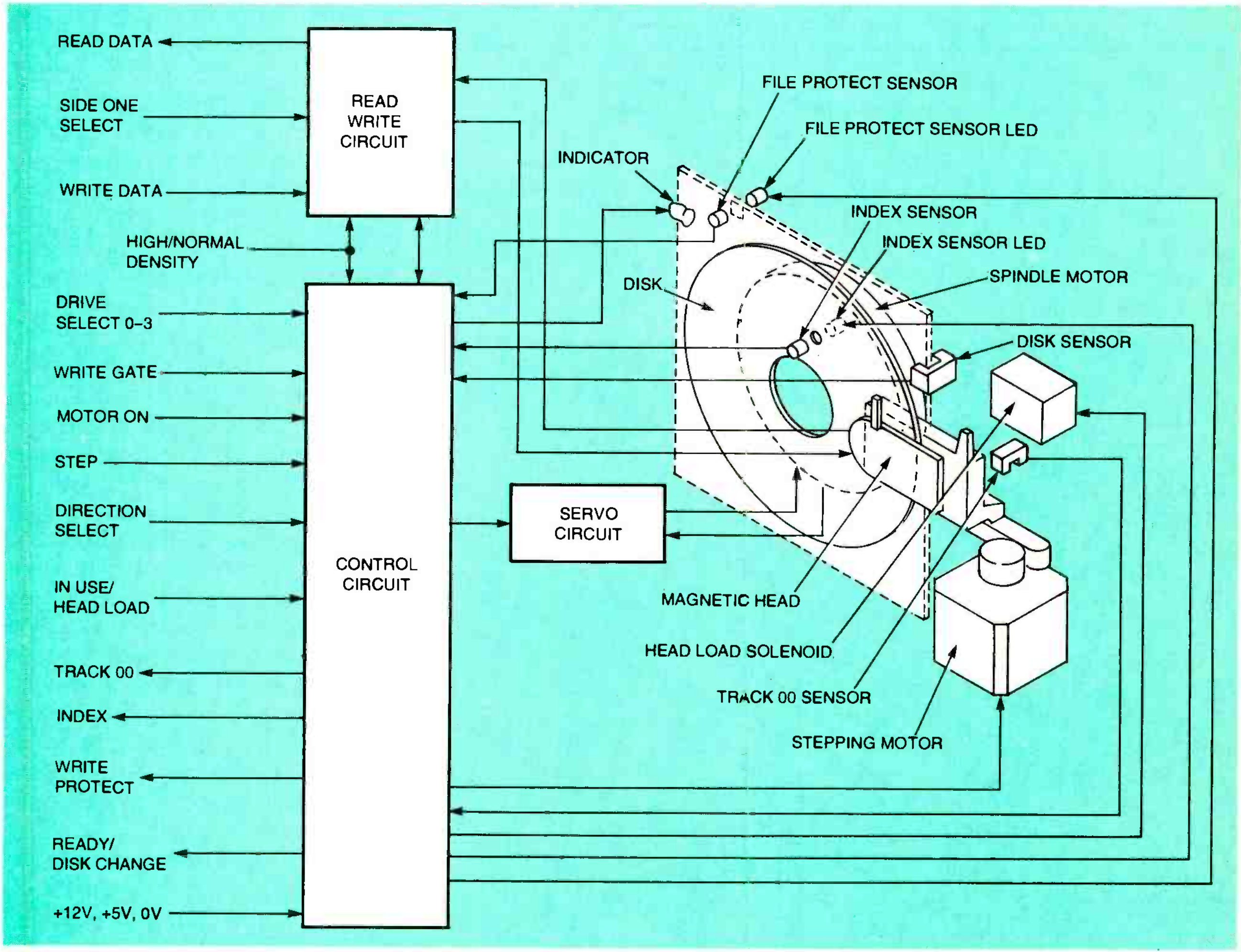


Fig. 2. This block diagram of a floppy drive shows us how everything works together. It also shows the major control signals used by the drive.

not a new concept. Technicians have tested and aligned floppy drives for years using oscilloscopes and test disks containing precise, specially recorded data patterns. You may already be familiar with the classic "cat's eye" or "index burst" alignment patterns seen on oscilloscopes. That kind of manual alignment requires you to find the right test point on your particular drive's PC board, locate the proper adjustment in the drive assembly, and interpret complex (sometimes rather confusing) oscilloscope displays. Manual alignment also requires stand-alone drive-exerciser equipment to run a drive outside of the computer. Fortunately, there is a better way.

Although manual drive-alignment techniques are still used today, they are being largely replaced by automatic alignment techniques. Software developers have created interactive control programs to operate with their specially-recorded data disks. Those software tool kits provide all the features necessary to operate a suspect drive through a wide variety of tests while displaying the results numerically or graphically right on a computer monitor. As you make adjustments, you can see real-time results displayed on the monitor (see Fig. 3). Software-based testing eliminates the need for an oscilloscope and ancillary test equipment. You also do not need to know the specific signal test points for every possible drive.

AUTOMATIC Drive Test 'Esc'- For Previous Menu

Test	Track	Head 0 Data	Head 1 Data	Test Limits	Results	
Speed	NA	360 RPM / 166.5 mS		360 ± 6 RPM	Pass	NA
Eccentricity	44	50 uI	NA	0 ± 300 uI	Pass	NA
Radial	0	72% 750 uI	72% 750 uI	60 - 100 %	Pass	Pass
Radial	32	87% 300 uI	89% 250 uI	60 - 100 %	Pass	Pass
Radial	79	100% 0 uI	97% -50 uI	60 - 100 %	Pass	Pass
Azimuth	76	-7 Min	-13 Min	0 ± 15 Min	Pass	Pass
Index	0	143 uS	187 uS	200 ± 600 uS	Pass	Pass
Index	79	185 uS	255 uS	200 ± 600 uS	Pass	Pass
Hysteresis	32	200 uI	NA	0 ± 500 uI	Pass	NA

uI = Micro-inches uS = Microsecond mS = Millisecond
Min = Minutes NA = Not Applicable NT = Not Tested

Note: Radial is expressed as LOBE RATIO and OFFSET from track center line.
Auto Test Completed 'Esc' For Previous Menu

Fig. 3. Floppy-drive alignment software will display the results of its tests right on your computer's monitor. No oscilloscope or additional test gear is needed.

There are three popular tool kits on the market; AlignIt by Quarterdeck Select (formerly Landmark Research International Corp.), FloppyTune by Data Depot, Inc., and DriveProbe (shown in Fig. 4) by Accurite Technologies Incorporated. The contact information for each manufacturer is listed elsewhere in this article.

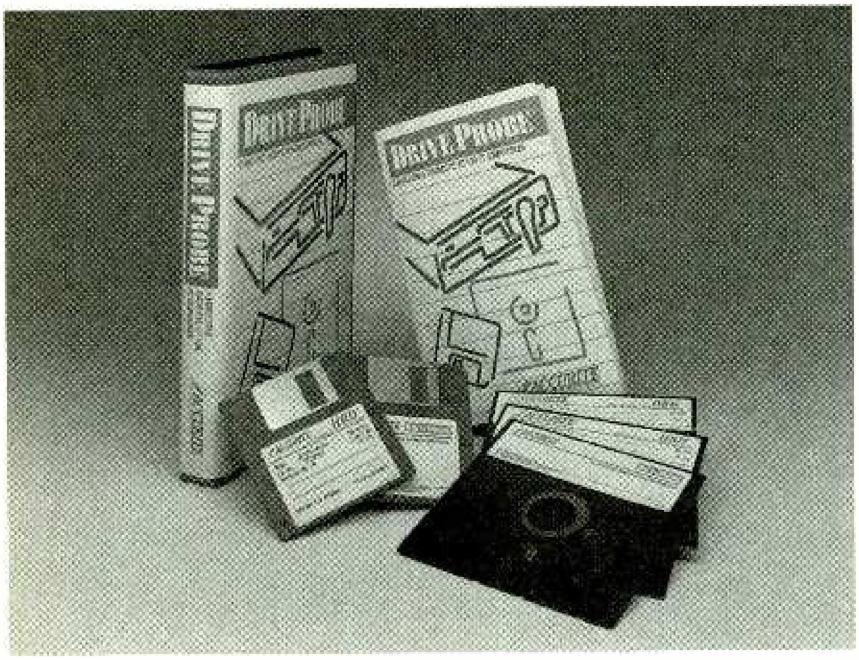


Fig. 4. DriveProbe from Accurite Technologies is among the more popular drive alignment products currently available.

Aligning the Drive. Once you have alignment software available, you are ready to go to work. Before starting your software, however, you should disable any caching software that will cache your floppy drive(s). Because caching software effects the way in which data is read or written to the floppy disk, caching will radically effect the measurements produced by the alignment software. To ensure the truest transfer of data to or from the floppy disk, boot the PC from a "clean" boot disk to disable all TSRs or device drivers in the system.

Once the alignment software is started, there are eight major tests to gauge the performance of a floppy drive; clamping, spindle speed, track 00, radial alignment, azimuth alignment, head step, hysteresis, and head width. Keep in mind that not all tests have adjustments that can correct the corresponding fault.

It is also important to realize that a single test is not always fool-proof. When you see a test that indicates a problem, you should always repeat the test several times to confirm your results.

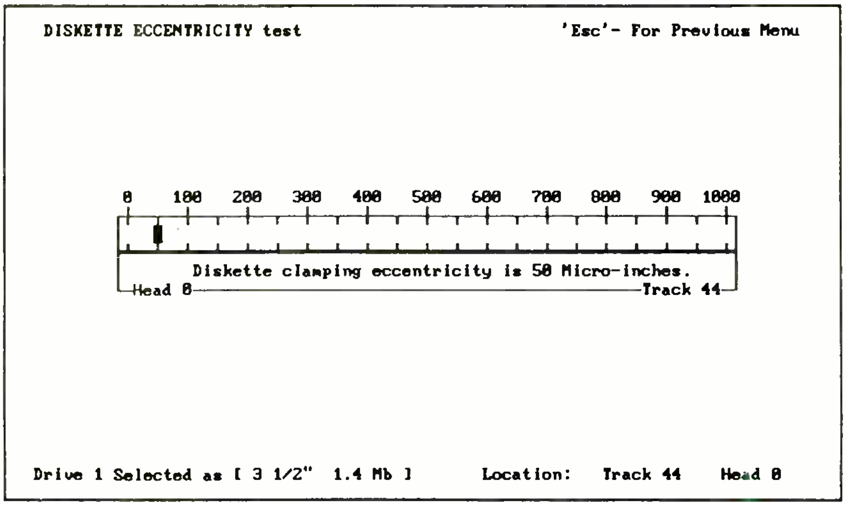


Fig. 5. The spindle clamp test measures disk eccentricity. That test should be performed first as any problem here will affect all the other tests.

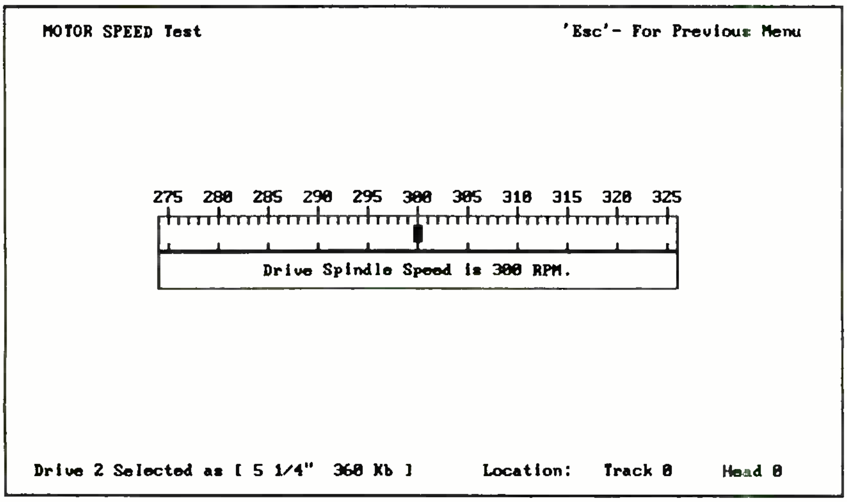


Fig. 6. Here's the display for a spindle-speed test. The drive's speed should be accurate to within ±1.5%.

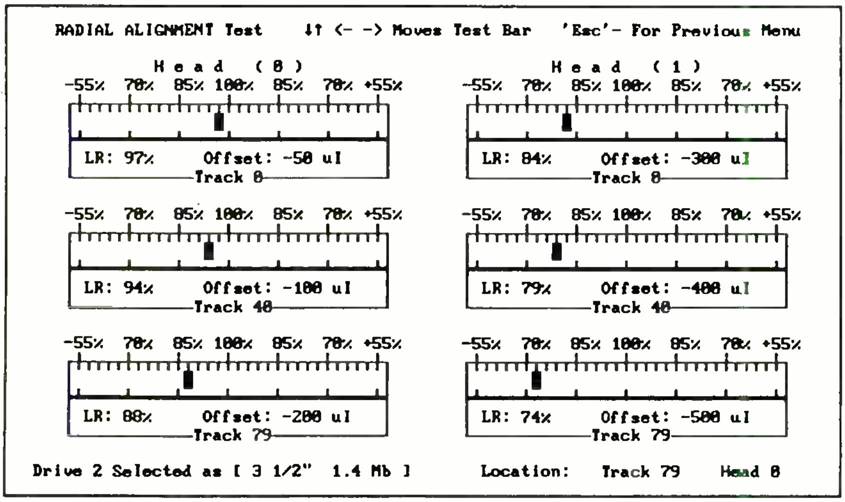


Fig. 7. If the radial-alignment test reveals an error of more than several hundred microinches, the head's alignment must be adjusted.

Cleaning the Heads. As we discussed earlier, dirty R/W heads are "wedged" away from the media by accumulations of oxides and ordinary dust. Dirty heads can cause erroneous readings during testing and alignment. Since alignment disks are specially recorded in a very precise fashion, faulty readings will yield erroneous information that can actually cause you to misadjust the drive. As a general procedure, clean the drive thoroughly before you test or align it.

Drive R/W heads can be cleaned manually or automatically. The manual method is just as the name implies. Use a high-quality head cleaner on a soft, lint-free, anti-static swab, and scrub both head surfaces by hand. Wet the swab but do not soak it. You may need to repeat the cleaning with fresh swabs to ensure that all deposits are removed.

It goes without saying that all computer power must be off before manual cleaning begins. Once cleaning is complete, allow a few minutes for the cleaner to dry completely before restoring power. If you do not have head-cleaning chemicals on-hand, you can use fresh ethyl or isopropyl alcohol. The advantage to manual cleaning is thoroughness—heads can be cleaned very well with no chance of damage due to excessive friction.

If manual cleaning sounds like something you'd rather not do, most software tool kits provide a cleaning disk and software option that allows you to clean the disk automatically. With computer power on and the software tool kit loaded and running, insert the cleaning disk and choose the cleaning option from your software menu. Software will then spin the drive for some period of time—10 to 30 seconds should be adequate, but do not exceed 60 seconds of continuous cleaning. Choose high-quality "dry" cleaning disks that are impregnated with a lubricant. Avoid "bargain" off-the-shelf cleaning disks that force you to wet the disk. Wetted cleaning disks are often harsh, and prolonged use can actually damage the heads from excessive friction. Once the

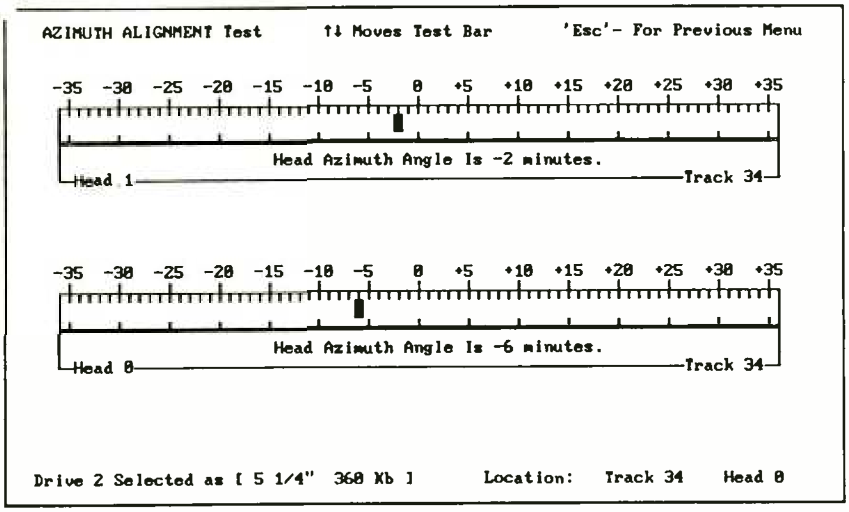


Fig. 8. When the heads are perfectly perpendicular to the disk, the azimuth-alignment test will show an angle of 0 minutes.

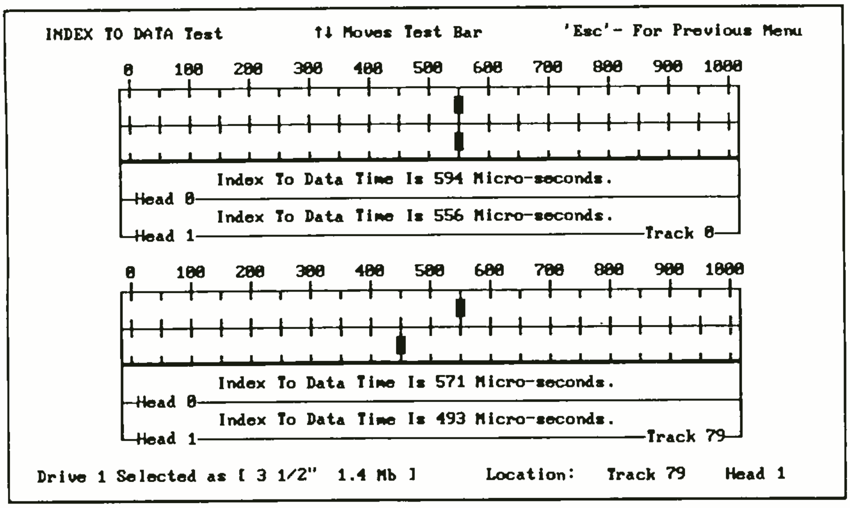


Fig. 9. The head-step test measures the amount of time between a step pulse from the coil driver circuits and a set of timing-mark data recorded on the test disk. As shown here, you typically will see time measurements for both heads on the inner and outer tracks.

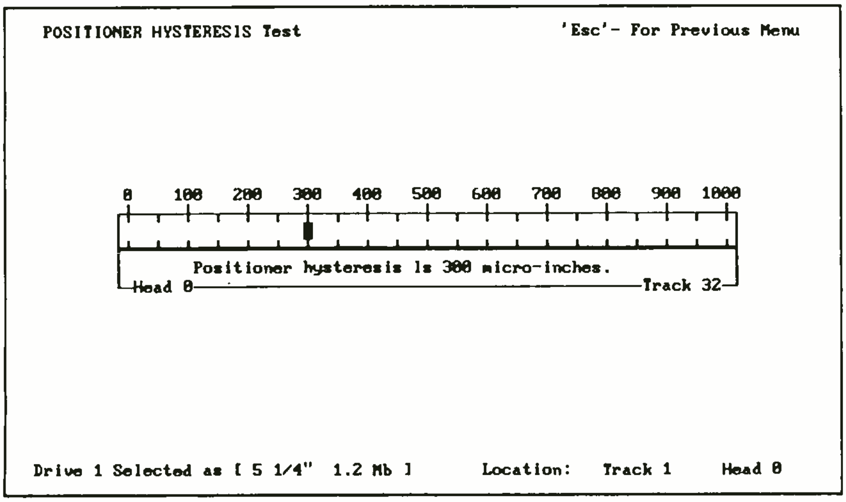


Fig. 10. The hysteresis test looks for excess play in the drive mechanism. If that is encountered, the best recourse is to replace the drive.

drive is clean, it can be tested and aligned.

Spindle Clamp (Eccentricity) Test. A floppy disk is formatted into individual tracks laid down in concentric circles along the media. Since each track is ideally a perfect circle, it is critical that the disk rotate evenly in a drive. If the disk is not on-center for any reason, it will not spin evenly. If a disk is not clamped evenly, the eccentricity introduced into the spin may be enough to allow heads to read or write data to adjoining tracks. A clamping test should be performed *first* after the drive is cleaned because high eccentricity can adversely affect other disk tests. Clamping problems are more pronounced on 5.25-inch drives where the soft Mylar hub ring is vulnerable to damage.

