January 1989

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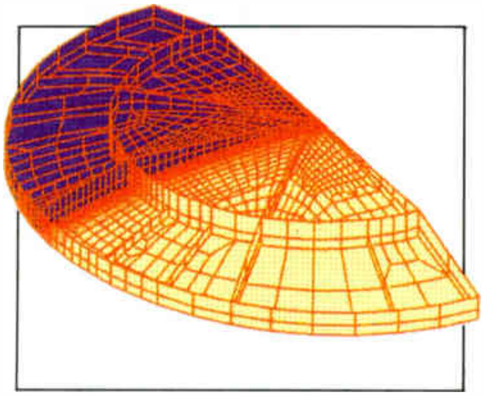

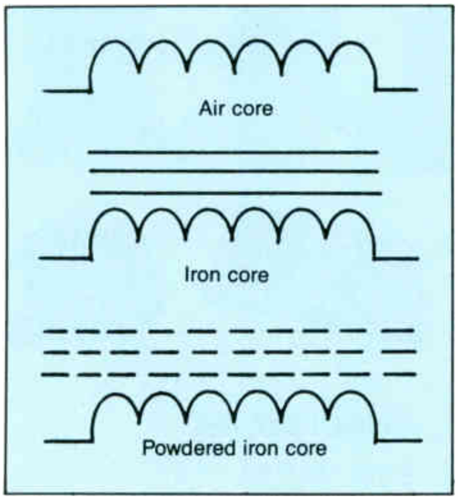

Features

Cover

Preventive maintenance keeps the system in top performance. Art by Geri Saye.

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From the Editor

Contentment doesn't win Superbowls or promotions

1989! The dawn of a new year for the cable industry. Do we look forward to better ourselves or just "keep on truckin'"?

Let me draw an analogy. I am an avid, fanatic Denver Broncos fan. This past season, however, it seemed to me that the Broncos were content to just play average (or worse) football and collect their salaries. The end result was that the Broncos compromised themselves into being an inferior team; several players won't be around next season to collect their salaries. (By the way, did your favorite team make the playoffs? If so, congratulations. If not, why not?)

Words of wisdom

I recently received a letter from Mike Mayberry, construction coordinator for Continental Cablevision in Belleville, Ill. It's called "If I don't care, who will?" Hopefully, his letter (as follows) will hit home with all of us, Monday morning quarterbacks or not.

"Recently, adding and subtracting took on a whole new look for our pole count. Continental Cable in Belleville increased its pole attachments by approximately 1,100 poles. All in just a three-month period! The only problem with this increase was it was a reality on paper but not in real life. It was a simple, honest mistake made by one of the utilities, found by me and researched by two of our chief technicians.

"This small but almost costly error brings me to one of the biggest dangers in the cable television industry: complacency! It's not just a problem in pole counts, but it does serve to illustrate the problem. Complacency along with time can be costly both in terms of output and outlook. The longer one has been at the job, the easier it is to say, 'What the hell!' But when you realize that everyone from CSRs to installers and technicians are part of a team and when one is not at full strength, the others suffer! Wages, prestige and jobs are all affected. Attitudes toward your fellow employees and work all come into play.

"Complacency and time are slow killers and are easily overlooked or avoided. The saying, 'It's not my job,' is no joke! The definition of complacency is 'satisfied.' Since no one I know is ever satisfied with their earnings, the same should be true with your job. If people are satisfied with their job, I think it means they have stopped learning. As long as you work and try to increase your wages, it would seem only fair to try to increase your knowledge. Both are particular aspects of your work and of the cable industry in general.

"I suppose some of these remarks sound like a sermon. I don't think they are. I think that continuous mistakes hinder growth, that accuracy in cable gives stability to the workplace and jobs. If the cable industry hopes to have any longevity in the field of entertainment, constant proficiency has to be a recurring factor in cable systems at any level. I have always believed in the consensus that I will not make money unless the company I work for makes money. Let's hope that cable companies believe the same way. Any job in the industry has to achieve a professional status; each department has to believe that without one the next step of the job cannot be complete. Without construction, installation has nothing to do, and in turn the technical department cannot maintain something that doesn't exist. Finally, the CSRs or sales personnel cannot sell what has never been built, installed or maintained. When complacency is *eliminated* by workers, output is enhanced and knowledge gained. When complacency by cable companies is *erased* and recognition for all departments is equal, productivity is their reward.

"It would have been just as easy for us to go over the pole count and sign off what the utilities maintained was the new total. Oh, someone might have caught the discrepancy in time; pole rental will never break a cable company. But if the 'what the hell' attitude persists, where do you say enough? Complacency and time will slow the growth of the industry. And you know what that means. We will all have to go out and get REAL jobs!"

Toni I. Barnett

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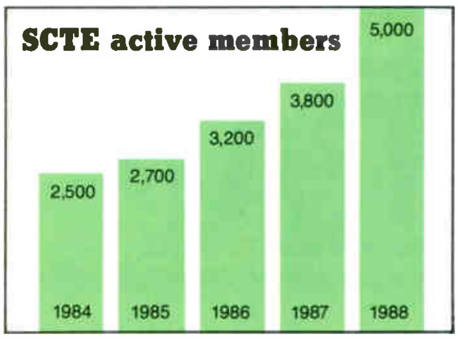
News

Society announces plans for 20th anniversary, expo

EXTON, Pa.—As the new year begins, the Society of Cable Television Engineers will celebrate its 20th anniversary and offer new services and benefits to its members. According to the Society, the success of its Chapter Development Program, BCT/E Certification Program and annual Cable-Tec Expo and Engineering Conference have contributed to its drastic membership increase from 3,800 in 1987 to more than 5,000 members at the end of 1988 (see accompanying chart).

One new service for SCTE members is the Insurance Benefits Program, the result of its newly forged relationship with Smith-Sternau Organization. By participating in a group trust program, the Society will be able to offer reduced rates to its members.



The Society's *1989-1990 Membership Directory and Yearbook* will be available later this year. This special anniversary edition will include information on the Society's formation and history.

In addition, plans are under way for Cable-Tec Expo '89, to be held June 15-18 at the Orange County Convention Center in Orlando, Fla. A special Expo Evening will be held at Sea World to celebrate the Society's anniversary. A personalized membership certificate will be included with expo registration packets sent to active national members in February. These custom-designed certificates are provided as a service to the national organization, its board of directors and the Member Benefits Committee.

TCI, NCTI announce training agreement

DENVER—Tele-Communications Inc. and the National Cable Television Institute signed a training agreement that calls for NCTI to provide technical training to TCI employees in cable systems throughout the country. NCTI's full range of courses includes Installer, Installer Technician, Service Technician, System Technician, Advanced Technician and CATV System Overview. All new entry-level personnel are required to complete the Installer course as a condition of employment.

The two companies also plan to provide a series of short duration workshops on various technical topics this year. NCTI would develop course material and promote the workshop and instructors from American Television and Communication's National Training Center would teach the workshops.

In related news, NCTI added a lesson titled "Signal Level Meters" to its Installer Technician course, covering the importance, history, operation and use of one of the most essential tools used to troubleshoot the drop. The lesson focuses on analog tuned meters and will be followed by a second SLM lesson on digitally tuned meters.

Klein Tools helps earthquake victims

CHICAGO—Klein Tools went to the aid of the survivors of the devastating earthquake that ravaged Soviet Armenia last month. The company donated more than $700,000 worth of Klein products including tents, tools and construction equipment. According to authorities, the catastrophe killed at least 55,000 people, injured approximately 13,000 and left 500,000 homeless. The tents are intended for use as temporary shelter, while the remaining equipment will help in rescue and cleanup operations.

Society membership tops 5,000

The national membership of the Society of Cable Television Engineers (SCTE) has passed the 5,000 mark, it was recently announced. This milestone in the Society's history coincides with another important event, as 1989 marks the year in which the SCTE will celebrate the 20th anniversary of its formation in 1969.

This represents a drastic increase from 1987's year-end membership count of 3,800. The figure (as of December 1988) of 5,000 members indicates growth of 1,200 in 12 months, indicating that the Society attracted an average of over 100 new members a month. This growth is partially attributable to the popularity and success of the Society's many programs and services, including the Chapter Development Program, Broadband Communications Technician/Engineer (BCT/E) Program and annual Cable-Tec Expo and Engineering Conference.

The Society plans to commemorate its 20th anniversary in a variety of ways. The Expo Evening, to be held June 16 at Sea World in conjunction with Cable-Tec Expo '89, will be the site of a special celebration of the Society's 20 years of service to the industry. Additionally, the new year will see the publication of the Society's *1989-1990 Membership Directory and Yearbook*, a special anniversary edition that will include information on the Society's formation and history.

