THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

# ELECTRONIC Servicing & Technology

September 1998

## New consumer electronics technology

## Test accessories update


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THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

# ELECTRONIC
## Servicing & Technology

Volume 18, No.9 September, 1998

# Contents



page 6

page 14

page 50

## ON THE COVER

The oscilloscope is the technician's window into the internal workings of electronic circuits. Through use of an oscilloscope, all of the normally invisible electrical activity taking place in the circuit becomes visible, thus revealing information upon which the technician can base a diagnosis of a faulty circuit. It is important that a technician select an oscilloscope that is adequate for the applications for which it will be used. (Photograph courtesy of MCM Electronics)

## EDITORIAL

# Test probes

Have you ever connected your oscilloscope to a circuit and observed the waveform, only to find that the signal you saw wasn't the signal you expected to see. Oh, maybe it was kinda, sorta, like the waveform in the service literature, but some of the corners were rounded, or the amplitude of the signal wasn't as high as that of the signal in the manual, or there was some other kind of distortion.

The problem in a case like this might have been that the circuits in the product weren't operating properly and were, in fact, the cause of the problem that you were trying to correct. On the other hand, the distorted waveform might have been caused by using an oscilloscope that didn't have sufficient bandwidth to properly display the signal. Or the distortion might have been caused by a set of probes that weren't designed for this application. In fact, the probes themselves might be loading down the circuit and causing the signal to change shape.

When the use of inadequate probes causes distortion of a signal of interest, at the least, it can make it difficult to determine the nature of the problem that the technician is trying to analyze. At worst, the wrong probes can make the technician think that the signal distortion he's observing is caused by circuits in the unit being serviced, and send him on a wild goose chase trying to correct a problem that doesn't exist.

But then false readings can be a problem whenever the operation of a product or system is being observed. The mere act of observing any phenomenon causes a change, however slight, in the phenomenon. Thus any tests and measurements on a circuit have the potential to cause changes, however slight, in the operation of that circuit. Therefore, it's important to exercise care to make those measurement effects as slight as possible.

Of course, in service work, frequently "close enough," is close enough. It frequently is not necessary to see the exact shape of a waveform. In many cases if you can measure a resistance to within 20 percent or so, or the voltage at a point to within a few volts, or if the general waveshape of a signal is similar to the one in the manual, you have enough information to determine whether or not that part of the unit is within tolerances.

On the other hand, sometimes the difference of a few ohms, or a few tenths of a volt, or a slight change in the shape of a waveform, may mean the difference between proper operation and failure of the unit.

It helps the cause of accurate diagnosis if the technician has sufficient experience to know the difference between the two cases, and test equipment and accessories that introduce a minimum of distortion when that type of accuracy is needed.

As the article on test accessories in this issue points out, the oscilloscope probe can introduce distortion into the observed signal that may confound a technician's efforts to diagnose a problem in a defective product. The high-impedance probe that is commonly used with oscilloscopes in service work may be fine for lower frequency work, but at higher frequencies may introduce inaccuracies because of capacitive loading.

As the article further discusses, a low impedance probe may be better for use in some applications than a high-impedance probe, but if used in the wrong application, a low impedance probe could introduce enough loading on the circuit being observed to cause erratic operation. That would lead a technician to think that the product was defective, if he weren't aware of this type of problem.

One answer to both problems is to use an active probe. But as the article points out, active probes are expensive and can be damaged by overvoltage.

In the final analysis, though, the most important implication of this entire discussion of test probes is the importance of adequate education and training for technicians in all aspects of the profession. The firmer the grasp that the technician has on the theory of how electronic circuits work, the better prepared he'll be when things don't seem to be working the way they're supposed to, and the better he'll understand how to apply the test equipment and accessories to diagnosis of the problem.

It is, of course, useful and helpful, and a very good idea, to have tips and tricks available when troubleshooting. For example, it's nice, and it saves a lot of time, to have one of those computer databases available that tells the technician: "in the HyperTV Model TV705, if the symptom is a blank screen, replace Q70563 in the switching power supply." But when he runs across a problem that he doesn't have a tip for, the technician has to rely on the knowledge and skills that he has developed during his formal education, if any, and during his years of working experience. The more thorough and intense that training and experience, the better the technician will be at diagnosing and correcting problems.

These days, the difficulties facing technicians are intensified by the fact that the circuitry in consumer electronics is increasingly complex and unfamiliar, even to a seasoned technician. In sets in use today, digital devices and circuits sit side by side with the more familiar analog circuits. Technicians have to know what these devices are and how to test them.

I remember the approach that my lab courses took back when I was going to school. Very little instruction was given in the use of the test equipment. It was just there and to be used in carrying out lab experiments.

Given the complexity of both the circuitry in use in consumer electronics products, and the sophistication of the oscilloscope itself, to say nothing of other test equipment, it would seem that technicians could benefit from a course in theory of test equipment and its proper operation and application. Or, barring that, intensive study as part of their on-the-job training in the service center. The rewards of such training would be reduction of confusion and faster diagnoses.

Nils Conrad Persson

## CEMA publishes U.S. Consumer Electronics Industry Today

The Consumer Electronics Manufacturers Association has published its annual review of the consumer electronics industry, *U.S. Consumer Electronics Industry Today*. The 122-page book includes highlights and updated statistics on the industry, along with a look ahead to the trends of tomorrow.

*U.S. Consumer Electronics Industry Today* analyzes the following product categories: video, audio, mobile electronics, multimedia, communication and information, integrated home systems and accessories. The book also includes a detailed history of the industry, both as an essay and a thorough timeline; a list of CEMA members; and contact information for related associations.

All statistics in *U.S. Consumer Electronics Industry Today* were compiled by CEMA's Market Research department and its market activity report program.

Copies of *U.S. Consumer Electronics Industry Today* are available from CEMA's Communications department at (703) 907-7674.

## Year 2000 not a problem for consumer electronics products CEMA member survey finds few products affected and fixes readily available

The Consumer Electronics Manufacturers Association (CEMA) has filed comments with the Federal Trade Commission FTC) stating that the vast majority of consumer electronics products will not experience Year 2000 (Y2K) problems. CEMA's comments were the result of a recent member survey conducted in response to the FTC's May 6 request for comment. Member company input indicates that only a few products may be affected, and fixes will likely be available for affected products.

Consumer electronics products that use dates are VCRs, TV/VCR combination products, camcorders, fax machines, personal computers and home automation and security products. According to feedback from CEMA members, most of these products do not use the date to function. Only a few products, including a limited number of older models of video and personal computer products, are likely to be affected by the date change. The impact is not expected to be significant because simple manual resetting or the addition of software upgrades can provide a remedy in most cases. On products for which manual resetting of the date is not an option, the Y2K phenomenon will not affect the functioning of the product.

"We believe the number of CE products likely to be affected by the turn of the century is negligible. For older model CE products, Y2K problems probably won't affect the function of the product, and will often be remedied by simply resetting the date," said Gary Shapiro, president of CEMA. "For personal computers, software fixes should be readily available and, in many cases, free of charge."

According to survey results, many member companies have widely disseminated information about the Y2K status of their products. Several manufacturers have established Web sites dedicated to providing consumers information on their products and Y2K, some inviting e-mail from consumers with particular Y2K concerns. Manufacturers also are making information available to consumers via mail, technical support centers and through consumer electronics dealers.

CEMA's comments also expressed a willingness to participate in public workshops to facilitate public dialogue and the gathering of information regarding Y2K issues, should the FTC decide to convene such meetings in the future.

A copy of CEMA's comments and links to related member sites are available at <http:\\www.CEMAcity.org>.

CEMA is a sector of the Electronic Industries Alliance (EIA), the 74-year-old Arlington, VA-based trade organization representing all facets of electronics manufacturing. CEMA represents U.S. manufacturers of audio, video, accessories, mobile electronics, communication, information and multimedia products which are sold through consumer channels. CEMA also sponsors and manages the International Consumer Electronics Show (CES), the world's largest annual trade event showcasing consumer electronics products.

## Manufacturers, broadcasters and retailers convene at CEMA-NAB DTV summit

Attendees review rollout announcements, discuss latest consumer research and challenges for upcoming introduction to prepare for the upcoming digital television (DTV) launch, a capacity crowd of some 300 executives from the manufacturing, retail and broadcast industries met in Dallas on July 17 at the DTV Summit co-sponsored by the Consumer Electronics Manufacturers Association (CEMA) and the National Association of Broadcasters (NAB). The day-long event was attended by representatives of all the major television manufacturers, major broadcast networks and local affiliates, national and specialty retail chains and the computer industry. Conference programs highlighted industry rollout plans, results of the latest consumer research, regulatory news and other challenges affecting DTV introduction.

"The industries represented here have come a long way together. We have a world-leading HDTV standard, a timetable for the DTV transition, consensus on definitions and a marketing logo for the technology," said CEMA President Gary Shapiro. "We are right where we should be; this will be a gradual transition, but there will be bumps in the road. That is why this summit — and continued cooperation — are so critical to our mutual success and the ability to deliver this extraordinary technology to consumers."

"Broadcasters are excited about this transition and are making a $16 billion investment to make it happen," said NAB Executive Vice President Chuck Sherman. "We expect to have between 35 and 40 stations broadcasting digital television by the end of 1998." Network representatives and local affiliates were on hand to provide updates on station transition efforts. Sherman said the challenges currently facing the broadcast industry include tower site issues, cable carriage of DTV and receiver reception issues.

Representatives of the major TV manufacturers reviewed product announcements and schedules to make DTV and related technologies available nationally

*(Continued on page 60)*

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# ELECTRONIC
Servicing & Technology

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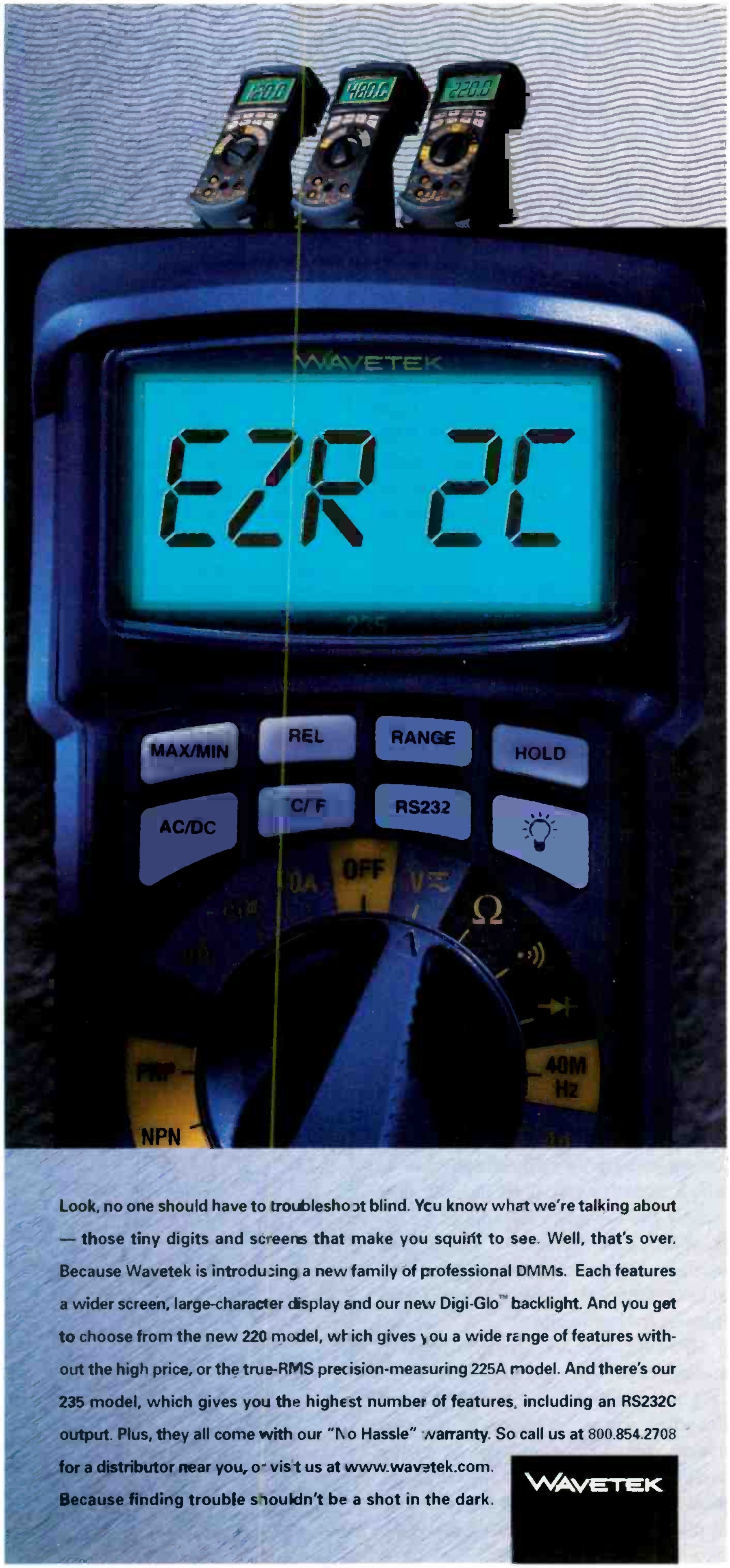



Circle (78) on Reply Card

# Oscilloscope update: Selecting an oscilloscope

by the ES&T Staff

The oscilloscope is the most versatile instrument that the consumer electronic technician uses in the diagnosis of products such as TVs, VCRs and personal computers. To make the most accurate and complete measurements, it's important to choose the right oscilloscope. It's important to match the effects of bandwidth, sample rate, memory, and the probe you choose to the circuits you're testing and the measurements you need to make.

Because of space limitations, this article will confine itself to a general comparison of analog and digital oscilloscopes, and then provide a discussion of bandwidth and sample rate. These criteria discussed briefly here will help technicians make informed decisions about waveform measurements. This is not intended to be an exhaustive or comprehensive guide. Rather it is intended as a thought starter. When you're ready to go out and buy an oscilloscope, you should consult with several vendors to determine what each of them recommends, and then make your choice based on the combination of their recommendations.

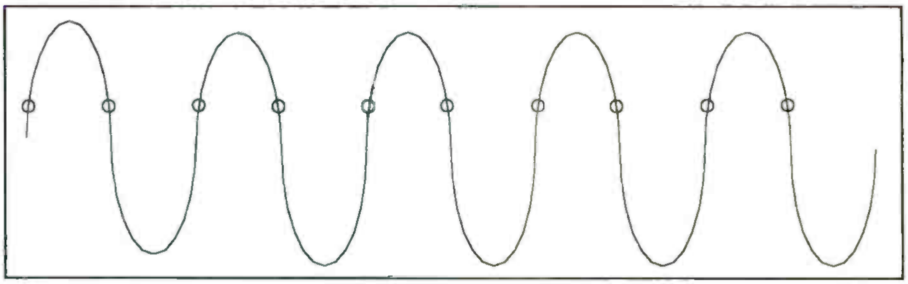


Figure 1. This drawing shows a sine wave with frequency f, sampled at a rate of 2f. If you saw only the sampled record, you might conclude that there was no signal present.

## Analog oscilloscopes

There are a few advantages of an analog scope, and they're important advantages. An analog oscilloscope offers instantaneous response to its familiar front panel controls. More important, it has an essentially real-time display in which intensity variations indicate how rapidly the signal is changing at each point along the trace. An experienced oscilloscope user can extract a great deal of information about complex waveforms from an analog display.

However, there are some drawbacks to analog scopes. For one thing, the accuracy is limited by at least two factors: nonlinearities in the deflection system and human judgment. Similarly, an analog oscilloscope's cathode-ray tube limits its bandwidth. Other disadvantages include display flicker and/or a dim display, the inability to view pre-trigger events except for repetitive signals, and limited built-in measurement capability.

## Digital oscilloscopes

Digital scopes, also have a few advantages just where the analog scopes do not. Digital oscilloscopes can capture and display pre-trigger information even for single-shot events. Since their images are synthesized from stored data, digital scope displays are bright and well-focused under just about all conditions.

## Digital oscilloscopes have some disadvantages too

With all of their advantages, digital scopes have some drawbacks. For one thing, all the added functionality of a digital scope comes at the cost of added operational complexity. The additional features are often accessed with softkey menu structures which may also require multiple layers. This can lead to confusing and unfamiliar controls.

Some vendors have addressed this problem with creative digitizing scope architectures and front panel layouts that approximate the "simple" feel of an analog scope. This type of oscilloscope is well worth shopping for, especially in an instrument that is targeted for everyday use. The time saved and the frustration avoided over the hundreds or thousands of measurements made with the oscilloscope can really be significant.

Another potential disadvantage of a digitizing oscilloscope is that its display is always based on sampled data, so it may be distorted by artifacts of the sampling. There are various ways to avoid this prob-

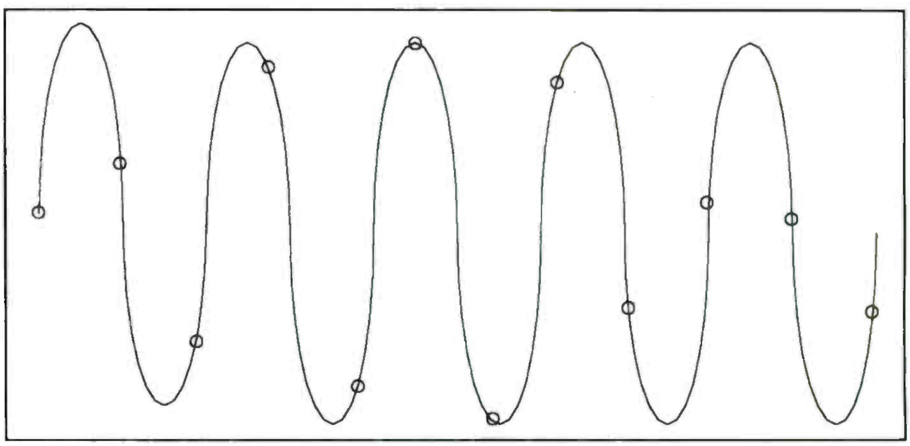


Figure 2. If you increase the sampling rate of Figure 2 slightly, however, only one sine wave can be drawn to fit all the sample points, as shown here. Therefore, for this sine wave sampled at greater than 2f, you know everything about it, just as Shannon's theorem predicted.

lem, and it is important that you understand them so that you can have total confidence in your display.

One final place where digitizing oscilloscopes struggle is their responsiveness. Since acquiring and processing the samples takes time, most digital scope displays are not real-time representations of the waveform at the probe tip. Whereas a good analog scope can acquire some 400,000 waveforms per second, many digitizing oscilloscopes are hard pressed to acquire more than 100. Scope vendors have taken different approaches to addressing this problem. Some focus on architectures which speed the entire cycle while maintaining total functionality, and others can display lots of data quickly but they reduce features in that mode.

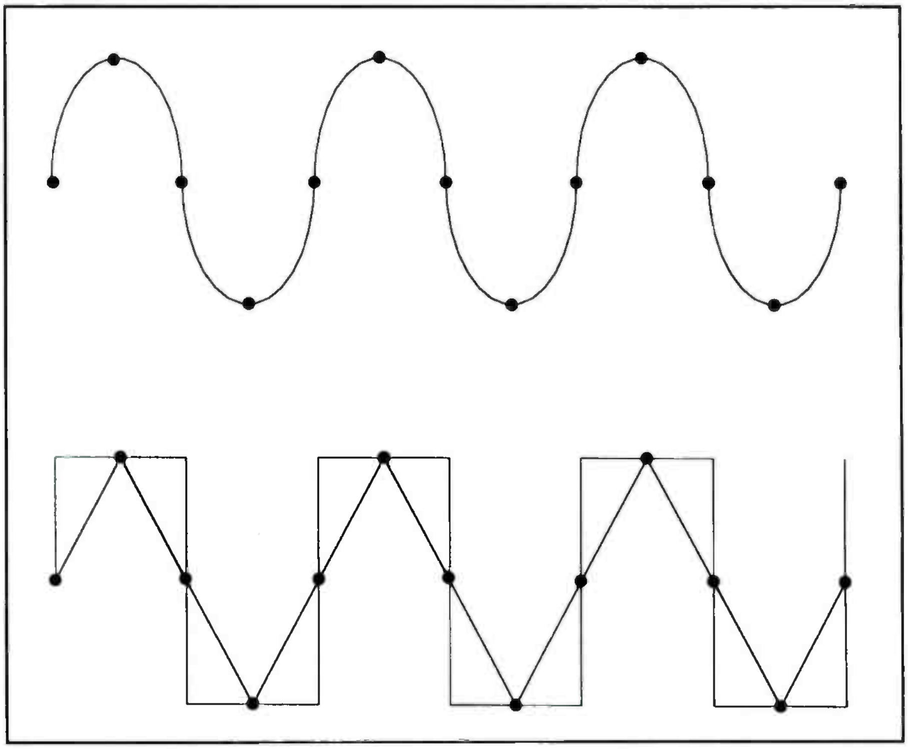


**Figure 3.** If the signal to be sampled were a square wave or a triangular, samples might represent a sine wave or some complex waveform. A square wave or triangular wave is made up of a series of sine waves and contains frequencies higher than the fundamental frequency. To accurately reproduce the square wave, you must sample it at a rate at least twice the highest frequency in its Fourier expansion.

### Food for thought

Decide if you can benefit from the additional bandwidth or the additional functionality offered by today's digitizing scopes. If the answer is *yes*, evaluate scope alternatives for usability. The most intricate functionality in an instrument is of no value if it doesn't get used because it's too difficult to locate, to understand, or to set up. In addition, the extra time taken to wade through levels of menus or to set up common measurements can significantly detract from the time spent understanding your measurement or troubleshooting a defective product.