To perform the test, start your alignment software, then insert the alignment disk containing test patterns into the questionable drive. Select a clamping or eccentricity test and allow the test to run a bit. You will probably see a display similar to the one shown in Fig. 5. Typical alignment products can measure eccentricity in terms of microinches-from-true-center. If clamping is off by more than a few hundred microinches, the spindle or clamping mechanisms should be replaced. You can also simply replace the floppy drive. Try reinserting and retesting the disk several times to confirm your results. Repeated failures confirm a faulty spindle system.

Spindle-Speed Test. The diskette media must be rotated at a fixed rate in order for data to be read or written properly. A drive that is too fast or too slow may be able to read files that it has written at that wrong speed without error, but a disk so written might not be readable in other drives operating at a normal speed. Files recorded at a normal speed also might not be readable in drives that are too fast or too slow. Such transfer problems between drives are a classic sign of speed trouble (usually signaled by the operating system as "General

Disk Read/Write Errors"). Drive speeds should be accurate to within ±1.5%, so a drive running at 300 RPM should be accurate to ±4.5 rpm (295.5 to 304.5 rpm), and a drive running at 360 rpm should be accurate to within ±5.4 rpm (354.6 rpm to 365.4 rpm).

After cleaning the R/W heads and testing disk eccentricity, select the spindle-speed test from your alignment-software menu. The display will probably resemble the one in Fig. 6.

Today's floppy drives rarely drift out of alignment because rotational speed is regulated by feedback from the spindle's index sensor. The servo circuit is constantly adjusting spindle-motor torque to achieve optimal spindle speed. If a self-compensating drive is out of tolerance, excess motor wear, mechanical obstructions, or index-sensor failure is indicated. Check and replace the index sensor, or the entire spindle-motor assembly. You can also replace the floppy drive.

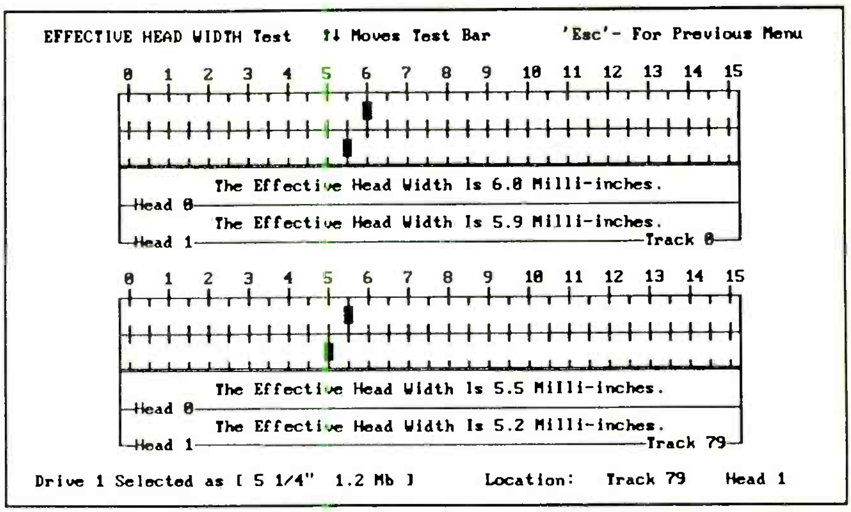


Fig. 11. As its name implies, the head-width test looks at the effective width of the R/W heads. If they are too wide, they are worn and the drive should be replaced; if they are too narrow, they are probably dirty and the drive should be cleaned.

Track 00 Test. The first track on any floppy disk is the outermost track of side 0, which is track 00. Track 00 is important because it contains the boot record and FAT (File Allocation Table) information vital for finding disk files. The particular files saved on a disk can be broken up and spread out all over the disk, but the FAT data must always be in a known location. If the drive can not find track 00 reliably, the system may not be able to boot from the floppy drive or even use diskettes. Floppy drives use a sensor to physically determine when the R/W heads are over the outermost track.

Select the track 00 test from your alignment-software menu and allow the test to run. A track 00 test measures the difference between the actual location of track 00 versus the point at which the track 00 sensor indicates that track 00 is reached. The difference should be less than ± 1.5 mils (one-thousandth of an inch). A larger error might cause the drive to encounter problems reading or writing to the disk.

The easiest and quickest way to fix track 00 problems is to alter the track 00 sensor position. That adjustment usually involves loosening the sensor and moving it until the monitor display indicates an acceptable reading. Remember that you only need to move the sensor a small fraction, so a patient, steady hand is required. The track 00 sensor is almost always located along the head carriage lead screw. Mark the original position of the sensor with indelible ink so that you can return it to its original position.

Radial-Alignment Test. The alignment of a drive's R/W heads versus the disk is critical to reliable drive operation because alignment directly effects contact between heads and media. If head contact is not precise, data read or written to the disk may be vulnerable. The radial-alignment test measures the head's actual position versus the precise center of the outer, middle, and inner tracks (as established by ANSI standards). Ideally, the R/W heads should be centered perfectly when positioned over any track, but any differences are measured in microinches. A radial alignment error of more than several-hundred microinches may suggest a head-alignment error.

To check the radial alignment, select the radial-alignment test from your alignment software and allow the test to run. A radial-alignment test display is shown in Fig. 7.

If you must perform an adjustment, you can start by loosening the slotted screws that secure the stepping motor, and gently rotate the motor to alter the lead screw position. As you make adjustments with the test in progress, watch the display for the middle track. When error is minimized, secure the stepping motor carefully to keep the assembly from shifting position. Use *extreme* caution when adjusting radial head position—you only need to move the head a fraction, so a very steady hand is needed. You should also re-check the track 00 sensor to make sure the sensor position is acceptable.

Azimuth-Alignment Test. Not only must the heads be centered perfectly along a disk's radius, but the heads must also be perfectly perpendicular to the disk plane. If the head azimuth is off by more than a few minutes (1/60th of a degree), data integrity can be compromised and disk interchangeability between drives—especially high-density drives—may become unreliable. When the heads are perfectly perpendicular to the disk (at 90 degrees), the azimuth should be 0 minutes.

Select the azimuth test from your alignment software menu and allow the test to run. Figure 8 shows an azimuth-alignment test display. An azimuth-alignment test measures the rotation (or twist) of R/W heads in terms of + or - minutes. A clockwise twist is expressed as a positive (+) number, while a counterclockwise twist is expressed as a negative (-) number. Heads should be perpendicular to within about ±10 minutes. It is important to note that azimuth adjustments are not easily made in most floppy drives. Unless you want to experiment with the adjustment, it is often easiest to replace a severely misaligned drive.

Floppy Drive Alignment Software

Accurite Technologies Inc.
(DriveProbe)
48460 Lakeview Blvd.
Fremont, CA 94538-6532
Tel: 510-668-4900
Fax: 510 668-4905
URL: www.accurite.com

Data Depot, Inc.
(FloppyTune)
1710 Drew St., #5
Clearwater, FL 34615-6213
Tel: 813-446-3402
Fax: 813-443-4377

Quarterdeck Select (formerly Landmark Research International)
(AlignIt)
5770 Roosevelt Blvd.,
Blg 400
Clearwater, FL 34620-3431
Tel: 813-523-9700
Fax: 813-523-2391

Head-Step Test. The head-step (or index-step) test measures the amount of time between a step pulse from the coil driver circuits and a set of timing-mark data recorded on the test disk. In manual adjustments (using an oscilloscope), that would be seen as the "index burst". Average index time is typically 200 microseconds for 5.25-inch drives, and 400 microseconds for 3.5-inch drives. In automatic testing with your alignment software, you will see time measurements for both heads on the inner and outer tracks as shown in Fig.9. The actual range of acceptable time depends on your particular drive, but variations of ±100 microseconds or more is not unusual.

If the head-step timing is off too far, you can adjust timing by moving the index sensor. As with all other drive adjustments, you need only move the sensor a small fraction, so be *extremely* careful about moving the sensor. A steady hand is very important here. Make sure to secure the sensor when you are done with your timing adjustments.

Hysteresis Test. It is natural for wear and debris in the mechanical head positioning system to result in some "play"—that is, the head will not wind up in the exact same position moving from outside in, as moving from the inside out. Excessive play, however, will make it difficult to find the correct track reliably. Testing is accomplished by starting the heads at a known track, stepping the heads out to track 00, then stepping back to the starting track. Head position is then measured and recorded. The heads are then stepped in to the innermost track, then back to the starting track. Head position is measured and recorded again. Under ideal conditions, the R/W heads should wind up in precisely the same place, but natural play almost guarantees some minor difference.

You can see a typical hysteresis test measurement display in Fig. 10. If excessive hysteresis is encountered, the drive should be replaced.

Head-Width Test. As R/W heads wear down from use, their effective width increases. If the effective width is too low, the heads may be contaminated with oxide buildup. Normal effective head widths are 12 or 13 mils for 5.25-inch double-density drives, 5 or 6 mils for 5.25-inch high-density drives, and 4 or 5 mils for all 3.5-inch drives.

As you run the head-width test with your alignment software, you will see effective width displayed on the monitor as shown in Fig. 11. When small head widths are detected, try cleaning the drive again to remove any remaining contaminates. If the width reading remains too small (or measures too large), the heads or head carriage may be damaged. You can replace the R/W head assembly, but often the best course is simply to replace the drive.

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Floppy Drive Glossary

Actuator—A motorized assembly that carries the R/W heads.

Alignment—The process of adjusting a device's characteristics in order to bring its operation into an acceptable range.

Centering Cone—On a 5.25-inch drive, an assembly that centers the disk as the drive door is being closed.

Clamping Ring—On a 5.25-inch drive, a part of the spindle that grabs the disk along its center hole in order to turn it.

Data Patterns—A data series used to generate an error if reading circuitry is too sensitive, not sensitive enough, or otherwise defective.

Guide Rod—A simple rod used as a rail for a moving assembly (such as the R/W heads). The guide rod helps to keep the assembly even and steady.

Ferrous Oxide—The generic magnetic layer used to hold magnetic information on a floppy disk.

Head—A R/W head.

Hysteresis—The amount of mechanical "play" in the R/W-head positioning system.

Lead Screw—A coarsely threaded rod that is turned—usually by a stepper motor—and in turn moves the R/W heads.

Load—Allowing the R/W heads to contact the disk surface.

Seek—The process of stepping a R/W head assembly in or out in order to find a desired track.

Spindle—The motor and clamping assembly that holds and spins the disk media.

Spiral Track—A disk with its tracks recorded as a spiral rather than concentric rings. The positioning of those tracks allows precise signal measurement, which allows the drive's operating characteristics to be determined very accurately.

HIGH-TECH BATTLEFIELD MEDICINE

BY BILL SIURU

See how electronics and other technologies are coming to the aid of soldiers in the field, and how civilians could benefit, too.

When serious injuries occur, the difference between life and death could be determined by the care a victim receives in the first "golden hour." Nowhere is that more true than on the battlefield. That's why the U.S. military's medical community is constantly developing technology and hardware to assure more of the wounded receive the appropriate trauma care before the golden hour is over. That includes reducing the time needed to locate the wounded warrior and evacuate him to a Mobile Army Surgical Hospital (MASH) facility.

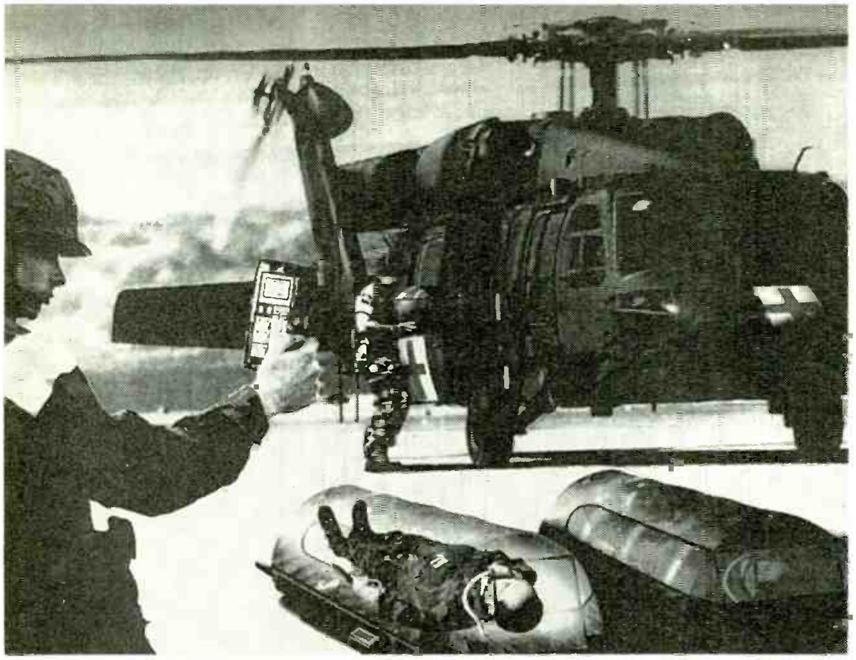
Survival also often depends on the first responder's—usually a young combat medic—knowledge and experience to take the right actions quickly. The U.S. Army is now developing electronics to bring the skills of a trained doctor or senior medical technician to assist the medic treating a wounded soldier on the battlefield. Those developments are important to everyone because, like other military technology developments, spin-offs will probably find their way into the civilian emergency-medical-service (EMS) world. Let's take a look at the new technologies.

LSTAT. One such development, LSTAT, which stands for Life Support for Trauma And Transport, is now under development by the U.S. Army. That mini intensive-care unit and evacuation platform could bring care as close to the battlefield as possible, greatly reducing the time before resuscitation and stabilization—the key actions for survival—can start.

LSTAT is being developed by the Walter Reed Army Institute of Research and Northrop Grumman with assistance from the biomedical community and academic institutions. Both existing and emerging technologies are being combined in LSTAT to demonstrate front-line casualty medical care that includes life support, life-stabilizing, diagnostics, and patient monitoring.

The LSTAT's on-board micro-ventilator, about the size of a cigarette package, is used with a suction unit for clearing a patient's airway so that the ventilator can be used. The ventilator system includes an on-board oxygen generator that eliminates the weight, volume, and fire hazard associated with traditional oxygen bottles. The oxygen generator uses an oxygen collector with a high-voltage osmotic membrane to concentrate oxygen gas from atmospheric air. Like several other parts of LSTAT, the oxygen generator is based on technology used in aerospace life-support systems similar to those found in high performance aircraft.

Advanced technology like non-invasive sensors, data fusion, image recognition, signal processing, and so forth are used in LSTAT. For instance, skin sensors like those used by astronauts and test pilots continually monitor the patient's vital signs. Other sensors are integrated within the intravenous (IV) catheter. Those sensors are considered non-invasive since they are part of the IV used in virtually all trauma incidents. Sensors also could be used in closed-loop diagnostic systems that not only monitor patient



Here's an artist concept showing two LSTAT units with patients attached to ventilators. The medic is watching their status via a handheld medical monitor.

The Medic-Cam visor holds the tiny TV camera (upper right side of visor), TV monitor (center of visor in front of medic's eyes) and microphone. In the background are the control unit (right) and battery (left) plus associated cabling.

condition, but also automatically change, for example, IV rates and ventilation levels as needed. Sensors combined with image-recognition techniques would let a busy medic quickly assess the severity of burns.

Other labor-saving features include easy-to-monitor displays on the side of the LSTAT showing the status of both the patient and the LSTAT unit itself. Medics could remotely keep tabs on several LSTATs using hand-held, wireless medical monitors. That system could alert the medics if emergency intervention is needed or could be used to remotely control various LSTAT subsystems. There is also a defibrillator on board.

The LSTAT's environmental control system (ECS) filters the air contained within the LSTAT canopy, provides both heating and cooling, and isolates the patient from nuclear, biological, and chemical warfare contaminants. Power for the LSTAT is supplied by advanced batteries or it can be drawn from power supplies on the transport vehicle.

The LSTAT is designed to be carried on High Mobility Multi-Purpose Wheeled Vehicles, more familiarly called Hummers, on the ground or aboard UH-1 Huey or UH-60 Blackhawk helicopters and C-130 aircraft. The LSTAT would function as an ICU (intensive care unit) while in transit. The stretcher-compatible LSTAT is designed to fit within a NATO-defined envelope (roughly 2 × 7 × 1.5 feet) so it can be used with the equipment of our allies as well. The unit is built using advanced materials so that the entire system weighs under 88 pounds.

An advanced prototype is planned for evaluation later this year, with operational units slated to appear in the field in a few years. However, many of the individual techniques and technologies could appear sooner, and many will reach the civilian market as well.

For use in the more distant future, researchers are investigating remote telepresence surgery. Here an injured soldier after being placed in a special medical vehicle could be operated on remotely by surgeons located in relative safely behind the battle lines. High-resolution data transmission and remote manipulators could allow life-saving operations within the "golden hour," even faster than emergency services that could be provided by a LSTAT and air evacuation to a MASH unit.

Medic-Cam. Developed by the Army Research Laboratory, "Medic-Cam" in essence makes an experienced doctor part of the first-response team. Though not physically at the scene, the doctor's eyes, knowledge and experience are there via video and satellite communications.

Medic-Cam consists of a miniature, 7mm diameter, high-resolution color camera mounted on a lightweight visor. There is also a tiny, ½-inch color-TV monitor on the visor so the medic can see the picture being broadcast. A microphone and earpiece allow the doctor and medic to talk to one another. The medic can also input and transmit patient data.

Video pictures, conversation, and data are transmitted by microwave to

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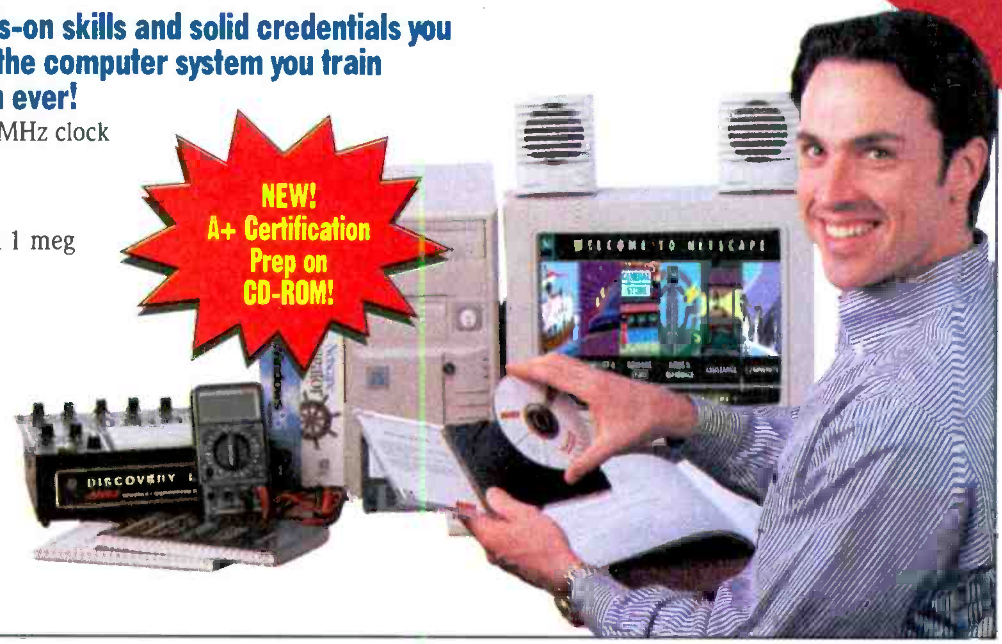

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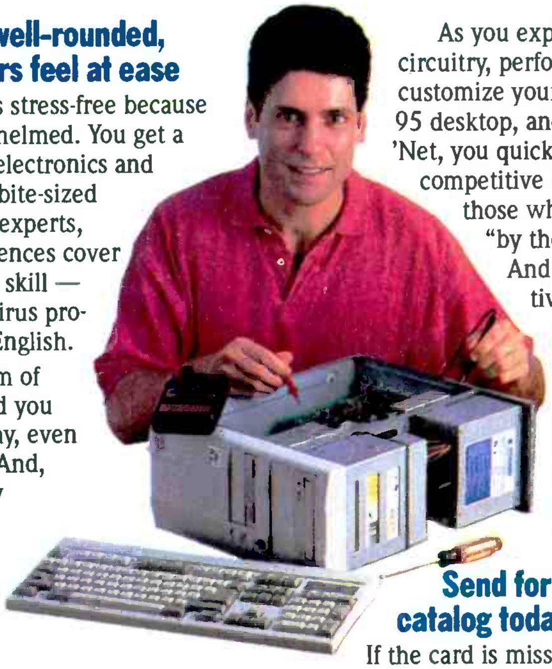

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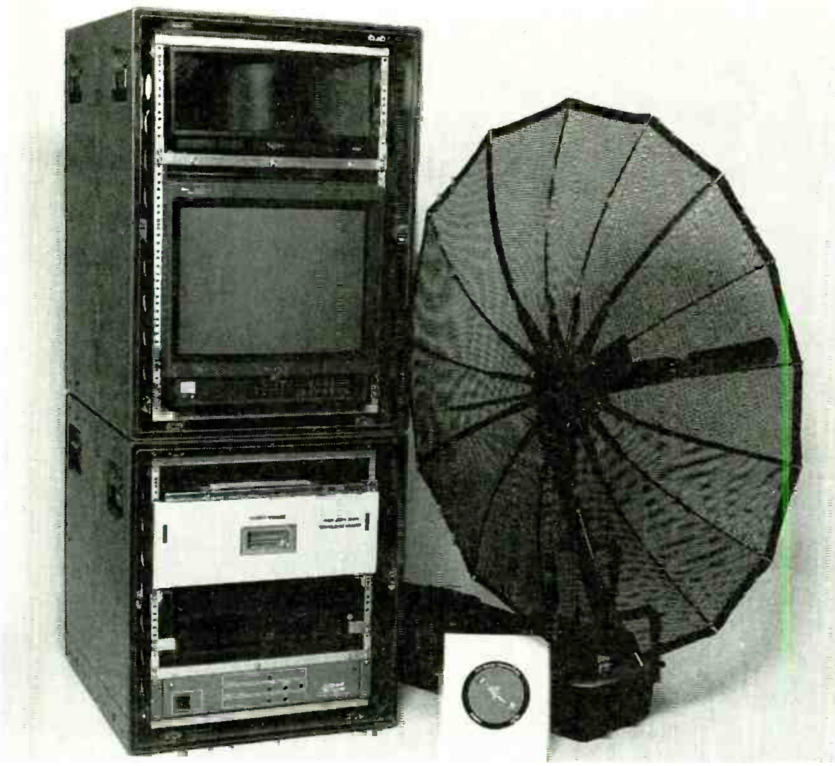


Here's a portable Video Teleconferencing Center (VTC) like the ones already in use with peacekeeping forces in Bosnia. The steerable camera is located above the monitor. Handheld and document cameras are located in the drawer.

