October 1989

IT INSTALLER TECHNICIAN

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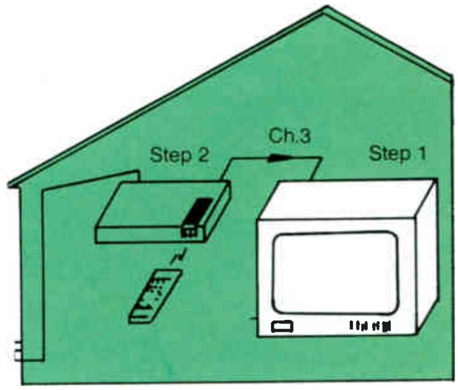

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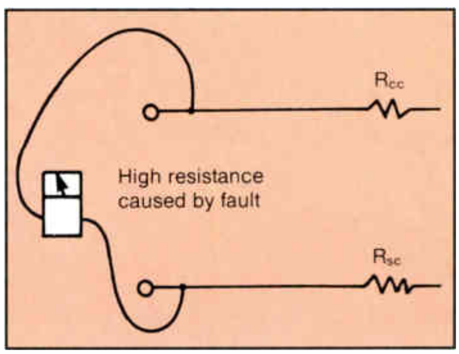

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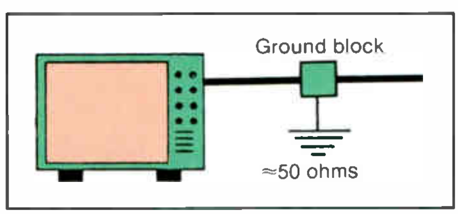

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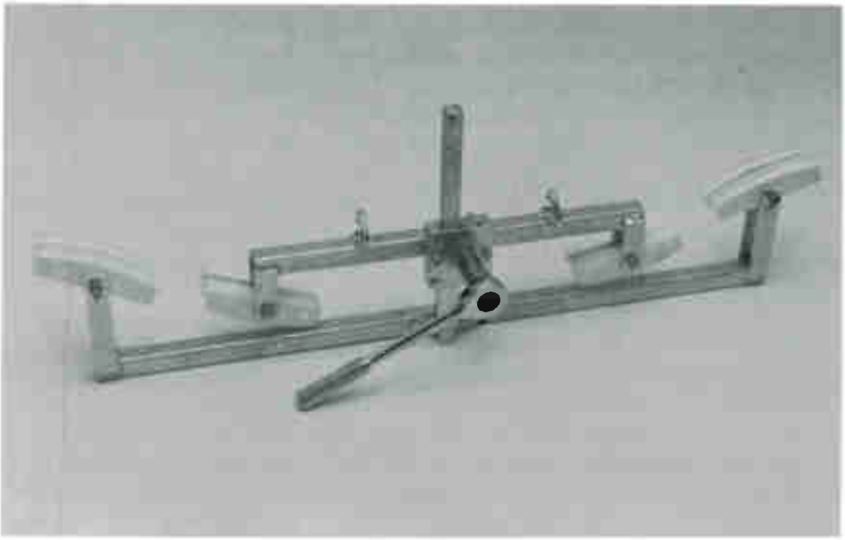

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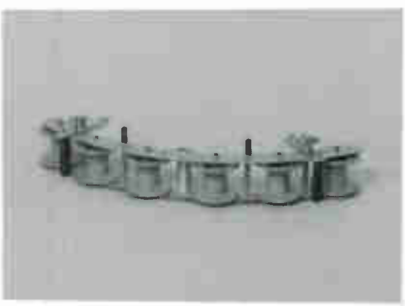

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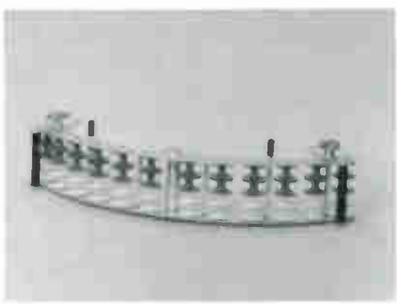

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Reader Service Number 3.

From the Editor

Quality over quantity

If I seem to be much taller today it's because I am once again on a soapbox. This time my attack is targeted toward greedy system operators that provide cable service by using inexperienced contractors and "cheap and quick" installations. All these system operators are interested in is making money without putting forth any effort.

So, the end result is that installer/technicians must make installations as quickly as possible. To these operators, it is quantity, not quality, that counts. (Looks like the Federal Communications Commission will have a ball yanking pay channels because these systems leak like a sieve.)

Hindsight's 20/20

You might wonder why I am directing these comments to you, the installer/techs. If an inexperienced contractor does a poor job, it's the grunts who will have to pick up the pieces. Also, customer service will have a great time with all the subscribers who have problems because the install was done incorrectly due to meeting management's quota of installs. (It reminds me of police officers giving speeding tickets to fill their quota.)

The irony in this scenario is that if installs were done correctly, the system wouldn't have to spend additional money on service calls and subscribers would be a lot happier.

I received a letter from Jeffrey Herr, owner of Cass Communications, a CATV contractor on the East Coast who referenced an article in July's "Installer Input" column. The article, "How an installer saved my cable system" by Gregg Nydegger of Cardinal Communications stated, "Installs, upgrades, downgrades and service calls—these are basics of cable life. Done well, they pay the bills. Done poorly, they eventually do in any cable system." Nydegger also stressed his concern about installs: "A final word on new installs: Give the installer time to do the job right. Over-booking only leads to frustrated workers and poorly done, sloppy installs. Quality work takes time."

The following letter points out a few problems not covered in Nydegger's article:

"After working in the utility industry more than 20 years and dealing with the likes of DOTs (departments of transportation), phone companies and power companies, I would like to express a point of view about the CATV industry that you overlooked.

"Your article was very informative and factual but it excluded two very important factors:

1) CATV operators do not want to pay to have quality installers, whether in-house or contractors.

2) System operators *demand* more hookups for the buck (11 to 12 installs per day, per installer). This is reality and survival.

"Having many friends in the industry, I talk to a lot of people who work for different systems, whether MSOs or mom and pop systems, and the verdict is the same!

"Fact one: The in-house installers aren't trained properly or payed enough for their responsibilities. Fact two: Qualified and trained contractors don't make any money because there isn't enough money for a profit margin. Don't bore me with the rhetoric, 'I know a contractor making $1,000 a week.' We are aware of all of the quasi-legal contracting scams in the CATV industry."

All indications from our sources in the field (confidential) reveal that Herr's statements are accurate. What surprises me is that most system operators know there will be fewer service calls (hence, less money spent) if they go by the book and don't take shortcuts. Figure that one out.

Toni I. Barnett

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News

Jones approves use of Catel's TransHub

FREMONT, Calif.—Jones Intercable recently gave full approval to the first use of Catel Telecommunications' TransHub III (TH III) in the 800-mile CAN (cable area network) fiber-optic rebuild of the Jones system in Broward County, Fla. During a source inspection here at the Catel facility Aug. 10, the TH III units were certified to conform with all Jones specifications. Earlier this year Jones had given final approval to the system and product design specifications.

The completed portion of the TH III equipment, which converts AM-on-fiber to VSB/AM for coaxial cable, represents about 20 percent of the total to be delivered under the contract with Jones. Catel's total contract for the Broward County system (estimated at over $1 million), calls for more than 30 TH III units plus 1,700 miles of fiber and over 50 transmit lasers.

Atlantic Show '89 announces sessions

ATLANTIC CITY, N.J.—With the theme "Cable cares," the eighth annual Atlantic Cable Show, cosponsored by the Maryland/Delaware/District of Columbia, New Jersey, New York and Pennsylvania cable TV associations, is scheduled for Oct. 3-5 in the East Hall of the city's convention center. As usual, the show will feature technical sessions coordinated by the Society of Cable Television Engineers. The technical sessions will cover high definition television, signal leakage and CLI measurements, video and audio signals and systems, and fiber-optic technology.

Oceanic fiber trial yields high numbers

OAHU, Hawaii—Recent field trials of a Jerrold Cableoptics 5.4-mile AM fiber link installed here from a headend in Panaluu to a node site in Kaaawa reported excellent numbers. According to officials at the American Television and Communications Corp.'s Oceanic Cablevision, the link exceeded committed specifications for a 6 dB loss budget, including 52 dB carrier-to-noise (C/N), 65 dB composite triple beat and 60 dB composite second-order distortion carrying 55 channels over two fibers.

Oceanic's Engineering Vice President Mike Goodish said that "in comparison to the single-laser AM fiber systems Oceanic has evaluated and installed, the Jerrold system has delivered the best C/N and distortion measurements." He indicated that Oceanic would probably continue to use the link after the trials.

Chicago cops given communications net

CHICAGO—In a recent press conference, Mayor Richard Daley and Police Superintendent LeRoy Martin unveiled a new Police Communications Network that will use the cable system to enhance the police department's communications. The new network, installed by Chicago Cable TV (TCI) and Group W Cable, connects the Police Academy and district headquarters using the same cable lines that hook up over 250,000 subscribers. Special signal scrambling equipment allows the police to televise messages in code, thereby preventing the sub from seeing or hearing what is being transmitted.

According to Martin, Chicago is the only city to develop this type of CATV-based police network. It is planned to be used several times each day, usually at roll call, to disseminate the latest information to officers in each district. Police training films, meetings, emergency announcements and routine administrative matters also can be telecast.

First installer members welcomed

Thirty-four people have joined the Society of Cable Television Engineers (SCTE) at the installer level since the introduction of the Installer Certification Program. These people are the first to join the Society at this newly inaugurated level of membership.

The Society's new Installer Certification Program was officially launched at Cable-Tec Expo '89, held June 15-18 in Orlando, Fla. The program, which tests and certifies the skills of cable system installers through written and practical examinations, was introduced in a workshop presented June 16 and 17 by Installer Certification Committee Program Chairman Richard Covell and Director of Chapter Development and Training Ralph Haimowitz. Examinations in the program were administered for the first time on the final day of the expo, June 18.

Seventeen people participated in testing at Expo '89. Since the introduction of the program, an additional 17 people have taken exams in the program. A list of these 34 test takers, who joined the Society at the installer level, follows.

The Installer Certification Program will be administered, from training to testing, through the Society's local chapters and meeting groups under the auspices of the national organization. Modeled after the Society's highly successful Broadband Communications Technician/Engineer (BCT/E) Certification Program, the Installer Program was developed to establish a standardized level of both technical and practical expertise for drop installations and certify that an individual has acquired this expertise and can accomplish a satisfactory installation, whether it be aerial or underground, or at a single home or multiple dwelling unit.

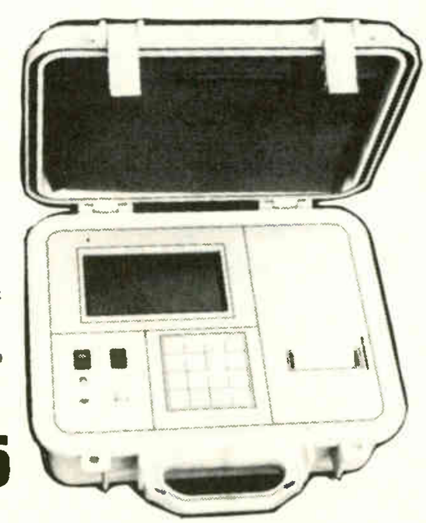
The cable television industry needs to maintain a highly qualified base of CATV installers. Installers desire a career path in their field, a way to be recognized for their knowledge and ability, and a way to increase their worth and their income.

Participants in Installer Program testing at Expo '89

Edgar Ardon
Joe Ballard
Jim Bowen
Charles Brand
Michael DeBello
Richard Flanders
George Gardner
Victor Gates
Michael Guitter
Douglas Hair
Bill Kohrt
Pete Luscombe
Mike Mason
Randy Melius
Ronald Perocchi
Theodore Taylor Jr.
Terrance Weinman

Participants in subsequent installer testing:

Jeff Bowman
Tom Candelaria
Matt Crider
Jonnell Cyr
Karl Johnson
David Rhoadez
Heinz Schreier
Hal Truman
Kim Truman
Terry Turnmire



Kevin Logan
Joe Macarillo
Jeff Rankin
Ron Rhoades
Michael Walters
Reilly Walsh
Dennis Whitehead

"Technology for Technicians II" scheduled

The Society of Cable Television Engineers is proud to present the latest in a series of technical training seminars titled "Technology for Technicians II." This is an advanced three-day hands-on technical training program for the broadband industry's maintenance technicians, chief technicians and system engineers. It will be introduced Nov. 13-15 at the Harvey Hotel in Dallas. The original "Technology for Technicians" training program, designed for installer/technicians, service technicians and their field supervisors, premiered in September 1988.

Like the original program, the all-new "Technology for Technicians II" will be conducted by SCTE Director of Chapter Development and Training Ralph Haimowitz.

The first portion of the seminar will deal with mathematics and measurement, and include information on ratios, cable-applicable mathematics, decibels, the decibel-millivolt and logarithms. The period on amplifier systems will cover unity gain concepts, equipment specifications, attenuation and equalization, and automatic system controls.

The section on powering will cover equipment power supplies, system powering, calculating voltage drops and determining power requirements. The next area of concentration, coaxial cable, will include material on the types and uses, connectors, cable properties, loss calculation and cable faults associated with this type of cable.

When covering system operation and maintenance concepts, the seminar will focus on calculating system noise, calculating system intermod, system tests and measurements, and deregulating amplifiers. The section on cumulative leakage index tests and measurements covers 1990 FCC requirements, signal leakage, and CLI measurements and calculations. The hands-on laboratory sessions will feature demonstrations of spectrum analysis, signal leakage tests and measurements, and system signal level meters.

People interested in attending the "Technology for Technicians II" seminar in Dallas or those who would like to see the seminar presented in their area can contact the SCTE.

SCTE chapters and meeting groups

As a service to SCTE members, the following is an up-to-date listing of the Society chapters and meeting groups.