### What bandwidth is required?

Bandwidth and sampling rate are both important attributes of digitizing oscilloscopes because both affect the margin of error in critical time measurements. The following will examine the key concerns in choosing the bandwidth you'll need to make your measurements.

### Scope bandwidth and amplitude accuracy

An oscilloscope is designed to give the highest possible fidelity in its display of complex waveforms. The Fourier theorem states that complex signals, such as square waves or triangular waves, can be represented mathematically as the sum of a series of sine waves. If you know the phase, frequency, and magnitude of every sinusoidal component, you know everything about the complex signal.

As a general rule, the greater the bandwidth of an oscilloscope, the more accurate the representation of a complex signal on its scopeface.

The bandwidth is determined by the bandwidth of the components (probe, attenuator, preamplifier, and so on) that convey the input signal from the tip of the scope's probe to its analog-to-digital converter. In essence, the scope is a low-pass filter between the probe tip and your eyes.

### Scope bandwidth and timing accuracy

The oscilloscope's rise time has the effect of a low-pass filter on transition-time measurements. The displayed rise time is equal to the square root of the sum of the squares of the signal transition time and the scope rise time.

If you measure a step with a rise time of 1ns using an oscilloscope with a rise time of 1ns, the oscilloscope will indicate a rise time of approximately 1.4ns. This value is an error of 40%.

If you measure the same step using an oscilloscope with a 330ps rise time, the indication will be 1.05ns. This figure represents only about 5% error.

Thus, the higher the ratio of signal transition time to scope rise time, the smaller the measurement error. Because of the scope's gaussian frequency response, the product of its rise time and bandwidth is a constant. For rise times measured in seconds and bandwidth measured in hertz, the constant is 0.35.

### What sampling speed?

Sample rate is an important aspect of digital scope performance. However, the oscilloscope's single number specification can be very misleading. You need to understand what sampling methods the scope uses and how sample rate is related to repetitive and real-time bandwidths because these are the things that determine whether you can make the measurements you need to make.

The Shannon sampling theorem says that if you sample a signal at a rate that is somewhat greater than twice the highest frequency component of the signal being sampled, all the information about the signal is contained in the samples. To get an idea of what that means, consider a sine wave with frequency f, sampled at a rate of 2f (Figure 1).

If you saw only the sampled record, you might conclude that there was no signal present. If you increase the sampling

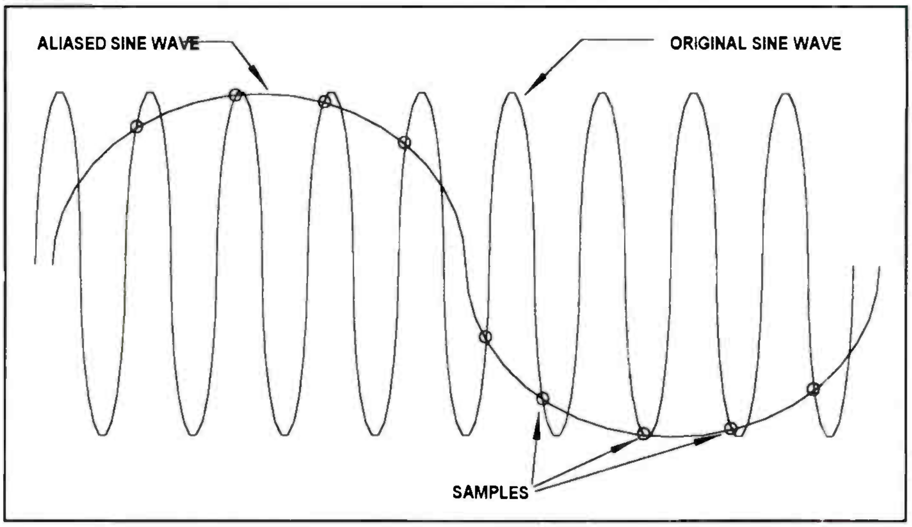



**Figure 4.** If you sampled the higher frequency sine wave in this figure at the sampling rate shown, the set of resulting samples would be indistinguishable from samples of a lower frequency sine wave. To avoid aliasing, the bandwidth of the incoming signal must be limited to something less than half the sampling rate.

rate just slightly, however, the picture looks very different.

Only one sine wave can be drawn to fit all the sample points in Figure 2. Therefore, for this sine wave sampled at somewhat greater than 2f, you know everything about it, just as Shannon's sampling theorem predicted.

But what if the signal were a square wave or a triangular wave (Figure 3), instead of a sine wave? Samples might represent a sine wave or some complex waveform, or a triangular wave, made up of a series of sine waves and contains frequencies higher than the fundamental frequency. If you sampled a square wave at a rate equal to four times the fundamental frequency, and if you reconstruct the samples as a sine wave, you will indeed have all the information about the square wave up to the sampling frequency. This is no different from viewing the same square wave on a scope with insufficient bandwidth to reproduce the higher frequency components. To accurately reproduce the square wave, you must sample it at a rate at least twice the highest frequency in its Fourier expansion.

### Aliasing

One of the effects of inadequate sampling rate is the same as the effect of insufficient bandwidth: loss of high-frequency information in the signal. There is an additional complication associated with sampling a signal, however. If the signal contains frequencies higher than half the sampling rate, then there will be errors due to aliasing. Consider sampling a sine wave at a rate less than twice the frequency of the sine wave (Figure 4).

If you sampled the higher frequency sine wave in the figure at the sampling rate shown, the set of resulting samples would be indistinguishable from samples of a lower frequency sine wave. To avoid aliasing, the bandwidth of the incoming

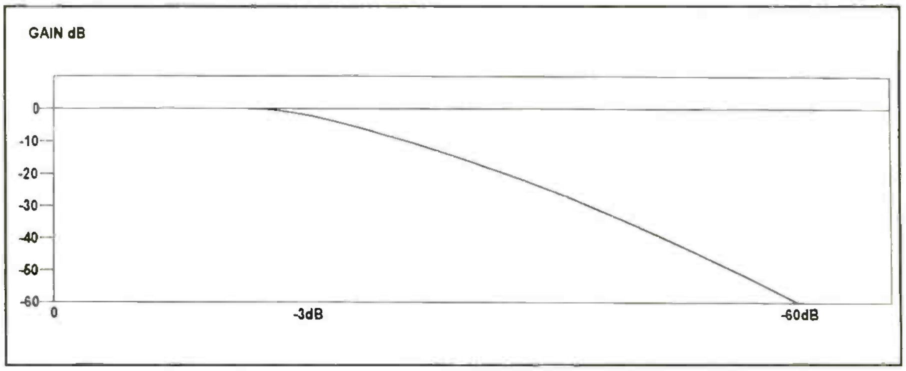



**Figure 5.** If you select a filter whose -3dB frequency is equal to the Nyquist frequency (half the sampling rate), a significant amount of energy will be allowed to pass through at frequencies above the Nyquist frequency. This will result in significant errors due to aliasing. A more conservative choice would be to set the -3dB frequency to 1/4 the sampling rate. Then the response will be down 12dB at the Nyquist frequency.

signal must be limited to something less than half the sampling rate.

Remember that the bandwidth of an oscilloscope is specified as the frequency at which the response is down 3dB. At that point the amplitude is only attenuated by approximately 30%.

Referring to Figure 5, if you select a filter whose -3dB frequency is equal to the Nyquist frequency (half the sampling rate), a significant amount of energy will be allowed to pass through at frequencies above the Nyquist frequency. This will result in significant errors due to aliasing. A more conservative choice would be to set the -3dB frequency to 1/4 the sampling rate. Then the response will be down 12dB at the Nyquist frequency.

### Avoiding aliasing

Aliasing can be a concern even on a digitizing oscilloscope that limits the bandwidth to less than 1/4 the maximum sampling rate. The reason for this is that when you select a slower sweep speed, the sampler has to be slowed down to less than its sample rate to avoid filling up the available memory before the entire time window is captured. The sampling rate cannot be higher than the sweep time/division times the number of divisions divided by the memory depth as shown.

To avoid aliasing, start at a fast sweep speed and then slow the sweep speed down to see the desired portion of the signal. Most digitizing scopes have an "Autoscale" or "Autoset" key. Pressing that key will set the scope to the correct sweep speed for the input signal, and using this as a starting point is a good way to avoid problems with aliasing.

Some digitizing scopes use equivalent-time sampling techniques to achieve high bandwidth on repetitive signals without requiring a sampling rate higher than the bandwidth. Because the bandwidth on these oscilloscopes may be specified at many times the sampling rate, you must be alert to the possibility of aliasing when using them for single-shot measurements. In the absence of bandwidth limiting or reconstruction, a rule of thumb is that the usable single-shot bandwidth is 1/10 of the sampling rate.

### What sampling speed is actually required?

The sampling speed that any digital oscilloscope user needs depends on the application. If the measurement you need to make is a single-shot measurement of the time between two pulses - like a hold-time measurement or a propagation-delay measurement - the resolution of the measurement will be the sampling interval (inverse of the sampling rate) of the scope. For example, if you need to resolve a time interval to 10ns, a 100MSa/s scope will just fit your needs, while a 200MSa/s scope, with its 5ns resolution, will give you a nice margin.

If you are trying to measure a long delay of several microseconds or more, the scope's acquisition memory depth (the number of digitized samples it can store) may be more important than its maximum sampling rate. Because all digitizing oscilloscopes have a finite amount of acquisition memory, they must reduce their sampling rate as the timebase is set to slower sweep speeds or else they will run out of memory before completing one acquisition. Most digitizing oscilloscopes, therefore sample at their maximum rate only on their fastest sweep speeds. This leads to the real sampling speed question: how fast does this scope sample at the timebase settings I need to view my waveform?

Some scopes offer independent control of the sample rate, meaning you can adjust either the sample rate or the amount of data shown on the screen(timebase) without one setting affecting the other. This feature allows you to maintain the desired resolution over all timebase settings. Without independent control of the sample rate, the answer to our question depends on the scope's memory depth. If two scopes have the same maximum sampling rate, the one with the deeper memory will have a sampling rate advantage at the slower sweep speeds.

If your application requires the single-shot capture of a complex waveform - when you're troubleshooting a mixed-signal embedded controller, for example - bear in mind the high-frequency components of the complex signal and shoot for a sampling rate that will capture the highest important frequency component with at least two samples per period.

Note that a higher sampling rate doesn't translate directly into a more responsive display. A digitizing oscilloscope's display performance is more a function of its processing power than its sampling speed, except when the trigger rate is very low. In that case, the scope that samples faster will build up a display more quickly than one with a lower sampling speed.

In most cases, however, processing captured data to present it to the display is what takes most of the time. Since most digitizing oscilloscopes today are based on a single embedded processor, they cannot accept updated input data from the A/D converter until they have finished processing what they have in hand. This results in the scope being "blind" for long times during its acquisition-process-display cycle. Manufacturers who adopt multiple-processor scope architectures overcome this limitation by applying parallel processing techniques.

## Analog or digital?

The question of whether a consumer electronics service center should choose an analog scope or a digital scope for most of the work that needs to be done is a complex one and can only be answered by the managers and technicians within the service center. If most of the work being performed is related to standard consumer electronics products, the best bet, and most economical, is probably a good solid analog scope with a bandwidth of 100MHz. That is especially true considering that a few manufacturers offer oscilloscopes that are especially made for TV/Video work and that are especially easy to use for servicing those products.

A service center that is going to be doing more exotic work, including personal computers, for example, might want to consider a digital oscilloscope. Larger service centers that employ a number of technicians working on a broad mix of products, and that require a number of oscilloscopes, might want to consider having both types. ■

# DMM update

by the ES&T staff

For quick measurements that give a technician a snapshot of the general health of a consumer electronics product, it's hard to beat the DMM. Today's DMMs provide a host of measurement parameters: ac and dc voltage (including rms voltage in some instances), ac and dc current, resistance, capacitance, inductance, continuity, semiconductor junction, transistor test. The DMM is pretty much the Swiss Army Knife for technicians.

The marvelous thing about today's meters is the amount of functionality and accuracy that manufacturers have been able to pack into such a small, lightweight device. Of course the thing that makes it possible to do all this is the integrated circuit. It allows product manufacturers to pack hundreds of semiconductor devices in a very small space.

The DMM is such a popular piece of test equipment because it's easily portable, quite rugged, sips power from its batteries, and provides a large proportion of the test functions that technicians need. The technician can toss the DMM into the tool kit and forget it for weeks or even months (although it's unlikely that it will go unused that long), and when he takes it out of the case to make measurements, it's ready to go.

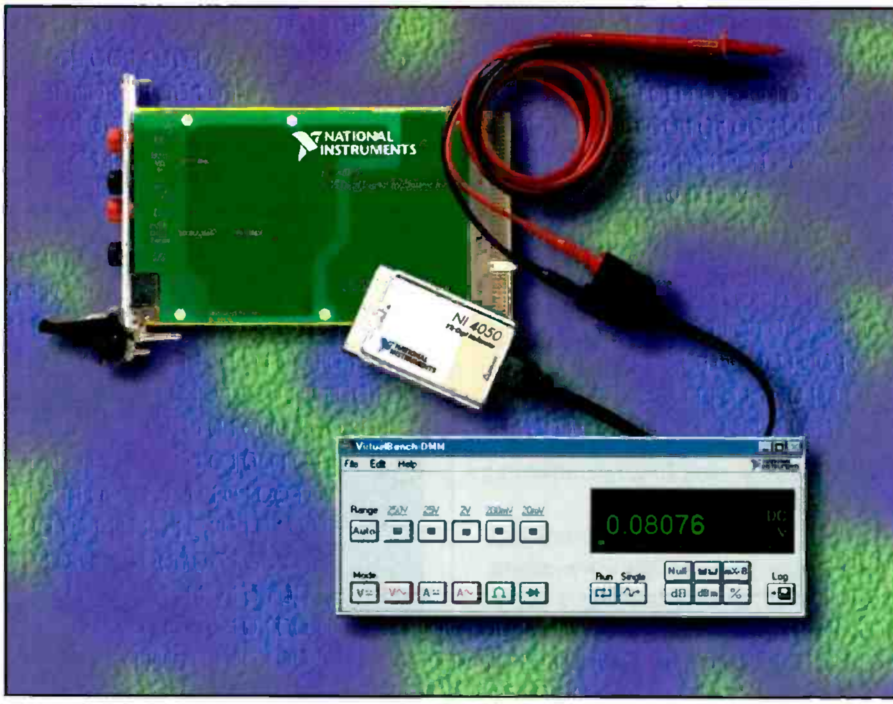



**Figure 1.** Interface hardware combined with the appropriate software can turn a personal computer into a virtual multimeter (VMM).

## The virtual multimeter

For the foreseeable future, the DMM will continue to be the first choice of technicians when they need to make measurements in pursuit of a diagnosis of a trouble in an electronic product. But something has come along that makes it possible for a technician to use a personal computer as a DMM that has functions that a standard DMM does not have. This computer-based DMM is called a VMM (virtual multimeter) (Figure 1).

As we have seen, the personal computer is a very versatile device. Using word processor software, a writer can turn it into a virtual typewriter. Accountants can turn it into a virtual spreadsheet. Data base software can turn the personal computer into a virtual card file. As time goes on, clever programmers have turned personal computers into virtual banking machines and drafting equipment. In the area of electronics, programmers have turned computers into circuit design and analysis devices and oscilloscopes. Now with the right software, you can even turn a personal computer into a virtual multimeter.

Computer-based instruments use the hardware and software already in the PC, from the microprocessor and memory to software and firmware, to simulate stand-alone instruments. Computer-based instruments add user-configurability by expanding functionality and adding flexibility.

The latest PC processors, such as the Pentium II, for instance, are many orders of magnitude faster than the dedicated 8-bit microcontrollers inside most instruments today. Signal processing algorithms execute faster on today's PCs than inside traditional instruments. In addition, data transfer rates to memory, data logging speeds to mass storage, and many other elements, such as memory size and display size in today's PCs, also surpass the dedicated elements inside a traditional instrument.

## Computer-based instrument advantages

Unlike a traditional instrument, computer-based instruments can log vast amounts of data; timestamp and even annotate data; instruct the user how to take a measurement with pictures or even full-motion video; and tell the user which measurement to perform next. In addition, computer-based instruments can access the Internet and send results via e-mail; communicate directly with corporate databases and information systems; automatically generate reports and presentations; and perform high-quality laser and color printing.

Perhaps the most dramatic advantage of new-generation, computer-based instruments lies in the fact that you can customize data analysis and signal processing algorithms. Because these execute on the PC, you essentially have unlimited flexibility. This is in sharp contrast to traditional instruments, whose fixed vendor-defined algorithms are embedded in internal, inaccessible ROM. Analysis thus becomes part of the instrument.

### Computer-based multimeters

The computer-based multimeter combines all the functions of traditional digital multimeters (DMMs) with the advantages of your computer. For traditional functions, the DMM has measurement capabilities for voltage (ac and dc), current, and resistance. In addition, the VMM easily implements advanced features, such as frequency measurements and trending.

Accessories such as high-voltage probes, current shunts, clamp-on current probes, thermistor probes, and multiplexing/scanning options increase DMM versatility even further. In addition, many choices are available, ranging from a plug-in card with the exact analog circuitry of traditional DMMs to general-purpose plug-in boards that capture entire signals and use signal processing software to compute traditional DMM measurement parameters.

A traditional DMM can be upgraded to a computer-based DMM using an IEEE 488 interface or an RS-232 serial interface. Although in this case much DMM measurement functionality is provided by the traditional DMM instrument, many aspects of instrument operation can be enhanced by connecting it to the PC with a GPIB interface. A technician can create a custom user interface, for example, via a front panel implemented on the computer screen. This user interface can duplicate the exact physical interface on the instrument itself, or it can be tailored for more intuitive operation or to add additional features, such as data logging, report generation, Internet access, and more.

You can also build a computer-based DMM using a specific multimeter plug-in board for PCMCIA, PCI, ISA, VXI, or other bus architecture. The same traditional front-end signal conditioning and A/D conversion components used in traditional DMMs are implemented on a single, modular plug-in board, but you accomplish the analysis and display with the computer.

### VMM specifications

Here is a list of the specifications of one virtual multimeter:

- 5 1/2 digits with ac/dc coupling
- 20mV to 250Vdc range with 0.005% to 0.006% accuracy
- 20mV to 250Vac range with 0.3% to 0.4% accuracy
- 200Ω to 2MΩ range with 0.007% to 0.05% accuracy
- 20mA to 10Adc range with 0.1% to 0.15% accuracy
- 20mA to 10Adc range with 0.4% to 0.55% accuracy
- 10Hz, 50Hz, 60Hz reading rates
- Designed for CE and UL compliance

### Many instruments in one

Software is available that will turn a personal computer into a number of different instruments: DMM, oscilloscope, and arbitrary waveform generator, for example. This means that with this software, the personal computer can be used as an all-in-one instrument. And because of the computer's power, the instruments will possess these characteristics:

- High-speed data processing - taking advantage of the most current processing power available with newer PCs
- High-resolution display - with computer-based instruments, the technician can select the display option best suited for your application
- Expandable memory - the user can equip an off-the-shelf PC with the memory you need

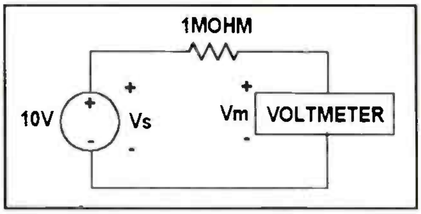



**Figure S1.** To measure the internal resistance of the voltmeter function of a DMM, construct this circuit. The voltage read by the voltmeter in this circuit is not only the voltage across the series combination of the voltage source and the 1MΩ resistor, it is also the voltage across itself. Using simple math as described in the text, the resistance of the meter can be calculated.

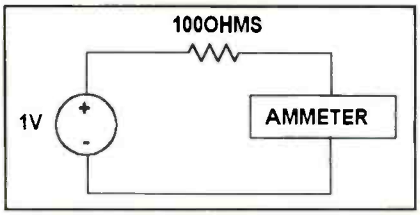



**Figure S2.** To measure the internal resistance of the ammeter function of a DMM, construct this circuit. Using Ohm's law, you can calculate the current in this circuit, and subsequently the resistance of the meter, as described in the text.

## Do you know the internal resistance of your DMM?

The voltmeter and ammeter functions of the DMM are two very useful functions for technicians. And they're generally quite accurate. One of the determinants of accuracy in a meter is its internal resistance. Ideally, a voltmeter would have an internal resistance of infinite ohms. Otherwise, the resistance of the meter, in parallel with the resistance between the points across which the voltage is being measured, causes the resistance to become lower, thus distorting the reading. A well-designed DMM has a very high internal resistance on the voltage function.

An ideal ammeter would have an internal resistance of zero ohms. Any departure from that ideal introduces some inaccuracy into the readings taken by the meter. Since an ammeter is inserted in series with the circuit being measured, any ammeter resistance would add to the total circuit resistance, thus reducing the circuit current. A well-designed DMM has very low resistance on the ammeter function.

Did you know that you can measure the internal resistance of your DMM? Here's how.