The same technology used to detect breathing and heartbeat with the Sudden Infant Death Syndrome detector can be adapted to detect whether a downed soldier is dead or injured.

a satellite and then to the doctor or other medical professionals virtually anywhere in the world. The Medic-Cam-equipped medic also carries a small box containing the camera controller, microwave transmitter, and audio and video conditioners. A rechargeable lead-acid battery provides up to eight hours of operation.

The Army plans to use the Medic-Cam on the battlefield in conjunction with the Mobile Medical Mentoring Vehicle, or M3V. The M3V is a Hummer that is equipped with a special, climate-controlled shelter. Inside, a doctor and senior medic communicate via satellite links with up to four medics equipped with Medic-Cams. In the future, the Medic-Cam could interface with the Global Positioning System (GPS) of navigational satellites to help locate wounded soldiers and attending medics to greatly speed up evacuations.

VTC. Front-line medical providers could access the most experienced specialists who might be located anywhere in the world with the portable Video Teleconferencing Center (VTC), also developed by the Army Research Laboratory. The VTC consists of three cameras—a steerable TV camera, a hand-held camera, and a document camera. There is a TV monitor, a modem for satellite communications, and a computer to operate the system. Many of the components are commercially available items that have been reconfigured to withstand the shock and vibration found in the military environment.

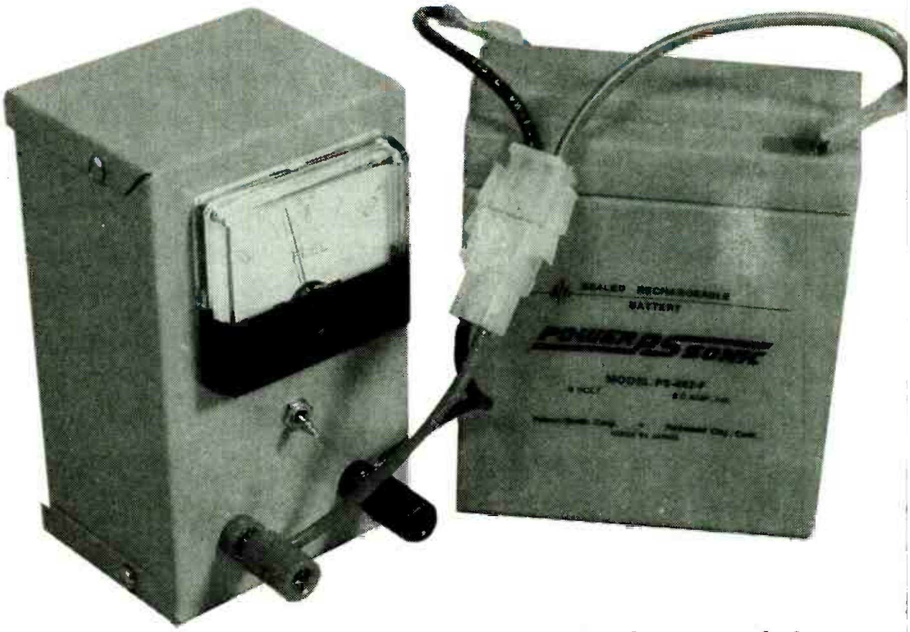
Besides helping on the battlefield, the VTC can support more routine medical care. For example, medical personnel in an isolated field hospital might find patients with infections or medical conditions they are not familiar with or that they have had limited experience in treating. The VTC permits field-hospital personnel to confer with a specialist at a major medical center or large hospital.

The VTC not only means faster treatment for patients but can result in considerable cost savings since the patient does not have to be transported to a major medical center to be diagnosed and treated. It can cost thousands of dollars to transport a soldier from Europe or Korea to the

(Continued on page 72)

JOHN PIVNICHNY

BUILD THE FUEL GAUGE— A CAPACITY INDICATOR FOR YOUR BATTERY PACK



Know how much charge is left in your batteries with this easy-to-build project.

Have you ever experienced the frustration of turning on your battery-powered radio and finding out after only a few minutes of use that the battery needs recharging? If you only had a meter that told you how low the battery pack was getting the last time you used the radio, you could have recharged it between uses. The FuelGauge presented here is just the thing you need to monitor battery level and intelligently schedule recharges.

Accurately Measuring Battery Capacity. As the charge in a battery gets used up, the terminal voltage decreases. That is true for all types of batteries, including NiCd, lead-acid, nickel-metal-hydride, and even non-rechargeable alkaline or zinc-carbon cells. Each type of battery has its own characteristic curve, which can be used to find the percentage of charge left based on the terminal voltage. A typical curve, shown in Fig. 1, is for a 7-cell NiCd pack. By accurately measuring the voltage of a battery pack, the state of charge can be found by referring to the battery type's characteristic curve. The FuelGauge does that calculation for you automatically.

Accuracy and high sensitivity is extremely important because the voltage change is small compared to the total battery voltage. The voltage reading of a completely discharged battery is almost as high as the voltage when the battery is charged. For that reason, the FuelGauge's circuit features a suppressed-zero method for driving the meter. The meter will read full scale for a fully-charged battery, while dropping down to zero when the battery is completely discharged. That feature allows for the meter to read percent full on a linear scale with 100% at the right, 50% in the center, and 0% at the left.

A second requirement for the circuit is low power drain. It doesn't make much sense to put a charge monitor on a battery pack if it will be a big drain. The FuelGauge is designed to draw just a little more than the current needed to move the meter needle itself. The total drain to run the FuelGauge is less than 2 milliamps when measuring a full charge.

Circuit Description. The circuit that the FuelGauge is based on is shown in Fig. 2. Zener diode D1 creates a reference voltage to which the battery voltage is compared. The diode specified has a breakdown voltage of

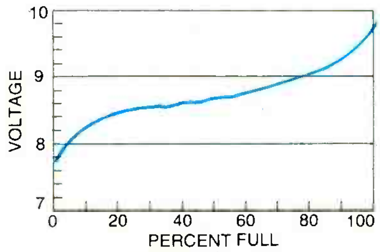


Fig. 1. All batteries have a characteristic discharge curve like this one. If you measure the no-load voltage of a battery and look up the reading on the battery's discharge curve, you will have an accurate way of measuring how much charge is left in the battery.

5.1 volts. That rating will work fine with most 6- or 7-cell NiCd battery packs, as well as 12-volt lead-acid batteries. The circuit may be customized to a particular battery by selecting a unit for D1 that has a voltage rating about 1 volt below the completely-discharged voltage of the battery pack you wish to measure.

Transistor Q1, wired as an emitter-follower amplifier, greatly increases the sensitivity of the circuit over what it would be if R7 were connected directly to the wiper of R6. A further advantage to that arrangement is in reducing the current drain that flows through R1, R2, and R6. By amplifying the current flowing through the resistors, the resistance value can be increased to a very high value, lowering the total current draw of the circuit. Resistor R6 adjusts the meter to read 0

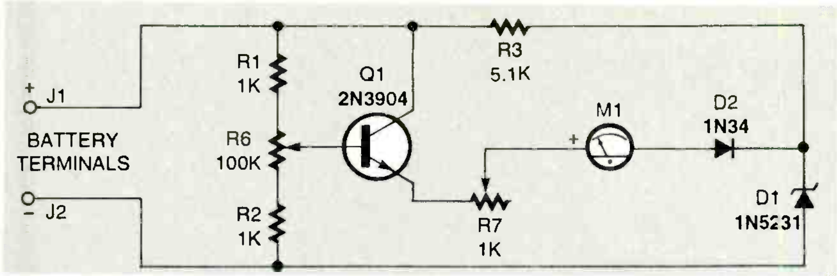


Fig. 2. Here's the basic circuit for the FuelGauge. Since the current flow through a resistor depends on the voltage, this circuit is a very sensitive voltmeter. Using a transistor to amplify the current flow through the resistors allows the circuit to be adjustable over a wide range without wasting any extra power.

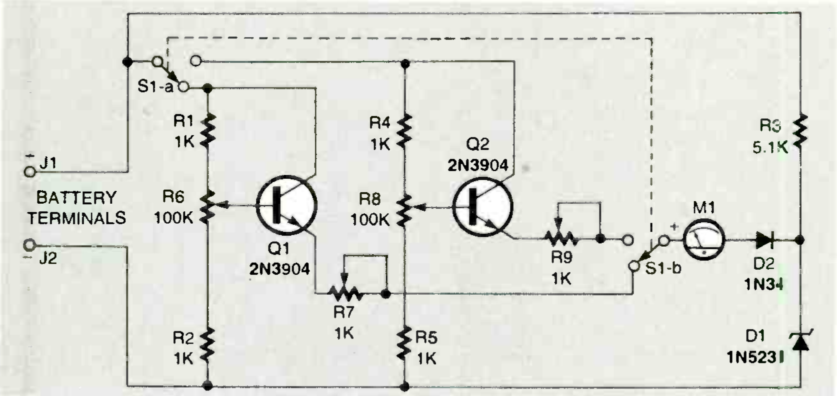


Fig. 3. The dual-use version of the FuelGauge consists of two basic circuits and a switch. Each circuit can be calibrated for a different type of battery, making the FuelGauge very versatile.

milliamps when the battery is completely discharged, and R7 adjusts the meter to read 1 milliamp when the battery is fully charged.

If the FuelGauge is accidentally connected backwards to the battery, current would flow through D1 and M1. The transistor would become reverse-biased, allowing a complete path back to the battery. That situation would allow excessive current to flow through D1, M1, and Q1, destroying them in the process. To protect the FuelGauge and the battery, D2, R1, and R2 are included to prevent any current flow in case the battery is reversed.

A Dual-Use Meter. The versatility of the FuelGauge can be increased by adding a second input circuit. That allows the unit to be calibrated for two different types of batteries. That circuit is shown in Figure 3. A double-pole, double-throw switch, S1, selects one of the two input circuit. One circuit is adjusted to one type of battery, and the other circuit is adjusted to a second type of battery. For instance, one position of S1 may be set to monitor the battery of a hand-held two-way radio, and the second position may be

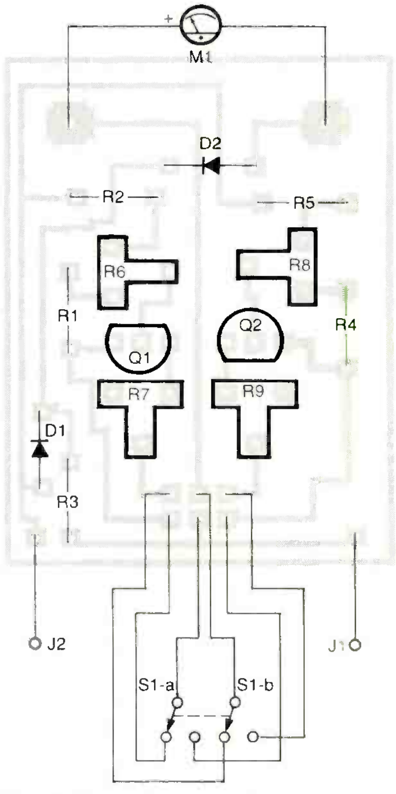


Fig. 4. Here's the parts-placement diagram for the dual-use version of the FuelGauge. If your panel meter's terminals are spaced the same distance as the pads of the PC board, you can mount the board directly to those terminals.

PARTS LIST FOR THE BATTERY FUEL GAUGE

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R2, R4, R5—1,000-ohm
R3—5,100-ohm
R6, R8—100,000-ohm, potentiometer
R7, R9—1,000-ohm, potentiometer

SEMICONDUCTORS

D1—1N5231 Zener diode
D2—1N34A germanium diode
Q1, Q2—2N3904, NPN transistor

ADDITIONAL PARTS AND MATERIALS

M1—Meter, analog, panel-mount, 0-1 milliamp DC
S1—DPDT toggle switch, panel-mount
J1—red binding post
J2—black binding post
PC board, case, insulated hookup wire, solder, etc.

Note: The following items are available from: Unicorn Electronics, Inc., Valley Plaza Drive, Johnson City, NY 13790, Tel: 607-798-0250: Kit of all parts (including all electronic components, etched and drilled PC board, drilled case, and meter with fuel scale), $35.95. Meter with fuel scale, $18.75. Etched and drilled PC board, $3.00. Please add $3.50 for shipping and handling. Please send check or money order with all orders. New York State residents must add appropriate sales tax.

used for a 12-volt lead-acid motorcycle battery.

Construction. The FuelGauge's circuit is simple enough to wire up using standard perfboard. If you wish to use a PC board, a foil pattern for a single-sided board has been supplied. A feature of the PC board pattern is the location of the connection pads for the meter. They are positioned for mounting the PC board directly to the screw terminals of a standard panel-mount meter. As an alternative, you may connect the board to the meter by wires, and mount the board separately in an enclosure.

If you use the foil pattern for a PC board, or buy one from the source given in the Parts List, use the parts-

(Continued on page 74)

BY FRANKLIN J. MILLER

A Microphone Primer

MICROPHONES ARE PRECISION INSTRUMENTS. THEY ARE MADE TO CLOSE TOLERANCES AND ARE DESIGNED TO WITHSTAND PHYSICAL PUNISHMENT. DESPITE THAT FACT, THEY NEED TO BE HANDLED CAREFULLY IF YOU WANT THEM TO LAST A very long time and consistently deliver their best performance.

All microphones are transducers that are designed to take acoustic energy and convert it into electrical energy, which then is used in audio systems. There are acoustic filters built into some mikes that shape the sound before it is converted into electrical energy. Those filters are designed to eliminate unwanted sounds and to tailor the sound to provide a desired effect. One very typical example is the external windscreen that prevents breath pop and reduces wind noise when the microphone is used outdoors. As another example, inside most microphones, you'll find a small disk with many holes punched into it some specific pattern. That is a filter for acoustic waves at specific frequencies. The device is called a Helmholtz filter and it acts as a frequency-response shaping device.

Whether you are a hobbyist making recordings for fun, or a professional setting up for a live recording session, this article will guide you through the proper techniques for recording each type of musical instrument. One of the most diffi cult tasks for a microphone is to record a full orchestra. If it is your responsibility to choose and set up microphones for that purpose, you already know the many decisions you must make. Each instrument presents its own special problems. There is no universal microphone that can be used to give maximum performance. The microphone must be selected for its frequency response and other characteristics including its pickup patterns.

TABLE 1

Type of Input	Frequency Range	Type of Mike*
Lead vocals	82 Hz-10 kHz	C, E, D, O, F
A choir(Background)	82 Hz-10 kHz	CP, O, C, F
Piano	30 Hz-5 kHz	CP, D, O
Strings	30 Hz-8 kHz	CP, E, C
Woodwind	30 Hz-4 kHz	C, CP, E, D
Brass	40 Hz-1 kHz	C, D
Guitar	70 Hz-1 kHz	C, E, D
Percussion	40 Hz-10 kHz	C, CP, E

*O—Omni, C—Cardioid, H—Hyper C, F—Figure 8, CP—Capacitor, E—Electret, D—Dynamic

Every microphone has specific characteristics. This article is only a guide to making better recordings. Your personal experiences in real applications will be your best guide. If the finished recording tells the story that you feel is right, then you have achieved your goal. The art of audio recording is a matter of taste. Part of the process is scientific, and part is art. Art is very subjective. My job is to give you the scientific part and leave it to you to provide the art (sometimes akin to black magic).

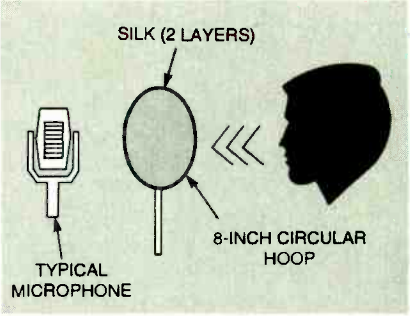


FIG. 1—AN ACOUSTIC FILTER placed in front of the microphone helps with the clarity of recording the P's and T's of a soloist's voice.

Let's look at a specific example. We have to record a lead vocal, back up singers, string section, piano, woodwinds, brass, percussion and guitars. That can be done with a multi-track machine. Here, each section is recorded separately, and we later mix down into either stereo and/or mono tracks. The instrument listing is a definition of an orchestra. Each part presents is own specific problem that must be solved. We attack the problem by first looking at the range of frequencies that each orchestra segment will handle. Table 1 shows the breakout for this example.

That chart is not the ultimate selection guide. Your personal experience is always the best guide to microphone selection. The proper choice of a microphone will surely enhance the quality of any recording you make. Proper equalization will also enhance the quality of the finished work. The best thing you can do for your recording is to capture the audio as faithfully as possible before doing anything with it. Equalization and signal processing should be used sparingly.

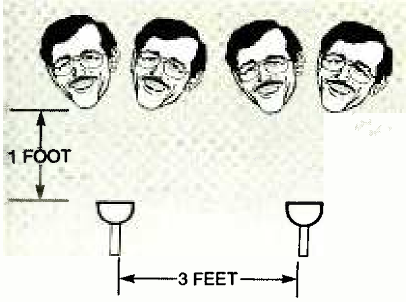


FIG. 2—RECORDING A GROUP OF SINGERS can be handled with two microphones positioned three feet apart and one foot in front of them.

Dealing with Vocals

Solo vocal recordings are very difficult to handle. Any small imperfection will cause all kinds of trouble during the recording process. The "P" and "T" sounds are always a great problem. Figure 1 shows one way of handling the situation. There, an acoustic filter made up of two layers of silk is placed in front of the microphone itself. The "S" sound is another problem; however it is generally handled by an electronic device.

The distance between the vocalist and the front of the microphone is also important. I find that 19 to 20 inches works well. The distance can be changed if the vocalist can control their projection (how loud they are). Remember, overloads will lead to distortion.

The microphone should have some warmth to its sound to help make the final recording sound natural. The natural increase in level in the 1 to 3-kHz band will add presence. A microphone designed for vocals will already have that feature built into it. If not, one can always increase that feature in the mixing console

The next type of recording is a group of back-up singers, or perhaps, a small choir. For our example let's deal with a group of four singers and all the possible combinations of miking them. Figure 2 shows an arrangement of four singers and two microphones. The important fact is that these people and microphones are not in a vacuum. They are in a room with all its accompanying problems. Therefore, it is important to know the room where the recording is made as it will add or subtract from the tonal quality of sound.