Appalachian Mid-Atlantic Chapter
Contact: Richard Ginter, (814) 672-5393
Cactus Chapter
Contact: Harold Mackey, (602) 866-0072
Caribbean Area Chapter
Contact: Jerry Fitz, (809) 766-0909
Cascade Range Chapter
Contact: Peter Rumble, (503) 779-1814
Central Illinois Chapter
Contact: Tony Lasher, (217) 784-5518
Central Indiana Chapter
Contact: Lou Zimmerman, (317) 632-2288
Chapparral Chapter
Contact: Bob Baker, (505) 763-4411
Chattahoochee Chapter
Contact: Jack Connolly, (912) 741-5068
Chesapeake Chapter
Contact: Doug Worley, (301) 499-2930
Delaware Valley Chapter
Contact: Scott Weber, (215) 961-3800
Florida Chapter
Contact: Denise Turner, (813) 626-7115
Gateway Chapter
Contact: Darrell Diel, (314) 576-4446
Golden Gate Chapter
Contact: Tom Elliott, (408) 727-5295
Great Lakes Chapter
Contact: Daniel Leith, (313) 549-8288
Greater Chicago Chapter
Contact: Joe Thomas, (312) 362-6110
Heart of America Chapter
Contact: Wayne Hall, (816) 942-3715
Hudson Valley Chapter
Contact: Wayne Davis, (518) 587-7993; or Bob Price, (518) 382-8000
Inland Empire Chapter
Contact: Randy Melius, (509) 484-4931
Iowa Heartland Chapter
Contact: Dan Passick, (515) 266-2979
Michiana Chapter
Contact: Dave Miller, (219) 259-8015
Miss/Lou Chapter
Contact: Mike Latham, (601) 226-2886
Mt. Rainier Chapter
Contact: Sally Kinsman, (206) 867-1433
New England Chapter
Contact: Jeffery Piotter, (508) 685-0258
North Central Texas Chapter
Contact: M.J. Jackson, (800) 528-5567
North Country Chapter
Contact: Doug Ceballos, (612) 522-5200
North Jersey Chapter
Contact: Jim Miller, (201) 446-3612
Ohio Valley Chapter
Contact: Bill Ricker, (614) 236-1292
Oklahoma Chapter
Contact: Herman Holland, (405) 353-2250
Old Dominion Chapter
Contact: Margaret Harvey, (703) 238-3400
Piedmont Chapter
Contact: Rick Hollowell, (919) 968-4661
Razorback Chapter
Contact: Jim Dickerson, (501) 777-4684
Rocky Mountain Chapter
Contact: Rikki Lee, (303) 792-0023
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Troubleshooting the cable system

By Terry W. Bush
Vice President, Instrumentation Products, Trilithic Inc.

All complex communications systems will periodically require some maintenance activities to maintain peak performance. The cable system falling into this category presents many opportunities for failure that may not be under the direct control of the technician. Besides the occasional electronic component failure, mechanical failure due to environmental conditions, such as storms and adverse weather, also can disable even the best of systems. The system technical staff should be prepared for both preventive and spot maintenance activities on an ongoing basis to assure continued service to subscribers.

Tools of the trade

No technician can be expected to maintain and repair the system without proper tools. For the cable technician, these consist of both mechanical tools and electronic instrumentation. The mechanical tools selected should allow the technician to open, close, adjust, tighten, loosen and connect any of the components in the plant. This will allow access to the problem and assure timely repair.

The technician also should be armed with proper test equipment for the job. As we are dealing with a technology that essentially moves electrons, and electrons are invisible to the naked eye, we can only study the effect of this movement on certain instrumentation to deduce problems. The basic selection of instrumentation should include:

- a signal level meter
- a volt ohmmeter
- a signal leakage receiver
- other equipment (dependent on system)
- as-built plant schematics

Armed with this equipment, the technician should be able to affect the repair. To speed up the process, knowledge of symptoms and a logical progression of test and analysis will prove invaluable to these efforts.

Symptoms and analysis

To solve a transmission problem, the operator must first deduce the cause by analyzing certain symptoms. For this article, we'll take the approach of symptom and possible solutions, concentrating on the most logical process to repair the system. In the long run, sheer experience will prove the most valuable asset and, in this case, practice makes perfect.

Symptom: There are no pictures at subscriber's home.

Solution process: First, verify with a signal level meter that the subscriber's set has not failed. If no other complaints have been called in, then the problem is probably drop related. Proceed directly to the tap, visually inspecting drop connections on the way. Carry a signal leakage detector with you, as open or poor connections will generally radiate signal.

Next, check the drop levels. In most systems, drop levels are a constant and should be in the +10 dBmV to +15 dBmV range. If the drop levels at the tap are okay, remove connections found. If the tap levels are found to be out of specification, move to the nearest source amplifier for level verification, visually inspecting the aerial coax while en route. Again, the leakage detector may pinpoint possible open circuits, finding the problem.

If the amplifier's levels are okay, the problem has been localized between that point and the subscriber's drop. Check tap levels until the problem is found.

Symptom: All pictures are snowy, some worse than others.

Solution process: Check subscriber levels. If the low frequency channels are substantially higher in amplitude than the high frequency channels, the problem may be a shorted center conductor.

If the opposite is true, the suspect is an open or poor connection. Proceed to the tap to verify levels and inspect drop connections while en route. A TDR (time domain reflectometer), although not mentioned earlier, would be very useful in pinpointing this problem. Again, level inspection at connection points will most likely reveal the culprit.

Symptom: Some channels are distorted, others are fine.

Solution process: This problem could have many sources but some symptoms may indicate ingress. Check the channels that are suffering interference. If these channel frequencies are available off air, suspect ingress. Use the leakage detector and thoroughly evaluate drop integrity. Ingress problems will usually generate leakage and should be investigated immediately.

If the problem is not in the drop, backtrack the feeder system until the leak is found. Remember, it may be leaking some distance away from the subscriber's home. Feeder leaks have the potential to generate large field strengths as line levels are generally much higher than trunk levels. These problems should carry a higher priority.

Symptom: There are horizontal bars of distortion moving slowly in a vertical manner.

Solution process: Generally, this problem is related to hum modulation. Two bars on a television set indicate 120 hertz hum modulation and are most likely sourced from an amplifier. A single bar of modulation is sourced from half-wave rectification and may be caused by a line passive. This problem also can be related to improper or poor grounding conditions that may be harder to locate.

The technician should first verify that the subscriber's television set is in proper order. A quick hum test with a signal level meter at the drop may be used to verify this. In the case where two bars are present, line amplifiers should be checked. Evaluate hum at the amplifier input vs. hum at the amplifier output. The culprit will most likely be the power supply.

One bar hum may be more difficult to locate. Passive failures, corrosion or internal component failure could be sources. Check upstream from the drop and test for percent hum with a signal level meter.

Symptom: Pictures exhibit noise problems; drop levels are okay.

Solution process: This may be a sign of carrier-to-noise problems. Follow the system upstream to the nearest amplifier and perform a carrier-to-noise test. The carrier level should be greater than +20 dBmV to assure good test results.

If levels are correct upstream, the problem may exist in the trunk. Use the one-half or double rule. This rule states that carrier-to-noise should get 3 dB worse as the cascade of similar amplifiers is doubled and 3 dB better as the cascade of like amplifiers is halved. If the problem does prove to be in the trunk, automatic gain controls are probably compensating for a trunk station failure.

This is only a sample of many problems that could challenge the cable technician. Armed with basic test equipment and tools, these problems should be addressable with a high degree of success. ■

Troubleshooting the house drop

By Ralph Haimowitz
Director of Chapter Development and Training
Society of Cable Television Engineers

What separates an individual who puts in a house drop service from the installer/technician is the ability to be more than a mechanic who can put something physically together. The installer technician does as good or better because he not only knows how to make an installation, he also knows how and why it works, and if it doesn't work, he can find out if the problem occurred in his work and correct it. Nothing is more frustrating to a customer than having to wait for something they are paying for.

In many cases our customers may have to wait for a week or more after they have signed up for cable services just to have it installed. You can imagine how happy they are when the installer arrives and they anticipate they will soon be watching their favorite movies or programs on cable. After the installer completes his work and turns the customer's television on, he finds it doesn't work. At this point, he is just an installer; he informs the customer that something is wrong with the service and he will have to schedule the customer for a trouble call. Usually a problem of this kind is taken care of the next day by a service technician, but there have been times when a customer has had to wait two or three days for a service call.

Visualize the customer's reaction to the news that there won't be any cable service tonight. What do you suppose the customer thinks about the installer and the cable company?

Most of the time when there is a problem with reception after an installation has been accomplished, the trouble is either a bad TV set, which should be checked out beforehand, or a problem in the new installation. The installer technician should have the tools, knowledge and test equipment needed to find and fix those problems. When a technician uses knowledge, tools and test equipment to locate a reception problem, the procedure is called troubleshooting. Troubleshooting of a cable television reception problem begins at the customer's TV set.

First, look at the picture on the TV set and try to analyze what the problem might be. If there is no picture and no sound, a condition we call "snow-no-pic," there is no signal being received by the TV set. Diagonal lines in the picture or color may indicate that there are intermodulation beats (distortions) in the cable signal. Let's take a look at what you, the installer technician, should look for and steps you need to take to get the problem corrected.

DPU interference

DPU (direct pick-up) results when there is a strong, local off-air station in the vicinity where broadcast signal is being picked up by the TV set when it is tuned to that channel, and the cable signal of that same channel is being received by the TV set slightly delayed in time because of the signal distribution through the cable system. The usual cause is the poor quality of metal shielding that the TV manufacturer placed around the TV tuner, allowing the off-air signal to get into the set's RF circuits. DPU will appear as a picture "ghost" on the left (leading) edge of the picture. Installation of a converter whose output frequency is different from any local off-air channel will eliminate this type of DPU problem.

Sometimes a very serious cable fault can appear as a combination of DPU and a cable system fault. In this case you will see a DPU leading edge ghost as well as a cable fault ghost that appears on the right (trailing) edge of the picture. When installation of a converter fails to remove the leading edge ghost, this indicates that there is a point where the DPU is entering the cable system through a fault location such as a cracked cable shield or broken connector.

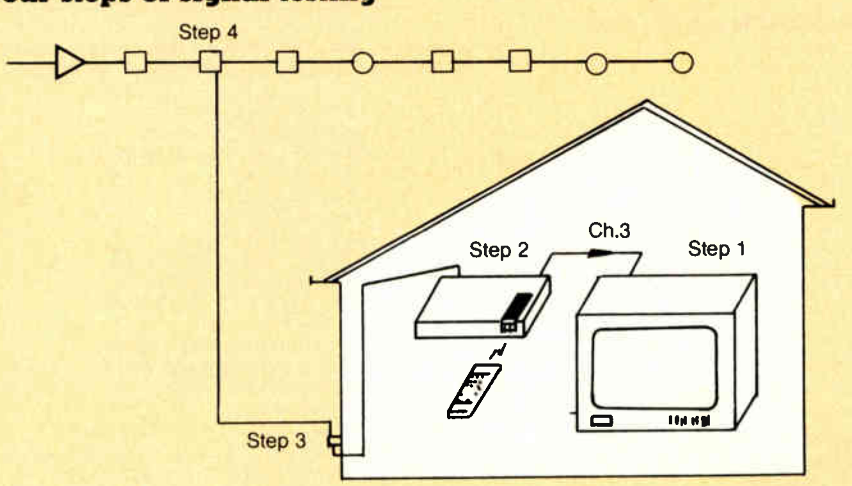
The DPU-related ghost is caused by the strong local station signal entering the cable fault point where the DPU is leading the same channel signal on the cable. The trailing ghost also is a result of the same major fault where a significant portion of the cable signal is being reflected because of the mismatch at the fault location. A cable reflection (trailing ghost) also should be present on those channels that would not have a local station signal.

To verify that the fault is not in the recently installed house drop, connect your TV test set to the distribution tap subscriber port with the drop disconnected. Unless the ghosting completely disappears, the problem causing it is in the trunk or distribution system and will require a service call.

Troubleshooting techniques

With a very grainy picture, or no picture at all, the first step is to measure the signal level at the TV set (see accompanying figure, Step 1). Using the signal level meter, carefully measure to see if there is adequate signal strength

Four steps of signal testing



to the TV set. Remember that we are looking for about +3 dBmV and that anything less than 0 dBmV could be causing your problem. The next point of measurement is at the converter input, where a converter is being used (Step 2) to ensure that it is not a converter problem. Again, we would like to have +3 dBmV at the converter input.

If the level of signal is good, back up to the wall plate that feeds the interior drop to the TV set and check levels if there is a connection, or go one step further to the input of the ground block and measure the signal level there (Step 3). Levels should be somewhat higher than the TV set level of +3 dBmV due to cable loss from the ground block to the TV set, and the loss of any splitter that may be in line after the ground block.

It is usually safe to add the splitter loss to an average of about 75 feet of drop cable loss to figure a ballpark level at the ground block. For example, if you wanted +3 dBmV at the TV set or converter input, and you were feeding signal through a two-way splitter to two TV sets, you would anticipate a level of about +9 dBmV at the ground block. Using the same type of theoretical reasoning, the drop from the distribution tap (Step 4) to the ground block would take about another 3 dB of signal level so that you should have about +12 dBmV or better out of the distribution tap subscriber port.

It is obvious that good troubleshooting is a combination of following step-by-step procedures, taking specific tests and measurements, and analyzing the results to locate the problem. Corrective repair then becomes a matter of what needs to be done to correct what is wrong, whether it be installation of a new piece of drop cable, replacement of a converter, etc.

The greatest error that most technicians make is trying to troubleshoot by replacement rather than by procedural testing and evaluation to find the exact problem. One can only guess the number of F fittings that have been replaced on a wholesale basis or how many times a converter has been changed in the same location because the technician either did not know how to troubleshoot the problem or just did not make the effort to do so.

All too frequently the problem is not really solved in these cases and the customer is subjected to a service call from another technician. This certainly must cause the customer to wonder about the competence and professionalism of the employees.

