August 1988

Microwave and fiber optics

IT INSTALLER TECHNICIAN

The cable magazine for installers and technicians. Formerly CATJ, Cable Tech.

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Group Vice-President/Technology
Jones Intercable

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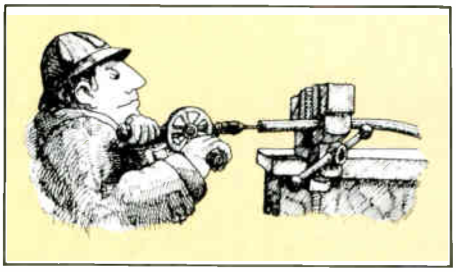

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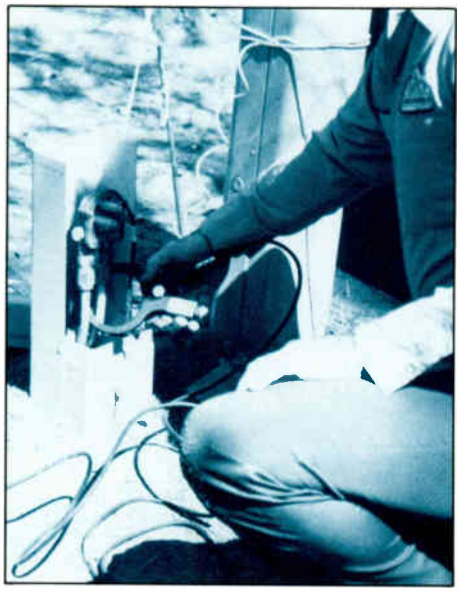

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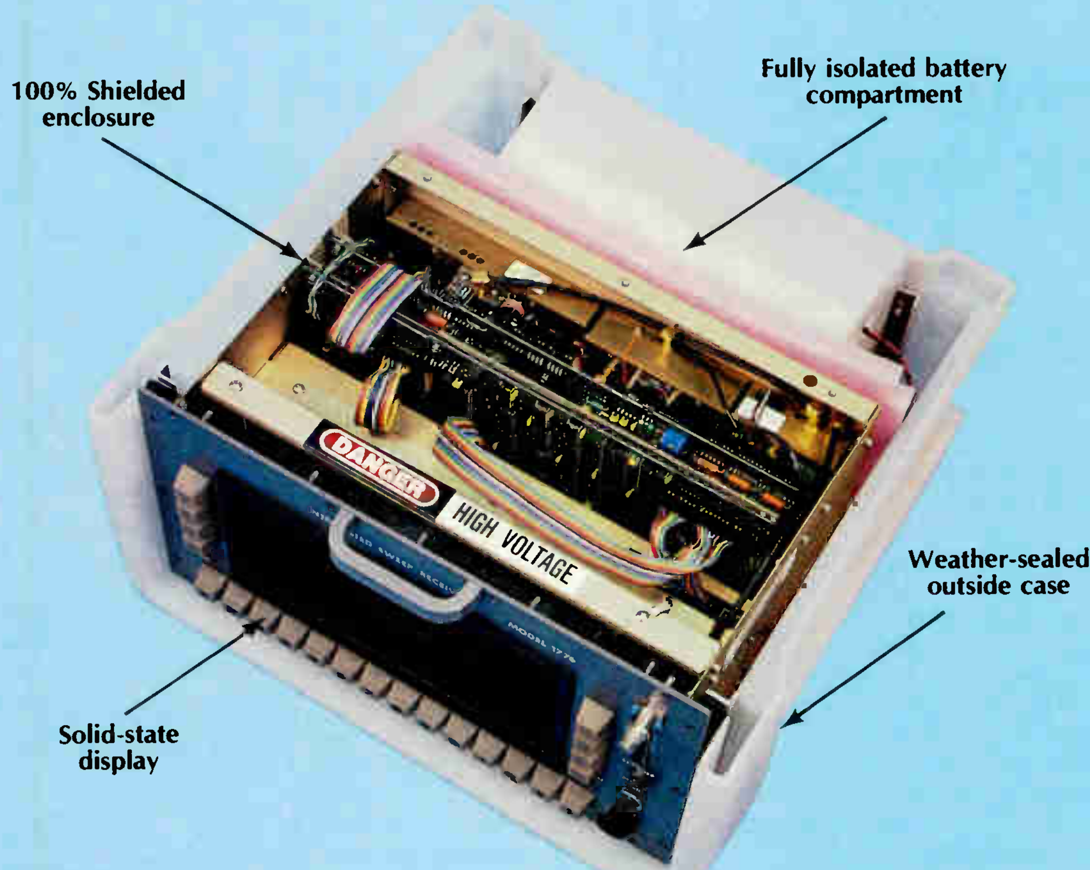
The Inside Story on Reliability



Reliability built into a CALAN, Inc. Model 1776 Sweep Receiver is very apparent from the outside: the totally weather-sealed case; the ruggedized overall construction; the moisture-sealed key covers on the front panel.

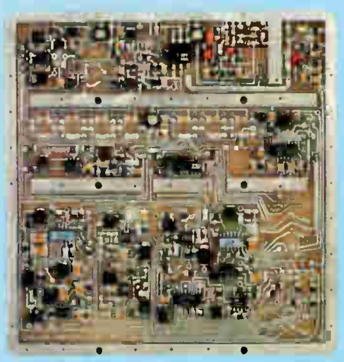
But what really makes this unique equipment reliable is on the ***inside***.

It's high-reliability components throughout the design, allowing incredible stability over temperature and humidity extremes.

It's complete RF shielding, allowing extended dynamic range for precise tests like Composite Triple Beat.

It's a solid-state Electro-Luminescent display, replacing the outdated CRTs.

It's new Surface-Mount RF Technology, making critical RF boards more reliable and more accurate than ever possible before. And a battery compartment that is totally isolated from the electronics, for absolute protection of the unit.



CALAN Surface-Mount RF Technology

It's microprocessor control, making testing easier, faster, and more accurate.

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Reader Service Number 3.

From the Editor

Technician, tweak thyself

A technician from the Midwest writes: "This really happened to me. It was around 2 p.m. when I got the call. The customer was watching the *Gilligan's Island* marathon on a superstation when, in the middle of the episode where Mrs. Howell is planning a soiree for the castaways, the channel selector began selecting its own channels. According to him, first it ran through the entire lineup from Channels 0 to 79 and back again, then it went random.

"I got to the address in seconds flat and approached the residence warily. As the door opened, I asked, 'Having trouble?'

"'Darn right,' he said. 'Look at that.' He pointed to the living room floor. By now, the problem had gotten out of hand. The converter had unplugged itself and began strangling the remote control with coaxial cable. 'Can you fix it?' the man asked me.

"It wasn't easy chasing then subduing the villainous converter, but with a snip of the pliers it was history. Checking its connector, I realized the perpetrator had overloaded on too much input from gangster movies. (A common occurrence.)

"But in a few minutes, the picture was back to normal. And, thank goodness, the remote control had regained its color. As I left, the customer was in cable heaven with Gilligan, the Skipper, too, and so on.

"Just as I got back in the van, the dispatcher had another job for me. Something about signals that leaked all over a neighbor's rose garden. Well, all in a day's work."

Walk on the light side

Perhaps you've got a humorous (but true) anecdote of your own that happened on the job. Maybe one of your fellow installers had to replace a melted aerial drop due to a rambunctious barbecuer. Or a vicious pack of mice kept you at bay when you tried to enter a damaged pedestal. Whatever it is, just jot it down and send it to us at: IT Lighter Side, P.O. Box 3208, Englewood, Colo. 80155. If it's good, we'll use it in an upcoming issue.

As you canine lovers have already noticed, last issue we began a new department in *IT* called "Out of Focus"; this month it appears on page 58. Those of you who take photos and/or have some funny technical photos clipped to the visor of the van or on the bulletin board, send them to: IT Out of Focus, P.O. Box 3208, Englewood, Colo. 80155. If we choose one of your photos, we'll use it and send you $25.

Tip, tip, hooray

In response to our request in the June issue, we've received many excellent "tech tips." Several of them appear this month, such as on page 54. We love 'em, and so will you. So just keep them coming. We're also interested in your queries about writing for *IT*. For more information on how to send in your tech tips or receive editorial guidance, see page 32.

In the meantime, I hope you're surviving the "dog days" of summer.

Rikki T. Lee

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News

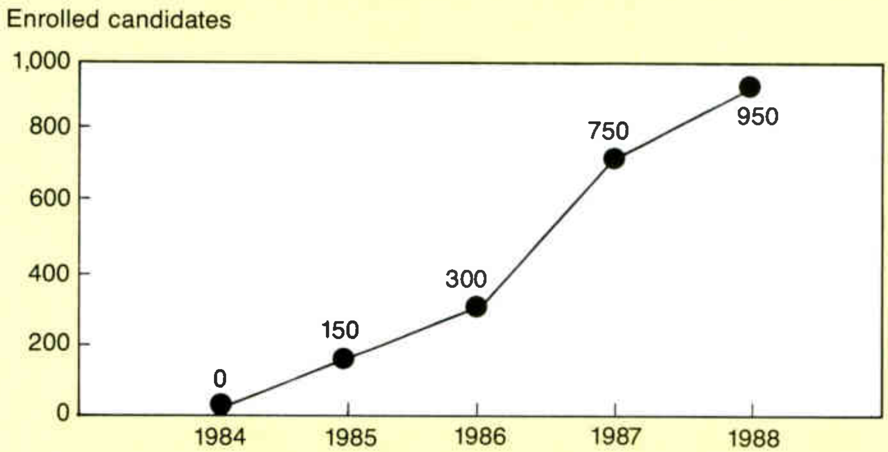
Over 950 enrolled as BCT/E candidates

EXTON, Pa.—The Society of Cable Television Engineers announced a record enrollment of over 950 candidates in its Broadband Communications Technician/Engineer (BCT/E) Certification Program in June. BCT/E exams are offered at major cable shows as well as at seminars conducted by the SCTE's 42 chapters and meeting groups. Also, more than 300 BCT/E examinations were administered to over 140 candidates June 19 at the Society's Cable-Tec Expo in San Francisco.

Candidates currently certified at the technician level include Ron Hranac, Todd Acker and Bob Kanarr of Jones Intercable; Hamlin Robertson of Pacific Cable; Kevin McNichol of Continental Cablevision; James Goins of Florida Cable and Alan Babcock of the ATC National Training Center. Those certified at the engineer level include Leslie Read of Sammons, David Large of Raynet, Don Ward of Post-Newsweek Cable, Steven Johnson of American Television and Communications Corp., Hranac and McNichol.

The Society's new Installer Certification Program also was introduced in a special expo workshop by Installer Certification Program Committee Chairman Richard Covell and SCTE Director of Chapter Development and Training Ralph Haimowitz. Written and hands-on testing of candidates will be administered by local chapters and meeting groups.

BCT/E program over the years



System activates fiber-optic cable link

SURFSIDE BEACH, S.C.—American Telecom Services (ATS) recently completed and activated a 13-mile fiber-optic cable link in Clearview Cablevision's system here. The link between the existing headend and a new hub site replaces traditional coaxial trunk that was part of a 52-amplifier cascade. The 66-channel fiber delivery system is part of the rebuild of Clearview's 450 mile, 22,000 subscriber system being managed by ATS on a turnkey basis.

Correction

In the July issue, the author of "Installer's nightmare" is *Rey* Johnson, not Ray Johnson. We regret any confusion caused by this error.

JUST HOW GOOD IS THE MODULATOR YOU ARE USING?

If the manufacturer of the modulator you are now using says that ...there is an additional charge for Hyperband operation and that ...to guarantee meeting FCC21006 you will need a comb generator, ...but if he will only guarantee his work for one year, then you should consider the following:

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59
CHANNEL
RF LEVEL
OFFSET FREQ
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-25
0
+12.5
+25
KHz

More on Installer Certification

This month's column continues its overview of the nine areas covered in the manual for the SCTE's new Installer Certification Program. This information is provided to inform industry installers of the program and inspire them to participate in this valuable educational undertaking.

The manual was developed for the Society by Richard Covell and his fellow members of the Installer Certification Committee: Ron Cotten, Daniels & Associates; Allen Kirby, Anixter; Dave Pangrac, American Television and Communications Corp., Roy Tartaglia, RTK; and Dave Willis, Tele-Communications Inc.

The following topics are covered in the manual's nine chapters: 1) customer interface, 2) safety, 3) tools and materials, 4) cables and connectors, 5) house drops, 6) building prewires, 7) multiple dwelling units, 8) grounding and bonding and 9) testing/troubleshooting. Certification in the program will require written and practical demonstrations of a candidate's skills in each of these areas. Both written and hands-on testing will be administered by local SCTE chapters and meeting groups.

Cables and connectors begins with a detailed report on drop cable including its electrical characteristics (loss, shielding) and physical characteristics (non-messengered/messengered, non-flooded/flooded and jacket composition). A valuable feature of the section on loss is a chart of typical loss figures per 100 feet of cable for RG-59, RG-6 and RG-11. The shielding section emphasizes the importance of proper shielding of drop cable, providing information on the various methods and materials used in the shielding process. In examining the physical characteristics of cable, the manual looks at the flooded and messengered cable options and discusses the materials most commonly used in cable jackets.

Connectors play an important part in the cable hookup as they interface drop cables with a variety of devices, including tap ports, splitters and ground blocks. The portion of the chapter devoted to connectors examines one-piece F connectors and sealed F connectors. The chapter concludes with information and detailed illustrations on proper installation techniques placing particular emphasis on cable and connectors.

House drops is broken into three parts based on the major steps of house drops: 1) pole to ground block, 2) pedestal to ground block and 3) ground block to television. The first part begins with a passage on preparing and equipping oneself for a house drop. It next provides a step-by-step explanation of proper procedures for drop-related pole work taking into account safety, weatherproofing, clamping, climbing, ty-wraps, drip loops, messengers and taps. It also looks at installation work done in and around the subscriber's house. Included in this section is information on placement of the house hook, keeping proper clearances and providing service without damaging the home. The section on grounding the drop contains guidelines that must be followed in accordance with the National Electric Code when grounding the cable system to the house's present common electrode system. It concludes with a list of proper clearance heights that must be maintained when routing drop cable from pole to house.

The second part starts with a section on underground drop installation that reviews the three most common underground installation methods (hand-digging, plowing and joint trenching) and examines important considerations in underground drops such as site surveying, route selection and selection of the entry point. Methods of burying the drop and dealing with obstructions are emphasized next. The following section instructs participants on how to complete the drop at the pedestal. It concludes with a general review of basic building construction.

The final part includes information on cable routing, explaining the plan to the subscriber, drilling entry holes, placing the cable, working in basements, crawl spaces and attics and wall finishing. This part also has a section on consumer scrambling, addressability, VCRs and TV sets.

Building prewires informs participants on practices to follow when wiring new residential and multi-unit buildings during their construction. Surveying the site, working on the building's inside and outside, locating outlets, wiring, pulling the cable, drilling and labeling are among the procedures described in this chapter, which ends with a summary of the procedures.

Next month's column will cover the chapters on multiple dwelling units, grounding and bonding and testing/troubleshooting.

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, with each group's contact person and phone number. Members should take this opportunity to join a local group.

For more information on becoming a member, contact Pat Zelenka at the SCTE national headquarters, (215) 363-6888.

Appalachian Mid-Atlantic Chapter
Contact: Ron Mountain, (717) 684-2878
Cactus Chapter
Contact: Harold Mackey, (602) 866-0072
Cascade Range Chapter
Contact: Norrie Bush, (206) 254-3228
Central Indiana Chapter
Contact: Steve Murray, (317) 788-5968; or Joe Shanks, (317) 649-0407

(Continued on page 19)

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A MESSAGE FROM THE PRESIDENT

We often don't take time to say "Thank You" to our customers, and I feel I must say THANKS to the System Operators, Engineers, Technicians, and Installers who have, over the last 14 years, supported and assisted us in our growth and development.