It is also important to make sure that you have the phase considerations right. Strange things happen while recording if phase problems are not fixed. You can get cancellations and adding of effects in the recording, and those are things you do not want to have.

String Instruments

Strings, including violins, violas, cellos and double bass, are usually recorded in a group. Figure 3 shows how the instruments are usually arranged. All string instruments have one thing in common; they are all based on vibrating strings that do not radiate sound directly. Their sound slices through the air, hardly moving it at all. Instead, the sound that we hear is transmitted to the instrument's sounding board through a bridge. The rear portion of the sounding board is usually dampened by the human body. The sides of the instrument are also usually stiff due to their size. The high frequencies are usually strongest at right angles to the front panel. The lower frequencies are radiated in an omnidirectional pattern. That is important to understand because the placement and type of microphone will produce different effects.

Therefore, a compromise must be made in the placement of the microphone. You will need to experiment a bit to develop the best sound for the recording. Figure 4 shows how you might set up the microphone for recording a violin. The lowest note of a violin is 196 Hz. The highest frequencies are about 10 kHz. From that information you can see that a microphone with a limited range would be fine. The viola can be treated the same as a violin, but its low frequency limit is extended.

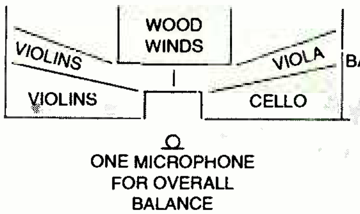


FIG. 3—STRINGS ARE BEST RECORDED as a group. This diagram shows one way to arrange the variety of instruments.

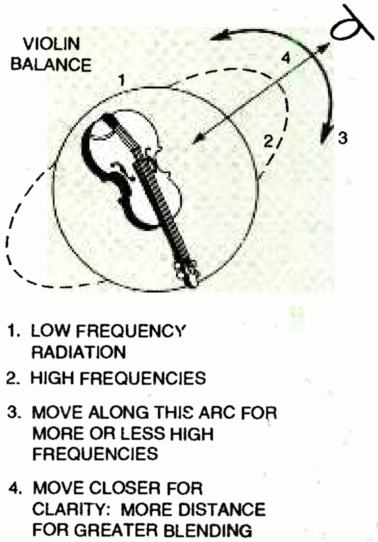


FIG. 4—SETTING UP TO RECORD A VIOLINIST calls for considering all the factors shown here. The fact that the violin has a limited frequency range does help.

The cello presents a different set of problems. The frequency of the microphone should extend below 100 Hz at the working distance. If that is not possible, the mixer can handle it. Be sure that no other instruments are in the way of the sound path. A cardioid mike is a good choice here if you plan to mike in solo fashion. A double bass is also popular in many kinds of recording. It must be close miked, several inches from the bridge, and looking down at the strings. A cardioid figure-eight type is recommended.

There are other ideas you can try. Use them and see what delivers the best combination of balance and sound. Try placing a cardioid microphone near the f-hole by the upper strings. A small microphone can be suspended from the bridge. Another suggestion is to try a small microphone wrapped in a layer of foam and suspended by its cable inside the f-hole. The tools are out there for your use. Be creative and learn what does what, so when you are faced with a real situation, you will be ready and able to handle it in the correct manner.

Woodwinds

This category of musical instruments are those that have fingered or keyed holes, with most of the sound generated from the holes rather than the bell. You should try to capture the sound "at the source". To do that, point the microphone toward the first few holes of the instrument, in front of and above the players for well balanced sound. If some specific sound is important to the musical piece, change the position or use an additional mike in conjunction with the first or primary one. That choice is up to the recording engineer or the musical director. Figure 5 shows how to mike the group with a single microphone and obtain an overall presence of the group. Several microphones may be needed for solo performances. Again, this is up to the recording engineer or the musical director.

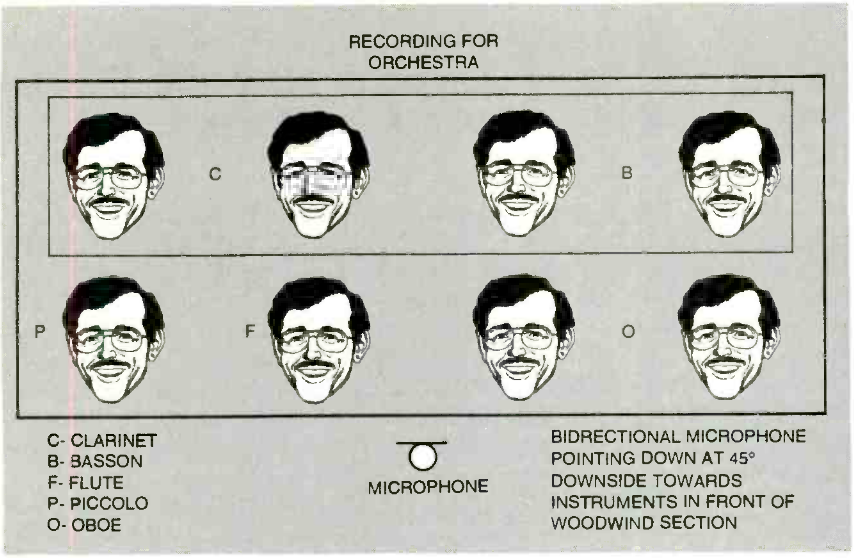


FIG. 5—WHEN RECORDING THE WOODWINDS, use this set up to obtain the presence of the group with a single microphone.

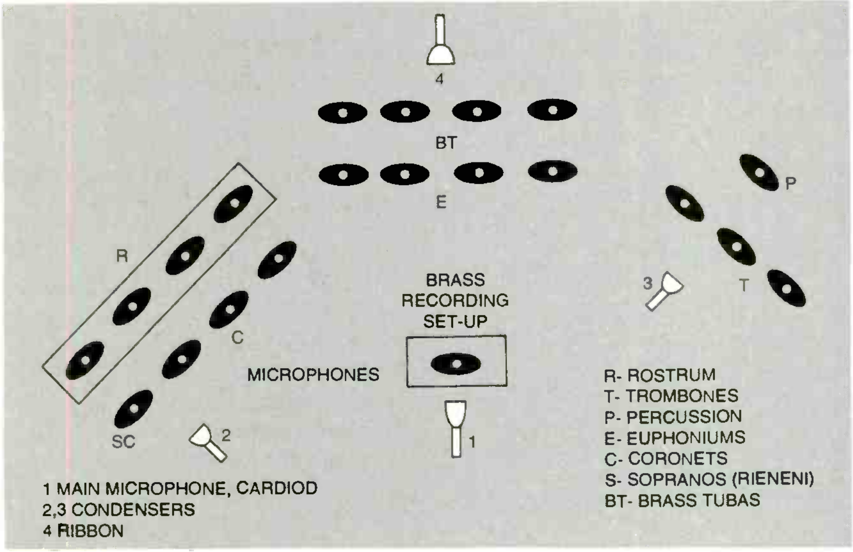


FIG. 6—IF IT IS TO BE DONE properly, taking care of the brass often requires more than one microphone.

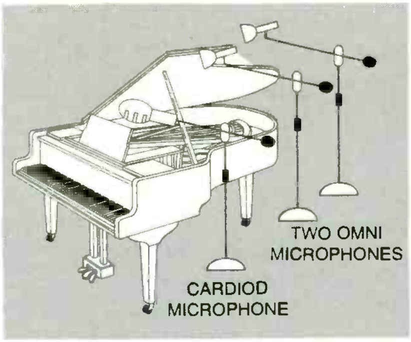


FIG. 7—Here's how to record a piano using the three-microphone technique, one of the popular and proper ways to handle the task.

The flute presents a special problem. The musician blows across the top of the instrument. Therefore, the microphone should be placed in front of the musician, about a foot away from the instrument. Another choice would be to place it mid-way between the flutist's mouth and the finger position, slightly below the instrument, to eliminate the air flow effect over the mouthpiece.

In popular music, the presence of any one instrument may have to be heard above the other instruments. That can be done by introducing an electronic boost of approximately 5 to 8 dBs, centered in the 2500 to 3000-Hz range. That is something you need to actually try to be sure the desired effect is musically correct.

Dealing With Brass

Brass instruments provide a large dynamic range. That is both good and bad for the recording engineer. Because that possible large dynamic range can hit faster than the fader can be adjusted, it is good technique to place a pad in front of the microphone-preamp input. It is also a very good idea to use microphones with a large dynamic range. The electret condenser microphone fills that need well. The selected microphone must also have low distortion, so it will not add to the overall distortion of the system.

Trumpets or trombones direct their sound straight out of the front of the instruments. The sound of a tuba, by contrast, is directed to the ceiling. The French horn's sound is directed to the floor. Although all of those instruments present real problems to the recording engineer, the fix is easy. The correct way to set up your microphone for brass is shown in Fig. 6. It is helpful to use reflecting screens and/or to place the group of horns in some specific way that will maximize the quality of the audio. In the electronic area, the mixing console can increase the effectiveness of those microphones in the 6000 to 9000-Hz region by 2 to 4 dBs.

Percussion Problems

Percussion instruments, including drums, are very important to the overall musical piece. In miking a drum set, the key to a good job is overall balance. The drums themselves produce high acoustic power in the low frequencies. The triangles, cymbals, gong, and snare drum all radiate strongly in the extreme high frequencies (10,000 Hz and above), but with less power. In that situation, the dynamic cardioid microphone is probably the best choice. Several microphones placed in strategic spots will also do the job very well. You can solve the balance problem by placing those microphones carefully and making any needed adjustments at the mixing console.

Pianos, A Special Case

Pianos are modified string instruments. Their strings are struck by little hammers. The strings then vibrate on a sound board. There are two basic types of pianos: the upright type and the grand and baby grand type. Uprights can be miked over the top, which should be left open. A microphone can also be placed inside at the back by the sound board. Experiment to find what delivers the best results. Remember, the recorded sound should be real and not contrived.

The sound recorded should not be

continued on page 74

BY DON LANCASTER

Video, Video Editing, Character Generators, and More

I JUST GOT HOLD OF A BRAND NEW VIDEONICS POWERSCRIPT PS-1000 NTSC ANIMATED VIDEO-CHARACTER GENERATOR. IN ADDITION TO ITS MANY IMPRESSIVE FEATURES, THIS IS ONE OF THE FIRST STAND-ALONE UNITS TO EXTEND THE POSTSCRIPT computer language for work in professional video animation and editing. Thanks to that, you get instant access to nearly unlimited fonts, plus all of the paint and illustration programs. But before we get into more details, I thought it might be a good time to once again go over some basics.

A Few Film and Video Fundamentals

A typical theater film consists of one or more reels of multiple 35 millimeter or larger frames. The main difference between a single frame of a motion picture and a slide from your home 35mm camera is that the frames are usually arranged landscape across a film, rather than portrait along it.

During projection, the frame gets violently jerked into position by the *film gate*, held there, then violently jerked away using a *Geneva Stop Mechanism*. A rotating shutter behind the film then illuminates each frame *twice*, projecting your image through optics to the screen.

Each illumination can be called a *field*. There are usually 48 fields per second and 24 frames per second. The most significant reason for two-fields-per-frame is to reduce the *flicker*. Depending on a few highly subjective factors, less than 40 fields per second or so might seem to blink badly. More than 40 fields per second will be perceived by the eye and the brain as continuous motion.

Black and white television largely tried to imitate film. But unlike film, early video was only able to "project" one single dot at a time. And all that could be controlled was that dot's position and brightness. A typical early television set had an electron beam in its CRT (cathode ray tube) scan rapidly to the right and slowly downward. Every trip across the screen generated one *horizontal scan line*. As before, each completed downstream trip was a *field*.

A sneaky trick called *interlace* scanning was used to try and improve the flicker. As with movies, two fields per frame were used. Only this time, the odd field started in the upper middle, scanned on down and finally ended up at the extreme right of the screen bottom. The even field started in the upper left, scanned on down and ended up at the bottom middle. The eye then combines the two fields into one single frame.

At the time, interlace sounded like a good idea. It very much reduced the flicker and bandwidth, and it worked just fine for *Captain Video* or *Roller Derby*. But interlace reduces flicker only if adjacent scan lines are pretty much the same. Unfortunately, interlace is totally useless for character displays or other high resolution video because the adjacent lines are rarely similar—especially on the dots in small characters.

Original b/w TV used a *horizontal scan frequency* of 15,750 hertz and a *vertical field frequency* of 60 hertz. Even and odd fields both had 262½ scan lines for a 525-line total.

The *vertical resolution* of a simple video display is set by the number of scan lines. The *horizontal resolution* depends on the *channel bandwidth*, or how fast you can

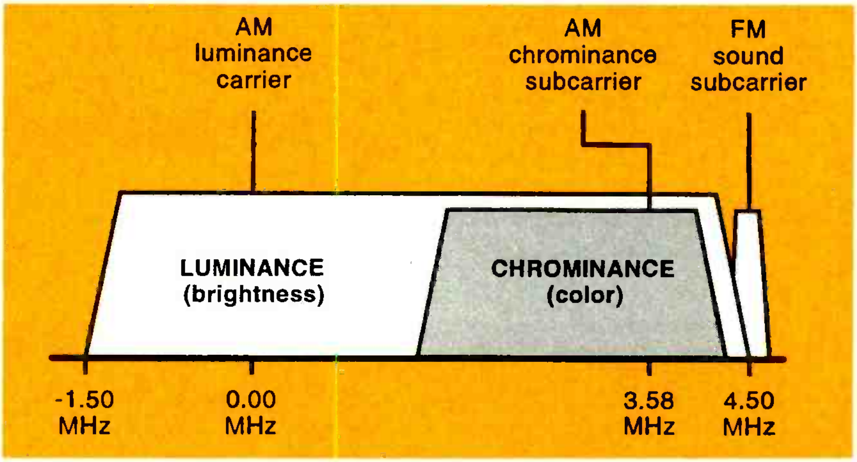


FIG. 1—THE NTSC COLOR TV broadcast channel. The chroma and luminance sampled data spectra do not share identical frequencies. Instead, their energy distributions magically interleave with each other. Vestigial sidebands improve fringe reception. Chroma bandwidth is low and depends on color.

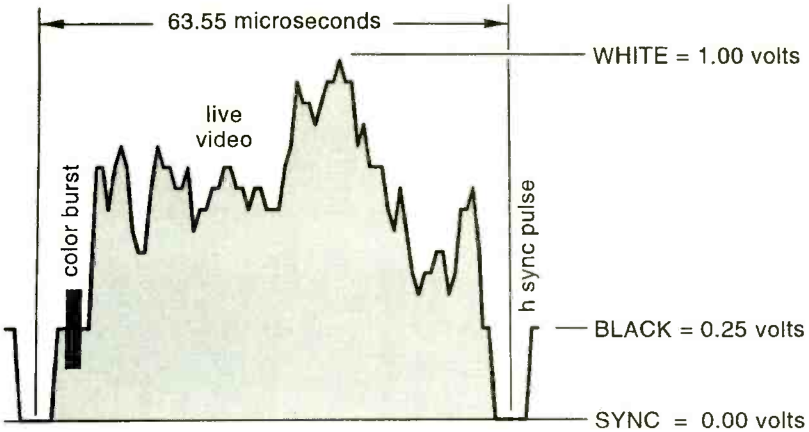


FIG. 2—A TYPICAL NTSC HORIZONTAL scan line. The blanking interval between lines gives the electron beam time to reset. Over time, a lot of additional information has been placed in the blanking interval.

change the video information. Because of bandwidth limitations of broadcast TV channels, their video bandwidth was limited to four megahertz or so, though cheap sets didn't even offer that much.

That made both the horizontal and vertical resolution nearly the same. Nobody knew at the time that they were severely restricting their ability to show alphanumeric data. Unless you go to some very sneaky tricks, it is quite difficult to display more than 40 characters across the screen of a normal TV.

Actually, it is hard to display even that many. In the early days of TV, voltage regulation was an unheard of luxury. To prevent ugly black stripes from showing up on the sides and tops of home TV sets, manufacturers *overscanned*, purposely wrapping the picture around the unwatchable sides of your receiver. Which leads to the concept of the *safe area* or *safe title area*.

The safe area is that blob in the middle of the screen where you are reasonably sure to be able to read an entire message regardless of the set it is displayed on. Any decent TV camera person knows to always keep the action and interest inside the safe area, and that certainly applies to all video titles.

NTSC Color

In the early fifties, manufacturers, broadcasters, and the government devised a scheme to add color to broadcasts without rendering existing black and white TVs obsolete. The result was today's utterly horrible *NTSC* color system, which is disparagingly referred to as *Never the Same Color*.

Under that system, three pieces of information are needed to specify a *pixel* in a given screen position: the *hue* (the color), *saturation* (how much white has to be mixed with the color), and the *brightness* (how much energy the pixel radiates). The brightness is easy enough; you use the existing b/w signal. What remains is some way to include the hue and the saturation. Let's see how that was done.

Monochrome TV is an example of a *sampled data system*. Look into the spectrum, and you'll find clumps of harmonic energy repeating in 15 kHz spaced steps, but there is very little energy in between. Thus, there will be a lot of repeating "holes" in the spectrum of a monochrome video signal. So, the color information was placed onto a carefully designed *subcarrier* that more or less filled the holes in the existing signal. That subcarrier was at the magic frequency of 3.579545 megahertz.

To make everything work, numbers were adjusted slightly, ending up with a horizontal scan rate of 15,735 hertz and a 59.94 vertical field rate. Many compromises were involved. Not the least of which was restricting your color bandwidth so that a color could only be specified over a small group of pixels.

Figure 1 shows us what a typical 6-MHz wide NTSC broadcast TV channel looks like. The full upper sideband and a *vestigial* (or reduced) lower sideband is used. The vestigial lower sideband increases the received energy in the sync pulses and gross picture energy for improved reception in weak signal areas.

The black and white (or the color luminance) material gets amplitude modulated onto the RF carrier. The color information gets placed on a 3.579545-MHz color subcarrier, where it nicely plops into the "holes" of the b/w luminance spectrum. The phase of that subcarrier sets your hue, and the subcarrier strength sets the saturation. A second narrow subcarrier at 4.5 MHz is frequency modulated for sound.

To reduce *Moiré* effects and color artifacts, the color subcarrier phase gets reversed on every line and every frame. Thus, your basic transmitted "unit" consists of two frames, or four fields. That fact is important for serious video editing, where it always pays to work in synchronized units of two frames, and four fields, of which you get 15 per second.

Figure 2 shows us one scan line of NTSC color video. You'll find an *active* portion of the scan line where video actually gets sent. There is a *retrace* portion of the scan line that gives the set a chance to get back from right to left to start the next line. That retrace portion is also known as the *blanking interval* since you obviously do not want anything to show whenever an electron beam is resetting itself.

You have to fully synchronize the transmission and reception of a TV signal. Fail to do so and the picture rolls, tears, or provides wildly wrong colors. Three synchronizing features are required. A *horizontal sync pulse* takes place once each scan line. It is used to lock individual scan lines. A much larger and longer *vertical sync pulse* happens once each field. It is used to lock entire fields together. The vertical sync is fairly fancy: It has to keep providing useful horizontal lock information and also provide for the *equalizing pulses* that properly set up interlace.

Over time, other useful stuff also got put into the blanking interval. That includes such things as test and color-quality signals, closed captioning, data services, and various timing signals.