Use your meters and your TV test set to find the problems, then correct them if they are in the house drop service. If the problem is coming from the distribution system as you have identified it at the distribution tap, you then have proper justification to report it as a service problem and can inform the customer that a service technician will be scheduled to find and correct the problem. Finally, be sure that you follow up on your paperwork and with your supervisor or dispatch to have a trouble call scheduled.

Common cable faults

Hum modulation: A form of distortion where the power-line frequency modulates the TV signal, causing hum bars to appear in the picture. Hum bars are broad horizontal bars, alternately black and white, on the picture of a TV set. They may be stationary or move vertically. The cause is usually a 60 hertz interference frequency or one of its harmonics, and is most frequently caused by failure of a filter capacitor in amplifier power supplies.

Intermodulation: A form of distortion involving the generation of interfacing signal beats between two (second order) or more (triple beat) carriers. A result of non-linearity of amplifiers and/or radio frequency interference (RFI) ingress into the cable system.

Co-channel: Interference between any two or more TV signals on the same designated channel, either off-air or after conversion by CATV headend equipment, that have the same video carrier frequency.

Ghost: A shadowy or weak image in the received picture, offset either to the right or left of the primary image.

Cross modulation: A form of signal distortion in which modulation from one or more RF carriers is imposed on another carrier. Usually appears in the distribution system and frequently is the result of a line extender running hot or having too many (more than three) line extenders in cascade.

Noise: Random spurts of electrical interference or energy always present in electronics systems. A noisy TV picture has a "salt and pepper" effect in the the picture and is often referred to as "snow" or "snowy" picture. ■

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Effective use of the ohmmeter

This is the first of two parts on troubleshooting using an ohmmeter.

By Glenn Shield
Regional Technical Trainer, Rogers Cable TV-Vancouver

One of the most underutilized pieces of test equipment in the cable industry is the volt ohmmeter or multimeter. In particular, the ohm function is not used to its full potential. The purpose of this article is to demonstrate how the correct use of the ohm function (to measure resistance) can be helpful in effectively troubleshooting a CATV system.

There is a lot of very good and very expensive test equipment available to analyze the RF characteristics of a transmission line. Time domain reflectometers (TDRs), closed loop radar systems and sweep equipment costing many thousands of dollars do a very good job, but we should not overlook the capabilities of the ohmmeter, which costs less than $100. All too often the expensive and sophisticated test equipment relegates the ohmmeter to a second class citizen in the world of test equipment. Let me explain.

Drop problems

How often have you been called to a subscriber's home because of snowy pictures, only to find them mysteriously improved when you arrived? Or maybe you witnessed the snowy pictures and after taking the drop wire off the back of the set and measuring good signal, the picture was perfect when you replaced the cable on the TV set. Try as you would, you couldn't get the problem to occur again at the time of the call. Sound familiar? Well, here is where the ohmmeter may come in handy.

The TDR does a fine job of analyzing the RF characteristics of the transmission line but it does not analyze the DC characteristics of the line, in particular, the DC resistance. Consider for a moment a good piece of drop wire of about 150 feet in length. From an RF point of view this line consists of an infinite number of 75 ohm circuits (Figure 1).

Figure 1: Transmission line

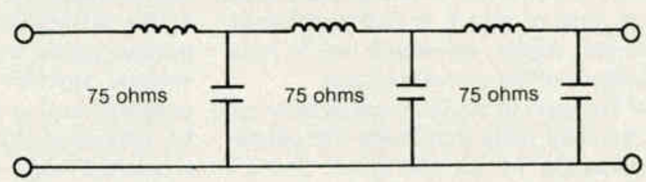


Figure 2: Center conductor and sheath resistance

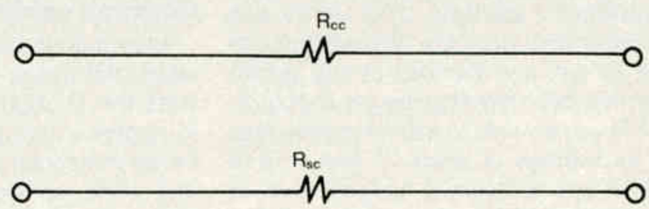


Figure 3: Short circuit

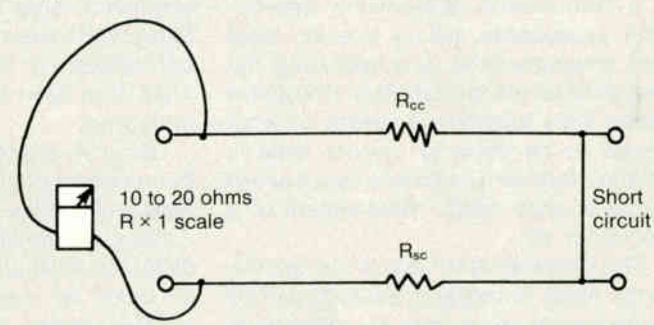


Figure 4: Open circuit

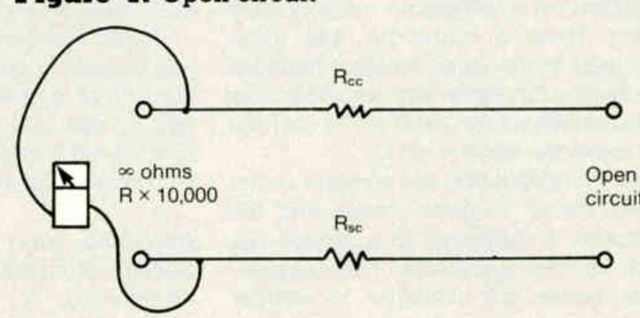


Figure 5: Partial open circuit

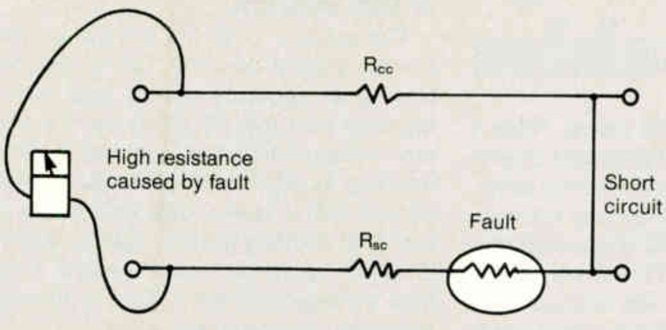
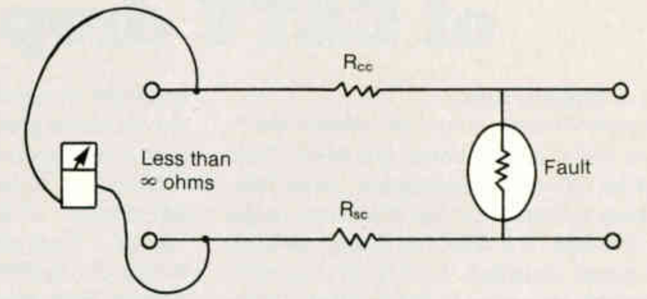


Figure 6: Partial short circuit



However, if we look at the same length of drop wire from a DC point of view, we are looking at two resistors—the resistance of the center conductor (R_{cc}) and the resistance of the sheath (R_{sc}). This can be drawn as a simple resistor diagram (Figure 2).

There are two conditions that exist on a good drop wire and this depends on what happens at the distant end. If the distant end is shorted together, then when an ohmmeter is connected between the center conductor and the sheath, the short circuit loop resistance is measured (Figure 3). Typically, it should read low resistance, say 1C to 20 ohms depending on the cable and its length. This is measured using the lowest ohm scale on the meter, usually the R × 1 range.

Let's look at the other situation. If the distant end is an open circuit then, because these conductors are separated by an insulating material or dielectric, there should be infinite (∞) ohms resistance between the two conductors measured using an ohmmeter set on its highest resistance scale. In other words, the ohmmeter movement will not move or, in the case of a digital ohmmeter, the digits will flash 999, 111 or something exhibiting infinity (Figure 4). That is the case of a good drop wire. What about the faulty drop wire?

Faulty drop wire

Let's consider a drop wire with a high resistance, partial open circuit (Figure 5). This is often seen in the field as a corroded outer conductor, corroded splice or poor spring tension on a multitap spigot. Sometimes this resistance is such that it can be easily overlooked by a casual measurement using a TDR, particularly if the fault is at the distant end, far away from where you are measuring.

(Continued on page 46)

Grounding and bonding of CATV drop cables

By J. Richard Kirn
Applications Engineer, Times Fiber Communications

In 1971 The National Electrical Code (NFPA 70-1970) addressed cable television systems for the first time under article 820. The National Electrical Code is either adopted directly or indirectly through reference in the building codes into local statutes in virtually every community in the United States. The code established firm requirements for bonding and grounding of the CATV cable in the subscriber's home, office, store, etc. There has been a lot of confusion in the CATV industry over the years with regard to the exact requirements caused by a lack of training. (It should be noted that the final authority in judgement of these matters rests with the local code inspector.)

The National Electrical Code established a single building ground. Bonding together of all grounding electrodes to form a single building grounding system helps to protect equipment and people from shock and damage caused by lightning induced voltages, power switching transients, power lines falling on communications lines, etc. Let's look at what happens if each service (power, phone, CATV, water, heat, etc.) had separate grounds at the home. Table 1 shows some ground resistances of a ⅝-inch 5-foot ground rod in various soils.

Note that grounds or ground rods are not perfect, or 0 ohms (Ω) resistance. Figure 1 illustrates a TV set connected to a CATV system and the house power system. Both grounds have a reasonably good resistance of about 50 ohms.

The power system with an extensive outside distribution system is subject to a current surge from lightning or switching transients. From Table 2 it is not unrealistic to assume an induced momentary current of 1000 amperes (A) flowing in the power line ground. This amount of current is not unusual. It could be, and often is, considerably more.

According to Ohm's law, the power ground will rise momentarily to a potential of 1000 amperes x 50 ohms = 50,000 volts (V). However, the CATV ground is still sitting there at ground potential, resulting in 50,000 volts across the TV set.

The same situation would exist if the current surge was on the CATV cable. As you can see it is quite easy to generate voltages sufficient to destroy components in converters and TV receivers, ignite flammable materials and potentially electrocute a subscriber.

Figure 1: TV set connected to the CATV system and power system

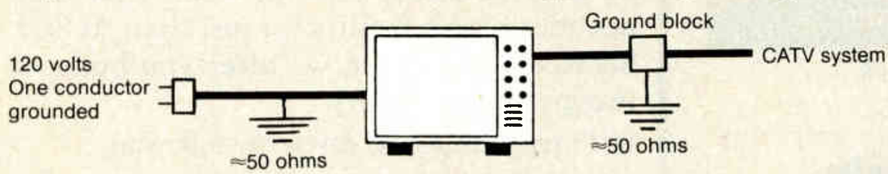


Table 1: Earth resistivity of different soils measured per three-point method

R & ρ / Soil fills	Resistance* in Ω 16 mm (⅝") x 1.5 m (5') rods			Resistivity in Ω/cm³ or Ωcm		
	Avg.	Min.	Max.	Avg.	Min.	Max.
Ashes, cinders, brine waste	14	3.5	41	2,370	500	7,000
Clay, shale, gumbo, loam	24	2	98	4,060	340	16,300
Same, with varying proportions of sand and gravel	93	6	800	15,800	1,020	135,000
Gravel, sand, stones with clay or loam	554	35	2,700	94,000	39,000	458,000

*National Bureau of Standards Technical Report No. 108

A safe solution

The solution is to bond between the power ground and the CATV ground. Now both grounds go up and down together and the TV set does not see any voltage difference across it. The bonding together of all grounds (power, phone, CATV, water, gas, etc.) forms a monolith building ground system, which protects equipment and people from high voltage potentials. This is exactly what the code requires.

In practice, the CATV drop should be located in the general vicinity of the electric service entrance if possible, with a ground wire run from the ground block to the main electrical ground. Figure 2 illustrates the two different types of grounding arrangements in the electrical service entrance permitted by the code. The ground wire coming out of the meter housing or service equipment enclosure (fuse or circuit breaker box) goes to the building ground and in most cases is a metallic cold water pipe when it exists.

The CATV ground block must be bonded to the building structure ground. Some of the common bond locations in order of priority are as follows:

1) A metallic cold water piping that is continuous and in contact with earth for a minimum of 10 feet. Where water is provided by a private well the cold water pipe and well casing must be bonded together.

2) Customer electrical service grounding electrode or grounding conductor, using a separate approved clamp.

3) Customer electrical service equipment cabinet or panel, provided that the connection is made using a suitable clamp, stud or screw that is used for no other purpose.

4) A metallic conduit between the load side of the watt-hour meter and the customer's service entrance panel or equipment cabinet, provided that paint and rust are removed from the conduit before attaching the grounding clamp or strap.

5) A metallic conduit between the weatherhead and meter pan, provided the supplying electric utility does not object. A ground thus attached must be 40 inches (minimum) from the power conductors.

6) To the meter pan, only if it has a welded grounding stud provided for communications system grounding and if the supplying electric utility does not object.

Table 2: Lightning parameters

Parameter	90 percent **	50 percent**	10 percent**	Maximum observed	Number of observations
Crest current	2 to 8 kA (kiloamperes)	10 to 25 kA	40 to 60 kA	230 kA	4,150
Current rate of rise per pulse (10 to 90 percent) crest value	2 kA/μs (microseconds)	8 kA/μs	25 kA/μs	50 kA/μs	40
Total stroke duration	0.01 to 0.1 s (second)	0.1 to 0.3 s	0.5 to 0.7 s	1.5 s	100
Duration of a single pulse in a stroke	0.1 to 0.6 ms (millisecond)	0.5 to 3.0 ms	20 to 100 ms	400 ms	150
Time interval between end of one pulse and start of next pulse	5 to 10 ms	30 to 40 ms	80 to 130 ms	500 ms	525
Time between start of pulse and half crest value on decay side	10 to 25 μs	28 to 42 μs	52 to 100 μs	120 μs+	425
Time to crest for a single pulse	0.3 to 2 μs	1 to 4 μs	5 to 7 μs	10 μs	45
Number of pulses in an individual stroke	1 to 2	2 to 4	5 to 11	34	500
Time for atmosphere to recharge after a stroke so that another stroke will be produced	—	20 s	—	—	—

NOTE: Range in values caused by variations in observations
**Percent of strokes that will have parametric values exceeding those indicated.
(From *Lightning and Lightning Protection* by Hart and Malone.)