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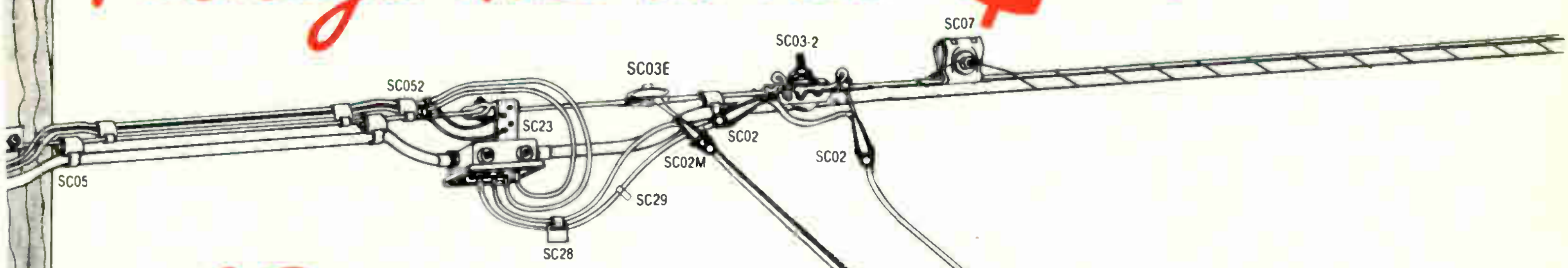

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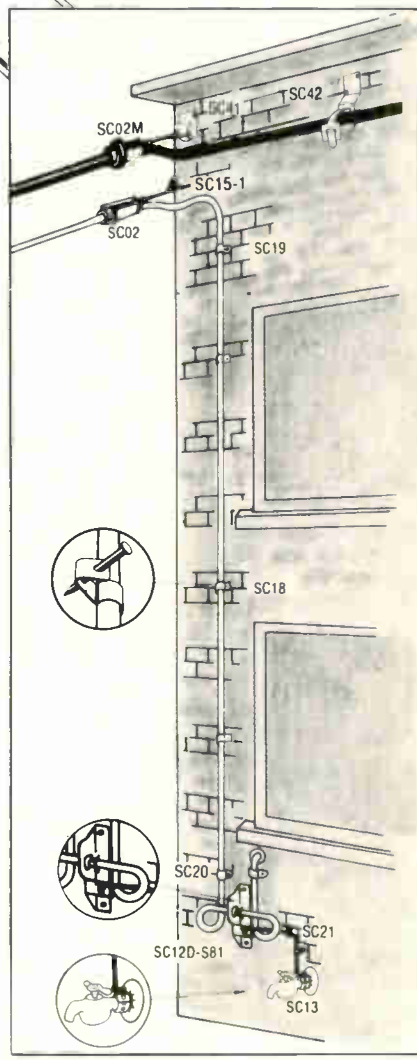

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Tech Tips

Now that summer is in full swing, many rural cable system technicians have had encounters with red bugs (the country folks call them "chiggers"). These little devils can be stopped cold by putting a dog's flea collar around one of your boots. It doesn't matter which one, and I switch sides every few days.

Bill J. Naivar Jr.
Chief Technician
Douglas County Cable TV
Douglasville, Ga.

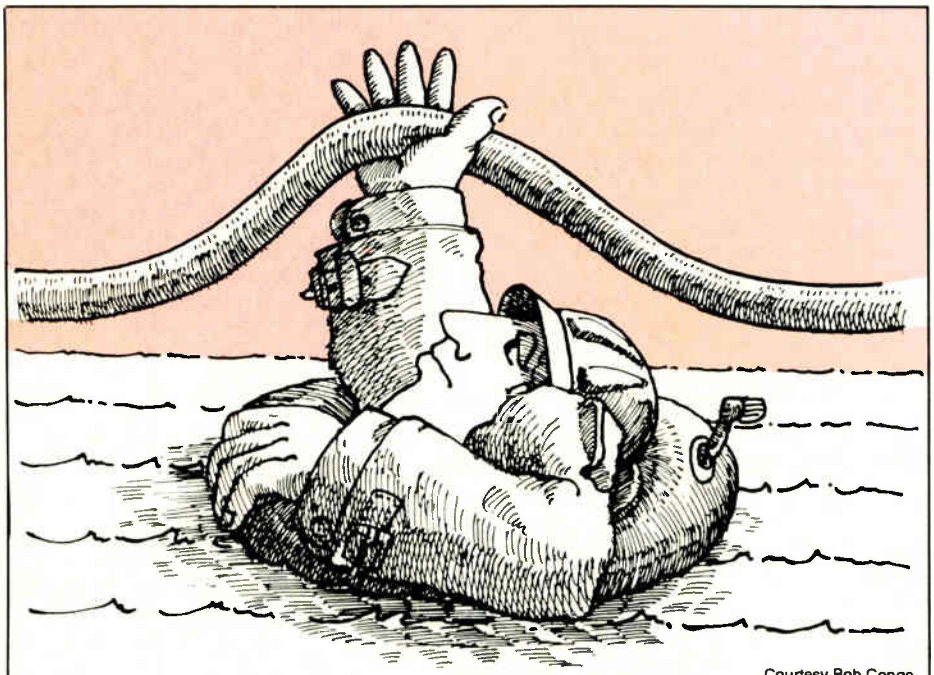
Optical fiber myths

This is the first installment of a series on optical fiber. Future topics will include splicing and handling techniques.

By Scott A. Esty
Market Development Supervisor
Telecommunications Products Division
Corning Glass Works

Once upon a time, a new technology burst upon the scene and took the communications industry by storm. Optical fiber—thin strands of glass capable of transmitting voice, data and video transmissions by pulses of light—quickly revolutionized the nation's long-distance telephone networks. The presence of fiber also is emerging in CATV plant as fiber supertrunks become standard practice and new concepts emerge for optical distribution of programming.

With more than 5 million miles of fiber installed in North America, many of the myths that surrounded the technology have been put to bed. Yet, there are a few nagging concerns regarding the installation and care of fiber that seem to have taken on almost mythical qualities.



Courtesy Bob Conge

Myth: Water causes optical fiber to deteriorate.

Courtesy Bob Conge

Myth: You can't splice one manufacturer's fiber to another's.

Myth: Fiber is fragile.

All of us have been repeatedly reminded since we were children to be careful with glass. But now glass can be made much stronger than you think. An optical fiber without flaws has a theoretical strength of more than 2 million pounds per square inch. Although it is not recommended, field crews have been known to accidentally run over fiber cable with a truck, with no discernible effect to the fiber.

Myth: Glass "flows" over time.

Not so. Glass is an amorphous solid. It's not a liquid and does not flow over time. We've often heard the science teacher's example of windows in old buildings that seem to have settled to the bottom. That's a myth. Old windows were handmade glass and in those days thickness was difficult to control. Panes were installed with the thickest part at the bottom. In the Corning Museum of Glass in Corning, N.Y., there are examples of glass that date from 1,500 B.C. None has deformed from long-term effects of gravity.

Myth: Water causes optical fiber to deteriorate.

Personnel who work with fiber may have concerns about "stress corrosion." In the presence of moisture, if an optical fiber is under tension, a flaw may grow, causing the fiber to break. This is true, but a break requires the presence in sufficient intensity of each of all three ingredients: moisture, tension and a flaw. Without tension or stress as a factor, moisture will not cause fiber to corrode, even if there is a flaw.

Splice cases should be sealed to prevent the entry of large amounts of water, especially in climates where deep freezes occur. If a large quantity of water should freeze inside a splice enclosure, expan-

"Without tension or stress as a factor, moisture will not cause fiber to corrode, even if there is a flaw."

sion forces might put stress on the fiber. But field experience indicates that small amounts of water, such as atmospheric concentration, should not be a problem.

However, water can affect fiber coatings. Since the coatings may soften slightly when wet, care should be taken not to handle any fiber when it is wet. When dried, its original mechanical properties are unchanged. Exposure to some chemicals or extreme environments may darken the color of the coating but does not affect the fiber's performance or strength.

Myth: Cable cuts will cause cracks to propagate in fiber.

If an optical cable is inadvertently dug up by a backhoe, there may be enough force applied to the cable to break the fiber inside. The break, however, may not occur at the point of the sheath cut. When sufficient tension is applied to a length of fiber, the fiber will break at its weakest point along the length. That point may be some distance down the cable, but the fiber will break at only one point. It is called an "offset break" and no other cracks are induced in the fiber.

Myth: In a cut cable, laser light can leak out and blind you.

If a backhoe accidentally breaks a fiber cable, could the operator be blinded by the laser light? If the fiber is held directly to the eye for a prolonged period, there might be enough optical power present to cause injury; otherwise, the danger is quite remote. Power at the laser is usually about 1 mW. While that is considered hazardous if stared at directly, light intensity in the cable decreases considerably with distance. Also, the rough end face on the broken fiber helps to diffuse the laser's energy. In any event, prolonged staring into the end of a cut cable should be avoided.

Myth: You can't splice one manufacturer's fiber to another's.

Despite the differences that exist among glass fibers of various manufacturers, all fibers of a similar type can work together, spliced by either mechanical or fusion methods. Splicing can be done with low losses, high strengths and without significant resetting of commercially available splicing equipment. The fibers should be substantially alike (i.e, single-mode to single-mode), but even multimode fibers of different core sizes have been successfully fusion spliced.

Myth: Fiber has a hole down its center.

Many people think that light travels through a small tunnel in the center of the fiber; actually, the fiber is solid glass. The core glass in the center is surrounded by a cladding glass, which has a lower index of refraction. The two different indices of refraction create a reflective light trap, keeping the light pulses confined to the core glass.

Myth: Video pictures are projected into the fiber.

In fact, the video, audio and/or data are electronically encoded in a representative waveform transmitted over the fiber in pulses of light. These pulses are for-

matted in one of three general ways to represent the signal.

In the simplest, most direct format the signal is transmitted by amplitude modulation of the laser's or LED's light output. Here, the intensity or brightness of the light source is varied in time to define the waveform. This is the closest parallel technology to RF modulation in coaxial cable, requiring minimal signal processing or conversion at interfaces between the two media.

Another analog transmission format is accomplished by frequency modulation. Here, the light pulses in time with the frequency of the signal to define the representative waveform. The pulses of light can be thought of as on/off cycles, but in reality the laser is cycling from "on" to "brighter on."

The last broad category of transmission is digital. This requires more signal processing procedures, but the resulting transmission stream can be precisely accurate quality on the order of a compact disc. The signal is segmented in microsecond increments of time and the waveform measurement in each time slot is encoded in a binary series of ones and zeros. These can be transmitted as either a "pulse" or "no pulse" of light in each defined time slot.


Courtesy Bob Conge

Myth: Cable cuts will cause cracks to propagate in fiber.

Optical fiber can accommodate each of these different transmission technologies equally well. However, since consumer sets are analog today, digital technologies would be expensive to implement now. In the future, system upgrades can be accomplished simply by changing the end electronics. The fiber itself will survive through several generations of electronics. ■

Using fiber cable in the field

By Louis D. Williamson
Technical Staff Member, American Television and Communications Corp.

As the use of fiber optics becomes more prevalent in the CATV industry, many have fears that this technology will be difficult to implement. This fear, which is unwarranted, is due to a lack of understanding of how fiber-optic systems work. Working with fiber is very similar to working with coaxial cable. Field personnel need not concern themselves with the inner workings of a fiber system; their primary interest is the installation and maintenance of the system. With few exceptions, these tasks can be done just like they are handled in a coaxial plant. So don't be awed by the technology.

Safety

Before you begin to work on any fiber system, there are two important safety issues that need to be discussed. First, and most importantly, *never look into an optical source or into the end of a piece of fiber!* The light sources used in most fiber systems are invisible to the human eye. However, this does not mean that they can't hurt you. The power from optical sources can be greater than 10 mW. This is enough power to cause irreversible damage to the eye and even blindness. The light from the end of a source spreads out quickly after it leaves the end of the fiber. This makes the chances of the light bouncing off other surfaces and damaging your eyes low. But be especially careful when using instruments to inspect the ends of a fiber. Most have a magnifying lens that can refocus the light beam into the eye.

When inspecting the ends of a fiber cable, be sure that an optical source is not operating. Never look directly into the end of the fiber; view it at an angle. Also, cap the ends of fiber-optic connectors to protect the person who may not know that there is a fiber system operating in the area.

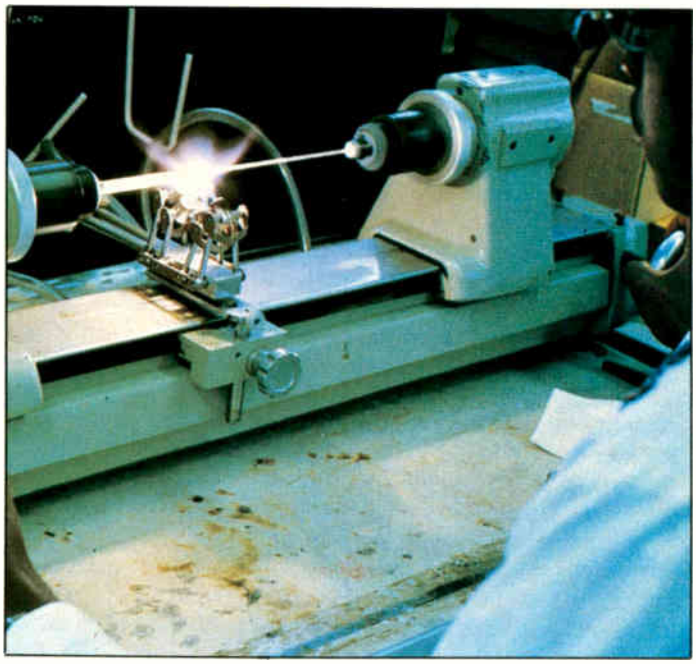
The other safety issue deals with the fiber, which is made from glass. Its outer diameter is 125 micrometers and is very flexible in long lengths. But short pieces of fiber are extremely sharp and rigid. When working with fibers be careful to dispose of all the short pieces of glass left over after splicing. If you get a fiber splinter stuck in your body, it will be extremely difficult to remove. The fiber is transparent; you won't be able to see it. To make matters worse, it has the same refractive characteristics as your blood so it won't even show up on X-rays. While the splinter usually works its way out of the body, during this time it will cause some discomfort.

A simple and convenient way to dispose of the fiber pieces is to stick them to a piece of masking tape. When you make a cleave, take the short piece of glass that's left over and stick it to the tape. When the tape becomes full of fibers dispose of it in a suitable waste container.

Installation

Fiber cable can be installed using the same techniques to install coax. Fiber can be lashed to existing aerial cables, buried in trenches, pulled through conduits or even plowed into the ground. The method used to install the cable is based solely upon needs of the job at hand.

When you install fiber, two things need to be remembered. The first is to monitor the tension on the cable at all times during the installation. The second is to not exceed the minimum bend radius of the cable. Remember that the fibers in the cable are glass. If you stress them, you may shorten their life.



Courtesy Times Fiber

To break a piece of window glass, all you have to do is to create a fault by scoring the glass. When the window pane is put under stress, it will break along the fault. If you introduce a fault into a fiber during installation, the fiber will break along this fault when subjected to external stress.

Most of the fiber cable used in outside plant have a loose tube buffer cable design. In this design, the diameter of the tube is several times larger than that of the fiber it holds. The fiber is longer than the tube, so it lays in a wavy pattern inside the buffer tube.

When the cable is put under tension, the fibers will straighten out. All of the stresses applied will be absorbed by the cable if you do not exceed the maximum tensile rating. But the cable can only endure a certain amount of force. After that point, additional force will begin to stress the fibers.

Always pull by the strength members in the cable and never on the glass fibers. Use a dynamometer (tension gauge) to monitor the tension of the cable as it is being installed so that you will know when you are approaching the maximum tensile rating.

A small bend radius also can cause the fibers to be damaged. If you bend the cable into a small diameter, the fibers will be forced into the side walls. This can create microscopic cracks that will eventually cause the fiber to break. When installing fiber be careful not to exceed the manufacturer's minimum bend radius. Typically, it is 20 times the diameter of the cable. If you have a 0.5-inch cable, it should never be pulled around a pulley with a radius of less than 10 inches. The radius of bends in a cable also will affect the attenuation of the fiber. If you leave a sharp bend in the cable, the attenuation of the fiber will be greater than specified.

Once the cable has been put into place, the ends of the separate fibers must be spliced. Splicing is the precise joining of the ends of two pieces of fiber. These pieces are so small that the task of joining them—and getting good losses—seems impossible. Yet, the splicing of fiber is a very simple task with the proper equipment. Whether using fusion (melting the glass fibers together) or mechanical splicing (holding the fiber together with a fixture), the technology of splicing has been developed to the point that most of the installation errors have been eliminated.

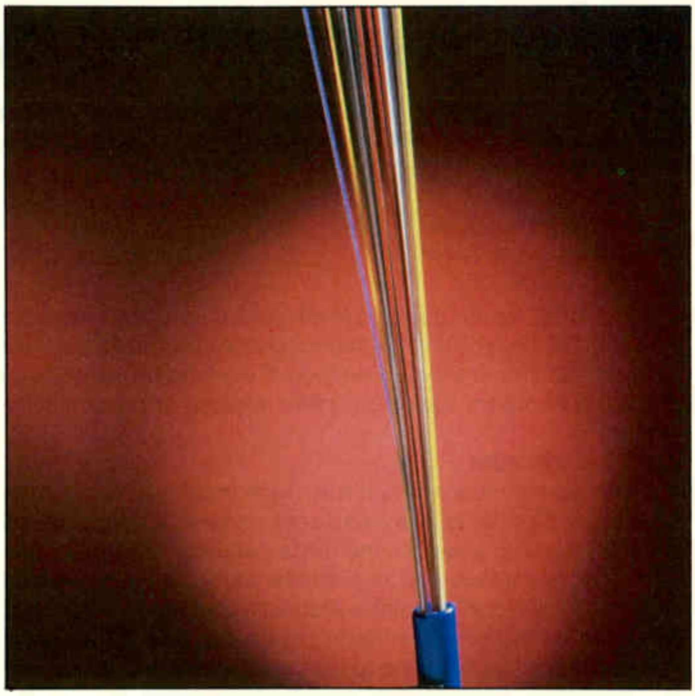
The thing to remember about splicing is to leave yourself enough fiber to do the splice conveniently. The splices are usually put inside a container called a *splice housing*. Inside a housing, leave about 60 inches of exposed fiber on each of the cables going into it. This extra fiber will be needed to reach from the inside of the housing to the fusion splicer or to the mechanical equipment.