Color locking is both the trickiest and your most critical. A color burst of eight cycles of 3.579545 MHz is placed in the blanking interval on the *back porch* of your horizontal sync pulse. This reference burst can get captured with a sampled phase-locked loop or a similar circuit to provide a continuous *zero-phase reference*. That new zero-phase reference then synchronously demodulates out that chrominance subcarrier into hue and saturation information. To improve the flesh tone stability, the "I" (in-phase) and "Q" (quadrature) reference channels

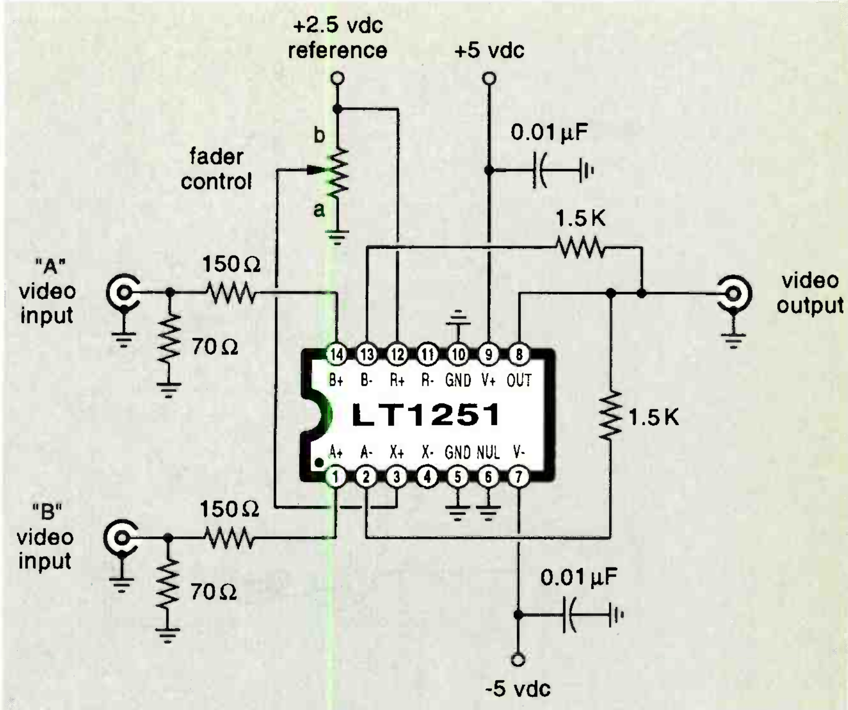


FIG. 3—AN ANALOG VIDEO FADER using the new Linear Technology LT1251. Both inputs must be fully synchronized at all times. An external input or a D/A converter may be substituted for the potentiometer shown.

are offset by 33 degrees. Video-amplitude levels are more or less standardized, with white being defined as 1.0 volts, black around 0.25 volts, and sync as "blacker than black" at 0.0 volts.

Enter Computers and VCRs

All of that was fine for stuffing blurry terrestrial broadcast TV into the narrow channels receivable by cheap electronics, but it is totally useless for presenting any modern computer and arcade video-game data. The four key problems that make NTSC worthless for serious computer or multimedia use are: (A) not enough bandwidth to present more than 40 characters across the screen; (B) the interlace that causes small text to flicker badly; (C) overscanning that hides all of the corners and much of everything else; and (D) the jamming of the chroma and the luminance into the same frequency band where they are hard to completely separate.

The *Apple II* was the first major color computer. It used some sneaky tricks to work around NTSC limits. For example, a side-by-side green and purple dot was used for one white pixel. Orange and blue were later added by a phase-shift scheme. Instead of letting the color phase subcarrier alternate each field and on each line, elegant timing kept color phasing the same, making it all possible. Rather than minimizing color-subcarrier artifacts, their entire display was nothing but one giant (and most brilliantly conceived) color-subcarrier artifact!

The monitor image size was reduced so you could view your corners free of overscan. Eventually, a monochrome 80-column text display was added, but only on a custom b/w video monitor having a bandwidth that was much higher than that of a typical home TV set.

The videocamera, videodisk, and VCR folks then stepped in with some improved variations on NTSC. Those included such things as raising its effective bandwidth and placing the chroma subcarrier into a high band where it was easier to separate from the luminance.

Creating New Video Standards

Most serious high-end computers, the professional video producers, and most multimedia systems don't use NTSC or any variation of it. Instead they use *component color* in which you'll find three or four totally separate channels to provide for fully isolated color information. Three of these channels are usually for red, blue, and green, with any sync signals normally provided on the green channel.

The optional fourth RGB channel has several possible uses. The video folks call

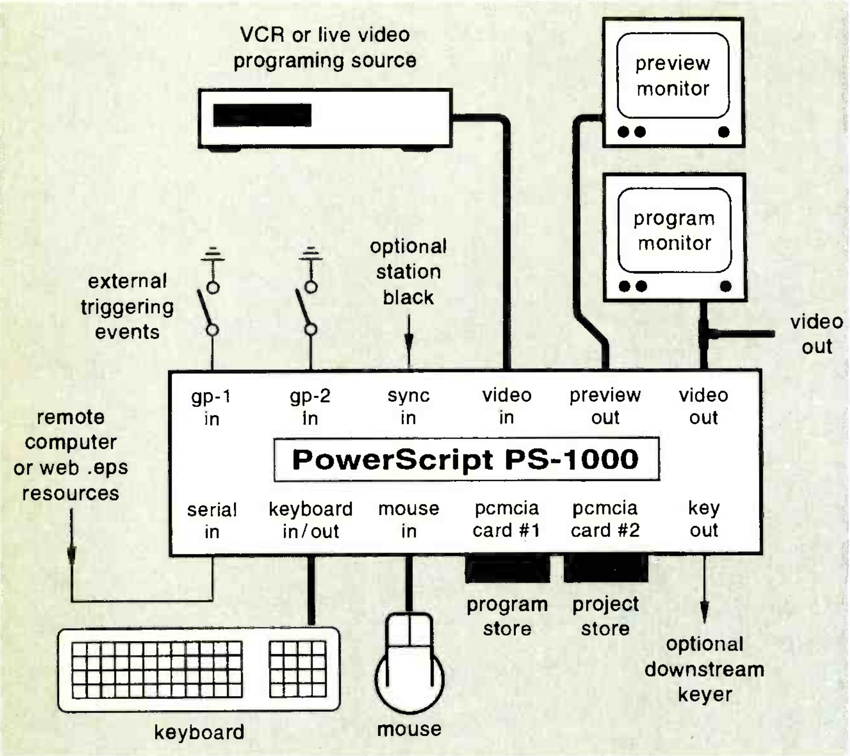


FIG. 4—THE POWERSCRIPT PS-1000 is a powerful new character generator from Videonics. A typical hook up is shown here.

it the *alpha* channel, and apply it to set the *keying* or to define the *transparency* of an overlay. One obvious purpose of transparency is to allow the selective fade in and fade out of a message screen.

Component RGB gives you much higher resolution. That's done first by increasing the number of non-interlaced scan lines, second by increasing the video bandwidth so that more color changes per line could get displayed, and third by providing unique color information for each pixel.

Various new schemes can reduce video bandwidth. *Compression* is any coding scheme that can remove any redundancy from a video picture so that only the essential information has to be sent or stored. Examples include JPEG for stills or MPEG for video. There are also vastly better, newer methods that use *wavelets* or *fractals*. Compression can be *lossless* (everything comes back exactly) or *lossy* (where an acceptably degrading approximation is made).

Since the eye is not nearly as good at spotting color changes compared to brightness changes, one color can sometimes be shared by two or more pixels, which leads to a whole new set of digital video standards with names like (4-2-2) color.

Sneaky tricks can also be played to improve what you see on screen. One is line doubling, where twice as many scan lines are placed down at double speed. There is no new real content, but the scan lines are now not nearly as obvious. *Genesis* is one supplier for line doubling chips.

Another trick is *anti-aliasing*, in which "slightly blurred" lines or dots are substituted. That eliminates the "jaggies" on slanty lines and greatly improves small text legibility. For instance, the text smoothing of Adobe Acrobat 3.0 can easily let you view three columns of tiny text on an ordinary computer monitor. See any of my MUSE, RESBN, or BLAT files for ongoing examples.

Much more information on the video and movie standards is available through SMPTE (Society of Motion Picture and Television Engineers).

Character Generators

A *character generator* used to be any scheme for overlaying words and graphics on an existing video stream. But these days, we have stand-alone character generators or full video-production editing systems. A stand-alone character generator does characters and art, limited wipes or fades, and limited animation all by itself. A video-production editor (such as Newtek's Video Toaster or Video Flyer) often includes paint programs, keyers, full 3-D animation, and lots of other features at higher costs. If you are interested in learning more on editors, check out *Video Toaster User* and *Lightwave* magazines.

We'll note in passing that there are three main video-editing schemes in use today: *cuts only*, *A-B roll*, and *nonlinear*. Cuts-only is the simplest and cheapest, but only permits fade-to-black transitions and is similar to splicing two pieces of film. With A-B roll, the new content is overlaid on top of an existing live or VCR input, giving you unlimited fade and wipe options. With nonlinear editing setups, one or more disk drives replaces the input feed, giving total random access to any sequence at any time.

Regardless of the type, here are four character-generation rules that should be followed: (1) Everything has to follow the exact same video standard. (2) Everything has to be stable. (3) Everything must be fully locked together. And finally, (4) Content must be compatible with the chosen video standard in use.

The process of locking everything together is known as *synchronization*. Your simplest synchronizer is a *gen lock* where you simply grab input sync pulses and count them to locate a desired position on screen. Simple gen locks are useful for such things as picture-in-picture, time codes, or for use with close captioning.

More desirable is *station-master sync* or *station black*, where a single timing source can be used to lock all cameras and processors together.

The *frame grabber* lets an entire input frame or pair get caught and stored in memory. Frame grabbing lets you handle such tricks as *chroma keying*, where new material replaces anything blue.

The fanciest locker of all is the *format converter*, where the input fields are digitized and written into a memory, changing them into some acceptable number of pixels and scan lines for the intended output video standard. Dual Port RAM chips greatly ease the design of format converters.

For synchronization, one or more additional *time base correctors* might be needed. A VCR is an unavoidably imprecise mechanism. Because tape stretches, slight jitter is inherent in any VCR-generated video. The time base corrector takes out that jitter and restabilizes. Time base correctors are *essential* any time videotape is in use as an input in the edit process.

A brand new video fader chip useful for character generation is shown in Fig. 3. The video fader lets you smoothly mix two video signals anywhere from all of input A, up through fifty-fifty, to all of input B. Inputs A and B have to get locked together and (if needed) time base corrected for a fader to work.

Older faders were analog and had a classic "T" handle on them. Push the handle up to fade in your title. Pull it down to return to your main program feed. The latest of faders are totally digital and capable of changing on a pixel-by-pixel basis. Being able to instantly switch or fade on the pixel-by-pixel basis lets you do *keying*; one example of that is substituting a weather map for the blue screen that is behind the weather person. Another example is to switch in only individual opaque letters over background video. The latter trick is what the previously mentioned alpha channel is all about. Content on a simple alpha channel can be thought of as a *mask*. Fancier alpha channel uses permit transparency.

Important sources of video faders and other chips useful for character generators include Analog Devices, Linear Technology, and Maxim.

A VIDEO RESOURCE SAMPLER

B&H Photo-Video
119 West 17th St.
New York, NY 10011
Tel: 800 947-1175

Black Range Films
Star Rt. 2 Box 119
Kingston, NM 88042
Tel: 505 895-5652

Cinefex
Box 20027
Riverside, CA 92516
Tel: 909 781-1917

Computer Graphics World
10 Tara Blvd. 5th Flr.
Nashua, NH 03062
Tel: 603 891-0123

Digital Creativity
470 Park Avenue S, 7N
New York, NY 10016
Tel: 212 683-3540

Digital Magic
10 Tara Blvd., 5th Floor
Nashua, NH 03062
Tel: 603 891-0123

EMedia
649 Massachusetts Ave., #4
Cambridge, MA 02139
Tel: 617 492-0268

Film & Video
8455 Beverly Blvd., #508
Los Angeles, CA 90048
Tel: 213 653-8053

Imaging Magazine
12 West 21 St.
New York, NY 10010
Tel: 212 691-8215

MIX Bookshelf
6400 Hollis St., #12
Emeryville, CA 94608
Tel: 800 233-9604

Multimedia Producer
701 Westchester Ave.
White Plains, NY 10604
Tel: 914 328-9157

New Media
901 Mariner's Island, #365
San Mateo, CA 94404
Tel: 415 573-5170

NewTek
1200 SW Executive Dr.
Topeka, KS 66615
Tel: 800 847-6111

PC Graphics & Video
201 E Sandpointe Ave., #600
Santa Ana, CA 92707
Tel: 714 513-8400

Photo Electronic Imaging
57 Forsyth St. NW, #1600
Atlanta, GA 30303
Tel: 404 522-8600

SMPTE
595 W Hartsdale Ave.
White Plains, NY 10607
Tel: 914 761-1100

3D Design
600 Harrison St.
San Francisco, CA 94107
Tel: 415 905-2200

TV Technology
5827 Columbia Pike, #310
Falls Church, VA 22041
Tel: 703 998-7600

Video Toaster User
411 Borel Ave., #100
San Mateo, CA 94402
Tel: 415 358-9500

Videonics
1370 Dell Avenue
Campbell, CA 95008
Tel: 408 866-8300

The Videonics PowerScript PS-1000

Now, lets get back to where we started. The PS-1000 NTSC is one premium ($3000 list) stand-alone character generator having some innovative and unusual new features. It is intended mostly for serious amateurs, for interpretive kiosks, smaller TV-station sports and weather departments, or for use with local cable front ends.

Innovations include superb 17-ns switching and using a clone of the PostScript language for zillions of high quality fonts and unlimited art. Editing is arranged by objects, pages, and projects. The supported objects include text, graphics, time displays, and anything you can represent as an .eps PostScript file.

Just as any PostScript printer will compose to paper, their PowerScript language instead composes PostScript objects to a color video screen. The unit is basically a rack-sized, inch-high dedicated computer having the usual keyboard and mouse. Inside is a power supply, a custom 40-Mhz computer that looks vaguely 486ish, and a video switcher/fader card.

The menu-driven graphics seem roughly comparable to Windows 3.1 or so, but with cruder resolution since they do have to display on an NTSC screen. One or more PCMCIA cards serves as program and project storage.

A typical setup using the device is shown in Fig. 4. You input live or VCR video in an NTSC or Y-C format. You hook a composite monitor to the preview output. You hook a second monitor (and your output feed, your recording VCR, or whatever) to the NTSC or Y-C program-output jacks.

An external computer or even the web can get used to input fonts and .eps graphics. Serial comm and PPP network protocols are supported. You can also insert an Ethernet card into the second memory slot.

The absence of an alpha channel in PostScript level II is gotten around by using CMYK color, and by then sneakily redefining the "K" or black channel as alpha transparency.

The 2-D animation is somewhat restricted, but the unit is otherwise impressive. You can crawl, slide, or bounce your message or artwork around, even changing its color or size as you go along. The pages can be much larger than your screen. "Tweening" is automatic. Set the initial and final point of any move, tell PowerScript how long the motion is to take, and it handles all the rest for you. Curved paths are done with key frames. Most of their effects can be done in real time, and those can be externally synchro-

NAMES AND NUMBERS

Adobe Acrobat
1585 Charleston Rd.
Mountain View, CA 94039
Tel: 800 833-6687

Analog Devices
PO Box 9106
Norwood, MA 02062
Tel: 617 329-4700

Butterworth-Heinemann
313 Washington St.
Newton, MA 02158
Tel: 617 928-2500

Coriolis Books
7339 E Acoma Dr., #7
Scottsdale AZ 85260
Tel: 602 483-0192

Digital Graphics
2800 W Midway Blvd.
Broomfield, CO 80020
Tel: 303 469-5730

EOM
13741 E Rice Place, #200
Aurora, CO 80015
Tel: 303 690-2242

GEMI Store
PO Box 3623
Littleton, CO 80161
Tel: 888 333-GEMI

Genesis Microchip
2111 Landings Drive
Mountain View, CA 94043
Tel: 415 428-4277

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035
Tel: 408 432-1900

Maxim
120 San Gabriel Dr.
Sunnyvale, CA 94086
Tel: 800 998-8800

Raychem
300 Constitution Drive
Menlo Park, CA 94025
Tel: 800 227-7040

Semtech
652 Mitcher Road
Newbury Park, CA 91320
Tel: 805 498-2111

SGS-Thomson
1000 E Bell Rd.
Phoenix, AZ 85022
Tel: 602 867-6259

Synergetics
Box 809
Thatcher, AZ 8555
Tel: 520 428-4073

nized by using the GP timing inputs, but fancy fonts and complex graphics may impose minimum scene display time limits.

Lots of other *Videonics* machines and software are available over a broad price and performance range. The Videonics web site can be found at *www.videonics.com.*

I've gathered more video stuff into this month's resource sidebar.

Names and Numbers

New from *SGS* Thomson is their ST7537 power line modem circuit for home automation. From Raychem, there's a new *Circuit Protection Databook*. From Semtech comes their *Battery Power Management Products* catalog.

An innovative source for the latest and best in computer language books and such is Jeff Dunteman's Coriolis Books. They have both a free catalog and a web site at *www.coriolis.com*. Five of their latest titles include *Java Database Programming*, an updated *The Power Mac Book* second edition, the *Sybase Client/Server*, *Networking with NT4*, and *Real-World Internets*. Most come with companion CDs. I've got a link to them on my *Guru's Lair* at *www.tinaja.com*.

Two newer trade journals: *Digital Graphics* on big color printing for posters, billboards, or vehicles and *EOM* for geographic, mapping, and earth information. One of the *EOM* advertisers is THE GEMI Store, who offer high resolution aerial photos of anywhere in the world for as little as $10 per square mile.

More on sonoluminescence can be located in the Nov 1st, 1996 issue of *Science* on pages 718-719. Unusual resources and materials for print shops and home publishing appear in the *Helene's Hotline* online newsletter. To sign up, e-mail *bottalk@printer-net.com* and put the single word *subscribe* in the body of the message.

A reminder here that my *CMOS Cookbook* is now back in print with Butterworth Heinemann as my brand new publisher. Autographed copies are available from my company, Synergetics, either by themselves or as a portion of the bargain priced *Synergetics Classics Library*. I also still have a few mint Tek 1230 logic analyzers and pods from our recent surplus sale.

As usual, most of the mentioned resources show up in the Names and Numbers or Video-Resource Sampler sidebars. Be sure to check there first before you visit my *www.tinaja.com* website or call our US technical help line. EN

NEED HELP?

Phone or write all your US Tech Musings questions to:

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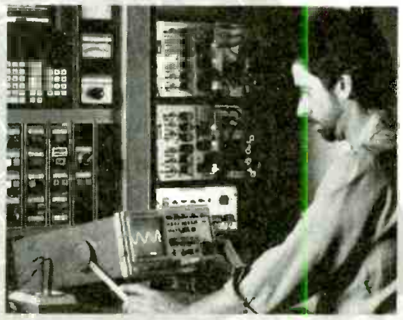

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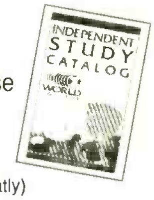

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BATTLEFIELD MEDICINE

(Continued from page 57)

United States to be evaluated. With VTC, the same evaluation can be done for a fraction of the cost and without the risks sometimes incurred by an evacuation.

The Army Research Laboratory has built some 15 VTCs and a couple are already in service with U.S. peacekeeping forces in Bosnia. Indeed, Hilliary Rodham Clinton and daughter Chelsea used the system to communicate with personnel at Walter Reed Army Medical Center in Washington.

On the Home Front. Michael Scanlon, an engineer at the Army Research Laboratory, was sitting on a waterbed in a mall store. Noticing how movement anywhere on the bed made the whole bed move, he came up with idea for preventing tragic deaths from Sudden Infant Death Syndrome, or SIDS, and a potential technique to save lives on the battlefield.

The result of two-and-half years of development, mostly on his own time and with little financial help, was a special pad that serves as a mattress in a crib or cradle. The liquid-filled pad is made of polychoprene rubber, an acoustically "invisible" material that does not interfere with the transmission of sound when in contact with water. A hydrophone like the ones used by the Navy for underwater sonar work is placed inside the pad to detect the infant's heartbeat and breathing. If either stops, the sensor alerts the parents by transmitter, pager, or alarm. Since the body is mostly water and the pad acts as a fluid extension of the body, the baby and pad are perfectly coupled. The sensor works well even when the infant is wearing clothing or there is a blanket between the infant and the pad. There is also a vibrating mechanism inside the pad to immediately start stimulating the infant to breathe. That greatly increases the chance that the infant can be awakened or resuscitated before suffering harm.

The SIDS detector technology could be adapted to a military role by attaching a pad to the soldier's torso. Medics often get injured or even killed because they go out to help soldiers who are already dead. A medic could interrogate the sensor pad to find out if the downed soldier is breathing or has a heartbeat before he goes after him. The sensor pad could also carry a microphone so the soldier could report on his condition and location, or, with a small video camera, a picture could be transmitted. Other options include a GPS capability to locate the wounded soldier and sensors to measure vital signs.

Another concept under consideration is a wrist-worn personal status monitor to track vital signs and send out an "SOS" in case of a wound or other trauma. The signal would include the wounded soldier's precise location obtained from a built-in GPS position receiver. No longer would lone soldiers bleed to death after a gunfight because no one knew of their situation.

