March 1989

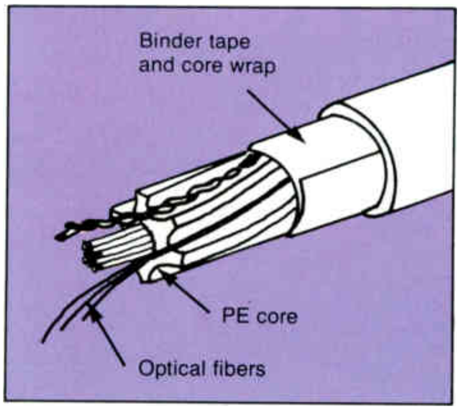
IT INSTALLER TECHNICIAN

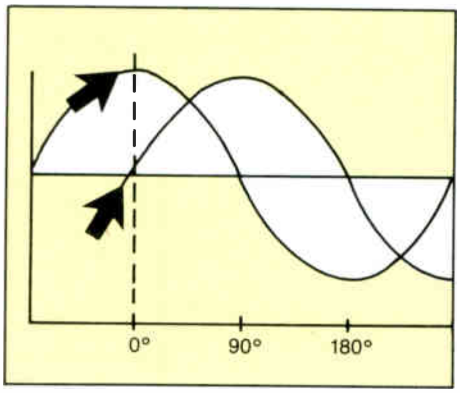
Focus on construction

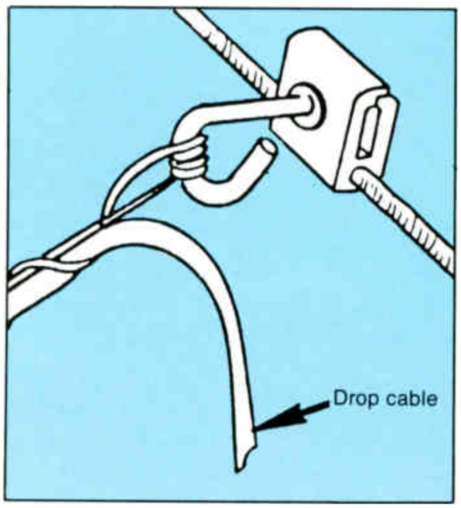
The training and educational magazine for cable television technical personnel.

Contents

Departments







Features

Cover

Constructing a better system from top to bottom.
Art by Geri Saye.

IT-Installer/Technician © 1989 by Communications Technology Publications Corp. All rights reserved. *Installer/Technician* (ISSN 104-1253) is published monthly by Communications Technology Publications Corp., 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112—or—P.O. Box 3208, Englewood, Colo. 80155, (303) 792-0023. March 1989, Volume, 1, Number 11. Office of publication is 12200 E. Briarwood Ave., Suite 250, Englewood, Colo. 80112. Change of address notices should be sent promptly; provide old (or copied) mailing label as well as new address, including ZIP code; allow 6 to 8 weeks for change. Second-class postage paid at Englewood, Colo., and additional mailing offices. POSTMASTER: Please send address changes to *Installer/Technician*, Box 3208, Englewood, Colo. 80155.

From the Editor

Sleep tight?

Picture this: It's 2 a.m. Outside, a snowstorm rages, but you don't care because you're cozy and warm under the blankets, dreaming of eating pineapple on a sunlit beach.

Suddenly, you are jolted awake by the insistent ringing of the telephone. As the fog clears out of your head, you realize the voice on the other end of the line is telling you there is an outage and you must go and find the problem immediately. Grumbling, you pull on your clothes, bundle up and head out into the swirling snow. Before long, your teeth are chattering, frost is forming on your eyebrows and your nose and ears no longer feel as if they are attached to your body and you wonder "Why me?"

Well, we all know that when something goes wrong it is not the owner of the system who has to go out in the middle of the night in subzero cold, it is you, the rank and file. So not only are the subscribers unhappy because their service has been interrupted in the middle of *Friday the 13th, Part XXIII*, but you are unhappy as well. And because of what? An improperly secured housing? A loose F fitting?

As many of you already may have discovered, if you overlook what seems to be the most nitpicking detail, it probably will come back to haunt you. And it could be in the form of anything from a ghost in a customer's picture to an entire system outage.

These problems, as well as small, everyday hassles, often can be prevented by careful attention to proper construction procedures. For example, in Larry Nelson's article on installing fiber-optic cable, he suggests installing extra cable at points along the run. Then if cable is damaged in the future, restoration can be done with a single splice.

According to Mike Mayberry in his article, keeping detailed records during construction is another way to help reduce problems later. If there is a question about a job, you can go back and see who did it, what was done and when it was done. This will save a lot of time and eliminate the confusion that can result if this information is not readily available.

Just knowing exactly how to perform a procedure correctly also will save you time in the construction itself. In Wayne Sheldon's "boring" article, he explains how to drill accurately for an underground install. Not only will you get the job done more quickly, but you will save yourself the embarassment of having to explain how Mr. Dittmeyer's prize flower bed met with an untimely demise.

Wouldn't it make your job a little easier if you didn't have to go back and fix things that shouldn't be broken in the first place? And isn't it nice when you can pat yourself on the back for doing it right the first time?

What's new?

Glad you asked. Next month we're introducing a new section in *Installer/Technician* magazine called "Instructional Techniques" that will be a training tool for CATV field personnel. Proper use of system equipment is vital to a cable system and your company's success. The key to opening that door is to provide the end user (field technicians and installers) with proper procedures on how the equipment functions.

The concept of "Instructional Techniques" is to provide our readers with "how-to" basics on operating and maintaining CATV equipment.

How many times have you been given test equipment with only "word-of-mouth" as instructions? How many times have you sent equipment back to the manufacturer because "it didn't work" when, in fact, you just didn't know how to properly use the equipment?

Obviously, manufacturers send application and spec sheets out with each device. The problem is that these instructions often do a magic act and disappear. You can always play with the device to get it to work or call the supplier and wait for the information to be mailed to you.

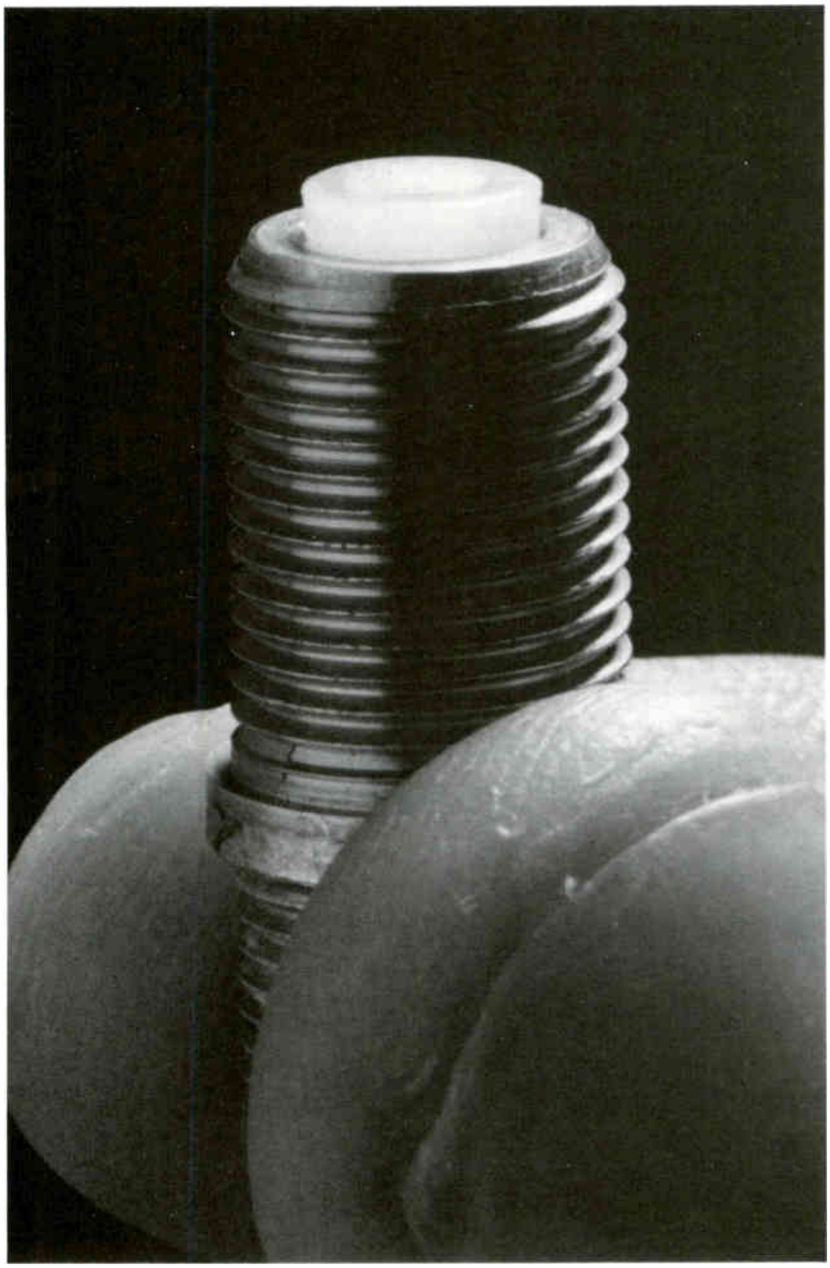
Your job is hard enough. That's a major reason we've decided to add this new section to assist you in your daily procedures. Let us know what you think of the idea.

Toni I. Barnett

Antronix Brings You The Greatest Cable Invention Since Cable Itself.

The New Antronix® CAM-Port®

The "Connector Activated Mechanism" (CAM)



Introducing a revolution in cable port design: the Antronix® CAM-Port®

The new CAM-Port delivers the most reliable, intermittent-free connections since the dawn of the cable era.

New CAM Action.

The new CAM mechanism will automatically grip any size center conductor with the exact contact pressure to insure a reliable, intermittent-free connection.

New Contact Design.

The key to a proper mechanical and electrical connection is the contact area. Present design, by its own nature has to have a marginal contact area. In the CAM-Port, the whole contact is the contact area.

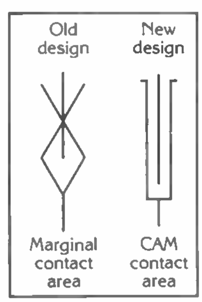
Normally Open Contact.

This normally open contact design allows perfect plating over the entire contact area.

The Incredible Result:

Exact contact pressure. No insertion wear on the contact. Perfect contact plating. No more loose connections. No more port failures.

The new CAM-Port is rapidly setting a new industry standard. Soon, it will be standard equipment on all Antronix cable products.



Antronix is now connecting the world of communications better than ever. And suddenly, every other cable port is obsolete.

Make your perfect connection by calling Antronix at 201-446-2626.

CAM-Port® is a registered trademark of Antronix®
Antronix® 1989.
Patent Pending.

ANTRONIX

Connecting the World of Communications.

Reader Service Number 4.

News

Drop Shop to distribute pedestals

ROSELLE, N.J.—The Drop Shop Ltd., a national distributor of drop and installation materials, entered into an agreement with Indiana Pressed Steel to become a master distributor of their complete line of CATV pedestals and accessories. According to President Dan Parsont, Drop Shop has all pedestal sizes in stock in its Hayward, Calif., warehouse and plans to stock its Union, N.J. warehouse and soon-to-be-opened facility in New Orleans to accommodate the rest of the country.

SCTE sells out expo exhibit space

EXTON, Pa.—The Society of Cable Television Engineers recently announced that there is no remaining exhibit space available for the 1989 Cable-Tec Expo. This annual conference and trade show will be held June 15-18 at the Orange County Convention Center in Orlando, Fla. Over 100 companies have already rented the exhibit floor to display all types of products, services and equipment and present live technical demonstrations of their products.

According to Bill Riker, SCTE executive vice president, this is the third consecutive year that the floor has sold out, but it has not done so as quickly as it has this year. Companies wishing to exhibit at the expo can contact SCTE national headquarters at (215) 363-6888 to be placed on a waiting list and contacted in the event of an exhibitor cancellation.

Jones, Anixter sign FO rebuild contract

ENGLEWOOD, Colo.—Jones Intercable last month signed a $3 million contract with Anixter Cable TV to supply Jones with fiber-optic products as part of the MSO's $15 million rebuild in Augusta, Ga. The Augusta system is expected to be a modification of the Jones "cable area network" (CAN) fiber design now being built in Broward County, Fla.

According to Bob Luff, Jones group vice president of technology, the CAN design, a hybrid fiber/coax architecture, significantly reduces the number of trunk amplifiers in the cascade; in Augusta, the cascade will be between five and 16. The design also employs signal and path redundancy on all AM fiber paths, while FM paths will be protected by a ring fiber route diversity architecture scheme planned for 1990.

Among the equipment being sold to Jones are six Synchronous Communications FM laser transmitters with 32 optical receivers, 20 Anixter AM LaserLinks, 1,200 miles of AT&T fiber-optic cable, and all related apparatus and accessories. Deliveries are expected to be completed by July. Anixter also will provide technical support services required for combining the AM and FM laser technologies with on-site engineering assistance and corporate product management functions.

Times Mirror upgrades with Pioneer

UPPER SADDLE RIVER, N.J.—Pioneer Communications of America sold its addressable converters to five Times Mirror cable systems nationwide, including Providence, R.I.; and Vista, San Juan Capistrano and Rancho Palos Verdes in California. It also sold its addressable system for use in the Kerrville, Texas, system.

Times Mirror subscribers in Kerrville will receive the BA-6000 converters to upgrade them to addressability and the system will utilize the M1D/M1B addressable controller. The other four systems were purchasing Pioneer's BA-5000 addressable converters, but will now upgrade to the BA-6000. Financial terms of the deal are valued at close to $5 million.

Learning tools for installers

This edition of "You and the SCTE" features selected items available from SCTE that will be of interest to installer/technicians.

Publications

DT-1, *Template, CATV Symbols*—A handy and versatile template featuring graphic symbols for power supplies, terminators, couplers, taps, amplifiers, equalizers and filters. Member: $6, non-member: $8.

DT-2, *Graphic Symbols for CATV Systems*—This thorough compilation of graphic symbols currently used in cable system drawings and diagrams was jointly developed by SCTE and the National Cable Television Association. Includes fiber-optic symbols and 22 other groups of symbols. Member: $5, non-member: $7.

DT-4, *Glossary of Cable Television Technical Terms*—Jointly published by SCTE and NCTA, this book contains over 60 pages of technical terms used daily by the cable television engineering community. Member: $5, non-member: $7.

TR-5, *Cable Television* by William Grant—A comprehensive guide to CATV technology, examining its equipment, systems and methodology, as well as many other important facets of the workings of cable television. Perfect for beginners and veterans alike. Second edition. Member: $30, non-member: $35.

TR-7, *Cable Communications* by Thomas F. Baldwin and D. Stevens McVoy—An insightful look at the CATV industry, encompassing its technology, services, organization, operations and future. Features special appendices on cable regulations, networks, policies, costs and audience survey methods. Second edition. Member: $37, non-member: $43.

Videotapes

T-1002, *Confident Climbing: Classroom Session*—Produced by Viacom Communications. Classroom setting covers basics of theory, equipment, safety and clothing, climbers, body belts, hard hats, straps and gaffs. Safe climbing techniques such as proper aim, angle and depth of penetration are discussed. Detailed instructions include hand and foot movements, balancing, knee and leg angles, posture, and ascending and descending the pole. (30 min.) VHS: $50, 3/4": $75.

T-1003, *Confident Climbing: Field Demonstration and Technique*—Produced by Viacom Communications. On-the-pole demonstrations emphasize proper footwear, what to avoid, setting the gaff and physical stress. Hazards of hesitation, and proper belting-in procedures, maintaining balance, estimating clearance, circling the pole and work positioning are included. Practice exercises, "hitchhiking" and "reaching out" are demonstrated. (30 min.) VHS: $50, 3/4": $75.

T-1011, *CATV Converter Repair Procedures*—Basic block diagrams explain multichannel varacter converters, RF modules, power supply and control box functions. Electrical and mechanical features, tuning voltages, disassembly and testing, meter leads, lifting loads on power supply and troubleshooting are addressed. Test points are identified. Overall converter repair procedures are presented. (30 min.) VHS: $50, 3/4": $75.

T-1012, *Multichannel Cable Converter Alignment*—The setting for this video program is the converter repair bench. Block diagrams, demonstrations of alignment techniques and procedures and final assembly are presented. The videotape stresses the importance of following proper procedure in order to maintain low service call rates. (30 min.) VHS: $50, 3/4": $75.

T-1018, *Broadband Coaxial Cable Basics*—Addresses proper handling techniques of coaxial cable. Cable construction is detailed and special features explained. Dielectrics, adhesion and compression are covered. Hazards of improper unloading procedures are outlined. Stacking and storage of reels, wrapping, dealing the rolling edge and benefits of lagging are included. Velocity of propagation, TDR settings and testing problems are highlighted and techniques for moisture protection are covered. (30 min.) VHS: $50, 3/4": $75.

T-1020, *Broadband Coaxial Cable Handling and Installation*—Techniques used to pull cable into the pole line, locating cable reels, separation and placement, angle, bending the cable and using the reel for support are displayed with graphics. Short clearances, "chutting" to the first pole, braking and pressure are explained. Sag and temperature, cable twisting or swivel, single and multiple cables, tools, backlash, playing the loop, lashing techniques and internal tension are covered. Temperature coefficients are explained and shown on graphics. (30 min.) VHS: $50, 3/4": $75.

T-1028, *Cable Preparation and Connector Installation*—This three-part presentation, produced by LRC, discusses recommended practices for preparing the ends of coaxial cables and proper methods for the installation of cable connectors. (30 min.) VHS: $35, 3/4": $70.