SCTE now has 28 chapters and 17 meeting groups, a total of 45 groups. All Society members can benefit from these groups, as they provide valuable forums for the exchange of technical knowledge at the local level, expanding each member's knowledge of the industry as well as aiding in individual professional development.

"Reaching the 5,000 mark is an important event in the Society's history," stated SCTE Executive Vice President Bill Riker. "It indicates the broadband industry's increased appreciation of the training and service the Society provides. Membership in the Society has become very important to industry personnel in the years since its formation. As SCTE enters its 20th year of existence, we will strive to sustain the excellence that has become synonymous with the Society of Cable Television Engineers."

Planning begins for Cable-Tec Expo '89

Preparations are currently underway for the SCTE Cable-Tec Expo '89, to be held June 15-18 at the Orange County Convention Center in Orlando, Fla. The expo's exhibit floor will feature a vast array of manufacturers displaying the latest in equipment and services for the broadband industry. Over half of the floor's booth space has already been reserved. Firms interested in exhibiting at the expo should contact SCTE national headquarters at (215) 363-6888 for further information and a prospectus.

Packages containing attendee registration materials and information for the expo will be mailed to all active national members in February. Upon receipt of the packet, members will be able to register for the expo—the premier training and CATV hardware conference presented annually by SCTE. This packet also will contain a schedule of events planned for the expo and information on accommodations and services available to attendees.

SCTE membership preregistration fees for the expo—unchanged since 1986—are as follows: $195 for the Engineering Conference and expo, $145 for the expo only, and $120 for the Engineering Conference only.

SCTE has continued a winning combination of quality and value in the planning of Expo '89. Sleeping room rates at the headquarters hotel (Stouffer's Resort at Sea World) are $82 for single occupancy and $92 for double occupancy. Nearby official expo hotels start at $62 for single or double occupancy.

Always a highlight of any Cable-Tec Expo is the 1989 Expo Evening, to be held June 16 at Sea World. It will feature a special exhibition of SCTE's 20th anniversary along with a sumptuous dinner and exciting entertainment.

The expo promises to be a well-attended event, with an attendance of 1,500 expected from all levels of the cable television and related industries, including all levels of technical and non-technical personnel.

Cable-Tec Expo '89 is being planned by this year's Program Committee, which includes Richard Kirn (chairman), Mike Aloisi of Viacom Networks, Paul Levine of CT Publications, Bill Riker of the SCTE, Wayne Sheldon of Coast Cablevision, John Walsh of Cablevision of Central Florida and Scott Weber of Comcast Cablevision.

Membership certificates in Expo '89 packages

A personalized certificate signifying SCTE membership will be included with the registration packages for Cable-Tec Expo '89 when they are mailed to all active national members in February. Each certificate will bear the member's name in handwritten calligraphy, as well as the member's SCTE identification number. The month and year through which the membership is valid also will be shown. The year will be indicated by a sticker placed on the certificate. Upon expiration of the membership and payment for its renewal, the member will receive a new sticker to place on the certificate. These handsome 8- × 10-inch certificates were custom-designed by the SCTE national headquarters staff and are suitable for framing. The certificates are provided as a service of the national organization, its board of directors and the Member Benefits Committee.

More information on Society Insurance Program

Further details on the SCTE's new Insurance Benefits Program were announced in a press conference held Dec. 7 at the Western Show in Anaheim, Calif. The Society has forged a relationship with Smith-Sternau Organization Inc., an insurance broker that represents a number of engineering associations. By participating in a "group trust" program, the Society will be able to offer reduced rates to SCTE members. All members will receive an information packet explaining the programs in detail, and Smith-Sternau will make a toll-free number available to answer questions from participants in the program about claims and any other insurance-related matters.

All SCTE members currently have personal liability insurance at all Society functions. As recently approved by the Board of Directors, all members also will auto-

PUBLICATIONS CORP. FOCUS

January 1989

We're Working for You!

Coming back from a quite successful Western Show, we can't help but be excited about the possibilities and challenges that lie ahead of us in '89. The strength to face these opportunities can be found in our people. And, since last month, some new faces were brought on board. Please meet them below and be reintroduced to a few others. We're working for you, stronger than ever!

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(Front row, seated) Brad Hamilton, Danielle Kelley, Shelley Bolin, Lu Ann Curtis; (middle row) Sharon Lasley, Marla Sullivan, Marty Laven, Marie Beert, Mary Sharkey, Patti Wilbourn; (rear) Wayne Lasley, Toni Barnett, Paul Levine, Kenny Edwards, Kathleen Jackson, Rikki Lee, Geneva Hobza, Neil Anderson.

Looking Back, Looking Ahead

Since 1984—when we started the company and launched **Communications Technology**—we've been working for you. Over the years, we've added new projects, new publications, new people. And our products have always kept pace with the industry, changing and growing with it.

Our past growth is only a foreshadowing of the future. So, after five years, where do we go from here? We will continue to listen and respond to your input as well as improve planning to better serve our readers and advertisers. Some examples: A marketing director with extensive system operations experience has just joined our staff. Also, we plan to add to the marketing mix with special events, direct mail, telemarketing and merchandising. Plus, a new editor for **Cable Strategies**, who is a cable system veteran, has also come aboard. And we plan exciting new things for all three publications, including circulation audits for **Installer/Technician** and **CS** and expanding the scope of **CT**. In the near future, we plan to hire additional staff and to move our headquarters to a bigger, better workspace.

We've been successful five years, but we're not sitting on our laurels. The best years are yet to come as we continue to dedicate ourselves to the cable TV industry.

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SCTE Chapters and Meeting Groups

As a service to SCTE members, the following is an up-to-date listing of the Society chapters and meeting groups, with each group's contact person and phone number. Members should take this opportunity to join a local group.

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

Appalachian Mid-Atlantic Chapter
Contact: Ron Mountain, (717) 684-6966
Cactus Chapter
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Contact: Diana Riley, (717) 764-1436
Florida Chapter
Contact: Dick Kirn, (813) 924-8541
Gateway Chapter
Contact: Darrell Diel, (314) 576-4446
Golden Gate Chapter
Contact: Tom Elliott, (408) 727-5295
Great Lakes Chapter
Contact: Daniel Leith, (313) 549-8288
Greater Chicago Chapter
Contact: John Grothendick, (312) 438-4200
Heart of America Chapter
Contact: Wendell Woody, (816) 474-4289
Hudson Valley Chapter
Contact: Wayne Davis, (518) 587-7993; or Bob Price, (518) 382-8000
Iowa Heartland Chapter
Contact: Dan Passick, (515) 266-2979
Miss/Lou Chapter
Contact: Rick Jubeck, (601) 992-3377
New England Chapter
Contact: Bill Riley, (617) 472-1231
North Central Texas Chapter
Contact: Vern Kahler, (817) 265-7766
North Country Chapter
Contact: Tony Werner, (612) 522-5200
North Jersey Chapter
Contact: Art Muschler, (201) 672-1397
Ohio Valley Chapter
Contact: Robert Heim, (419) 627-0800
Oklahoma Chapter
Contact: Gary Beikman, (405) 842-2405
Old Dominion Chapter
Contact: Margaret Harvey, (703) 238-3400
Piedmont Chapter
Contact: James Kuhns, (704) 873-3280
Razorback Chapter
Contact: Jim Dickerson, (501) 777-4684
Rocky Mountain Chapter
Contact: Rikki Lee, (303) 792-0023
Tip-O-Tex Chapter
Contact: Arnold Cisneros, (512) 425-7880
Bonneville Meeting Group
Contact: Roger Peterson, (801) 486-3036
Central California Meeting Group
Contact: Andrew Valles, (209) 453-7791
Chaparral Meeting Group
Contact: Bill Simons, (505) 988-9841
Chesapeake Meeting Group
Contact: Thomas Gorman, (301) 252-1012
Dairyland Meeting Group
Contact: Jeff Spence, (414) 738-3180
Dixie Meeting Group
Contact: Greg Harden, (205) 582-6333
Hawaiian Island Meeting Group
Contact: Howard Feig, (808) 242-7257
Idaho Meeting Group
Contact: Jerry Ransbottom, (208) 263-4070
Inland Empire Meeting Group
Contact: Michael Lajko, (208) 263-4070
Michiana Meeting Group
Contact: Thomas White, (219) 259-8015
Midlands Cable Training Association
Contact: John Page, (712) 323-0420
Mt. Rainier Meeting Group
Contact: Russ Eldore, (206) 251-6760
Palmetto Meeting Group
Contact: Rick Barnett, (803) 747-1403
Southeast Texas Meeting Group
Contact: Harold Null Jr., (713) 645-3738 or Victor Vozzo Jr., (713) 662-7876
Southern California Meeting Group
Contact: Tom Colegrove, (805) 251-8054
Tennessee Meeting Group
Contact: Joe Acker, (205) 932-7264
Upstate New York Meeting Group
Contact: Ed Pickett, (716) 325-1111
Wyoming Meeting Group
Contact: Drew Fleming, (307) 745-7333 ■

Anti-icing earth station antennas

By Joe Lemaire
Broadband Application Manager, Raychem

The Ku-band is here for nationwide cable TV, and a new generation of C-band antennas is coming as well. Throughout the United States, Canada and Europe, the preferred transmission means is shifting from the traditional large dish C-band (3-5 GHz) to smaller C-band antennas and to the Ku-band (12-14 GHz). The shift represents an important move to relieve problems in locating new headends in areas of congested microwave traffic. An important benefit of the Ku-band is the reduced antenna size required for excellent reception; 3+ meter antennas provide comparable gain with the 5+ meter antennas used for C-band.