### Measuring the resistance of the voltmeter function

To measure the internal resistance of the voltmeter function, construct the circuit of Figure S1. The voltage read by the voltmeter in this circuit is not only the voltage across the series combination of the voltage source and the 1MΩ resistor, it is also the voltage across itself. And because this is a simple series circuit, the current that flows through the resistor is also the current that flows through the meter. The equation for the current is:

$$I = (V_S - V_M)/R$$

If we know the current (I) and the voltage ($V_M$), using Ohm's law we can calculate $R_M$:

$$R_M = V_M/I = V_M/[(V_S - V_M)/R]$$

$$= RV_M/(V_S - V_M)$$

### Measuring the resistance of the ammeter function

To measure the internal resistance of the ammeter function, construct the circuit of Figure S2. According to Ohm's law, the current in this circuit will be I=V/R, where R = R + $R_M$. The current can be found by using the equation:

$$I = V_S/(R + R_M)$$

Since we know I, $V_S$ and R, we can solve for the unknown quantity, $R_M$ as follows:

$$R_M = (V/I) - R.$$

• Internet and intranet connectivity - the data acquired with computer-based instruments is available to anyone who needs to see it worldwide

• On-line data logging, trending, and report generation - using the features in computer-based instruments and the PC, the user can automatically log data for storage, trending, and report generation using virtual instrument software or PC office software.

## Don't throw away your DMM or oscilloscope

The VMM and other personal-computer-based instruments are pretty interesting and exciting, and things such as data logging are very useful. For example, you could connect a VMM to a point in a TV that had been exhibiting intermittent problems, and leave it running, collecting, say, voltage readings periodically, as specified by you. By reviewing the changes in voltage at that point in the circuit, over several hours, you might be able to come to a conclusion about the problem that you wouldn't have been able to reach without that data over time.

But you can't just throw your laptop computer in the toolbox and have it handy the next time you're on a call. And you can't just turn it on and go, as you can with a traditional DMM. You have to load up the software to make the computer a DMM. And what if you're using the PC as an oscilloscope, or a waveform generator or even a word processor at the time. You certainly can't afford to be using a $2,000-plus PC as a dedicated VMM.

And, while a virtual oscilloscope is a valuable tool, the bandwidth of most, or perhaps all, virtual oscilloscopes is considerably less than the 100MHz required for much television work.

From this vantage point, it looks as though VMMs, as well as other virtual instruments, are useful, and provide useful functions that stand-alone instruments don't provide, and might make a valuable supplement to the test equipment owned by consumer electronics service centers; a supplement that might help a technician make a diagnosis that he couldn't make otherwise. But they shouldn't be counted on to replace the tried and true instruments that a service center has come to rely on to get the job done.

*This article was based on information provided by National Instruments.* ■

# New technology

**by the ES&T Staff**

It's just amazing to see all of the consumer electronics technologies we ever dreamed of, and some we never could have dreamed of, become reality, first as prototypes, then as very expensive consumer products, then as products everyone can afford.

Just look around. It seems, for instance, that the driver of every car, and everyone at the mall where I shop is talking on a cellular telephone; a product that wasn't even available at all just a few years ago.

And remember when the compact disk player was introduced? That was in the early 80's and they cost several hundred dollars. Now you can buy one for less than $100, and if you want, make it one small enough to carry around.

And computers. Even after the desktop computer had been introduced, who would have ever thought that manufacturers would be able to put a powerful computer, a modem, a keyboard, a floppy disk drive, a display, and a battery capable of running it all into a package that's no larger than a notebook.

We do live in an age of wonders. Those wonders affect all of us, but no one quite as much as the technicians who are called upon to fix them when they cease to be wonderful. This article describes the current state of some of the wonders that either have been introduced recently or are expected to be introduced soon. But first, here are some predictions, from a highly credible source, on what kinds of marvels we might be seeing ten year in the future. They don't all have to do with consumer electronics, but we thought that most readers would be interested.

### Battelle's list of the top 10 household technology breakthroughs for 2008

Your home in 2008 will have fewer wires, cleaner air, and a handful of fun products to keep you healthy, informed and entertained.

In its latest technology forecast, Battelle, a world-renowned technology organization based in Columbus, OH, has identified what it expects will be the 10 most important technological breakthroughs in household products over the next decade.

"We're forecasting breakthroughs that will lead to major new benefits for consumers, will give the developing companies a three-year lead in the marketplace, and will create new product lines for growth," says Dr. Stephen Millett, leader of Battelle's Breakthrough Center.

"The technical know-how is already out there to develop these products and have them on the market within 10 years," says Dr. Susan Brown, Technology Access Leader in Battelle's Consumer Products Group. "We're assuming that the investments will be made to bring these products from the imagination, to the laboratory, to the store shelf."

The list of household product breakthroughs follows several technology forecasts Battelle has published over the past four years including forecasts for top 10 technologies, technological challenges, innovative products, and sports-related technologies.

1. *Disappearing cords and cables.* Wires will begin to disappear from view in homes as we move toward wireless communication, data transmission and energy distribution. That means more cordless telephones, wireless hook-ups to the internet, and even electric lamps and small appliances that don't have to be plugged in to operate.

"We'll have an increased use of more powerful batteries, fuel cells, solar and other power sources," says Brown. "We can even envision devices to transfer energy from your outlets to lights, vacuum cleaners, and other appliances without the use of wires."

Other energy-saving products may include roofing shingles that serve as solar collectors, reducing the need for electricity transferred by wires to homes.

2. *Products for a healthy home.* "The environmental movement is expanding from the great outdoors to the cozy confines of our living rooms, kitchens and

baths," says Millett. Bacteria scares and concerns about indoor air quality will lead to products that improve our indoor environment. These products could range from smart filters on furnaces and air vents to localized filtering appliances to new concepts, such as anti-allergen and anti-bacterial surfaces and self-vacuuming carpets that serve as filtering systems.

The home and yard environment may also be improved with the development of genetically engineered lawns that require fewer or no chemical treatments.

3. *Home health monitors.* "There's a rapidly growing need for simple, user-friendly medical equipment for the home," says Richard Rosen, Vice President of Battelle's Medical Products Group. "As our population ages, monitoring and maintaining our health at home will be extremely important. Technically, we can do it. We can help people stay at home and stay healthy."

These relatively inexpensive, reliable, and non-invasive home health monitors could track a wide range of physical functions and analyze nutrition and exercise programs. "They'll serve as your own live-in medical team," Rosen says.

4. *Home waste management.* Imagine an in-home system that sorts, recycles and disposes of home waste — eliminating the need for hand sorting. We may even see the development of systems for at-home water treatment and recycling.

5. *Highly miniaturized communication and electronic products.* In 10 years, we will have developed wristwatch-size telephones and highly specialized, hand-held, wireless personal computers that will help us perform a variety of day-to-day activities, from managing your banking and investments to planning your weekend entertainment.

"Millions of grown-up kids will be thrilled to see that the day of the Dick Tracy style wrist-phone is at hand," says Will Kopp, coauthor of the forecast. "We'll also have available to us a variety of easy-to-use, miniature information appliances. One might provide us with a telephone directory for the entire country; in the palm of our hand. Another might give us a constantly updated calendar of weekend events and restaurant menus in our community. And we might use yet another such appliance to manage our banking, investing and bill playing."

6. *Affordable, digital, high-definition television.* Digital HDTV is here now, but the breakthrough will come in making it affordable to a mass market.

Battelle researchers predict that future digital HDTV sets will incorporate home videoconferencing, computing, and networking to hold down costs for the consumer. To hold down costs, many of these more advanced systems will be leased.

7. *Virtual reality products.* Virtual projections and sound environments will be used to enhance computer games, music systems, video entertainment systems and exercise equipment. We will see a convergence of home entertainment, information and well care.

"More and more, people want technology to make everyday products more fun. We want to be entertained," says Millett. "Virtual reality will be one of the best tools for doing that."

8. *Electronic commerce.* We will enjoy electronic shopping and banking, including financial transactions that are error-free, secure, easy to use, and low cost.

"The companies that develop the technology and the products that make electronic commerce safe, secure and simple will have a very hot product on their hands," says Brown.

9. *Voice-activated products.* Products throughout the home, such as televisions, computers, lights, and other electronic appliances will be capable of being operated by voice commands.

10. *Personal security.* New identification systems will take personal security to new levels, including protection of homes, automobiles, and other property; security over computer networks; and security for electronic commerce. Brown says these systems may include DNA chips and bio-electronic security.

## Consumers want their digital TV if price is right

Sales of digital television sets would quadruple if manufacturers lower prices, according to a new survey sponsored by A.T. Kearney, Inc., a global management consulting firm.

Results of the consumer survey, which polled 1,000 households before the holidays, showed that price is the most critical variable driving consumer purchases of digital television sets.

"Consumers are excited about digital television, but right now the premium prices that the sets are expected to command will keep consumers out of the stores," said Joseph Kraemer, vice president of the communications practice at A.T. Kearney. "The lower the price, the faster the penetration of digital television in the United States," he said.

The survey found that price is the most critical variable driving consumer purchases of digital television sets. At a premium of $1,000 over analog television sets, only six percent said they were likely to buy a digital set. But when the premium fell to the $500 level, the number of potential buyers jumped to 24%. "Price is the one factor that many manufacturers can control to accelerate penetration," Kraemer said.

Unless the sets become more affordable, most consumers are likely to wait years after digital television service has been introduced before buying a digital television set.

Major broadcasters will introduce a new digital television broadcasting service in 1998. Consumers will need to purchase a digital television or a converter box to take advantage of the new services. The new digital broadcasting ultimately will replace the 50-year-old NTSC analog service.

Digital broadcasting will offer a wide variety of services, including high-definition television (HDTV). The service also could deliver about 30 channels or more in a given market, offering consumers an alternative to cable or satellite television.

The survey also found that a sizable percentage of consumers would drop their cable or satellite service if they could receive numerous channels free through digital television. Because price is such a concern to consumers, the price of a digital set could be offset by the reduction or elimination of monthly payments for cable or satellite service.

"This new piece of information about the willingness of consumers to drop other television services could be used as a marketing tool to boost consumer interest in digital television," Kraemer said.

Other survey results:

- Asked whether they would access the World Wide Web through their digital television, 63% said yes they would do so. This could double Internet penetration in U.S. households.

- Asked to name what will most influence a decision to buy a digital television: 42% said cost; 22% said analog service terminating; 20% said to replace a broken set; 11% said for quality and/or service.

- Assuming a reasonably priced set, two out of three households said they would buy a set within five years of introduction.

The survey of 1,000 households was conducted over the telephone in November by Caravan Opinion Research Corporation International.

A.T. Kearney's Communications Industries consulting practice serves clients around the world in the telecommunications, wireless, entertainment, broadcasting, publishing and electronics industries and regularly analyzes consumer and technology trends, and other major government initiatives that affect these converging industries.

### Broadcasters more optimistic about DTV conversion timetable and costs, survey shows

The vast majority of U.S. broadcasters expect to have a digital television (DTV) signal on the air by the year 2002, and they are increasingly confident they can afford the conversion to DTV, according to a new study.

The independent study, conducted for Harris Corporation of Melbourne, FL, shows that a majority of the nation's broadcasters are likely to convert to digital broadcasting within the next five years. Only a small handful of broadcasters indicated they were not likely to convert by the end of 2002.

The survey was released at the International Winter Consumer Electronics Show (CES) in Las Vegas in January. Harris, the leading manufacturer of digital television transmitters, unveiled the results of its study at a symposium attended by broadcast executives and others interested in the transition from analog to digital television.

DTV will allow consumers to receive a television signal with twice the visual detail of current systems, compact disc-quality sound, and services — all within today's single television channel.

The study of 400 broadcasting executives, representing 481 stations nationwide, also shows that a vast majority feel they can afford the conversion process. This represents a significant improvement over a study last year, which showed less than half of the broadcasters felt they could afford the changeover.

Bruce M. Allan, vice president and general manager of Harris' Broadcast Division, was encouraged by the findings. "Broadcasters are more committed and are addressing Digital Television issues more aggressively than our research indicated. Not only do more than 90 percent of those polled believe they can meet the FCC-mandated timetable, but two-thirds now feel they will be able to afford the DTV investment."

The survey also found that most broadcasters that were polled said they plan to offer digital high definition television (HDTV) programming during prime time and multiple standard definition television (SDTV) programs during the day.

Study findings:

• 93% of broadcasters polled felt they were very likely or somewhat likely to convert within five years.

• 66% felt they could afford the conversion, compared with 42% in a survey conducted or Harris last year.

• 83% hope the conversion will become a reality, up from 72% who said that in last year's survey.

• While 44 percent said they have yet to define the mix between HDTV and other digital services, 23 percent said that they expect to use the digital channel primarily for HDTV and 33 percent said they expect to use it primarily to deliver multiple standard-definition programming.

• 76% felt keeping digital receiver prices low was the most important factor in consumer acceptance of DTV.

The phone survey was conducted during the first two weeks of December by Systems Research Corporation of Rochelle Park, NJ. SRC asked 400 television executives, representing 481 of the 1,551 stations in the U.S., their feelings on the planned conversion to DTV from the current standard. Sixty-four percent were members of their station's DTV committee and 36 percent were final decision makers on DTV equipment issues. Broadcasters surveyed were selected to reflect the real-world composition of the U.S. television market, with proportionate representation from all sizes of markets and station types; from affiliate to independent to public broadcasting. The survey, which has a potential error rate of +/-4%, was commissioned by Harris.

Harris is the leader in advanced transmitter equipment for DTV systems and the leading manufacturer of digital radio broadcast equipment in the U.S. The company has signed agreements to provide DTV transmitters to more than 200 television stations in the U.S. Last year, a Harris transmitter became the first in the U.S. to broadcast commercial digital television signals. The company also developed the test bed that was used to evaluate each of the digital television systems proposed for the U.S. market.

Harris has provided transmitter equipment for six of the United States' seven experimental DTV stations, including PBS-member stations WETA (Washington, D.C.), KCTS (Seattle) and Oregon Public Broadcasting (Portland), as well as stations WCBS (New York), WRAL (Raleigh, North Carolina), and WHD (Washington, D.C.), the nation's model station. Additionally, Harris has supplied digital transmitters for high-definition TV demonstrations worldwide.

### Industry standards in home automation technology

Thanks to years of work in product development labs, committee rooms and, yes, the field, manufacturers and contractors now have a number of choices in enabling technologies and standards they can put to use to make systems integration and automation happen in the home. Among the most pervasive and high profile are the following:

*CEBus.* The CEBus standard gives manufacturers from multiple industries a uniform way to link household products. Home LANs (Local Area Networks) treat the home's electronic devices and equipment as nodes on the LAN. Products attached to the home LAN put messages on and take messages off the home LAN. The CEBus standard tells manufacturers what their products must do to send and receive CEBus compliant messages on a home LAN. The CEBus standard also defines how the home's wiring can be used to transport messages between CEBus compliant products throughout the house. Options include: the home's powerline wiring: telephone wire (4 pair); video wire (dual coax); and, wireless options such as radio frequency (RF) and infrared (IR) signals.

Manufacturers using CEBus to develop products for home LANs can give their products CEBus compliant features during the manufacturing process. They also have the option of creating an add-on module that gives their product the ability to send and receive CEBus compliant messages via the home LAN.

### CEBus features

CEBus, which allows for five different media of transmission, can handle a great many more commands per second than standards utilizing power lines.

CEBus makes high bandwidth data channels available, and can assign them to appliances facilitating use.

The CEBus system provides for 2-way communication.

The CEBus standard is a consensus specification developed for industry, by industry and remains controlled by industry — unlike proprietary standards.

The CEBus standard provides uniform speed on all media. The signaling speed for control channel messages is the same on the powerline, twisted pair, coaxial wire, radio frequency and infrared. No buffers are required.

A home with a CEBus automation system is "future-proof," that is, ready for the technological advancements of tomorrow.

### LonWorks

In a LonWorks network, no central control or master-slave architecture is needed. Intelligent control devices, called nodes, communicate with one another using a common protocol. Each node in the network contains embedded intelligence that implements the protocol and performs control functions. In addition, each node includes a physical interface that couples the node microcontroller with the communications medium. LonWorks is an "open" technology and is accessible to all. The Neuron chip, which is the enabling technology for, and the core component of, every LonWorks node, is manufactured and sold worldwide by both Motorola and Toshiba.

Features:

- The technology can work with existing power lines.
- Small control components consume little power and are ready to be designed into home products.
- Increasing volume is rapidly lowering the cost of the Neuron Chip.
- Any product with a LonMark can work as part of a system, regardless of who made the part.

### SMART HOUSE

Molex created the SMART HOUSE home automation system, unifying cables for power and signal distribution and making available a wide selection of "intelligent" outlets and switches. Cables direct all communication functions into the system controller, providing a pathway through which the system infrastructure is accessed.

Features:

- Easy to install
- Easily upgraded
- Enables peer-to-peer communications
- Has no contention problems
- Provides benefits of client-server networks
- Provides secure off-site access and programmable notification
- Has three primary options for interfacing with the network
- Enables closed loop power control
- Has hardware and software development tools
- Has local control default in the event of network failure
- Has built-in diagnostics

The two leading manufacturers of SMART HOUSE System Integration and Control Technology are AMP Inc. and Molex Inc.

### X-10

The X-10 Group designs, develops, manufactures and markets a wide variety of home automation and security products that work by sending signals over existing power line wiring. These home automation products are called "power line carrier" (PLC) devices. X-10 also manufactures compatible PLC products which are installed in commercial buildings and private homes by professional contractors and electricians. The commercial applications are primarily for energy management. The residential products are often installed by builders who want to offer home automation as an additional selling feature.

The home automation line consists of "controllers" that automatically send signals over existing electric power wiring to receiver "modules", which in turn control lights, appliances, heating and air conditioning units, etc.

Features:

- X-10's PLC technology saves labor and wire, since the ability to send control signals from point A to point B does not require additional wiring.
- The necessary controllers and modules are considerably less expensive than hardwired models and do not require the initial expense of a server or a node.
- X-10 systems require less than 20 percent of the time needed to install a hardwired system; add-ons and modifications are simple.
- To make a home X-10 compatible, just replace a home's wall switches, dimmers and receptacles with X-10 components.
- X-10 manufactures their own products and they own the patent.
- X-10 is more readily available and cost effective. A consumer can walk into a nearby electronics store, such as Best Buy, Home Depot, Incredible Universe and Lowe's, and purchase all of the necessary equipment to automate his or her home with the X-10 standard.

### Panasonic prepares for new digital video era

In 1998, the promise and excitement of digital television will finally be realized," says Jeff Cove, vice president and general manager, Television Division, Panasonic Consumer Electronics Company. "And, when broadcasts begin in major U.S. markets this Fall, Panasonic will be there... with exciting new products to handle whichever digital format is chosen."

Digital television promises to deliver crystal clear video that approaches the quality of 35mm movies, as well as near-CD quality sound. Through its laboratories and design facilities in the U.S., Panasonic has actively pursued research and development activities on digital TV and HDTV since 1982. As evidence of Panasonic's ongoing development work to usher in the new digital television era, the company previewed a number of current and prototype digital television products at the 1998 Winter Consumer Electronics Show in Las Vegas.

Among the products growing out of development efforts and shown at this annual trade gathering were: the CT-36VG50, a "digital-ready" SVGA TV/Monitor introduced earlier this year; a prototype 36" wide-screen (16:9 aspect ratio) direct view digital television; and a 56" (16:9) projection television, replaying different format digital signals through a set-top converter box, also under development. In addition to demonstrating playback of taped digital video sources, the prototype products also played special over-the-air programming transmitted from experimental TV facilities at a local Las Vegas network affiliate.

"Panasonic's digital television strategy will address two different audiences," says Cove. "For the early adopter, we will offer new full-featured digital televisions, as well as transitional products, such as Panasonic's unique multi-scan SVGA TV/Monitor which accepts all digital signals and displays them at up to a maximum 800 lines of horizontal resolution. And, for the consumer who looks to retain an existing NTSC set and still receive digital signals, we plan to offer a Panasonic-developed set-top converter. As easily connected to a television as a cable box, the converter will receive all digital signals and play them back on NTSC televisions."

Panasonic anticipates offering digital television products in the Fall of 1998. To help encourage a smooth and rapid transition to digital television, in whichever format broadcasters will select for over-the-air transmissions, each of the company's planned offerings will be able to receive and decode all Advanced Television Systems Committee (ATSC) digital signal formats, including wide-screen HDTV.

Panasonic consumer digital television products will be marketed in the United States by Panasonic Consumer Electronics Company, a division of Matsushita Electric Corporation of America (MECA). Other MECA division companies are already providing digital and HDTV video equipment to the major broadcast networks, as well as digital electronic news gathering and production equipment for local television stations, as they prepare for the country's transition to digital broadcasting. MECA is the principal North American subsidiary of Matsushita Electric Industrial Co., Ltd. (MEI), of Japan, one of the world's largest producers of electronic and electric products for consumer, business and industrial use.

### Software for TV set-top computer boxes

IGS Technologies, Inc., of Santa Clara, California, demonstrated Windows CE applications for TV Set Tops, at the Microsoft Windows CE Partner Pavilion at the Consumer Electronics Show in Las Vegas in January. Set Top Box applications include digital TV, web surfing/internet access, video phone, DVD playback and 3D games. The multimedia accelerator used by IGS Technologies is the CyberPro2010, the only 2DTV multimedia accelerator that integrates a CPU bridge (FlexiBus), 64bit GUI Accelerator and an NTSC/PAL digital TV encoder (TVDirect) in a single chip. This enables the CyberPro2010 to interface directly to any embedded RISC CPU.

The CyberPro2010 has a video port for video phone, MPEG/live video capture applications. Its proprietary flicker-free technology provides quality video, graphics and text output on any TV. The chip has 6 internal DACs that enable 2 TV outputs and 1 CRT output simultaneously.

There are two demo systems currently available with Windows CE. One uses the AMD Elan 486 chip, and the other uses a NEC MIPS VR4300. Both have been ported by BSQUARE.

IGS Technologies, Inc. (formerly known as InteGraphics Systems, Inc.) was founded in 1993 to develop leading edge multimedia component solutions for emerging markets, including NC, Set Top, Information Appliances and PC TV. The company has since forged partnerships with the industry's leading companies and OEM customers in these emerging markets.