Maintenance

There are only two pieces of equipment you will need to test the system: the optical test set and the optical time domain reflectometer (OTDR).

An optical test set is both an optical power meter and an optical source. The measurements on the fiber system are made just like on a coax system. To find the total loss of the fiber, measure the power out of the optical source. Then, connect the source to the cable, go to the other end and measure the received power with the meter. The difference between the readings is the total fiber loss, including splices. Just like in a coaxial system, if you want to know the loss at 400 MHz, you need to measure the cable at 400 MHz. The loss at 300 MHz will be different. Likewise, the loss of a fiber is different at 850 nanometers (nm) than it is at 1,300 nm. If the system you plan on installing uses an 850 nm laser, test it with an 850 nm laser.

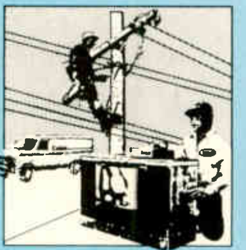
An OTDR is an instrument used to measure the losses in your fiber system. It operates on the same principle as its RF equivalent, the time domain reflectometer. The OTDR launches a short pulse of light down the fiber. As the light travels, some of it is scattered due to the characteristics of the fiber. This light is then reflected back down the fiber to a detector located in the



Courtesy Times Fiber

OTDR. By measuring the time that the light arrives and the power of the received light, the distance and losses of the cable can be determined. Even splice losses can be read directly off of the OTDR's screen, since the light reflected back down the fiber also is attenuated by splices.

The ODTR is the primary piece of equipment used in locating broken fibers. When it is connected to the end of a cable with a broken fiber, the OTDR will display on its screen the distance to the break. So, even if the fiber is broken underground, the break can be easily located. ■



Tech Tips

When finished with setting up a new headend or with an existing site I have found it most helpful to use an embossing gun and mark the front and back of each piece of equipment. In this way any technician can come into your site and become familiar with how the equipment is laid out (it also helps in troubleshooting a problem quicker). When marking the equipment, the processors and modulators should be identified by channel or program identification or the off-air channel identification for that particular area on the front and back. Receivers should be marked in the front by number, satellite, and transponder channel or frequency (just in case it gets bumped or changed accidentally), the back of the receiver by number only. VideoCiphers should be marked by program identification only, front and back. Scramblers should be identified by the channel that they are scrambling.

I have found that a one- or two-drawer filing cabinet in the headend is most useful for keeping equipment catalogs and manufacturers' manuals (this keeps them close when you need to know something and it is fresh in your mind). This is also a good place to keep VideoCipher hot lines and your regular headend maintenance logs (copies only). Also, I like to keep a copy of the satellite diagrams (where the dishes are positioned and which dish is which) and the tower diagram with the last time the tower was checked and who climbed it last.

Neil Waseman
Chief Engineer
Adelphia Cable Communications
Blairsville, Pa.

Instead of keeping loose F fittings in your pockets try this: Take a tennis ball and cut a horizontal slit about one third the way around it. Now poke a hole in the top to put a piece of messenger wire or lashing wire through and attach the ball to your tool pouch. By squeezing the tennis ball the slit will open like a coin purse so that you can put in or take out fittings.

Bill J. Naivar Jr.
Chief Technician
Douglas County Cable TV
Douglasville, Ga.

Basic electronics theory

This is Part IV 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 Deschler
Cable Correspondence Courses

This month we are going to continue our study by analyzing a parallel DC circuit using its characteristics and Ohm's law. Also covered this month will be a method of working with both large and small numbers, called *scientific notation* or powers of 10.

Parallel circuits

A parallel circuit is a circuit with more than one path for current to flow. Figure 1 is an example of a parallel DC circuit showing a DC source, a switch and three paths for current to flow. Each path has a load and an ammeter to measure the amount of current flowing in that path. Also included is an ammeter to measure the total current flowing in the circuit.

Parallel circuits have the following characteristics:

1) The voltage across each branch of a parallel circuit is the same and equal to the applied voltage (E_{app}).
2) The total resistance in a parallel circuit is smaller than any of the individual branch resistances. The formulas used to determine total resistance are as follows:

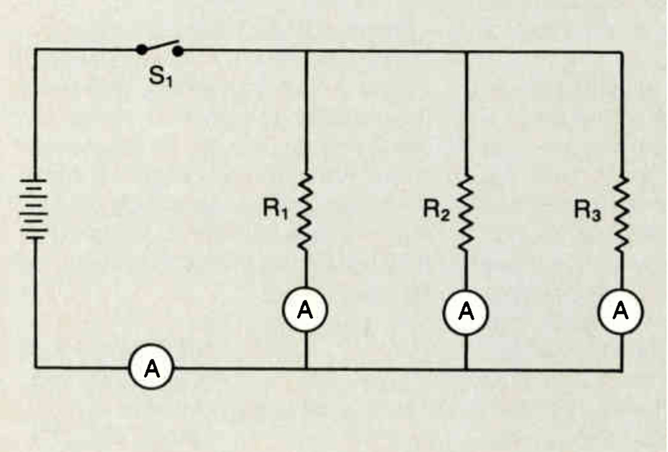
$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} \text{ (2 resistors)} \quad \textbf{(1)}$$

$$R_T = \frac{1}{1/R_1 + 1/R_2 + 1/R_3, \text{ etc.}} \text{ (3 or more resistors)} \quad \textbf{(2)}$$

3) The total current in a parallel circuit is equal to the sum of the individual branch currents.

$$I_T = I_1 + I_2 + I_3, \text{ etc.} \quad \textbf{(3)}$$

Figure 1: Parallel DC circuit



4) The total power losses in a parallel circuit is equal to the sum of the individual power losses.

$$P_T = P_{R1} + P_{R2} + P_{R3}, \text{ etc.} \quad \textbf{(4)}$$

Using Figure 1, let us assign some values and find the remaining ones using the characteristics of parallel DC circuits and Ohm's law.

Given:

E_T = 60 volts R_2 = 20 ohms
R_1 = 10 ohms R_3 = 40 ohms

Find:

R_T = I_{R2} = P_{R2} =
I_T = I_{R3} = P_{R3} =
I_{R1} = P_{R1} = P_T =

Step #1:

$$R_T = \frac{1}{1/R_1 + 1/R_2 + 1/R_3} = \frac{1}{1/10 + 1/20 + 1/40} = \frac{1}{.10 + .05 + .025} = \frac{1}{.175}$$

= 5.714 ohms

Step #2:

I_T = E_T/R_T
= 60/5.714
= 10.5 amperes

Step #3:

I_{R1} = E_{R1}/R_1
= 60/10
= 6 amperes

Step #4:

I_{R2} = E_{R2}/R_2
= 60/20
= 3 amperes

Step #5:

I_{R3} = E_{R3}/R_3
= 60/40
= 1.5 amperes

Step #6:

I_T = $I_{R1} + I_{R2} + I_{R3}$
= 6 + 3 + 1.5
= 10.5 amperes

Step #7:

$P_{R1} = I_{R1} \times E_{R1}$
$= 6 \times 60$
$= 360$ watts

Step #8:

$P_{R2} = I_{R2} \times E_{R2}$
$= 3 \times 60$
$= 180$ watts

Step #9:

$P_{R3} = I_{R3} \times E_{R3}$
$= 1.5 \times 60$
$= 90$ watts

Step #10:

$P_T = P_{R1} + P_{R2} + P_{R3}$
$= 360 + 180 + 90$
$= 630$ watts

or:

$P_T = I_T \times E_T$
$= 10.5 \times 60$
$= 630$ watts

Scientific notation (powers of 10)

When mathematical calculations involving either extremely small or very large units are to be performed, *scientific notation* is generally used. The ability to convert these units to a more workable form is a distinct advantage when working problems in electricity and electronics. In order to convert a number to scientific notation, we must first decide how we wish to change its value. This is accomplished by counting the number of places we wish to eliminate.

When we covered metric units in the second installment of this series, we found that a number could be simplified through the use of a prefix. For example, 5,000 volts could be designated 5 kV. To change a number such as 5,000 using scientific notation, we determine the numerical value we wish to use and then assign the remaining places as an exponent of 10. An *exponent* is a small number placed to the upper right-hand portion of the number, and is called the "power" of that number. For example, 5^2 indicates that 5 is to be multiplied by itself two times, therefore $5^2 = 5 \times 5 = 25$.

The number 10 is unique because when it is raised to a power, the exponent indicates how many zeros have to be added to 10. For example:

$10^2 = 10 \times 10 = 100$
$10^3 = 10 \times 10 \times 10 = 1{,}000$
$10^4 = 10 \times 10 \times 10 \times 10 = 10{,}000$
$10^5 = 10 \times 10 \times 10 \times 10 \times 10 = 100{,}000$

As you can see from these examples, the number of zeros in the answer corresponds to the value of the exponent. We can see then that 5,000 may be written as:

500×10^1
50×10^2
5×10^3
$.5 \times 10^4$, etc.

Through the use of a negative exponent we can change small units to more managable values, as in .0007. This small value may be rewritten as:

$.007 \times 10^{-1}$
$.07 \times 10^{-2}$
$.7 \times 10^{-3}$
7×10^{-4}

We can see from these examples that the value of the exponent tells us how many places we have moved the decimal point to obtain the number value we wish. As a positive exponent increases in value, the decimal point moves to the left. As a negative exponent increases in value, the decimal point moves to the right.

To illustrate the advantage of changing a value through the use of scientific notation, which way of multiplying 5,000 and .0007 would you prefer?

a)
```
  5,000
  x.0007
 -------
  35000
  0000
 0000
0000
 -------
3.5
```

b) $5{,}000 \times .0007$

$(5 \times 10^3)(.7 \times 10^{-3})$
$(5)\ (.7)$
3.5

Notice that when numbers in scientific notation are multiplied, their exponents are added; e.g., $3 + (-3) = 0$.

To divide .0007 into 5,000 we can use the conventional method or we can simply convert to scientific notation:

$$\frac{5 \times 10^3}{.7 \times 10^{-3}} = 7.142866 \times 10^6$$

Notice that when numbers in scientific notation are divided their exponents are subtracted; e.g., $3 - (-3) = 6$.

Check yourself

Using Figure 1 and the following circuit values:

Given:

$E_T = 10$ volts
$P_T = 36.67$ watts
$R_1 = 5$ ohms
$R_2 = 10$ ohms
$R_3 = 15$ ohms
$P_{R3} = 6.67$ watts

Find:

1) $I_T =$
2) $R_T =$
3) $I_{R1} =$
4) $I_{R2} =$
5) $I_{R3} =$

Next month we will analyze a combination of a series and a parallel circuit known as a series-parallel circuit. We also will explain the principles that govern electromagnets. ■

Answers to quiz

1) 3.667 amperes
2) 2.727 ohms
3) 2 amperes
4) 1 ampere
5) 0.667 amperes

Techniques in using a cable locator

By Ken Zalewski
Chief Engineer, Jones Intercable Inc.


The typical approach to a job site. Where do I begin?

Haven't we all heard: "The underground cable runs straight along the fence then turns about here—I think we buried it back in '75 (or was it '77?)." Cable locating is becoming more complicated by the year. Things started out simple—power and maybe phone, then gas, then cable TV. If we were buried jointly, locating was easy. If we were separate, it got a little complicated, but still no big deal. Today, it can be *very* complicated. Power, phone, gas, CATV, independent fiber-optic and other independent circuits, all trying to fit into an easement.

Developments that demand all conductors be jointly buried or in conduit are an attempt to organize the situation. The trend is toward underground facilities. It's evident with new-builds as well as existing customers requesting their services be changed from aerial to underground. With the trend continuing, the area below the surface is becoming a world in itself.

Calling for a locate

Knowing whom to contact to get a locate also can be complicated. Most people have little or no idea who might have buried facilities. In Wisconsin, we have a one-call service "Digger's Hot Line." The concept is that anyone needing a locate can place one toll-free call. The hot line then conveys this information to computer printers located at all companies subscribing to this service. What comes out of the printer will indicate all excavation to be done and only in your area of interest, on a daily basis. You then have three working days to complete the locate.

To do this, you need a locator. It's more than someone with a box in one hand, marking flags and paint in the other and wearing orange-tipped boots. The success of this locating job affects our outage logs, maintenance budgets and our image as professionals in the community. Over the years all sorts of gadgetry has been sold in the pursuit of locating underground facilities.

What you want is a device rugged yet simple enough to use. In most systems locating may yet not be a full-time job. Therefore the locator will be used by a number of people. Get a good, simple and rugged machine from a company that has been around for a long time. The utility companies can be of assistance to find such equipment. When talking to Wisconsin Bell and being told that company started using a specific model back in 1975 and still is, I took notice. Use these sources of information available to you.

Selecting the right unit the first time is a must. It's important that you know what you're buying. Have hands-on before buying. Also, don't let cost be the deciding factor; the price range is from about $200 to $2,000, depending on features.

When you receive the unit, check it out. Be sure you have all the accessories and instructions—and that it works. The very next thing to do is to record the equipment's serial number in your company asset inventory. Next, label the unit with your company name, phone number and the word "reward." If misplaced, it will be easier to contact you with the help of this incentive.

Training of personnel who will use the equipment is also important; don't assume they already know. All too often you hear, "Yeah, I know. I've done it before." Familiarizing personnel will not take long. Instruction can be in the classroom or field and well worth the effort.

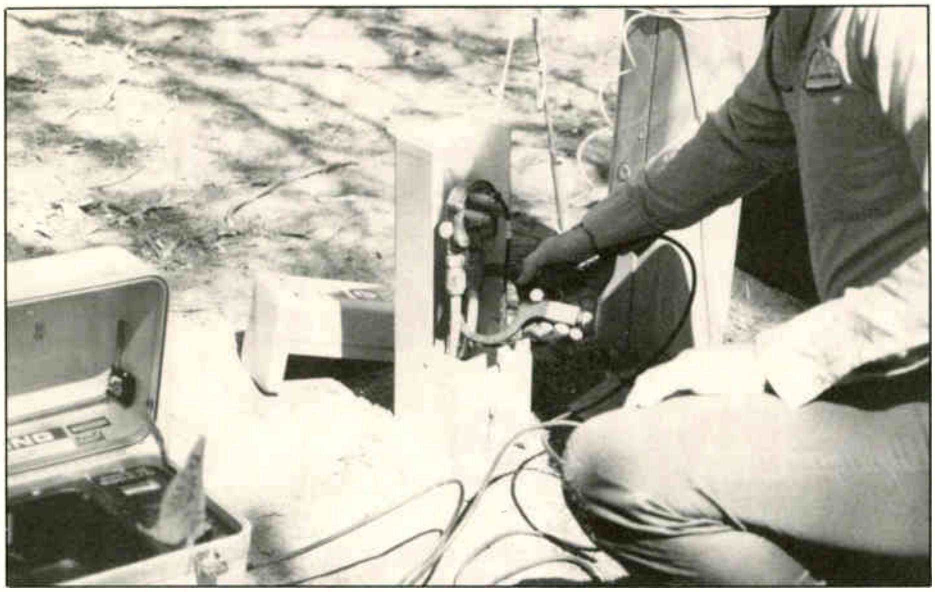
Theory of operation

Cable locators are similar in operation. The basic model is made up of a transmitter and a receiver. The transmitter puts an RF or audio tracing tone on the shield of the cable. The receiver detects the specific tone and will peak or null on it, depending on the selector switch. RF is used in most locates; it is a high-frequency tone that provides accuracy in congested service areas. This mode offers a variety of ways to trace or identify a conductor and is less susceptible than other frequencies to power and man-made interference. Also, it does not require metallic contact or far-end grounding.

Audio transmission is a low-frequency tone that carries for long distances. It also can be used for other metallic service tracing, such as gas and water pipes. Audio requires direct connection to a conductor and the far end must be grounded. It may be susceptible to power influences or other man-made interferences.

There are three basic RF transmitter setups: 1) *direct connection*, where the transmitter connects directly to the shield of cable to be traced; 2) *inductive coupling*, where the transmitter is connected indirectly by means of an inductive loop; and 3) *general induction*, where the transmitter is placed directly over the buried cable. This method will induce a tone in the desired cable as well as any others near by. It works best when only one conductor is buried.

Receivers will be equipped with some sort of signal strength meter as well as a



An example of hooking up an inductive loop.

speaker to guide you when your eyes are busy directing you around bushes and poison ivy.

Practice makes perfect

Locating (like anything else) improves with practice. Until you're proficient at it, dig up and expose the cable. This will give you confidence in what you're doing and an opportunity to check the accuracy of the depth most locators are capable of. Knowng how to use your equipment as well as its capabilities will make your job easier. Features such as peak and null are

> ***"The success of locating affects our outage logs, maintenance budgets and our image as professionals in the community."***

a must. This gives you the option to check the trace in two modes — a double check. Another plus is being able to transmit by several modes. There will be many a time when you will have to use all your options just to get the job done.