7) An 8-feet-by-⅝-inch driven ground rod, provided that the ground rod is bonded to the building grounding electrode system with a #6 copper bonding jumper.

8) The metal frame of a mobile home using a suitable grounding clamp such as a Fargo GC-167-M. In corrosive atmospheres a Fargo GC-167-P is recommended. Verify that the mobile home is properly grounded.

The CATV ground block must be located as close as practicable to the point where the CATV drop passes through the exterior wall, floor slab, etc. The ground wire must be insulated, not smaller than #14 AWG copper and must have current capacity at least equal to the cable outer conductor (Table 3). The ground wire must be run to the building ground in as straight a line as practicable.

The code does not specify a maximum length for residential grounding wire, however, common sense would suggest that the shortest, most direct route should be used, even if this means running extra drop cable external to the building. Where necessary, the ground wire must be protected from physical damage with molding, etc. All connections to the structure ground must be made with a separate approved device or lug. This does not mean wrapping the wire around a handy sheet metal screw or the clamping screw of a non-metallic cable connector.

Figure 2: Two types of grounding arrangements

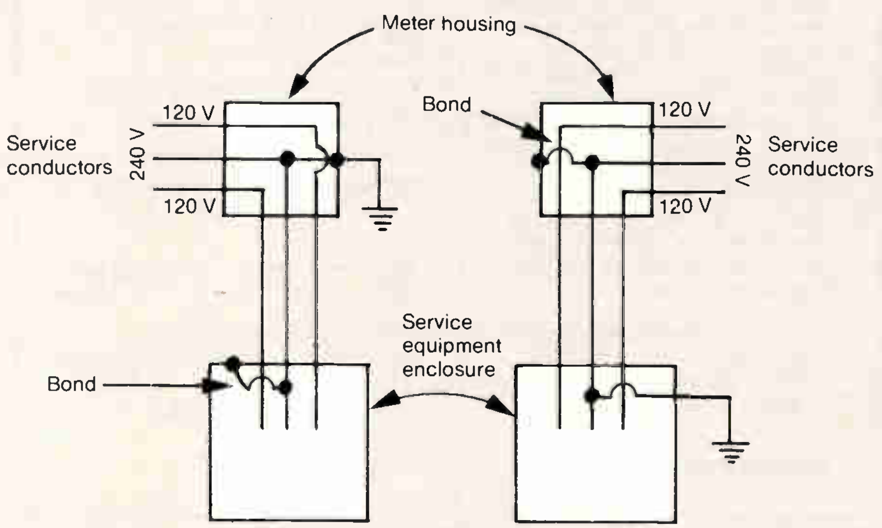


Table 3: Grounding wire gauge for drop cable

Cables types	Ground wire gauge
All single RG-59, RG-6 and RG-11 types	14 gauge
RG-59 and RG-6 siamese with 70 percent or more braid and quadshield	12 gauge
All other RG-59 and RG-6 siamese	14 gauge

If an attachment is made to a metallic water pipe on the output side of the water meter, the installer should verify that there is continuous metallic water pipe back to the meter, that it passes into the ground and that it is a cold water pipe. A ground wire jumper must be placed around the water meter for protection if the meter is removed.

Grounding connections may *not* be made to the following:

1) Natural, manufactured or propane gas piping systems.

2) Hot water supply pipes, heating pipes, air conditioner frames or refrigerant pipes.

3) Any part of a fuel oil storage tank or supply pipes.

4) Electric power neutral at the service weatherhead.

5) Electric meter pan, unless a welded stud provided for communications systems grounding is available and the supplying electric utility permits attachment thereto.

6) Telephone company ground rods or grounding conductors.

7) Non-metallic sheathed cable clamp at the load side of the watt-hour meter.

8) Lightning rod grounding conductor or grounding electrodes.

9) Metal screws securing covers on electrical outlets or breaker panels.

10) Antenna grounding conductors or grounding electrodes.

When the CATV drop is grounded to the building ground it becomes part of the electrical neutral and a current may flow in the drop cable sheath if 120 volts of power is being used in the building. If there is no ground fault in the system, only small currents (less than 1 ampere in single RG-59 or RG-6) are to be expected. Heating of the drop cable or large blue arcing when attaching ground conductors (currents in excess of 2 amperes in single RG-59 or RG-6) is indicative of a serious ground fault in the building and the cable drop should be removed and the subscriber instructed to contact the electric utility company. Clamp-on ammeters are useful for investigating ground fault problems; however, the meter must have a low range full scale of not more than 3 amperes. ■

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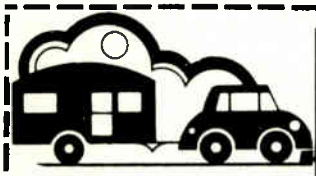

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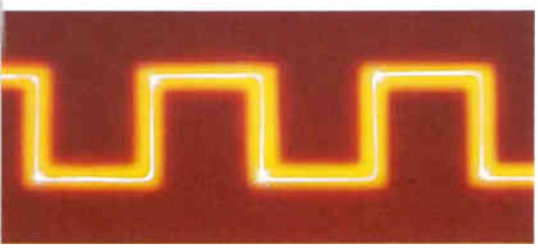
Your power supply gives you a choice: you can keep trucks in the field servicing equipment or you can roll them out to make new installations. Power Guard is designed to eliminate costly repair hours, so your technicians can be producing revenues.

Power Guard's Modularity Means Lightning Fast Repairs

From the wiring harness to the circuit boards, Power Guard is completely modular. Every component is designed for fast plug-in replacement in the field, so there's no need to remove and reinstall housings with Power Guard. Getting back on the air



even if lightning damages your wiring will take only a matter of minutes.

The normal power supply weighs only 40 pounds, the standby power module only 30 pounds, so the man in the field can pull a damaged module quickly, safely and restore power in a few seconds. That is what Power Guard is all about, keeping you on the air.

The Efficiency Expert

Since Power Guard pioneered the long life 90% efficient power supply in 1985, we continue to set the industry standard in reducing power costs while remaining trouble-free. Because our units are rated at actual output, your bottom-line costs will also be less. For maximum efficiency, your power supply should be operated at or near full load. That's why we designed our ferroresonant supplies with different load ratings, so you can closely match the supply's current rating to the load requirement at each power supply location and save.

Power Guard lets you choose 5, 8, 10, 15 or 18 amp modules. So, when you need 8 amps, use the 8 amp module to get the lowest operating costs with consistent output and high efficiency.

That Makes You A Cool Operator

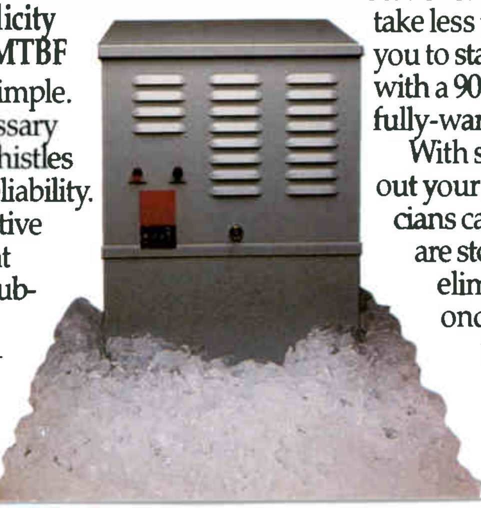
Maximum efficiency means that less energy is lost in heat build-up which causes costly burnout and equipment failure. True efficiency is achieved with Power Guard's cool operation, adding years to the life of your power supply (and your field technician's). And the cool operation allows for a smaller enclosure and less pole space.

Flexibility To Grow On

As your system grows, you can increase your load capacity by swapping out the existing module for one with a higher capacity and plugging in more power in the field.

Simplicity Spells MTBF

We kept it simple. No unnecessary bells and whistles to reduce reliability. Just productive features that keep your subscribers in the picture-features to give you the maximum mean time between failures and the minimum down time in case of a failure.



We build a quality product with a powder-coated, all-aluminum housing that will withstand the most severe weather conditions for years of trouble free service. That's why we can give you the longest warranty in the CATV industry today.

Retro-Fit To Standardize

Our small, highly efficient modular design allows us to Retro-Fit virtually all of our competitors' power supplies, standby and non-standby, while using your existing housings in their current locations. Retro-Fits cost less and take less time to install. They allow you to standardize your entire system with a 90% efficient, totally modular, fully-warranted supply.

With standard equipment throughout your system, your service technicians can make sure their trucks are stocked for in-field repairs eliminating unnecessary second trips. And eliminating the need for cross-training.

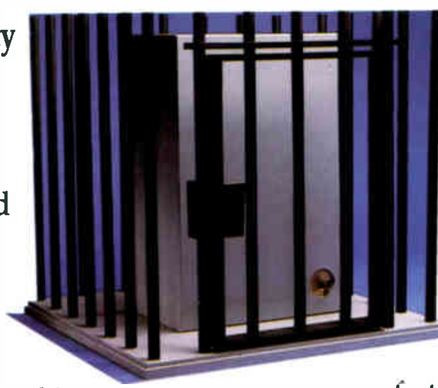
ke Installations, Not
wer Guard And The Beast.™

The Beast Guards Your Connections

The beauty of this apartment box is that it ends theft of service and signal leakage due to tampering...and reduces truck rolls so your technicians can make more hookups, less unproductive audits and repairs.

The Beast Is Under Maximum Security

We caged the Beast in a box-in-a-box. Stainless steel arc welds eliminate rust and prevent prying. Our 16-gauge aluminized steel remains corrosion-free and outlasts galvanized steel five to one. Coatings withstand high impact for years of use without chipping or cracking.



SuperLocked To Stay Locked

Developed exclusively for CATV, we built the lock you can't defeat.

Since we introduced SuperLock in 1983, it has remained the benchmark for apartment box security, meeting all internal and external security requirements for the CATV industry.

The brass tumbler is enclosed in a 16-ounce solid brass housing. All moving parts are brass or stainless steel to remain rust-proof and free-moving. SuperLock is recessed and encapsulated in a deep drawn steel shroud for double protection, in all weather.

The Key To The Beast's Success

The key to the Beast cannot be reproduced. You control the access to all Beast apartment boxes, simply by logging in and out all keys you distribute to your service technicians.

The key must be in the locked position in order to be removed, so it is impossible to leave the Beast unlocked without detection.

Installing Without Stalling

Six leads or sixty, we've got your box. Custom features and options such as knockouts, mounting plates, organizers, matching locks and ground lugs won't slow us down. Installations of our products are faster, more efficient.

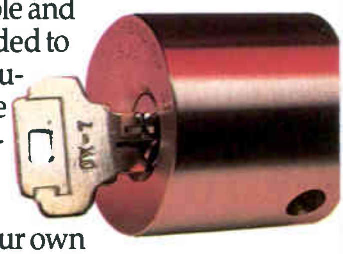
A Pack Of Protection

Swinging Beast, Beast, Lock Box and Beast II–choose the Beast that's best for you. Cable Security Systems offers a choice of four models to meet your cost and security requirements.

The new Swinging Beast has a non-removable, hinged lid that makes servicing quicker, safer and more convenient. No more lost lids.

Our original model, the Beast, is the industry standard for durability and security in all conditions.

The Lock Box™ is adaptable to almost any locking system. It offers durability and serviceability that's affordable and may be upgraded to maximum security at any time without rewiring. It can be keyed to the Beast™ with our own 2″ solid brass padlock.



The Beast II has a sliding, retained lid with a self-locking, solid brass lock that can also be keyed to the Beast. The Beast II is a durable system for areas where high security is required.

Reliance Makes Compliance Easy

Meeting new government regulations to prevent signal leakage is critical to keeping your license–and your customers. Many operators have been spending a lot on costly truck rolls to audit their apartment boxes to detect tampering and theft, which is also a major cause of signal leakage.

Cable Security Systems products give you the security you need to prevent tampering. And knowing that tampering is limited by one of the Beasts, you can eliminate those expensive audits.

So, when you send a truck out, your service technicians can spend their time on new installations not inspections.

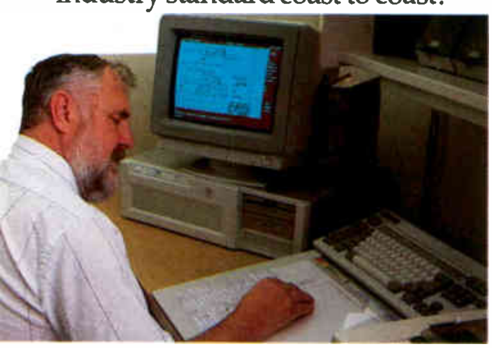
Let Power Guard and the Beast truck you to the bank.

A Powerhouse Of New Ideas In The Cable Industry

Power Guard and Cable Security Systems are innovators in techniques to control CATV operator costs and generate improved revenues. We have brought some of the finest creative minds in the field together to concentrate on products that serve the cable industry. Because we are serious about quality, we have consistently set industry-wide standards of performance including 100% testing for quality control.

So What Have We Done For You Lately?

In 1974, Jerry Schultz pioneered the first reliable standby power supply for CATV. Today, these very same power supplies are still in use. The Beast was introduced in 1982 as this industry's first true high security apartment box. It is now the industry standard coast to coast.



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Basic electronics theory

This is Part XVII of a series about basic electrical and electronic principles, designed for the individual with little or no training in either electricity or electronics.

By Kenneth T. Deschler
Cable Correspondence Courses

Last time we looked at semiconductor materials, doping, biasing and the construction of a P-N junction diode. This month we will cover some of the more common types of diodes used in the electronic industry as well as in equipment found in CATV distribution plant and headends.