Higher power C-band satellite transponders also have made possible the use of smaller (3-meter) antennas for CATV reception. Smaller antennas mean rapid installation and simple site preparation. The new 3-meter antennas in the C-band enable inexpensive earth stations to be dedicated to individual satellites.

The problem addressed in this article is the interference with signal reception caused by snow and ice attenuation of the satellite signal. Snow outages of the larger C-band earth stations have been common problems in the past. Newer C-band antennas may have less gain margin than the earlier models. The Ku-band offers greater gain per unit area of antenna surface, but increased moisture attenuation poses more serious challenges and calls for reliable and effective anti-icing solutions.

Why deice?

All satellite communications can be impaired by weather conditions. Attenuation of microwave signals due to rain is well-known, and margins are provided for the most common rainstorm conditions. Data is readily available on the relative attenuation of signals from atmospheric moisture and oxygen for frequencies of interest.[1] More difficult to predict are the effects of snow and ice accumulation. The degree of attenuation of the signal will depend on: the attenuation and relative concentrations of ice/water mixtures, the depth of accumulation or rate of snowfall, the density of snow, and the weather conditions that prevail after snowfall. Snow and ice attenuation measurements have been obtained from several sources [2,3,4] and are illustrated for 11.7 GHz in Figure 1.

Figure 1: Snow attenuation at 11.7 GHz during storm

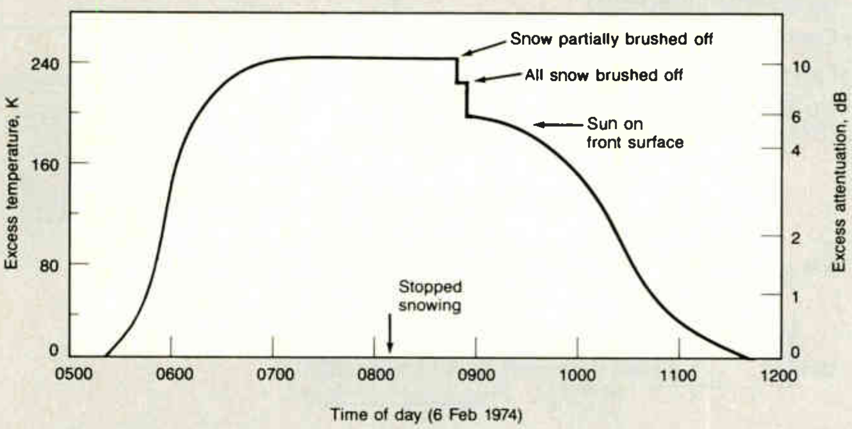


Table 1: Summary of heat losses

	Environmental condition			
	Moderate		Extreme	
Wind:	20 mph	30 mph	20 mph	30 mph
Heat loss Snowfall:	1.3 in./hr.	1.3 in./hr.	2.0 in./hr.	2.0 in./hr.
component Temperature:	26°F	26°F	10°F	10°F
Convection (losses to the air)	16.3	22.2	45.5	63.1
Evaporation (losses in moisture)	8.2	12.0	15.5	23.4
Sensible heat (raise temperature of ice)	1.8	1.8	2.0	2.0
Latent heat (melting)	26.9	26.9	24.5	24.5
Total	53.2	62.9	87.5	113.0

All data in watts/square foot.

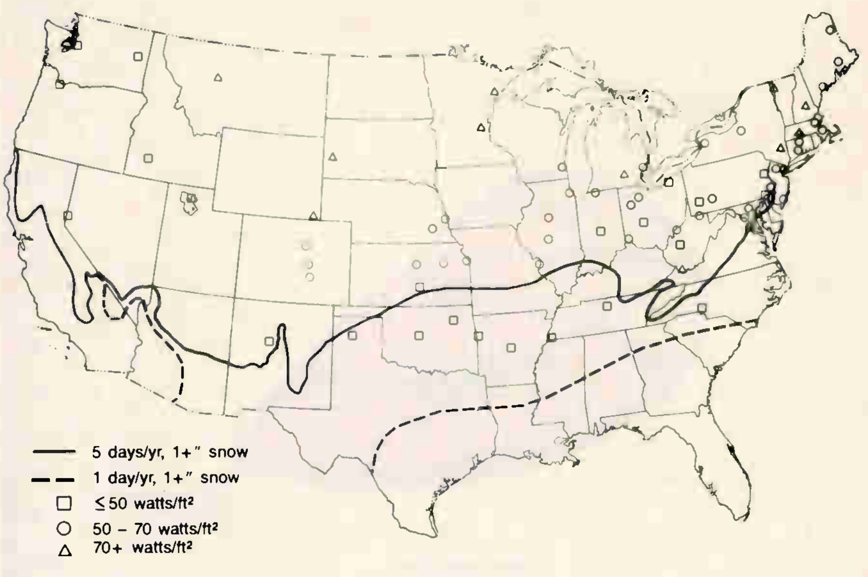
In addition to direct attenuation, the weight burden of snow or ice can serve to distort the shape of the antenna, particularly in a large antenna, requiring additional structural design effort. Signal reflections also can occur from the surface of a snow/ice accumulation.

In the past, snow removal has been possible by earth station attendants mechanically pulling away the snow cover. Retrofit kits for deicing have been available, along with installation services by contractors. If weather has posed a sufficiently serious problem during the initial years of operation of these stations, retrofitting the systems has been a practical, although costly, course of action for later years.

Excellent weather data is available from the U.S. Geologic Service[5], the Department of Commerce[6], the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)[7], and weather almanacs[8,9]. Of primary interest to the network designer are the periods of moist snowfall and ice glazing. Useful maps are available for frequency of significant snowfall and for frequency of freezing rain. The *ASHRAE Handbook* cites snowfall and freezing temperature data for 30 cities in the United States. This data can be used to obtain a comparison of weather risk among these cities. Although the availability of satellite communication systems should be higher than the predicted risk level, deicing equipment can assure that weather interruptions are reduced to a minor consideration.

The moisture content of snow not only affects signal attenuation but determines the stick/slideoff characteristics of precipitation on relatively vertical antenna surfaces. Since weather conditions change dramatically during the course of a typical snow storm, the wet snow may cover the surface of an antenna, then freeze in place as temperatures drop and drier snow prevails during the balance of the storm. A snow cover must not be allowed to develop, because subsequent thaw and refreeze cycles will permit significant amounts of retained moisture to attenuate signals.

Figure 2: Selected anti-icing heat flux values

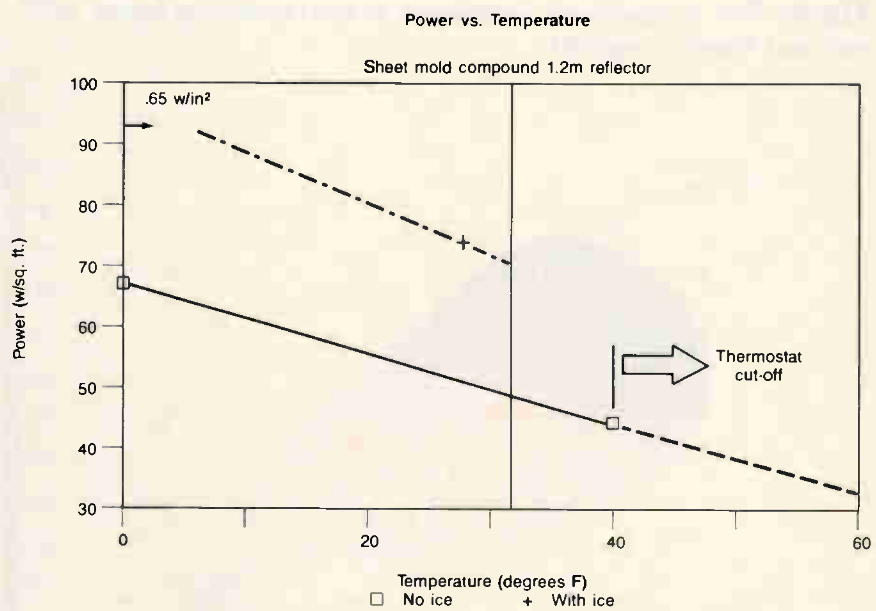


Deicing fundamentals

A range of choices is available to improve the tendency of antenna surfaces to shed water. Because even thin films of water "sheeting" the surface of an antenna will result in measurable degradation of antenna performance, coatings that reduce sheeting tendencies can be beneficial. Antenna manufacturers have utilized epoxy paint coatings with low surface energy characteristics to assist in water runoff. Several manufacturers use special hydrophobic coatings to create even lower surface energy characteristics. These coatings can be demonstrated to be effective in eliminating water sheeting when new. Manufacturers of these coatings recommend that they be maintained on a periodic basis to assure that water-repelling properties are retained. Low surface energy coatings also may serve to reduce the buildup of wet snow, which might more easily slide off due to the action of the coating against the high moisture content of wet snow.