And one more thing: when marking the route, use a combination of flags and paint. The flags identify you, and the paint will remain long after the children pull out your flags. Good luck! ■

Acknowledgement: The author would like to thank Richard Rudiger, the tech in the photos, presently a maintenance tech in Stevens Point, Wis.

References

1) Dynatel locator instruction manual, p. 12.
2) Metrotech marketing brochure.

When you need drop equipment, don't talk to a service representative.

Talk *first* with The Drop Shop's "DropPro's."

Drop and installation materials are the lifeline of your cable system. When you order them, you shouldn't have to talk to some freshly-minted "service representative" just out of order-taking school.

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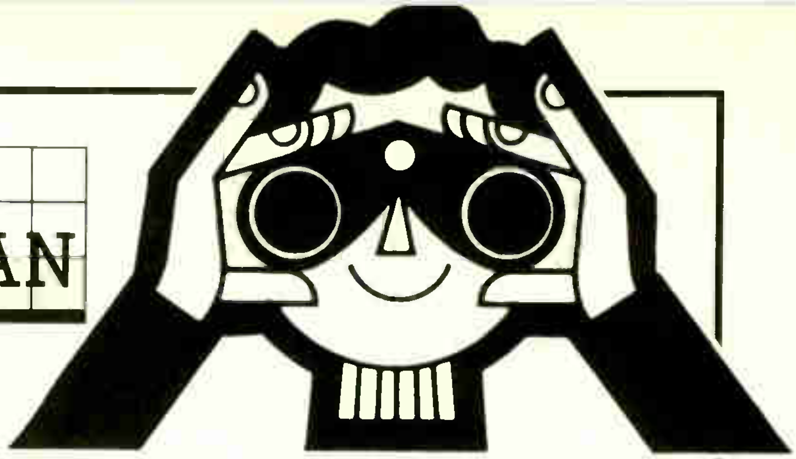

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...climb a pole ...troubleshoot a TV picture
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Understanding AML microwave basics

The following is an excerpt from the "Signal Processing II" lesson contained in the NCTI CATV System Overview course. This material was written to provide a basic understanding of the role of each amplitude modulated link (AML) microwave system component in getting the various input signals from the CATV headend, to a specific hub site and onto the CATV trunk cable. Basic definitions, descriptions, function statements, equipment photos and simplified block diagrams are all used to describe and visualize how each AML single-channel transmitter input signal is upconverted, combined, transmitted, received, downconverted, amplified and finally inserted onto the CATV trunk cable.

"AML utilizes the same standard bandwidth as broadcast TV (VHF or UHF, 6 MHz) and is thus less expensive, but noise is more of a factor."

By Ray Rendoff
Editorial Director, National Cable Television Institute

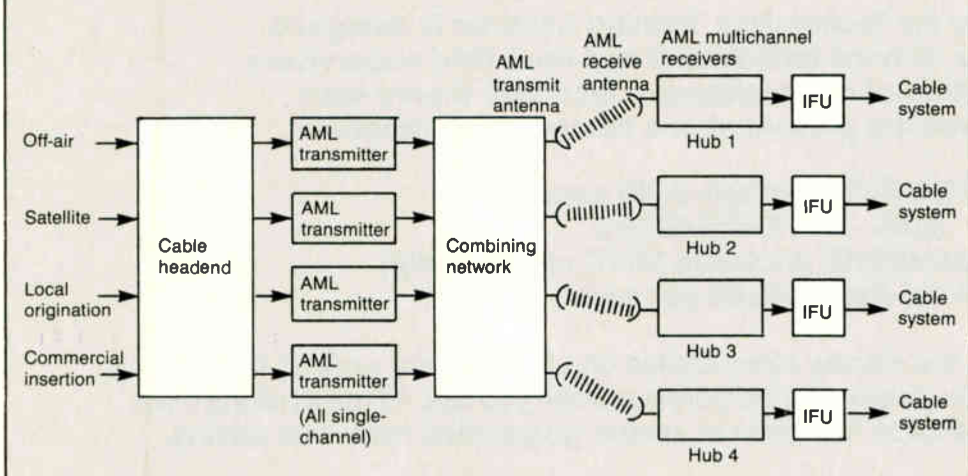
The *amplitude modulated link* is a multichannel AM terrestrial microwave system used for local distribution of TV programming. Unlike single-channel FM (frequency modulated) terrestrial microwave, which is placed ahead of the headend, AML signals are processed and transmitted after the headend and fed to one or more hubs in the CATV distribution system. Single-channel FM terrestrial microwave brings the signal to the headend and is more expensive per channel because of its required wide bandwidth (25 MHz), but provides excellent quality of audio and video.

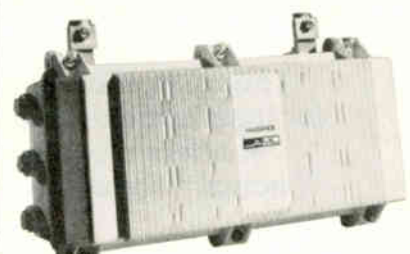
AML utilizes the same standard bandwidth as broadcast TV (VHF or UHF, 6 MHz) and thus is less expensive, but noise is more of a factor. However, because of the lower cost, AML microwave is the more practical means of serving high density commercial and residential units and communities. The AML microwave system (Figure 1) consists of AML transmitters, transmit antennas, receive antennas, AML receivers and interface units (IFU).

The off-air, satellite, local origination, commercial insertion, satellite stereo TV audio and data signals have all been processed in the headend prior to being sent to the AML equipment. The signals that arrive at the input of the AML transmitter are RF carriers at standard cable TV frequencies that are already modulated with video and audio information. Therefore,

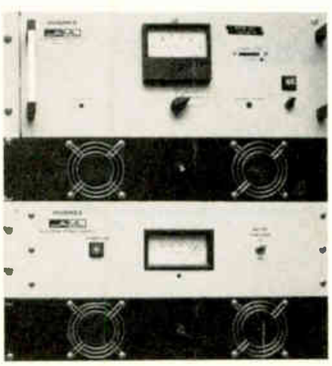
(continued on page 37)

Figure 1: AML microwave system

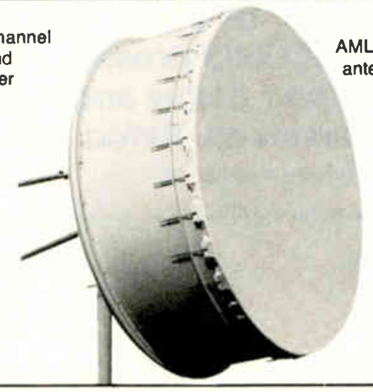




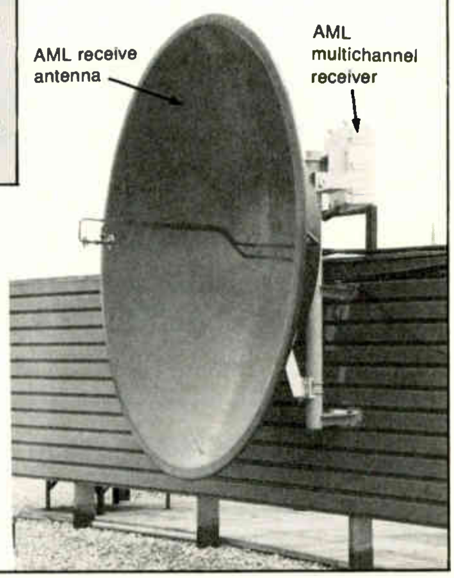
Interface unit



AML single-channel transmitter and power amplifier power supply



AML transmit antenna



Photos courtesy United Cable Television of Colorado, Cablewave Inc. and Hughes Microwave Communications Products.

Microwave communications basics

By Ron Hranac
Senior Staff Engineer, Jones Intercable Inc.

In cable television, we are accustomed to dealing with RF (radio frequencies) ranging from a few to several hundred megahertz (MHz). But once you enter the realm of microwave communications, you are dealing with frequencies in the thousands of megahertz. Frequencies above 2,000 MHz, or 2 gigahertz (GHz), are considered microwave frequenicies. Table 1 summarizes RF allocations up to 300 GHz.

At microwave frequencies, radio waves tend to behave a bit more like light than those at lower frequencies. Because of this, microwave communications generally is restricted to line-of-sight and signal transmission techniques normally associated with optics are used. The world of microwave communications includes such terms as reflection, fresnel zone, focusing, beam bending and refraction.

Figure 1 is a representation of the microwave frequency spectrum up to 32 GHz, and Table 2 summarizes a number of bands within that spectrum that are important to cable television. The cable industry's use of microwave involves both AML (amplitude modulated link) and FML (frequency modulated link) signal transmission. This includes TV channels, video, audio and data over long-haul and medium-haul links (generally FML with repeaters), low density short-haul (AML or FML point-to-point) and high density short-haul links (AML local distribution service or point-to-multipoint).

At frequencies used for microwave communications, we no longer have the luxury of the signal transmission techniques we take for granted at lower frequencies. Above about 2 GHz, coax has too much attenuation for long cable runs. Microwave signals are more efficiently transmitted in hollow pipe called *waveguide*. Above 10 GHz, the size of raindrops is close to that of the wavelength of the microwave signals, causing precipitation to be a concern in over-the-air transmission. The wavelengths of microwave signals in general also can be fairly close the the physical sizes of the components and circuits through which they travel.

At microwave frequencies, it is difficult, costly and sometimes impossible to generate high RF powers that are common at lower frequencies. This is where the similarity of microwave to light is a distinct advantage. Focusing techniques, such as the use of parabolic antennas, concentrate relatively low power levels into extremely high effective radiated powers. These concentrated signals can then be pointed, much like a spotlight, to a distant receive site.

A microwave signal's similarity to light in over-the-air transmission creates a few restrictions that must be considered when planning a microwave link:

- Signals follow a straight line or line-of-sight (LOS) path
- Signal propagation is affected by free space attenuation
- Signal propagation is affected by precipitation
- Microwave energy is absorbed by or diffracted around solid objects
- Microwave energy is reflected from flat surfaces such as water and the sides of buildings
- Microwave energy is subject to refraction (bending) by the atmosphere

Free space attenuation, or path attenuation, is determined

Figure 1: Microwave frequency bands

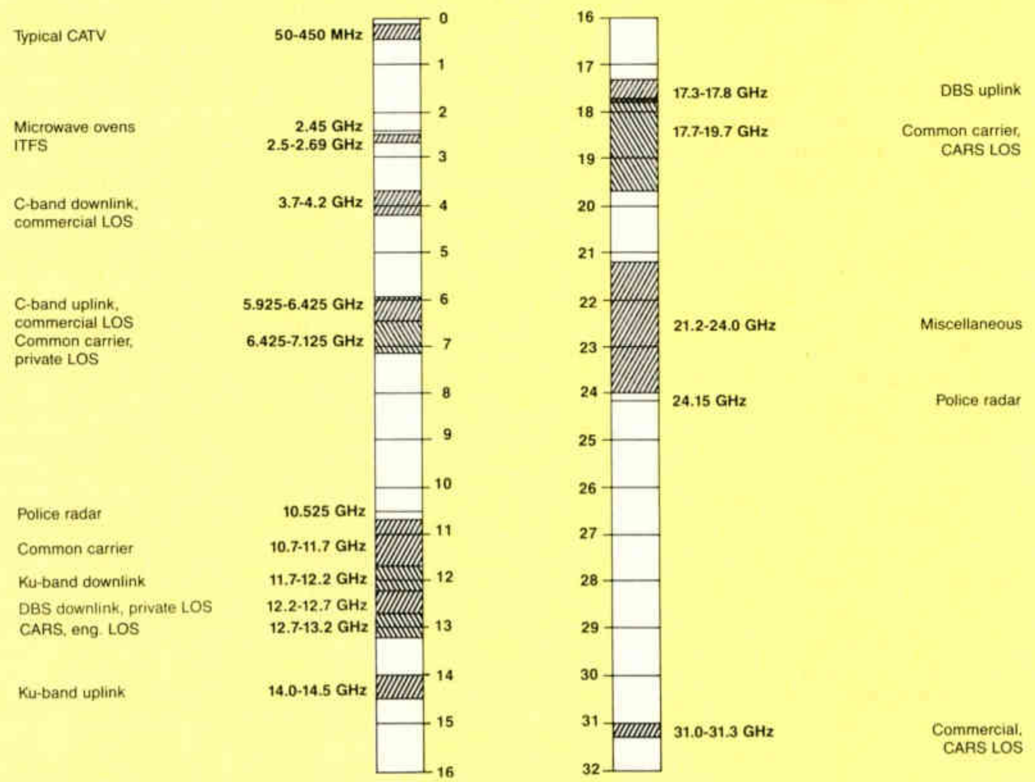


Figure 2: Waveguide polarization

Waveguide and antenna polarization is determined by the direction of the microwave signal E-field vectors (arrows in diagram), either parallel (horizontal) or perpendicular (vertical) to the Earth's surface.

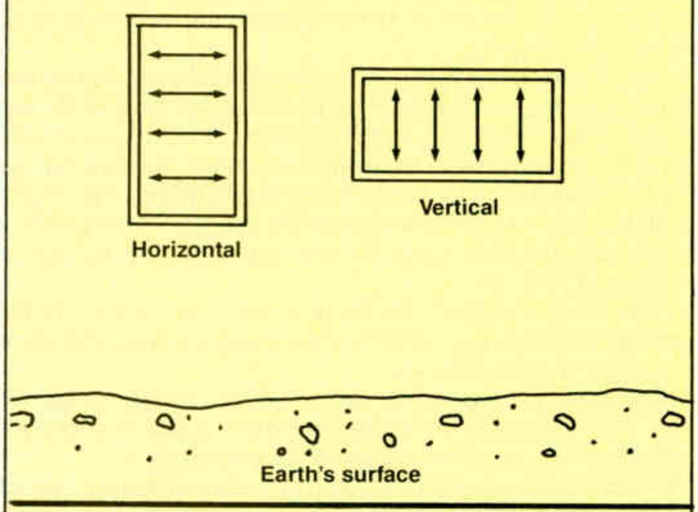


Table 1: RF frequency allocations

Frequency range	Description
3 kHz- 30 kHz	Very low frequency (VLF)
30 kHz-300 kHz	Low frequency (LF)
300 kHz- 3 MHz	Medium frequency (MF)
3 MHz- 30 MHz	High frequency (HF)
30 MHz-300 MHz	Very high frequency (VHF)
300 MHz- 3 GHz	Ultrahigh frequency (UHF)
3 GHz- 30 GHz	Superhigh frequency (SHF)
30 GHz-300 GHz	Extremely high frequency (EHF)

Table 2: Microwave frequencies of interest to CATV

Frequency range	Application
3.7 - 4.2 GHz	C-band satellite downlink and terrestrial links
5.925 - 6.425 GHz	C-band satellite uplink and terrestrial links
11.7 - 12.2 GHz	Ku-band satellite downlink
12.7 - 13.2 GHz	CARS band and ENG links
14.0 - 14.5 GHz	Ku-band satellite uplink
17.7 - 19.7 GHz	Terrestrial links and 18 GHz CARS band
21.2 - 24.0 GHz	Terrestrial links and miscellaneous communications

by using the formula:

Attenuation (dB) = 96.6 + 20log(F) + 20log(D)

where:
F = frequency in GHz
D = total path length in statute miles

Another way to look at path attenuation is to imagine a microwave signal that is being transmitted by an isotropic antenna (a theoretical antenna that radiates equally well in all directions and has 0 dB of gain). At a distance of one wavelength from the antenna, the path attenuation is 22 dB, two wavelengths away it is 28 dB, four wavelengths away it is 34 dB and so on. Each time the path length is doubled, the path attenuation increases 6 dB; each time it is halved, path attenuation decreases 6 dB.

Using waveguide

While coax can be used to a limited degree at microwave frequencies, the use of waveguide is much more efficient. Waveguide, which resembles hollow pipe, is available in a variety of configurations. Those types used by the cable industry include rectangular, circular, elliptical and flex waveguide. Table 3 provides a summary of attenuation specifications for several common waveguides used in CARS (cable television relay service) band communications.

The physical dimensions of waveguide are related to the frequencies that can be contained and transmitted within a particular waveguide. The lowest frequency that a waveguide can transmit is called its *cutoff frequency*. The cutoff frequency's half-wavelength is equal to the inside dimension of the waveguide's wide wall. The narrow wall of the waveguide is usually about half the width of the wide wall, although this dimension is not critical in the standard mode of waveguide propagation (TE_{10}).

The waveguide mode designator, TE_{10}, refers to the magnetic and electric fields of the signals carried within the waveguide. TE, or transverse electric, means that the signal's electric field lines are transverse (not parallel) to the direction of propagation in the waveguide. The two numbers refer to the number of electric field half-alterations across the wide and narrow walls of the waveguide, respectively.

Waveguide and antenna polarization are determined by the direction of the microwave signal electric field vectors (represented by the arrows in Figure 2), either parallel (horizontal polarity) or perpendicular (vertical polarity) to the Earth's surface. In other words, if the wide wall is parallel to the Earth's surface the polarity is vertical; if the narrow wall is parallel to the Earth's surface the polarity is horizontal. The hybrid splitters and directional couplers used in cable TV will not work at microwave frequencies. Fortunately, waveguide can be configured into such devices.