Characteristic curves

A *characteristic curve* is a graph that is plotted to show the relationships between changing values. A characteristic curve used for most diodes is shown in Figure 1. From this curve we see that forward current through the device will remain at zero until the barrier potential of 0.7 volts is reached. Once reached, forward bias provides an increase in the forward current value. Also seen in this graph is that when a sufficient amount of reverse bias is applied across the device, a reverse current will flow that, in most instances, will destroy the diode. Figure 2 shows the schematic symbols for the diodes covered in this lesson.

Figure 1: Characteristic curve

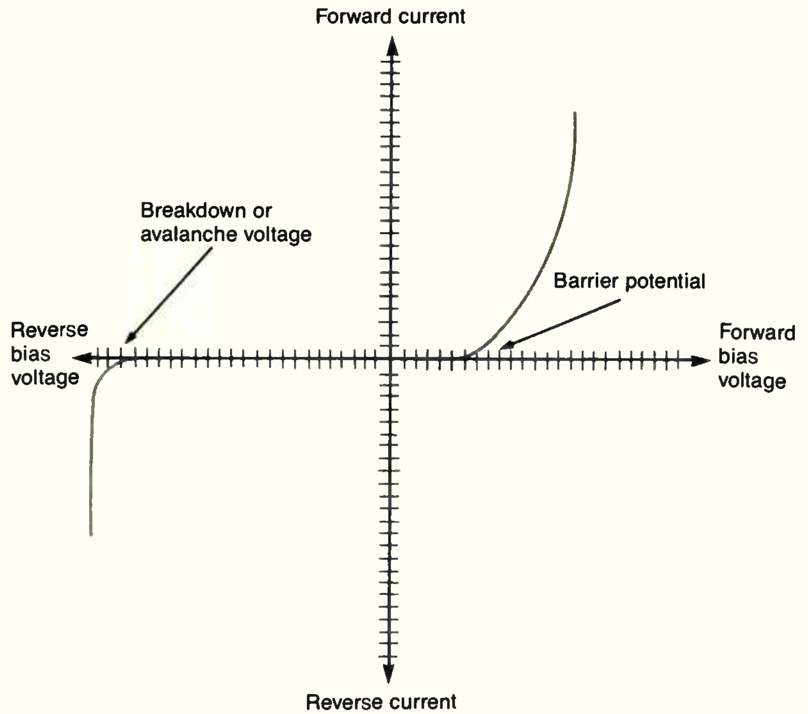
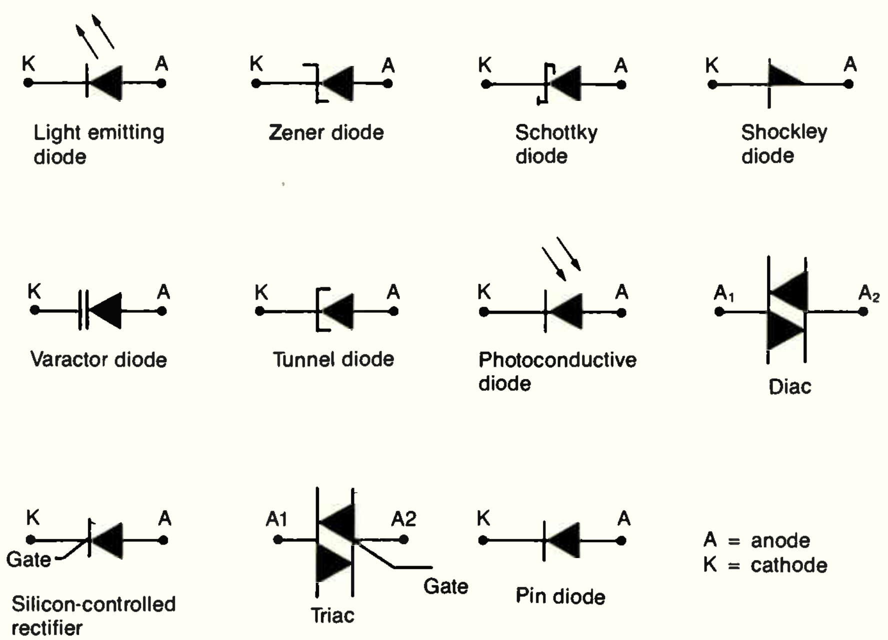


Figure 2: Schematic symbols for diodes



A *light emitting diode* (LED) is a P-N junction diode constructed with special materials that can produce green, yellow, red, white or blue light when they are forward biased. The more common materials used for LEDs are gallium arsenide, gallium arsenide phosphide and gallium phosphide.

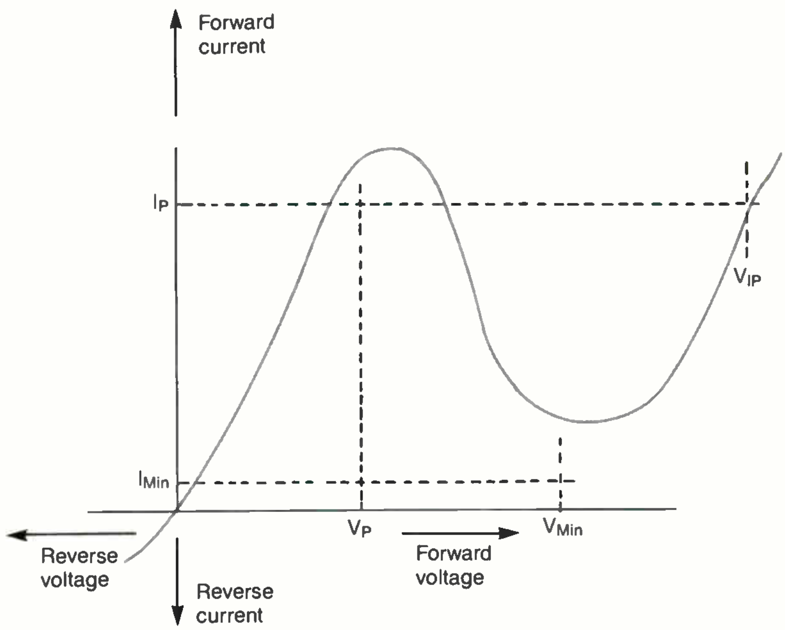
When a forward bias of approximately 1.6 volts is applied, electrons are excited to a higher energy level causing the diode to emit light energy instead of heat. The amount of light emitted is proportional to the value of current flow. LEDs are used as indicators and readout displays. Special types are used to produce infrared inputs to fiber-optic cable. A lens system is used to magnify and direct the light.

A *zener diode* is a special junction diode whose breakdown point, when reverse biased, is controlled by the doping process. In Figure 1 we saw that at some point during reverse bias, the value of current will destroy most diodes. In the case of zener diodes however, reverse currents up to 25 milliamperes are permissable before the diode is in danger. The chief use of zener diodes is in voltage regulating circuits where the diode is placed in parallel with the load. When its breakdown voltage is exceeded, it allows current to flow through it thereby maintaining a constant voltage. Zener diodes have voltage rating from 2.4 to 200 volts.

The *Schottky diode* has a metal-to-semiconductor junction rather than the semiconductor-to-semiconductor junction found in conventional diodes. Typical metals such as gold, aluminum and silver are used. Schottky diodes, sometimes

Figure 3: Shockley diode

Figure 4: Negative resistance



I_P = peak current
V_P = peak voltage
I_{Min} = minimum current
V_{Min} = minimum voltage
V_{IP} = voltage at which I_P is reached again

known as "hot carrier diodes" are used primarily in high frequency and digital circuits. Digital circuits handle voltage or current pulses as zeros or ones. Because it operates only with majority carriers, it has the ability to switch from conduction to non-conduction and back, rapidly.

The *Shockley diode* is constructed of four layers of semiconductor material with three P-N junctions, as shown in Figure 3. This diode is used as a solid-state switching device for light dimmer circuits, motor speed control and in auto ignition systems.

The *varactor diode*, also called a tuning diode, is a device whose junction takes on the characteristic of a capacitor. The capacitance is controlled by the method of doping and the physical area of the depletion region. The value of the capacitance is dependent upon the amount of reverse bias voltage applied. Varactor diodes are used primarily in communication receivers to control resonant circuits.

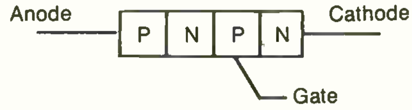
Tunnel diodes are so named because it was discovered that heavy doping of their junction caused the majority carriers to "tunnel" through the depletion region. Tunnel diodes exhibit a phenomenon known as "negative resistance." Negative resistance exists at that point on a characteristic curve where any further increase in forward voltage results in forward current decreasing to almost zero before starting to increase again. This can be seen in Figure 4.

Tunnel diodes are used in both amplifier and oscillator circuits. Amplifiers and oscillators will be covered in later lessons.

Photoconductive diodes conduct in proportion to the amount of light that falls on their junction. They act as switches when sufficient light strikes them. A typical use of a photoconductive diode would be as the sensing device in a dusk-to-dawn lighting system.

The *silicon-controlled rectifier* (SCR) is a four-layer device that allows current to flow from cathode to anode when a voltage pulse is applied to its gate element (Figure 5). Like the Shockley diode, it acts as a switch by being either in the "off" or "on" position. Typically silicon-controlled rectifiers are used in both motor control circuits and relay control circuits. Once it is "on" it requires either a current in the opposite direction or an interruption of the current through the device to turn it off.

Figure 5: Silicon-controlled rectifier



The *diac* is a four layer device that has the ability to conduct in either direction. The diac conducts whenever the breakover voltage is reached, regardless of polarity. The current through a diac increases until it reaches a point called the holding point. Once the holding point is reached, the current flow through the device remains steady.

The *triac* is similar to the diac except that it can be turned on by a pulse on its gate terminal. The amount of current flow through the triac is dependent upon the polarities of A_1 and A_2. Triacs are used to control voltages.

The pin diode has two heavily doped regions separated by an undoped area. The pin diode acts like a capacitor when reverse biased and like a variable resistor when forward biased. Pin diodes may be used as either a DC controlled switch or as a current controlled resistance.

Next month we will utilize some of these diodes in circuits such as clippers, limiters and voltage regulators.

Test your knowledge

1) What is the barrier voltage for diodes constructed from silicon?
2) Define breakdown voltage.
3) What is the most common use of LEDs?
4) Name four devices covered in this unit that act as switches.
5) What two devices utilize a gate? ■

Answers

1) 0.7 volts.
2) A reverse bias voltage sufficient to cause current to flow in the reverse direction. This current is sufficient to destroy most types of diodes.
3) Indicators.
4) Schottky, Shockley, photoconductive and pin diodes as well as silicon-controlled rectifiers.
5) SCR and triac.

Advertorial

Calculating grounding resistance

The problem definition

Until now, one of the more difficult problems within the electrical engineering discipline was the design of a grounding system. Although there is a wealth of data available on what influences the design, there has been little in the way of logic to the designer. Further, there are all too often situations where either limited space or high soil resistivity, or both have made it impractical to achieve a given resistance to earth.

Designers have resorted to the use of long rods, which usually does not help real resistivity, or too many in a given area. This adds to their frustration and does not improve the situation significantly.

Improper measurement techniques, particularly for large ground grids, further complicate the problem by providing a low resistance reading and the real resistance is much higher. Proper use of a three-point, fall-of-potential measurement system can minimize the risk of false resistance measurements. For large ground fields it is essential to be outside its influence with the measurement equipment.

The resistance of one electrode

The resistance of a single electrode to true earth is dependent on the soil resistance and the character of that grounding electrode (rod). There are three factors of real significance that must be understood; these are presented in Tables 1 through 3.

Of these, moisture and mineral content in the soil have the greatest influence; but while the mineral content is reasonably stable, the moisture is not. From Table 1 it is obvious that soil resistances *for a given type* vary over several orders of magnitude. From tests by others, it has been shown that the resistance of a given soil location can vary by up to 250 percent due to variations in moisture and to some degree, temperature.

Therefore, the first step in assessing the potential resistance of one rod in a given soil is to measure that soil's resistance; and determine its condition with respect to moisture, and temperature when applicable. From Table 2, estimate the approximate situation that fits your measurement. This then establishes:

1) Soil resistance (ρ), and the

2) Range in resistance ($\Delta \rho$)

The resistance (R) of a single rod to earth driven into a soil of known

Figure 1: Chem-Rod impact on grounding resistance (100 Ω-m soil)