The majority of snow and freezing rain conditions do not contain sufficient surface moisture to assure the coatings will always be effective as a means of deicing. Under some freezing rain simulations, relatively thick ice crusts have been built up due to the freezing of relatively high-profile water beads that result from these coatings. In addition, tests by the U.S. Army Cold Regions Research Laboratory[10,11] have shown several versions of these coatings to be of limited effectiveness without the simultaneous application of heat.

Figure 3: Power/temperature relationship for self-regulating heater



Active prevention or elimination of snow or ice accumulations is achieved by directly heating the antenna. A system designed to maintain the surface temperature of the antenna at temperatures above freezing is referred to as an *anti-icing system*. Energized before the beginning of precipitation, snow is melted upon contact with the reflector surface by heaters, and rain that would otherwise freeze upon contact with the antenna does not do so. Power requirements for anti-icing systems vary depending on the weather conditions (wind, temperature and snowfall rate) stated in the design basis. However, these power requirements are generally less than those required for the elimination of snow accumulations that occur prior to energizing the heater system. A system designed for this latter case is referred to as a *deicing system*. Obviously, an anti-icing system designed for extreme weather conditions also will serve as a deicing system under less extreme conditions.

There is no single standard for heat flux concentrations to achieve either anti-icing or deicing. Calculations have been performed for the heat required to achieve snow melting. The heat budget must allow for the heat losses from the surface due to free convection and forced convection by winds. Allowances must be made for increasing the antenna surface temperature to a level above freezing, for increasing the temperature of incident snow to the melting point and for the enthalpy of melting. Estimates of these heat requirements for a useful range of weather conditions are shown in Table 1.

Figure 4: Heat flux distribution for self-regulating heater

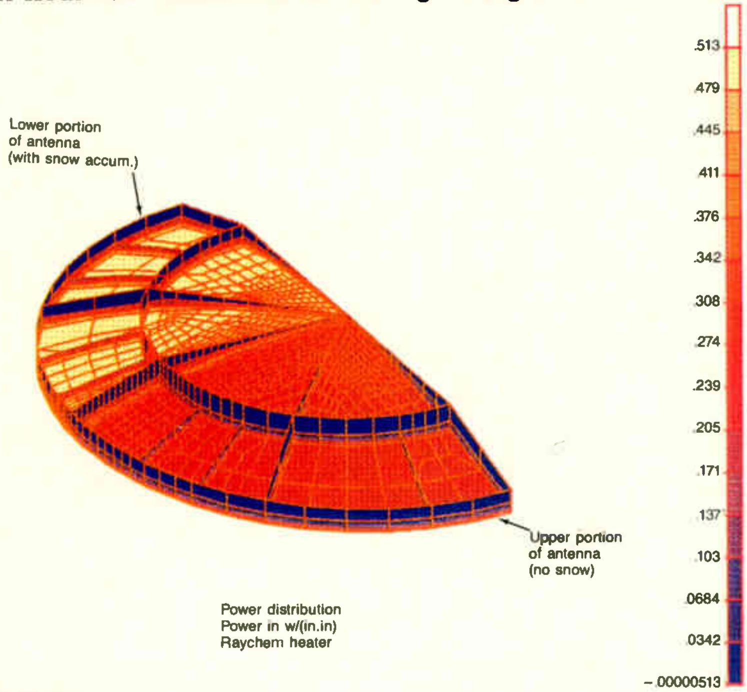
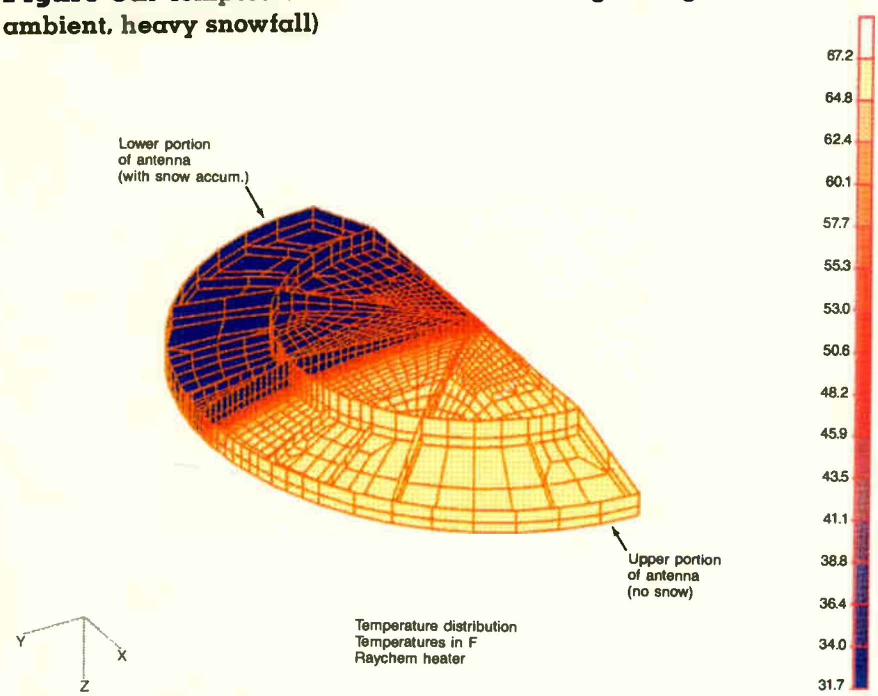


Figure 5a: Temperature distribution of self-regulating heater (10°F ambient, heavy snowfall)



The *ASHRAE Handbook* contains heat flux concentrations for anti-icing of non-critical and critical service surfaces. These vary, as one might expect, depending on the location of the system and the local weather of that location. Figure 2 illustrates these commonly chosen heat flux values. Although this data is eclectic, it serves to illustrate common practices and can be used with the weather maps to make judgments on the selection of deicing systems and their design.

For antenna systems a close tradeoff between desired heat flux and antenna thermal distortion must be carefully examined. Differential thermal expansions from the temperature differences across the antenna during snowfall or from the variations between reflector surface and rib structure must be minimized. Higher heat fluxes generally result in higher surface temperatures and aggravate this problem.

Active deicing methods

Three approaches have been used for antenna anti-icing or deicing system design. Shrouds can be mounted on the rear of the antenna and hot air circulated on the rear surface of the reflector. Resistance heaters producing a constant heat flux can be mounted on the rear surface of the antenna or embedded in the antenna material. Finally, resistance heaters with a variable heat flux can be mounted on the rear of the antenna. The advantages of each system will be discussed.

Blown air systems:

Systems are available for heating an enclosed air space behind the antenna, utilizing continuously circulated air heated to temperatures sufficiently high to permit heat transfer through the reflective surface. Usually a baffle or ducting arrangement is employed to achieve improved circulation of heated air. Thermodynamics dictate that high temperature resistance heaters or gas burners be used, since the convection of heat by air is inefficient relative to heat induction.

Such systems have been used for antennas of all sizes. In some cases an array of sensors is used to detect surface temperature (both exterior and interior). These sensors determine whether the system is turned on or off to maintain a desired reflector temperature. If the shroud encloses the rib structure and is insulative, then relatively uniform temperatures are achieved in the antenna structure and on the reflector surface when snow is not present.

Constant wattage resistance heaters:

Relatively inexpensive heaters can be obtained at a variety of heat flux ratings for direct mounting on the rear surface of the antenna. When used in combination with temperature sensors, especially in any array of heaters and sensors, it is possible to achieve a degree of uniformity in antenna surface temperature performance. High reliability thermostats that tolerate the continuous on/off cycling in moderate temperature conditions can be used, thus preventing overheating of the antenna.

Heaters used in a series resistance fashion must be balanced to achieve even heating. Redundant heater circuits can be used to prevent system failure in the event of an open circuit condition. Constant wattage heaters should be well bonded to the surface being heated to assure that disbonding will not result in hot spots.