Some advanced battlefield medical-assistance concepts were even designed by students at the famed Art Center College of Design in Pasadena, California as classroom projects. For instance, two students designed a hand-held thermal oximeter monitoring infusion device (TOMI). The TOMI straps onto the patient's upper arm to administer fluid and medication intravenously while monitoring vital signs. A stretcher was designed using reinforced vinyl with carbon fiber telescoping poles that would fit in a standard army-issue backpack. It has clips that attach to the sides of the paramedic's belts to help support the stretcher.

Two other students designed "Verticel," a compact paramedic's unit with various modules that attaches to a backpack frame. Carried by two paramedics, the system combines a lightweight collapsible stretcher in one backpack; another pack carries medical and life support equipment. A digital cervical collar with detachable pulse oximeter monitors the patient's blood pressure, heart rate, and vital signs. Diagnostic information could be downloaded into a patient monitor worn by each medic, which also includes navigation electronics to help in search-and-rescue operations.

Many of those technologies could find their way into the hands of civilian care givers. Indeed, the SIDS detector technology will probably find its way into baby cribs long before it appears under army fatigues. The Medic-Cam concept has many potential applications beyond the battlefield. It could be used in large scale disasters like earthquakes, hurricanes, or terrorist bombings. As the cost goes down, which is likely as most of the components are simply modified commercial items, it could find its way into the typical civilian EMS vehicle. Ω

FOR MORE INFORMATION

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136258	Powered breadbrd	$99.95	$89.95

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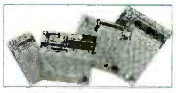

Part No.	Description	1-4	5-9
132644	PICProto 18	$9.95	$8.95
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132636	PICProto 3	14.95	13.49
132652	PICProto 64	16.95	14.95

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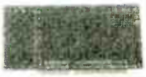

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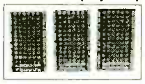

- For single chip circuits
- (2) 1206 surface mount bypass capacitor sites, (16) general purpose sites and (2) 0805 sites
- Size: 1.4"L x 0.8"W • Weight: 0.02 lbs.

Part No.	Description	1-4	5-9
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Part No.	Description	1-4	5-9
136590	4½-digit	$69.95	$62.95

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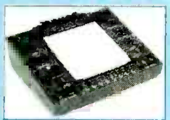

- Solderless breadboard
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Part No.	Description	Price
136266	Digital-Analog lab Special	$314.95

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- Programs 16Kbits to 512Kbits EPROMs
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Part No.	Description	1-4	5-9
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Part No.	Description	1-4	5-9
136207	17.5W mono amp.	$12.95	$11.49

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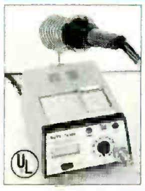

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Part No.	Description	1-4	5-9
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Part No.	Description	1-4	5-9
136004	2-in-1 sold. iron	$19.95	$17.95

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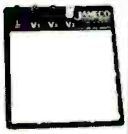

- Formed with V-shaped cross-sectional groove, which allows DIP IC pins inserting across two parts and to increase the rate of utilization due to small pitch • Dovetail protrusions and recesses designed to connect two adjacent tightly together

Part Number	Contact Points	Size L x W	Pricing 1-9	10-49
136910	960	5.5 x 2.8	$9.95	$8.95
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- Weight: 3.3 lbs. • One-year warranty

Part No.	Description	Price
136101	PC lab board .... Special	$319.95

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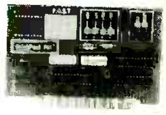

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Part No.	Description	1-4	5-9
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AUDIO UPDATE

continued from page 62

too wide, because we have a mental image as to the size of this instrument. A cardioid microphone is a good choice, because it can help localize the sound. Thus, it can reduce the other sounds in the background.

Grand and baby grand pianos are used in almost every musical piece. Therefore, it is very important to learn how to place microphones for the piano. There are several possible ways to record pianos. The first and simplest method is to use a single microphone. Open the piano's lid and place the microphone on a boom arm in the middle of the strings. Position the mike between six and twelve inches above the strings. That will usually provide an overall balance between the high and low frequencies. Adjusting the microphone can change that tonal balance to suit the particular recording. Cardioid microphones are well suited for this application, while the normal use of the proximity effect does not add too much coloration to the sound. Again experiment to obtain the best overall sound.

If you are able to find a two-way cardioid microphone (difficult to do), it would be a great choice, as this type can be particularly responsive to string harmonics.

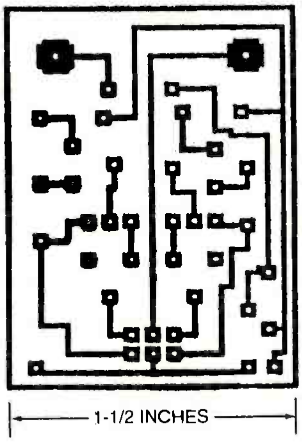
Another way to mike a piano is the three-microphone technique. That technique combines one cardioid and two omni microphones. All three microphones are boom mounted to permit proper placement. Place the cardioid mike close to the piano to capture the sharp rise and fall times. Be sure that you don't let it get too close to avoid favoring any particular string. The point is to get the overall sound of the piano. Place the other two microphones over the piano to capture the ambient sound. They should be mounted about six feet high and about three feet apart (see Fig. 7 for details). The exact position depends on room acoustics. The larger the room, the greater the distance should be. EN

BATTERY FUEL GAUGE

(Continued from page 59)

placement diagram in Fig. 4 as a guide. The pattern shown is for the dual-use version; should you wish to build a single-use version, simply eliminate R4, R5, R8, R9, and Q2. Obviously, a single-use version will not need S1, either. Appropriate jumpers should then be inserted in the locations where switch S1 would normally be connected.

A small metal box measuring 5 inches × 3 inches × 2-¼ inches will hold all of the parts comfortably. The most difficult part of the construction is cutting a suitable hole in the box for the meter. One method that works well is using an adjustable hole-drilling bit with an ordinary ¼-inch electric drill. If you do not like metal cutting, a kit containing a pre-drilled case is available from the source given in the Parts List.



Here's the foil pattern for the FuelGauge. Two independent circuits fit easily onto this single-sided board.

The markings on a 1-milliamp analog panel meter can be read as percentages of battery charge left. If you'd like to dress up the meter face, you could draw a replacement scale on a self-adhesive label. One possible style is an automotive fuel gauge. The size of the replacement scale should be the same size as the scale of the meter you are using for the FuelGauge.

Battery Contacts. You will have to use your ingenuity to find the best way to connect the FuelGauge to your particular battery. One example is certain models of batteries used by Icom transceivers. Those have an extra set of contacts on the back that are meant for use by an optional fast charger. To use those contacts, you will need brass strips, ¼-inch wide, which are available at hobby shops. The strips are bent to fit around the bottom of the battery. A solder blob on one end serves to make connection with the spare battery contacts. An 18-inch length of hook-up wire with a banana plug on one end is soldered to the other end of the brass strip for connection to the FuelGauge.

Calibration. The FuelGauge is calibrated by first connecting it to the battery you'd like to use it with when the battery is fully discharged. Assuming you are using the dual-circuit version of the FuelGauge, select which circuit will be used with S1. Adjust R6 (or R8) to the point where the meter first starts to indicate (just a hair above the empty mark). Disconnect the FuelGauge and fully recharge the battery. Remove the charger, reconnect the FuelGauge, and set R7 (or R9) for a full scale reading (just at the full mark). If you are going to use the dual-use version of the FuelGauge with another type of battery, repeat the calibration procedure with the other battery and S1 in its other position.

The FuelGauge is now ready for use with that battery (or batteries). Remember that the FuelGauge draws between 1 and 2 milliamps from the battery when in use. While in some applications you may leave the FuelGauge connected, on smaller battery packs or over extended periods you may want to eliminate that small drain by disconnecting the FuelGauge or adding a switch in series with the terminal connections.

There you have it—a highly-accurate fuel gage for your battery packs that will have paid for itself the first time you *don't* mistakenly try to use a battery pack that is almost discharged. You'll get a lot of satisfaction and peace of mind always knowing the state of charge of your battery pack. Ω

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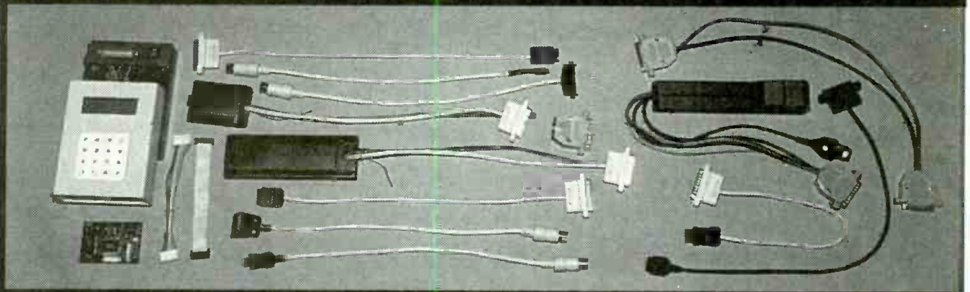

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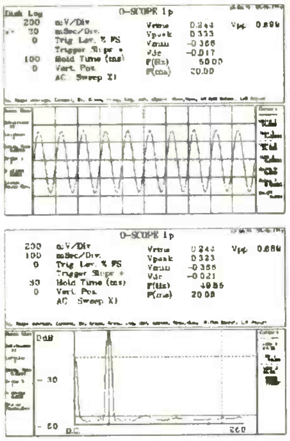

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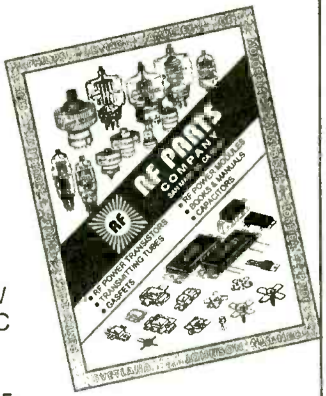

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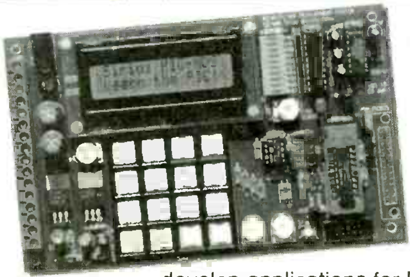

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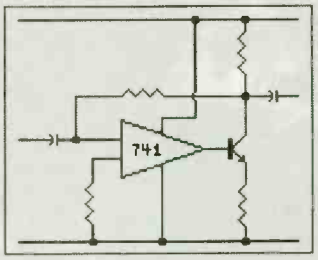
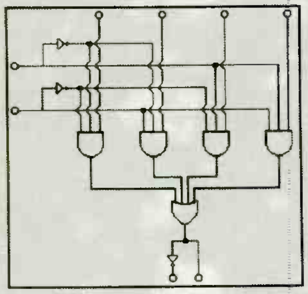
Now you can learn from the same training videos that are being used by technical schools, the Army, Navy, Air Force, Coast Guard, CET's and industries all across the United States and around the world. Advancing your trouble-shooting skills has never been easier, thanks to UCANDO's extraordinary video training library. These unique training videos will teach you more in less time as you watch theory come to life. Each video is approximately one hour long and comes complete with a student workbook.

Basic Series

MODEL	DESCRIPTION	REGULAR	SALE
VT201	Direct Current: Series circuits, Parallel Circuits, Ohm's law, how to use the DMM. 55 Minutes	44.95	39.95
VT202	Alternating Current: The sine wave, coils, capacitors, transformers. 62 minutes	44.95	39.95
VT203	Semiconductors: Semiconductor theory, common diodes, transistors, switching devices. 57 Minutes	44.95	39.95
VT204	Power Supplies: Rectifier circuits, filter circuits, regular circuits, troubleshooting. 56 Minutes.	44.95	39.95
VT205	Amplifier: Amplifier basics, class A, class B, class C, operational amplifiers. 57 Minutes	44.95	39.95
VT206	Oscillators: LC and RC oscillators, crystal oscillators, crystal ovens. 56 Minutes	44.95	39.95



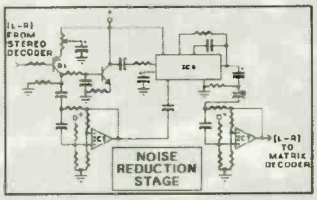


Digital Series

MODEL	DESCRIPTION	REGULAR	SALE
VT301	Digital 1: Digital basics, basic gates, binary notation, binary math, decimal notation. 54 Minutes	44.95	39.95
VT302	Digital 2: Octal notation, hexadecimal notation, flip-flops, counter circuits. 55 Minutes	44.95	39.95
VT303	Digital 3: Complement numbers, multiplexers, registers, decoder drivers, displays. 56 Minutes	44.95	39.95
VT304	Digital 4: R-2R DAC circuits, binary weighted no.s, slope circuits, S/A & flash circuits. 57 Minutes.	44.95	39.95
VT305	Digital 5: Memory devices, ROM, PROM, EPROM, EEPROM, SRAM, DRAM, MBM. 56 Minutes	44.95	39.95
VT306	Digital 6: The central processing unit, input devices, output devices. 56 Minutes	44.95	39.95

Other Popular Videos

MODEL	DESCRIPTION	REGULAR	SALE
VT401	AM Radio: Major stages of AM, signal conversion, signal detection, audio reproduction, AM stereo. 61 Minutes	44.95	39.95
VT402	FM Radio Part 1: Bandwidths, RF amplifier, mixer-oscillator, IF amplifier, limiter FM detector. 58 Minutes	44.95	39.95
VT403	FM Radio Part 2: Frequency doubler, stereo demultiplexer, audio amp stages, digital data encoding/decoding. 58 Minutes	44.95	39.95
VT404	TV Part 1, Intro to TV: Gain an overview of the television system and how the stages work together. 56 Minutes	44.95	39.95
VT405	TV Part 2, The Front End: UHF-VHF tuning stages, automatic fine tuning, remote control. 58 Minutes	44.95	39.95
VT406	TV Part 3, Audio: The sound strip, stereo TV, secondary audio programming, professional channels. 57 Minutes	44.95	39.95
VT501	Understanding Fiber Optics: Basic fundamentals, cable design, connectors, couplers, splicing. 58 Minutes	44.95	39.95
VT502	Laser Technology: Laser theory, types of lasers, applications, safety precautions. 57 Minutes	44.95	39.95
VT102	Intro to VCR Repair: This video is designed for the serious technician. (workbook not available). 84 Minutes	44.95	39.95
VT103	Learn How To Clean Your Own VCR: This video is not technical, but will save you money. (workbook not available). 32 Minutes	29.95	25.95



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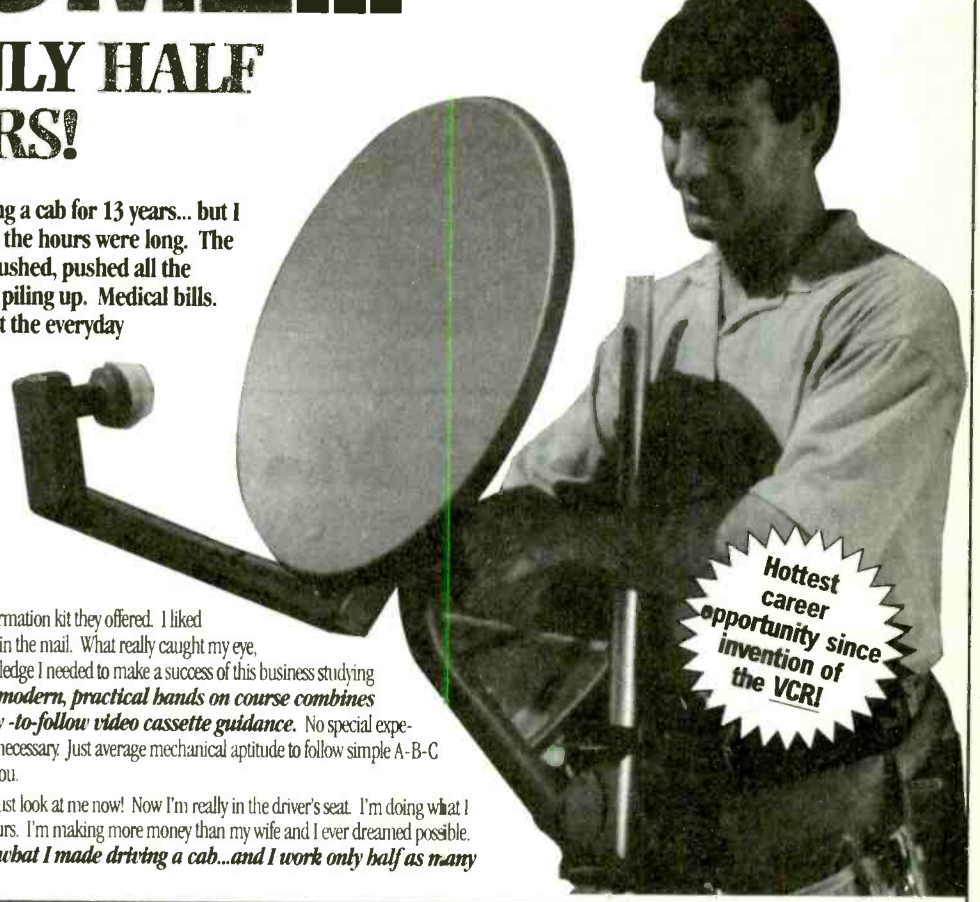
CIRCLE 332 ON FREE INFORMATION CARD

I DOUBLED MY INCOME...

WORK ONLY HALF THE HOURS!

I covered a lot of miles driving a cab for 13 years... but I sure didn't get anywhere! I mean the hours were long. The pay was short. My boss pushed, pushed, pushed all the time. In the meantime bills were piling up. Medical bills. House repairs. Charge cards. Just the everyday things. I was not just behind the wheel, I was behind the eight ball.



That's when I saw a magazine article that talked about the hottest big money-making career opportunities of the 90's. The one that interested me the most pertained to the *NEW explosive SATELLITE DISH/TV/ELECTRONICS field.*

I mailed the coupon for the FREE information kit they offered. I liked what I saw when the information packet came in the mail. What really caught my eye, however, was the idea I could gain all the knowledge I needed to make a success of this business studying in my spare time at home. ***Foley-Belsaw's modern, practical hands on course combines simple step-by-step lessons with easy -to-follow video cassette guidance.*** No special experience, education or electronics background is necessary. Just average mechanical aptitude to follow simple A-B-C repair procedures that are clearly outlined for you.

I decided to get in on the action... and just look at me now! Now I'm really in the driver's seat. I'm doing what I want to do. I'm my own boss. I set my own hours. I'm making more money than my wife and I ever dreamed possible. ***Would you believe I'm making twice what I made driving a cab...and I work only half as many hours.***

Get in the *FAST LANE* on the New "INFORMATION SUPERHIGHWAY" Everyone's Talking About!

It's exciting! It's gigantic! The technology of tomorrow is here today! You've been reading and hearing about the amazing INFORMATION SUPERHIGHWAY. ***It's so NEW that few technicians are equipped to service this fast emerging field! Foley-Belsaw gives you SATELLITE DISH technology (including New MINI-DISH)...*** along with the electronics expertise you need to make BIG MONEY servicing TVs and other electronics equipment.