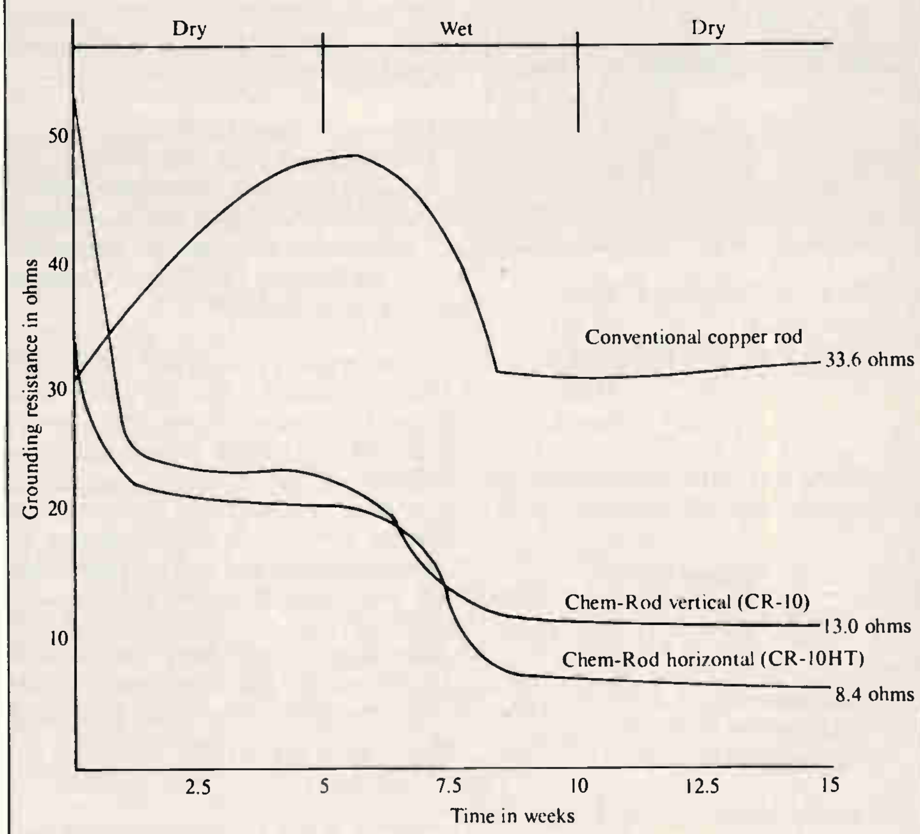


Figure 2: Soil resistance influences as a function of distance from rod

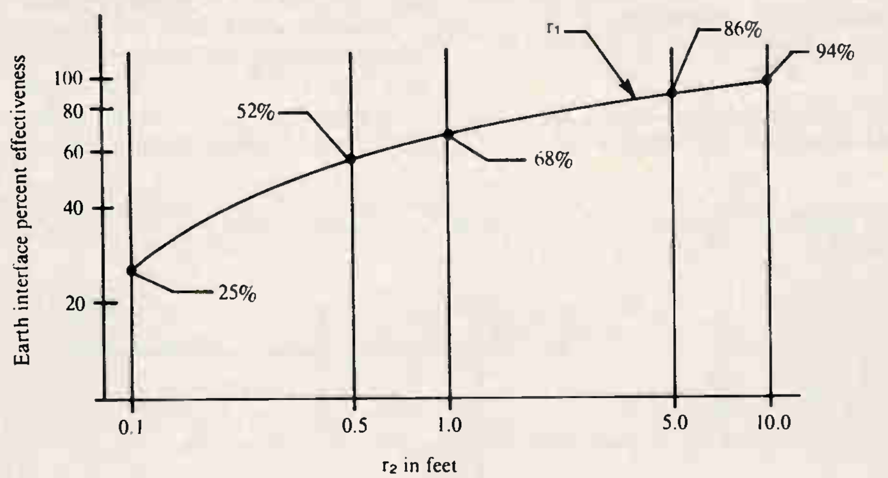
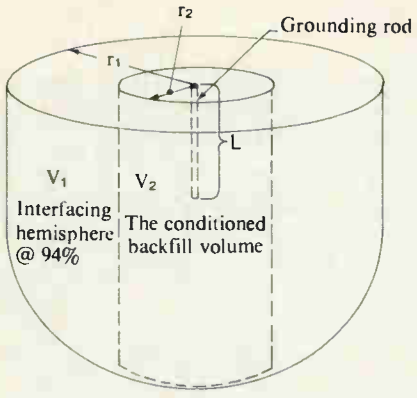


Figure 3: The earth interfacing hemispheres



resistivity (ρ) is expressed follows:

$$R = \frac{\rho}{2L}\left(\ln\frac{4L}{a} - 1\right) = \text{ohms (using MKS units)}$$

Translating this into English units for use with conventional ground rod sizes:

$$R = \frac{\rho}{1.92\,L}\left(\ln\frac{48L}{d} - 1\right) = \text{ohms}$$

Where:
ρ = ohm-meters
L = length of rod in feet
d = rod diameter in inches

For a conventional ¾-inch by 10-foot rod, this reduces to:

$R = 0.337\,\rho$

For a 10-foot Chem-Rod® (2½-inch diameter) this reduces to:

$R = 0.275\,\rho$

For an 8-foot Chem-Rod®, (also 2½-inch diameter) this reduces to:

$R = 0.328\,\rho$

The foregoing is based on the electrode (rod) physical characteristics only. That is, its length and diameter. Further, the soil resistivity is assumed to be that derived from soil resistance tests. The impact of conditioning has not been considered.

Conditioning of the local soil can be obtained through one or a combination of two methods:

1) *Use of Chem-Rod®* filled with a metallic salt that slowly makes the surrounding soil more conductive.
2) *Replace the local soil* with a highly conductive soil such as bentonite, or preferably LEC-GAF (grounding augmentation fill).

Use of the Chem-Rod® (CR) will yield a reduced soil resistance and therefore a reduced grounding resistance (R_{CR}). Figure 1 illustrates the impact of the CR on grounding resistance as a function of time. Note that the vertical CR was 38 percent of the conventional rod and the horizontal rod was only 25 percent of the conventional rod. At three months these percentages would have dropped to approximately half the values. Using 25 percent as a conservative estimator:

$R_{CR} = (0.275)\,(.25)\,\rho$ or about
$= .069\,\rho$

Use of a soil augmentation fill can have a significant impact on the ultimate resistance; and stability of the rod grounding resistance. Bentonite and LEC-GAF both have low resistance; 2.5 and 1 ohm-meter respectively.

From previous data, we know that each grounding electrode, conventional or Chem-Rod®, requires a hemispheric volume of soil 2.2 times the length of the rod in diameter and 1.1 times its length below the base of the rod as illustrated by Figure 2. This is referred to by some as the 90 percent effective interface. The IEEE Green Book considers it the 95 percentile. The difference is inconsequential. This, therefore, infers that the soil within that hemisphere *will determine the approximate resistance of a contained electrode to earth.* Given this premise it becomes obvious that if all the soil in that hemisphere is replaced with highly conductive soil, that soil will determine the electrode resistance (R). Therefore, for bentonite and a conventional ¾ × 10-foot rod:

$R = .337\,\rho$ (for bentonite)

$= (.337)\,(2.5)$ or 0.84 ohms

For LEC-GAF and that same rod:

$R = .337\,\rho$ (for LEC-GAF)

$= (.337)\,(1.0) = .337$ ohms

Note that both of these estimates must be corrected to compensate for the remaining 10 percent of earth interface.

The foregoing premise is based on replacing *all* of the soil in the immense hemisphere, a possibility but an expensive option to say the least. Other options are worth considering. Consider the impact of reducing the volume of earth replaced. Again, from the IEEE Green Book we find the data presented as Figure 2 and illustrated in perspective by Figure 3. These data indicate a non-linear relationship between the radius of the reduced hemisphere radius (r_2) and the resulting grounding resistance. That is, the first increment of soil close to the electrode has the greatest effect on grounding resistance.

Referring again to Figure 2, note that at a six-inch radius or a one-foot diameter hole, filled with conductive fill around the grounding electrode would make up 52 percent of the effective interface. If this volume was, therefore, filled with bentonite or LEC-GAF, the resistance of the rod in that hole would be a function of the resistance both the backfill and the surrounding soil; but the backfill should predominate because of its proximity to the grounding electrode. Therefore, the electrode resistance (R) for a ¾ × 10 foot should be:

$R = .337\rho_1\,(.52) + .337\rho_2\,(.48)$

or $.337\,(.52\rho_1 + .48\rho_2)$ ohms

Figure 4: The K factor for combining more than one rod

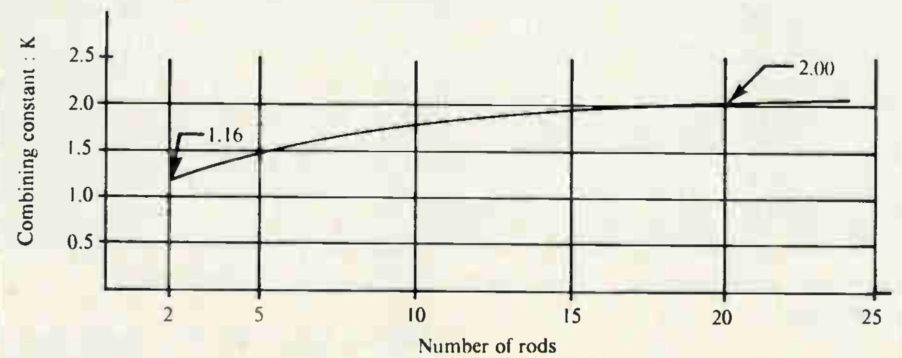


Table 1: Resistivity of soils and resistances of single rods

Soil	Resistivity (Ω-cm) Avg.	Min.	Max.	Resistance of ⅝-inch (16 mm) × 10-ft. (3 m) rod (Ω) Avg.	Min.	Max.
Fills, ashes, cinder, brine waste, salt marsh	2,370	590	7,000	8	2	23
Clay, shale, gumbo, loam	4,060	340	16,300	13	1.1	54
Same, with added sand and gravel	15,800	1,020	135,000	52	4	447
Gravel, sand, stones, with little clay or loam	94,000	59,000	458,000	311	195	1,518

where:

ρ_1 = the resistance of the backfill

ρ_2 = the resistance of the surrounding soil

When LEC-GAF is used with that conventional rod, this further reduces to:

$$R = (.337)(1)(.52) + (.337)(.48)\rho_2$$

$$= .175 + .162\rho_2 \text{ ohms}$$

For a Chem-Rod®, *prior to conditioning of outer soil,* this reduces to:

$$R = (.275)(1)(.52) + (.275)(.48)\rho_2$$

$$= .143 + .132\rho_2$$

After the conditioning period (less than three months) the end resulting resistance should be:

$R = .143 + .132\rho_2$ (*.25) *The resultant impact on ρ_2 after three months.

or $.143 + .033\rho_2$

Selecting the number of rods required

Very often, even under the best of conditions, using only one Chem-Rod® will not provide the required resistance to true earth; or we wish to achieve the lowest practical resistance for a given piece of real estate. The use of multiple rods will help us achieve this objective.

Table 2: Effect of moisture content on soil resistivity

Moisture content (% by weight)	Resistivity (Ω-cm) Top soil	Sandy loam
0	>1,000 • 10⁶	>1,000 • 10⁶
2.5	250,000	150,000
5	165,000	43,000
10	53,000	18,500
15	19,000	10,500
20	12,000	6,300
30	6,400	4,200

Table 3: Effect of temperature on soil resistivity*

Temperature (°C)	(°F)	Resistivity (Ω-cm)
20	68	7,200
10	50	9,900
0 (water)	32	13,800
0 (ice)	32	30,000
-5	23	79,000
-15	14	330,000

*Sandy loam, 15.2 percent moisture

These are two separate questions to answer:

1) How many rods can be effectively used in a given area; and
2) How many rods are required to achieve a given resistance?

To determine the number of rods (N) required for a given resistance, several researchers have shown that N can be assessed as follows:

$$N = \frac{R_1 K_N}{R_N}$$

where:

R_1 = the resistance of one electrode under the conditions to be used

R_N = the required resistance with N rods

K_N = a constant, related to the number of rods; see Figure 4 (varies between 1 and 2.5)

To determine the maximum number of rods that will fit in a given area, the best way is to approach the problem geometrically first; then calculate the resulting resistance. Proceed as follows:

1) Lay out the area on a drawing to scale.
2) Make a number of loose circles, equivalent to 22 feet in diameter for 10-foot rods; and/or 18 feet for 8-foot rods. These are independent of the type of rod used (conventional or CRs).
3) By "fitting" them in the space available determine how many rods can be used. This will establish the practical limit. Exceeding this number will yield little improvement in resistance to earth.
4) Calculate the resulting resistance to earth for each option and select the option providing the lowest grounding resistance. ■

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How to minimize the consumer interface dilemma

By Rick Cooper
Broadband Design Specialist
Graphic Mapping Systems

I've noticed that even though we've had several years to solve the problem there is still interest in stop-gap measures to minimize the consumer interface dilemma. Here's another option that we used with success in a 270 MHz system with pay channels in the mid-band.

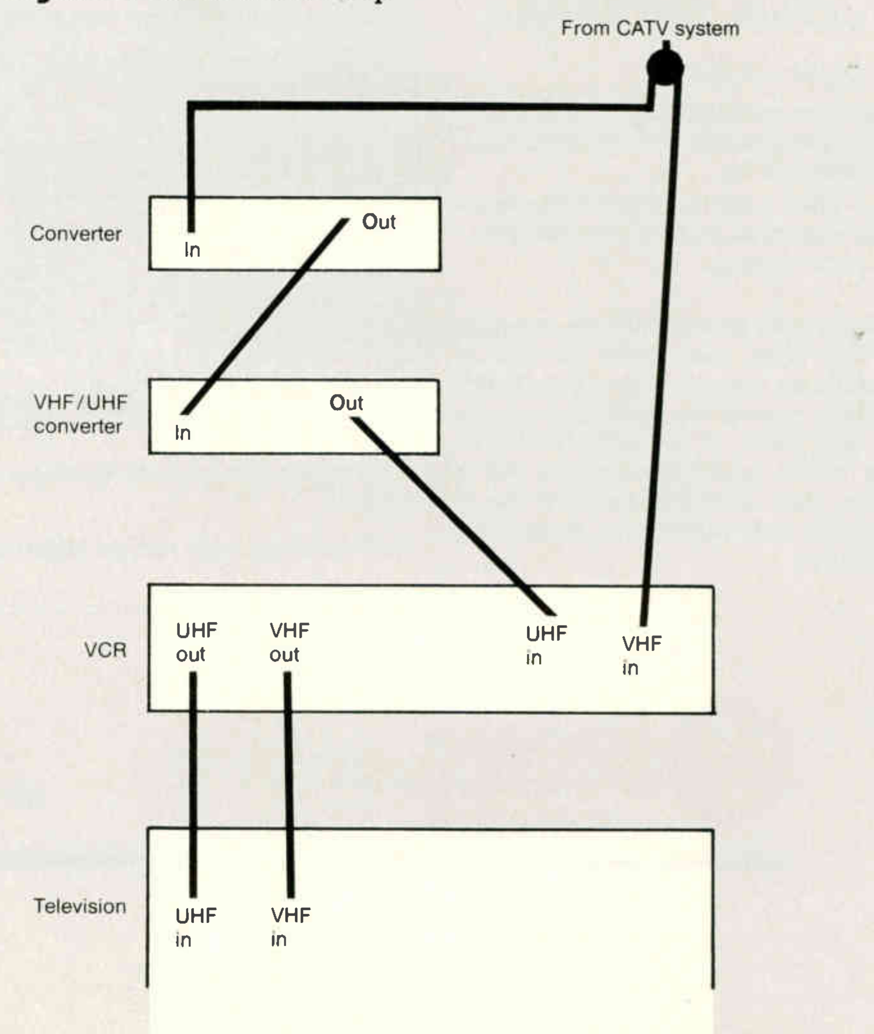
The system began using addressable converters about the same time VCRs were becoming popular and pay disconnects were a problem. It was found that the loss of VCR convenience, features and remote control lowered the perceived value of the pay channel and subscribers found movie rentals a viable alternative. The usual A/B switch hookup only contributed to the complexity, further alienating everyone who wasn't a videophile or under 13. Of course service calls also increased.