T-1032, *SCTE Promotional Tape*—This videotape, commissioned by the SCTE board of directors, describes the history of the Society since its inception in 1969 and the goals of the organization in providing technical training. (10 min.) VHS: $20, 3/4": $35.

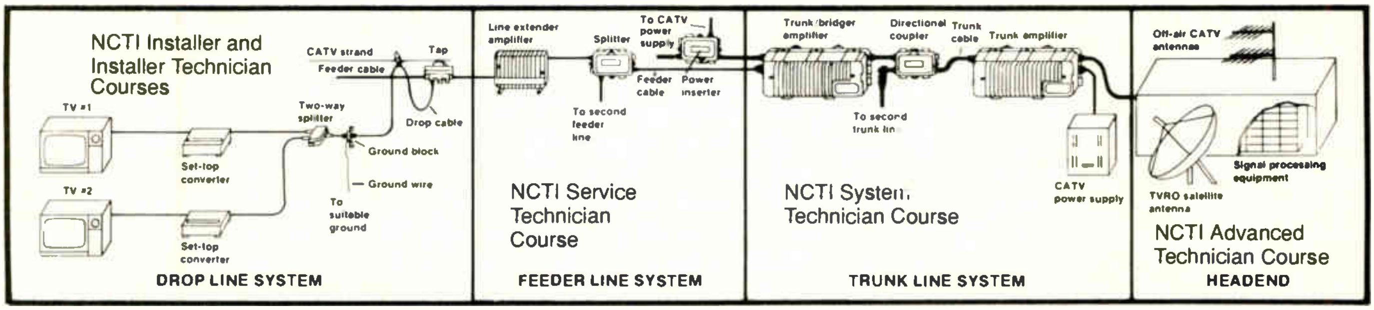
T-1042, *Pole Climbing*—A comprehensive course produced by the Atlee Cullison Training School, that develops climbing skills and safety habits. Includes valuable information on climbing apparel and equipment, safe methods of ascending, descending, and testing poles to ensure climbing safety. (1 hr.) VHS: $250, 3/4": N/A.

T-1043, *Extension Ladders*—A course designed to provide thorough and comprehensive instruction on the safe use of extension ladders. Includes segments on ladder positioning, transporting and carrying, securing, climbing and safety. (35 min.) VHS: $175, 3/4": N/A.

T-1064, *Installer Certification Program Overview*—This program provides key insight into the comprehensive SCTE Installer Certification Program. It covers key topics that a qualified installer must understand. It also deals with how to use the SCTE program as a basis for your own internal program, as well as how it can supplement an MSO's already established program. (1 hr.) VHS: $35, 3/4": $70. ■

For more information, contact SCTE, 669 Exton Commons, Exton, Pa. 19341, or see *The Interval* in this month's issue of *Communications Technology.*

From Headend to Drop



NCTI is the industry's technical training source

Where is your technical training need?

At the installer level? Continuing education for your Chief Tech? Technical insight for your Customer Service Reps? No matter what level of technical training your operation needs, NCTI has courses to offer.

For more than 20 years NCTI has been providing the technical training cable industry professionals need to ensure engineering excellence. Why has NCTI become the industry's technical training source?

Technical Excellence

NCTI lessons are authored by experts and reviewed by a Board of Technical Advisors which includes some of the industry's most experienced engineers and technicians.

Up To Date

NCTI lessons have been undergoing an intensive updating process. Material is carefully screened and changed to reflect the rapid advancement in technology and techniques.

Comprehensive

From F-connectors to satellite receivers, from modulators to set-top converters, NCTI covers the full range of cable industry technical issues.

Self Paced

NCTI's courses are designed to allow students to progress at their own pace, and to study when and where they are most comfortable. As a result, NCTI students complete a far greater proportion of courses than most like training programs.

Easy To Administer

NCTI takes the pain out of your technical training. We make it simple to enroll students and monitor their progress. Each time a student submits an exam, a grade report is promptly returned. And, each quarter management receives a Progress Report showing the status of each student in their system.

Our goal is to provide the industry's best training materials and to produce qualified technicians and engineers equipped to construct and operate first class cable television systems.

To learn how you can put NCTI training to work in your system, or how to enroll, call us at (303) 761-8554, or return the coupon. **Do it today!**

Send For Your FREE Training Kit Today!

Name____________________

Title____________________

Company____________________

Address____________________

City__________ State____ Zip____

Phone____________________

Mail this form to:

NATIONAL CABLE TELEVISION INSTITUTE

P.O. Box 27277, Denver, CO 80277

(303) 761-8554

IT 3/89

Reader Service Number 8.

Underground gets boring

By Wayne Sheldon
President, Sheldon Electronics

As much as we like to have an open trench, there are many places where you have to go under various obstacles. These include sidewalks, driveways, streets and sometimes lawns and flower beds. In many cases it is impractical to open trench, and sometimes franchise agreements require that you drill rather than cut the surface.

The type of soil you have will determine the specific method of drilling you use—either expansion or spoil removal.

In expansion drilling, just as the name implies, the soil is pushed aside by an expansion auger that resembles a large wood screw. This works well and is generally the best method to use in clay and loam soils that are slightly moist, but does not work in hard clay or gravel soils. Very moist clay soils will flow back closed in a matter of minutes, so you must install your conduit immediately after drilling the hole.

In hard soils you should use spoil removal boring. The soil is loosened with a cutter and then removed to make room for the conduit. In most cases you will inject water through the drill steel so that as the cutter loosens the soil it is turned into a soft mud that is easily pushed from the hole as the conduit is fed in. Of course you cap or tape over the end of the conduit before you push it through. Before injecting water under streets or highways be sure to check with the public works department as some prohibit the injection of water under traveled streets.

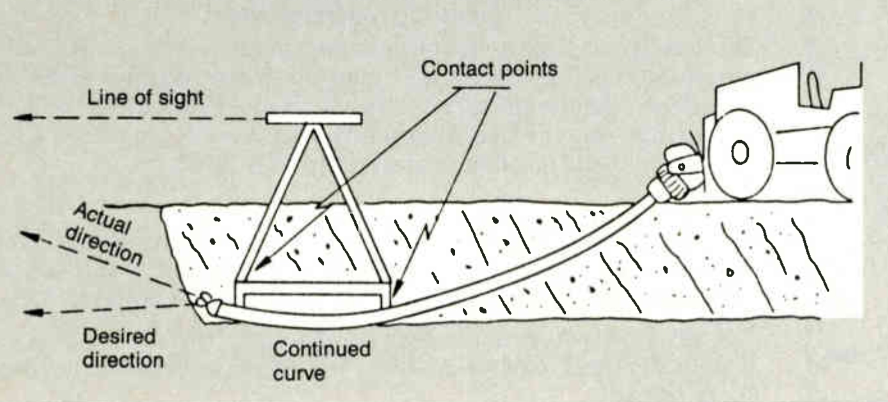
In sand type soils it is often advisable to use air rather than water. As the cutter loosens the soil it is blown clear of the hole by the air stream. You will require a compressor in excess of 100 CFM to make this work in holes more than 15 to 20 feet long.

Needless to say, it is futile to try to drill long holes in soil that contains many large rocks. Even if you can get through they will usually deflect the drill and you will not be able to get a hole to come out in the target area.

The main object in drilling is to get the hole to come out where you want it, in your target area. In order to make the drill steel go straight without climbing up you must be deep enough that the soil is of even consistency. In most cases you should not consider drilling holes longer than a few feet unless there is at least 2 feet of soil above the bit. Otherwise the soil will be softer above the bit, causing it to drift toward the surface of the ground as the hole progresses. Even an asphalt street will not hold a bit down.

For a long hole, the drill must be very accurately aimed. The horizontal direction is very easy; simply sight down the steel to determine the direction. The vertical direction is a little harder since the steel will have a bow due to the elevation difference between the drive motor and the desired level of the hole. Avoid using the wide aiming devices supplied by some trencher manufacturers (see drawing). The bow in the steel makes the actual direction different than the apparent direction of the bit. Use only about 8 inches of the steel directly behind the bit as the true direction. Either make a short sighting device that sits on the steel or, as I prefer to do, use a short 8-inch level to aim the bit. After the bit is about 5 feet into the hole, you cannot change its direction no matter how you move the drill steel. With a little practice, in good soil you will be able to consistently hit a target area of about 1 square foot for a 40 foot long hole. Of course there are many horror stories where the bit was deflected by a rock or pipe and ended up 10 feet from the target, usually straight down.

Exaggerated effect of using a wide sighting device.



"In order to make the drill steel go straight without climbing up, you must be deep enough that the soil is of even consistency."

Most of you will use the boring attachment for your trencher. This is adequate for most applications. However for some locations this is too bulky an arrangement. There is a large variety of small lightweight machines available for use in "tight" situations. These are all toys, in that you would not use them for production boring, but they are useful toys. Where you cannot get the bigger machines in, they allow you to get the job done, even if it takes considerable effort.

All the readily available boring rigs have the power unit above the ground, and since you are drilling in excess of 2 feet underground, this means that the drill rod must flex so that the bit can be aligned. Be sure to use a good quality flexible steel drillrod. Water pipe is brittle and tends to break easily, especially at the couplings. Most of the small machines use ¾-inch water pipe as a drill steel so breakage is a problem. Instead of waterpipe couplings, use electrical conduit couplings. The threads are slightly different, allowing the pipe to screw further into the couplings. This makes a much stronger joint and reduces breakage of the pipe. Better yet buy or make a special coupling that supports the drill pipe on both sides of the joint so that there is no flexing at the threaded portion. To make this device, two pieces of pipe about 8 to 10 inches long of a size that just slides over the drill pipe are required. Carefully weld one to each end of a standard coupling. This will be time well spent if you do any amount of drilling. However you should carry a pipe die to cut new threads if you happen to break a piece of pipe. Fortunately, the pipe usually breaks outside the hole in the trench about a foot before it enters the soil. This makes recovery easy.

The type of cutter you use makes a big difference in the ease of boring. Most boring kits are supplied with a "fishtail" cutter. These are fairly good cutters if they are kept sharp. They must be sharpened just like a drill bit. When it gets dull, hard work—low production.

(Continued on page 30)

Fiber-optic cables—Installation and maintenance

By Larry W. Nelson
Executive Vice President, Comm/Scope Division, General Instrument

As we all know, fiber-optic technology is beginning to find appropriate applications in CATV. As this technology comes out of the laboratories and into use over the next decade, the local system technical people will learn to deal with it on a daily basis. One aspect of this technology is the installation and maintenance of the fiber cable plant itself. In this article, we will discuss the fundamental physical characteristics of glass fiber and the resultant cable designs, installation practices and maintenance practices that will yield success.

Cable designs

Casual observations of most fiber-optic cables will reveal that they differ in construction from traditional coaxial and twisted pair metal cables. The nature of glass has presented the cable manufacturer with several challenges. First is the size of the fiber, which is many magnitudes smaller than typical metallic conductors. Mechanically, glass exhibits very high tensile strength but very low elongation. This means particular attention must be paid to bending of the fiber to prevent breakage, whereas copper and aluminum have relatively good bending characteristics. However, perhaps the most challenging characteristic is fiber's performance sensitivity to mechanical strain. Under even very small sustained strain loads, the transmission characteristic will be altered and the life of the fiber may be shortened.

The first requirement of good cable design is to furnish finished product that has the intended life and performance under the installed conditions. Communications fiber-optic cables have followed the design life objectives of our traditional coaxial and twisted pair products. Thus, materials and environmental protections applied should under most conditions, exceed 20 to 30 years excepting physical damage. Careful attention must be given to construction techniques and to unusual environmental conditions so as not to compromise the design life.

Cable designers have been successful in developing cables that can be installed by conventional means with very few exceptions or changes. In fact, the areas of concern in construction practice for fiber cables mirror those of our traditional CATV coaxial lines. Materials and geometric design elements are chosen to combat severe bending, tensile elongation and impact loads. All construction techniques can be utilized including aerial lashed, aerial messengered, plowing, trenching and duct.

As with metallic cables, the most destructive environmental element is water in its several forms. Fiber cables intended for outdoor use, whether aerial or underground, must be protected from water ingress. For this reason, you will find flooding materials and bonding between cable elements commonly used in all cables. Glass is attacked by water in a process called hydrogenation. This results in microcracks that will propagate over time, ultimately resulting in fiber failure.

Three basic cable designs have evolved, all of which are successful in obtaining the objectives set out. These are known as loose tube, slotted core and ribbon cables. Several implementations of basic loose tube design are available. One generally representative sample is shown in Figure 1. Figure 2 shows one of several variations in slotted core (open channel) construction. A very high density fiber design available from AT&T is the ribbon cable, shown in Figure 3. In many respects this design is similar in concept to a loose tube construction.

All of these designs utilize the concept of buffering and incorporate a strength member. Buffering simply means that the cable design attempts to mechanically isolate the fiber from all adverse conditions including impact, crushing, bending, ten-

Figure 1: Loose tube cable

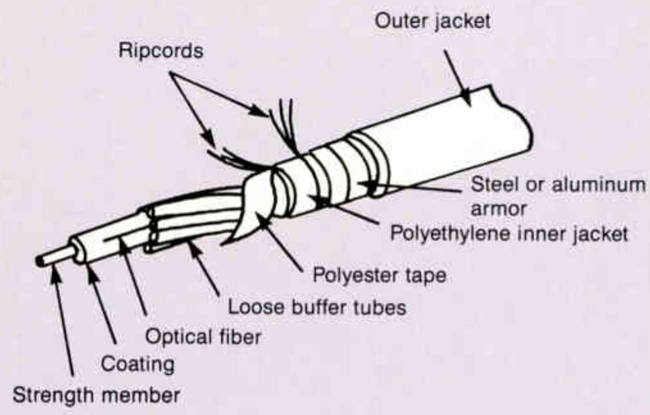


Figure 2: Slotted core cable

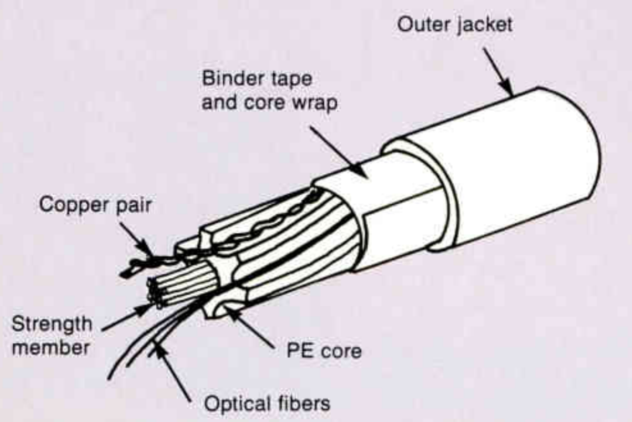


Figure 3: Ribbon cable

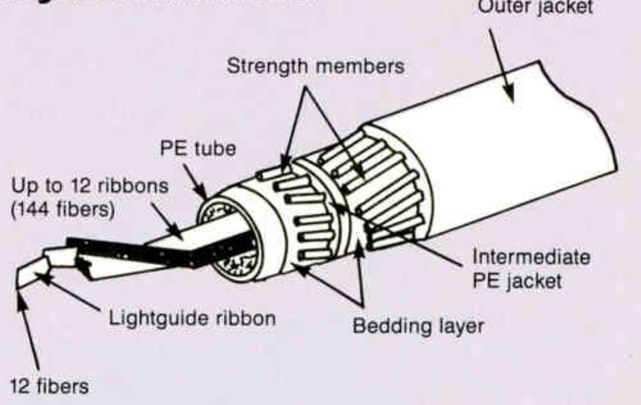


Figure 4: Back pull (stationary reel) installation method

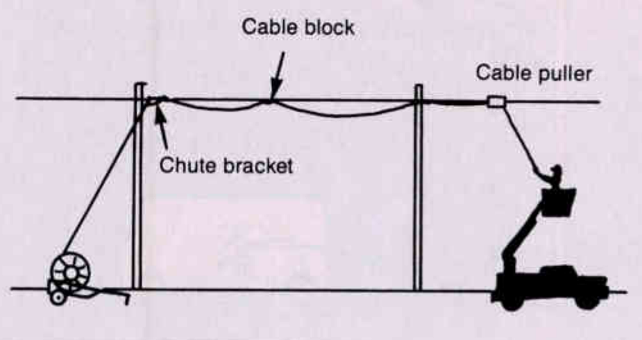
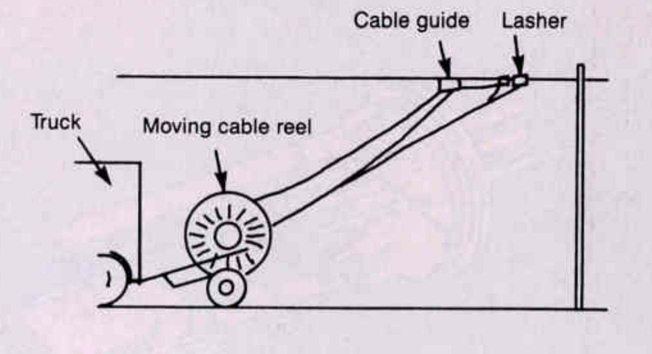


Figure 5: Drive off installation method



sile and thermal stress.

Strength members are available as either steel or a dielectric such as Kevlar or FRP. Both materials produce cables which meet all the mechanical, physical and optical requirements set forth. In cable designs that place the strength member in the center surrounded by fibers, the use of a dielectric is advantageous to prevent the possibility of an electrical potential between the strength member and outer steel armor or aerial strand. Use of all dielectric designs for duct and buried plants also may be particularly advantageous in higher lightning areas of the country. The marginal increased cost of dielectric materials are worthy of consideration particularly with higher fiber count cables that carry proportionately higher revenue traffic.