Self-regulating resistance heaters:

Self-regulating heaters have been available for the past 15 years for freeze protection of critical piping systems and other structures. Usually these heaters are polymeric in nature and rely on a dispersion of a conductive media in a semi-crystalline polymer matrix. At high ambient temperatures the thermal expansion of the semiconductive matrix increases the resistivity of the material many orders of magnitude, assuring that the heater will not achieve temperatures greater than an established level. In conditions favoring heat conduction or at lower ambient temperatures, higher power output is achieved.

Results are shown in Figure 3 for a version of self-regulating heater specifically formulated for use in deicing antenna surfaces. Until recently, the power output of heaters used for deicing has been modest. High overall power output can be achieved through special formulations of the polymeric compound and the use of aluminum fin materials, which also mount the heater to the rear surface. As indicated in Figure 4, the presence of potential icing conditions on the front surface of the reflector increases the power output of the heater through the self-regulation principle. Other areas of the antenna surface, where snow would tend not to accumulate due to surface inclination, are heated at somewhat lower fluxes (typically one-half to two-thirds the former level).

The benefit to antenna structural distortion of self-regulating heaters is considerable. A comparison can be made between a self-regulating heater and a heating system that applies a constant heat flux over the entire rear surface of the antenna. Figures 5a and 5b illustrate the temperature profiles associated with a self-regulating heater and constant wattage heater, each producing maximum power at a snow load condition that achieves 32°F over the lower half of the antenna. Because the self-regulating heater reduces its power output in the upper half of the antenna, where snow is not assumed to be accumulating, the surface temperatures are more uniform.

Finite element analyses have been performed to predict the antenna distortion patterns that would result from the thermal patterns in Figures 5a and 5b. The benefit of self-regulating heating is the analytical prediction of a reduction of antenna surface distortion (for composite antenna structures) of 90 percent. The distortions of the surface have been exaggerated for illustration by the computer and are shown in Figures 6a and 6b.

In addition to reliability and minimal distortion, the maximum temperatures that would occur in the antenna if a thermostat was not used or if the thermostat would fail in the "on" position are reasonable. Because power is greatly reduced at high ambient temperatures, the antenna surface is always below critical temperatures, for composite structures. Tests on self-regulating heaters used for anti-icing in small antennas indicate a maximum reflector temperature only 12°C above ambient on very hot days.

Finally, very uniform antenna temperatures are achieved in the structural elements behind the antenna, provided that the system is encapsulated by an insulative backshell. Tests indicate that combined radiant and convective heating in the dead air space behind the reflector allow temperature variations of less than 5°C. ■

Acknowledgments: The writer wishes to acknowledge the contributions of Terry Kitagawa and Arthur Muller of the Raychem Heater Technology and Corporate R&D groups respectively, who have contributed to the analytical and modeling portions of this article and who have provided

Figure 5b: Temperature distribution of constant wattage heater at .65 W/in² (10°F ambient, heavy snowfall)

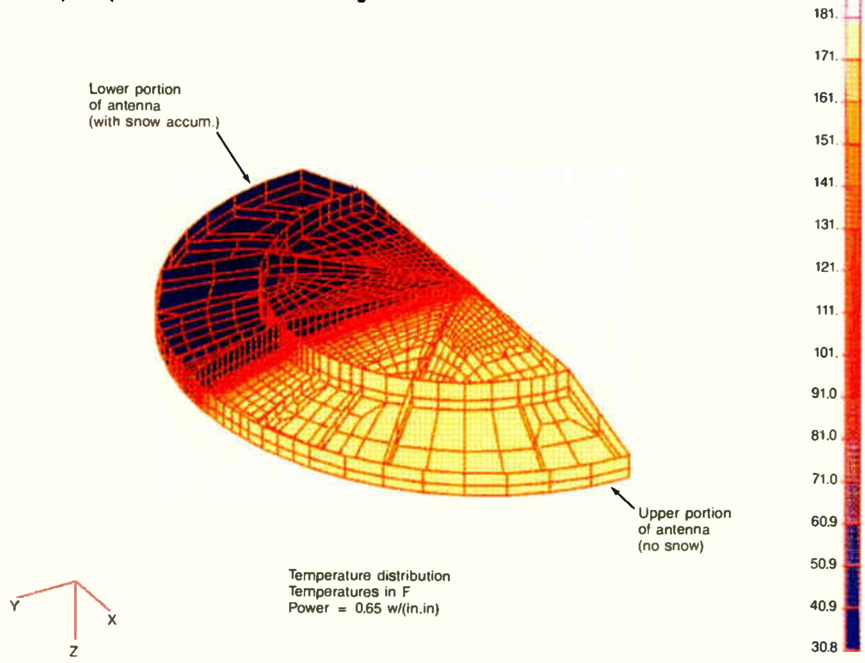


Figure 6a: Magnified deflection contours of self-regulating heater

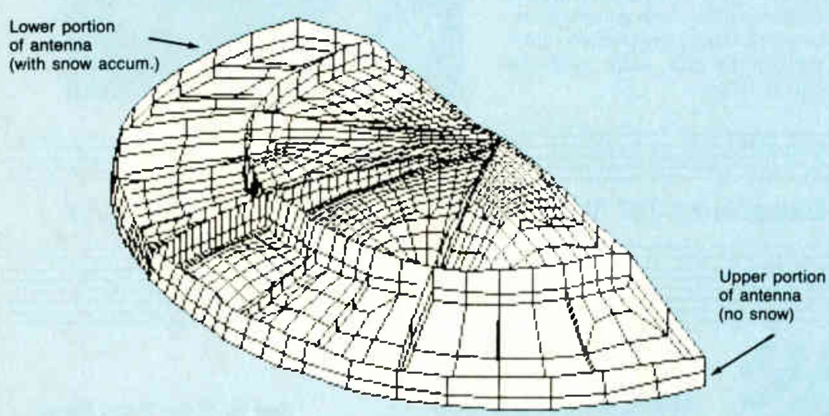
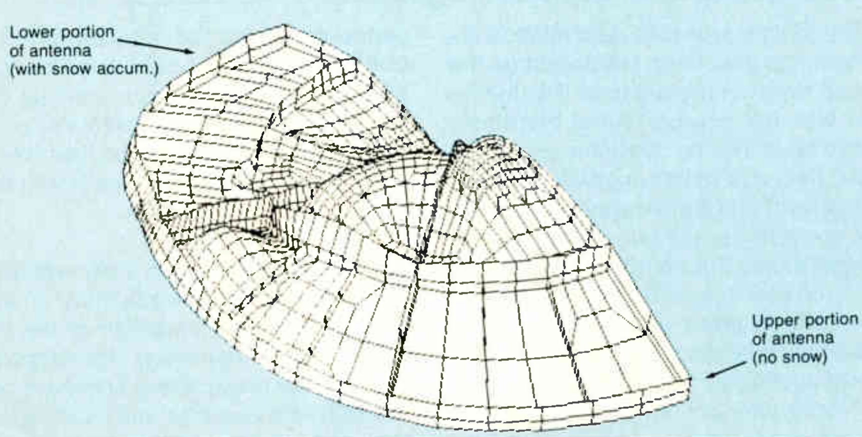


Figure 6b: Magnified deflection contours of constant wattage heater



much input to Raychem's antenna deicing program. The writer also acknowledges the cooperation of M/A-COM and Prodelin Inc. (in particular N. Moldovan) and wishes to express appreciation for their guidance.

References

[1]Hogg, D.C. and Semplak, R.A., "The Effect of Rain and Water Vapor on Sky Noise at Centimeter Wavelengths," *The Bell System Technical Journal*, September 1961, pg. 1331.

[2]Allnut, J. "Slant-Path Attenuation and Space Diversity Results Using 11.6 GHz Radiometers," *Proceedings of the Institute of Electrical Engineering* (GB), Vol. 123, No. 11, November 1976, pg. 1197-1200.

[3]Lange, W.R. and Pettinger, M., "Optimal Control of Antenna Heating Systems for Satellite Receiving Installations," *Nachrichtentech, Z.* (NTZ) (Germany), Vol. 38, No. 8, pg. 562-565.

[4]Davis, W., "Electrical Effects of Snow and Ice Coatings on Reflector Antennas," Air Force Institute of Technology, Wright Patterson AFB, Ohio, AFIT-TR-77-8, December 1977.

[5]U.S. Department of the Interior, Geologic Survey, *National Atlas of the United States of America*, Washington, D.C. 1970 edition.

[6]Baldwin, John L., *Climates of the United States*, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, UDC 551.582(73), Washington, D.C., 1973.

[7]American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., *ASHRAE Handbook*, 1984 Systems, Chapter 35 ("Snow Melting").