Because of their high gain and efficiency, parabolic antennas are commonly used in microwave communications. The higher the frequency, the more gain a given antenna will exhibit. The larger an antenna, the higher its gain and narrower its beamwidth will be. For severe environments, radomes may be installed on parabolic antennas to reduce wind loading or ice buildup problems. The use of radomes must be carefully considered when a microwave communications system is being engineered, since they do add loss to the system. Table 4 summarizes CARS band antenna and radome specifications.

The gain of a parabolic antenna can be found using the formula:

Gain (dB) = 20log(D) + 10log(10.2E) + 20log(F)

where:
D = antenna diameter in feet

E = antenna efficiency (a percentage, typically around 55 percent)
F = frequency in GHz

Table 3: Waveguide attenuation (12.7 - 13.2 GHz)

Waveguide type	dB/foot	dB/100 feet
Rectangular	0.0415	4.15
Elliptical (EW-122)	0.0410	4.10
Elliptical (EW-127)	0.0370	3.70
Circular*	0.0125	1.25
Flex	0.15	15.00

*Circular waveguide loss does not include top and bottom transition loss, which is typically 0.3 dB total.

Table 4: Antennas and radomes (12.7 - 13.2 GHz)

Size	Antenna gain	Radome loss
4′	41.5 dB	1.5 dB
6′	45.1 dB	1.7 dB
8′	47.6 dB	1.8 dB
10′	48.8 dB	2.1 dB
12′	50.9 dB	2.2 dB

Microwave generally is used by the cable industry as a signal transportation alternative, particularly where it is not feasible to use coax or fiber. It is commonly used to transport signals from a remote antenna site to a headend or from a headend to the community being served. Microwave can be used to serve several communities from a single hub site or to break up long trunk cascades in large service areas. It also can interconnect cable systems and transport specialized services such as ad insertion programming.

FML microwave is usually used where a small number of channels must be transported, because FML signals occupy from 12.5 to 25 MHz bandwidth per channel. In FML, each microwave channel requires a transmitter and receiver. Baseband video and accompanying audio subcarriers (from an off-air demodulator or satellite receiver) frequency modulate the microwave carrier in the transmitter. The output of the corresponding receiver also is a baseband signal, so a modulator is required for each channel at the receive site to allow the signals to be carried on a cable system.

AML is different from FML in that VHF television signals are upconverted directly to microwave either in broadband transmitters or single-channel transmitters, and occupy only 6 MHz bandwidth per channel, just as they do at VHF. A single broadband AML receiver block downconverts the microwave signals back to VHF television frequencies ready for carriage on the cable system.

A basic microwave communications link consists of a signal source, transmitter, transmit waveguide, tower, transmit antenna, microwave path, receive antenna, tower, receive waveguide and receiver. Of course, fully engineered links are much more complicated than this, but the fundamentals of microwave communications apply equally well to all links. ■

AML microwave

(continued from page 33)

no modulation or demodulation process is required at the AML equipment.

The *single-channel AML transmitter* is a combination heterodyne upconverter and power amplifier (Figure 2). A single VHF channel input signal from standard headend processing equipment is upconverted to a microwave frequency (VHF channel frequency plus microwave local oscillator frequency) and then amplified. All the outputs from the array of single-channel AML transmitters go into a combining network prior to being sent out from the transmit antenna(s). The combined signals are fed through waveguide runs to a parabolic microwave transmit antenna(s) for transmission by line-of-sight to the receiving antenna(s).

Figure 2: Single-channel AML transmitter

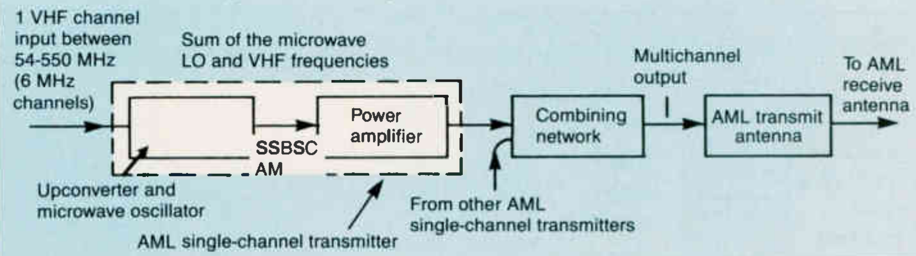
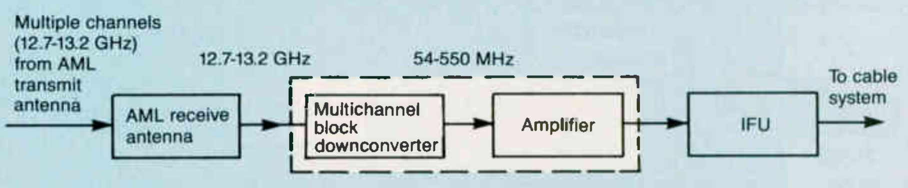


Figure 3: AML multichannel receiver



The AML signal is captured by the receiving antenna and fed to the *multichannel AML receiver* (Figure 3). The AML receiver block-downconverts the microwave frequencies (12.7-13.2 GHz) to the original VHF cable system frequencies (54-550 MHz) and channel assignments that were established by the headend.

The *interface unit (IFU)*, although not mandatory, is a convenient interface between the AML receiver and the CATV trunk line. It can take the place of the first trunk amplifier in the CATV system, provide an additional 15 dB of automatic gain control (AGC), and can provide a convenient means of inserting a local origination signal. ■

HDTV transmission or any channel backup capability for the AML-MTX-132 transmitter

By Davis G. Young
Manager, Manufacturing Engineering
AML Product Line
Microwave Products Division, Hughes Aircraft Co.

The Hughes frequency-agile standby upconverter Model AML-AUPC-135 is a solid-state, 550 MHz broadband, linear upconverter designed specifically for use with any Hughes MTX-132 transmitter (CARS band 12.7 to 13.2 GHz). Once installed in an MTX-132 bay, this standby upconverter only requires three quick cable connections and a driver amplifier adjustment to quickly restore service to any defective channel in the entire transmitter. In addition, the standby upconverter will allow test transmissions and evaluation of any of the competing HDTV formats regardless of channel bandwidth.

The AML-AUPC-135 also could be used to carry a non-premium channel and then switched over to carry a premium channel in the event of a failure. This is a cost-effective way to delay the purchase of an extra bay when you only need one additional channel.

Your AML-AUPC-135 comes with an installation kit. With this kit, you can obtain the quick service restoration described by pre-installing the four coaxial-to-waveguide adapters at the bottom of four circulator strings and the cross-guide coupler above the redundancy switch before you need to put the AUPC-135 into service.

The AML-AUPC-135 obtains local oscillator drive from the klystron pump at the redundancy switch prior to the eight-way divider. This connection is made with a 20 dB cross-guide coupler and a waveguide-to-SMA-adapter provided with the standby upconverter. (See Figure 1.) For RF safety, remove the RF input from the klystron amplifier before inserting the coupler and adapter. Once these are connected, the RF input can be reconnected. Next, a low-loss coaxial cable (3½ foot) is used to connect the adapter to the standby module's RF input jack.

The VHF channel input comes from the output of the normal VHF driver amplifier of the channel being routed to the standby upconverter. A 10-foot cable with BNC connectors is provided in the kit for this purpose. This allows connection to any driver amplifier in an 80-channel system if the standby module is mounted near the center of the array.

Next, the standby module's output is connected to any of the four previously installed coaxial-to-waveguide adapters with a very low-loss cable (4 foot). (See Figure 2.) Care must be taken to connect the standby module output into a channel multiplexing string that does not include a channel with 10 MHz of the channel being carried by the AML-AUPC-135. Normally a guard band of two video channels is used. Example: When adding Channel 10, the multiplexing string cannot contain Channel 8, 9, 11 or 12.

When you are ready to activate the standby upconverter:

1) connect its RF output cable to the proper string;

Figure 1: MTX-132 transmitter block diagram showing agile upconverter installation

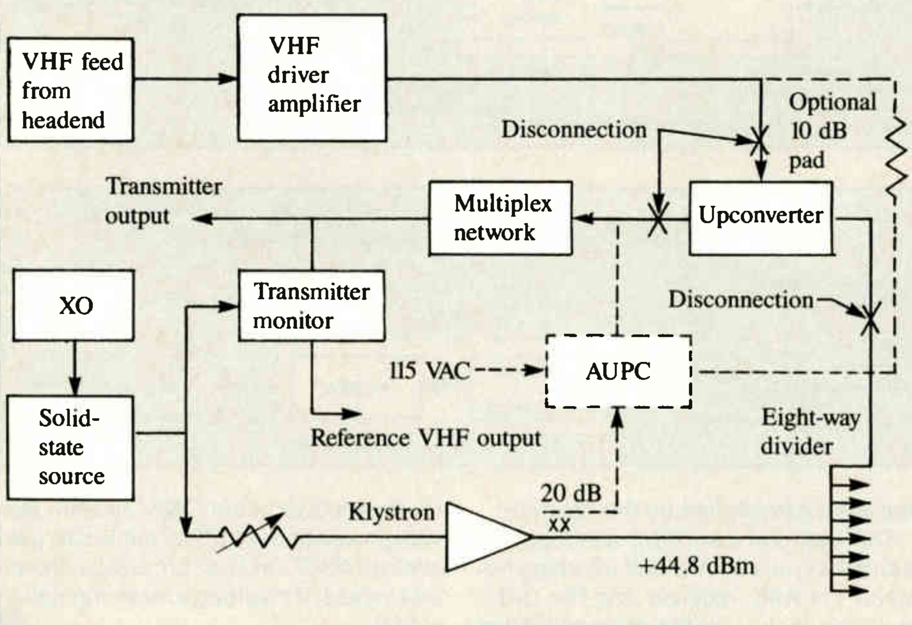
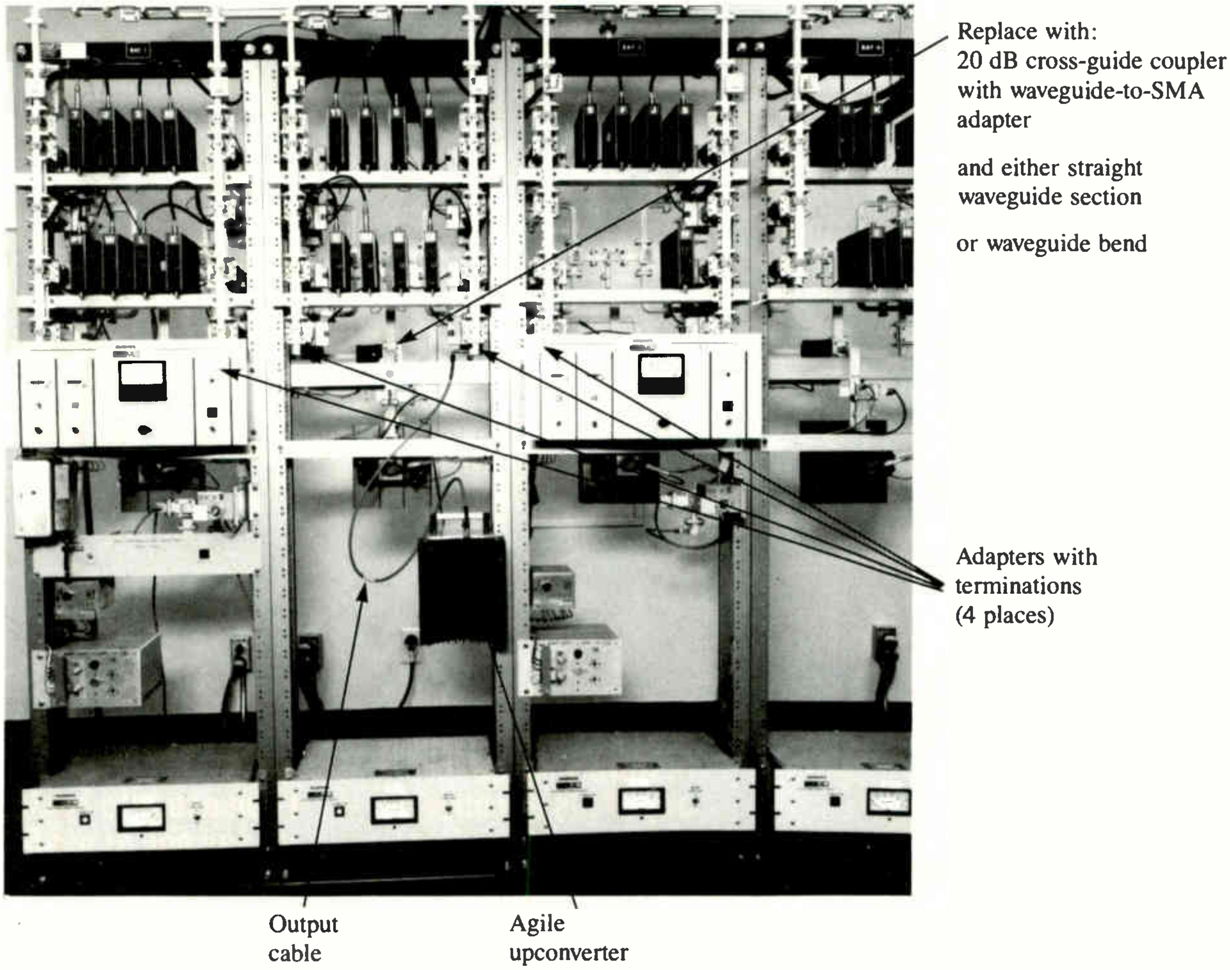
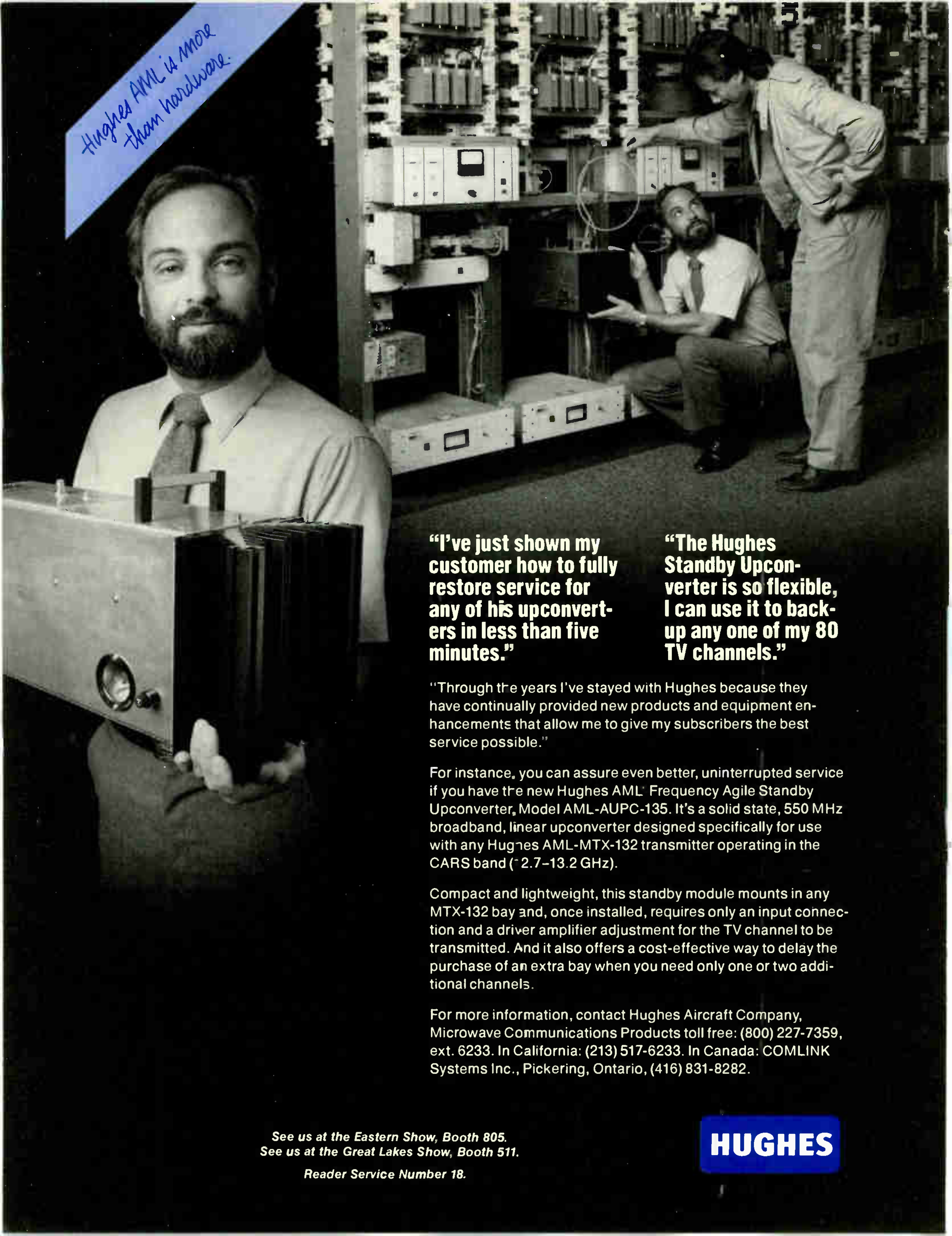


Figure 2: AML-MTX-132 five-bay configuration, front view (first three bays of a five-bay array)



2) connect the AC power line;
3) connect the VHF input cable from the channel driver amplifier to the stand-by module;
4) adjust the VHF driver amplifier for proper channel output. If the level cannot be reduced enough to match the levels of the other channels, add the 10 dB pad to the output of the driver amplifier.