Aerial installations

All of the general techniques and methods of aerial installations that have been successfully used with coaxial cables can be applied to fiber-optic cables (Figures 4 and 5). In order to have a successful install the fiber must be protected from stress. If a fiber is subjected to a stress equal to 30 percent or more of its breaking strength, there will be a reduction in the life of the fiber. Such excessive stress produces microcracks in the glass that will propagate over time, resulting in failure.

Cables are designed and specified for maximum tensile load strength such that the fibers are sufficiently protected. It is vital that the cable specifications are adhered to. Most cables carry a specification of at least 600 pounds maximum pulling strength. Observing this limit strictly during pulling will prevent fiber damage. It is recommended that a tensiometer, fusable link or other device be used during the pulling process to guarantee the maximum pull strength specification is not exceeded.

All cable designs incorporate one or more strength members to absorb the tensile load applied during installation and the life of the cable. Attaching the pulling devices to the cable properly is essential to transferring the load to the strength member rather than to the fiber. Kellums grips, pulling eyes, etc. should be effectively attached to the central strength member.

One characteristic of fiber cable is its light weight. In most cases the cable is lighter than coax. Even so, rollers and other support devices must be used along the spans to support the cable during a backpull. The size, number and spacing should be equivalent to good coaxial cable installation. Failure to use sufficient support may result in excessive drag or exceeding the minimum bend radius.

Cable designs have been chosen to give minimum bend radius essentially equivalent to other types of cables. This is usually specified at about 10 times the cable diameter. Thus, the standard practice with regard to corner blocks should be followed. Obviously every additional corner encountered during the pull will increase the pulling tension.

The splice case will contribute substantially to the overall life of the installation (Figure 6). First of all, it must be environmentally qualified for the installation. Water entry into the case will create a significant problem. The internal structure of the case must be designed with the bending characteristics of the fiber, the type splice to be used, the type cable and convenience of the splicer in mind. The case must be designed to contain excess fiber lengths up to several meters. This allows the fiber ends to be brought out to the splicer for easy effective work. The excess length also allows the fiber to be coiled back into the case with large enough radiuses to avoid damage or excess attenuation. Specific coil frames are usually provided to hold the fibers. The case also should contain some mechanical means of holding the splice after the job is finished. The splice cannot be allowed to hang free. All of these requirements usually are fabricated into what is generally called a fiber organizer inside the splice case.

All splicing techniques are relatively sensitive requiring some equipment and a convenient work space for the splicer. As a result, common practice is to do the splicing at ground level as shown in Figure 7.

After splicing is complete, the splice case and excess cable is lashed up to the strand as shown in Figure 8. Care should be taken to place the case and cable away from the pole to prevent damage by other pole occupants.

Fiber cables need to be as longitudinally stable as can be reasonably accommodated. Thus, unlike coaxial cable sag and tension practices, a tight span is preferrable to a loose span. The objective of the cable design and installation is to minimize the chance of stressing the fiber. A very loosely sagged strand will exhibit more differential length movement due to temperature, ice, wind and snow, which in turn increases the chance of applying stress to the fiber. In practice sag conditions will usually be restricted by other cables installed on the poles. Whenever possible, place the fiber cable in the uppermost available space on the pole.

Overlashing of a fiber cable to existing cables is acceptable with a single precaution. The strand must be of sufficient size and installed correctly so that the finished installation of fiber cable and other cables will meet the sag and tension needs of all the cables.

Standard practice in CATV coaxial cable construction requires expansion loops periodically to accommodate the difference in thermal coefficients of expansion of steel and aluminum. In fact, specific care must be given to the geometric configuration of the loop to prevent premature failure of the cable.

Figure 6: Splice case

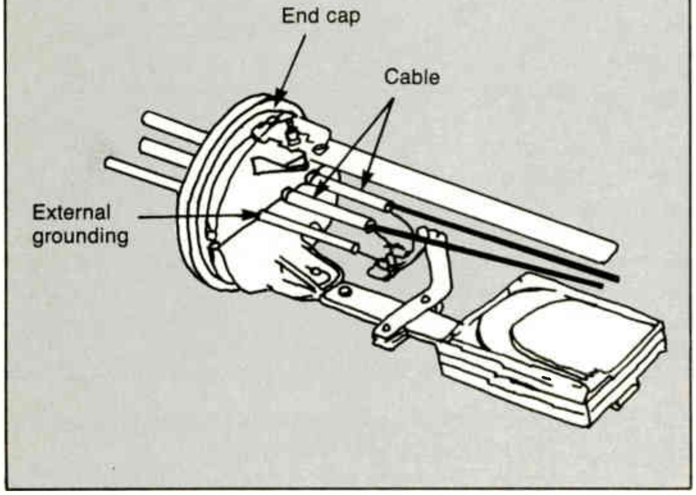
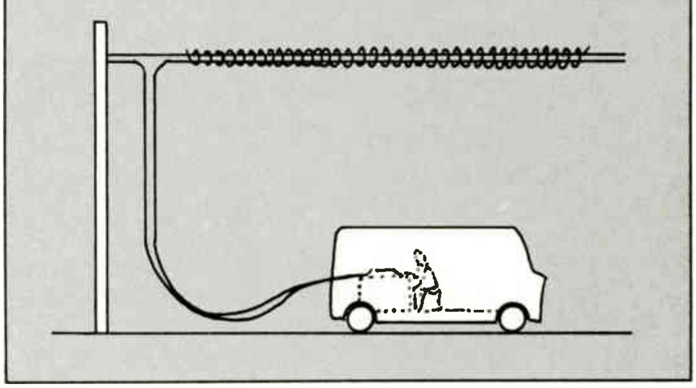


Figure 7: Splicing at ground level



The materials used and the configuration of fiber cables present a different situation and in fact, the requirements may differ between cable types and even between implementations of the cable type. For example, loose tube cables can be designed such that expansion loops are not required. This is achieved by carefully constructing the cable in such a way as to accommodate the expansion and contraction of the strand. It is best to consult your cable supplier for a specific recommendation. Conservative practice may be to install a minimum number of loops. Because of the flexibility of fiber cables and their lack of susceptibility to stress concentrations, the natural shape of an expansion loop is quite adequate.

Direct burial

Fiber cables are suitable for direct burial using either the trenching method or plowing. All of the precautions considered in aerial installations apply here with a few additions. For plowing operations, special attention is needed for the plow design and for the entry of the plow into the ground. In both cases, precautions must be taken so that severe bend stress is not put on the cable. For added strength, bend protection and environmental protection, an armored cable design is recommended for underground.

Duct installations are quite common with fiber cables and should present no problems. Some precautions should be observed to prevent over tensioning of the cable. The duct should be cleared before pulling the cable. An inner duct may have to be pulled in to assure sufficient clearance. Never attempt to fill a duct over 60 percent of its cross sectional area as excessive filling will create excessive tension. Use of lubricants is recommended to reduce tension.

The success of a fiber cable installation is planning and careful attention to stress. The cable runs should be planned well for clearances, avoidance of obstructions, location of splice points and placement of long lengths of cable. All conditions that will create difficulties should be eliminated or accounted for in the planning stage.

One of the advantages of fiber optics is to utilize long lengths of cables and in fact, splicing should be minimized. For particularly long runs, whether aerial or duct, there is potential for generating excessive stress or in the case of aerial construction, having to go above other facilities perpendicular to the run.

A technique that can help in these situations is to start the cable placement in the middle of the run and work in both directions, reducing the run by half. To accomplish this, it will be necessary to take the last half of the cable length off the reel in order to access the bottom end. The cable can be laid on the ground in a figure eight configuration. By using the figure eight, the cable will pull out into the last half of the cable run without kinking. This prevents the natural twist that would be induced if a simple coil were used.

To clear obstacles along the route of an aerial placement, one can use the figure eight technique. After "figure eighting" the cable on the ground, the cable end is pulled over the obstacle and the cable can then be rewound onto the cable reel by hand.

Restoration

Repairing a damaged fiber cable will be a necessary part of the system maintenance. Unlike the initial installation that usually is done by specially equipped contractors, restorations may be done locally to save time and money.

The first step is to have some extra cable on hand; usually some additional length is added to the initial order to have on hand for repair purposes. Since fiber cables are generally made to order, obtaining a repair length from the factory may require several weeks. If necessary, long jumper cables can be used as a temporary repair. If a length of the original cable is not available but a different cable containing sufficient fibers is, then it certainly can be used. Under emergency conditions, even splicing together fibers from a different manufacturer is acceptable temporarily; for multimode fibers they must be equal core sizes.

For the permanent repair, two splice kits and a length of appropriate cable will be needed. The type of splices and splice cases chosen should be consistent with the objectives originally set out for the entire cable run. Some factors to be considered are splice loss, cost, reliability and local expertise.

How much cable should be removed to assure that all damaged fiber is eliminated? One concern is that all overstressed fiber (that now has a reduced life) be removed. It is probably impossible to know the answer with any certainty due to the variability of installations and type of damage incurred. One rule of thumb commonly proposed is to cut back 10 meters on each side of the damage.

A second factor to consider is the introduction of modal noise due to locating two splices close together. The importance of this factor is dependent on the particular manufacturer's fiber used. Avoidance of this situation requires separating the splice by 20 meters. From a practical point of view it seems that whenever reasonable, a repair section should be about 20 meters long. If a particular situation makes this difficult, consult your cable supplier.

Figure 8: Splice case and cable lashed to the strand

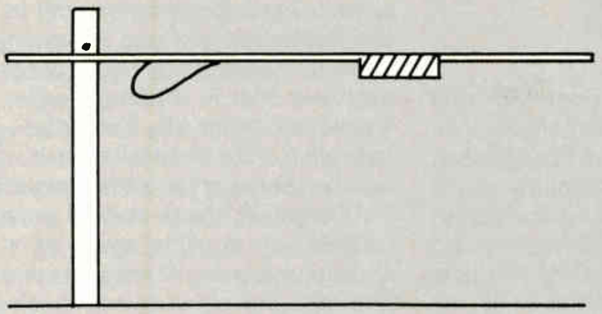
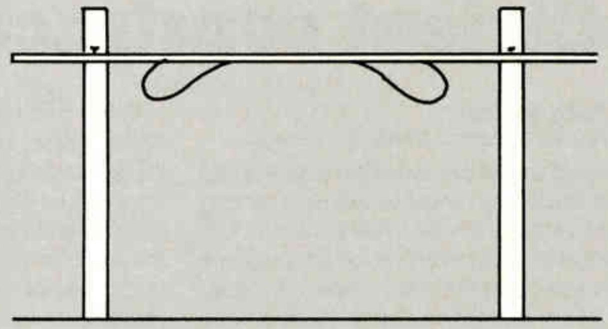


Figure 9: Installation of extra cable



Another approach is to install an accumulated excess of cable at points along the cable run. These points could be chosen for their proximity to likely damage locations such as an area that is expected to see significant construction and development in the near future. The accumulation of excess cable can be set up as in Figure 9, always keeping in mind minimum bend radius and tension. This excess cable can then be pulled out and relashed so the restoration can be done with a single splice.

Single-mode fibers used for telecommunications today have parameters that in most cases are standards.

- Attenuation
  0.40 to 0.70 dB/km at 1300 nm
  0.30 to 0.70 dB/km at 1500 nm
- Fiber mode diameter (μm) $\approx$9.0
- Fiber outer diameter (μm) 125 $\pm$ 3
- Coated fiber diameter (μm) 250 $\pm$ 15

Other physical characteristic differences between fibers are generally artifacts of the manufacturing process employed. While these do produce some operational differences, they are of secondary importance. With accepted cable design and installation and splicing practice it should not significantly impact the installed system operation.

The objectives of designing a cable fall broadly into the categories of protecting the fibers and providing ease of use. Protection specifications are relatively standardized because they are quantitative and the requirements are well understood due to the long history of building and installing metallic cables. On the other hand, ease of use, convenience, adaptability, etc., are more qualitative attributes and vary depending on the needs of the specific installation. Typical physical specifications for single mode telecommunications cables include:

- Operating temperature range: −50°C to +70°C
- Crush resistance:
  Armored: 460 lbf/in
  Non-armored: 400 lbf/in
- Impact resistance:
  Armored: 20 times at 3.7 lbf/ft
  Non-armored: 20 times at 2.2 lbf/ft
- Minimum bend radius (depending on fiber count): $\approx$10 times cable outer diameter
- Maximum pulling tension: 600 lbf

The specific geometric configuration and materials used in the cable may bear on the convenience to the user. Single tube, multitube, open channel or ribbon cable designs each have their own strengths and weaknesses from a user perspective. The choices may depend on individual preferences, installation, etc.

Fiber-optic cables are finding use in CATV systems today and many are predicting much wide use in years to come. The CATV operator can be assured that the cable manufacturers have the ability to provide products and accessories that can be installed and maintained in a practical sense. Some understanding of the characteristics of fibers and the design philosophy of cables by the user will help make the deployment of fiber cables successful. The objective of the cable manufacturers is to provide product that minimizes the need for special treatment. ■

References

1) Training Manual, DTS-1100, January 1988, Ditel.
2) Fiber-Optic Splice Training Course, March 1988, Ditel.
3) Alcatel Cable Systems Group; Celwave/Valtec Cable Products Catalog and Specifications, August 1987.

Reprinted with permission from the 1988 NCTA Technical Papers.

Hints for a more efficient construction

By Mike Mayberry
Construction Coordinator, Continental Cablevision

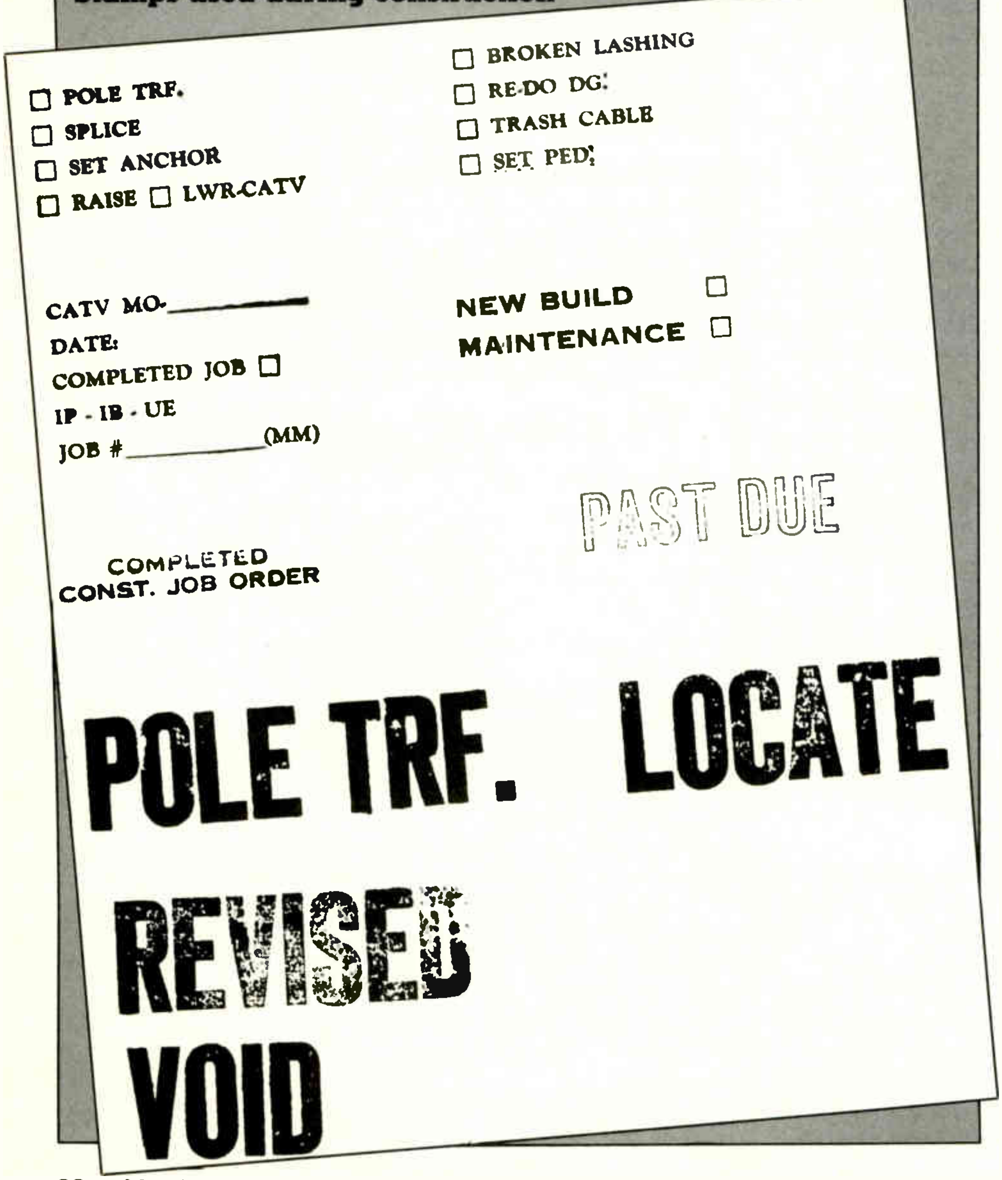
Trying to get construction crews to do a job the way you want it, without writing *War & Peace*, can be a real problem. Different crews can interpret job descriptions differently, even with plat maps. What construction personnel want—both those handing the orders out and those doing the actual work—is a quick, simple way to tell each other what has to be done. Put a stamp on your job. The accompanying figure shows only a fraction of what stamps are used by Continental Cablevision of Belleville, Ill. Maybe your cable company has some other ideas.