### High-performance cathode ray tubes for PC/TV applications

Toshiba America Electronic Components, Inc. (TAEC) has developed two high-performance cathode ray tubes (CRTs) specifically designed for emerging PC/TV applications. Designated the 36V and the 32V, these new tubes provide the high contrast, high brightness excellent picture sharpness that these applications demand and can be used for both personal computer and television display.

As digital television becomes mainstream, TV viewing is beginning to shift from a passive to an active experience. Applications such as home shopping, home banking, video-on-demand, remote education and web browsing are becoming a reality. "Toshiba believes that PC/TV applications such as Internet browsing on the family room TV will soon become a standard home entertainment activity," said Dan Ryan, sales engineer for display products, Electron Tubes, and Devices. "Standard NTSC picture tubes do not provide the necessary quality that consumers demand. The edges appear fuzzy and the icons look distorted. PC monitor color display performance is necessary for PC/TV applications."

### Advanced Features

The new CRTs provide 800 x 600 resolution and feature a number of Toshiba's latest technology developments, including an improved saddle/saddle-deflection yoke (S/S-DY), the DF-II dynamic focus electron gun with impregnated cathode and an INVAR mask.

The improved saddle-type deflection yoke enables hi-scan (40kHz), suppresses rises in temperature, even at wide deflection angle and high power operation, and achieves optimum convergence and distortion. The dynamic focus (DF) II electron gun offers excellent sharpness, in both text and moving pictures, across the entire screen. The impregnated cathode allows high current loading and a longer life time. The INVAR mask has only one tenth of the thermal expansion coefficient of an iron mask which is essential to avoid discoloration resulting from mask doming in freezing images.

### Technical Specifications

*Product Name 32V Multimedia CRT*
Bulb (Panel & Funnel) FS
Deflection Angle 110 degrees
Neck Diameter (mm) 32.5
SCN PH 0.80
Resolution (HxV) 800x600
Mask INVAR
Gun DF-II
Deflection Yoke S/S
fH 48kHz
Mechanical useful screen diagonal: 806 mm (minimum)
overall screen area: 3118cm2
mass: 49kg

*Product Name 36V Multimedia CRT*
Bulb (Panel & Funnel) FS DT
Deflection Angle 110 degrees
Neck Diameter (mm) 32.5
SCN PH 0.90
Resolution (HxV) 800x600
Mask INVAR
Gun DF-II
Deflection Yoke S/S
fH 40kHz
Mechanical useful screen diagonal: 902mm (minimum)
overall screen area: 3905cm2
mass: 59kg

### The virtual cable

Philips Semiconductors has announced a Virtual Cable data communications system, which will provide a new, low cost way for computers and other consumer and industrial devices to communicate without cable connection.

Designed for PCs and PC-compatible devices, the Virtual Cable hardware and software solution uses the Digital Enhanced Cordless Telecommunications (DECT) standard to exchange data via radio waves between devices.

Virtual Cables are already being tested for communication in applications as diverse as interactive cable TV return paths, Point Of Sale (POS) terminal connections, vending machine polling and automatic stock control systems.

"The Virtual Cable provides data connections at speeds easily sufficient for hundreds of business, residential and industrial applications," explained Walter Conrads, managing director of international marketing and sales, Philips Semiconductors, "making this the perfect solution for adding low cost, cable-free enhancements to existing products. Every person we speak to about this concept dreams up another application."

The system has a range of 50 meters to 300 meters and can transmit data through walls, partitions and floors. Simple to set up and use, the Virtual Cable units create a direct, invisible connection using radio waves between two pieces of qualified equipment, which are selected from pop-up screen menus.

During the development of the Virtual Cable solution, Philips leveraged its knowledge of the DECT telephone system, for which it is one of the world's leading suppliers of integrated circuits (ICs).

With the company's advanced integration techniques, Virtual Cable units can be made in any size, including a size small enough to fit into a standard type II PCMCIA format, for use in laptops and palmtops. Virtual Cable is also ideal for creating plug-and-play cordless connections for computers and other devices over the Universal Serial Bus (USB).

### Technical Information

The hardware portion of the Virtual Cable solution is a pair of DECT Data Modules from ALPS Electric, which are PCMCIA-sized cards that plug directly into serial I/O ports. They are based around Philips Semiconductors' highly successful DECT controller chips, a Philips Semiconductors 80C51 microcontroller and a miniature RF module developed by ALPS.

These plug-and-play modules operate independently of the host computer's CPU. All the user has to do is plug a module into the serial I/O port at each end of the link. The portable end of the link is subscribed to the basestation end by pressing a single button, in much the same way a user subscribes a DECT cordless phone to its basestation. Then, the data link is operated as normal with no modifications required to the computer's communications software.

The OM5878 DECT Data Services Software, which Philips Semiconductors has developed with Silicon & Software Systems (S3), implements all the data communications tasks involved, including the DECT data protocol, link access protocol and V.24 UART interface to the host computer.

Full hardware flow control (RTS/CTS) and Circular Redundancy Check (CRC) error protection are provided across the entire link, together with automatic link setup and release and automatic link re-establishment after interruptions. DECT standard data encryption, together with automatic module authentication, ensure the security of transmitted data.

### Cable/CE joint engineering group defines basics for cable ready DTV receivers

Activity is taking place on many fronts to make digital television (DTV) a reality. Recently, a working group of the Joint Engineering Committee (JEC) of the Consumer Electronics Manufacturers Association (CEMA) and the National Cable Television Association (NCTA) identified eight essential elements of all cable-ready digital TVs. These building blocks are fundamental to the reception of DTV programming which use the transmission standards developed by the Society of Cable Telecommunications Engineers (SCTE).

"If cable operators adhere to these standards and receivers are designed to support them, all non-scrambled cable programs would be accessible by commercially available digital receivers without the need of a set-top box," said George Hanover, vice president of engineering for CEMA.

The JEC concluded that, while these components are needed, they will consider additional functions before recommending the final definition of a cable-ready digital television receiver. Other important aspects include if and how the receiver will descramble premium programs and link to external products and services which may not be supported in the receiver itself.

For example, the group is considering the plug-in descrambler defined by another JEC committee and standardized under EIA-679, the National Renewable Security Standard. "If a descrambling function can be added to the elements of the cable-ready receiver, a majority of the needs of cable subscribers will be served with the receiver only," said Hanover. Also, for example, to add extra functionality, a high-speed digital interface based on the IEEE 1394 can be included.

According to the working group, cable-ready receivers and cable operators should:

1. Support ATSC Digital Television Standard A/53, which describes the overall system characteristics of the U.S. Advanced Television (ATV) system,

2. Follow RF performance recommendations per draft EIA-23 (RF Interface Specification for Television Receiving Devices and Cable Television Systems) which defines tuner and corresponding cable signal characteristics,

3. Tune cable channels per EIA-542 (Cable Television Channel Identification Plan) which lists the frequencies to be used for each cable channel,

4. Use only 64/256 QAM modulation as specified in SCTE standard DVS-031 (Digital Transmission Standard for Cable Television) or 8VSB and possibly 16VSB modulation, as defined in ATSC A/53,

5. Support draft standard SCTE DVS-093 (Digital Video Service Multiplex and Transport System Standard for Cable Television), which defines the MPEG-2 packetization of program material,

6. Use only the transmission video display formats defined in ATSC standard A/53 table 3 and in table 2 of SCTE standard DVS-033 (Submission on "Class A" Issues-Profiles, Levels and Formats),

7. Use the in-band Program and System Information Protocol for Terrestrial Broadcast and Cable, SCTE standard DVS-097, which defines the data format for tuning parameters, v-chip information and on screen program guides, and

8. Support emergency messaging.

The JEC, in part, advises the Cable/Consumer Electronics Compatibility Advisory Group (C3AG) on technical matters. The C3AG is expected to take the JEC's recommendations to the Federal Communications Commission (FCC).

### Digital television

In a surprise announcement that should spur interest in high definition television, DIRECTV and Thomson Consumer Electronics demonstrated at the January Consumer Electronics Show satellite–delivered HDTV programming planned for the fall of 1998. The demonstration represented the first satellite transmission ever of HDTV program material.

The RCA 61–inch projection TV set used in the demonstration is expected to have an entry retail price of around $7,000, said James E. Meyer, COO and Executive Vice President, Thomson

Consumer Electronics. Thomson also announced plans for a more active position in digital television that includes the production of additional HDTV receivers and HDTV product support for the broadcasting industry.

In addition to a commitment to offer both 38-inch and 34-inch RCA direct view widescreen HDTV receivers, Thomson will build DSS functionality into all RCA and ProScan receivers and decoders. Thomson will also enter the business of supplying HDTV encoders to broadcasters and other distributors of programming. The encoders were expected to be available in late summer.

"The joint announcement by DIRECTV and Thomson will put HDTV programming in 48 states simultaneously, and open the way for national demonstrations of the new technology at participating dealers. It will be an opportunity to turn every dealer sales floor into an HDTV movie theatre," Meyer said.

The two companies previously worked together in 1994 to introduce the DSS Digital Satellite System which generated over one million sales in the first 10 months of the product's introduction.

### Consumers want HDTV

The demand for digital high-definition television — and the variety of features it offers consumers — is real, according to recent focus group research conducted by the Verity Group and sponsored by the Consumer Electronics Manufacturers Association. Highlights of the study were released at the 1998 International Consumer Electronics Show (CES), where manufacturers introduced commercial HDTV receivers for the first time.

The focus groups targeted a broad base of opinions concentrating on consumers in two categories: (i) early adopters - those with a high awareness level of Digital and HDTV and enthusiasm about the digital TV transition, and (ii) mainstream adopters — those with little knowledge or initial interest in the technology who own a wide variety of other consumer electronics. Together, these groups represent approximately 50 percent of the purchasers in the potential DTV market. Participants were shown a video and audio demonstration of the improvements offered by digital and high-definition television. When participants were shown an HDTV picture, the reaction was unanimously positive among all consumers, and virtually all strongly preferred HDTV to any lower-resolution digital sets. Early adopters especially preferred the wide screen presentation format of HDTV over the resolution offered by today's sets.

"This research is consistent with what we have seen all along with HDTV: Seeing is believing," said Gary Shapiro, president of CEMA. "Until now, HDTV has been an intangible promise for consumers. Now, with the introduction of retail HDTV product, consumers can actually see what this technology is all about - a revolutionary improvement in picture and sound and a variety of other benefits. This research reinforces what the entire history of our industry tells us — that consumers want the highest quality of video and audio performance."

Focus group participants said they were more likely to purchase a set that could provide them with access to the Internet, interoperability with adjunct products like digital cameras and videophones, and add-on products like DVD. When asked about "multi-casting," the ability to simulcast several channels of digital programming, mainstream adopters expressed dissatisfaction with current programming, saying quality improvements in programming were much more important than access to additional channels.

"In addition to the higher quality video and audio offered by HDTV, they want connectivity and compatibility. They are looking at HDTV to be a multi-function device," said Todd Thibodeaux, Vice President and Senior Economist at CEMA. "While some differences occur on pricing issues effecting when they will buy, there is little doubt that the majority of consumers will purchase this technology at the right price."

The industry estimates that initial sets will range from $2,000-$5,000 more than today's sets of comparable size. But, as with other consumer technologies, prices will drop quickly as economies of scale are reached. Conservative predictions are 30% household penetration of digital television sets by 2006.

"The research demonstrates that some consumers will pay a premium for digital or high-definition receivers and will purchase the new sets later this year. Others will wait for the prices to come down as mass production occurs in future years," said Gary Shapiro. "This follows the pattern of most new consumer electronics products. This research further solidifies our hope for HDTV - it will be a great success with consumers."

The focus groups were conducted during August, 1997. Two groups each were held in Orange County, CA, Atlanta, GA, and Dallas, TX. The sessions were moderated by the Verity Group, Inc., Fullerton, CA. Approximately 70 participated in the groups viewing demonstrations of a 35" 4 X 3 analog TV, a 34" 16 X 9 digital TV capable of 720 lines of vertical resolution, and a 38" 16 X 9 HDTV capable of 1080 lines of vertical resolution (interlaced). Roughly half of all group participants were pre-selected to represent early adopters while the other half of the group were selected to represent mainstream adopters.

### Digital TV technology for PCs

Capitalizing on its patented digital television (DTV) technology, Zenith

# Test Your Electronics Knowledge

By J. A. Sam Wilson

This TYEK is more difficult than most. If you answer all of the questions correctly write to me in care of this magazine and tell me. I will send you a highly-coveted Achievement Certificate. Be sure to include your snail-mail address!

1. What is the name of the component circuit in Figure 1?

2. What is the aspect ratio of an HDTV picture?

3. Can you define the term "BAUD rate"?

4. A magnetron is a
   A. form of magnetic amplifier.
   B. device that measures the strength of the earth's magnetic field.
   C. diode.
   D. (None of these answers is correct.)

5. What is the purpose of an ATR switch in a radar system?

6. What is the name of the component in Figure 2?

7. What is the voltage at point A in Figure 3?

Wilson is the electronics theory consultant for ES&T.

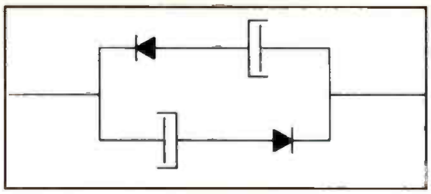


**Figure 1.** What is the name of the component that is the equivalent of this arrangement?

8. Which of the following is used as a parasitic suppressor?
   A. Four-layer diode
   B. Ferrite bead
   C. Bead Ledge
   D. Thermistor

9. Regarding the meter movement in a VOM, which of the following is more rugged?
   A. Jeweled
   B. Taut band

10. If a voltmeter has a 20,000Ω per volt rating, how much current is required for full-scale deflection?

*(Answers on page 54)*

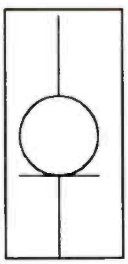
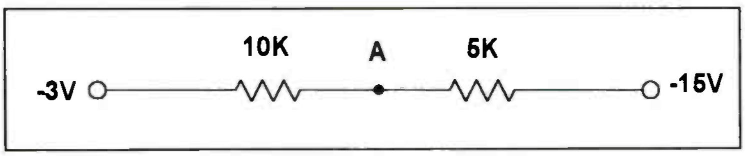


**Figure 2.** What is this component called?

**Figure 3.** What is the voltage at point A in this circuit?




Electronics Corporation is working with Intel Corporation to develop demodulator cards that will allow personal computers (PCs) to receive DTV broadcasts.

This announcement, made at the 1998 International Consumer Electronics Show, is expected to enhance the multimedia experience of digital TV broadcasts and reflects the important role that PCs will play in receiving DTV broadcasts, including datacasting services.

"We view this relationship as important to supporting the commercial launch of digital television broadcasts and to promoting widespread use of Zenith VSB technology in a variety of products and applications," said Tom Sorensen, Zenith's director of new technologies and business development.

Intel's Tom Galvin, director of market development, digital broadcast and broadband, said the joint development effort with Zenith on VSB demodulator cards for personal computers "supports Intel's vision of bringing exciting digital content and broadband services to millions of Intel Architecture-based computers around the world."

Intel has integrated the VSB technology into a prototype PCI board design for cost-effective PC implementation, while Zenith is providing its expertise in digital demodulation and its VSB technology.

Zenith invented the VSB (vestigial sideband) digital transmission system adopted by the Federal Communications Commission as part of the ATSC (Advanced Television Systems Committee) DTV broadcast standard. Any consumer product that receives an ATSC DTV signal will use Zenith's patented VSB technology.

In addition to licensing its VSB technology to manufacturers of digital high-definition television (HDTV) receivers, digital set-top boxes and broadcast equipment, Zenith plans to license its DTV technology to the PC industry.

### The beat goes on

There you have it. Technological developments are everywhere in consumer electronics, and the consumers appear to want them. Eventually, some of these new products will succeed while others will fail, and that's where readers of this magazine come in. ■

# New generation system control circuits

**By Steven Jay Babbert**

System control (syscon) microprocessors, also known as microcontrollers, microcomputers or embedded controllers, are used in nearly all of today's TVs. Because they are digital devices and are usually buried in a maze of input and output connecting lines, many techs find themselves in unfamiliar territory during troubleshooting. The good news is that many of the new-generation devices are designed to interface directly with analog systems. This greatly reduces the number of interconnecting lines and simplifies servicing.

In a previous installment we began a course in state-of-the-art television by looking at the power supply of a Magnavox model #25P506-00AA. In this installment we will continue the series by examining a new-generation syscon used in the same model. We will also look at the closed caption decoder and memory ICs that are closely associated with the syscon (Figure 1).

## Analog keyboard

The first thing that jumps off the page as a departure from the norm is the simple keyboard interface circuit. Typical television microprocessors require multiple input and output pins and a number of switching diodes to interface a matrix type keyboard. In this system, IC345 requires only one pin. When any key is pressed, its associated resistor forms a voltage divider with pull-up resistor R309. The resultant voltage is applied to pin 17. An internal analog-to-digital converter enables the syscon to coordinate many basic functions based solely on the level of this voltage.

When troubleshooting a matrix type keyboard, it is necessary to use an oscilloscope to check for correctly timed pulses on the various lines. This sometimes requires service information. All that is needed to troubleshoot keyboard-related problems in this chassis is a DMM or suitable multimeter. To determine what voltage should be measured at pin 17 when a given button is pressed, simply use the basic voltage divider formula. For example, if the volume-down button is pressed connecting R303 into the circuit, the voltage at pin 17 should measure 2.5V.

Babbert is an independent consumer electronics servicing technician.

## IR module

There is nothing unusual about the remote receiver IR91. This module contains all of the stages needed to condition the IR (infrared) signal for input to the syscon (pin 44). This includes an IR detector, an amplifier, a Schmidt trigger to square up the pulses, a limiter and a lowpass filter. The module's output can be scoped if you suspect a problem, but they rarely fail. Many scopes will not lock on to this signal and display a stable waveform but if pulses are present when a remote button is pressed then the module is probably good.

## The clock

Like virtually all microprocessors, IC345 has an internal oscillator or clock. The clock frequency of IC345 is set at 12MHz by ceramic resonator Y320 on pins 11 and 12. There is also an LC network associated with the clock at pins 14 and 15. This clock must be running in order for the syscon to function; it should run whenever the set is plugged in.

The clock can be tested by scoping any of the above mentioned pins. A more convenient testpoint, however, is pin 3. With the timebase set for 50microseconds, you will observe a 5V$_{pp}$ squarewave. Note: the squarewave at pin 3 is a divided-down version of the main clock signal and is only present when the chassis is in the standby mode. If the clock does not run when the set is plugged in, check for power on supply pins 13 and 40. If the supply is up then it is likely that Y320 or the syscon itself is defective. Of the two, the syscon itself is the most likely problem.

In a dead-set situation, if the clock stops as soon as you attempt to power up the chassis the problem is likely to be in the secondary power supply or the horizontal output section (the horizontal output section must be running in order for the secondary supply to function). If the secondary supply does not take over shortly after the primary supply voltage comes up, the standby supply will shut down due to the action of standby protector switch Q404 (a detailed explanation of this can be found in the power supply installment of this series).

The fact that the clock stops indicates that the syscon is probably good. The primary supply would not have come up at all if the syscon had not been capable of carrying out the power-on command. Remember that this applies to the main clock signal only; the signal on pin three is only present in the standby mode.

## Reset pulse

As with all microprocessors, a reset pulse is required to initiate the program sequence. When the set is first plugged in, the voltage on pin 16 begins to rise due to its connection to the low-voltage power supply via R418, Z402 and R406 (refer again to the power supply schematic). D345 clamps the voltage to one diode drop (0.6V) above the value of 5V supply source number 3. Capacitor C413, a 47muF capacitor, lengthens the rise time of the voltage at pin 16 because it takes time to charge. This prevents the voltage at pin 16 from reaching the threshold needed for reset until after the syscon's supply voltage is up.

It will be apparent from the above discussion that in this case the "pulse" is actually nothing more than a low-to-high logic level transition. Without it the syscon may operate erratically or not at all. If C413 loses capacitance reset may come too soon. It is also possible for the reset pin to get stuck, in which case it might assume a logic high level as soon as the chip is powered up (before the reset pulse builds), or it might remain low.