Now that the AML-MTX-132 has the capability to restore service to any channel in less than 30 seconds, you can turn your attention to other headend maintenance tasks. ■


Hughes AML is more than hardware.
"I've just shown my customer how to fully restore service for any of his upconverters in less than five minutes."
"The Hughes Standby Upconverter is so flexible, I can use it to backup any one of my 80 TV channels."
"Through the years I've stayed with Hughes because they have continually provided new products and equipment enhancements that allow me to give my subscribers the best service possible."
For instance, you can assure even better, uninterrupted service if you have the new Hughes AML Frequency Agile Standby Upconverter, Model AML-AUPC-135. It's a solid state, 550 MHz broadband, linear upconverter designed specifically for use with any Hughes AML-MTX-132 transmitter operating in the CARS band (12.7–13.2 GHz).
Compact and lightweight, this standby module mounts in any MTX-132 bay and, once installed, requires only an input connection and a driver amplifier adjustment for the TV channel to be transmitted. And it also offers a cost-effective way to delay the purchase of an extra bay when you need only one or two additional channels.
For more information, contact Hughes Aircraft Company, Microwave Communications Products toll free: (800) 227-7359, ext. 6233. In California: (213) 517-6233. In Canada: COMLINK Systems Inc., Pickering, Ontario, (416) 831-8282.
See us at the Eastern Show, Booth 805.
See us at the Great Lakes Show, Booth 511.
Reader Service Number 18.
HUGHES

Common myths of agility

By John Coiro
President, Marketing and Sales, ISS

There are many common myths about agility and its "limitations" in cable TV applications. While many of these myths were true at one point in time, technology has taken agility beyond its earlier limitations.

Spurious beats. *"Agiles throw beats all over your system."* Development and implementation of better converters and better alignment techniques have made "beats" an unheard of complaint at ISS. Of all QC reports for the last six months, beats have not accounted for a single rejection.

Carrier-to-noise. *"You can't stack agiles without C/N eating your lunch."* True, it is a known fact that a broadband hybrid outputs a low-level noise on the unmodulated bandwidth and the summation of these "noises" will pull your C/N to an unacceptable level. However, rather than a) pretend the problem does not exist or b) go elsewhere and use an inflexible technology, we have opted to do something unheard of in the industry—work with the customer. If you are going deeper than four channels, ISS will provide at no cost the filtering necessary to exceed the NCTA spec of a C/N of 60 dB. In fact, this filtering allows C/N of better than 90 dB out-of-band. The C/N actually becomes unmeasurable on most test equipment found in CATV systems.

Why buy agile, my system lineup won't change. True, and pressure taps are good enough and 220 MHz is all the bandwidth needed for cable. Literally hundreds of firms and individuals are reaping fortunes in the sale of surplus equipment annually. This surplus is simply because system needs and lineups *do* change. This change, sadly enough, occurs before a piece of equipment has lived its useful life. This only serves to increase the real cost of equipment.

Another key factor for both the customer and manufacturer is that the cable TV version of Mr. Murphy's Law states that *"Regardless of the channel desired, there will be a six-week lead time before that item is manufactured and in stock."*

With agility there is no need for a manufacturer to forecast what channels to build for the next production and any channel you might need is available with a simple selection of a DIP switch. If someone needs a Channel W and inadvertently orders a "WW" there is no panic, no restocking charge and no lead time. You simply retune, via a DIP switch, from WW to W.

Stability, offsets, scramblers and the FCC. *"Brand X says that the only way to get required stability in hyperband is to buy special outputs and a comb generator"* or that *"Special charges apply for your offset requirement,"* or *"To get the offset you need, we offset the IF and your scramblers won't work."* We have been able to offer as a standard specification ±5 kHz stability from 2 through WW. But this is only a specification and not to be believed. In actual measurements in the field and in QC the ISS modulator averages ± 3 kHz throughout the entire bandwidth. Offsets are a user selectable option with ISS. You can choose 0, plus or minus in 12.5 and 25 kHz. In offsetting, you do not lose standard IF frequencies. The ISS modulator offsets via microprocessor control, not by shifting the IF frequency. In fact, ISS agile equipment meets all FCC requirements through 1990.

HRC, IRC or T channels. *"You just can't get agiles for these requirements."* Because of microprocessor control, all of these are available (even in the demodulator) with a whopping one-week lead time and $150 option charge.

Reliability. *"The technology is too new and they just won't work for more than a month."* In fact, the techology used for agility is not new; it has been proven in other markets but is now being applied to cable TV. The reliability of ISS agile modulators allows us to stand behind them with a **full three-year warranty.**

ISS Engineering Inc.
104 Constitution Drive, #4, Menlo Park, CA 94025
Phone 415-853-0833 Telex 383524 ISS FAX 415-853-0908
Toll Free: West 800-227-6288 East 800-351-4477

A 'Reel' Problem in Cable

By Tom Wood Jr.
Accounts Manager, Resource Recovery Systems

Organized and systematic reel disassembly and cable retrieval.

The concept of single-usage disposable containers, although once popular, has been shown to be a very wasteful and costly approach to packaging. The increase in the number of states that are mandating source separation of "garbage" into saleable groups such as glass, plastics, metals and paper, together with the decrease in the number of available landfills, is a reflection of this change in attitude.

The easiest way to get people's attention is to hit them where it hurts the most: in the pocketbook. Ecology and recycling are not new concepts. They have, however, become very much in vogue with the increase in profitability of the materials to be recovered from the recycling process. Conversely, those items that are perceived as "non-recyclable" or, more acccurately, "non-profitable" continue to be ignored in lieu of a viable solution to their disposal.

One such item within the cable industry are the wooden reels upon which the all-important trunk and feeder coaxial cable is spooled. Without these cables there would be no cable TV industry; yet the single item upon which this costly signal transmission material rides is often overlooked as if it did not exist. Anyone who has had to deal with these reels in the field can tell you, however, that they do exist. In fact, they take up a considerable amount of room at a contractor's crowded yard or in an expensive warehouse both before and after they are used.

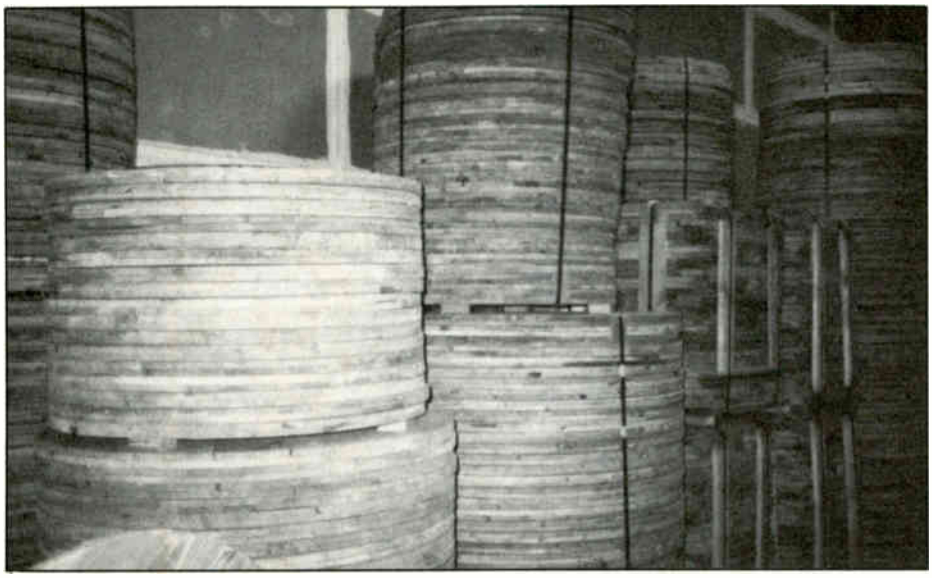
The cable systems' construction contractors will go out into the field with full reels of cable to be strung (aerial) or laid (underground) each day. Dependent upon factors such as pole spacing and the amount of cable spooled on each reel, there will invariably be a certain amount of cable left on the reels that is too short to utilize. This remnant coax can be sold once it has been removed from the reels, but who is responsible for accomplishing this and what happens to the reels themselves?

Space-consuming accumulations of cable and reels.

Historically it has been the responsibility of the construction contractors, who often receive the cable directly from the manufacturer, to dispose of the reels and cable generated during the system build process. If, however, these contractors are not entitled to the money generated from the sale of these materials, why should they care what happens to the reels or the cable? Consequently, much of this material finds its way into dumpsters and eventually landfills (those that are still open) around the country. Those systems that do take the time to strip the cable from the reels are still left with the problem of the disposal of the reels themselves.

For years the various coax manufacturers have been content to pass this problem, inherent with the very product they are selling to the system operators, along to those same customers. The problem of what to do with the reels was passed from manufacturer to MSO to construction contractor. Eventually the reels would either rot in a field somewhere, be used surreptitiously for firewood or picnic tables, or find their way to a dump.

Not until Resource Recovery Systems took the "package" approach to system scrap recycling has there been a cost-



Disassembled reels prepared for shipment back to their manufacturer.

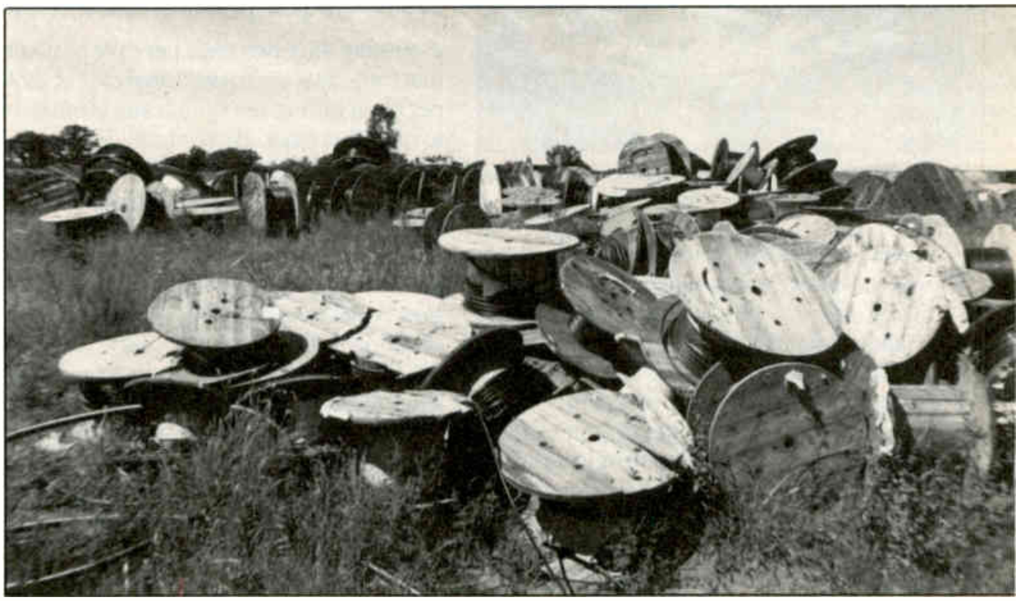
"Unfortunately, the predominant attitude with the cable manufacturers is that the reels are a headache to fool with."

effective and realistic solution to the problem. In addition to paying for the cable removed, we also utilize our own crews to handle the dismantling and removal of the wooden reels at no cost to the system. This can only be done, however, where the various coax cable manufacturers have agreed to utilize refurbished reels for their cable.

For years the cable manufacturers have contended that the wooden reels were never meant to be more than a "one-way, non-returnable shipping container" for their cable. Reusing something made of wood was considered unfeasible. Even now there is a "behind-the-scenes" battle being waged by Resource Recovery Systems to either implement or continue existing reel reuse programs, but to what purpose?

A reel that has been left to deteriorate or has been damaged beyond repair is obviously of no further use to anyone, but what of those thousands of spools that can be recyled? The revenue generated from the sale of these reels back to the cable manufacturers, either directly or through a third party who specializes in such refurbishment, can be used to offset the cost of the labor to dismantle them. Disassembling the reel is the easiest way to remove any saleable residual cable. In addition, dismantled reels are much less bulky and space consuming to either ship back to the manufacturer or to dispose of.

For a cable system to use its own expensive labor to disassemble reels, put them in costly trash dumpsters and then pay to have them hauled away simply does not make good business sense. Yet this is exactly the procedure that cable systems all across the country are utilizing to handle these materials. Then if a local scrap dealer comes along and offers to purchase the cable that has been removed, the MSO feels that they are getting either good "service" or a good "deal," neither of which is true.



Old forgotten "problems" pose health and safety hazards.

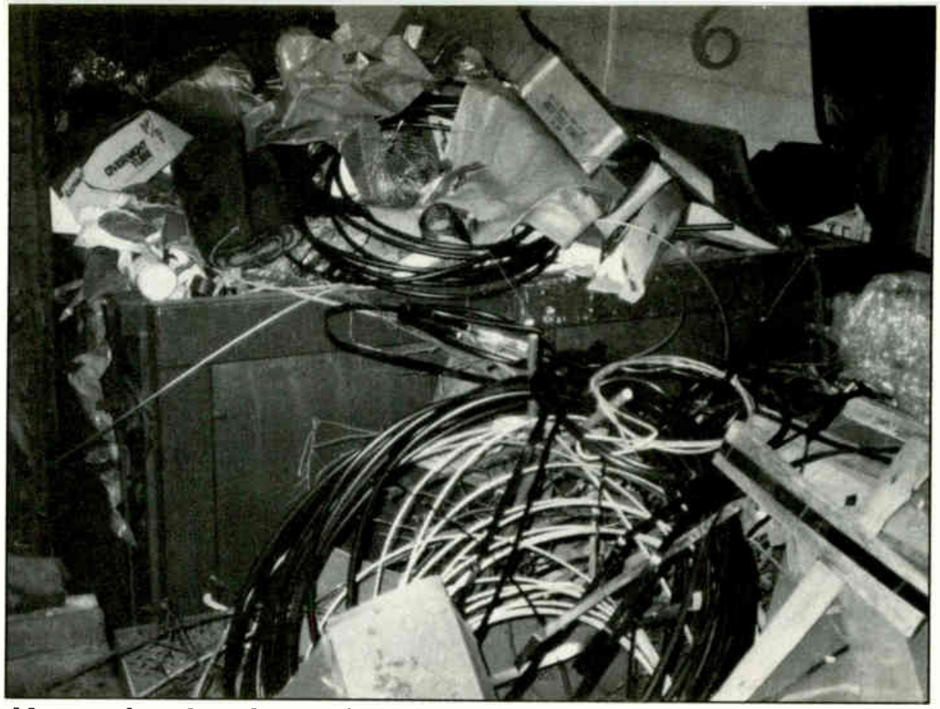
Only by utilizing a company such as Resource Recovery Systems, with a proven track record of truly handling all salvageable materials, can cable systems assure themselves of maximum dollar return without the hassles of having to provide separate contractors for the labor, hauling, etc. There must be a cooperative effort on the part of the cable systems themselves, however, to ensure their own frugality.

If a considerable amount of money can be saved by utilizing the cable that comes on a recyclable reel, why, then, would one use anything else. The answer is that a good number of people in the cable industry simply do not know of the potential problem that exists with these reels. Those that do know have, in essence, helped "persuade" those cable manufacturers that did not recycle their spools to initiate their own programs.

Unfortunately, the predominant attitude with the cable manufacturer is that the reels are a headache to fool with. This is usually translated into "Our customers are concerned about the quality of the product and do not want a recycled reel." In reality, most field-level construction or engineering personnel couldn't care less whether the reel had been used once or a dozen times as long as the cable is sweepable. In fact, some individuals have stated that the refurbished reels are often in better condition than when they were new!

The ability to save the cable system money by recyling the wooden spools has

Ongoing access problem at system headend.



Messy and costly reel and cable disposal dumpster.

been an overlooked sales tool even by those companies who have such programs. The very people who are purchasing this material for distribution in the field often do not even know whether or not their supplier has a reel buy-back program because the manufacturers do not go out of their way to advertise it. Upon questioning, however, it is grudingly admitted as if it were something to be ashamed of, rather than something that could help them sell their cable as well as save themselves and their customers money.

The cost of the disposal of these materials has to come out of someone's pocket. That someone, unfortunately, has ultimately been the subscriber. Imagine the reaction of the public if they could be shown where their local cable company routinely landfills 10 percent or more of its total construction materials' budget, necessitating an increase in their basic subscriber rates!

As an example, a new cable reel might cost $30 to produce, the labor to dismantle it $5, and the cost to landfill it (including dumpster fees) another $15. Conservatively assuming only two reels per mile of plant, that translates to an additional cost of $100 per plant mile to the system and ultimately to the subscriber. By contrast, if the reels are recycled even once, the savings to everyone involved are considerable. If you then consider the revenue to be generated from the sale of the cable scrap, you are now talking in terms of positive cash flow rather than negative; a more desirable situation in anyone's vocabulary. Not until the MSOs themselves begin to acknowledge the vast potential for wastage and lost revenue that exists in the field during system construction can the latter of these two alternatives be achieved. Recognizing this, however, often begins well in advance of actual construction.