With the frequency over the past several years of bad poles mentioned on construction jobs, I believe a "Danger/Bad Pole" must be considered for the stamp list. When trying to give the most advanced information on a job to crews, nothing is more important than safety. All these stamps are inexpensive, normally not more than $8 and as little as $5.

If you have both aerial and underground construction crews or more than one of each, sometimes talking to them can be a luxury. The stamp can be placed on a construction job and left for the respective crews to pick up along with a plat map so the need for talk is minimized. This is especially helpful if you're checking on one crew while the second is at a different job location. "New-Build/Maintenance" is another helpful stamp for billing purposes when using subcontractors and for pinpointing locations of jobs. For example, if you see maintenance being performed over and over in a certain sector, you should investigate why. It could be a good indication of the need for a clean-up in a new-build area or just self-improvement.

All together, these stamps provide a concise way to utilize space on a construction job order. At the same time you can get your point across quickly yet accurately.

Stamps used during construction



For the record

Another practice that I believe helps a construction job become complete is record keeping in a "pole transfer book." This is a simple ledger book that describes what you need to know about an active job (i.e., performing a pole transfer, lowering or raising cable, splicing in replaced cable, setting new anchors, etc.) including:

1) area location (where it is)
2) job description (what is to be done)
3) construction personnel (who did the job and number of vehicles)
4) utility job order number
5) CATV job number
6) completion date or void

This might seem like pretty basic information, until you take a look at what can go wrong without that all-important record.

Area/location: No problem, right? But if your area is like ours, you have more than one street named Elm or Ruby. I know we do in at least three construction areas as they cover several towns and municipalities. Pinpoint the location; it makes for fewer calls to the dispatcher.

Job description: Is it a pole transfer relocation or emergency pole transfer? Are you raising or lowering for a height requirement or setting new poles that will change the route of the cable? Check your assigned plats and, if all else fails, call whomever is sending out the job for your crews to do.

Construction crews: Did subcontractors or in-house personnel do the job? You may think, "Who cares?" unless the job was done at the right address but the wrong location. It can happen. What also can happen is that a crew tells you they did a job one way, while a customer, utility engineer or someone else says it was not done that way. With correct sign-off, you can check.

Utility job order number and CATV job

(Continued on page 29)

Cable Exchange

Technically certified equipment
Largest database of equipment available

The following is a partial listing
available for immediate shipment to qualified buyers.

Call: 1-(800)-422-2567 to place your order.

In Colorado, call 1-(303)-694-6789

Item Number	Description
C229760	INPUT CONV. 6150 CH-A
C229860	OUTPUT CONV. 6350 CH-02
C229865	OUTPUT CONV. 6350 CH-07
C229868	OUTPUT CONV. 6350 CH-10
C229870	OUTPUT CONV. 6350 CH-12
C229871	OUTPUT CONV. 6350 CH-13
C229872	OUTPUT CONV. 6350 CH-A
C229873	OUTPUT CONV. 6350 CH-B
C229874	OUTPUT CONV. 6350 CH-C
C229875	OUTPUT CONV. 6350 CH-D
C229876	OUTPUT CONV. 6350 CH-E
C229877	OUTPUT CONV. 6350 CH-F
C229878	OUTPUT CONV. 6350 CH-G
C229882	OUTPUT CONV. 6350 CH-K
C229884	OUTPUT CONV. 6350 CH-M
C229888	OUTPUT CONV. 6350 CH-Q
C229890	OUTPUT CONV. 6350 CH-S
C230250	SPECTRUM INVRT. 6350
C274780	LO REF. LOOP THRU 6350
C342690	AUDIO MOD. 6350
C345153	OUTPUT CONV. 6350 CH-A+
XRPG-3	PILOT CARRIER GENERATOR
122006-02	POWER SUPPLY TRUNK AMP
142000-01	BRIDGER AMP T4XX
142014-02	BRIDGER AMP
300199-01	POWER SUPPLY T4XX
E-417E	LINE EXTENDER
E-417H	HOUSING FOR E-417E
T400H	HOUSING W/PS T4XX
T400HB	HOUSING BER T4XX
T421-002	TRUNK AMP
T470-002	TRUNK AMP
T470-003	TRUNK AMP
T470-030	TRUNK AMP
T470-051	TRUNK AMP
T470-052	TRUNK AMP
T500H	HOUSING W/XF T5XX
T507-030	TRUNK AMP
JLE-300	LINE EXTENDER 300 MHZ NH
JLE-300H	HOUSING FOR JLE 300
JLE-7400-2W	LINE EXTENDER 400 MHZ
JLE-7450-2W	LINE EXTENDER 450 MHZ
JLH	HOUSING FOR J SERIES L.E.
RCG-115N	RETURN CARRIER GENERATOR
SAM	AUTO SLOPE MOD.
SAM-PT	AUTOMATIC MODULE
SAM-PT-300	AUTOMATIC MOD. 300 MHZ NH
SAS-300	AUTO SLOPE AMP 300MEG
SAS-S	AUTO SLOPE AMP
SAS-S-300	AUTO SLOPE AMP 300 MHZ NH
SBM-300	BRIDGER MAN. 300 MHZ NH
SBM-P	BRIDGER MODULE
SBM-S	BRIDGER MODULE
SCD	TRUNK CHASSIE
SCD-2W	CHASSIE FOR TRUNK AMP
SCD-2W-300	TRUNK AMP 300 MHZ NH
SCD-2W-300H	HOUSING FOR SCD-2W-300
SCD-2W-R115	TRUNK CHASSIE W/RFC-115
SCD-2W-T108	TRUNK CHASSIE W/TRA-108M
SCD-2W-T30	TRUNK CHASSIE W/TRA-30M
SCD-2WD	CHASSIE FOR TRUNK AMP
SCD-2WE	BASEPLATE CHASSIS
SCL	TRUNK CHASSIE
SCL-2W	CHASSIE FOR TRUNK AMP
SCL-2WD	TRUNK CHASSIE

Item Number	Description
SDH-P	DISTRIBUTION MOD.
SDHP-300	DIST. AMP 300 MHZ NH
SJAS-400	TRUNK AMP 400 MHZ NH
SJBM-300	BRIDGER MODULE 300 MHZ
SJBM-301	BRIDGER MAN. 300 MHZ NH
SJBM-400	BRIDGER MAN. 400 MHZ NH
SJBM-450	BRIDGER MANUAL 450 MHZ NH
SJDL-301	DIST. AMP 301 MHZ NH
SJDL-400	DIST. AMP 400 MHZ NH
SJDL-405	DIST. MOD.
SJDL-450	DIST. AMP 450 MHZ NH
SJM-400	TRUNK AMP 400 MHZ NH
SJMM-300	MANUAL MODULE 300 MHZ NH
SJMM-301	MANUAL MODULE 301 MEG
SJMM-400	MANUAL MODULE 400 MHZ NH
SJMM-450	MANUAL MOD. P/P 450 MHZ NH
SJSP-60	POWER PACK 60V
SJSW-30	POWER PACK
SJSW-60	POWER PACK 60V
SLE-2P	LINE EXTENDER
SLE-300	LINE EXTENDER
SLE-300-2W	LINE EXTENDER 300 MHZ NH
SLE-300A-2W	LINE EXTENDER 300 MEG
SLE-300H	HOUSING FOR SLE-300
SLH-2	STARLINE L.E. HOUSING
SLR-300-2W	LINE EXTENDER
SMM	MANUAL MOD.
SMM-P	MANUAL MOD. NH
SMM-PT	MANUAL MODULE
SMM-S	MANUAL MODULE
SMMS-300	MANUAL MOD. 300 MHZ NH
SPCM-30	POWER CONTROL MOD 30V
SPCM-60	POWER CONTROL MOD 60V
SPP	POWER PACK
SPP-30	POWER PACK
SPP-60	POWER PACK 60V
SPP-S-30	POWER PACK
SPP-S-60	POWER PACK 60V
SPS-12	POWER SUPPLY 12V
SPS-30	POWER SUPPLY 30V
SPS-30B	POWER SUPPLY 30V
STH-7	STARLINE TRUNK HOUSING
STH-7B	HOUSING BER
TRA-108A	RETURN AMP
5-D440	DISTRIBUTION AMP 440 MHZ
5-T330	TRUNK AMP 330 MHZ
5CC-440	COMPLETE CONTROL 440 MHZ
5LE-440/30	LINE EXT. 440 MHZ 30V
5LE-440/60	LINE EXT. 440 MHZ 60V
MX-504H	HOUSING FOR MX-504
CEPS-3	POWER SUPPLY (CASCADE)
234430	TRUNK I/T FORWARD NH
CTN-1200	POWER SUPPLY
KCMG	MANUAL GAIN BRIDGER
PCAB-1	TRUNK AGC BRIDGER
PCAD-1D	BRIDGER TRUNK AGC NH
PCAD-1H	HOUSING FOR PCAD-1D
PCM-4	TRUNK AMP NH
PCM-4H	HOUSING FOR PCM-4
PCMB-2	TRUNK AMP NH
PCMB-2H	HOUSING FOR PCMB-2
PCRA	RETURN AMP

Cable Exchange

Item Number	Description	Item Number	Description
PCTB-6	TRUNK TERMINATING BRIDGER	FFT4-17D	TAP 4W 17DB
PH	HOUSING—P SERIES TRUNKS	FFT4-17F	TAP 4W 17DB
T3LE	LINE EXTENDER NH	FFT4-20	TAP 4W 20DB
T4CM	CONTINUITY MOD. NH	FFT4-20D	TAP 4W 20DB
TFAV	TRUNK AMP AGC	FFT4-20F	TAP 4W 20DB
TFM	TRUNK AMP MGC	FFT4-23	TAP 4W 23DB
TFPS	POWER SUPPLY	FFT4-23D	TAP 4W 23DB
TH	HOUSING FOR T SERIES L.E.	FFT4-23F	TAP 4W 23DB
XH	HOUSING FOR X SERIES L.E.	FFT4-23H	TAP 4W 23DB
XR2A	FORWARD AGC MOD.	FFT4-26	TAP 4W 26DB
XR2B	BRIDGER INTERMEDIATE	FFT4-26D	TAP 4W 26DB
XR2B-2	BRIDGER 2 OUTPUT	FFT4-29	TAP 4W 29DB
XR2B-4	BRIDGER 4 OUTPUT	FFT4-29D	TAP 4W 29DB
XR2DA	DIST AMP HYBRID AGC	FFT4-32D	TAP 4W 32DB
XR2DM	DIST AMP HYBRID MGC	FFT4-7T	TAP 4W 7DB
XR2F-1	INPUT MOD.	FFT4-7TD	TAP 4W 7DB
XR2F-13	INPUT MOD.	FFT8-4D	TAP 8W 4DB
XR2F-14	OUTPUT MOD.	SHS-2	HYBRID SPLITTER
XR2F-19	OUTPUT MOD.	SO-2	FEEDER MAKER
XR2F-3/110	INPUT MOD.	SO-4	FEEDER MAKER 4DB
XR2F-4	INPUT MOD.	SPJ-2	POWER COMBINER
XR2F-5	OUTPUT MOD.	SPJ-3C	DIRECTIONAL COUPLER 3DB
XR2F-7/110	OUTPUT MOD.	SPX-0.5	PAD 0.5DB
XR2F-8	OUTPUT MOD.	SPX-00	PAD 00 DB
XR2HA	LINE AMP HYBRID HRC	SPX-01	PAD 01 DB
XR2HM	LINE AMP HYBRID HRC	SPX-02	PAD 02 DB
XR2LA-PS	POWER SUPPLY	SPX-03	PAD 03 DB
XR2LAF-1	POWER INPUT MOD.	SPX-06	PAD 06 DB
XR2LAF-2	POWER INPUT MOD.	SPX-09	PAD 09 DB
XR2LAF-3	POWER OUTPUT MOD.	SPX-1.5	PAD 1.5 DB
XR2LAF-4	POWER OUTPUT MOD.	SPX-12	PAD 12 DB
XR2LARA	REVERSE AMP MOD.	SSP-12	POWER INSERTER
XR2LS-3	LINE EXT.	STC-12	DIRECTIONAL COUPLER
XR2M	FORWARD MGC MOD.	STC-12C	DIRECTIONAL COUPLER 12DB
XR2PS	POWER SUPPLY	STC-16	DIRECTIONAL COUPLER
XR2RHA110	REVERSE AGC MOD.	STC-3	DIRECTIONAL COUPLER
XR2SPH	HOUSING FOR XR2SP	STC-3B	DATA LINE
XRBI	INTERMEDIATE BRIDGER	STC-3C	DATA LINE
XRCE-3	LINE EXT.	STC-3D	DIRECTIONAL COUPLER 3DB
XRCE-6	LINE EXT.	STC-8	DIRECTIONAL COUPLER
XRDC-16	LINE EXT.	STC-8B	DIRECTIONAL COUPLER 8DB
XRDC-8	LINE EXT.	STC-8C	DIRECTIONAL COUPLER 8DB
XRLA	LINE EXT.	STC-8D	DIRECTIONAL COUPLER 8DB
XRLS-2	LINE EXT.	DCW-06DB	MINITAP 06 DB
XRLS-3	LINE EXT.	DCW-09DB	MINITAP 09 DB
XRPR	POWER SUPPLY	DCW-12DB	MINITAP 12 DB
XRRP	LINE EXT.	DCW-16DB	MINITAP 16 DB
XRSP	LINE EXT.	DCW-20DB	MINITAP 20 DB
N4-S5	TRAP CH. 5	2-14BW	TAP
BPF-B	BAND PASS FILTER CH. 8	2-17BW	TAP
BADC	B.A. DIRECTIONAL COUPLER	2-20BW	TAP
BAEQ-12-1	B.A. EQUALIZER	2-23BW	TAP
BAEQ-3-3	B.A. EQUALIZER	2-26BW	TAP
BAEQ-8-1	B.A. EQUALIZER	4-08BW	TAP
BASP	B.A. SPLITTER	4-14BW	TAP
CSA-300-3	EQUALIZER T4XX	4-26BW	TAP
DISP-3	DISTRIBUTION SPLITTER 3-3	4-32BW	TAP
EQ-450/13	EQUALIZER 450 MHZ 13DB	8-17BW	TAP
EQ-450/15	EQUALIZER 450 MHZ 15DB	8-20BW	TAP
EQ-450/8	EQUALIZER 450 MHZ 8DB	8-26BW	TAP
EQA-1A	EQUALIZER T4XX	8-29BW	TAP
EQA-220-2	EQUALIZER T4XX	8-32BW	TAP
EQA-220-4	EQUALIZER T4XX	EQ-04DB	EQUALIZER 450MHZ
EQA-220-6	EQUALIZER T4XX	EQ-08/250	EQUALIZER
EQS-0	EQUALIZER LAN 0DB	EQ-08/300	EQUALIZER
EQS-186-4	EQUALIZER LAN 4DB	EQ-08DB	EQUALIZER 450 MHZ
EQT-450/10	EQUALIZER 450 MHZ 10DB	EQ-12/300	EQUALIZER
PB-0	PAD 0DB	EQ-15DB	EQUALIZER 450MHZ
PB-1	PAD 1DB	EQ-16DB	EQUALIZER 450MHZ
PB-2	PAD 2DB	EQ-18DB	EQUALIZER 450MHZ
PB-5	PAD 5DB	PCSPL-1	SPLITTER
PB-6	PAD 6DB	PCSPL-2	SPLITTER
PPLUG	POWER PLUG T4XX	PCSPL-3	SPLITTER
DS-200	SPLITTER 2-WAY 3.5 DB	PD-0	PLUG-IN PAD 0DB
DS-300	SPLITTER 3-WAY 5.5 DB	PD-3	PLUG-IN PAD 3DB
DS-3EL	SPLITTER 3-WAY 5.5 DB	PD-6	PLUG-IN PAD 6DB
DS-400	SPLITTER 4-WAY 6.5 DB	PD-9	PLUG-IN PAD 9DB
DS-4GB	SPLITTER 4-WAY 6.5 DB	PPLUG	POWER PLUG
DS-800	SPLITTER 8-WAY 11DB	T4BDC-8	PLUG-IN PAD
FFT4-10D	TAP 4W 10DB	T4BDL-12	PLUG-IN PAD
FFT4-10F	TAP 4W 10DB	T4SPL	PLUG-IN PAD
FFT4-14	TAP 4W 14DB	VEQ-08/300	EQUALIZER
FFT4-14D	TAP 4W 14DB	VEQ-12/250	EQUALIZER
FFT4-14F	TAP 4W 14DB	VEQ-12/300	EQUALIZER
FFT4-17	TAP 4W 17DB	XR2-13	TAP 4WAY 13DB

Reader Service Number 11.

Basic electronics theory

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

By Kenneth T. Deschler
Cable Correspondence Courses

This month we will cover the opposition offered to alternating current (AC) by inductors, capacitors and resistors.

Inductive reactance is the opposition to alternating current offered by an inductor. Previously we learned that a collapsing electromagnetic field induces a voltage that causes current to continue to flow in the original direction. This property, known as *self inductance*, was explained by Lenz's law. Inductive reactance is proportional to the frequency of the AC source as well as the value of the inductor. The symbol for inductive reactance is X_L and its unit is the ohm.

The formula for finding the reactance of an inductor is as follows:

$$X_L = 2\pi FL$$

where:
X is in ohms
F is in hertz (Hz)
L is in henrys
π is a mathematical constant equaling 3.14; therefore 2π equals 6.28

The following example illustrates how the reactance of an inductor may be found:

Given:
F = 120 Hz
L = 3 henrys

Solution:

$$X_L = 6.28 \times 120 \times 3$$
$$= 6.28 \times 360$$
$$= 2{,}260.8 \text{ ohms or } 2.26 \text{ kilo-ohms}$$

The phase relationship within a purely inductive circuit is such that the voltage (E) leads the current (I) by 90 electrical degrees. Figure 1 shows this relationship.