**MAGNAVOX MODEL TS2572C202 (CHASSIS 25P506-00AA)**

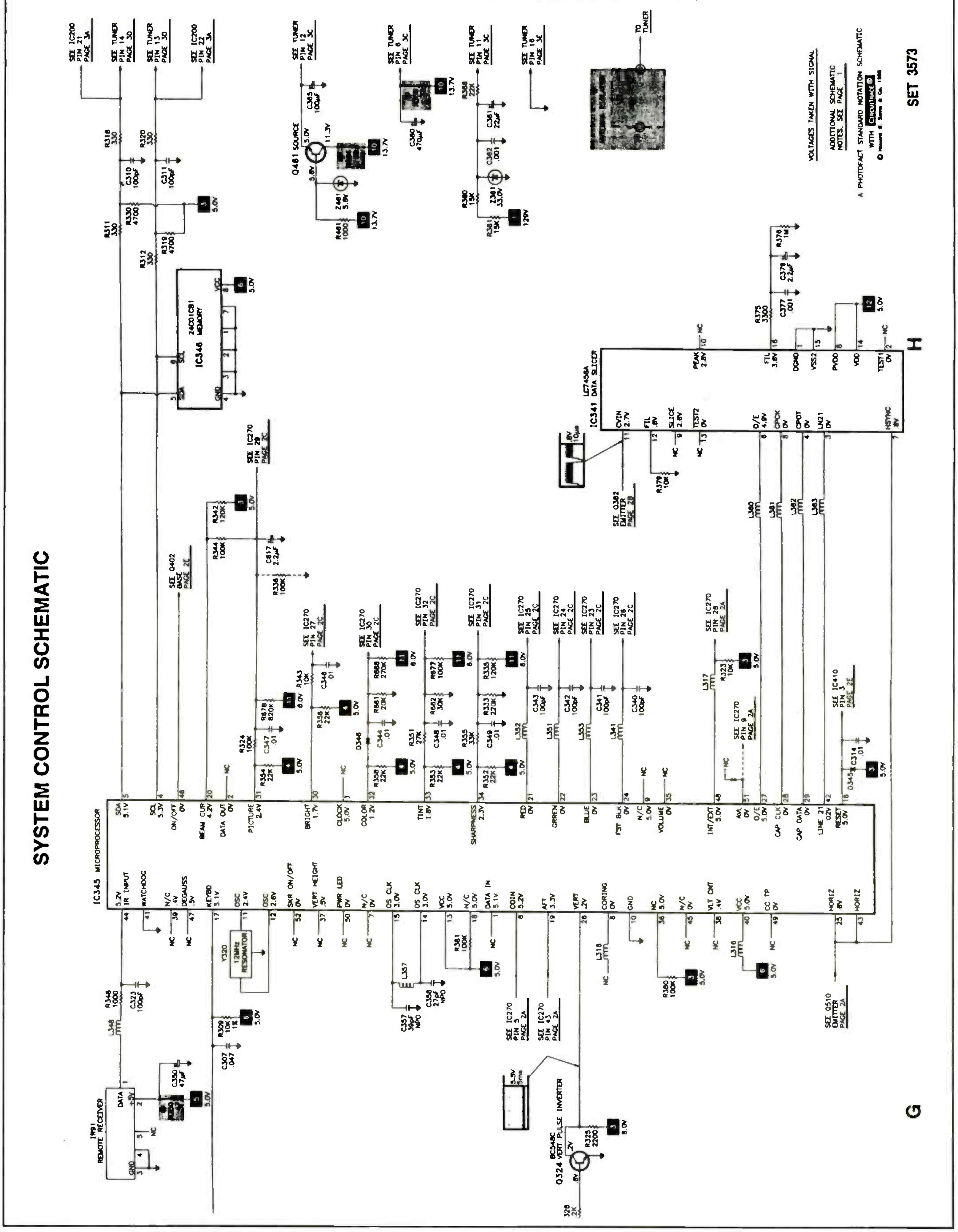



Figure 1.

Wicking the solder from pin 16 may help to verify if such a problem exists. If it does, the IC will have to be replaced.

### $I^2C$ BUS

Another unique feature of this syscon is that it uses an $I^2C$ (Inter IC) bus for communication with other ICs. This bidirectional bus has become a de facto standard in Phillips products. Only two lines are required for connection between devices. Serial clock (SCL) and serial data (SDA) are made through pins 4 and 5 respectively. The $I^2C$ bus connects to the tuner and the stereo processor, IC200. These will be covered in separate installments.

The $I^2C$ bus also connects to IC346, a 1K serial EEPROM (Electrically Erasable Prom). The SDA line is used to transfer addresses and data into and data out of the memory. The SCL line allows the syscon to synchronize data transfer. This memory device holds information pertaining to tuner and stereo processor settings. It also holds information pertaining to various syscon settings (e.g., color level, brightness level, tint, etc.)

### Closed caption and OSD

IC341 is a Line Twenty-One Acquisition or "Data Slicer" IC that works in conjunction with the syscon to extract and display the closed caption information which resides on line 21. It will be remembered that line 21 is a part of the vertical blanking interval which also contains the VITS (Vertical Interval Test Signal) information. Line 21 is in the overscan portion of the raster and does not contain active video information. The data on line 21 can be considered as a "slice" of a single field (262.5 lines). A sample of the CVBS (Composite Video Baseband Signal) enters pin 11 of the data slicer. This signal comes from the emitter of video buffer transistor Q382 (not shown here).

A caption clock signal from syscon pin 28 goes to pin 5 of the slicer to synchronize operation. A pulse from slicer pin 3 signals the syscon to read the data on pin 29 at the appropriate time (during line 21). A square wave from slicer pin 6 informs the syscon whether a given data slice is part of an odd or even field. This signal resembles a VCR head switching pulse. All of this info is needed to properly decode caption information. Note that a horizontal sync pulse is applied to slicer pin 7 as well as syscon pins 25 and 43. This is necessary because the caption information has to be horizontally synchronized as does all video information including OSD (On Screen Display).

The syscon also requires vertical synchronization in order to process closed caption and OSD information for display. Q324 applies a vertical pulse to pin 26. If this pulse is absent there will be no closed caption or OSD. Note that the vertical pulse is inverted due to the common emitter configuration.

All caption and OSD related video information processed by the syscon exits via pins 21 through 24. Red, blue, green and blanking signals are routed to the video processor section (to be covered in a future installment). If blanking information is absent there will be no caption or OSD. Absence of any of the color signals will cause the display to be the wrong color.

### Picture control

The syscon electronically controls video processing parameters such as brightness, picture, color, tint and sharpness by adjusting the voltage on pins 30 through 34. Each of these pins has a pull-up resistor tied to 5V source number 4. Digital-to-analog conversion is achieved by pulse width modulation; open-collector output transistors in the syscon switch on and off causing the associated pin to alternate between low and high. Because the frequency of the PWM signal is relatively high, the video processor IC responds to the average dc value only. This value is a function of the duty cycle.

If an adjustment problem exists, the first step is to isolate the problem to either the syscon or the video processor. It will be helpful to measure the voltage on a given line while attempting to make an adjustment. The voltage should ramp from between 0V to about 5V as the OSD indicates a change in level from minimum to maximum. This corresponds to a change in the duty cycle of the PWM signal from zero to 100%. The PWM signal can be scoped with the timebase set for 20 microseconds.

It is important to remember that the OSD may indicate that an adjustment command is being carried out, even though the voltage on a given line is not changing. Such would indicate a defective syscon or a problem with the interface circuit such as an open pull-up resistor or a loaded line. Lifting component legs may help to isolate loading problems but remember that the line will not ramp up without the pull-up resistors (open-collector output transistors require pull-up resistors in order to turn on).

### Additional functions

The on/off function was covered in the power supply installment and is quite simple. An "on" command causes pin 46 to drop to 0V (it is pulled up to around 4V in the standby mode). This causes on/off switch Q402 to change state. See the previous installment in the April 1998 issue for a detailed description of how this energizes the power supply.

You will notice that pin 35 (volume) has no connection in this chassis. This is because volume is controlled via the data bus discussed above. This microprocessor may be used in other chassis using a simpler sound chip with a connection to pin 35. Other syscon options also unused in this chassis are degauss (pin 47), vertical height (pin 37) and power LED (pin 50). Pin 48 (int/ext) controls signal source selection and will be covered in a future installment as will AFT (pin 19). ■

# Test accessories update

by the ES&T Staff

What could be simpler than connecting your oscilloscope to a circuit to be tested? You plug the leads into the scope and attach the probes to the point of interest in the circuit. Then you set the controls to the desired positions and observe. However, if you're not careful in connecting the probes, you might cause distortion of the measured waveforms.

Oscilloscopes, like all measuring instruments, are subject to the classic measurement problem — observability. The simple act of connecting an oscilloscope affects the measurement. It is important for users to understand this interaction and the impact it can have on a measurement. As oscilloscope technology has advanced, the tools and techniques for connecting the instrument to the measured device have become increasingly sophisticated. Early oscilloscopes, with bandwidths measured in 100's of KHz, were often connected to circuits with pieces of wire. Modern oscilloscopes employ a wide variety of connection techniques intended to minimize measurement errors. Users should be familiar with the characteristics and limitations of not only the oscilloscope, but also of the way in which it is connected to the device being measured.

Consider how the connection of an oscilloscope can affect a measurement. The device being measured can generally be modeled as a Thevenin equivalent voltage source with some internal source resistance and capacitance. Likewise, the input circuits and the interconnections can be modeled as a load resistance with a shunt capacitance. This simple measurement system is shown in Figure 1.

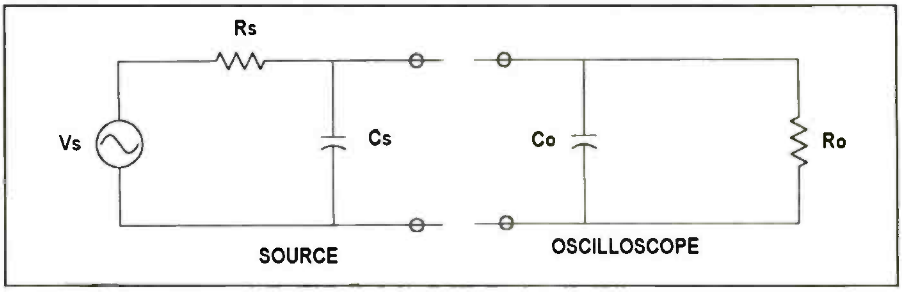



**Figure 1.** Model of a simple measuring system including a source and an oscilloscope

When an oscilloscope is connected to a source, the loading effects of the oscilloscope reduce the measured voltage. At low frequencies, the loss is dependent on the ratios of the resistor values, Rs and Ro. At higher frequencies the source resistance and the capacitive reactance of Cs and Co become a major factor in determining the loss. Another effect is the reduction of system bandwidth due to the capacitive loading of the oscilloscope. This also affects the dynamic timing measurements such as pulse risetime.

Oscilloscope designers have sought to minimize these loading effects by approaching the loading problem from two different points of view.

- High impedance probes, using both passive circuits and active circuits, are used to minimize loading effects by using either compensated attenuators or low capacitance, field effect transistors (FET) buffer amplifiers.
- Input circuits with 50Ω internal terminations have been added to oscilloscopes for direct connections in high frequency applications. In these applications, most circuits are designed for a constant,

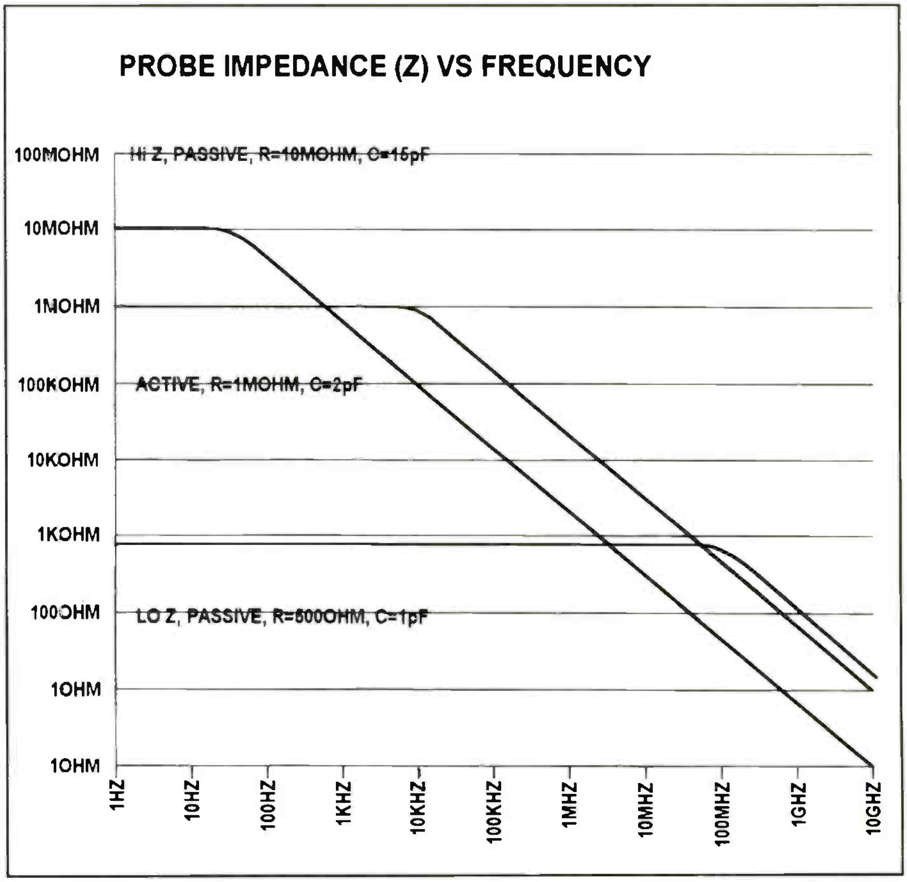



**Figure 2.** Probe equivalent impedance as a function of frequency

50Ω, load impedance. Low capacitance probes, designed to be terminated in 50Ω, minimize capacitive loading effects.

| Probe Type | Typical Useful Frequency Range | Typical Maximum Input Voltage |
|---|---|---|
| Passive, High-Impedance (1 MΩ) | 0MHz to 50MHz | 600V |
| Passive, Low-Impedance (500Ω) | 0GHz to 8GHz | 20V |
| Active | 0GHz to 2 GHz | 10V |

**Table 1.** Probe types, usable frequency ranges and input voltages

### Which probe for which application

In general, probes can be divided into three common classes:

- passive high impedance probes,
- passive low impedance probes,
- active probes.

Each of the probe types offers' advantages and disadvantages that should be considered carefully before selecting one for a particular measurement application. Table 1 lists the three probe types and shows how they are suited for frequency response and input voltage.

Unfortunately, knowing a probe's key specification (frequency range and maximum input voltage) is not sufficient for an engineer to select a probe for a given application. In fact, other probe characteristics (such as capacitance, impedance and bandwidth) have a dramatic effect on a probe's overall performance. For example, the equivalent impedance of a probe is a function of the input signal frequency. Figure 2 shows the effect for the different probe types.

The dynamic characteristics of the probes make them suited to different applications. As a guide, Table 2 lists a variety of different logic families and shows which probe type are commonly used for each application.

### High impedance probes

High impedance (Hi-Z) probes are the most commonly used oscilloscope probes. They are available with attenuation factors of 10:1 (X10) and 100:1 (X100) and bandwidths of up to 350MHz. However, it is important to point out that while the bandwidth may be as high as 350MHz, in practice high impedance probes are typically used in applications where the signal frequency is below 50MHz. The poor high frequency performance of these probes is due largely to the adverse effects of capacitance loading. Consider the typical X10 probe shown schematically in Figure 3.

The impedance input of a typical 300MHz bandwidth oscilloscope consists of a 1MΩ resistance in parallel with a 15pF capacitor. Direct connection of the oscilloscope to a circuit by means of a coaxial cable or X1 probe will add an additional capacitive load, due to the cable, of approximately 50pF per meter. The combination of the input and cable capacitance is approximately 65pF. The oscilloscope input impedance is represented in the probe schematic by R2 and C2. Both the oscilloscope and cable capacitances are represented by C2.

The high impedance probe isolates the measured circuit by adding a large resistor, R1 in this example, in series with the oscilloscope input. R1 forms a resistive voltage divider with the oscilloscope input resistance, R2. The value of R1 is set to 9MΩ for a X10 probe and 99MΩ for a X100 probe for an oscilloscope input resistance of 1MΩ. Capacitor C1 is adjusted so that the RC product, R1C1, equals the product R2C2. This compensates the probe so that it provides the desired attenuation at all frequencies. Therefore, before using any high impedance passive probe, the user should adjust Capacitor C1 with a 1kHz square wave, to seek an optimal compensation. A typical X10 probe has an equivalent input impedance consisting of a 10MΩ resistance in parallel with 15pF, where the 15pF capacitance is partly due to the series combination of Capacitors C1 and C2 and partly to the stray capacitance of the probe tip to ground, $C_{tip}$.

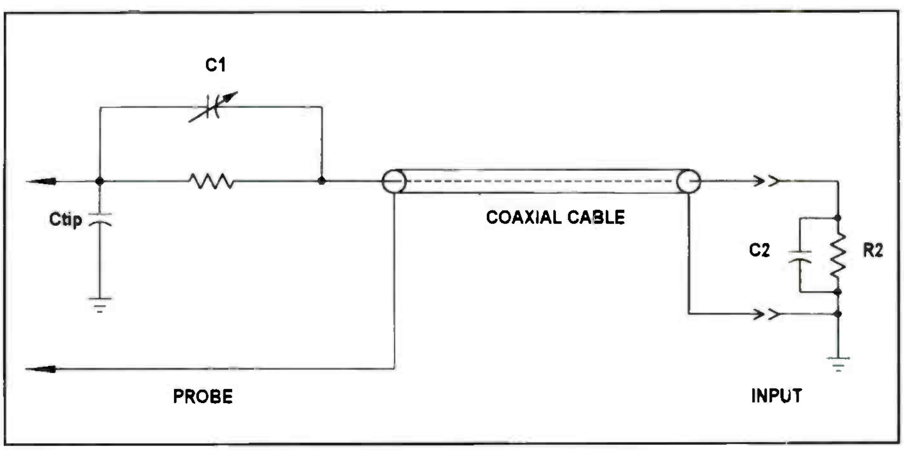



**Figure 3.** Simplified schematic diagram of a typical, X10, high impedance probe

As previously mentioned, the high impedance probe is best suited for general purpose applications where the signal frequencies are below 50MHz. These probes are relatively inexpensive and, since they use only passive components, they are mechanically and electrically rugged. In addition, they have a very wide dynamic range. The low end of the amplitude range is limited by the probe attenuation factor and the vertical sensitivity of the oscilloscope. The attenuation does, however, offer advantages in dealing with high level signals up to the maximum input voltage range, typically 600V for 10:1 oscilloscope probes.

Mechanically, these probes are available with a variety of convenient cable lengths and are generally supplied by the manufacturer with a wide variety of probe tips, adaptors, and ground leads.

### How high impedance probes affect measurements

When an oscilloscope is used to make measurements in a circuit or device, it is advantageous to anticipate how the device being measured is affected by the instrument. In most cases, it is possible to model the oscilloscope's input circuits, including the probes, and to quantify the loading effects and signal aberrations.

| Probe Type | Logic Family |
|---|---|
| Passive, High-Impedance (1 Ω) | TTL (Standard, Low Power) with rise times > 5 ns or CMOS with 5ns rise times |
| Passive, Low-Impedance (500Ω ) | ECL (10kH, 100 k, ECLinPS) Low Impedance Transmission Lines |
| Active | Fast TTL (Standard, Low Power, High Speed) Fast CMOS (BiCMOS, FACT, HCMOS, etc.) |

**Table 2.** Common probe types and their typical application

The user's knowledge of the measured circuit, together with the oscilloscope manufacturer's characterization of the oscilloscope/probe specifications, can be combined to model the entire measurement system.

Consider the simplified measurement system model shown in Figure 4. The actual circuits of the oscilloscope and of the high impedance probe have been reduced to an equivalent parallel resistor-capacitor (RC) circuit. Similarly, as was done in a previous discussion, the circuit being measured has been simplified and reduced to its Thevenin equivalent form. If the circuit's source resistance, Rs, is approximately 50Ω and the measurement is made using a conventional 10:1 high impedance probe, then it is reasonable to ignore the probe's 10MΩ resistance, Ro. The equivalent circuit for the system now consists of a series resistance, Rs, and a shunt capacitance, with a value equal to the sum of the source, Cs, and the input capacitance of the probe/oscilloscope, Co. From this simple model we can predict the effect of the oscilloscope on the risetime of the circuit. Using classical circuit analysis, the risetime, tr, of this RC circuit in response to a step function input is related to the values of resistance and capacitance by the equation:

$$t_r = 2.2RC$$

The following example, using typical component values, will provide good insight into the effects of using a high impedance probe:

For: Rs = 50Ω, Cs = 9pF, and Co = 15pF

The risetime of the source alone, $t_{rs}$, is:

$$t_{rs} = 2.2\ (50)\ (9 \times 10^{-12}) = 1\text{ns}$$

The risetime of the source with the probe and oscilloscope connected, $t_{ros}$, is:

$$t_{ros} = 2.2\ (50)\ (24 \times 10^{-12}) = 2.6\text{ns}$$

The act of connecting the probe increased the risetime by 160% due to the additional capacitance of the probe.

The additional capacitance also increases the loading on the generator, especially at higher frequencies. The capacitive reactance component of the load impedance varies inversely with frequency as described in the following equation:

$$X_c = 1/2\pi fC,$$

where the capacitive reactance, Xc, in Ohms, is an inverse function of frequency, f, in Hertz, and capacitance, C, in Farads. A simple calculation using the values from our previous example will show this increased loading. At a frequency of 100 MHz, the load impedance due to the total capacitance of 24pF is:

$$XC = 1/2\pi(100 \times 10^6)(24 \times 10^{-12}) = 66\Omega$$

Obviously, at frequencies above several kHz the capacitive loading becomes the major element causing loading the source. The 10MΩ input resistance of the high impedance probe only applies at dc. On the basis of these two examples it should be obvious why so much effort is put into lowering the input capacitance of oscilloscope probes.

Another approach to characterize the effects of connecting a probe to a circuit is to consider how it affects the bandwidth of the circuit. The bandwidth of this RC circuit, which is actually a simple low pass filter, is the frequency at which the output voltage falls to 70.7 percent of the unloaded source voltage.