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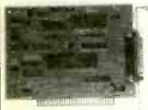
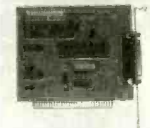
ANA100 Analog I/O .... $ 99



- 8 Channel 8-Bit
- 0 to 5 Volt Input
- 14 TTL I/O lines
- Analog Output
- 400KHz Sampling

DIG100 Digital I/O .... $ 39



- 8255 PPI
- 24 or 48 TTL I/O Lines option
- Selectable Base Address

ANA150 Analog/Counter... $ 89

- 8 Channel 8-Bit 0 to 5 Volt Input
- 3 16-Bit Counters
- 400KHz Sampling

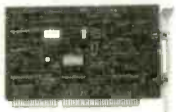
DIG200 Counter I/O .... $ 79

- 3 16-Bit Counters
- 8 TTL Input lines
- 8 TTL Output lines
- Selectable Clock Frequency input

ANA200 Analog I/O .... $ 79

- 1 Channel 12-Bit 0 to 5 Volt input optional bi-polar
- 100KHz / 300KHz Sampling rate
- 24 TTL I/O lines

ANA201 Analog .... $ 129



- 8 Channel 12-Bit
- x1, x5, x10, x50 Programmable Channel gain
- 100KHz/300KHz Sampling rate

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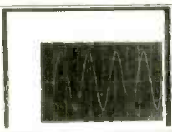

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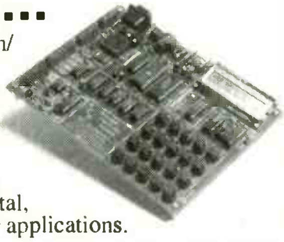

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- 8237 DMA 8253 TMR
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- UP TO 8 MEG ROM
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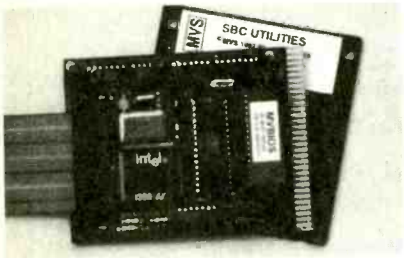
EVAL KIT $295



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8088 SINGLE BOARD COMPUTER .... OEM $27 ... *95
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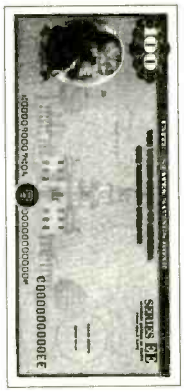

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Check Out What We Have To Offer:

Fantastic DMM Offer!!!

Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch. **Rubber Boot Included**

Our Best Offer Ever on a High Quality Full Sized DMM

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity

Overrange Indication: 3 Least Significant Digits Blank

Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%

Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)

Power: 9V Alkaline or Carbon-Zinc Battery(NEDA 1604)

Low Battery Indication: BAT on Left of LCD Display

Dimensions: 188mm long x 87mm wide x 33mm thick

Net Weight: 400g

$19.00 any qty

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	
20V	10mV	±(1%rdg+2dgts)
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input. 2A/250V fuse.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Frequency Range: 45Hz-450Hz

Maximum Allowable Input: 750V rms

Response: Average Responding. Calibrated in rms of a Sine Wave.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Switchable Scope Probe Sets

(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe Set DC~150MHz	24.95	21.95	18.62

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12" NEW!	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12" NEW!	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12" NEW!	22.09	18.35	14.68

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

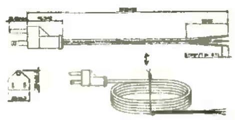
Etching Tank

This handy etching system will handle PC boards up to 8"x9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

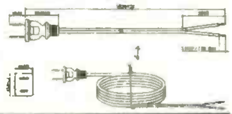
AC Power Cords



Our power supply cords are economical and practical for OEM and replacement applications. We stock 6' lengths, with the open end conveniently stripped and tinned (5mm).

CAT NO	SIZE	TYPE	RATING @ 125V (A)	LENGTH (ft)	COLOR	TEMP
SPT-1BLACK	18/2	SPT-1	10	6	Black	60°
SPT-1GRAY	18/2	SPT-1	10	6	Gray	60°
SPT-2BLACK	18/3	SPT-2	10	6	Black	60°

CAT NO	PRICE EACH 1	10	100	500
SPT-1BLACK	$ .88	$ .57	$ .51	$ .46
SPT-1GRAY	.92	.61	.55	.49
SPT-2BLACK	1.97	1.21	1.07	.97



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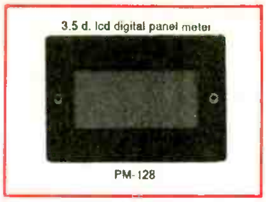
CIRCLE 327 ON FREE INFORMATION CARD

Digital Panel Meters (LCD & LED)

Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.



Applications Include:
- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

PM-128: 3-1/2D LCD Digital Panel Meter

PM-129: 3-1/2D LED Digital Panel Meter

Features
- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)

Specifications - PM-128/PM-129

Maximum Input	: 199.9mV DC
Maximum Display	: 1999 counts (3-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: PM-128 - LCD Display PM-129 - LED Display
Measuring Method	: Dual-Slope Integration A/D Converter System
Overrange Indication	: "1" Shown in the Display
Reading Rate Time	: 2-3 Readings per sec.
Input Impedance	: >100 Mohm
Accuracy	: +-0.5% (23+-5°C, <80% RH)
Power Dissipation	: PM-128 - 1mA DC PM-129 - 60mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: PM-128 - 9V DC PM-129 - 9V DC
Size	: 67mm x 44mm

3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

PM-328: 4-1/2D LCD Digital Panel Meter

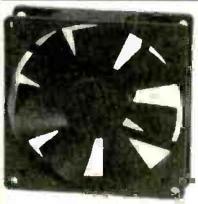
Features
- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

Specifications - PM-328

Maximum Input	: 199.99mV DC
Maximum Display	: 19999 counts (4-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: LCD Display
Overrange Indication	: "1" Shown in the Display
Input Impedance	: >100 Mohm
Accuracy	: +-0.05% (23+-5°C, <80% RH)
Power Dissipation	: 1mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: 9V DC
Size	: 67mm x 44mm

AS LOW AS $5.25 ea.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	100	250
PM-128	3-1/2 Digit LCD Panel Meter	$ 9.90	$ 7.09	$ 6.40	$ 5.86	$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93



Ball Bearing 12V DC Fans

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CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

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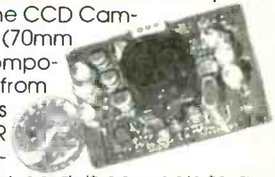

Power Supply Regulating Kit for CA-H34 This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$99.00	$85.00
A34	Power Supply Regulating Kit	$6.95	-----

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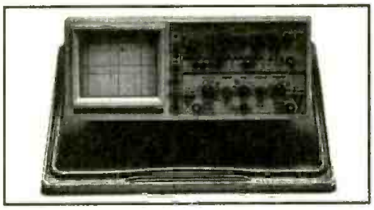

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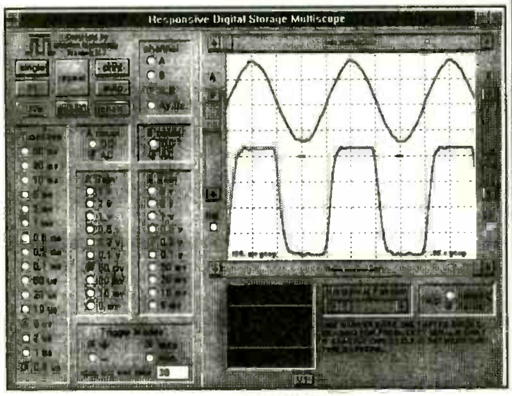

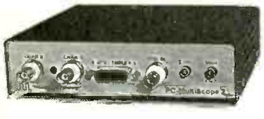

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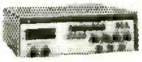

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TAP30X Ready to Use $84.50
3 Mi Voice Transmitter
• Ultra-Sensitive Mike
• Crystal Clear
• Tunes 80-130 MHz.
FMV1K Kit/Plans $39.50
See In Total DARKNESS!
• High Quality IR Night Vision Scope with IR illuminator.
SD10 Ready to Use $199.50
Electric Charge Gun
Life is Precious - PROTECT IT!
Stuns & immobilizes attackers 15 feet away! Check your state laws for legality. More knockdown power than most handguns. No permanent injury. ID coded.
ECG1 Data (Creditable to purch) $10.00
ECG10 Charge Gun, Ready to Use, Includes FREE Stun Gun! $249.50
STUN GUNS - sold separately:
STUN100 100,000 Volts $34.50
STUN200 200,000 Volts $49.50
3 Mi Tracker Transmitter
• Tunable Output
• Uses FM Radio
• Excellent Signal Beacon
HOD1K Kit/Plans $39.50
"Drop-In" (Imi) Telephone Transmitter
Easily tunable over FM radio. Never needs battery! #DROPIN Kit/Plans .... $ 19.95
FANTASTIC BRIGHTNESS!
High Quality Laser Pointer
LAPN64 15mw equv, 2000' $39.50
LAPN61 50mw equv, 4000' $84.50
Window Bounce Laser Listener
Aim at window and listen to sounds from reflected light. CAUTION - Not for illegal use. LWB3 Plans $10.00
LWB3K Kit/Plans (req's vid tripod) $149.50
MIND CONTROL!
Places subjects under your control. Programmable audible & visual stimuli with biofeedback. Induces strange & bizarre halucinations without drugs. Caution - not FDA approved.
MIND2 Plans .... $15..00
MIND2K Kit and Plans $49.50
MIND20 Assembled Unit $69.50
1000' Potato Cannon
Not a Toy! Uses electronic or piezo ignition. CAUTION REQUIRED!
POT1 Plans (dangerous product) ... $10.00
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B&K Precision Scopes

60MHz ANALOG WITH DIGITAL STORAGE

Model 2560

- Cursors and readouts
- RS-232 port
- 20MS/s real time sampling
- 1GHz equivalent time sampling (at 0.1µs/div.)
- Prints via RS-232 port to any HP-GL plotter

$1995

20MHz ANALOG WITH DIGITAL STORAGE

Model 2522A

- 20MHz analog bandwidth
- 20MS/s sampling rate
- 2K memory per channel
- 300MHz equivalent time sampling
- Pre-trigger capture

$869.95

100MHz THREE-TRACE

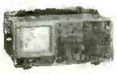
Model 2190A

- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- 15KV accelerating voltage

$1379.95

60MHz DUAL-TRACE

Model 2160A



- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- V mode-displays two signals unrelated in frequency.
- Component tester

$949.95

40MHz DUAL-TRACE

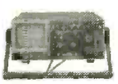
Model 1541C

- 1mV/division sensitivity
- Video sync separators
- Z-axis input
- Single Sweep
- V mode displays two signals unrelated in frequency
- Component tester

$695

60MHz, CURSORS & READOUTS, DUAL TIME BASE

Model 2260



- Cursors and readouts
- 1mV/div sensitivity
- 23 calibrated ranges - main time base
- 19 calibrated ranges - delayed time base
- Signal delay time
- V-mode - displays 2 signals unrelated in frequency.
- Component tester
- Z-axis input
- Single sweep

$1225

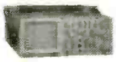
20MHz DUAL-TRACE

Model 2120 - 2 Year Warranty

Special $389.95

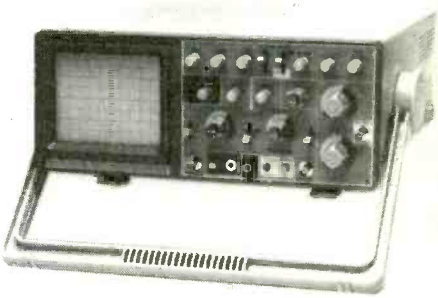
Model 2125 with delayed sweep

$539.95



- 1mV/division sensitivity
- AUTO/NORM triggered sweep operation
- AC, TVH, TVV and line coupling
- Calibrated 19 step time-base with x10 magnifier
- Compact low-profile design

Quality Scopes by Elenco



60MHz

DS-603 $1350
- Analog / Digital Storage
- 20MS/s Sampling Rate

S-1360 $749
- Analog with Delayed Sweep

40MHz

S-1345 $569
- Analog with Delayed Sweep

S-1340 $475
- Analog

2 Year Warranty

25/30MHz

DS-303 $1095
- Analog / Digital Storage

S-1330 $439
- 25MHz Analog
- Delayed Sweep

S-1325 $325
- 25MHz Analog

OSCILLOSCOPE SELECTION CHART

ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232

Affordable Spectrum Analyzers by B&K

500MHz Series

Model 2615 - $1595
Model 2620 w/ tracking generator - $1895

1.05GHz Series

Model 2625 - $2395
Model 2630 w/ tracking generator - $2995

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V-209 - 20MHz Battery Operated
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V-422 - 40MHz Was $965,
NOW **$765 Save $200**

V-525 - 10MHz w/ Cursors
Was $1355, NOW **$955 Save $400**

V-552 - 50MHz Was $1195,
NOW **$850 Save $345**

V-555 - 50MHz w/ Cursors
Was $1375, NOW **$975 Save $400**

V-695 - 60MHz w/ Cursors
Was $1815, NOW **$1395 Save $420**

V-1065A - 100MHz w/ Cursors
Was $2139, NOW **$1565 Save $574**

V-1560 - 100MHz Was $1790,
NOW **$1490 Save $300**

V-1565 - 100MHz w/ Cursors
Was $1960, NOW **$1595 Save $365**

V-252 - 20MHz **$419**

Fluke Scopemeters

91 ...... **$1225**
92B **$1445**
96B **$1695**
97 ...... **$1795**
97A **$2945**
99B **$2095**

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Synthesized FM Stereo Transmitter

Microprocessor controlled for easy freq programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit........ $129.95

Tunable FM Stereo Transmitter

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit........... $34.95
CFM, Matching Case and Antenna Set................ $14.95

RF Power Booster Amplifier

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Power required: 12 to 15 volts DC at 250mA, gain of 38dB at 10 MHz, 10 dB at 1000 MHz. For a neat, professionally finished look, add the optional matching case set.

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

Micro FM Wireless Mike

World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

FM-5 Micro FM Wireless Mike Kit.................... $19.95

Crystal Controlled Wireless Mike

Super stable, drift free, not affected by temperature, metal or your body! Frequency is set by a crystal in the 2 meter Ham band of 146.535 MHz, easily picked up on any scanner radio or 2 meter rig. Changing the crystal to put frequency anywhere in the 140 to 160 MHz range-crystals cost only five or six dollars. Sensitive electret condensor mike picks up whispers anywhere in a room and transmit up to 1/4 mile. Powered by 3 volt Lithium or pair of watch batteries which are included. Uses the latest in SMT surface mount parts and we even include a few extras in case you sneeze and loose a part!

FM-6, Crystal Controlled FM Wireless Mike Kit......... $39.95
FM-6WT Fully Wired FM-6......................... $69.95

Call for our Free Catalog !

RAMSEY

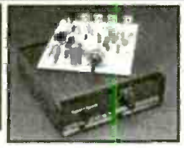
Super Pro FM Stereo Radio Transmitter

A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes sharp-looking metal cabinet, whip antenna and 120 volt AC adapter. Also runs on 12 volts DC.

We also offer a high power export version of the FM 100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit....... $299.95
FM-100WT, Fully Wired High Power FM-100.......... $429.95

Speech Descrambler Scrambler



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

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

Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit.......................... $99.95
CTG, Matching Case Set for TG-1 Kit............... $14.95
TG-1WT, Fully Wired Tone Grabber with Case........ $149.95
AC12-5, 12 Volt DC Wall Plug Adapter............... $9.95

Mini-Peeper Micro Video Camera

Super small, high quality fully assembled B & W CCD TV camera the size of an ice cube! Provides excellent pictures in low light (2 lux), or use our IR-1 Infra-Red light source to invisibly illuminate an entire room on a pitch black night! Imagine the possibilities... build it into a smoke detector, wall clock, lamp, book, radio. Exact same camera that's in big buck detective catalogues and stores. Kit includes: fully assembled CCD camera module, connectors, interface PC board kit with proper voltage regulation and filtering, hook-up details, even a mini microphone for sensitive sound! Two models available: Wide Angle Lens 3.6mm/f2, adjustable focus lens, 92 degree view; Pinhole Lens 5.5mm/f4.5, 60 degree view. The Pinhole Lens is physically much flatter and provides even greater depth of focus. The camera itself is 1.2" square. The Wide Angle Lens is about 1" long, Pinhole Lens about 1/2", interface PC board is 1" x 2" and uses RCA jacks for easy hook-up to VCRs, TVs or cable runs. Power required is 9 to 14 VDC @ 150 mA. Resolution: 380 x 350 lines. Instruction manual contains ideas on mounting and disguising the Mini-Peeper along with info on adding one of our TV Transmitter kits (such as the MTV-7 unit below) for wireless transmission!

MP-1, Wide Angle Lens CCD TV Camera Outfit........ $169.95
MP-1PH, Pin-Hole Lens CCD TV Camera Outfit........ $189.95

MicroStation Synthesized UHF TV Transmitter

Now you can be in the same league as James Bond. This transmitter is so small that it can fit into a pack of cigarettes - even including a CCD TV camera and battery! Model airplane enthusiasts put the MTV-7A into airplanes for a dynamite view from the cockpit, and the MTV-7A is the transmitter of choice for balloon launches. Transmitter features synthesized, crystal controlled operation for drift-free transmission of both audio and video on your choice of frequencies: Standard UHF TV Channel 52 (which should only be used outside of the USA to avoid violating FCC rules), and 439.25 MHz or 911.25 MHz which are in the amateur ham bands. The 439.25 MHz unit has the nifty advantage of being able to be received on a regular 'cable-ready' TV set tuned to Cable channel 68, or use our ATV-74 converter and receive it on regular TV channel 3. The 911.25 MHz unit is suited for applications where reception on a regular TV is not desired, an ATV-79 must be used for operation. The MTV-7A's output power is almost 100 mW, so transmitting range is pretty much 'line-of-sight' which can mean many miles! The MTV-7A accepts standard black and white or color video and has its own, on-board, sensitive electret micorphone. The MTV-7A is available in kit form or fully wired and tested. Since the latest in SMT (Surface Mount Technology) is used to provide for the smallest possible size, the kit version is recommended for experienced builders only. Runs on 12 VDC @ 150 mA and includes a regulated power source for a CCD camera.

MTV-7A, UHF TV Channel 52 Transmitter Kit.......... $159.95
MTV-7AWT, Fully Wired Channel 52 Transmitter....... $249.95
MTV-7A4, 439.25 MHz TV Transmitter Kit............ $159.95
MTV-7A4WT, Fully Wired 439.25 MHz Transmitter...... $249.95
MTV-7A9, 911.25 MHz TV Transmitter Kit............ $179.95
MTV-7A9WT, Fully Wired 911.25 MHz Transmitter...... $269.95
ATV-74, 439.25 MHz Converter Kit................. $159.95
ATV-74WT, Fully Wired 439.25 MHz Converter......... $249.95
ATV-79, 911.25 MHz Converter Kit................. $179.95
ATV-79WT, Fully Wired 911.25 MHz Converter......... $269.95

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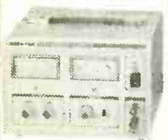
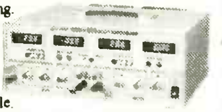
DC POWER SUPPLY



PS-303 $159.00 0-30VDC, 0-3A; 0.02%+2mV line regulation; 0.02%+3mV load regulation; 1mVrms noise & ripple; Short circuit/overload protection; constant current/voltage(CC/CV).
PS-303D $314.95 dual output, tracking
PS-305 $219.95, 0-30VDC, 0-5A.
PS-305D $399.95, dual, tracking.



8110 $289.95 0-60VDC, 0-3A.
8112 $399.95 0-60VDC, 0-5A.
8108(8109) $549.95($699.95) 0-60VDC, 0-3A(5A), dual, independent tracking. Low ripple.
8102(8103) $399.95($489.95) triple outputs, 0-30V/0-3A(5A) x 2, fixed 5VDC/3A, indepedent & tracking operation, constant voltage and current. Slave/Master, Serial/Parallel connection.
PS-1610S(8107) $289.00($399.95) 0-16VDC(0-30VDC), 0-10A.
PS-2243(2245) $139.00($159.00) 0-12/0-24VDC,3A(5A).
8200(8201) $179.95($239.95) 0-30VDC(digital meter), 0-3A(5A). **8210(8211) $199.95($259.95)** two digital meters.
8202(8203) $499.95($549.95) 3 outputs, digital display, dual 0-30VDC/0-3A(5A), a fixed 5VDC/3A, independent tracking operation, constant voltage and current.

AM/FM SWEEMAR SCOPE

SM-6225B/C $1999.95
Freq Range: (AM)490KHz; (FM) 10-11.4MHz, *Acuracy*: ± 0.1%
Marker: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

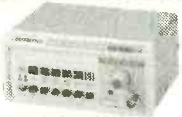
STEREO SCOPE OS-7505B $369.00 trigger, 0-10MHz.

ALIGMENT SCOPE OS-7001A $369.00 0-200KHz.

AM/FM STD SIGNAL GEN.

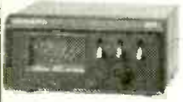
SG-4110A $1799.00
Freq: 100KHz-110MHz
Display: 6-digit LED
Accuracy: <±(5x10-E5 ±1 count)
Resolution:100Hz (100-34.99MHz); 1KHz (35MHz-110MHz).
Output: -19dBu, -99dBu, 1dB steps. *Impedence*: 50Ω VSWR 1.2.

NTSC TV COLOR BAR PAT. GEN.