Capacitive reactance

Capacitive reactance is the opposition to current flow offered to AC by a capacitor. When we studied capacitors we found that capacitance was the ability of a capacitor to store an electrostatic field within the dielectric located between its plates. As capacitance increases, more current is able to flow, thus reducing capacitive reactance. Similarly, a reduction of reactance occurs when the frequency is increased. The symbol for capacitive reactance is X_C and its unit is the ohm.

The formula for finding the reactance of a capacitor is as follows:

$$X_C = \frac{1}{2\pi FC}$$

where:
X_C is in ohms
F is in Hz
C is in farads
2π equals 6.28

Figure 1: Phase relationship in an inductive circuit

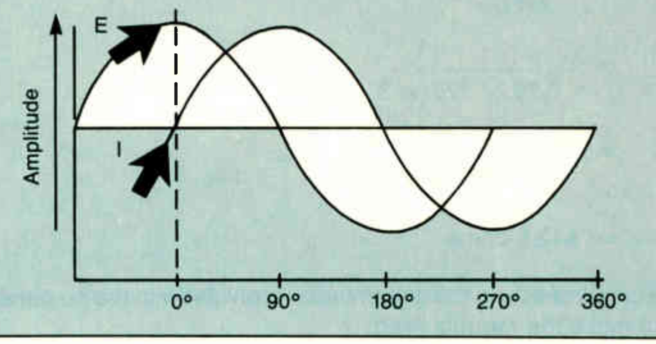


Figure 2: Phase relationship in a capacitive circuit

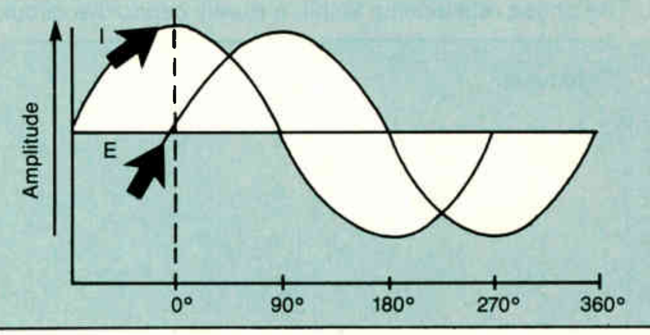
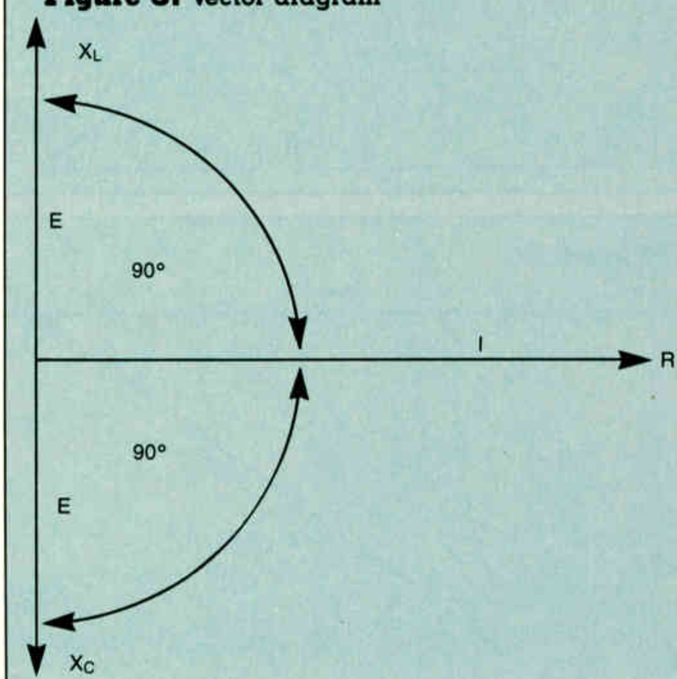


Figure 3: Vector diagram



The following example illustrates how the reactance of a capacitor may be found:

Given:

$F = 120$ Hz
$C = 3$ microfarads

Solution:

$$X_C = \frac{1}{2\pi FC}$$

$$= \frac{1}{6.28 \times 120 \times 3 \times 10^{-6}}$$

$$= \frac{1}{2{,}260.8 \times 10^{-6}}$$

$$= 442.5 \text{ ohms}$$

Sometimes 2π in the denominator is divided into the numerator to make the formula read:

$$X_C = \frac{0.159}{FC}$$

The phase relationship within a purely capacitive circuit is

Figure 4

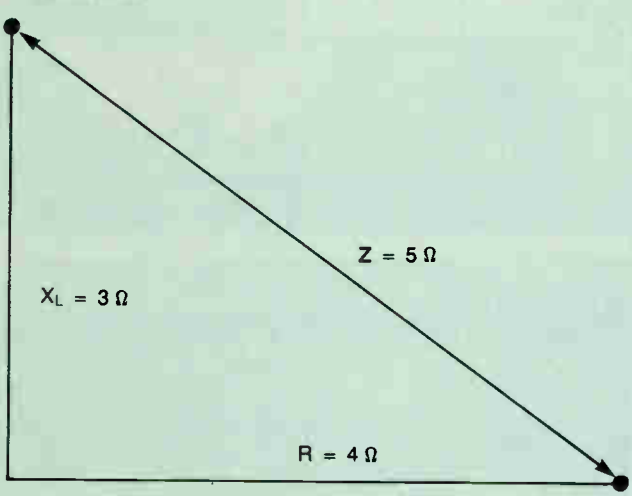


Figure 5

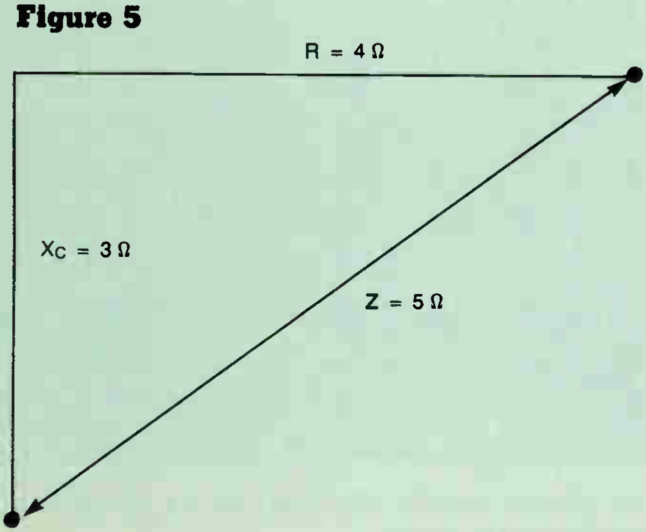
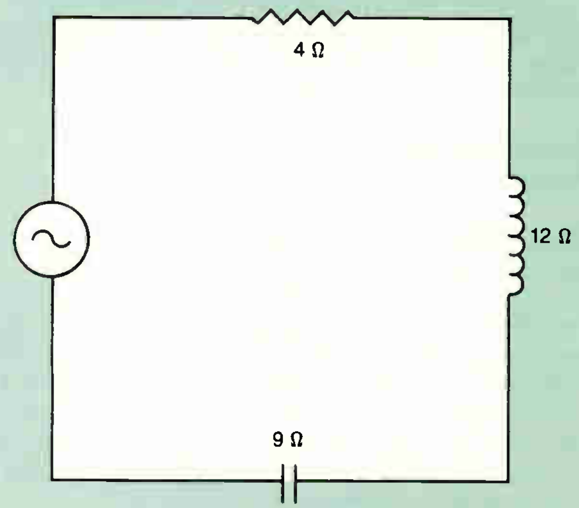


Figure 6



such that the current leads the voltage by 90 electrical degrees. Figure 2 shows this relationship.

An easy way to remember the relationship of voltage and current when dealing with reactors (inductors and capacitors) is to memorize the phrase "ELI the ICE man." The letters I and E stand for current and voltage, the L stands for inductance and the C stands for capacitance. From this phrase we see that voltage leads current in an inductor while current leads voltage in a capacitor.

Impedance

Impedance is the total opposition to current flow within an AC circuit and results from the combined opposition of both reactance and resistance. Impedance is measured in ohms and its symbol is the letter Z.

The formula for finding the impedance of a series circuit is found by taking the square root of the sum of the individual quantities squared. As an example, let's find the impedance of a resistance of 4 ohms in series with an inductor with a reactance of 3 ohms.

$$Z = \sqrt{R^2 + X^2}$$
$$= \sqrt{4^2 + 3^2}$$
$$= \sqrt{16 + 9}$$
$$= \sqrt{25}$$
$$= 5 \text{ ohms}$$

The impedance also could have been found by using a graphical method called *vector analysis*. In a vector diagram of the circuit, the line representing the resistance is placed horizontally and the lines representing the reactances are placed vertically. Because of the 90° difference in voltage and current in a reactor, X_L quantities are shown going upward while X_C quantities are shown going downward. Looking at Figure 3, we can see how this is represented. Because voltage and current are in phase through a resistor, the line representing resistance also becomes the reference point for current. Going clockwise we see that the voltage across an inductor leads the current by 90° and that the voltage across a capacitor lags the current by 90°.

Figure 4 shows that if we were to draw lines whose lengths were in proportion to the values of resistance and reactance,

(Continued on page 42)

The Heat Is On for

The Society of Cable Television Engineers

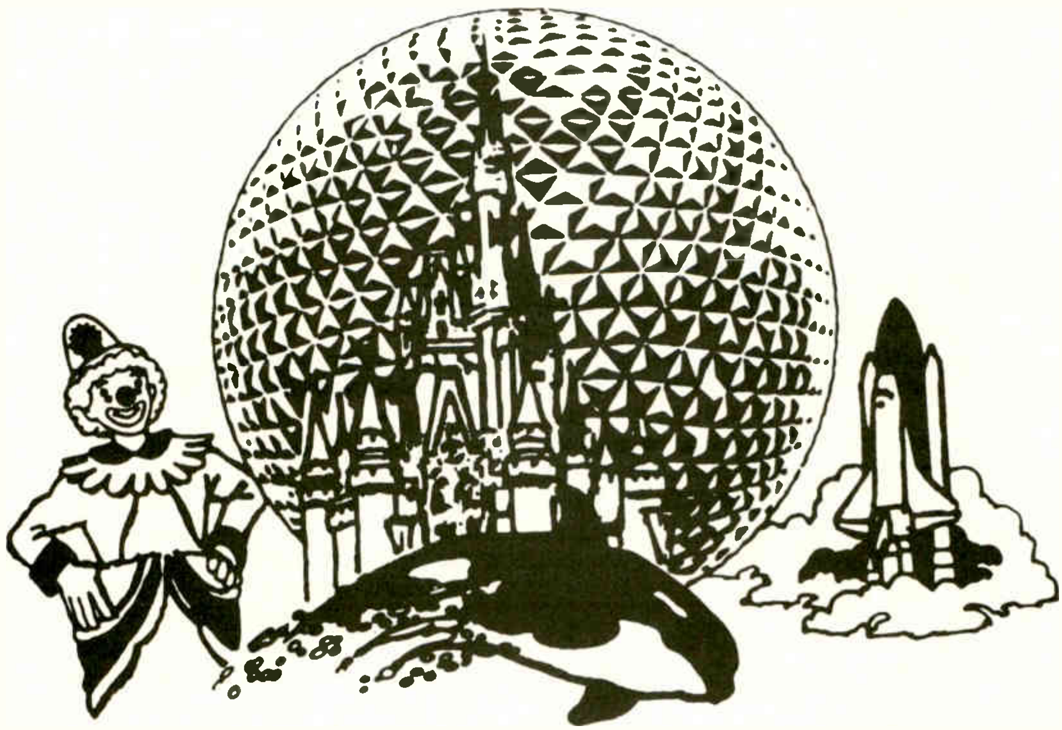
CABLE-TEC EXPO `89

Orange County Convention Center
Orlando, Florida

June 15-18

SCTE
1969-1989
20 Years of Service

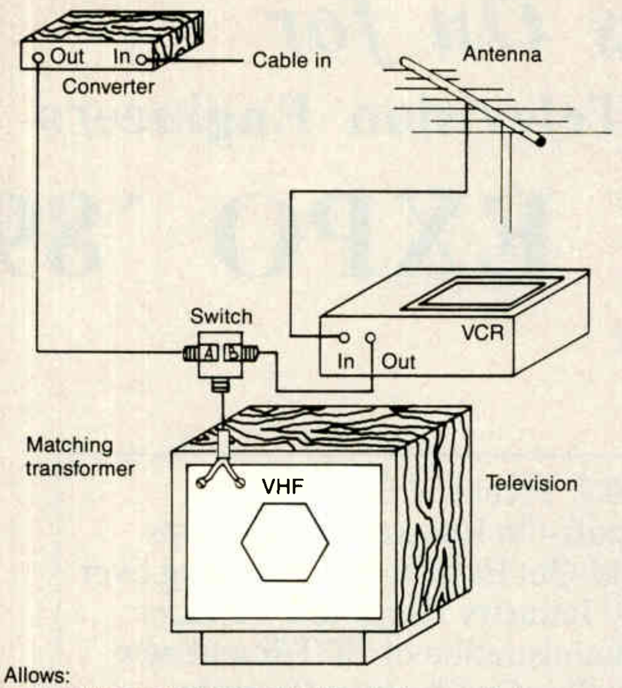
- 100% Technical Orientation
- Hands-On Breakout Workshops
- Sold-Out Exhibit Hall featuring over 100 Industry Hardware Vendors
- Administration of BCT/E and new Installer Certification Program Examinations



COMPLETE REGISTRATION INFORMATION FOR CABLE-TEC EXPO `89 WILL APPEAR IN NEXT MONTH'S *CT* MAGAZINE.

Reader Service Number 12.

Figure 9

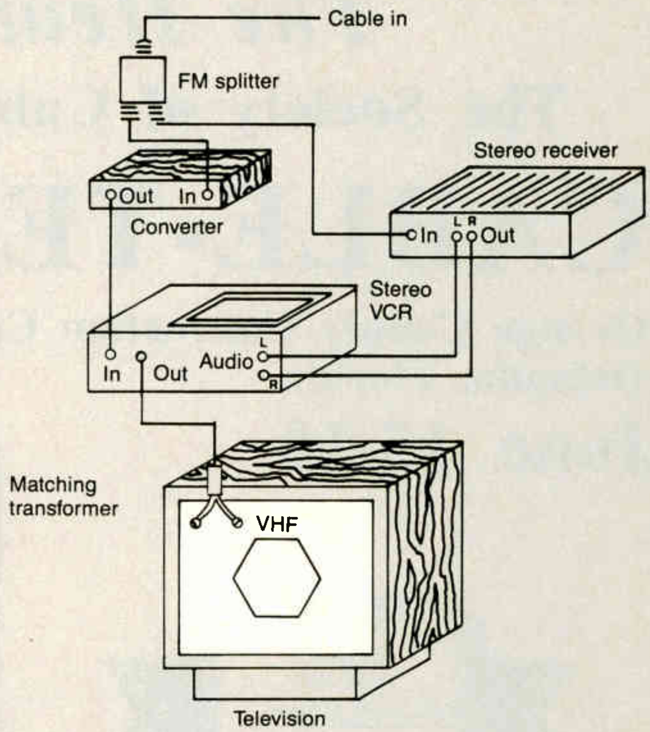


Allows:
- recording of off-air channel, while viewing any off-air or any cable channel
- timed, multichannel, multievent recording (i.e., ability to program the VCR to record a movie on Ch. 5 at 6 p.m., and then a second program on Ch. 26 at 8 p.m.) of off-air channels only
- full use of the VCR remote control

Precludes:
- channel selection by the TV remote control
- recording of any cable channel

Necessary drop level: 0 dBmV

Figure 10



Allows:
- recording of any channel, while viewing the same channel
- recording of simulcast audio

Precludes:
- timed, multichannel, multievent recording (i.e., ability to program the VCR to record a movie on Ch. 5 at 6 p.m., and then a second program on Ch. 26 at 8 p.m.)
- channel selection by the TV remote control
- channel selection by the VCR remote control

Necessary drop level: +1 dBmV

Recommended practices for consumer interfacing

This is the fourth part in a series on connecting consumer electronics products in the subscriber's home. The installation setup guide and Figures 1 through 8 appeared in Part III. Future installments will provide Figures 14 through 27.