The following relationship is used to calculate the bandwidth, BW, in Hz, of this RC circuit, for resistance in Ohms and capacitance in Farads:

$$BW = 1/2\pi fC$$

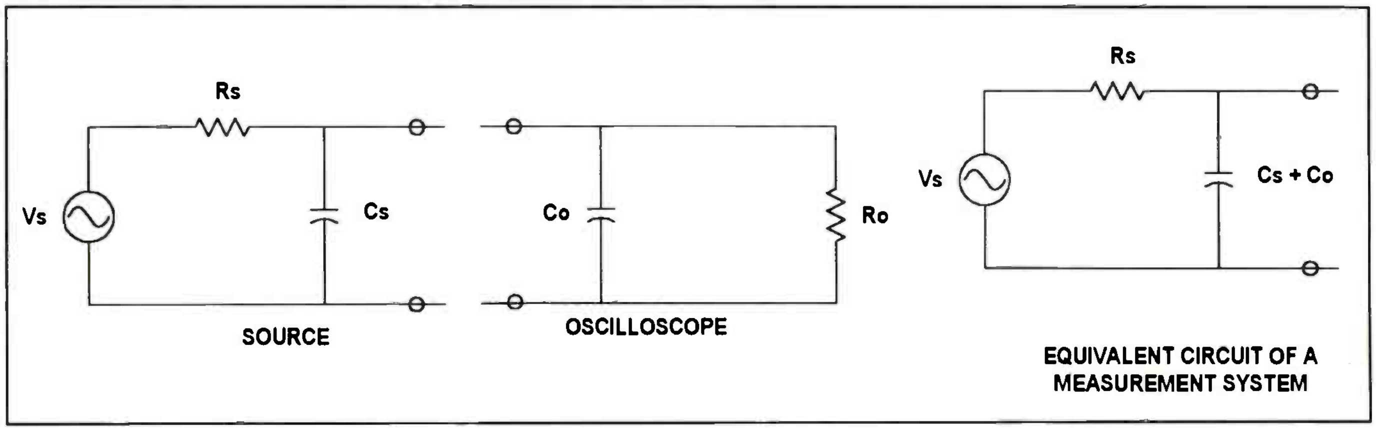



**Figure 4.** Deriving an equivalent circuit for a measurement system

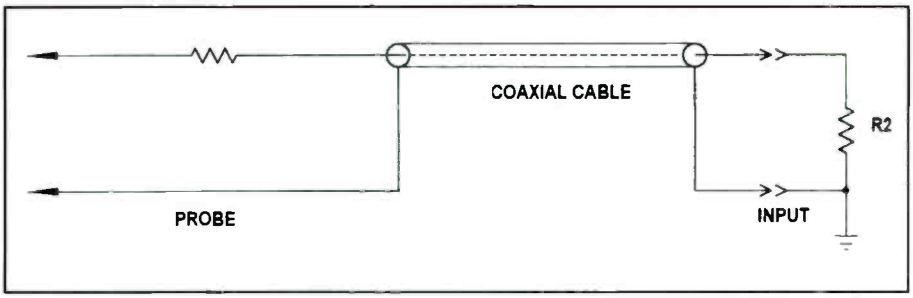



**Figure 5.** Simplified schematic diagram of a typical, X10, low capacitance probe

There is another classic equation which relates the risetime, tr, in seconds, and bandwidth, BW, in Hertz, of this simple RC circuit model:

$$t_r = 0.35/BW$$

The last equation is useful because many oscilloscope and probe specifications are described in terms of bandwidth and not risetime.

A knowledge of the risetime of each stage in a multi-stage, cascaded measurement can be used to estimate the composite risetime. The risetime of the composite system is the quadratic sum, i.e. the square root of the sum of the squares of the risetime of each element. For instance, the risetime of a signal shown on an oscilloscope screen, the measured risetime, includes the actual signal risetime as well as the risetime of the measurement system. It is possible, using the following relationship, to calculate the actual risetime of the signal, $t_{sig}$, based on the measured risetime, tmeas, and a knowledge of the system risetime, $t_{sys}$:

$$t_{sig} = \sqrt{(t^2_{meas} - t^2_{sys})}$$

To see how these equations can be used, consider the following practical example:

A pulse risetime measurement is made with an oscilloscope using a 10:1 probe which has a bandwidth at "the probe tip" of >250MHz. The goal is to estimate the actual risetime of the signal. The oscilloscope manufacturer's specification provides a composite risetime for both the oscilloscope and the probe (assuming a 25 source impedance), combining both into a single value. The signal risetime can be estimated as follows:

tmeas = 1.69ns

tsys = 0.35/250 x 106 = 1.4ns

$$t_{sig} = \sqrt{(t^2_{meas} - t^2_{sys})}$$
$$= \sqrt{(1.69 \times 10^{-9})^2 - (1.4 \times 10^{-9})^2}$$
$$= 0.95\text{ns}$$

Since the bandwidth of the oscilloscope and probe combination was only specified as a limiting value, i.e. >250 MHz, the calculated value is a lower limit. If a signal with known risetime and source impedance is measured, then it is possible using the same relationship, to determine the bandwidth of the oscilloscope "at the probe tip".

The dynamic performance of the high impedance probe is easily determined using the preceding equations. Keep in mind that these equations provide the first order estimation of a probe's behavior.

### Low capacitance probes

Another passive probe is the low capacitance or low impedance (Low-Z) probe. These probes are designed to provide 10:1 attenuation into an oscilloscope's 50Ω input termination. Where the high impedance probe uses capacitive compensation to provide flat frequency response with minimum capacitive loading, the low capacitance probe uses transmission line techniques to achieve extremely wide bandwidth with very low capacitance. A typical low capacitance probe is shown schematically in Figure 5.

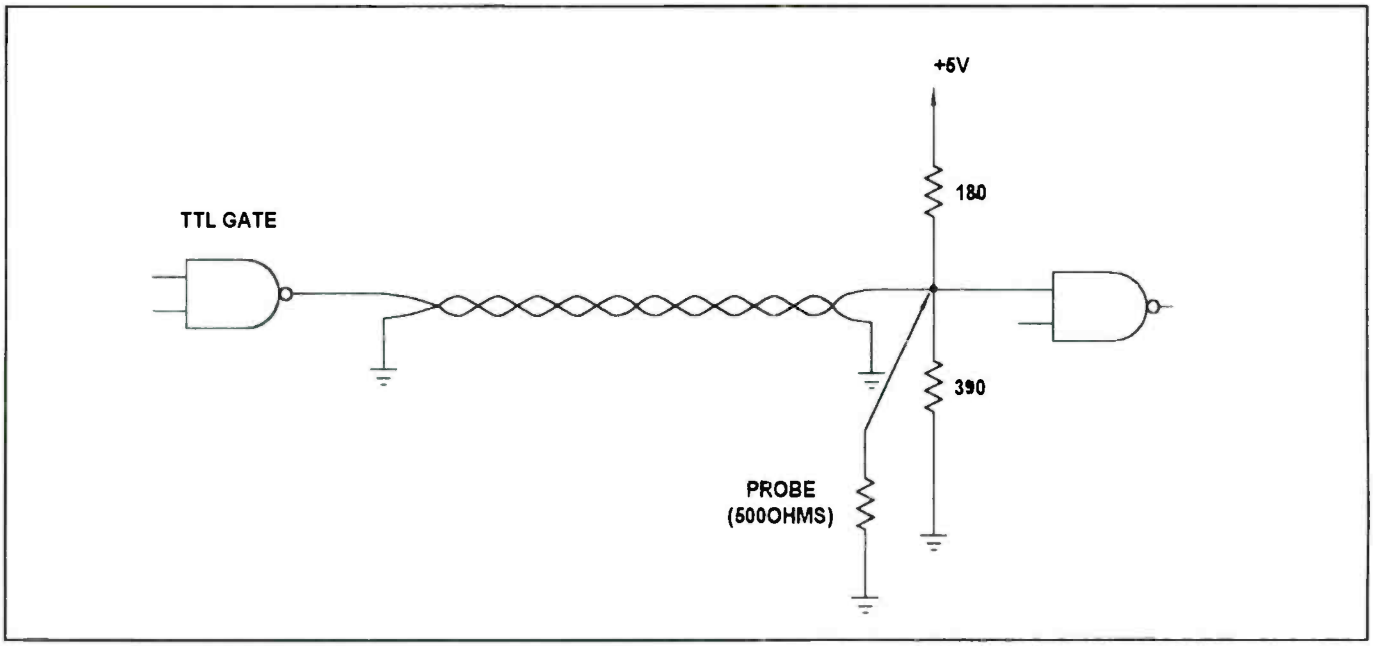



**Figure 6.** An example of poor probing technique using a low capacitance probe

The oscilloscope input resistance, R2, provides a matched termination for the low loss coaxial cable. Ideally, the terminated cable presents a pure, 50Ω, resistive load to the input resistor, R1, at all frequencies. The probe input resistance and attenuation ratio is determined by the series resistor, R1. For a 10:1, 500Ω probe, its value would be 450Ω. Special care is taken in the mechanical design of these probes to minimize parasitic reactances. With careful design, the low capacitance probes have usable bandwidths as high as 8GHz, risetimes of 50pS, and an input capacitance of 0.5pF. Since these probes are optimized mechanically for high frequency operation, they do not offer any choice of probe tips or ground connections.

Low capacitance probes should be used for wide bandwidth or fast transient measurements in circuits that can drive 50Ω load impedances. For these applications, low impedance probes offer excellent frequency response and a relatively low cost. Another advantage of low impedance probes is that they do not require compensation to match the oscilloscope.

| Probe Input Resistance | Measured Voltage | Error |
|---|---|---|
| 500Ohm | 2.7V | 20% |
| 1000Ω | 3.0V | 11% |
| 5,000Ω | 3.3V | 2% |
| 10,000Ω | 3.38V | 1.2% |
| 1MΩ | 3.41V | 0.1% |

**Table 3.** Voltage error due to loading effects

### How low capacitance probes affect measurements

A typical low capacitance probe provides 10:1 attenuation with an input capacitance of 1pF and an input resistance of 500Ω. The relatively low input resistance of these probes restricts their use to measurement situations where the devices or circuits being investigated are designed to work in 50Ω loads. It is important to keep the low resistance of these probes in mind when using them.

Figure 6 shows a TTL logic gate being used to drive a transmission line. The line with 120Ω characteristic impedance is terminated by a resistor network which biases the gate at approximately 3.5V. This type of termination is used because TTL can only source a few mA of current in the high state and the biasing increases noise immunity. If a 500Ω, 10:1 probe is used to measure the signal at the receiving end it lowers the termination resistance to about 98Ω and drops the bias to 2.7V. The probe loading reduces the noise immunity of the circuit and may cause it to behave intermittently. This type of measurement is best made with a low capacitance probe which will not degrade the line termination conditions. Table 3 lists the error in the measured voltage as a function of the input resistance of the probe, for the circuit of Figure 6.

While the user must be aware of the problems related to the use of low capacitance probes, this should not limit the al use of these probes in appropriate applications. These probes are well matched to measuring low impedance circuits found in power supplies, RF amplifiers, line drivers, and similar applications.

Many of the applications where low capacitance probes are used involve circuits which drive transmission lines. A common problem in such measurements is waveform distortion due to signal reflections, or standing waves caused by improper termination of the transmission line. This is not a problem related to the probes, unless the probe itself is improperly terminated, but it occurs frequently enough to warrant discussion.

A transmission line terminated with a resistive load equal to the line's characteristic impedance is said to be "matched". A matched line has a driving point impedance which is independent of the line's length and equal to the characteristic impedance. So, a length of RG-58, a 50Ω coaxial cable, terminated with 50Ω, represents a purely resistive load to the circuit which drives it. If a transmission line is not terminated properly then it can distort an applied signal in a variety of ways. If the signal is continuous, the voltage and current will vary with distance along the line, resulting in a standing wave pattern. Driving such a line with transient signals, like step and pulse waveforms, results in signal reflections. The amplitude and timing of the reflected signals varies with the degree of impedance mismatch and the length of the line. Reflected signals combine with the applied signal to produce highly distorted waveforms.

Figure 7 shows a measurement setup where the variance of the termination resistor, $R_0$, controls the amplitude and polarity of the reflected signal. The signal source generates a 1 MHz square wave with inS transitions. The source impedance, Zs, is set to match the cable's characteristic impedance, 50Ω. The oscilloscope, using a 10:1, 500Ω probe, is connected to the driving point of the cable.

When a transmission line is not terminated in its characteristic impedance, then transient signals, such as step or pulse waveforms, are reflected from the cable end. The amplitudes of the reflected wave, Vr, and the incident wave, Vi, are related by the following equation:

$$Vr/Vi = \Gamma_T = (R_0 - Z_0)/(R_0 + Z_0)$$

Where $R_0$ is the termination resistance, $Z_0$ is the characteristic impedance of the cable, and T is the reflection coefficient of the termination.

In the examples that follow, three values of $R_0$ will be used, $R_0 = 0$ (a short circuit), $R_0 = \infty$ (an open circuit), and $R_0 = 75\Omega$. These values of $R_0$ will result in reflection coefficient values of -1, +1, and +1/3, respectively.

A shorted cable results in a reflection coefficient of -1. A step waveform with an amplitude of +1.8V is reflected as a step with an amplitude of -1.8V. The timing of the reflection depends on the length of the cable. The propagation delay of RG58, used in this example, is about 1.5ns/foot. The delay between the incident and reflected wave is about 12ns for the 4 foot cable length used. This can be observed in the width of the measured pulse. The signal on the oscilloscope face would show that the original square wave edge has been distorted by the reflected wave into a narrow pulse. This is repeated for the negative-going edge, resulting in a negative pulse with the same width.

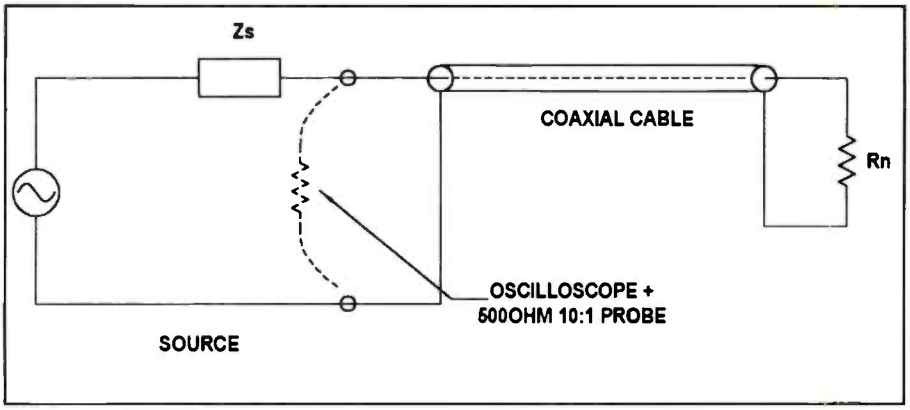



**Figure 7.** A measurement setup for observing signal distortion due to reflections.

An open termination results in a reflected wave of the same amplitude and polarity. The reflected wave adds a second, delayed transition to the waveform. This produces a stair-step appearance in the resulting measured waveform.

When the termination is changed to 75Ω, the size of the impedance of the reflected wave is reduced in amplitude to 1/3 of the incident step size.

It is important to keep in mind that improperly terminated transmission lines can cause waveform distortion. Low capacitance probes, which use the characteristics of the transmission line to reduce input capacitance, must work in the specified load impedance, typically 50Ω. Impedance matching between the probe and oscilloscope is of paramount importance. As a result, low impedance probes should only be used with high bandwidth oscilloscopes that have good 50Ω termination.

### Active (FET) probes

For applications that require high impedance and high frequency measurement (up to 2GHz) the active probe is a vital tool. Active probes use the high input impedance of a field effect transistor amplifier to buffer the probe tip from the oscilloscope input. A typical active probe provides 1:1 voltage gain with an input resistance of 1MΩ, input capacitance of 2.2 pF, and a bandwidth of 1GHz. A simplified schematic of an active probe is shown in Figure 8.

The key element in the active (FET) probe is a field-effect transistor configured as a source follower. This stage is followed by complementary bipolar transistors wired as emitter followers. The FET stage provides a very high input resistance; typically $>10^{11}\Omega$. The probe's input resistance and capacitance are determined by the resistors R1 and R2, which, with C1, form a compensated attenuator. Note that provision is made for adjusting the offset voltage by applying a bias voltage through R2. The output resistor, R3, back terminates the output in 50Ω and protects the output stage against accidental short circuits.

Active probes require a power source and have a more restricted dynamic range than passive probes. In fact, a major drawback with high bandwidth active probes is that they are easily damaged by overvoltage. Since active probes are much more expensive than their passive counterparts, users should be careful to ensure

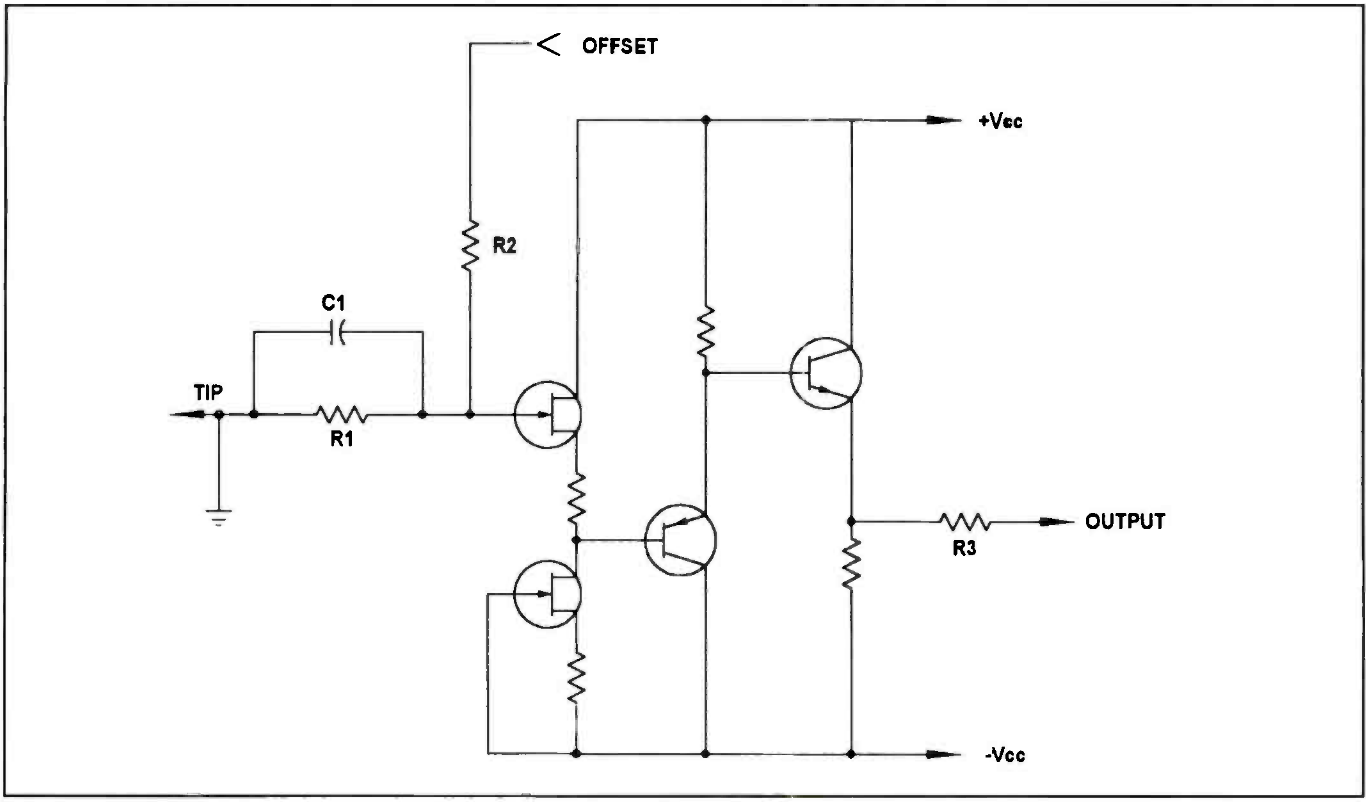



**Figure 8.** Simplified schematic of a typical active (FET) probe

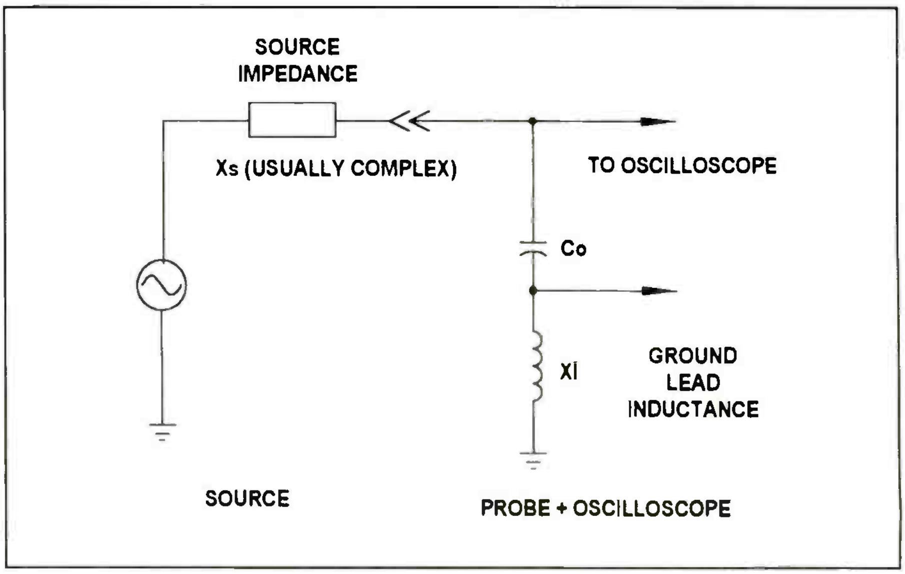



**Figure 9.** Measurement model including ground lead inductance

that they avoid this problem. In practice, active probes fill the niche between high impedance probes and the low capacitance probes. Operating bandwidths of up to 2GHz are supported with relatively high input impedance and the ability to drive relatively long cables. This latter capability, together with the ability to adjust offset and coupling at the probe tip, makes active probes ideal for ATE environments where the measuring instruments may be located at some distance from the device under test.