The solution was to split the incoming signal, route one leg directly to the VCR VHF terminal and the other leg to the converter. The converter was tuned to the pay channel and the Ch. 3 output was applied to a VHF/UHF converter. Ch. 3 was converted to about Ch. 37 UHF and this was connected to the VCR UHF terminal. All unscrambled channels were tuned on the VCR VHF tuner and Ch. 37 was tuned on the UHF tuner. This allowed subscribers to regain all the features of their VCRs including programmed taping and remote control.

We searched and found a fairly stable UHF converter for under $20 and, after torturing our subs with previous methods, most were glad to pay for the unit. Other drawbacks besides stability were added distortion and yet another AC cord to plug in behind the television.

Again, most customers dismissed these problems as unimportant as they dusted off their remote controls. Most reported they couldn't tell a difference

Figure 1: Residential hookup



Ad Index

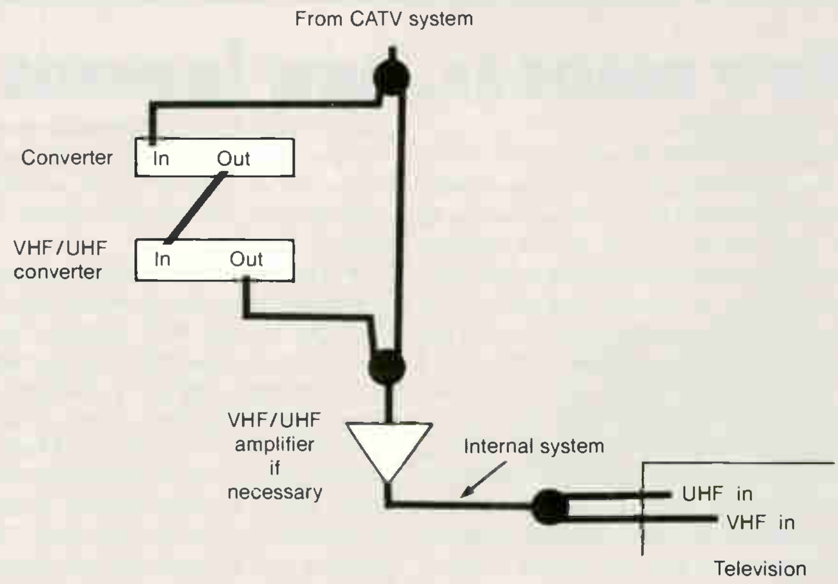
in picture quality anyway. The converter still had to be tuned for more than one pay channel but this inconvenience was minimal compared to the benefits; most customers had a favorite they remained tuned to. As word got out we even had requests for the unit from subs without VCRs but with remote control television and even those who wanted the "ugly box" off their furniture.

Checking out the motel problem

At about the same time we wanted to provide motels in our area with a pay channel but were dreading placing converters in each room. We were concerned not only with the theft angle but with the folks out there who still didn't know how to operate converters. The ideal solution, for motels with cable ready televisions, would have been a pole-mounted descrambler. There was one featured in the 1980 Jerrold catalog compatible with their SSE-200 scrambler but we didn't find any or anyone who knew of them.

We decided to place a converter in the maid's room TV terminal area along with a headend quality VHF/UHF converter. The converted and unconverted splitter legs were combined, amplified and sent through the existing loop. At the set the cable was split and connected to both the VHF and UHF terminals.

Figure 2: Hotel/motel hookup



Now the manager just tells his customers to turn to U for the movie channel. (In older motels the actives and passives may need to be upgraded; watch those long cable runs/loops.) The use of only one converter in a locked room and the ease of operation make the initial sale easier and also cuts down on future maintenance. ■

From the NCTI

New courses, new lessons and hot rumors

By Tom Brooksher
Marketing Director, National Cable Television Institute

The following are short takes I jotted down while wondering why so many of us look at the FCC's signal leakage compliance requirements as a detriment rather than a terrific opportunity to provide better service to our customers through improved systems:

- Last month I told you about our newest course, CATV Fiber Optics. For several months we had been getting requests for a course on fiber optics that combined the basics of optic theory and the application of fiber in cable systems. While we expected the course to be of interest, we weren't expecting quite the reception it received when we announced it last month. From the morning the first announcement hit the streets we began receiving phone calls and enrollments. The response, both to the announcement and the course itself, has been tremendous. Thanks for the support, and if a thorough understanding of fiber optics will help you do your job in the future, give us a call and ask for information on NCTI's CATV Fiber Optics.

- The first two of eight lessons on troubleshooting the drop are now being included in new NCTI Installer Technician course shipments. The two lessons are Troubleshooting TV Problems and Troubleshooting Drop Cable. They are detailed, how-to lessons filled with practical teaching and excellent illustrations. Since the vast majority of service problems occur at the drop, these lessons and the ones that will follow will be particularly valuable for all Installer Technician course students. Troubleshooting TV Problems and Troubleshooting Drop Cable will be made available under the Graduate Update Program later this year.

- Speaking of improved customer service, we've all heard a lot about it around the industry lately. Generally it's in the context of an overall industry need to increase the quality of our customer service. Despite all the recent rhetoric, customer service isn't a concept invented specifically to give cable personnel a hard time. Customer service is important to all businesses . . . yes, even to technical training institutions. At NCTI we spend a great deal of time listening to our customers and trying to refine our program with better customer service in mind.

In recent months we've introduced two such program enhancements designed to do just that. The first one began with a visit that Byron Leech and I had with a client last spring. The client had been using NCTI courses to train his employees for several years, but he had one nagging concern. After one of his students had completed a course and had finished taking his final exam, our client was worried about mailing the

"Despite all the recent rhetoric, customer service isn't a concept invented specifically to give cable personnel a hard time."

employee's final exam to NCTI for grading. He felt like depending on the mail system to transport the exam to NCTI without losing it—and all of his employee's hard work—left him at more risk than he was comfortable with.

He had temporarily solved the problem by photocopying exams before sending them, but he felt like there had to be a better way. We thought so too. After returning from the trip, Byron sat down with Julie Phillips, our resident computer expert, and they devised a final exam answer sheet. Now, each time the computer creates a final exam, it creates a final exam answer sheet. The answer sheet has all the information we need to identify the students and the unique exam that each student is taking, and gives students a place to transfer answers off of their exams. Thus, the original exam can be kept on file and just the answer sheet returned.

It's probably worth noting here for those of you who aren't familiar with NCTI's program, after a student finishes studying a course and successfully passes the exam for each lesson our computer creates a final exam that is unique to that student for that course. To do this, the computer pulls a variety of questions out of a large database of questions for the course. In selecting questions for that student's exam the computer is analyzing such factors as when the question was last used and where it was used (i.e., was this question recently used in the same system?). The computer also analyzes the content of the exam with the objective of selecting a representative sampling of questions from all subjects covered in the course. Because the resulting exam is unique to the student, there is no security concern with keeping it on hand. Even if another employee in the system will soon be taking a final exam for the same NCTI course, his exam will be significantly different from the one on file.

If you've ever taken an NCTI course and wished you didn't have to take the time to write out your name, address, student number, lesson number, etc. at the top of every lesson exam card you sent in, you'll like the second student services enhancement we recently instituted. In an effort to save students the time (not to mention writer's cramp) of writing out this duplicative information, we are now creating customized pre-preprinted labels for each student's course. So the next NCTI course you enroll in will come with a set of preprinted exam card labels. Each label has your name, the course name, the number of one exam and the course number on it. When you complete an exam and transfer the answers onto an exam card, all you have to do is find the label with the matching exam number on it and stick it on the top of the card. If you use the label you don't have to complete any of the other information at the top of the form because the label contains all the information we need to find you in our system.

• A new fiber course, new troubleshooting lessons, new student services enhancements. Just in case that's not enough new news from NCTI, there's a rumor circulating that NCTI is about to announce two more new courses. While I'm not at liberty to provide all the details, I can confirm that the rumor is true. Lately we've been inundated with requests for technical training from two groups: industry vendors and non-technical personnel.

Vendors (including hardware, services and programming suppliers) tell us they are increasingly finding that their marketing, administrative and even some of their technical personnel need a better understanding of the technical operation of cable systems. And, they tell us, who better to provide such training than NCTI, the company that trains cable systems technical personnel. We agree, so we're developing a course on CATV technology for supplier personnel.

We've been getting similar input from non-technical personnel at cable systems and MSOs. For the past couple of years we've been meeting that need with our CATV System Overview course. But now we're hearing that non-technical personnel, from system managers, marketing officials and CSRs, to MSO managers and directors, want more information than we can provide in the short, six-lesson forum of the Overview. In the next thirty days you can look for an announcement from NCTI of a new course on CATV technology for non-technical personnel. So, if there are any non-technical employees around your office that keep wandering back asking you to explain the difference between a tap and a trap, have them give us a call. Remember, you heard it here first! ■

Classifieds /Directory

Help Wanted

Service Technicians

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10	25	40	55	70	85	100	115	130
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Installer's Tech Book

Converting dBmV to μV/m

By Ron Hranac
Senior Staff Engineer, Jones Intercable Inc.

Channel 10 (193.25 MHz)

dBmV	μV/m	dBmV	μV/m	dBmV	μV/m	dBmV	μV/m
-60	4.06	-36	64.32	-10	1283.33	16	25605.83
-59	4.55	-35	72.17	- 9	1439.92	17	28730.21
-58	5.11	-34	80.97	- 8	1615.62	18	32235.83
-57	5.73	-33	90.85	- 7	1812.75	19	36169.19
-56	6.43	-32	101.94	- 6	2033.94	20	40582.50
-55	7.22	-31	114.38	- 5	2282.12	21	45534.31
-54	8.10	-30	128.33	- 4	2560.58	22	51090.34
-53	9.09	-29	143.99	- 3	2873.02	23	57324.30
-52	10.19	-28	161.56	- 2	3223.58	24	64318.93
-51	11.44	-27	181.28	- 1	3616.92	25	72167.02
-50	12.83	-26	203.39	0	4058.25	26	80972.73
-49	14.40	-25	228.21	1	4553.43	27	90852.90
-48	16.16	-24	256.06	2	5109.03	28	101938.63
-47	18.13	-23	287.30	3	5732.43	29	114377.03
-46.15	**20**	-22	322.36	4	6431.89	30	128333.13
-46	20.34	-21	361.69	5	7216.70	31	143992.14
-45	22.82	-20	405.83	6	8097.27	32	161561.84
-44	25.61	-19	455.34	7	9085.29	33	181275.37
-43	28.73	-18	510.90	8	10193.96	34	203394.31
-42	32.24	-17	573.24	9	11437.70	35	228212.17
-41	36.17	-16	643.19	10	12833.31	36	256058.26
-40	40.58	-15	721.67	11	14399.21	37	287302.10
-39	45.53	-14	809.73	12	16156.18	38	322358.26
-38.19	**50**	-13	908.53	13	18127.54	39	361691.91
-38	51.09	-12	1019.39	14	20339.43	40	405825.00
-37	57.32	-11	1143.77	15	22821.22		

Channel 11 (199.25 MHz)

dBmV	μV/m	dBmV	μV/m	dBmV	μV/m	dBmV	μV/m
-60	4.18	-36	66.32	-10	1323.18	16	26400.83
-59	4.69	-35	74.41	- 9	1484.63	17	29622.22
-58	5.27	-34	83.49	- 8	1665.78	18	33236.68
-57	5.91	-33	93.67	- 7	1869.04	19	37292.17
-56	6.63	-32	105.10	- 6	2097.09	20	41842.50
-55	7.44	-31	117.93	- 5	2352.98	21	46948.06
-54	8.35	-30	132.32	- 4	2640.08	22	52676.59
-53	9.37	-29	148.46	- 3	2962.22	23	59104.10
-52	10.51	-28	166.58	- 2	3323.67	24	66315.89
-51	11.79	-27	186.90	- 1	3729.22	25	74407.66
-50	13.23	-26	209.71	0	4184.25	26	83486.76
-49	14.85	-25	235.30	1	4694.81	27	93673.69
-48	16.66	-24	264.01	2	5267.66	28	105103.61
-47	18.69	-23	296.22	3	5910.41	29	117928.19
-46.41	**20**	-22	332.37	4	6631.59	30	132317.60
-46	20.97	-21	372.92	5	7440.77	31	148462.79
-45	23.53	-20	418.43	6	8348.68	32	166577.99
-44	26.40	-19	469.48	7	9367.37	33	186903.58
-43	29.62	-18	526.77	8	10510.36	34	209709.27
-42	33.24	-17	591.04	9	11792.82	35	235297.67
-41	37.29	-16	663.16	10	13231.76	36	264008.33
-40	41.84	-15	744.08	11	14846.28	37	296222.21
-39	46.95	-14	834.87	12	16657.80	38	332366.79
-38.45	**50**	-13	936.74	13	18690.36	39	372921.67
-38	52.68	-12	1051.04	14	20970.93	40	418425.00
-37	59.10	-11	1179.28	15	23529.77		