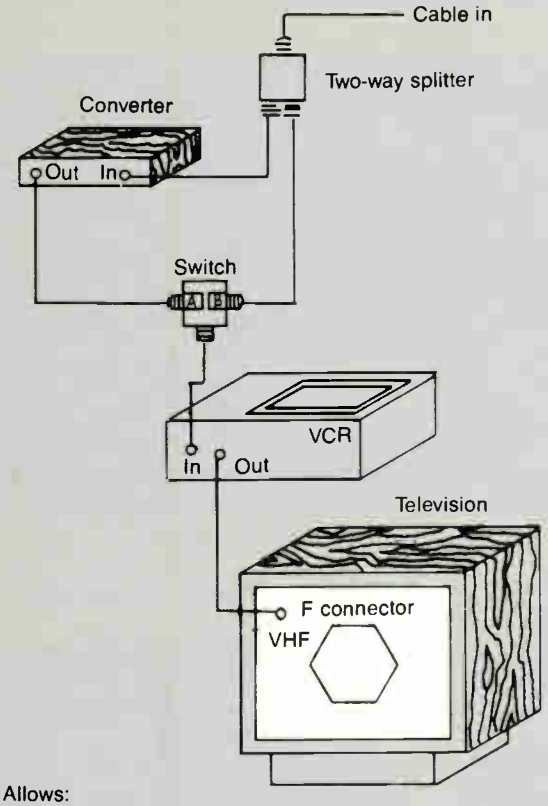
By the NCTA Engineering Committee's Subcommittee on Consumer Interconnection

You will need to keep these factors and their relative importance in mind when choosing an installation configuration:
- simplicity of operation
- ability to use TV or VCR remote control (all illustrations allow for use of a converter remote control)
- ability to use timed, multichannel, multievent VCR feature
- total signal attenuation (i.e., if your system levels are near 0 dBmV and the installation diagram calls for a four-way splitter, your subscriber will get snowy pictures)
- number of high-quality A/B switches (yielding 70 to 80 dB of isolation at minimum) needed
- 0 dBmV is assumed to be the minimum input level for a converter
- mid-UHF converters may not translate all super-band channels to UHF
- VCRs in bypass require high drop levels

In the accompanying figures:

1) Some TV sets are shown with 300 ohm input terminals, others with direct coaxial inputs. Either input terminal type is acceptable as far as the diagrams are concerned.
2) If direct connection to external antenna systems is part of the installation scheme, operators *have* to keep potential signal leakage in mind and avoid it with proper A/B switch quality and isolation.
3) If three-way splitters are used, note that the dot in the illustration's splitter denotes the higher level output leg, assuming one leg at −3.5 dB and two legs at −7 dB. If the splitter has equal splits or is hooked up differently, the minimum acceptable drop signal level will need to be increased.
4) Where only one input and output cable is shown for a VCR, it is intended to designate the VHF terminals.
5) Presence of cable-compatible TVs and VCRs is assumed in "no-converter" hookups.

Figure 11



Allows:
- recording of only non-scrambled channels, while viewing any non-scrambled channel
- recording of scrambled channel while viewing same channel

Also allows (for non-scrambled channels only):
- timed, multichannel, multievent recording (i.e., ability to program the VCR to record a movie on Ch. 5 at 6 p.m., and then a second program on Ch. 26 at 8 p.m.) of off air channels only
- channel selection by the TV remote control
- channel selection by the VCR remote control

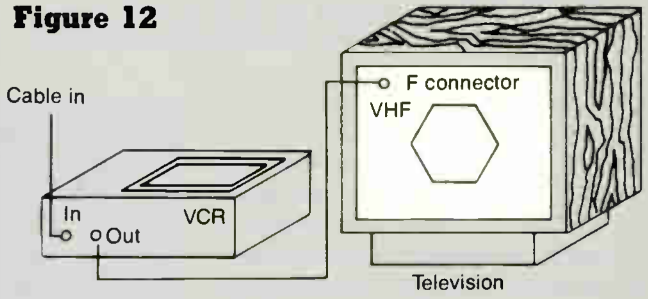
Note: only real benefit of this connection appears to be use of VCR remote and independent timed, multichannel, multievent recording
Necessary drop level: +3.5 dBmV

6) It is assumed that most converters do not have a timed channel selection scheme.
7) Connections can accommodate two TV sets by the addition of a two-way splitter at the drop.

The following terms are used in the figures:

- Allows: assumes that simultaneous TV and VCR use (to a greater or lesser degree of access to a full range of paid-for cable programming) is the subscriber's aim
- Any channel: "any" means whatever channels a subscriber's home equipment (TV, VCR, converter) is capable of receiving and that a subscriber has paid for
- Scrambled: a signal that requires a descrambler
- Non-scrambled: a signal that is never scrambled; sent in the clear
- Off-air: channels received via an external TV antenna, not delivered via "over-the-wire" cable TV service
- Cable channels: any channels delivered via "over-the-wire" cable TV service that a subscriber has paid to receive
- Recording: videocassette recording ■

Figure 12

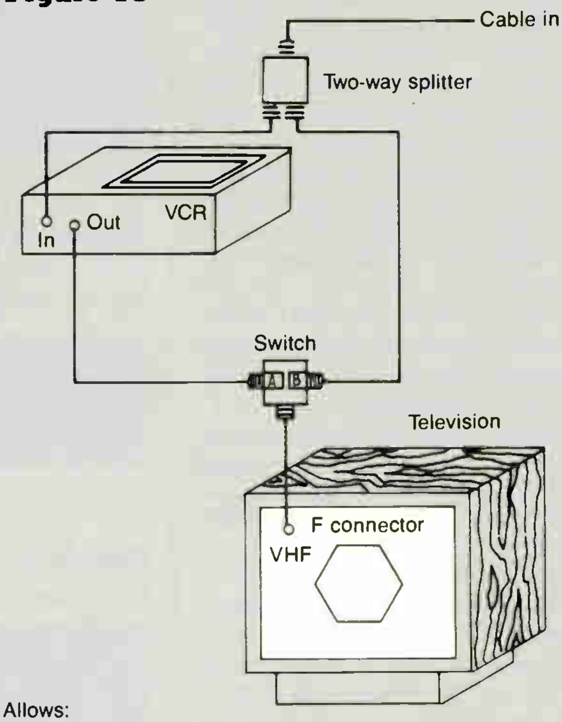


Allows:
- recording of any channel, while viewing any channel
- timed, multichannel, multievent recording (i.e., ability to program the VCR to record a movie on Ch. 5 at 6 p.m., and then a second program on Ch. 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

Precludes:
- non-cable compatible VCRs

Note: assumes all channels are non-scrambled
Necessary drop level: +5 dBmV

Figure 13



Allows:
- recording of any channel, while viewing any channel
- timed, multichannel, multievent recording (i.e., ability to program the VCR to record a movie on Ch. 5 at 6 p.m., and then a second program on Ch. 26 at 8 p.m.)
- full use of the TV remote control
- full use of the VCR remote control

Assumes:
- VCR does not have a bypass or the bypass has high insertion loss
- all channels are non-scrambled

Necessary drop level: +3.5 dBmV

Reprinted with permission from "Connecting Cable Systems to Subscribers' TVs and VCRs—Guidelines for the Cable Television Industry" (1987) by the NCTA.

CATV installation in the home

By David B. Sinclair
Technical Instructor, Henkels & McCoy

Cable television is probably the largest form of entertainment in the home today. For a CATV company to be successful, it must maintain a base of satisfied residential customers. The technician that installs service in the home is the only representative of the company that the customer will ever meet. If the technician performs in a professional, efficient and neat manner, chances are good relations will exist for the entire length of the contract.

When the technician goes to a home to install service, it is imperative that he be prompt, neatly dressed and polite. The first step in performing the install is to introduce yourself to the customer, verify that it is the proper location and that the work order is correct. It is important to discuss things such as the cable route, what will be fastened to the home and any holes that may need to be drilled. Make sure the customer is in agreement before you do any work; do not accept agreement from a minor occupant of the home.

For this discussion, we will be installing service to a single unit residence with two television sets and a VCR. The building is a ranch style home with a full basement. The cable company service is provided using aerial cable equipped with a multiple tap. The customer has been identified and has agreed with the work to be done and the plan of installation.

The installer must now install a drop cable from the pole to the house. Where possible, this cable should follow the same route to the home as the other utilities. Set up the cable caddy at the house and pull the cable from the house to the pole where the tap is located; do not damage the lawn, fencing or flowers with the cable or the caddy. While pulling the cable to the pole make sure that the ground area is free from obstacles such as toys, lawn furniture and lawn tools and that the cable is not routed under trees, bushes or clothes lines.

Figure 1: Strip out 18 inches of messenger wire

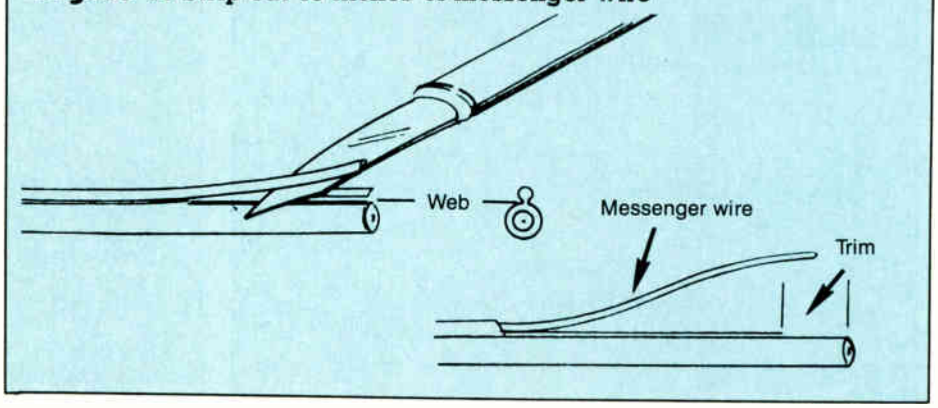


Figure 2: Strip ½ inch of outer jacket from the cable

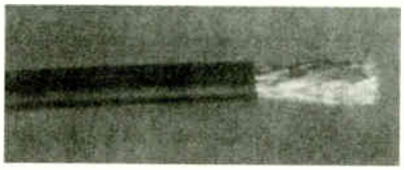


Figure 3: Fold inside braid back over outer jacket and trim to 1/8 inch

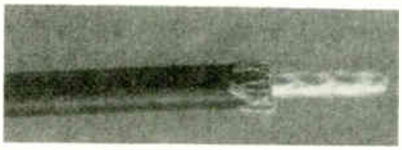


Figure 4: Remove 3/8 inch of inner conductor shield

Figure 5: Slide the fitting on the cable

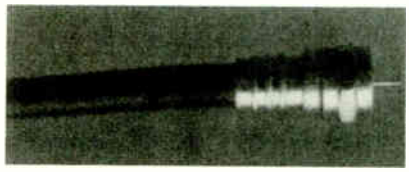
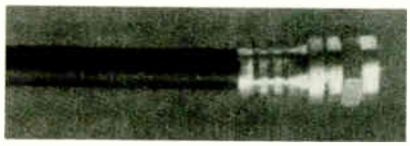


Figure 6: Crimp the connector to the cable

Figure 7: Trim the inner conductor 1/16 inch beyond the end of the fitting



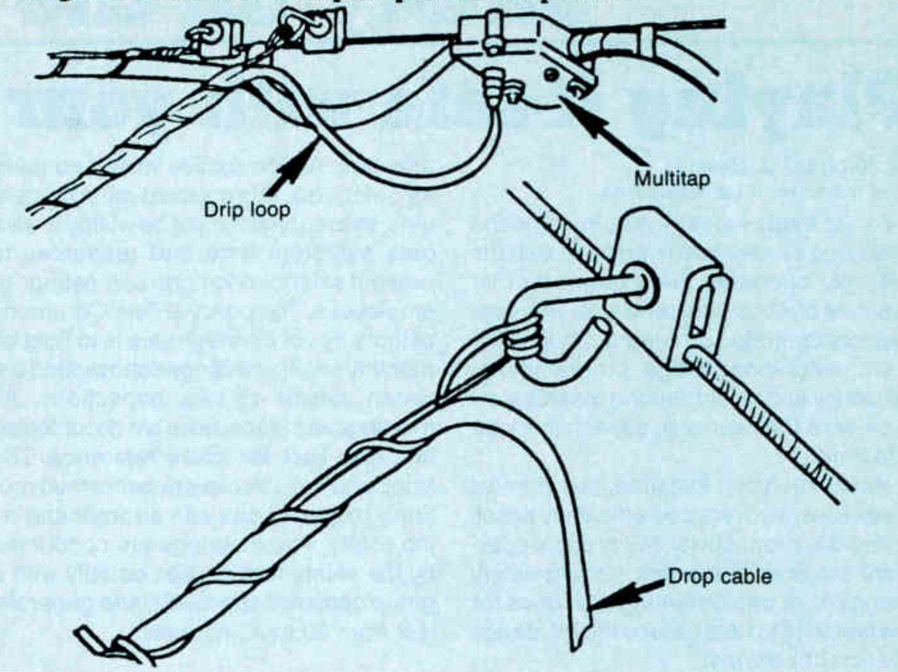
Making the connection

The next operation is to prepare the tap end of the cable for connection to the multitap and the pole hardware. This can be done while on the pole, but it is safer and more convenient to do as much work as possible on the ground. If you are using messenger cable, strip out 18 inches of the messenger wire and then attach the F fitting (Figure 1).

Attaching F fittings to coaxial cable is one of the most critical operations the installer will perform and when done properly the signals are passed without noticeable loss or distortion. The fitting must be the proper size for the cable being used. Strip 1/2 inch of the outer jacket from the cable, being careful not to damage the inside braid (Figure 2). Fold the inside braid back over the outer jacket and trim it to 1/8 inch (Figure 3). Remove 3/8 inch of the inner insulation and foil, again being careful not to nick the center conductor (Figure 4). Slide the connector on the cable with the inner sleeve between the braid and the foil, and the outside sleeve over the cable jacket (Figure 5). Using a crimp tool equipped with the proper size die, crimp the connector to the cable (Figure 6). Trim the inner conductor leaving 1/16 inch exposed beyond the end of the connector (Figure 7).

"If the technician performs in a professional, efficient and neat manner, chances are good relations will exist for the entire length of the contract."

Figure 8: Provide a drip loop in the drop cable



The installer must make a physical inspection of the pole to determine if it is safe to climb. If the safety of the pole is questionable contact your supervisor or the company safety officer before proceeding. Prior to ascending the pole, inventory your tool belt for necessary tools and materials. It also is a good practice to verify that the identification or address tag for this drop is correct.

Once on the pole and in a good working position, wrap the messenger around the span clamp at least twice and then around the cable six to eight times. If there is a terminator on the tap port, remove it. Lightly coat both the tap port and the F fitting with silicone grease and connect the F fitting to the port hand tight. Using a 7/16 wrench, tighten the fitting one-eighth of a turn. Remember to provide a drip loop in the drop cable (Figure 8). This will allow water from rain, snow and condensation to drip away from the port, preventing damage from freezing or corrosion. Finally, attach the address tag or identification tag to the drop. ■

Construction hints

(Continued from page 20)

number: These serve the same purpose: a cross-reference check to make sure everybody did the same job the way the company that requested it wanted it done. These numbers also are helpful since the utilities very seldom send in the same job at the same time.

Completion date: This is important when the job you are researching is two or more years old. For example, a particular utility company called me and could not remember issuing an order two years ago or find their job order number. Not only did Continental Cablevision have the utility job order number, but a corresponding CATV number, their station and transformer number, the address at which the pole was located, a photo of the pole and the reason the utility company wanted that pole replaced.

The record book on construction jobs/pole transfer is not the only reading material we have at Continental Cablevision. I keep one book on each of the following items: splicing, dig numbers (J.U.L.I.E.) and damage claims (for and against CATV). As time goes on, all this material can be put on computers if the expense vs. the total miles of a particular system warrants it. ■

Playing it safe with your system

By Michael J. Berrier
Chief Technician, TCI of Pennsylvania

As the cable industry matures and the likelihood of new-builds and expansions dwindle, operators are exploring other avenues of increasing revenues, with concern concentrated on community involvement, saturation, image, programming, efficiency and safety. Among these, safety is an area that warrants especially close attention.

Personal injury, lost time, mechanical breakdown and reduced efficiency are all barriers to productivity. Many cable operators are examining their current safety programs or implementing new ones for the first time to help reduce the incidence of such conditions.

People tend to place a priority on the safety of themselves and their families. A good safety program will help employees realize that they are responsibile for the safety of their co-workers and the public in general, as well as their own.

For such a plan to be realized, however, you must have the cooperation of management. All companies voice a concern for safety, but this concern must be genuine; management must be willing to allocate sufficient time and resources to present safety workshops or meetings to employees. The policy of Tele-Communications Inc. of Pennsylvania is to hold bimonthly safety meetings sandwiched between vehicle or tool inspections. All meetings and inspections are documented and files kept for future reference. The truck and tool checks are performed routinely by employees with an emphasis on job safety. The meetings are conducted by the safety coordinator, usually with a group centered approach, and generally last from 30 to 45 minutes.

Picking a topic

Out of the 52 weeks in a year, 17 are devoted to group safety meetings. The safety coordinator is responsible for researching and developing interesting and informative topics for the meetings. Occasionally, the topic will pertain to all employees, not just the field personnel. Many resources are available to help you pick a safety topic. For example, the company safety manual should be covered in detail. Also, all new equipment contains the manufacturer's literature, which always has safety hints. Government agencies, health organizations and utility companies will provide you with informative articles and publications on request. It also is beneficial to keep an eye open for articles in the newspaper that can be adapted for use in the meetings.

The topics covered can be as varied as the possible situations that can be faced by a CATV professional. Seasonal conditions due to weather can run the gamut from heatstroke to hypothermia. Other physical problems that may be encountered include poison ivy, sun poisoning, animal bites, snow blindness and dehydration, just to name a few. Some other areas to explore may be pole climbing, ladders, flagging and traffic control, defensive driving, CPR, fire extinguishers, cones, hardhats, pole transfers, gaff sharpening, trailer pulling, working around children and drugs and alcohol.

Driving accidents account for the majority of lost time and reduced efficiency problems, so this area cannot be emphasized enough. Field personnel are on the roads daily and in the public eye, which is a safety concern as well as an image concern. Courteous and defensive driving techniques should be practiced by all.

Safety discussions often include personal experiences or secondhand accounts of incidents in other systems. Encourage everyone to make suggestions for improving conditions and offer advice to co-workers. The varied accounts of accidents and problem areas help illustrate the need for continued awareness and concern for safety.