[8]Ruffner, James A. and Blair, Frank E., *The Weather Almanac, Second Edition*, 1977, Gale Research Co., Detroit.

[9]Bryson, Reid A. and Hare, F. Kenneth, "Climates of North America," *World Survey of Climatology*, Volume II, Elsevier Scientific Publishing Co., New York, 1974.

[10]Hannamoto, B., Gagnon, J. and Pratt, B., "Deicing a Satellite Communication Antenna," United States Army, Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, N.H., Special Report 80-18, April 1980.

[11]Ackley, S., Itagaki, K. and Frank, M., "An Evaluation of Passive Deicing, Mechanical Deicing and Ice Detection," United States Army, Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, N.H., Report No. FAA-RD-74-50, November 1973.

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From Headend to Drop

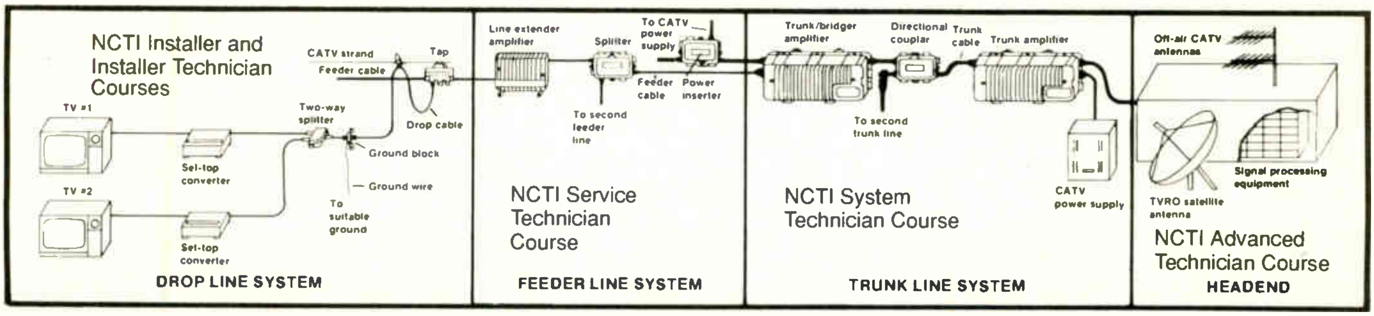

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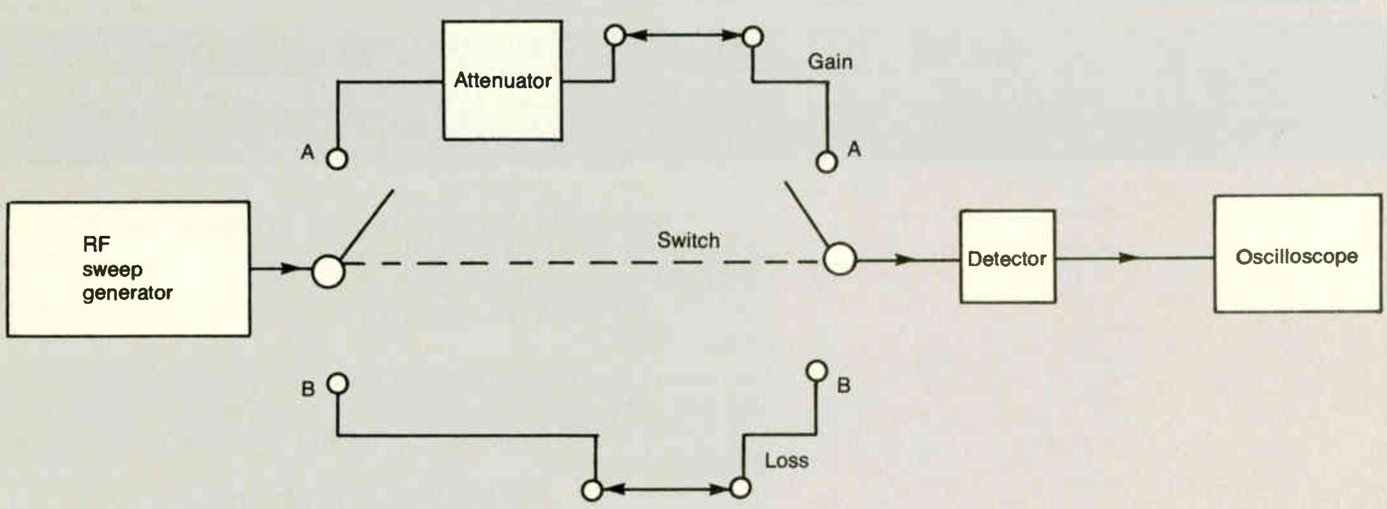
Figure 1



The bench sweep system

By Al Dawkins
President, Al Dawkins Enterprizes Inc.

Many technicians do not get a chance to use bench sweep equipment. You may have gotten a chance to rotate to bench tech or go to a school that features bench sweep, but the average tech may not have a chance to understand the full capabilities of this method of testing.

The sweep system consists of a sweep, marker generator, comparator and oscilloscope. The sweep is available in a 400 or 500 MHz model. With the arrival of 550 MHz cable systems and possibly higher, a new, more flexible 1,000 MHz system is now available. For our purposes, the older, more commonly used 400 MHz system will be used.

As seen in Figure 1, the output of the sweep is split by coaxial switches to form two channels of information. In this way a measurement by comparison can be made using the internal precision attenuators to determine the value in dB. This system is used to test amplifier gain, frequency response, input and output return loss (impedance match), coaxial cable loss and return loss. It also can be used to test tap values, through loss, tap port isolation, return loss, bandpass filter frequency response, pay TV traps (positive or negative), center frequency and depth.

All gain measurements and only gain measurements are made with the gain device inserted into Ch. A. Ch. B is jumpered to provide a reference 0 dB gain. The attenuators are used to bring down the entire response to cross the reference trace at the desired frequency. All loss measurements are made with the loss device in the B channel; the A channel is jumpered to form a 0 dB reference. The attenuators can now be used to bring the reference A trace to cross the B trace at the desired frequency; loss is read off the attenuator dials.

The following procedures will contain simple loss tests for coaxial cable, tap value, tap through loss and tap isolation. These tests are commonly run to determine the operation of a device. Many systems test all cable for possible problems due to shipping or a manufacturer defect, which will save problems upon activation. The same holds true for passive devices, taps, DCs, splitters, etc.

As technicians replace passive devices in the system, there are times when the device is still good and a connector is the cause of the problem. By testing the device on a bench sweep it can be returned to the field. (Interconnection of the cables will not be discussed here, since most bench sweeps are left connected or the manuals for the equipment adequately show cable connections.)

Upon connecting the cables to the units used in the test and initial turn-on, you will see a presentation similar to Figure 2, which is a result of jumpering both loss and gain test ports. This shows that both gain and loss are at zero and both traces are not the same. There are controls on the equipment to balance the two traces and when both are superimposed on each other the system is balanced (Figure 3) and the test may begin.

The first test is loss of coaxial cable

using a signal level meter. A Ch. 2 known level can be injected into one end of a length of cable and the level measured at Ch. 2 on the other end. The difference between the levels is the loss at Ch. 2. This can be done at all channels but it is very time-consuming. The sweep does this all at once as the generator sends a carrier signal out from 0-500 MHz at a very fast sweep rate and the results are quickly seen.

In Figure 4 the A trace is a flat line just as it was calibrated with no loss or gain. Trace B represents the coaxial loss due to frequency. The markers are set for 100 MHz, therefore the screen shows 0-500 MHz.

To measure loss at a specific frequency, the A trace is brought down by adjusting the attenuators until it crosses the B trace at the correct frequency using the markers as a point of measurement. In Figure 5 the attenuators have been inserted to bring the trace down to cross trace B at 300 MHz and the loss is read off the attenuators. With this setup you can measure the loss at any frequency up to 500 MHz.

Another test is for positive or negative traps; Figure 6 shows a trace of a negative trap. The sweep can determine the width of the trap at 3 dB down points and the depth that it will attenuate the channel.

Figure 7 shows a common tap and the tests that can be made using that tap. These tests are performed in the loss side as was the coaxial loss and the results are not as dramatic as far as loss due to frequency. Loss in a tap such as through loss and isolation are fairly flat but is always measured at worst case. In other words, it is the most loss at any frequency between 50 and 400 MHz if 400 MHz taps are being tested.

Return loss can be measured using a return loss bridge, an accessory that has three ports with two connected to the loss ports of the sweep and the third connected to the point from which you want to measure return loss. Again, return loss is the match of the port or how close to 75 ohms the port is at all used frequencies. For instance, if the input port of a tap is measured, its return loss should be at least 16 dB. This means that there is 16 dB difference between the level going into the port and the level being reflected back.