Channel 12 (205.25 MHz)

dBmV	µV/m	dBmV	µV/m	dBmV	µV/m	dBmV	µV/m
-60	4.31	-36	68.31	-10	1363.02	16	27195.84
-59	4.84	-35	76.65	- 9	1529.33	17	30514.23
-58	5.43	-34	86.00	- 8	1715.94	18	34237.53
-57	6.09	-33	96.49	- 7	1925.32	19	38415.14
-56	6.83	-32	108.27	- 6	2160.24	20	43102.50
-55	7.66	-31	121.48	- 5	2423.83	21	48361.80
-54	8.60	-30	136.30	- 4	2719.58	22	54262.83
-53	9.65	-29	152.93	- 3	3051.42	23	60883.90
-52	10.83	-28	171.59	- 2	3423.75	24	68312.86
-51	12.15	-27	192.53	- 1	3841.51	25	76648.29
-50	13.63	-26	216.02	0	4310.25	26	86000.79
-49	15.29	-25	242.38	1	4836.18	27	96494.48
-48	17.16	-24	271.96	2	5426.28	28	108268.58
-47	19.25	-23	305.14	3	6088.39	29	121479.35
-46.67	**20**	-22	342.38	4	6831.29	30	136302.07
-46	21.60	-21	384.15	5	7664.83	31	152933.44
-45	24.24	-20	431.03	6	8600.08	32	171594.14
-44	27.20	-19	483.62	7	9649.45	33	192531.80
-43	30.51	-18	542.63	8	10826.86	34	216024.23
-42	34.24	-17	608.84	9	12147.94	35	242383.17
-41	38.24	-16	683.13	10	13630.21	36	271958.39
-40	43.10	-15	766.48	11	15293.34	37	305142.33
-39	48.36	-14	860.01	12	17159.41	38	342375.33
-38.71	**50**	-13	964.94	13	19253.18	39	384151.44
-38	54.26	-12	1082.69	14	21602.42	40	431025.00
-37	60.88	-11	1214.79	15	24238.32		

Channel 13 (211.25 MHz)

dBmV	µV/m	dBmV	µV/m	dBmV	µV/m	dBmV	µV/m
-60	4.44	-36	70.31	-10	1402.87	16	27990.85
-59	4.98	-35	78.89	- 9	1574.04	17	31406.24
-58	5.58	-34	88.51	- 8	1766.10	18	35238.39
-57	6.27	-33	99.32	- 7	1981.60	19	39538.12
-56	7.03	-32	111.43	- 6	2223.39	20	44362.50
-55	7.89	-31	125.03	- 5	2494.69	21	49775.54
-54	8.85	-30	140.29	- 4	2799.08	22	55849.08
-53	9.93	-29	157.40	- 3	3140.62	23	62663.70
-52	11.14	-28	176.61	- 2	3523.84	24	70309.82
-51	12.50	-27	198.16	- 1	3953.81	25	78888.92
-50	14.03	-26	222.34	0	4436.25	26	88514.82
-49	15.74	-25	249.47	1	4977.55	27	99315.27
-48	17.66	-24	279.91	2	5584.91	28	111433.56
-47	19.82	-23	314.06	3	6266.37	29	125030.51
-46.92	**20**	-22	352.38	4	7030.98	30	140286.54
-46	22.23	-21	395.38	5	7888.89	31	157404.09
-45	24.95	-20	443.63	6	8851.48	32	176610.29
-44	27.99	-19	497.76	7	9931.53	33	198160.01
-43	31.41	-18	558.49	8	11143.36	34	222339.19
-42	35.24	-17	626.64	9	12503.05	35	249468.67
-41	39.54	-16	703.10	10	14028.65	36	279908.45
-40	44.36	-15	788.89	11	15740.41	37	314062.45
-39	49.78	-14	885.15	12	17661.03	38	352383.86
-38.96	**50**	-13	993.15	13	19816.00	39	395381.20
-38	55.85	-12	1114.34	14	22233.92	40	443625.00
-37	62.66	-11	1250.31	15	24946.87		

(For the formula used to derive the conversion data in these charts, see May 1989's "Installer's Tech Book.")

Products

Cable dispenser

Spoolmaster Products' Wheel Caddy is a portable cable dispenser equipped with two 6-inch diameter solid rubber tires for easy transport on the job site and is capable of transporting and dispensing spools up to 24 inches in diameter and 17 inches in width. The low profile design of the dispenser prevents it from tipping while in use.

The Wheel Caddy is constructed from carbon steel tubing that is powder coated with polyester resin finish. The spool bars are ½-inch solid steel and are zinc plated to prevent rusting. The unit folds for storage and transport.

For additional details, contact Spoolmaster Products, 2426 E. Westcott, Visalia, Calif. 93277, (209) 732-2736; or circle #131 on the reader service card.

Socket tool

Multilink's new Z coring stripping socket tool was designed to work with CommScope QR cable, Trilogy MC2 cable and Times Fiber TX cable. According to the company, the tool does not clog and tamper the aluminum sheath so the O ring does not get cut.

For more details, contact Multilink, 196 Morgan Ave., P.O. Box 955, Elyria, Ohio 44035, (216) 324-4941; or circle #126 on the reader service card.

Electrical converter

Tektronix introduced its SA-42 optical to electrical converter that enables high-bandwidth Tek spectrum analyzers and oscilloscopes to capture and characterize optical signals with bandwidths up to 7 GHz. The unit also works with other brands of scopes or spectrum analyzers for making light measurements. Connection is via a conventional front-mounted optical fiber connector.

Electrical power for the SA-42 is supplied by rechargeable batteries or by the external 12 VDC power supply that comes standard with the unit. The batteries may be recharged using the external power supply.

For more information, contact Tektronix, Jack Murdock Industrial Park, P.O. Box 3500, M/S C1-894, Vancouver, Wash. 98668, (206) 253-5757; or circle #132 on the reader service card.

Cable locator

Fisher Research Laboratory's Model TW-6 pipe and cable locator has crystal controlled frequency in both the transmitter and receiver, which is superheterodyne. This puts both transmitter and receiver on the same frequency for long tracing distance and eliminates frequency shifts in the transmitter caused by the ground plate assembly or the accessory coupling clamp.

Other features include a voltage controlled oscillator and a specific noise canceling circuitry. The unit is powered by eight standard AA batteries in both the transmitter and receiver; an optional rechargeable battery kit is available.

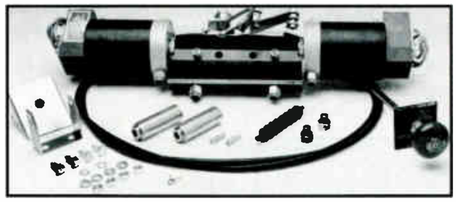
For more details, contact Fisher Research Laboratory, 1005 I St., Los Banos, Calif. 93635-4398, (209) 826-3292; or circle #123 on the reader service card.

Stripping system

According to Klein Tools, its new stripping system for fiber-optic cable can be used for a wide variety of applications for fiber-optic coatings and buffers ranging up to 900 microns and jackets from 0.103 to 0.140 inches. The system allows users to customize stripping tools for their individual needs.

Included are two different stripper-handle assemblies, and 14 sizes of interchangeable and replaceable cutter-blade sets ranging from 0.0055 to 0.054 inches. Also available are 12 sizes of tube guides to assure perfect alignment and scoring of cable jackets, buffers and coatings.

For further details, contact Klein Tools, 7200 McCormick Blvd., Chicago, Ill. 60645-2791, (312) 677-9500; or circle #125 on the reader service card.



Brake locks

Available from Mico, its 670 Accumulock System supplements a vehicle's standard parking brake by utilizing the dual or split hydraulic brake system. It does not interfere with normal braking.

This device provides a fluid accumulator to compensate for fluctuations in holding pressure due to temperature variations. It also includes a low pressure warning switch that signals when proper lock-up pressure is reached or when there is a loss of pressure.

For more information, contact Mico Inc., 1911 Lee Blvd., P.O. Box 2118, North Mankato, Minn. 56002-2118, (507) 625-6426; or circle #127 on the reader service card.

Hydraulic breaker

Allied's AH70 Hand-Ram is a 70-pound, hand-held hydraulic breaker capable of demolishing brickwork and concrete. This tool requires a hydraulic flow of 5.3 gpm to deliver up to 800 blows per minute and features an automatic cutoff valve if pressure is lost. Oil temperature is thermostatically controlled from the Allied power pack.

Exhaust from this unit is eliminated, reducing noise and dust levels, according to the company. An optional flow control valve permits the use of auxiliary power sources such as trenchers, backhoes and more.

For more information, contact Allied, 5800 Harper Rd., Solon, Ohio 44139, (216) 248-2600; or circle #121 on the reader service card. ■

Volt ohmmeter

(Continued from page 19)

If you were to measure the resistance between the center conductor and the sheath with the distant end open, it would appear to be okay, that is, you would read infinity ohms. But if you were to check the cable with the distant end shorted you would read high resistance, this being the resistance of the fault condition. Remember, a good cable should read *low resistance* (10 to 20 ohms when the far end is shorted).

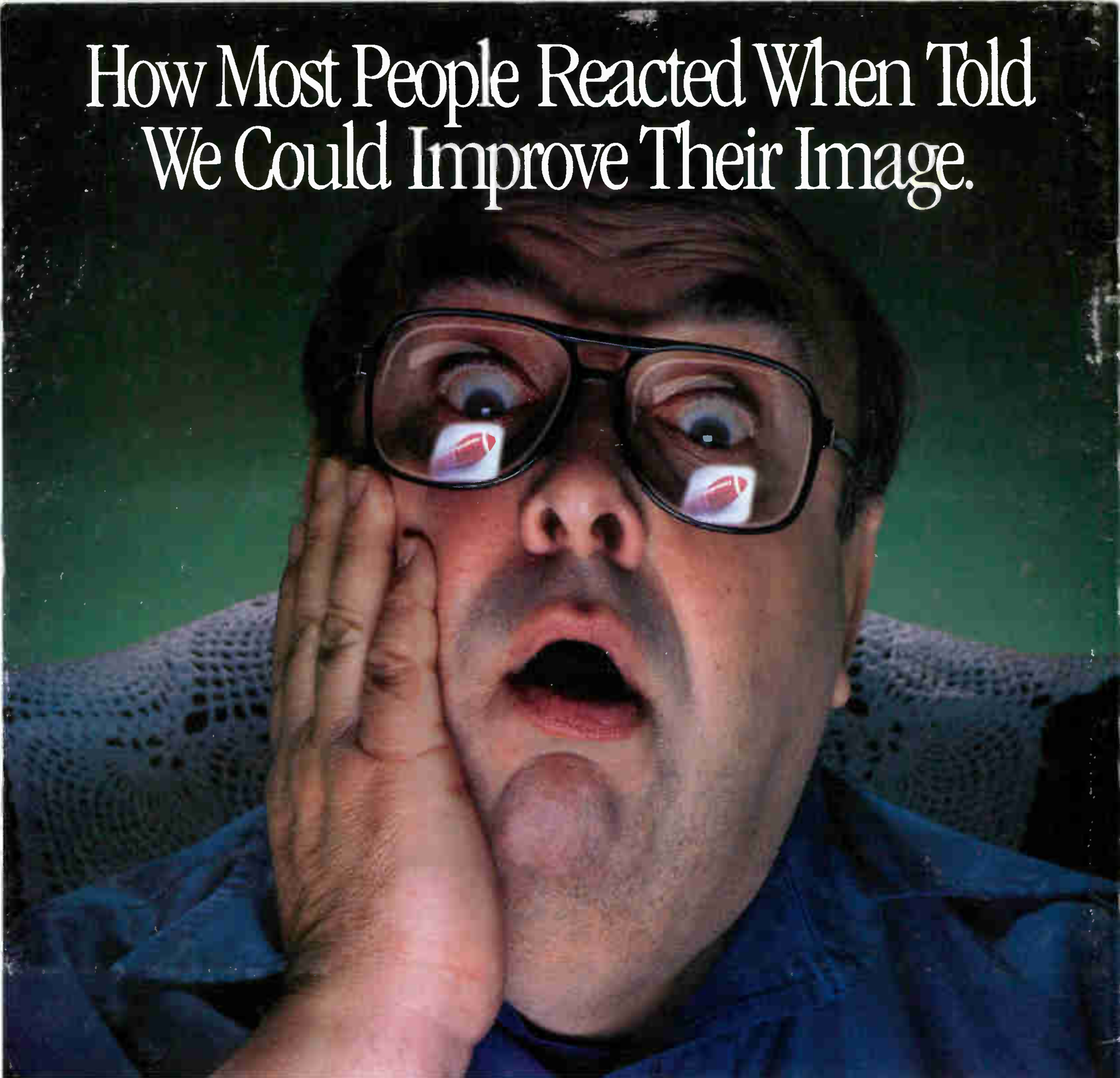
Let us now consider the other fault condition that sometimes occurs in a drop wire. Often when cables have been exposed to water or have been badly kinked they develop a partial short circuit condition between the center conductor and the sheath (Figure 6).

Again, this can be easily overlooked if one is not careful when using a TDR or the fault lies very close to the end of the cable. As with the open circuit fault condition, this can be quickly and easily checked using the ohmmeter.

In this situation (when the distant end is shorted) the cable will check out okay. The fact is there is low resistance in parallel with a high resistance (fault) and the effective resistance will therefore be very low. This time the distant end must be left *open*. Remember, if the cable is good, it should read infinite ohms on the highest ohm scale. If it doesn't, you are reading the fault condition. It is that simple.

The ohmmeter is indeed an extremely useful and often overlooked piece of test equipment. The principle of measuring resistance is as fundamental as Ohm's law. Sure, there is a lot of excellent and sophisticated test equipment but let us not forget the "lowly" ohmmeter.

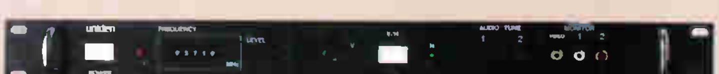
Next month I will describe how the ohmmeter will save you hours of time pinpointing those troublesome short circuits in the system that cause major outages of the trunk. ■



Introducing the new CAT100R, a startling new development from Uniden Satellite Television. The CAT100R features direct entry in 1 MHz steps, so you get pinpoint tuning. Pictures come through with incredible clarity, and the sound, in unbelievably rich stereo.

The CAT100R can also operate on both C and Ku bands. It's MAC-compatible. And since it's from Uniden, you're assured of the highest quality and best features at an astonishing price.

So if you're the least bit image-conscious, the only choice is Uniden's CAT100R. *Putting you face to face with a world of entertainment.*



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