The responsibility for the monitoring of the disbursement of all construction materials begins at the purchasing level. Without proper coordination between those who are buying the cable and those who are actually using it (usually the construction contractor), the system loses contact with its high-priced investment.

Quite often construction yards are makeshift facilities without proper unloading or storage capability. They are, therefore, conducive to materials damage and/or theft. Inadequate inventory control in such a situation might also allow the situation where usable partial reels of cable could become integrated with the non-reusable and eventually find their way to the scrap pile.

Another potential and not uncommon problem is that of the new reels containing more cable than a particular system's pole spacing can effectively accommodate. For instance, if the reels are routinely delivered with 2,400 feet of cable and the maximum pole spacing is 1,800 feet, there is a built-in "waste factor" of 600 feet or 25 percent!

All businesses, including the cable industry, are actively involved in improving their image within their respective communities. Local cable TV companies sponsor everything from fund-raising telethons to little league baseball teams to accomplish this. Why then do they continue to disregard their communities' increased concerns for the environment by allowing these bulky and often hazardous construction materials to pose a local disposal problem?

It's the responsibility of the MSOs themselves to ensure that the millions of dollars worth of materials that were paid for with real money (not potential lost revenue as with signal theft) do not continue to go into dumpsters and landfills or to unreputable scrap dealers around the country. Proper management of these materials before, during and after construction will ultimately ensure savings for cable systems as well as their customers. ■

Proper drop grounding practices

By Leo Garcia
National Training Director, Sachs Communications

What is the "best" ground electrode? What is a bonding conductor? What is a ground electrode conductor? What is a ground electrode system? Why should I care? These may be questions you have asked.

The primary purpose of bonding and grounding is to reduce the danger of potentially fatal electric shock to employees and the general public. The secondary purpose is to minimize system damage in the event of accidental contact of CATV strand with power lines. A third reason is to protect against transient currents with differing potentials to ground. Proper bonding and grounding is especially important in the event of lightning strikes, which, while lasting only milliseconds, can be fatal and cause costly damage to materials. (Need more be said about why you should care?)

The issue of selecting an appropriate ground source and determining when bonding is required is left to installers or technicians who often have not received any training—or at best have received minimal training in grounding and bonding requirements. These requirements are contained in the National Electric Code (NEC) Section 820, which specifically applies to the CATV industry. Also, it's a good idea to check any local codes that may be applicable for your system's area.

Defining terms

In order to answer the questions raised previously, we must first define some terms, including:

Ground—a connection to earth or a conductor serving as earth potential. This connection may be either intentional or accidental.

Bond—an interconnection of different ground conductors made by using a bonding conductor of sufficient size

"The primary purpose of bonding and grounding is to reduce the danger of potentially fatal shock to employees and the general public."

(usually #4 or #6 AWG copper wire) to conduct any current likely to be imposed.

Earth potential—To define this term it is necessary to define the components of the term. Earth or the rock, soil and moisture of which it is comprised provides our primary grounding source. Potential is the measurable voltage difference or electrical charge between two points in an electrical circuit. A grounded circuit at earth potential would therefore have 0 volts potential relative to a ground source acting as earth potential.

Ground electrode system—a series of ground sources or electrodes interconnected through bonding conductors to minimize electrical resistance to ground.

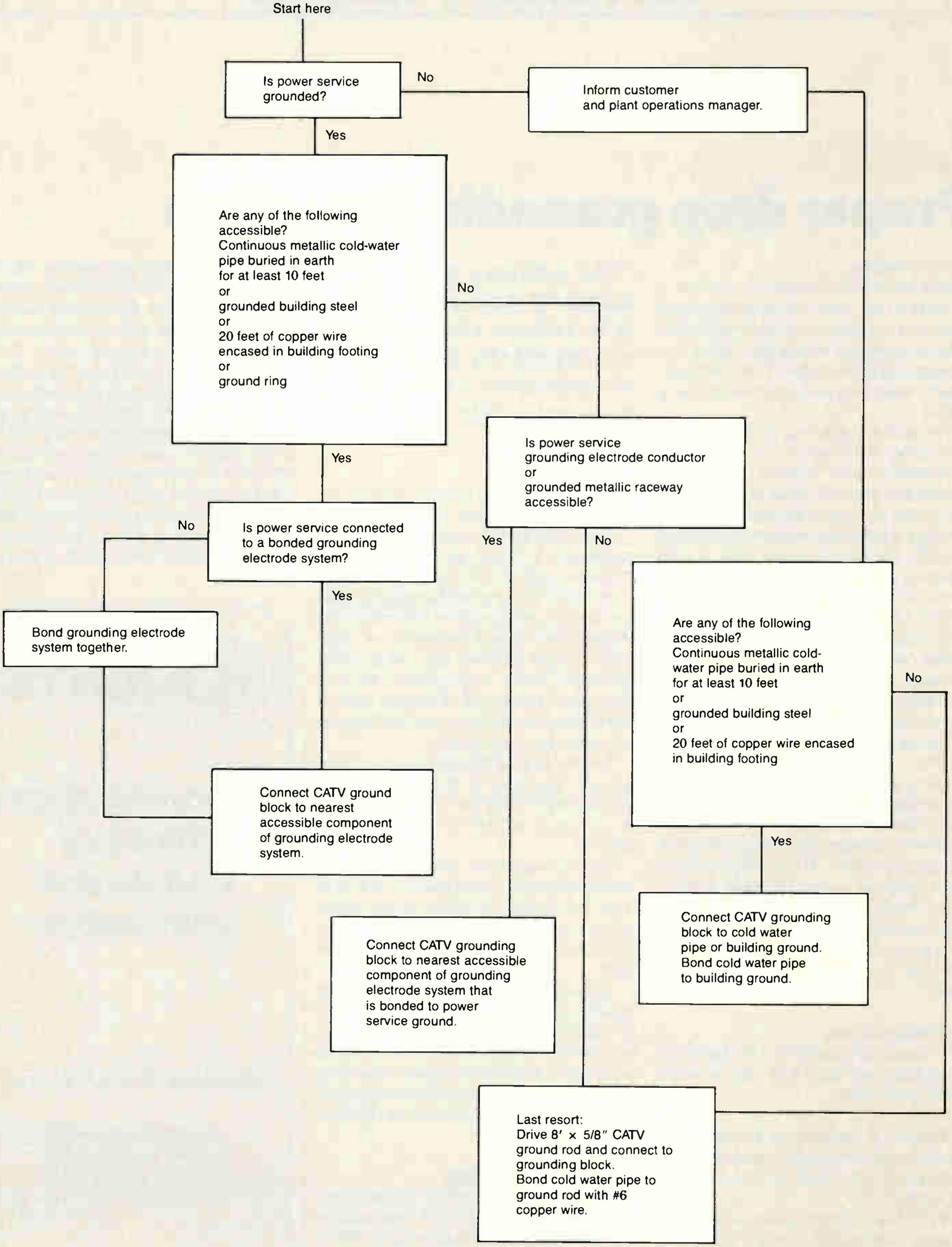
Ground electrode conductor—commonly referred to as a ground wire, it is used to connect the cable sheath to the ground electrode. We normally use #14 or #12 AWG plastic-coated copper ground wire.

Grounded drop—Where coaxial cable is possibly exposed to lightning or accidental contact with high voltage (300 volts) commercial power, a grounded drop is necessary. An effectively grounded drop involves connecting the outer conductive sheath of the coaxial cable to an effective ground electrode.

The best grounding

To answer the question: "What is the *best* grounding electrode?" we have to comply with the 1987 edition of the NEC. Simply, it states that if the following items are available and accessible, we will ground to them. Most commonly used is a metal underground water pipe; select a copper cold water pipe and attach a copper pipe strap. A second choice is the metal frame of a building, if the building has one that is verified as being effectively grounded. The third choice is a concrete-encased electrode (sometimes called a "Ufer ground"), which consists of at least 20 feet of ½-inch steel reinforcing bars or a #4 bare copper wire in direct contact with earth. A ground ring is the fourth choice, which consists of at least 20 feet of #2 AWG bare copper wire buried at least 2½

Grounding flow chart



feet below the surface of the ground.

Other selections for grounding conductor connections include external metallic contact points on the power service enclosure (such as the service mast, unused screws on the enclosure box or the grounding conductor from the enclosure) and grounded metallic raceways.

Ground wire should be run in as straight a line as possible and protected from physical damage. It should *never* be wrapped around nails or screws as a means of attachment to the customer's premises.

Where none of these grounding electrodes are available, a "made electrode" may be used. This must be of a conductive material, embedded below permanent moisture level in the soil, free from non-conductive materials (such as paint) and bonded to any other electrode used for grounding purposes. This is commonly called a "ground rod." It must be a minimum 8-foot by 5/8-inch copper-coated steel rod.

To quote the *NEC Handbook*, "The most common error made in grounding CATV systems is to connect the coaxial cable sheath to a ground rod, driven by the CATV installer at a convenient location near the point of cable entry to the building. This is permitted by the code only if the building or structure has none of the grounding means described..."

The ground rod is therefore the last available option in grounding the drop. If it is used, the NEC requires that it be bonded back to any other ground electrode with #6 AWG ground wire.

Cable grounding

Aerial plant is grounded every first, 10th and last pole on any given run. This is to protect the plant against damage from "foreign" voltage as much as possible. A resistance-to-ground of 5 ohms or less is desirable at this point.

The drop is grounded to the structure grounding electrode system and, although the desired resistance-to-ground is (again) 5 ohms or less, cable operators generally accept the limit of 25 ohms or less as required by the NEC.

Grounding the sheath of a coaxial cable when that cable is exposed to lightning or accidental contact with power lines exceeding 300 volts to ground constitutes an effective ground, as long as the cable is grounded at a point as close to cable entry into the building as practical. When the outer conductive sheath of a coaxial cable is grounded, no other protective device is required.

Effective cable grounding requires that the grounding conductor (wire) have a rubber or other suitable kind of insulation. The conductor should be copper or a corrosion-resistant conductive material, either stranded or solid. The size of the grounding conductor shall not be smaller than #14.

The accompanying flow chart will help installers and techs in their selection of an appropriate grounding electrode. It also will provide a tool to ensure that new employees receive simple, concise instructions on selecting grounding hardware.

Cable types

Not only are installers and techs required to make decisions on proper grounding techniques, but the 1987 NEC, for the first time, requires that field personnel also make decisions regarding the type of cabling used. No article discussing compliance with Section 820 of the NEC would be complete without discussing the new Section 820-15, which refers to regulations governing the type of cable used for specific applications. The section refers to flame, smoke and fire retardance of the specifically rated cables.

There are now five types of drop cable used for wiring customer premises:

CATVD: for wiring from pole to ground block.
CATVX: general use indoor cable for runs of less than 10 feet.
CATV: for wiring inside a residence.
CATVR: for use in vertical risers.
CATVP: for use in air plenums.

Many major companies are establishing policy guidelines for the use of specific cables. A general rule of thumb is that the cables listed higher than the one required for your application can be used as well. In other words, if you only need a type CATV cable, either CATVR or CATVP could be substituted. (For more on this, see *CT*, June 1988.)

The primary issue of Section 820 is to ensure compliance with accepted grounding techniques. Electricians have been complying with the NEC, as have telephone and power companies. Now as the CATV industry matures, we are taking an increasingly professional approach to this issue. The Society of Cable Television Engineers has many recognized experts in the field of grounding who are willing to make guest presentations or provide seminars on grounding to local chapters and meeting groups on request. ■

Whose responsibility is it?

The following is the policy of American Television and Communications Corp. and is taken from an ATC training manual.

By Gary Wesa
Technical Development Specialist
ATC National Training Center

The responsibility for safety lies with all employee levels—from installers to senior management. Employees with a good safety attitude have a mature outlook on life that allows for the consideration of others. Taking safety seriously will provide numerous benefits including good health, more pay, more friends and more satisfied families. Safety is a way of life and should be as familiar to you as breathing.

Employee responsibilities

The technical employee is ultimately responsible for following all applicable safety rules and regulations once given the proper training. Employees must realize that they, more than anyone else, are primarily responsible for their own safety and the safety of co-workers. Improvements can be made only as we become aware of areas that need to be improved.

For example, once trained on climbing equipment, any employee using climbing gaffs should continuously inspect for defects and replace any gaff less than 1¼ inches in length (as properly measured from the underside of the gaff). If the employee cannot remove or repair such an unsafe condition, then it is the employee's responsibility to promptly report the problem to the immediate supervisor.

A good safety plan aims at preventing unsafe acts and conditions. An example of an unsafe act would be failure to wear personal protective equipment; an unsafe condition would be defective equipment or plant conditions that create a hazard. Consequences for failing to report or correct such acts or conditions should be understood by all. Safety responsibilities include making suggestions toward improving conditions and giving helpful advice to fellow employees. Safety must be practiced all the time, not just when the supervisor is around.

There are places in the physical plant of the cable system that may be observed as hazardous conditions. Employees need to stress among themselves the importance of reporting unsafe acts or conditions that endanger either employees or the general public. An example may be a situation where a utility ground is broken at the pole, thus creating an electrical hazard. Besides having installers or techs exposed to such danger, it also can become a potential public danger.

Employees also have the responsibility to protect the equipment and materials entrusted to them. They should use safety equipment properly and treat it as if it were their own.

The chief technician plays an important role in the safety and health of the company. This person has a responsibility to see that all technical employees comply with established safety rules and regulations to ensure safe work practices. The chief tech must have a solid understanding of all safety rules established by the Occupational Safety and Health Administration (OSHA), company policy, National Electrical Code and local government or public utility policies that apply to cable TV.

It is important that this knowledge be given to employees through safety and technical training sessions. This is the only way that enforcement of safety procedures is possible. Documentation of all training sessions should be kept and filed for future reference.

The cable industry is required to follow all safety guidelines set up by OSHA, which were established by the U.S. Department of Labor in 1970. Cable TV guidelines are found in OSHA's labor book (Title 29) of the *Code of Federal Regulations*, Part 1910, Subpart R 1910.268 (the telecommunications section under the chapter "Special Industries"). Since it is reviewed for possible revision at least once each year, it is suggested that every system have the most recent copy on hand for reference. A second OSHA book, *Construction Standards* (29CFR1926) has certain applicable standards for the industry.

Besides being responsible for supervising workers to ensure correct work procedures, the chief tech also should assure the use of proper safety equipment. Safety guidelines established for personal protective equipment are usually based upon ANSI (American National Standard Institute) standards. ANSI is a non-governmental organization that provides recommendations to manufacturers and suppliers for their equipment ratings and tolerance levels.

An example of ANSI standards is seen on Class B hardhats for field personnel. These hats comply with ANSI guidelines that have established physical strength and electrical property limitations recommended to be safe for use by cable TV employees. The chief tech should see that all equipment issued to personnel is recorded and signed for by the receiving employee at the time of issuance.

Also, the chief tech should continuously observe all facets of work performed at all technical levels, concentrating on levels where accidents and injuries most often occur. Examples of this would be to frequently observe ladder handling, pole climbing techniques and driving habits where injuries typically run high.

Education

Deciding who needs safety instruction is a vital part of the chief tech's job, since good instruction contributes to safety by making the employee a better worker. Keep a training log showing who was trained, period of training, name of trainer and topics covered. Records on safety training of this type should be kept in a training record file.

Whatever method is used for safety education, it may be necessary to perform an accurate job safety analysis (JSA). The purpose of a JSA is to make a job safe by identifying hazards and eliminating or controlling them; it is intended to reduce the possibility of accidents and time lost from the job. It may be necessary to change the physical conditions that create any hazard, such as purchasing pole straps for ladders or protective heel guards for gaffs. ■

Decibels (Part 3)

By Ron Hranac
Jones Intercable Inc.

By itself, the decibel is a relative term used to express a ratio, e.g., gain or loss. But when the ratio includes a constant reference (and the reference and unknown are both measured across the same impedance), then the decibel can be used to represent absolute levels, expressed as ratios to the reference.

In cable television, that constant or 0 dB reference is 1 mV across 75 ohms. Thus, RF signal voltages measured across a 75 ohm impedance can be expressed as decibel-millivolts (dBmV) using the formula

$$\text{dBmV} = 20\log\left(\frac{\text{millivolts}}{1\ \text{mV}}\right)$$

Conversely, dBmV can be converted to millivolts with the formula

$$\text{millivolts} = 10^{\left(\frac{\text{dBmV}}{20}\right)}$$

The following table provides millivolt to dBmV conversions from −20 dBmV to +20 dBmV. Examples of the use of the above formulas are on the next page.

dBmV	millivolts	dBmV	millivolts
−20	0.1	0	1
−19	0.112	+ 1	1.122
−18	0.126	+ 2	1.259
−17	0.141	+ 3	1.413
−16	0.159	+ 4	1.585
−15	0.178	+ 5	1.778
−14	0.199	+ 6	1.995
−13	0.224	+ 7	2.239
−12	0.251	+ 8	2.512
−11	0.282	+ 9	2.818
−10	0.316	+10	3.162
− 9	0.355	+11	3.548
− 8	0.398	+12	3.981
− 7	0.447	+13	4.467
− 6	0.501	+14	5.012
− 5	0.562	+15	5.623
− 4	0.631	+16	6.309
− 3	0.708	+17	7.079
− 2	0.794	+18	7.943
− 1	0.891	+19	8.913
		+20	10

Examples

Problem
You measure +5 dBmV at the input to a customer's converter. What is that signal level in millivolts?