Trunk cable has the best return loss at 30 dB or above, feeder at 28-30 dB and drop cable at around 24 dB. Again, all three are worst case.

If you get a chance to use bench sweep equipment do so. Not only will it tell how well your equipment is functioning but it also will teach you the basics of how the devices function. This will help you understand the system's function to make your job easier as a troubleshooting technician. ■

Figure 2

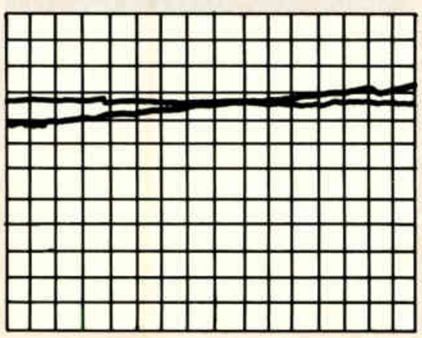


Figure 3

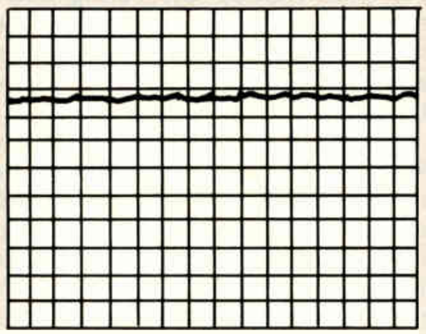


Figure 4

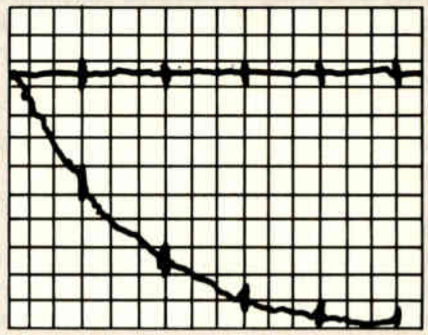


Figure 5

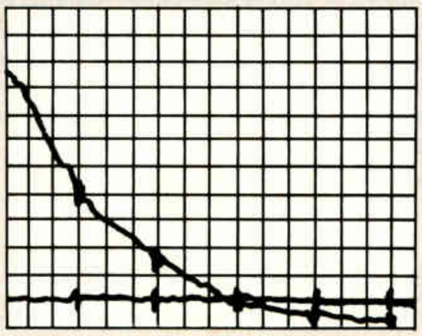


Figure 6

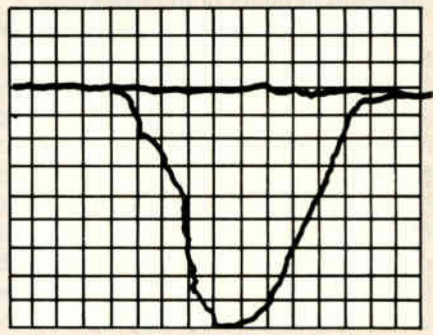
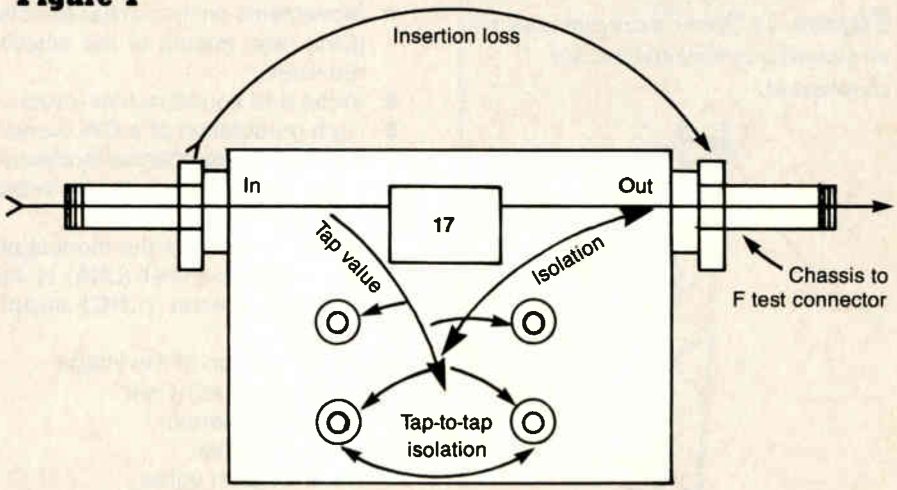


Figure 7



Tests

1) Insertion loss: measure in-out; all ports terminated.
2) Tap value: measure tap in to tap port output; other three ports terminated.
3) Isolation (tap-to-output): measure tap to output; all other ports terminated.
4) Isolation (tap-to-tap): measure tap port to tap port; all other ports terminated.

Preventive maintenance of headends

By Steven I. Biro
President, Biro Engineering

When the telephone rang at 6:50 a.m. on a December morning, I had a feeling that the news could not be very good. (How right I was!) The call came from a system manager. His 260-foot guyed antenna tower, located on the Atlantic coast, had collapsed the night before, partially destroying the headend building. As a result, a large area lost service. Could I help him? Could I come to see him right away?

My first question: Was anybody hurt, any homes damaged? Fortunately, the answer was negative.

On the way to the site, speculating about our chances to restore service, I asked myself: Could this catastrophic failure have been avoided by preventive maintenance? Why are headends—the single most important entity of the cable system—notoriously failing during the coldest weeks of the year or the most undesirable hours of the night?

Many headends are located neither in town nor next to the office. The classical American headend is situated at the outskirts of the town, frequently on a hilltop, in order to receive distant TV stations or to reduce electrical (AC), two-way radio or other common interferences, so typical of the urban environment. Every headend, especially those with access road problems in harsh climates, demands a preventive maintenance (PM) program. The objective is to *prevent* rather than correct unexpected failures. Corrective action may return the system to service, but it will not prevent the failure to occur again. Preventive maintenance, on the other hand, should identify the weak points in the headend *before* they become emergencies.

Obviously, we cannot monitor every headend component and function, nor is the CATV engineer expected to spend countless hours per day making routine measurements and logging the test results. There should be a compromise between not checking anything and the burden of constant monitoring.

Determining what to check is straightforward. The listing should contain the major components of the headend, breaking down into subsystems. The need for daily, weekly, monthly and semiannual testing requirements depends on the number of channels carried on the cable, the exposure to special environmental/weather conditions and the number of subscribers served, just to mention a few factors. A 40,000 subscriber system can and should afford a full-time headend technician. A 1,200 subscriber system, run by the chief engineer/manager, represents the other end of the maintenance spectrum.

1) *Daily checks*
   - Picture quality
   - Audio volume
   - Video/sound carrier ratio
2) *Weekly maintenance tasks*
   - Picture and sound quality at the headend test point
   - Signal levels at the antenna downleads
   - Movements on the carrier-to-noise (C/N) ratio meters of the satellite receivers
   - Video and sound carrier levels
   - Hum modulation of a CW carrier
   - Spurious beats, channel by channel
   - 1 volt peak-to-peak at the VideoCipher II inputs
   - Video deviation of the modulators
   - Low noise amplifier (LNA) or low noise converter (LNC) supply voltage
   - Pressurization of the Heliax
   - Air conditioner/heater
   - Standby generator
3) *Monthly schedule*
   - Tower beacon lights
   - Antenna array or antenna gate movements
   - Mechanical inspection of antenna downleads
   - Supply voltage for antenna-mounted preamplifiers
   - Movement of Heliax or coaxial cable from satellite dishes
   - IF levels of signal processors and modulators
   - Video carrier frequencies in the aeronautical frequency range
4) *Semiannual tests and measurements*
   - Video carrier frequencies of all modulators and off-channel operating signal processors
   - Frequency response of the signal processors
   - Cross-polarization isolation of satellite dishes
   - Mechanical inspection of the earth station

Antenna towers and small earth stations

Towers may appear intact, but without regular inspections their productive life can be substantially reduced or abruptly terminated. The semiannual inspection should include guywires and anchors, possible cracks in the foundation, plumbing of the tower, as well as grounding connections. Guywires are probably the most vulnerable tower items. The tensioning of the wires requires experienced and

Figure 1: Tower damage due to stretched guywires or anchor movement.