CPG-1366A $159.95
VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV.
Impedence: 75 Ohm;
Video Output: BNC, 1Vp-p

SWR/RF/mW POWER METER



310 $89.95
Freq.Range: 1.8-150MHz.
RF Power: 0-4W/20W/200W
SWR Measure.: 1.0 - ∞, 4W min.
Accurcy: 5%-10%; SO-239 plugs.
Insertion Loss: 0.3dB.
Input/Output Imp.: 50Ω.

320 $89.95, 130-520MHz.
330 $119.95, 1.8-520MHz.
SWR-3P $26.95 1.7-150MHz, *RF Power*: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz, *RF Power*: 0.5-10W.

mW RF Power Meter 340 $219.00

1.8-500MHz; RF power: 20mW/200mW/2W; Imp.: 50Ω; Accuracy: ±10% full scale; N-type connector,SWR <1.15.

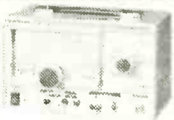
VHF/UHF ATTENUATORS

RT-8815 $199.00, VHF, 500MHz, 81dB, 50Ω, 0.5W.
RT-8815U $359.00, UHF, 950MHz, 81dB, 50Ω, 0.5W.
RT-8817 $199.00, VHF, 500MHz, 81dB, 75Ω, 0.5W.
RT-8817U $359.00, UHF, 950MHz, 81dB, 75Ω, 0.5W.
085E-2 $499.00, UHF, 950MHz, 61dB, 50Ω, 0.5W.
087E-2 $499.00, UHF, 950MHz, 61dB, 75Ω, 0.5W.

SALES - DC Power Supply

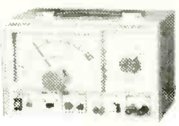
8102 ~~$399.95~~ **$359.95** triple outputs, 0-30V/0-3A x 2, fixed 5VDC/3A, indepedent & tracking operation, constant voltage (CV) & constant current (CC), Slave/Master, Serial/Parallel connection.
PS-303D ~~$314.95~~ **$282.95** dual outputs/tracking, CC&CV.
Limited quantity. Full one year warranty.

RF SIGNAL GENERATOR



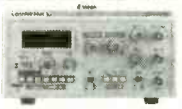
SG-4160B $124.95
100KHz-150MHz up to 450MHz on 3rd harmonics; 6 ranges; AM modulation. *RF Output*: 100mVrms to 35MHz. *Modulation*: Int. 1KHz AM, Ext. 50Hz-20KHz AM.
Audio Output: 1KHz, 1Vrms.
SG-4162AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals. Specification see SG-4160B above.

AUDIO GENERATOR



AG-2601A $124.95
10Hz-1MHz, 5 ranges;
Output Level: sinewave 0-8Vrms, square 10Vp-p.
Output Impedence: 600 Ohm.
Distortion: <0.05% 500Hz-50KHz; <0.5% 50KHz-500KHz.
AG-2603AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals. Specification see AG-2601A above

FUNCTION GENERATOR



FG-2100A $169.95
0.2Hz-2MHz in 7 ranges; Sine, Square, Triangle, Pulse & Ramp
Output: 5mVp-p-20Vp-p, 1% distortion.
VCF: 0-10V control freq. to 1000:1.
FG-2102AD $229.95 generates signals same as FG-2100; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
(FG)2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG.
Freq. Counter: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz.
FG-513 $719.95, Digital sweep generator; Sine, Square, Triangle, Pulse, Ramp, TTL & DC; 2Hz-13MHz in 7 ranges; ±(.01%+1dgt).
Freq. Counter & TCXO: 5Hz-100MHz, 6.5 digits. x1 & x20 attnt.

FM STEREO MODULATOR

AG-2011A $549.00
RF SECTION:
Carrier: 98MHz ±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%;*L-R Seperation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Seperation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz..

AC MILLIVOLT METER

MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV, dB &dBm; 300μV~100V in 12 ranges, 10μV resolution; -70~40dB in 12 ranges, 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedence 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement..

OSCILLOSCOPE

OS-7305B $249.00 DC~7MHz; *Vertical*: 10mV/Div; Horizontal: 250mV/Div, 10Hz~100KHz in 4 ranges; 3" CRT;Internal and External Sync.; Input: 1MΩ/35pF.
OS-7010A ~~$369.0~~ **$299.95** 10MHz 5" CRT, 10mV/Cm~10V/Cm, 1MΩ.
OS-622B $344.95 20MHz/dual trace
OS-653 $699.95 50MHz, dual, delay sweep, ALT trigger, TV syn.
OS-6100B $1329.95 100MHz, 4ch. 8 traces, delay sweep,best buy

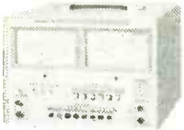
DIGITAL MULTIMETER

DMM-120 $24.95, 3½ digit, 600VDC/AC, 2ADC, 2MΩ, hFE/diode test.
DMM-123+Capacitance $44.95, 3½ digit, 600VDC/AC, 10ADC/AC, 2GΩ, 20μF, hFE/diode test, continuity beeper.
DMM-125 $54.95, Autorange/Bar Graph, 600VDC/AC, 2ADC/AC, 32MΩ, continuity beeper.
MIC-35 $59.95, Autorange, 3½ digit, LCD, 1000VDC/750VAC, 20MΩ, 20ADC/AC, diode/continuity check, data hold.
MIC-39 $149.95, Autorange/Bar Graph, True RMS, 3¾ digit, LCD, 40MΩ, 40μF, 1000VDC/750VAC, 20ADC/AC, 600KHz Freq. Counter, Data Hold, Drop-prove, Sleeping Mode, Memory & Read Functions.

GRID DIP METER

DM-4061 $89.95 1.5-250MHz, 6 bands;6 plug-in coils, 2 transistor, and 1 diode.
Modulation: ≈ 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absorption meter. Using 9VDCpower supply.

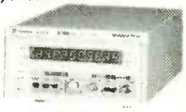
AUTO DISTORTION METER



DM-3104A $799.95
MEASUREMENT:
Range: 0.01%-30%, 0.1/0.3/1/3/10/30% full scale.
Freq.: 400Hz±10%, 1000Hz±10%(HPF).
Input: 3mV-100V, ratio measuring 20dB.
Auto. Switching Ranges: Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
DM-3204 $1,599.00 dual channels.

FREQUENCY COUNTER

FC-5250C $119.95
Freq. Range: 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10MHz-200MHz
Gate Time: 0.1 & 1sec.
Max. Input: 10Vp-p.
Input Sensitivity: 35mV 10Hz-200MHz. *Display*: 7-digit LEDs.
Input Imped.: (HF) 1MOhm, (VHF) 50Ohm.

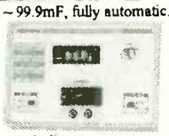


FC-5260A ~~$146.00~~ **$129.95** 10Hz-600MHz. 7-digit LEDs.
FC-5270 $149.95 10Hz-1.2GHz. 8-digit LEDs.
FC-5600B ~~$321.00~~ **$299.95** 10Hz-600MHz. 10-digit LEDs.
(FC)5700 $329.95 10Hz ~ 1.3GHz. 10-digit LEDs.

SIGNAL TRACER/INJECTOR

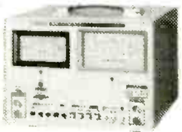
SE-6100 $134.95
TRACER: Gain Max. 60dB
Attenuation: 0/20/40/60dB
Input Imped.: 100KOhm
Output Imped.: 600Ohm;
Speaker: 8 Ohm.
INJECTOR: *Freq.*: 1KHz Squarewave; *Output Level*: Continuously variable 0 - 4.5Vp-p.

AUTO. CAPACITANCE METER



CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic.
Resolution: 0.1pF lowest, 0.1% full scale.
Accuracy: 0.5% of full scale±1digit to 99.9μF, 1% of full scale±1digit to 99.9μF.
Display: 3 digit LED.
Unit indicator: pF, nF, μF, mF. Overrange indicator.

WOW-FLUTTER METER



WF-3103A $699.95
Freq. Range: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN.
Range: 0.03/.1/.3/3% full scale.
Accuracy: ±5%.
WF-3105A $799.95, digital;
Function: LIN/WOW/Flutter/WTD.
Freq Cntr: 10Hz-9.99MHz.
Indication: CCIR/DIN/JIS.

MICROPROCESSOR TRAINER

8088 Trainer $699.00 BGC-8088, teach yourself 8088 assembly language programming. Assembly language coding, assembler, disassembler, single step and multi-breakpoint program debugger, display and rewrite registers, download/upload programs from/to external systems, I/O drivers, 56-key large size keyboard, LCD display, RS-232, UART, printer interface, two expansion slots, ±5V, ±12V switching power supply, 20 I/O applications available, e.g. servo& stepping motors, dot matrix display, D/A, A/D, sensors, ...etc. Learning Guide included.

8051/8052 Embedded Microcontroller $979.00 BGC-8052, teach yourself Intel 8051/8052 Microcontroller controls. 8051/8052 is one of the most popular Microcontroller used in today's appliance controls and is compatible with the new powerful MCS 251. Step-by-Step Learning Guide included.

CIC-100 $549.00 I/O control applications, learn Assembly, C, and BASIC programming languages, 800-pin solderless bread-board for circuit design and test, I/O drivers for controlling relay, step motor, LED, speaker, sensor, ..etc.. Application control modules available.

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OPTREX. DMF5005 *(non back-lit)* $69.00 or 2 for $129.00
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16x2 ....$8.00	20x4 (lg. char.)....$25.00	40x4 ....$25.00
16x2 (lg. char.)....$12.00	24x2 ....$12.00	4x2 ....$5.00
16x4 ....$15.00	32x4 ....$10.00	

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

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$35.00	480x128	Hitachi	$15.00
640x400 (backlit)	Panasonic	$25.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$15.00	240x64	Epson	$20.00
			160x128	Optrex	$15.00

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

LASER PRODUCTS

HeNe Laser Head (10Mw max. output) TEM00, 15.5" long MFG: NEC **$99.00**
Laser Power Supply (for HeNe tube) **$89.00**

LASER SCANNER ASSEMBLY $29.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator **$20.00**

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**
Index guided. Threshold current 40 ma typical.

3 and 4mW, 1,300nm LASER DIODES, 5.6mm package, $35.00
Mitsubishi Electric part number ML701BIR-E21A, General specs are:
1. Vop=1.25, Beam Divergence 25.6° x 28.6°; 2. Tc=24°C, Iop=19 to 20mA, ITH=10.7mA; 3. Wavelength range between 1,280nm and 1,330 nm

POLYGON MOTOR UNIT & DRIVER $79.00
Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

NETWORK

Proteon ProNet-4 Model p1347 Token Ring Board $49.00
16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • interoperable with IBM Token Ring network

POS & BAR CODE

MAGNETIC CARD READER $25.00
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300).....................$25.00

POWER SUPPLYS

SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts
73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
68 WATT Dim: 5.5" L x 3.2" W x 1.7" H • Output: 5V @ 4 A, 12V @ 4A
60 WATT Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A · 5V @ 1A · 12V @ 1A

CHARGE COUPLED DEVICES

"The Spy In The Sky" $49.00 **MATRIX TYPE**

Thomson 576X550 pixel CCD
400-1,100nm resolution and responsivity. **$500.00 Original cost device**

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V) $29.00
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².
Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

LINEAR TYPE

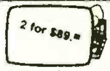
4096 element CCD $19.00
1024 element CCD $15.00
2048 element CCD $15.00 • 1728 element CCD $15.00

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $29.00 • 7 inch Amber $39.00
9 inch Amber or Green $29.95

5" COLOR MONITOR $49.00



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

9" monochrome SVGA MONITOR $99.00
Tilt and swivel type. **Mfr: WEN**

MISCELLANEOUS

ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25.00

IBM 370 option XT and AT emulation boards $35.00

HACKER CORNER

US made Micronics 486 VLB ALL in ONE $79.00 or 2 for $149.00
motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.

Board will not fit standard All in One case because of non standard location of riser board. VLB riser board is included with motherboard.

CAMERA BLOCK $99.00 or 2 for $169.00
FOR ROBOTICS AND EVERYTHING ELSE
Unit is for Hi Band 8mm CamCorders, includes 8X zoom lenses, D/D converters, built-in CCD 2/3 in, 420 thousand picture elements, complementary mosaic filters. Excellent performance. High resolution, high sensitivity, low lag, low smear, good color reproduction, no distortion, 1/60-1/10000sec variable speed digital shutters, TTL auto focus, auto white balance, one-push auto white balance, auto/manual iris and gain up switch. Can be controlled by a 4bit micro computer. Remote controlling is possible for zoom and focusing. **NOTE:** We have Composite or PAL (European Standard) Units. **MFR: SONY**

CELL SITE TRANSCEIVER $79.00 2 for $149.00
These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring video conferencing/desktop video conferencing **2 for $159.00**

SOLD OUT

This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC [illegible] use [illegible] popular video digitizing boards for Apple Macintosh and Microsoft vi[illegible] Wi[illegible] Connects directly to any composite monitor or VCR with "video" input. Its [illegible] sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

POINT OF SALE BANK TERMINAL $49.00 or 2 for $89.00
• LCD Display 20 Char. x 4 Line • Printer 16 Column Dot Matrix - Epson • 24 Key Domed Membrane Keypad • Intel 80C32 Processor • 2 PCMCIA Sockets (ICC Slots) • Dallas DS1287 Realtime Clock • 2 Solid State Buzzers (Piezo Electric) • 4 Crystals • Rockwell Modem Chip • Telephone Line Interface (4 Pin "RJ" Connector) • RS-232 Interface (8 Pin "RJ" Connector) • NI-CAD Battery Pack Inside
Note: We have not been able to bypass an access code in the software. Thus, while time of day and other introductory things are displayed on LCD, the full original capabilities of this unit cannot be guaranteed. Also, we do not have a source for the smart cards that were to go in the PCM CIA sockets. Requires 12 volt adapter for power. (Not included) Dimensions: 9-1/2L x 6-1/4W x 2-1/2 D • Original cost over $450.00

.6" COMPOSITE MINIATURE COLOR DISPLAY $99.00
Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal. 250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over $600.00

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Budget Project and Computer Books

☐ **BP317–Practical Electronic Timing $6.95.** Time measurement projects are among the most constructed gadgets by hobbyists. This book provides the theory and backs it with a wide range of practical construction projects. Each project has how-it-works theory and how to check it for correct operation.

☐ **BP415–Using Netscape on the Internet $7.95.** **BRAND NEW** Get with the Internet and with surfing, or browsing, the World Wide Web, and with the Netscape Navigator in particular. The book explains: The Internet and how the World Wide Web fits into the general scenario; how do you go about getting an Internet connection of your own; how to download and install the various versions of Netscape browsing software that are available; and how to use Netscape Navigator to surf the Web, and to find and maintain lists of usful sites. There's a heck of a lot more, too!

☐ **BP325–A Concise User's Guide to Windows 3.1 $7.95.** Now you can manage Microsoft's Windows with confidence. Understand what hardware specification you need to run Windows 3.1 successfully, and how to install, customize, fine-tune and optimize your system. Then you'll get into understanding the Program Manager, File Manager and Print Manager. Next follows tips on the word processor, plus how to use Paintbrush. There's more on the Cardfile database with its auto-dial feature, Windows Calendar, Terminal, Notepad, etc.

☐ **BP327–DOS: One Step at a Time $5.95.** Although you spend most of your time working with a word processor, spreadsheet or database, and are probably quite happy using its file management facilities, there will be times when you absolutely need to use DOS to carry out 'housekeeping' functions. The book starts with an overview of DOS, and later chapters cover the commands for handling disks, directories and files.

☐ **PCP119–Electronic Music and Midi Projects $14.95.** Save cash by building the MIDI gadgets you need. Want a MIDI THRU box, program change pedal, Metronome, analog echo unit, MIDI patchbay or switcher? Over 16 practical and very useful music and MIDI projects—all in this book! The projects are explained in detail with full instructions on assembly.

☐ **PCP120—Multimedia on the PC! $14.95.** What is Multimedia? What can it do for you? It can do lots of nice things! This 184-page book helps you create your own multimedia presentation. Multimedia applications by people like you can revolutionize educational and business applications as well bring more fun, fun, fun into your leisure computer activities.

☐ **BP404–How To Create Pages for the Web Using HTML $6.95.** **BRAND NEW**

Companies around the world, as well as PC users, are fast becoming aware of the World Wide Web as a means of publishing information over the Internet. HTML is the language used to create documents for Web browsers such as Mosaic, Net-scape and the Internet Explorer. These programs recognize this language as the method used to format the text, insert images, create hypertext and fill-in forms. HTML is easy to learn and use. This book explains the main features of the language and suggests some principles of style and design. Within a few hours, you can create a personal Home Page, research paper, company profile, questionnaire, etc., for world-wide publication on the Web.

☐ **BP377—Practical Electronic Control Projects $6.95.** Electronic control theory is presented in simple, non-mathematical terms and is illustrated by many practical projects suitable for the student or hobbyist to build. Discover how to use sensors as an input to the control system, and how to provide output to lamps, heaters, solenoids, relays and motors. Also the text reveals how to use control circuits to link input to output including signal processing, control loops, and feedback. Computer-based control is explained by practical examples.

☐ **BP411—A Practical Introduction to Surface Mount Devices $5.95.** This book takes you from the simplest possible starting point to a high level of competence in working with Surface Mount Devices (SMD's). Surface mount hobby-type construction is ideal for constructing small projects. Subjects such as PCB design, chip control, soldering techniques and specialist tools for SMD are fully explained. Some useful constructional projects are included.

☐ **BP136—25 Simple Indoor and Window Aerials $5.50.** Many people live in flats and apartments where outdoor antennas are prohibited. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out under a rug in a room can produce acceptable results. However, with experimentation and some tips, you may well be able to improve further your radio's reception. Included are 25 indoor and window antennas that are proven performers. Much information is also given on shortwave bands, antenna directivity, time zones, dimensions, etc. A must book for all amateur radio enthusiasts.

☐ **BP336—A Concise User's Guide to Lotus 1-2-3 Release 3.4 $7.25.** Discover how to use a three-dimensional Lotus spreadsheet in the shortest and most effective way. The book explains how: to generate and manipulate 3-dimensional worksheets and how to link different files together; to generate and add graphs to a worksheet, edit them, and then preview and print the worksheet; to use the SmartIcons and become more productive with your time; to use the WYSIWYG add-in to produce top quality screen and printed displays; and much more.

☐ **BP379—30 Simple IC Terminal Block Projects $6.50.** Here are 30 easy-to-build IC projects almost anyone can build. Requiring an IC and a few additional components, the book's 'black-box' building technique enables and encourages the constructor to progress to more advanced projects. Some of which are: timer projects, op-amp projects, counter projects, NAND-gate projects, and more.

☐ **BP401—Transistor Data Tables $6.95.** The tables in this book contain information about the package shape, pin connections and basic electrical data for each of the many thousands of transistors listed. The data includes maximum reverse voltage, forward current and power dissipation, current gain and forward transadmittance and resistance, cut-off frequency and details of applications.

☐ **BP403—The Internet and World Wide Web Explained $6.95.** You've heard about the Information Superhighway. Sort of makes you feel timid about getting on the Web. Put your fears aside! This book eliminates the mystery and presents clear, concise information to build your confidence. The jargon used is explained in simple English. Once the tech-talk is understood, and with an hour or two of Web time under your belt, your friends will call you an Internet guru!

☐ **BP92—Electronics Simplified: Crystal Set Construction $2.69.** This book is written for those who wish to participate in electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day when one can read intelligently and handle simple tools. The crystal set projects are designed to use modern inexpensive components and home-wound coils. A book highly recommended for all newcomers.

☐ **ETT1—Wireless & Electrical Cyclopedia $5.75.** Step back to the 1920's with this reprinted catalog from the Electro Importing Company. Antiquity displayed on every page with items priced as low as 3 cents. Product descriptions include: Radio components, kits, motors and dynamos, Leyden jars, hot-wire meters, carbon mikes and more. The perfect gift for a radio antique collector.

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TUBES: "oldest", "latest". Parts and schematics. SASE for lists. **STEINMETZ,** 7519 Maplewood Ave., EN, Hammond, IN 46324.

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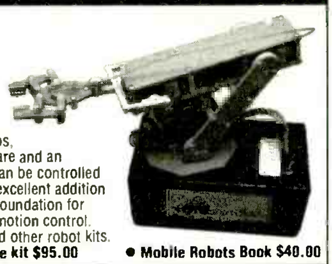

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