Solution
Use the formula

$$\text{millivolts} = 10^{\left(\frac{\text{dBmV}}{20}\right)}$$

$$= 10^{\left(\frac{5}{20}\right)}$$

$$= 10^{(0.25)}$$

$$= 1.778 \text{ mV}$$

Problem
The amplitude of a signal received on a headend off-air antenna is 0.5 mV. What is that signal level in dBmV?

Solution
Use the formula

$$\text{dBmV} = 20\log\left(\frac{\text{millivolts}}{1 \text{ mV}}\right)$$

$$= 20\log\left(\frac{0.5}{1}\right)$$

$$= 20\log(0.5)$$

$$= 20(-0.301)$$

$$= -6.02 \text{ dBmV}$$

Problem
If an antenna with 3 dB more gain were substituted for the one in the above example, what would the new received signal level (in millivolts) be?

Solution
First, add the gain of the new antenna to the original dBmV signal level.

$$-6.02 + 3 = -3.02 \text{ dBmV}$$

Then convert that level to millivolts using the formula

$$\text{millivolts} = 10^{\left(\frac{\text{dBmV}}{20}\right)}$$

$$= 10^{\left(\frac{-3.02}{20}\right)}$$

$$= 10^{(-0.151)}$$

$$= 0.706 \text{ mV}$$

Communication tower installation

By Ted Glatz
UNR-Rohn Inc.

A construction team assembles the tower.

There are many uses for communications towers in our fast-moving, modern society. Towers may be used for cable and broadcast TV, microwave, AM and FM broadcast, and cellular radio, just to name a few. As there are only two basic types of towers—guyed or self-supporting—the amount of land available and the cost usually are the deciding factors in the type chosen. Making sure the tower is designed and constructed/installed properly requires planning and experience.

Before the tower parameters can be determined certain information is required, such as wind- and ice-loading, antenna-loading, plot plan or site area, and any other specifications unique to the particular application. In addition, an accurate, detailed soil analysis should be performed so that the foundations can be engineered for the existing conditions.

Once the specific requirements are known, we utilize a computer-aided design to ensure that the tower and its components will meet the provided criteria. At the appropriate time in the construction schedule and after the necessary permits have been obtained, the installation is ready to begin.

The installation

Most tower installations are broken down into three phases: foundation installation, tower erection and antenna and line installation.

Depending upon the circumstances, a different subcontractor may be selected for each of these phases or just one chosen to install the entire job. Over the years towers have gotten much larger; foundations, likewise, must be much larger in order to support the added loads. In many cases, because of the larger foundations required for self-supporting towers, a specialized foundation subcontractor should be employed. Special foundations could consist of large mat-types, pier and pad, drill and bell or large diameter vertical shafts. Guyed tower foundations usually consist of a pier and pad base for the tower and three or more "dead-man" buried anchor blocks.

Tower foundations should be installed following the design parameters as well as industry mandated codes. These codes define minimum requirements for cement, aggregate, admixture, reinforcements, mixing, transporting of the ready mix material and placement of concrete. They also define minimum requirements for compaction of the back-fill against the installed concrete. We require our foundation subcontractor take concrete cylinder tests and have the results certified by the testing laboratory as added insurance that the concrete did in fact reach the specified strength. In some cases, slump tests also are taken at the time the concrete is poured.

Erecting the tower

After the tower foundation has cured for the appropriate amount of time, the tower material is shipped and arrangements made for the tower erector to be present upon arrival. The tower material usually is hauled to the site by 40-foot flatbed trucks. During the unloading procedure the erector lays out the material, with whatever is to be used first nearest the tower base. As well, the erector should take an accurate inventory against the packing list to make sure that all material needed for the erection of the tower is on hand.

Depending on the size of the tower, it may be assembled and erected with a crane or using a winch and gin pole to stack the tower. Because of the size and weight of the tower elements, many erectors now use mobile cranes or cherry-pickers to speed up the work. At times, depending on location, helicopters are used. In any case the tower, as assembled, should be kept true and plumb as it is being stacked.

Painting and lighting

If the towers are required to be painted in accordance with FAA regulations, this may be done at the manufacturer's facilities, on the ground at the site or in the air after erection. If lighting is required, this is done during erection. However, prior to the permanent lights being installed, temporary lighting must be used as set forth by the FAA.

The tower grounding system usually is attached to the tower base section at the commencement of the stacking procedure. During erection, certain attachments such as ladders and safety climbing devices, antenna mounts, ice shields, etc., are installed on the tower. After erection, the communication devices (antennas, horns, etc.) are installed along with the appropriate feed lines.

Upon completion of the erection work, minor adjustments may be necessary to make sure that the tower is true and plumb in accordance with specifications and recognized standards. ■

Reprinted from the January 1987 issue of "Communications Technology."

How do we find trained installers?

We at NCTI are frequently asked, "Hey, how do we find trained CATV installers without stealing them from another system?" Cable companies know that NCTI protects their training dollars by never releasing names of their employees.

This problem of helping cable companies find qualified people has been a difficult one to solve. In the past we presented what we thought was a solution. It wasn't. We tried to work with various vocational schools and other entities to establish training programs. However, most of this training did not meet the needs of the CATV system. In the end we had to terminate our relationship with all of these schools because the training did not meet NCTI standards.

So, what's the answer? It's what it has always been—NCTI's ongoing involvement in monitoring all phases of training. This includes training and validation of the training program's instructors and students. Instructors and students are tested with an exam equivalent to the ones given to employees of a system enrolled in NCTI courses. In addition, a school's instructors are recertified annually to ensure that changes in teaching staff will not jeopardize the integrity of the training program. Now, as in the past, NCTI is responding to industry needs.

Triangle Tech's successful program

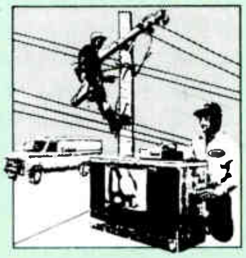
It works! Early this year we began working with Triangle Tech of Pittsburgh, Pa., to establish a program to meet the needs of CATV systems. We entered into an agreement to provide entrance level training programs. Triangle Tech is a school that has been in operation since 1944 and is accredited by the National Association of Trade and Technical Schools and approved by the state of Pennsylvania. Historically, its specialty has been education in the drafting fields, offering an Associate Degree in specialized technology in architectural and mechanical computer-aided drafting and design. In addition, programs have been added to include refrigeration, heating, ventilation and air-conditioning technology.

"A school's instructors are recertified annually to ensure that changes in teaching staff will not jeopardize the integrity of the training program."

Triangle Tech just graduated its first class of 11 NCTI-certified installers. In the agreement with NCTI, it submitted its instructors for NCTI training and testing to certify that they were qualified to teach a CATV installer course. Ray Rendoff, NCTI's technical training director, was sent to Pittsburgh to administer the testing of the teaching staff. Once that was accomplished, a class began in April with students enrolled in the NCTI installer course. The course was taught in the classroom along with practical hands-on training in pole climbing and installations. NCTI graded the individual lessons and monitored students' progress. Upon completion of the 10-week program, NCTI's student services director, Gerald Neese, went to Pittsburgh and administered an individual final exam to each of the 11 students. All students passed the final exam and were certified by NCTI. All students were hired by local cable companies and contractors upon graduation.

Triangle Tech just began a new class that will conclude in September. If you are interested in interviewing any of these graduates, contact Byron Leech at NCTI, (303) 761-8554.

Because of the exciting success of this program, we are interested in expanding this training opportunity and will be in contact with several schools in various states. So at last we can answer the question, "How do we find trained installers?" ■



Tech Tips

With the introduction of VCRs to cable TV, problems have arisen. What I have noticed is that the 75 ohm coaxial cable that comes with the VCRs has been causing certain problems. The first thing to do at a service call is remove this cable and replace it with a piece of RG-59. By doing this, you can eliminate off-air interference and loose connections and get better shielding. Keeping the cable shielded from the pole through the VCR and through the converter to the subscriber's TV set will help maintain leakage as well as give the customer a sharp and clear picture.

When a converter is installed with a VCR, I have found that tuning in Ch. 3 and only Ch. 3 on the VCR will help the customer in recording. By putting the selector switch from "TV" to "VCR" and turning the channel on the VCR, the picture will turn to snow until the channel selector on the VCR is put back to Ch. 3. This way the VCR, converter and TV set will all stay on Ch. 3.

James Knuth
Technician
Northwest Cable TV
Galesburg, Ill.

If you have ever unpacked one of the new VideoCiphers you may have noticed the rather large packets of silica gel dessicant crystals in the bag with it. Instead of wasting these I keep them on the bucket truck. Whenever I have to open an amplifier housing in the rain, I toss one into the housing before I close it. This helps absorb the moisture that gets trapped inside.

Bill J. Naivar Jr.
Chief Technician
Douglas County Cable TV
Douglasville, Ga.

100 watt amplifier

Available from Amplifier Research, the Model 100W1000M7 broadband amplifier delivers up to 180 watts and a minimum of 100 watts of CW power for RFI susceptibility testing, antenna and component testing, wattmeter calibration and general RF lab work in the frequency band from 100 MHz to 1 GHz. Linear output at less than 1 dB gain compression is 70 watts and flatness is ±1.5 dB typical, ±2 dB maximum.

The unit has instantaneous bandwidth with no need for tuning or band switching. Other features include total immunity to load mismatch and ability to reproduce AM, FM or pulse modulation appearing on the input signal.

For further details, contact Amplifier Research, 160 School House Rd., Souderton, Pa. 18964, (215) 723-8181; or circle #131 on the reader service card.

AC power supply

Performance Cable TV Products' ferroresonant power supply is designed to provide 60 VAC power required by cable systems using feedforward and power doubling amplifiers. It delivers 15 amperes of current and converts 120 VAC utility power to 60 V RMS.

An optional cooling fan may be plugged directly into the compact unit, eliminating the need for additional wiring. The input is protected from surges by an MOV and the circuit breaker is rated at 20 amperes.

For further information, contact Performance Cable TV Products, 1770 Macland Rd., Hwy. 360, Dallas, Ga. 30132, (404) 443-2788; or circle #130 on the reader service card.

Self-fusing tape

Polychem developed Polyflex SFT-150 self-fusing tape for housing-to-housing connections and all aerial or underground connections where the use of an open flame is prohibited or undesirable. According to the company, it features excellent weatherability, −55°C low temperature flexibility, simple installation and clean stripping.

For additional information, contact Polychem Electronics, 1248 Sussex Turnpike, Randolph, N.J. 07869, (201) 895-4919; or circle #126 on the reader service card.

Spectrum analyzer

Avcom introduced its PSA-37D portable spectrum analyzer with frequency coverage from less than 10 to over 1,750 MHz and from 3.7 to 4.2 GHz in five bands. Frequency readout is shown in MHz on a four-digit LCD front-panel display.

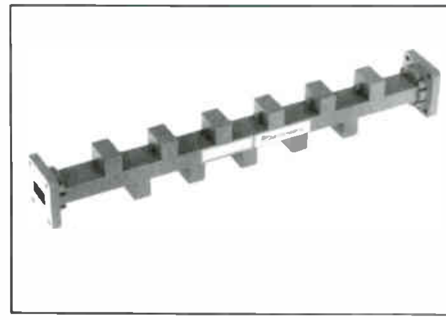
It also has a built-in DC block with +18 VDC for powering LNAs and BDCs, calibrated signal strength amplitude display and internal battery with charger. Selectable vertical sensitivity of either 2 dB or 10 dB per division is standard.

For more details, contact Avcom, 500 Southlake Blvd., Richmond, Va. 23236, (804) 794-2500; or circle #127 on the reader service card.

Tracking software

The Vehicle Information Center (VIC) from Long Systems is said to be the first full-feature software to track vehicle fleets written especially for cable systems. VIC tracks four categories of data—vehicles, drivers, maintenance and accidents. Its program design is modular and it works on all 100 percent IBM-compatible computers.

For more details, contact Long Systems, 9666 Businesspark Ave., Suite 105, San Diego, Calif. 92131, (619) 530-1926; or circle #135 on the reader service card.



Bandstop filter

The Model 6430 CARS band bandstop filter from Microwave Filter Co. isolates the receive signal to prevent interference at receive and transmit sites. Passband is 12,700-13,050 MHz with a loss of 3 dB maximum. Stopband is 13,062.5-13,150 MHz with a loss of 40 dB minimum. It is made in WR-75 waveguide and measures $11\frac{1}{4} \times 1\frac{1}{2} \times 1\frac{1}{2}$ inches with rectangular cover flanges.

For additional details, contact Microwave Filter Co., 6743 Kinne St., East Syracuse, N.Y. 13057, (315) 437-3953; or circle #133 on the reader service card.

Multimeter

The Professional Series Model 560 menu-driven multimeter from Simpson Electric Co. features ultrafast autoranging, according to the firm, and data logging capability on any selected range with a 2,150-measurement memory (battery backup), a 500 kHz frequency counter and continuity and diode check with audible beeper.

The dual LCD format has a five-digit, 52-segment measurement display and a four-line menu/programming display. The unit is available with a Centronics printer or RS232C interface.

For more information, contact Simpson Electric Co., 853 Dundee Ave., Elgin, Ill. 60120, (312) 697-2260; or circle #129 on the reader service card.

Business Directory

Calendar

August

Aug. 16: SCTE Oklahoma Meeting Group technical seminar on signal leakage and fiber optics, Marriott Hotel, Oklahoma City. Contact Herman Holland, (405) 353-2250.

Aug. 17: SCTE Delaware Valley Chapter technical seminar on HDTV, Super-VHS and impulse pay-per-view, Williamson Restaurant, Horsham, Pa. Contact Diana Riley, (717) 764-1436.

Aug. 17: SCTE Ohio Valley Chapter technical seminar on HDTV, Ramada Inn East, Columbus, Ohio. Contact Jon Ludi, (513) 435-2092.

Aug. 17: SCTE Hudson Valley Chapter technical seminar and BCT/E testing, Holiday Inn, Kingston, N.Y. Contact Wayne Davis, (518) 587-7993; or Bob Price, (518) 382-8000.

Aug. 17: SCTE Michiana Meeting Group technical seminar. Contact Tom White, (219) 259-8015.

Aug. 22-25: Siecor Corp. technical seminar on fiber-optic installation and splicing for LANs, building and campus applications, Hickory, N.C. Contact (704) 327-5539.

Aug. 23-24: SCTE Cascade Range Chapter technical seminar "Hands-on equipment workshop," Red Lion Inn at the Quay, Vancouver, Ore. Contact Randy Love, (503) 370-2770.

Aug. 24: SCTE Appalachian Mid-Atlantic Chapter technical seminar. Contact Ron Mountain, (717) 684-2878.

Aug. 24: SCTE Greater Chicago Chapter technical seminar on power supplies, batteries and grounding. Contact William Gutknecht, (312) 690-3500.

Aug. 26: SCTE Heart of America Chapter technical seminar. Contact Wendell Woody, (816) 474-4289.

Aug. 30: SCTE Satellite Tele-Seminar Program, a BCT/E review course on Category V, 12-1 p.m. ET on Transponder 7 of Satcom F3R. Contact (215) 363-6888.

Upcoming

Sept. 27-29: Great Lakes Expo, Cobo Hall, Detroit.
Oct. 4-6: Atlantic Show, Convention Center, Atlantic City, N.J.
Oct. 18-20: Mid-America Show, Hyatt Regency, Kansas City, Mo.
Dec. 7-9: Western Show, Convention Center, Anaheim, Calif.

September

Sept. 3-4: SCTE Heart of America Chapter and **Gateway Chapter** joint seminar on fiber optics and CLI with BCT/E testing. Contact Wendell Woody, (816) 474-4289.

Sept. 7-9: Eastern Show, Atlanta Merchandise Mart, Atlanta. Contact Nancy Horne, (404) 252-2454.

Sept. 8: SCTE Central California Meeting Group technical seminar on satellite technology. Contact Andrew Valles, (209) 453-7791; or Dick Jackson, (209) 384-2626.

Ad Index

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Out of Focus

Submitted by Steve Kerrigan, Community Cablevision, Newport Beach, Calif.

Track Down Tough To Find CATV, MATV And RF Distribution Troubles
• All Channel Digital Tuner (5 - 890 MHz)
• 5 Microvolt Sensitivity With Autoranged Attenuator
• Exclusive Frequency Offset Readout
• Automatic S/N And Hum On In-Use Channel
• Integrated Wideband Monitor
• AC/DC Volts Measurements Through RF Input
100% American Made and backed by Sencore's 100% "Made Right" Lifetime Guarantee
With The FS74 CHANNELIZER SR.™
TV-RF Signal Analyzer
$3495 Patented