Personal growth, new program development and implementation, plus technological advancements are but a few of the reasons that continually require a cable technician to learn new skills. Simply handing an employee a pole bit doesn't make him qualified to do pole transfers, nor does a driver's license indicate the driver's ability to safely pull a cable trailer. These skills, as well as many others, need to be taught and developed. Proper training of personnel is essential to make your system safe. ■

It gets boring

(Continued from page 14)

I find a better cutter is one made by Pengo Corp. This is a cutter that is designed for use as a pilot bit on the end of post hole augers. They come in various sizes from small up to ones that cut holes larger than 6 inches in diameter. For the one I use, their part number is SB-25. You will need to weld an adapter onto this to make it fit your drill steel. In case of water pipe a standard coupling is all that is required. Since this drills a cone-shaped hole, it tends to travel straighter than the fishtail cutter. For extremely hard ground there are carbide cutters available. They are expensive, but well worth the money.

Drilling in loose sand requires a completely different technique. The conduit must be installed as the hole progresses. Otherwise the hole caves in as fast as it is made. You must use a rigid conduit for this. Either heavy PVC or steel is required. Feed the cutter through the pipe and push the pipe in as the hole progresses. A good supply of air is required to keep the pipe blown clear. Sometimes you do not need a mechanical cutter as an air nozzle often will do the trick. Make sure there are some holes pointing to the rear of the nozzle so that the sand is brought out of the conduit.

On long holes you may only be able to push the conduit part of the way across the street before the friction seizes the pipe and you cannot move it more. The trick here is to start with a larger conduit, then when it stops, push a smaller pipe through it and continue on as before.

A different method of expansion boring that you may hear of is the use of an air-driven device that works somewhat on the principle of a jack hammer. Under proper conditions and when used properly this is a fine device. However, there are several problems. It will not work in soft or muddy soils. You cannot tell if you are hitting something. It gets lost in sand pockets where it often dives straight down. Sometimes it hits something, it gets stuck and you cannot pull it back out. There are several around the country that you can have for free if you go after them. They happen to be under freeways or in similar places. ■

This article has been reprinted and updated from CATJ, August 1980.

Reader Service Number 13.

Sweeping line extenders

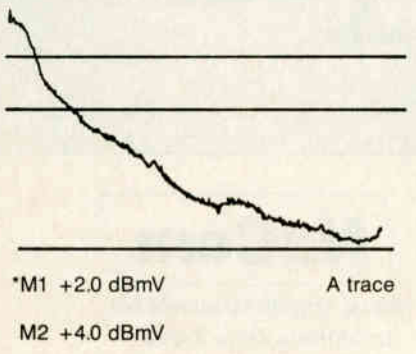
By Frank Adams
Maintenance Manager, Cablevision of Cleveland

For most cable systems, the glory days of franchising with massive new builds and huge new customer gains are over. Cable systems are now settling into a maintenance mode and are beginning to step back and take a good look at the condition of the plant and how well it performs. Cable operators are realizing that any future customer gains will be directly attributable to customer service. Good customer service means better retention and better retention translates to increasing customer gains.

Better customer service is a multi-dimensional commitment with all employees having a direct or indirect impact on its success or failure. One aspect of customer service is preventive maintenance (PM). The theory behind PM is to find and fix plant problems before they deteriorate into customer complaints—better known as service calls.

One of the best weapons in the arsenal of PM is sweeping the system. One of the hardest, most difficult obstacles to overcome in establishing a PM program is for a maintenance or plant manager to convince the general manager of the need for a regular program. This program necessitates dedicating a few top notch service technicians full time to the program, thus taking them away from doing service calls, and the benefits of the program are not immediately felt. So, you already have two strikes against you!

Figure 1: A typical input response



How do you make a hit with the big guy in the corner office and not strike out? The answer is with numbers. The big guy likes to see numbers so he can make a decision that will yield positive results. Here are some numbers to use for comparsion. My system put in place an aggressive PM program 5½ years ago. In 1983, we averaged 1,748 service calls per month with an average customer count of 54,828. In April 1986, we completed 1,326 service calls with a customer count around 70,500. Again, these numbers are strictly for illustration purposes, but I think it is easy to see the long range benefits of an aggressive PM program.

Don't hold back

Okay, so the numbers worked and now you have a PM sweep program in place. You are sweeping the trunk, fine tuning it, fixing problems, and getting it to run at peak efficiency. But, don't stop there! Sweeping the trunk is only half the battle. What about sweeping the distribution system? Granted, the trunk affects a greater number of customers, but there are more actives, passives, connectors and cable in the distribution system. Another way of looking at it is that there are many more things to go wrong in the distribution system than there are in the trunk system. Sweeping line extenders is an excellent means of detecting and correcting these problems.

Because of all of the passive devices and connectors on the distribution line, the sweep tech must have a keen eye and be able to spot problems by correctly interpreting the frequency response display on his receiver (Figure 1). (Unless otherwise stated, all references will be to the Wavetek 1865 hi level sweep receiver.) One common error techs make when analyzing a sweep response is to try and read the response while it's at the bottom of the oscilloscope screen. The scale on the oscilloscope is not calibrated to linear scale and any displays in the lower 50 percent of the scale will be compressed and hide any response faults. Therefore, in order to be as accurate as possible, make sure all frequency response displays are displayed in the upper 50 pecent of the scale.

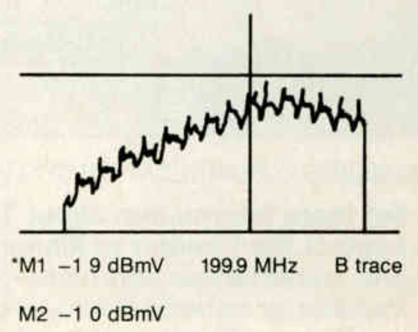
"One of the best weapons in the arsenal of PM is sweeping the system."

If you have ever swept an input to an amplifier, you know that the response will be severely tilted from the low-band to super-band with the super-band being in the extreme lower right hand corner of the display. This condition will compress the super-band and mask, or at least minimize, any faults in this part of the display. An excellent way to overcome this problem is to insert either a Wavetek E300-3 cable equalizer or an RMS CA-2200 tilt attenuator in the test cord. Both devices have the opposite effect of cable attenuation. They will attenuate less than 1 dB at 300 MHz and attenuate 3 dB or greater depending on the size of the equalizer at 40 MHz. The result is a flatter response that will be slightly attenuated. To bring the frequency response back into the upper 50 percent of the scale simply take out some attenuation with the attenuation control on the front of the receiver. Now you have a flat response that you can work with and you can spot defects more easily. This method will help detect any problems on the input side of the line extender.

Helpful hints

There are some tricks to use to find faults on the output side of the line extender as well. Suppose there is an open tap or severe mismatch on the output side of the line extender. If it is close enough to the line extender (usually within 600 feet) it will cause a standing wave in the frequency response. This fault can easily

Figure 2: A standing wave problem



be found with the aid of a special function on the Wavetek 1865 receiver and a simple formula. A standing wave will cause the frequency response to have a series of regular sine wave type peaks and valleys riding on the top of the response (Figure 2).

Select the cursors on the 1865 receiver to a vertical position. In this position, the receiver will now read frequencies. Place one cursor on top of one peak in the response and place the other cursor over the next peak so you can read one complete cycle of the sine wave. Use the digital readout of the 1865 receiver to get an exact measurement of the sine wave in MHz. Now work that number into the following formula to find the distance to the fault:

$$\left[\left(\frac{984}{\text{Frequency in MHz}}\right) \div 2\right] 0.87$$

In this formula the 0.87 represents the velocity of propagation factor for the cable under test. With the aid of design prints you can now easily find the source of your trouble.

Another advantage to sweeping line extenders is that it gives highly trained techs an opportunity to verify design prints. Just because the print is done in ink doesn't mean that it is 100 percent accurate. A design change may have been done to accommodate a new housing development or line extension and somehow the prints were never updated. It happens. Another very common problem occurs if pads or equalizers are changed to compensate for low input levels rather than troubleshooting the problem. It is good preventive maintenance practice to have only sweep techs carry pads and equalizers.

The sweep techs start adjusting levels from the beginning of the run. If the pad or equalizer values in the field don't quite match up to the prints and everything in between checks out okay, then the techs can make the necessary changes and feel confident that they are correct. Correct pad and equalizer changes should be brought to the attention of the design engineers so that system maps can be corrected.

As the program progresses, service techs will have confidence in the system maps knowing that the sweep techs have verified pad and equalizer values and that they are correct. Therefore, if there is a problem with input levels, the techs know to start troubleshooting into the distribution system to find the problem.

Another plus to sweeping line extenders is that it provides an opportunity to closely inspect the system for bonding and grounding and to repair any wet or corroded connectors and amp cases. The sweep tech also has an opportunity to make voltage and current checks—and possibly spot any powering problems.

Obviously, this program of line extender preventive maintenance is slow and time consuming. If you have any rear easement line extenders, you will need two techs for the job. You do not want to haul an expensive sweep receiver up any poles. The solution is that one man climbs while the other reads the receiver on the ground.

Is it really worth it and can you afford it? Well, it has been my experience that once the distribution system has been carefully analyzed, all pads and equalizers are correctly calibrated and all bad passives removed, the system remains very stable.

Sweeping line extenders are definitely worth the time and expense involved. An occasional spot check with a sweep receiver will verify system performance but a second pass through with a sweep receiver may not be necessary. Meter balancing with a signal level meter will suffice. ■

Business Directory

CATV DESIGN ASSOCIATES, INC.

- Design
- Strand Mapping
- As—Built Mapping
- System Analysis
- AutoCad Drafting
- LinexCad Drafting
- Cad Training/Setup
- Drafting Services

3100 S. LAMAR, SUITE 101, AUSTIN, TX 78704

STEVE WILLIAMS
President

(512) 444–2461

DOUG BURNS
Vice President

SIGNAL LEVEL METER REPAIR

Prompt, Professional Service at Reasonable Prices

JGL ELECTRONICS, INC.

4425 BLACKSTONE DRIVE
INDIANAPOLIS, INDIANA 46237
317-783-6130

CONTRACT CABLE TV INSTALLERS

CONTRACT INSTALLERS, INC.

UHF Radio Equipped Trucks • Uniformed Installers

HOUSE INSTALLATIONS
Aerial · Underground · Pre-wire
APARTMENT INSTALLATIONS
Post wire · Pre-wire · Commercial Building
Tap Audits

Install or Remove Traps and/or Converters
Drop change over for System Rebuilds

LENNY FISCHER
(414) 582-7087

P.O. Box 1564
Appleton, Wisconsin 54913-1564

WAVETEK SALE

SAM III D $1995 SAM I $895

WHILE THEY LAST

Bench and Converter Sweep Systems
Display Monitors
Spectrum Analyzers
and more

EMS Instruments 800-234-7434

TSB, Inc.

TSB

- DESIGN, STRAND MAP, AS-BUILTS
- CAD DRAFTING SERVICE
- HEADEND RACKING AND RENOVATIONS
- CLI
- TAP AUDITS
- ONSIGHT TECHNICAL TRAINING
- STRUCTURAL ANALYSIS OF TOWERS

P.O. Box 244
(605) 665-1393

Yankton, SD
57078

"Cable Television - Second Edition"

By Bill Grant

A complete text on basic CATV technology for self-study or reference including

Hard cover - 400 pages - 140 illustrations
Complete index - 10 page Glossary of Terms

$32 per copy includes mailing inside USA
(add $5 for shipment outside USA)

Send check or money order to:
GWG Associates, PO Box 473
Richmondville, N.Y. 12149
Phone (518) 234-7405

MC COMMUNICATIONS

NATIONWIDE CABLE SPECIALISTS

- Aerial/Underground Installations
- Prewire/Postwire MDU's
- Auditing Services
- Complete Operational Support
- Converter Recovery
- Drop Replacements
- Postwire Repairs
- Management Consultants

"Contractor Opportunities Nationwide"

Call Toll-Free Nationwide 1-800-348-9988

EXPERIENCED INSTALLERS NEEDED 704/633-8038

CABLE TV ENTERPRISES

CABLE TV HOME INSTALLATION
PRE-WIRING • POST-WIRING

Ronnie Speer
Carolyn Wilson

P.O. Box 503
Salisbury, NC 28144

Classified/Business Directory

Help Wanted

Join Our Growth Oriented Company!!

Managers
Supervisors
Installers
MDU Crews
Warehousemen

National Cable TV Contractor with offices in New York, Massachusetts, Maryland, Wisconsin, Delaware and California needs experienced subcontractors and personnel to complement our growth. Top pay and benefits. Send resume or call:

CABLE CRAFT, INC.
5520 W. Touhy Ave., Suite J
Skokie, Illinois 60077
(312) 673-0101

Cable TV Montgomery

Technicians

- **Service**
- **Preventive Maintenance**

Cable TV Montgomery is seeking experienced CATV technicians. A valid driver's license and good driving record is required. We offer an excellent salary and benefit package. If qualified, please contact:

Cable TV Montgomery
Human Resources Department
250 Hungerford Drive
Rockville, Maryland 20850
(301) 294-7667

SENIOR SWEEP TECHNICIAN WANTED

Growing 23,000 subscriber system serving the beautiful Miami Beach areas has great opportunity for Senior Sweep Technician.

Applicant should have a strong background in cable headend configuration, design, system balance, sweep and proof of performance testing. The selected person will be highly involved with a complete upgrade from 35 channels to 400 MHz.

We offer excellent salary and benefits to the right individual. Send resume or call: Martin Mohr, Gold Coast Cablevision, 1681 79th Street Causeway, North Bay Village, FL 33141. (305) 868-3860. Gold Coast Cablevision is an equal opportunity employer.

MICROWAVE/ HEADEND TECHNICIAN

Large, fast growing cable operator in the coastal San Diego, California area is seeking a Microwave/Headend Technician to install, repair and maintain all headend, hub and microwave facilities. Must have a minimum of two years experience on microwave systems or related communications and knowledge of all test gear related to RF and baseband signal measurement techniques. No phone calls please. Send resume to:

DANIELS CABLEVISION, INC.
P.O. Box 344
Carlsbad, CA 92008

Equipment For Sale

EXCESS EQUIPMENT SALE

S/A mods, Neg. filters and MORE!!!

CALL RON
(214) 243-2267

AERIAL BUCKET TRUCKS

Large selection geared for CATV
STANDARD TRUCK & EQUIPMENT CO.
1155 Hill St. S.E.
Atlanta, GA 30315
Phone: 1-800-241-9357

TOWERS

- 140-foot tower with torque arms 54″ face —*excellent condition.*
- 80-foot self-supporting heavy-duty tower.

BAY TOWER SERVICE
414-743-5320

IT INSTALLER TECHNICIAN

To Place A Classified Ad Call Barbara Bellomo at 1-303-792-0023

L.C.E.

Long Cable Electronics

"For the Finest in Converter Repair"
"Equipment Brokered"

For Converter Repair — Call 518-393-5415
For Converter Parts — Call 518-393-7976
112 Erie Blvd. Schenectady, NY 12305

White Sands

Jumper Cables

Custom connectors and cables for all aspects of CATV

Gilbert AHS
PPC
LRC and others

All types of cable from
Belden
Comm Scope
Times

Quick delivery on all colors and lengths.
Write or call: (602) 581-0331
P.O. Box 43437, Phoenix, AZ 85080-3437

New lessons on signal leakage

By Byron K. Leech
President, National Cable Television Institute

Signal leakage. These days just the mention of it strikes fear into the hearts of cable personnel around the country. We've all heard about the cumulative leakage index (CLI), flyovers and the FCC until we can't stand it any more. But the bottom line is, signal leakage is an increasingly important topic, starting with monitoring and eliminating signal leaks at the drop.

And this is not just because of the FCC. A tight installation, from an RF signal leakage perspective, is important for other reasons. Picture quality can suffer measurably due to drop leakage and this leakage is a common cause of service calls. Each time a truck has to be sent out on a service call, two things happen and neither one is good. First, it is costly. According to industry estimates, every truck roll costs an average of $30. Second, since service calls are by nature a response to a subscriber-level problem, ill will is created.

With these factors in mind, NCTI has just released three all-new lessons on signal leakage detection at the drop. Signal Leakage Detectors I, Signal Leakage Detectors II and Signal Leakage Detection are designed to give installation technicians the background they need to understand the effects of signal leakage, the regulatory concern, the purpose of signal leakage detectors, the operating procedures for using signal leakage detectors to monitor and find leakage, and the care and maintenance of detectors. These three lessons are now an important part of the NCTI Installer Technician course, and are available to NCTI graduates under the Graduate Update Program.

Signal Leakage Detectors I, Lesson Number 220-10: This lesson deals with the effects of signal leakage and the FCC's concerns with and regulation of cable signal leakage. It explains the purpose of signal leakage detectors and provides functional and physical descriptions of three hand-held leakage detectors—the ComSonics Sniffer Jr., Texscan Searcher and Wavetek CLR-4. Complete knowledge of features, characteristics and controls of these hand-held detectors will contribute to proper leak detection and location, help avoid harmful interference with off-air services, assist in compliance with FCC signal leakage limits and help maintain picture quality.

Signal Leakage Detectors II, Lesson Number 220-20: This lesson deals with the sensitivity, care and maintenance of signal leakage detectors. It defines detector sensitivity and the factors affecting it and features the same three models of detectors as Signal Leakage Detectors I. The maintenance procedures presented include cleaning, battery care and necessary repairs. Signal Leakage Detectors II will complete your background in the features, characteristics and controls of these popular models of signal leakage detectors. Due to the severity of the coming CLI regulation effective July 1, 1990, a proper understanding of detector sensitivity and proper treatment and maintenance of signal level detectors is important to all technical personnel.