### Probe grounding and waveform fidelity

As the frequency of measurements increases, the secondary effects, such as probe ground lead inductance, begin to have an effect on the measured waveform. The effects of ground lead inductance vary with both the inductance, related to the lead type and length, as well as the signal frequency content. Consider the simplified model in Figure 9 which shows how ground lead inductance impacts a measurement. The probe ground lead provides a return path for the signal being measured. The ground lead inductance is a function of the lead geometry. A conventional wire lead contributes about 25nH/inch, or 10nH/cm. The inductance of a typical 10:1, high impedance probe ground lead is about 100nH to 150nH.

This inductance, in series with the combined probe capacitance forms a series resonant circuit. For a typical probe capacitance of 15pF, a 7 inch ground lead would provide 175nH resulting in a series resonant frequency of approximately 98MHz. If the signal being measured has content at or near the resident frequency it will result in "ringing" and other wave shape aberrations.

With this setup, you would note on the oscilloscope that there was an obvious overshoot and ringing on the waveform measured using the 7 inch ground lead. The oscilloscope's pulse parameter readout of positive overshoot, over+, indicates an overshoot of 17.4%. A more subtle problem is that the measured risetime is 2.27ns, somewhat greater than expected. A simple way to avoid this sort of error is to reduce the inductance of the ground lead. Shortening the lead will have the greatest effect. The reduced ground lead inductance is manifested in reduced overshoot, faster settling time, and a more reasonable risetime.

### Conclusion

With modern electronics using faster analog and digital circuitry, the use of probes is becoming more complicated. As signal frequencies go higher, the effects of loading a circuit by touching it with a probe are more complicated. Engineers need to consider how they can minimize these adverse effects by ensuring that suitable probes and good probing technique are used in each application.

*This article was based on information provided by LeCroy Corporation.* ■


## Tools, test equipment and supplies catalog

Contact East introduces their new 284 page catalog filled with test instruments and tools for engineers, managers, technicians, and hobbyists. Featured are quality products from brand-name manufacturers for testing, repairing, and assembling electronic equipment. New Product Highlights include: Fluke's redesigned 70 'Series III' DMMs; Tektronix' TDS '600 Series' digital real-time oscilloscopes; and Metcal Rework Stations; as well as a full selection of DMMs, portable and bench top digital storage scopes, custom tool kits, power supplies, EPROM programmers, soldering and desoldering equipment, breadboards, heat guns, measuring tools, adhesives, precision hand tools and reference books. Also included are communication test equipment, Electrostatic Discharge (ESD) protection products, ozone safe cleaners, magnifiers, inspection equipment, workbenches, tool cases and more.

**Circle (84) on Reply Card**

## Test equipment catalog

Sencore introduces their new "Total Servicing Solutions" Catalog featuring more than 10 new and exclusive products and 29 other products with color photos, specifications and accessories clearly listed. The 69-page catalog contains products ranging from test instruments to interactive training courses, as well as solutions to modern servicing challenges.

The catalog covers eight areas of service, including: computer monitor servicing instruments, TV analyzing instruments, VCR/camcorder analyzing instruments, general analyzing instruments, service center management software, TV-RF distribution analyzers, tech training, and Tech Disc Multimedia Services. Also in the catalog, are value added business building resources that help service centers improve their business offerings.

**Circle (85) on Reply Card**


## Semiconductor master replacement guide

The 18th Edition ECG Semiconductor MasterReplacement Guide features new products , new product families, additions to existing lines and approximately 300,000 crosses. The guide is a comprehensive, single source of replacement information. An expanded cross reference guide, selector guides and other refinements makes it easy to select the best ECG part for the application, says the company.

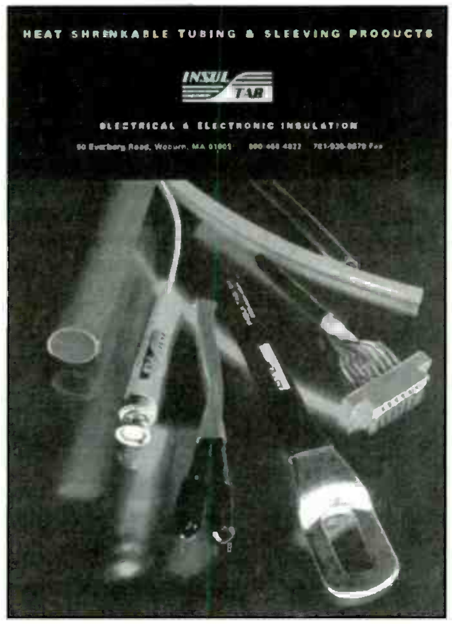
This replacement guide encompasses a wide variety of high quality devices that meet Entertainment and Industry/Commercial MRO replacement needs.

The company's Instant Cross program is also available in both DOS format and Microsoft Windows 3.1 and 95.

**Circle (86) on Reply Card**

## Wire harness products catalog

A new 28-page catalog that features a wide range of electrical and electronic insulations including heat shrinkable tubings and sleeving products is being offered by Insultab. The Electrical and Electronic Insulation products catalog features a full




line of Polyolefin heat shrinkable tubing, PVC-and multiple wall heat shrinkable tubings, tubing engineering kits, Kynar, Neoprene, and Viton heat shrinkable tubings, medical and non-toxic heat shrinkable tubings, PVC sleeving, spiral wrap, and value added products and services.

Highlighting the key features and typical uses of each product, to assist in selecting the best product for an application, the catalog includes technical specifications, complete with physical and chemical properties, and approvals. Value-added services described include cutting, printing, marking, custom colors, small quantities, and special packaging.

**Circle (87) on Reply Card**

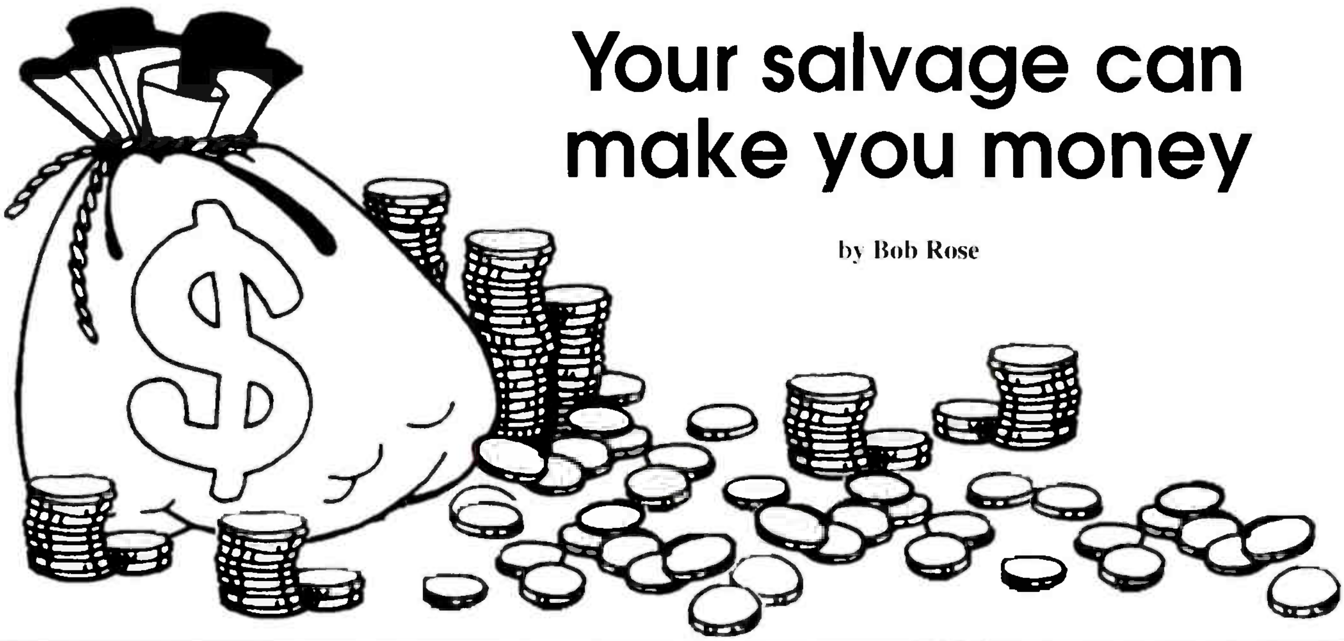
## Current measurements catalog

AEMC Instruments has released its Current Measurements Catalog. This full-line catalog includes comprehensive information on the company's line of clamp-on current probes covering the entire spectrum of applications, from electrical panels to substations.

Their current probes measure ac or dc current without interrupting the circuit under test and extend the measuring capabilities of DMMs, recorders, power meters and loggers. The numerous jaw sizes are designed to accommodate a wide variety of conductor diameters and ranges.

Also included in the catalog is application information and a selection guide.

**Circle (88) on Reply Card**



# Your salvage can make you money

by Bob Rose

A customer brings you a VCR for service. He says, "I don't want to spend more than $50.00 on it because I can buy a new one for $100.00." Or you put a 19" TV on your bench and see a note on the tag, "Not over $80.00." You know you could fix both if you could just get the parts you need at a reasonable price, but you will probably lose both jobs. This scenario is a logical product of the cost of parts versus bargain basement prices for new products.

I don't know about you, but I see more and more of this as the years go by. It has an inevitable, profound effect on the repair business. For example, five years ago my service center was one of seven in the county where I live. Now there are three, and one of them is open part-time.

I keep in touch with the vocational schools in West Tennessee. Most of their electronics students are going into industrial electronics. A good portion of the rest are looking at computer-related vocations. I don't know of a single student interested in consumer electronics; the reason being, "It doesn't pay enough."

Money may not be the motivating factor for choosing our profession or staying in it, but we can't survive without it. Naturally we in business are always looking for ways to cut expenses, increase profit, attract new customers, and do whatever we reasonably can to ensure our survival and peace of mind. In our quest to achieve those goals, we take advantage of business seminars, service schools, and other information, whatever their source, if those tips help us.

Rose is an independent consumer electronics business owner and technician.

### "Controlling" parts costs

We cannot avoid certain expenses like mortgage, utilities, transportation, equipment, literature, and continuing education. These are all a part of "the cost of doing business." So is the cost of parts. Beyond a certain point, we cannot control "the cost of doing business." But there is a way to control the cost of parts, and that is the subject of this article. Let me illustrate my point.

I received a Sharp VCR for service. The customer complained he could not watch TV through the VCR. On investigation, I discovered that the VCR had a defective tuner. Since this was an inexpensive VCR and could be replaced for about $135.00, I knew the customer would not spend more than $75.00 for the repair. A new tuner cost in excess of $70.00 which was not acceptable. I could have removed the damaged one and sent it to a repair depot. The cost to ship and repair would have been about $50.00. If I had chosen this route, my profit on the job would have been negligible.

What did I do? I went to my parts bin, retrieved a good, used tuner, and, after consulting with the customer to determine if a used unit would be acceptable to him, I installed it. I billed the customer $75.00 for a used part and gave him a good warranty on the repair. He was delighted, and I was happy.

Just last week, we picked up a 25" Zenith console for repair. The owner said since his wife liked the cabinet, he would like to get it fixed. However, he didn't want, as he said, "to spend a fortune." The TV had a defective picture tube.

> ***"You have to have a system if you are going to salvage parts. Otherwise, your salvage will either bury you or you will have so much you can't find what you want."***

Most of my customers will not pay to have a new picture tube installed since they can buy a new set for about a hundred dollars more than the cost of such a repair. I went into our storage room, retrieved a good, used CRT, installed it, and collected $150.00 for the job. My customer was pleased; so was I. The point? Your salvage can make you money.

### What is "salvage?"

What am I calling salvage? Some might call it "junk." It is those units that we sometimes throw away because we think they are useless, like the television whose circuit boards have been fried by light-

***"[Salvaging parts] won't make the difference between going out of business or staying in business, but it will help you increase your profits and add to the fun of being in business."***

ning, or the VCR that has so much damage it is not economical to fix, or the camcorder that has been dropped, or the stereo receiver that is defunct.

What about the television that lightning fried? Is the picture tube good? What about the customer controls? Is the flyback good, or the horizontal output transistor, or the video output CBA? The tuner may have been damaged, but did you know some repair depots will pay $5.00 to $10.00 for it just as a dud? And the defunct VCR: Are the video heads good? What about the capstan, the tuner, the rf modulator, and the various mechanical components that make up the deck? The same goes for the camcorder, the stereo receiver, the odd remote control you inherit, or the microwave oven that needs a new magnetron.

**Be systematic**

You have to have a system if you are going to salvage parts. Otherwise, your salvage will either bury you or you will have so much you can't find what you want. I usually junk out VCR's by removing known-good parts like video heads, rf modulators, and tuners and store them in those rectangular boxes common to our profession. I have dozens of such boxes, and each box is labeled by brand. If the VCR is relatively new, I will save the front panel and put the deck (minus the heads) on one of several shelves reserved for used decks. I may also save the main PCB if it is undamaged and contains some components that might come in handy. The boards also have their place in my storage room.

What about salvaged television parts? There was a time when if I wanted to save a picture tube I saved the cabinet, but I ran out of space. It is easier and takes far less space to pull the tube and put it on a shelf reserved just for CRT's.

I have in my "junk room" several shelves where I keep chassis. There is, for example, a section just for NAP products. If I need a NAP chassis, I go to the NAP shelf. It brings order to the junk room and saves time when we look for a part.

I remove small parts like transistors and large wattage resistors and tuners, but I leave large parts like flybacks on the board. It takes less storage and, parts are easy to find. Some parts are generic, like a D1555 HOT. That transistor goes into an envelope, and the envelope is filed in a box by its ECG number. I learned a long time ago that using ECG numbers facilitates easy storage and quick retrieval. Parts unique to the brand go into a box appropriately labeled.

**Selling tuners to remanufacturers**

What about damaged tuners? If I can't fix them or use them, I toss them into a box labeled, "Salvage Tuners." Like you, I get PTS's "want list" twice a year and I respond by selling the defunct tuners. Surplus modules, circuit boards, and tuners often net my business as much as $500.00 a year! I don't often sell defunct Zenith modules because just an IFT from a module will net more than the dud fee for the entire board.

**Salvaging other products**

I haven't said anything about the other products I service; audio equipment and household microwave ovens. The same principles apply for these. So I try to salvage controls, control panels, transformers, magnetrons, glass trays, microwave oven doors (a good item to keep), tape decks, optics, etc. Is it worth the effort? How about that amp you fixed by installing a good, used power transformer for less than half the cost of a new one, or the microwave oven into which you put a used magnetron? Remember, it is good policy to tell your customer you have installed a used part and that the part is fully guaranteed.

**Sources of salvage units**

Well, you should have gotten the idea by now. Let me, then, deal with a final question: Where do I obtain salvage units? There are several sources.

First, do you charge to perform a preliminary diagnosis, or an "estimate"? If a customer decides not to go ahead with a repair, I usually give the customer a choice by saying something like, "Since you don't want your product repaired, if you prefer, we will keep it in lieu of the estimate fee." A non-working product is rarely of value to the consumer. It is a potential "gold mine" for us servicers.

Second, there are those units brought in for repair that are not repaired and never called for. You have to follow the dictates of the legal system in your area, but there are ways to claim those unclaimed units. You can clear out precious storage space as well as add to your salvage.

Third, there might be a retailer in your area who offers "trade ins" for people who purchase electronics from them. That retailer might be willing to let you haul off his/her "trade-ins" just to get them out of the way. At the most, you might be able to buy them for as little as $10.00 a unit.

Fourth, you might have a repair facility/shop in your area not interested in their unrepairable units and will give them to you just to get rid of "junk". There are still lots of businesses out there more interested in selling new products than repairing the broken ones. It never hurts to ask!

Fifth, I am often able to buy complete circuit boards for salvage. For example, a retailer in Nashville (JAVANCO) often buys damaged products by the truck load. He will pull the salvageable items and sell them for parts. What do I mean? How about buying a perfectly good NAP chassis for as little as $25.00? The tuner alone is worth at least twice that. I noticed Fox International is doing the same thing. They advertised in a recent mailer a long list of NAP chassis. If you look, you will be surprised at what you find.

Sixth, a friend or acquaintance may call up and say, "I have a microwave oven (TV, VCR, radio), and I thought you might like it for parts. Will you pick it up?" It might be worth your trip.

**It could help your business**

I hope this gives you an idea about what I mean when I say, "Your salvage can make you money." I have described my system. Use it if you like it, or find one you do like. I think you will be surprised by the results. It won't make the difference between going out of business or staying in business, but it will help you increase profits and add to the fun of being in business. Who knows, you might even garner a reputation as a servicer who can get a product going at a reasonable price. Who can resist such a "commercial." ■

# What Do You Know About Electronics?

**by J. A. Sam Wilson**

*The opinions expressed in this article are Sam's and do not necessarily reflect the opinion of the editor or publisher of this magazine.*

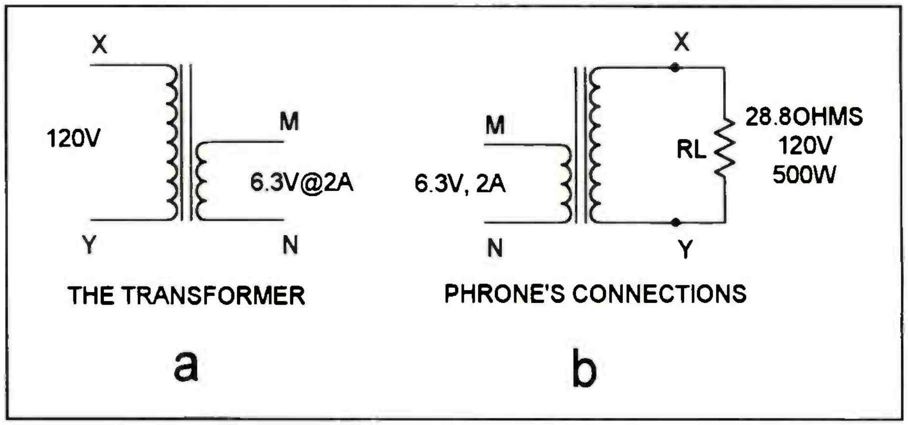



**Figure 1.** This filament transformer (a) is normally connected so that a 120V input results in a 6.3V output. When connected backwards as shown in (b) the transformer has an output of 120V when 6.3V is applied at the input.

We first met Phrone Smedge when he was a student. He got a grade of 100% on an Ohm's Law test. As a result, it was predicted that he would have a great career in electronics. Unfortunately, that grade was the highest point in his educational career. His grades went into a dive and he was barely able to get a diploma.

Phrone got a job in a small engineering company. His responsibility is to test components used in the company's designs. He has been given the job of testing a 500W resistor that operates with 120V applied. His test bench has only low-voltage dc and 6.3Vac outputs. His test station is located in a corner of a room with the ten other employees.

To get the 120V output needed for the test, Smedge decides to use a filament transformer (Figure 1a). Applying 6.3V across terminals M and N, he measures 120V across terminals X and Y. So, he connected the 500W resistor across terminals X and Y (Figure 1b), energizes the 6.3V test voltage, and wandered off to get a drink from the water cooler.

As we look in on Smedge we see that all employees are soaking wet. Papers on desks are a soggy mess. There are puddles of water on computers, printers and on the floor. A woman's purse is standing open and full of water. Apparently, Phrone's test setup triggered the smoke alarm which automatically set off the sprinkler system. We decide to come back some other time to look in on Phrone.

Here's a good place for you to do the very basic calculation Phrone should have done before making measurements.

Wilson is the electronics theory consultant for ES&T.

Answer: When the filament transformer is delivering 6.3V at 2A its primary current is calculated as follows:

$V_P/V_S = I_S/I_P$,
from which,
$I_P = V_S I_S/V_P = 6.3V \times 2A/120V$
$= 0.105A$

Even if you doubled that current as a safety factor the primary winding should not be required to carry more than 0.2A.

The resistance of the power resistor was 28.8Ω. When Smedge connected the 28.8Ω across the 120V winding, the current demand was:

$I = V/R = 120V/28.8\Omega = 4.17A$

The transformer primary winding ($L_1$) was over twenty times the allowable current (0.2A) and the transformer smoked.

**Canned experiments vs innovative experiments**

When I was teaching there was one kind of lab experiment I disliked - the experiment I called "canned". You know the type. The student is given a pictorial diagram of something to be built. The instructions go something like this: Connect the blue wire between terminal #3 to the center terminal on the volume control. The student gets a little bit of soldering practice and that's about all.

If you ask the student what that wire is there for you get a blank stare, or, "that's where the instructions say to put it."

Innovative experiments, on the other hand, require the student to make the decisions. I had a chance to use that type of experiment when I taught at Kent State University. I was allowed to purchase ten new color television receivers (different brands) for the second quarter lab. There was much concern about that at first. It was necessary to give a block diagram overview of color TV - especially the signals. Students were already given training in passive and active circuits.

Students were paired and given different assignments. As an example - "show me the VITS signal on your scope". At first the students got off to a slow start, but, by the end of the quarter they were very capable of using every piece of test equipment in the lab.

Here are a few more examples of the experiments they were able to do:

• Put a monochrome television picture from a local TV station on the screen of your oscilloscope.

• Show the signals that produce interlaced scanning.

• Explain what will happen if a certain given capacitor is open and then prove your explanation.

• Show me the burst signal (only) on your oscilloscope.

Of course, the students had to read and ask questions to perform these experiments, but the job eventually got done.

Do you have apprentices or stock persons who could learn from this kind of experiment? If things get slow in your service center you could give them a valuable learning experience.