Signal Leakage Detection, Lesson Number 220-30: This lesson presents procedures for operating signal leakage detectors to monitor, detect and locate cable signal leaks at the subscriber drop. It includes actual operating procedures for the three models of detectors featured in the other two lessons. It also includes instruction on methods to discriminate between true cable signal leaks and false alarms. Signal Leakage Detection will help ensure that all technical personnel are well versed in signal leakage detector operation and leakage detection procedures.

These three lessons are just the beginning of a series on new and revised lessons dealing with various aspects of installation troubleshooting that will be added to the Installer Technician course over the next few months.

For more information on our new signal leakage lessons or any of our other courses, give us a call at (303) 761-8554. ■

Basic RF design theory (Part I)

By Pam King
Jones Intercable Inc.

Installers usually do not have much of an opportunity to design system plant. However, there are many reasons for having a basic understanding of design theory, the most important of which is to know what type of signal levels to expect at different areas of the system when making signal level measurements. This is especially helpful when troubleshooting. Before doing any calculations, the installer needs to become familiar with the following terms and concepts. Next month, an example of how this information can be used in troubleshooting.

Active device: A device or circuit capable of some dynamic function, such as amplification, oscillation or signal control, which usually requires a power supply for its operation.

Amplifiers: Amplifiers are devices in the cable system that accept a signal at its input and present the same signal without appreciable distortion, but at a higher level amplitude at its output. CATV amplifiers are capable of amplifying a wide range of spectrum. Types of amplifiers include trunk amplifiers, bridgers and line extenders. When designing, use as few active devices as possible.

Passive device: A device basically static in its operation, that is, it is not capable of amplification or oscillation, and requires no power for its intended function. Passive devices must be able to pass AC power to active devices. Types of passive devices include splitters, directional couplers, taps and attenuators.

Attenuation: The difference between transmitted and received power due to the loss through equipment, lines or other transmission devices; usually expressed in decibels. Attenuation of cable increases as frequency increases, as indicated in Table 1. Design is done for the worst case or at the highest design frequency. However, the low design frequency still needs to be considered when calculating levels.

Cascade: Any number of devices connected in series, such that the output of one is connected to the input of the next.

Coaxial cable: Two metallic conductors separated by a dielectric material that share the same axis. The attenuation of the cable increases logarithmically with increasing frequency. Thus, the higher the frequency, the higher the attenuation.

Decibel (dB): A unit that expresses the ratio of two power levels on a logarithmic scale. When discussing loss or attenuation of cable the unit is dB.

Decibel millivolt (dBmV): A logarithmic unit of measurement referenced to one millivolt across a specified impedance (75 ohms in CATV); 0 dBmV corresponds to 1000 microvolts. When discussing the input or output signal levels the unit is dBmV.

Drop cable: The drop cable that runs from the tap to the customer's house is a small, high loss, low cost, flexible cable. For design, the drop is considered to establish average signal levels from the tap to the subscriber. An average drop length is considered to be 150 feet from the tap to the home. The size of the home and the number of televisions a customer owns also need to be considered. "Hot taps" have a higher average output than the rest of the system in order to serve homes that are more than 150 feet from the system.

Insertion loss: Loss in a system when a device such as a splitter is inserted; equal to the difference in signal level between the input and output of the device. Table 2 represents a "general rule" for insertion loss of splitters up to 400 MHz. Use the actual insertion loss for the manufacturer and frequency when designing.

Frequency: The number of complete alterations of a sound or radio wave in a second, measured in hertz. One hertz equals one cycle per second. One megahertz (MHz) equals 1 million hertz.

Gain: An increase in power produced by an amplifier and expressed in decibels. The amplifier will increase all frequencies equally, so the signals must enter the amplifier module "flat." An equalizer is installed in the amplifier to compensate for the difference in signal level between the highest and lowest frequency at the amplifier's input.

Table 1: Maximum allowable attenuations at 68° (attenuations are per 100 feet)

Cable size and type	5	30	54	108	211	220	270	300	330	400	450	500	550
	Frequency (MHz)												
RG 59 foam	0.77	1.55	2.00	2.60	3.62	3.71	4.15	4.35	4.52	5.10	5.40	5.60	5.90
RG 59 solid	0.77	1.90	2.46	3.64	4.90	5.00	5.50	5.80	6.10	6.60	7.00	NA	NA
RG 6 foam	0.65	1.15	1.53	2.10	2.97	3.03	3.35	3.55	3.72	4.15	4.40	4.55	4.75
RG 6 solid	0.65	1.60	2.08	2.91	4.05	4.10	4.60	4.80	5.15	5.50	5.80	NA	NA
611 foam	0.51	0.96	1.26	1.67	2.36	2.42	2.69	2.84	2.98	3.31	3.52	3.72	3.92
7 foam	0.35	0.71	1.00	1.45	2.03	2.07	2.26	2.39	2.50	2.78	2.96	3.10	3.30
RG 11 foam	0.33	0.71	0.95	1.35	1.90	1.95	2.13	2.25	2.39	2.60	2.75	2.93	3.08
RG 11 solid	0.44	0.97	1.37	1.90	2.65	2.70	2.90	3.10	3.23	3.55	3.75	NA	NA

Tap output calculation

Based upon the information we have so far, we can calculate the minimum tap output for a design. In order to do this, it is necessary to start at the customer's home. We need to make some assumptions regarding the number of outlets the customer has, what type of cable and at what frequency the design is to be done. Subscriber interface equipment such as VCRs also may be a consideration.

Problem

Assume:
Two outlets ——→ Two-way splitter needed
150 feet RG 59 cable at 400 MHz

Solution

Refer to the cable attenuation chart (Table 1), and note that the attenuation for RG 59 at 400 MHz is 5.1 dB per 100 feet, or .051 dB per foot. The loss of the two-way splitter is 4.0 dB per port. We can now complete our calculations as follows:

Footage × cable loss (per foot) = total cable loss
Total cable loss + total passive loss = total drop loss

150 feet × .051 dB/foot = 7.65 dB
7.65 dB + 4.0 dB = 11.65 dB

In our example, the minimum allowable tap output = 11.65 or 12.0 dBmV.

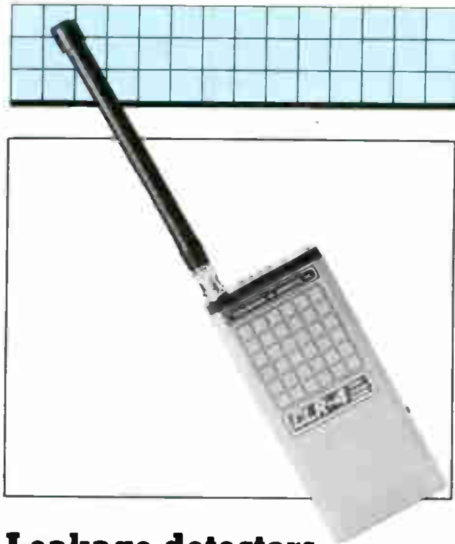
References

1) *Jones Dictionary of Cable Television Terminology, 3rd Edition*, Glenn R. Jones, 1987, Jones 21st Century Inc.
2) *Introduction to Design*, Jones Intercable Inc.

Table 2: Insertion loss

Device	loss leg 1	loss leg 2	loss leg 3	loss leg 4
Two-way splitter	4.0 dB	4.0 dB	NA	NA
Three-way splitter (even loss)	5.5 dB	5.5 dB	5.5 dB	NA
Three-way splitter (uneven loss)	4.0 dB	7.0 dB	7.0 dB	NA
Four-way splitter	7.0 dB	7.0 dB	7.0 dB	7.0 dB

Products



Leakage detectors

Wavetek introduced the CLR-4, a handheld four-channel scanning leakage detector/locator that emits a tone that varies in pitch in proportion to signal strength. As the detected field strength increases, the pitch locator tone increases. LEDs indicate which carrier frequency is being received. (For more on the CLR-4, circle #129 on the reader service card.)

The CLR-1 Ferret is a pager-sized, belt clipped leakage detector. It also emits a tone and provides a visual indication of relative field strength. (For more on the CLR-1, circle #124 on the reader service card.)

For further details, contact Wavetek RF Products, 5808 Churchman Bypass, Indianapolis, Ind. 46203-6109, (317) 788-9351.

Connectors

Andrew Corp. is introducing two $3\frac{1}{8}$-inch EIA flange connectors for its $2\frac{1}{4}$-inch Heliax air dielectric coaxial cable. The connectors interface the cable with FM transmitters and antennas that commonly terminate in $3\frac{1}{8}$-inch flanges, eliminating the need for adapters.

Model 82RF is a gas pass connector that allows pressure to flow through the connector interface to an antenna or other pressurized component. The Model 82RG includes a gas barrier at the interface to allow connection of the cable to non-pressurized components.

For more information, contact Andrew Corp., 10500 W. 153 St., Orland Park, Ill. 60462, (312) 349-3300; or circle #128 on the reader service card.

Crimp tool

Amphenol Corp.'s RF Division introduced its Econohex hand crimp tool and die sets designed to terminate RF connectors on most RG/U coaxial cables. The tool features a full cycle, reinforced ratchet control that is said to provide the high repeatability and reliability benefit of crimp-terminated connectors. Four die sets are available and provide the same crimp cavity sizes as MIL-T-22520 die sets /5-09, -11, -13, and -25.

For additional information, contact Amphenol Corp., 1 Kennedy Ave., Danbury, Conn. 06810, (203) 743-9272; or circle #123 on the reader service card.

Accessory tool

Cable Prep announced the availability of the RTH-4500 ratchet T handle accessory tool to the stripping/coring line of products. The product adapts to any coring tool with a $\frac{3}{8}$-inch shaft and three flats. The noiseless ratchet is said to be maintenance-free and can perform coring

Ad Index

or stripping/coring of coaxial cable by establishing a positive torque on the core direction. According to Cable Prep, the RTH-4500 is compact, lightweight and constructed with lubricated roller bearings for longer life.

For more information, contact Cable Prep, 207 Middlesex Ave., P.O. Box 373, Chester, Conn. 06412-0373, (203) 526-4337; or circle #132 on the reader service card.

Dictionary

Jones 21st Century published the *Jones Dictionary of Cable Television Terminology, Third Edition*, which defines more than 1,600 cable-related terms, phrases and acronyms drawn from the industry's engineering, operations, marketing, programming, management, manufacturing, finance, legal, international and regulatory arenas.

A major portion of the definitions, which run from one sentence to a brief paragraph in length, are devoted to technical and operations terms and are geared toward a basic technical level. The dictionary identifies more than 50 industry-related organizations, agencies and services, both national and international. Related computer and satellite terms also are included and all acronyms are cross-referenced.

For further information, contact Jones 21st Century, 9697 E. Mineral Ave., Englewood, Colo. 80112, (303) 792-3111; or circle #134 on the reader service card.

Cable testers

Tektronix's Communication Network Analyzers Division introduced its 1502B and 1503B time domain reflectometer cable testers. The 1502B delivers a 0.9 inch resolution between two faults and static suppression to protect the instrument against static blowouts. It also features a continuous display on-screen impedance readout at the cursor.

The 1503B delivers a two nanosecond pulse and resolution to less than one foot. It can find faults up to a 50,000 foot range for any general metallic cable application. Both models feature HyperTwist LCD display, optional internal printer, two operating levels, built-in memory and digital averaging.

For more information, contact Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97077, (503) 923-4415; or circle #125 on the reader service card.

Catalog

Marconi Instruments issued a 327-page catalog covering its entire product line. It outlines operating features and specifications for equipment such as spectrum analyzers, oscillators, sweep generators, RF test equipment, power meters and signal generators.

The catalog also includes a review of application notes and technical publications offered by the company as well as reprints of various articles written by engineers from Marconi.

For more information, contact Marconi Instruments, 3 Pearl Court, Allendale, N.J. 07401, (201) 934-9050; or circle #130 on the reader service card.

Basic electronics

(Continued from page 24)

that a line representing 5 ohms would exist between the extremities of these two quantities. If, instead of an X_L of 3 ohms, we had an X_C of 3 ohms, the vector diagram would look like Figure 5.

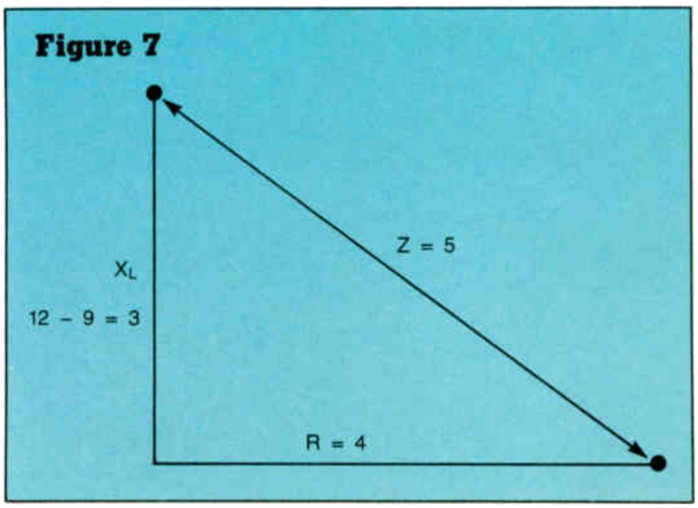


Figure 7

As another example, what would be the impedance of Figure 6 where a resistance of 4 ohms is in series with an inductor with a reactance of 12 ohms and a capacitor with a reactance of 9 ohms? Since the voltage across the inductor is 180° out of phase with the voltage across the capacitor, their values would subtract and the impedance of this circuit could be found by:

$$\begin{aligned} Z &= \sqrt{R^2 + (X_L - X_C)^2} \\ &= \sqrt{4^2 + (12 - 9)^2} \\ &= \sqrt{4^2 + 3^2} \\ &= \sqrt{16 + 9} \\ &= \sqrt{25} \\ &= 5 \text{ ohms} \end{aligned}$$

Figure 7 shows how the impedance could be found graphically.

Next month we will see how Ohm's law affects AC circuits and analyze series circuits containing resistors, capacitors and inductors.

Test your knowledge

1) What is the formula for X_L?
2) What is the formula for X_C?
3) What is the formula for Z?
4) What is a vector diagram?
5) What is the significance of "ELI the ICE man?"

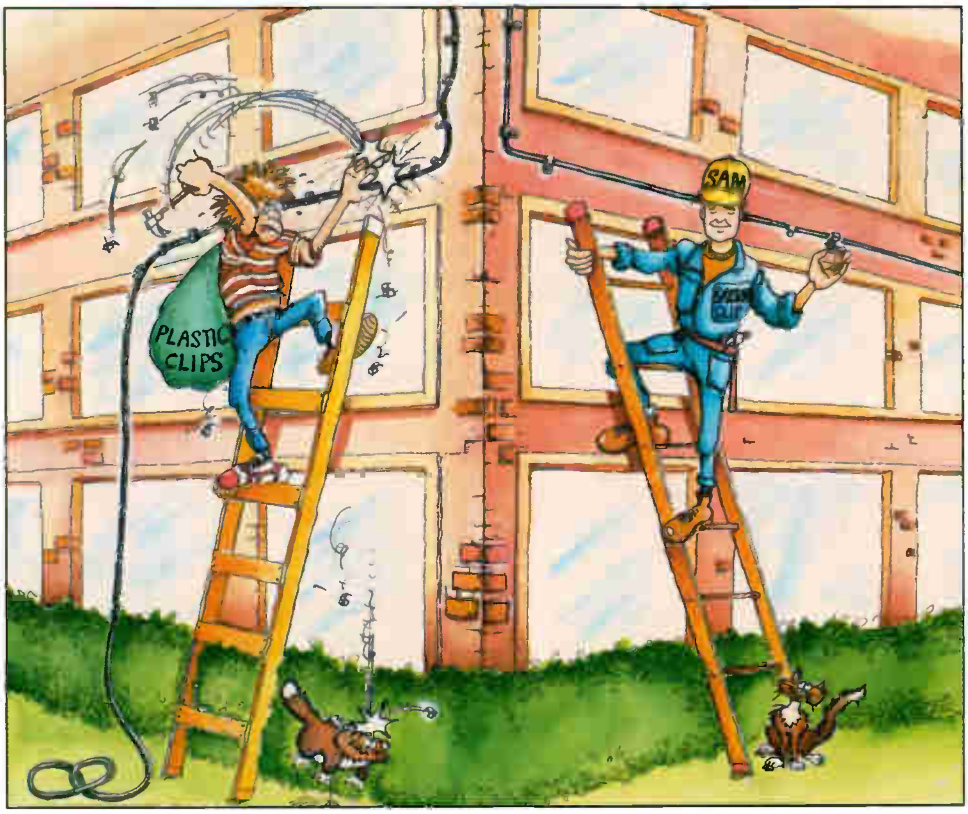
Answers

1) $X_L = 2\pi FL$
2) $X_C = 1 \div 2\pi FC$ or $0.159 \div FC$
3) $Z = \sqrt{R^2 + X^2}$
4) A graphical method of representing the magnitude and phase relationship between two or more quantities.
5) To make it easier to remember the phase relationship between the voltage and current of reactors.

Reader Service Number 17.

SAM SAYS ...

... SAXXON ARE FOR YOU !



THE SAXXON(TM) CLIP

Now also available in black

Metal Clip

Count on Saxxon(TM) Metal Clips to make your job easier ... Make the first time The last time

For a free trial sample call now toll free **1-800-361-3685**

SACHS® FAX: 1-514-636-0794

Sachs Communications Inc.
30 West Service Road
Champlain, N.Y. 12919-9703
1-800-361-3685

Sachs Communications Inc.
1885 West Darmouth Ave. Unit 1
Englewood, Co. 80110
1-800-361-3685/303-761-8339

Sachs Canada Inc.
745 Avenue Avoca
Dorval, QC H9P 1G4
1-514-636-6560

Reader Service Number 18.