Quickly! Name two things you should own but you don't want to use. (Answer at the end of this article.)

**Digital radio - some theory and some possibilities**

Canada has assumed leadership in the mandated digital radio arena. The conversion to digital radio has been partially due to public officials.

Assuming the USA will pattern its digital radio after the Canadian system, I will give you insight into what you might look forward to with this technology.

• Present radios that tune to the AM-FM bands will become obsolete. Digital broadcast radio will be on the L-Band (1452MHz to 1492MHz). Surely the craft magazines will give instructions on how to convert your present AM-FM radio into a flower planter which may give more pleasure than listening to what is often played on the radio these days.

• Digital radio will give a much better quality of sound for music. Hearing impaired - such as people with a tin ear - can keep music in their life by learning to hum or whistle a few tunes. That will save the cost of a new (necessary) digital radio.

• There is an alpha-numeric readout that will allow you to select stations by their call letters. A new class of "radio readers" will, no doubt, go to the homes of the vision impaired and read the choices broadcast on the alpha numeric readout. (That will be for a fee of course.)

• Poverty-level people who cannot afford to buy a new digital radio to listen to have several choices:

• Get a better job.

• Get your news by sharing a newspaper with several neighbors. Remember, newspaper news has never been replaced by the radio. (You cannot wrap your garbage in a radio.)

• Remove your useless car radio and fashion a tunnel into the engine compartment so you can watch for fire.

Now, here's the good news. You can look forward to pay-for-listening radio programming. That's actually included as a "benefit" of digital radio.

So far, not one fat-cat politician has complained about the conversion to digital radio or digital TV. Well, after all, they voted these new systems into a mandated existence, and they certainly can afford the new receivers.

**More on old technology**

I still maintain that much good technology has gone by the wayside because we are inundated with the new stuff. So, I've been including discussions of some of the old stuff in WDYKAE?

This month I'm reviewing (briefly) the gear wheel method of frequency measurement. It is from a great publication called the *Cornell-Dubilier CD Capacitor*. This particular idea comes from Volume 19 - the June, 1954 issue.

# Test Your Electronics Knowledge

Answers to test *(from page 26)*

1. Non-polarized electrolytic capacitor
2. 16:9
3. No - You cannot define it because baud is already a rate. It is the reciprocal of the shortest time used for sending a unit of data.
4. C
5. It prevents the return pulse from being dissipated in the radar system. NOTE: ATR = Anti-Transmit/Receive.
6. Constant-current diode
7. -11V
8. B - You might see one used as an inductor to prevent parasitic oscillation in an amplifier. It looks like a tiny black donut or bead.
9. B
10. 50 microamperes - (1/20,000A)

In the June, 1998 issue of **ES&T** we left out some important information. The article "Test probes update," as well as all of the photos of test probes, was based on information provided by ITT Pomona.



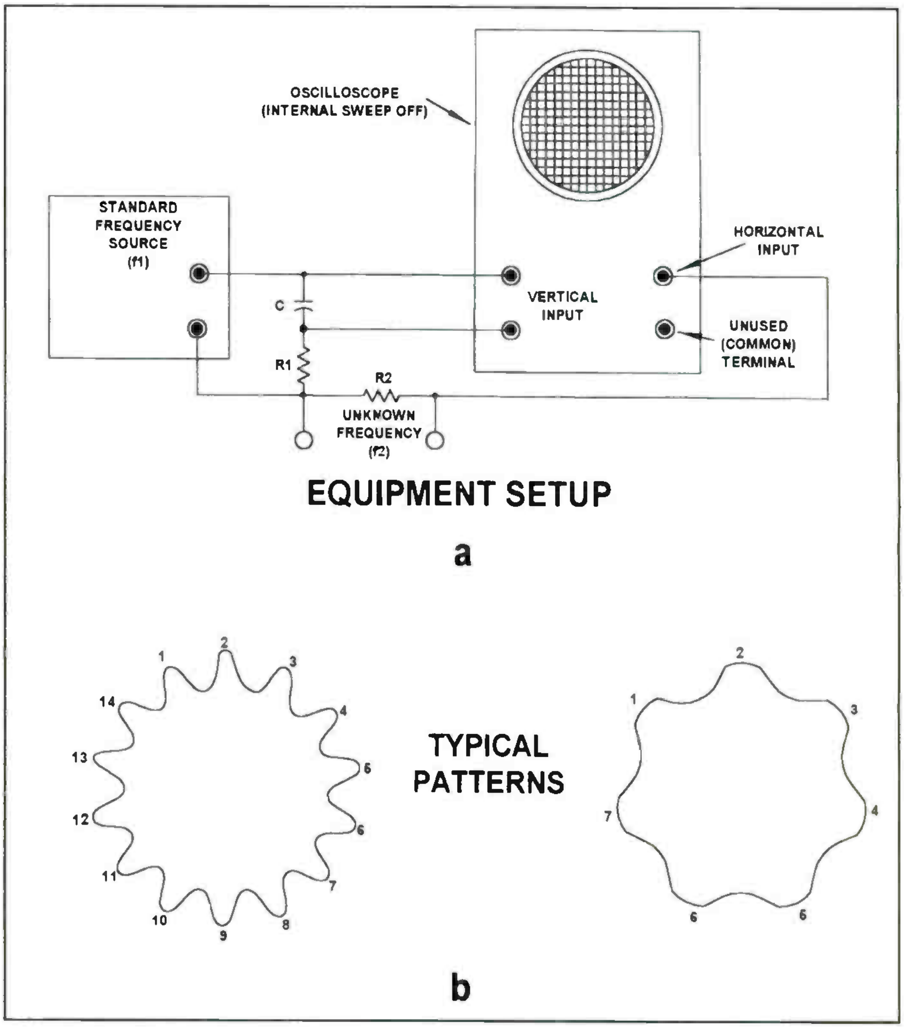



**Figure 2.** One way to measure frequency is to construct a circuit such as the one shown in (a). The resulting "gear wheel," or "roulette," patterns on the scope face (b) will provide the information needed to determine the unknown frequency.

I have seen this idea in a different publication and they called it roulette patterns. Figure 2(a) shows the test setup and Figure 2(b) shows two typical test patterns.

The circuit composed of $R_1$ and C provides the necessary $90^o$ phase shift to get the lissajous circle. The standard sinewave frequency is multiplied by the number of "gear teeth" to get the value of the unknown frequency.

If the unknown frequency is an exact multiple of the standard frequency the pattern will not rotate. It *will* rotate if the frequencies are *not* exact multiples.

Capacitor C can be any value between 0.1μF and 0.25μF. Resistor $R_1$ can be made variable so a good circle can be obtained. If you can't get a circle on the oscilloscope, one of the waveforms is probably distorted from a pure sinewave.

The article claims this measurement method is easier than the standard lissajous method; especially when the ratio of the two signals is equal to or greater than ten to one.

**No wonder grownups can't spell**

Are you keeping up with all of those abbreviations for DTV and HDTV and everything else? Here are a few additions to your list:

*SDTV* - Standard Definition TV

*QAM* - Quadrature Amplitude Modulation

*DVD* - Digital Video Disk

(Maybe we should keep a card file index of these terms!)

Answer to the question posed at the beginning of the article: An insurance policy and a fire extinguisher. By the way - do you have one? ■

### In-circuit capacitor and inductor analyzer

Sencore introduces their new LC103 "ReZolver" in-circuit capacitor and inductor analyzer. According to the manufacturer, the product allows the user to reliably pinpoint bad capacitor and inductors in-circuit, or completely analyze them out-of-circuit with exclusive, dynamic, automatic tests.

The tester also provides the industry standard tests made popular by other Z-meters offered by the company. These include complete capacitor tests that catch all four failure modes, and complete coil tests for value and shorted turns. The unit is Sencore's exclusive Z-Meter line that among provides complete dynamic tests that closely simulates normal circuit operating characteristics, as do the other meters in the product line. The product interprets the test results by comparing the results to EIA standard and displaying "GOOD" or "BAD".

The company claims that the analyzer will save time when testing components-especially, surface mount components. In addition, the tester allows the user to test SCRs and triacs as well as flybacks and other transformers with the patented "Ringer" function.

Circle (90) on Reply Card

### Visual fault finder for fiber optic cable

Wavetek introduces the VFF5 visual fault finder, a laser diode light source designed to find breaks, faulty splices and crimps, macro bends and poor components and connections in fiber cable runs. It can be used to verify continuity, test and find breaks in LANs, telephony, data links and loops and other applications where fiber is used instead of copper.

Packaged in a rugged metal housing, the tester is a slim, pen style, battery-operated tool that focuses a highly visible red light into the fiber. The operator detects breaks in the cable by seeing where the red light is exposed. The tester is equipped with a high power, extra long

life 670nm laser diode that operates either in continuous or modulated/blinking mode, and is user-selectable via a slide switch. Breaks and bends are seen as a bright glowing, or a flashing red lit area.

The unit is functional with either single mode or multi mode fiber cable over a distance of up to three miles (5 km). It is intended for use as a stand-alone, first line basic troubleshooting tool, or with an OTDR, to isolate faults.

Circle (91) on Reply Card

# BOOKS

***The Complete RF Technician's Handbook: Second Edition*, by Cottef W. Sayre, PROMPT Publications, 400 pages, paperback $29.95**

This is the handbook for the RF or wireless communications beginner, student, experienced technician, or ham radio operator. Although meant for people with a prior foundation in electronics, this book furnishes the reader with valuable information on the fundamental and advanced concepts important to the study and application of RF wireless communications.

In this second edition of *The Complete RF Technician's Handbook*, all chapters have been expanded, enhanced, and/or updated, including the addition of 45 new explanatory drawings along with an enlarged and comprehensive glossary. This book covers only the circuits that you will find in the majority of modern RF devices. Additionally, current test equipment and their applications are covered in order to help you become familiar with their basic functions. Troubleshooting of RF, digital, and audio circuits down to the component level is heavily stressed, as that is what most competent technicians will be required to do. Since digital circuits and modulation techniques have become such an important part of many electronic devices, digital methods and their real-world circuits are discussed as they apply to wireless communications.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

**Complete Guide to Audio, by John J Adams, PROMPT Publications, 163 pages, paperback $24.95**

*Complete Guide to Audio* was written for the consumer who wants to know more about sound and sound systems. With comprehensive, simple explanations, the *Complete Guide to Audio* sheds light on audio systems and answers questions you may have asked in the past but were unable to get answers for.

Stereo equipment is needed to bring us symphonies of the ages or bang-your-head rock music. It may be used to set the evening scene with mood music or to record your child's first words. It brings vocal and instrumental masterpieces into our homes and permanently etches life memories into electronic form. Aside from offering detailed explanations to common audio questions, the *Complete Guide to Audio* explains some common problems that you may run into while setting up your stereo system and home entertainment center. The information provided will help you make successful purchasing decisions and demystify the jungle of wires and connections that come with your audio system. Other topics include an introduction to audio equipment basics, home theater sound, amplifiers and preamplifiers, receivers and surround-sound decoders, computer sound, cassette decks, CD players, DVD, mini-discs, phonographs, brands and choices, hookups and accessories, and more.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

**Electronic Troubleshooting & Servicing Techniques, by J. A. Sam Wilson and Joseph A. Risse, PROMPT Publications, 316 pages, paperback $24.95**

Learn the procedures you need to know in order to service and repair electronic devices. *Electronic Troubleshooting and Servicing Techniques* is a compendium of troubleshooting tests, measurement procedure and servicing techniques designed to help the reader through typical repair procedures of household electronics.

This book covers the description and use of both analog and digital electronic instruments. Since the earliest days of electronics, an increasing dedication has been required to keep pace with the advancement of technology. *Electronic Troubleshooting and Servicing Techniques* will help you service that new technology from the simplest to the most complicated. With detailed schematics and thorough explanations, this book brings you informative chapters like troubleshooting basic analog circuits, servicing with an oscilloscope, learning signal injection and signal tracing, servicing closed-loop circuits, hunting for the causes of noise and intermittence, and more.

J.A. Sam Wilson has written numerous books covering all aspects of the electronics field. He has served as director of technical publications for NESDA and as CET test consultant for ISCET. Currently, Wilson is a full-time free-lance writer and consultant. Joesph Risse worked for several years as a chief engineer at radio/TV commercial broadcast stations. His career is now devoted to developing and writing courses, lessons, and laboratory experiments for International Correspondence Schools and other independent study schools.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

**Build Your Own Test Equipment, by Carl Bergquist, PROMPT Publications, 288 pages, paperback $24.95**

Build the twelve test bench projects detailed in this book, and you will have one of the most complete electronics prototyping and experimental labs around. From the ultimate prototype lab to an eight-digit frequency counter, these devices are designed to be highly practical, space conscious, and cost-efficient.

Test equipment is among the most important tool that can be used by electronics hobbyists and professionals. Not only does test equipment help you while constructing or troubleshooting electronics, building your own test equipment can carry you a long way toward understanding electronics in general. The twelve devices described in this book are designed to be practical in every way. The components required to build the pieces of test equipment are commonly available and reasonably priced. To battle those little anomalies that crop up in every project, the book includes as many construction tips as possible.

The twelve projects featured in *Build Your Own Test Equipment* are the prototype lab, a multi-output test bench power supply, a benchtop signal generator and tracer, a tristate logic probe, a bipolar transistor tester, an all-purpose tester, a portable digital capacitance meter, a universal four-digit counter, the workbench digital multimeter, the digital function generator, an eight-digit frequency counter, and a solid-state oscilloscope.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

during the fourth quarter of 1998. Addressing reception issues raised by the broadcast industry, manufacturers stated that regulation was unnecessary as market forces ensured adequate reception. On the issue of cable compatibility, manufacturers and a cable industry representative reaffirmed a commitment to work together to ensure finalization of a standard.

CEMA Vice President and Senior Economist Todd Thibodeaux reviewed preliminary results of the latest consumer research. A telephone survey of 1,000 U.S. households showed an increased awareness among consumers of DTV - from 27 percent last April to 58 percent today - and a continued need for education. The research also outlined likely purchasers of first-generation DTV - such as Generation X consumers - and content likely to drive initial DTV purchases - sports and movies. The research indicated the key role of retailers in DTV education and demonstrated that a majority (70 percent) of consumers are ready to visit retailers to see DTV demonstrations.

One panel focused on retail strategies to educate consumers on the importance of high-quality audio as part of the consumer DTV experience.

Other discussions at the conference highlighted partnership opportunities for local retailers, broadcasters and manufacturers to promote DTV and sales of current digital technologies. "DTV will bring consumers into retail stores and create opportunities to sell other consumer electronics and digital technologies," Shapiro said. "We should continue to work together to ensure a strong and successful launch that will carry us through the gradual and full transition to HDTV."

Former Federal Communications Commission (FCC) Chairman Dick Wiley was on hand to provide a regulatory perspective and an update on three critical issues affecting the rollout: FCC involvement in local siting issues, cable must-carry and public interest requirements for broadcasters.

The program opened with a reception at HDVision, a high-definition production facility based in Dallas. The reception included product demonstrations by Zenith Electronics Corp., Panasonic Co. and Sharp Electronics Corp., and a live, over-the-air HDTV broadcast from WFAA-TV, the local ABC affiliate.

All attendees responding to a survey said they found the summit worthwhile and would attend a similar event in 1999.

## CEMA plans September launch of certified electronics associates exam

To certify technicians on their competency in manufacturing and servicing electronics products, the Consumer Electronics Manufacturers Association (CEMA) plans to launch its national electronics technician certification program in September. Those who pass the exam will possess the knowledge and abilities to succeed in the highly competitive international electronics marketplace, including the consumer, component, industrial, government, medical and telecommunications electronic industries. Successful completion of the exam will qualify the candidate as a Certified Electronics Associate (CEA). Appropriate credentials indicating this status will be provided by CEMA.

The certification test questions were developed by Chauncey Group International, a subsidiary of Educational Testing Service (ETS), best known for the SAT, GRE and other entrance exams. The CEA exam received further validation from Computer Adaptive Technologies Inc. (CAT), a high-technology firm that specializes in test development and validation. The Sylvan Learning Center, with facilities nationwide, will administer the exams. A study guide, published by Simon & Schuster subsidiary Prentice-Hall Inc. in conjunction with Interactive Image Technologies Ltd., with an interactive CD-ROM for the CEA exam, should be available by September.

The program is part of the National Skills Standards & Curriculum that was begun in 1992 to develop voluntary national skill standards for entry-level electronics technicians. Hundreds of individuals from companies representing all segments of the electronics industry, and from allied associations like the Vocational Industrial Clubs of America (VICA) and the International Society of Certified Electronic Technicians (ISCET), participated in developing the 300 skills standards. Plus, experts from international companies measured the standards against international benchmarks to assure that U.S. workers can meet standards set anywhere in the world. Praised by the U.S. Department of Education as a model effort, the standards now are widely accepted as the industry's definitive statement of its requirements for entry-level technicians.

"By 2005, the U.S. electronics industry will represent a nearly $825 billion slice of the economy and will require an estimated 2.5 million electronics technicians with world-class skills," said Don Hatton, CEMA's vice president of product services. "Manufacturers need skilled labor to assure that electronics equipment is manufactured and maintained in accordance with quality standards and at product levels that meet market demands. The National Electronics Skills Standards and Curriculum, the CEA exam and other CEMA education programs help manufacturers hire employees with the necessary technical background for the electronic industries."

The CEA exam and skills standards are part of CEMA's growing programs to create more electronics training at the secondary and post-secondary levels. CEMA sponsors eight programs to keep technicians up to date on the newest developments in electronics technology. CEMA added two new managers to foster the reach of these programs. Bobby Rudder, formerly a national service manager for JVC Company of America, NEC America Inc. and Aiwa America Inc., recently came aboard as the manager of curriculum and certification. After a 10-year consulting relationship with CEMA, Brian Ott, winner of the 1988 Bronze International Youth Skills Competition Award, joined the department as the manager of training. The association staff works with CEMA's Product Services Committee, a panel of more than 60 service executives who are dedicated to developing and training technicians who service and repair consumer electronics equipment.

For more information on CEA testing and study guides, contact CEMA's Product Services Department at (703) 907-7670, or fax: (703) 907-7968. ■

# ES&T Calendar

CEMA Product Returns Conference
(CEMA)
September 15,1998
Marriott O'Hare
Chicago, IL
CEMA (VA): 703-907-7600
www.cemacity.org

PCS '98 (Pers. Communications
IndustryAssn.)
September 23-25, 1998
Orange County Conv. Center
Orlando, FL
PSIA (VA): 703-739-0300

105th AES Convention
(Audio Engineering Society)
September 26-29, 1998
Moscone Convention Center
San Francisco, CA
Chris Plunkett (CA)
212-682-0477
Cwp@aes.org;_www.aes.org

43rd National Association of
Service Managers
(NASM) Educational Congress
October 1-3, 1998
San Diego Princess
San Diego, CA
Caryn Worcester (CA)
619-562-7004;
Fax 619-562-7153
NASM@NASM.COM

EIA/CEMA Spring Conference
(Electronic Industries Ass'n/ Cons.
Electronics Mfrs. Ass'n.)
October 11-15, 1998
The Phoenician
Phoenix, AZ
CEMA (VA): 703-907-7600
www.cemacity.org

ASEA (AZ) State Convention
Oct. 14-18, 1998
Francisco Grande Resort
Casa Grande, AZ
Bob Lunn (AZ)
Work: 602-937-3241;
Home:602-937-3241;
Lunncet@aol.com

Personal Computer & Electronics
Expo (Expositions Inc.)
October 15-18, 1998
Nassau Veterans Memorial Coliseum
Uniondale. L.I., NY
Expo Inc. (NY)
800-886-8000;
516-889-6000

WIRED Technology Expo (WIRED
Magazine)
November 7-8, 1998
Tarrant County Conv. Center
Fort Worth, TX
Julie Garinger/Bruce Rabin (TX):
817-263-4041

COMDEX/Fall '98
November 16-20, 1998
Las Vegas Conv. Center and Hotels
Las Vegas, NV
http://www.Comdex.com

Int'l. Cons. Electronics Show (CEMA)
January 7-10, 1999
Las Vegas Convention Center and
Hotels
Las Vegas, NV
CEMA (VA): 703-907-7600
www.cemacity.org

Western States Conference
(Regional Associations Conference)
Feb. 18-20, 1999
Queen Mary
Long Beach, CA
Bob Lunn (AZ)
Phone/Fax: 602-943-0596
Lunncet@aol.com

Tri-States Annual State
Convention '99
March 11-14, 1999
Hood River Inn
Hood River, OR
Mike McCray (OR)
503-288-5356

# CLASSIFIED

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**Per column Inch** (classified Display): $235 per column inch, per insertion, with frequency discounts available, 1" minimum, billed at 1/4" increments after that 10" maximum per ad. Blind ads are $40 addition. Reader Service Number $25 additional to cover processing and handling costs. (Free to 4-inch or larger ads.) For more information regarding classified display advertising please call 516-681-2922. Optional color (determined by magazine) $150 additional per insertion.

Send your order, materials and payments to:
**Electronic Servicing & Technology, 25 Newbridge Road, Hicksville, NY 11801**
**Attn: Classified Department Phone: 516-681-2922 FAX: 516-681-2926**

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Sony TA 1150 and Sony TA-F70 stereo amplifier schematic. Project One/DC series tuner amplifier Mark 460, distributed by Playback Inc., SIN 806832B. *Contact: Stacey Chambers, 31 Salem St., Newark, NJ 07106.*

MITS calculator as featured in th November 71 issue of *Popular Electronics*. Will settle for kit or assembly manual. Will pay finder's fee. *Contact: Donald Dupre, 401-737-7118 or 401-886-3910, e-mail: dgd@cherry-semi.com.*

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7
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