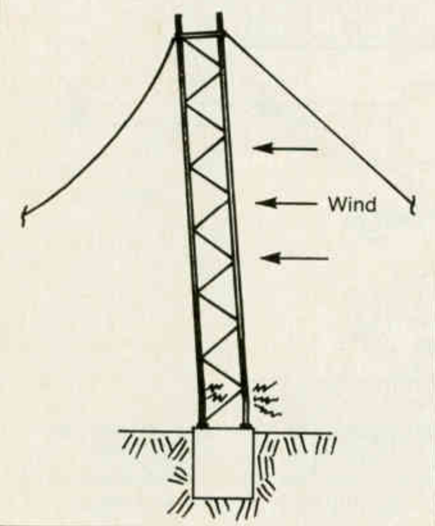
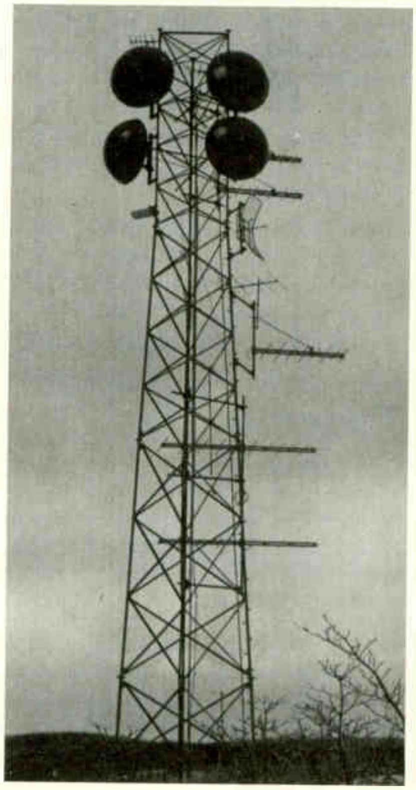


Figure 2: VHF-UHF antenna



authorized personnel.

Figure 1 shows what the stretching of the guywires or the movement of the anchor can cause. Another typical source of catastrophic failure is corrosion that is often neither prevented nor ever detected.

Tower-mounted beacon lights are designed to warn air traffic of hazards. Any lighting outage that will last longer than one hour should be immediately reported to the nearest airport or to the Federal Aviation Administration flight service station.

In metropolitan areas, where many off-air TV channels are commonly available, the VHF/UHF antennas form the heart of the receiving equipment (Figure 2). It is extremely important that the properly installed antenna arrays maintain their performance during inclement weather conditions.

The small earth station's antenna is the most expensive component in the vital link between satellite and the headend electronics. A well-designed, properly installed parabolic antenna provides:

- High gain
- Good cross-polarization isolation
- Low sidelobes (protection against terrestrial microwave interference)

Satellite receiving antennas must perform even under severe environmental conditions. High winds, accompanied by snow and ice can cause antenna pointing errors, movements of the feedhorn and deformation of the reflective surface. The net result: a probable 2 to 3 dB reduction in the system C/N ratio. Under the worst-case conditions of freezing rain and snow, moisture may get into the Heliax and half of the reflective surface is covered by snow. The resulting 8 to 10 dB degradation in C/N could wipe out the satellite pictures.

Headend electronics

Picture quality and sound intensity observations conducted twice daily do not require a visit to the headend and can be performed as a routine part of the maintenance program. These subjective channel-by-channel observations relate more closely to the headend performance than generally perceived. The system technician may not only find a missing carrier or a distorted sound transmission but could even discover at 6 p.m. that the headend located summation sweep transmitter was left on and all subcarriers see an annoying glitch at five-second intervals on all the channels carried on cable.

Subscribers are often disturbed when they scan through the channels and the audio volume goes through extreme variations. True, certain satellite programs exercise less than acceptable sound deviation controls. Is it so difficult to select a high quality broadcast TV station as a reference, adjusting the audio deviation of the modulators by ear to the same median volume?

The new 12.5 kHz video carrier offset assignments in the aeronautical band, augmented by the ±5 frequency accuracy requirements, necessitate monthly tests and frequency accuracy measurements. Older or modified signal processors and modulators should be checked biweekly. There is a wide variety of digital frequency counters available off the shelf, reaching (if necessary) into the microwave frequency domain. They have high sensitivity and reduced acquisition time, making the direct frequency accuracy checking of the highest amplitude-modulated (AM) signal in the multisignal spectrum a simple task.

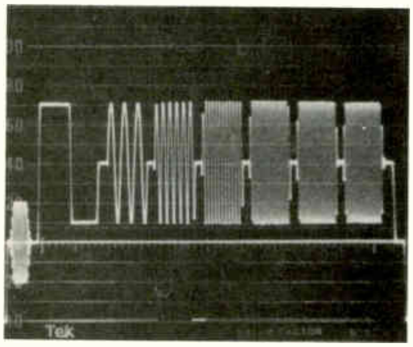
You can still obtain high accuracy from a digital counter that cannot exhibit periods, time intervals or perform reciprocal counting. A simple counter also requires less operator training, a tremendous advantage. CATV frequency accuracy measurements are generally in the 50 to 300 MHz range. A basic 250 MHz counter, from one of the high reputation suppliers, can normally count up to 300 MHz—although at reduced accuracy, which is still many times higher than the permitted ±5 kHz tolerance.

The scrambling of the majority of the satellite-delivered programs changed the common subjective testing of video signals drastically. These days a rack-mounted waveform monitor is almost mandatory to verify consistent 1 volt peak-to-peak amplitude across 75 ohms at the input of the VideoCipher II. The waveform monitor also is the perfect instrument to check essential video performance parameters.

Figure 3 shows the "textbook" multiburst signal, composed of identical amplitude 0.5, 1.0, 2.0, 3.0, 3.58 and 4.2 MHz burst frequencies. Figure 4 was taken at the headend where the frequency response was found to be less than perfect. Also, observe the leading edge of the multiburst, indicating a smear and a loss of picture resolution.

Headend electronics, particularly signal processors and modulators, are sensitive to freezing conditions or substantial temperature overruns. The video carriers will drift in frequency and amplitude. The drift in frequency may be more dangerous because it may violate the latest Federal Communications Commission (FCC)

Figure 3: Textbook multiburst signal



aeronautical frequency rules.

Is there any assurance that the electronics within the building will compensate for subfreezing temperatures during those critical winter months? The answer is no. Every headend must have an adequate power electric heater. Sustained air-conditioner failures can be even more dangerous, causing damage in sensitive electric components. A thermostat-controlled exhaust fan can prevent the otherwise predictable catastrophic failure.

Is your air conditioner large enough? To convert kilowatt hours into British thermal units (btu) multiply kilowatts by 3413. For example, 5.5 kW headend power consumption requires an air-conditioning unit of 5.5 × 3413 = 18,772 btu. Since 12,500 btu equals one ton of air moving capacity, order a 1.5 ton industrial-type air conditioner.

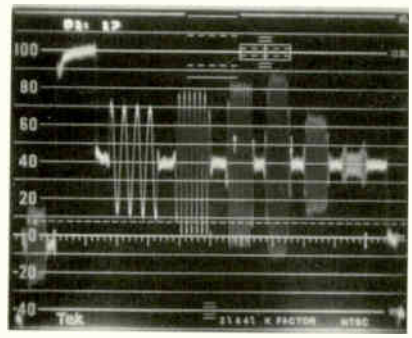
Outraged subscribers have every right to complain about loss of service as a result of headend power failure. With a little planning and moderate investment, every remote headend can be equipped with a standby power generator. The importance of standby power is constantly growing with the universal introduction of addressable systems, PPV events, data transmissions and other subscriber-oriented non-entertainment services.

The uninterruptible power supply can eliminate short-term brownouts as well as complete blackouts. Under normal power line conditions the headend is powered from the AC line and a rectified voltage is used to charge the 48 or 60 volt battery bank. When the power line monitor detects no power or low power conditions the load is transferred instantly to the DC-AC inverter.

Additional notes

Tests and measurements of the preventive maintenance program should be well-defined. The written procedures ought to be brief, field tested and understood by all parties, including your assistants. Of course, calibrated test instruments in good working condition are a must. Have you considered dedicating a top quality signal level meter (SLM) and a large screen color monitor (RF and video) to the headend? If you cannot afford the luxury of a rack-mounted SLM, at least use the same calibrated meter when it comes time for maintenance work.

Figure 4: Imperfect frequency response



The proper documentation of the test results should not be considered as an evil burden. The purpose of the logs is to focus the technician's attention toward undesirable trends and events. For example, the slowly decreasing antenna input signal level reading on the distant UHF channel may indicate that the TV transmitter developed some problems, although it is not very likely. It is more realistic to suspect that moisture penetrated the antenna-mounted preamplifier or insects built a nest at the input terminals of a folded dipole. Another good example is the C/N meter on the front panel of the satellite receivers. While it is true that these meters are not very accurate for C/N testing, once they are set at a certain level they can act as early warning signals for vegetation growing in front of the parabolic dish, snow building up on the feedhorn or a surface deformation of the 5 × 7 meter multifeed receiving antenna.

Headend maintenance starts well before turn-on, right at the planning (design) stage. The selection of equipment, components, hardware and cables (wiring) can mean all the difference between uninterrupted service and frequent failures. Equipment designed and marketed for MATV and SMATV systems should be used in MATV and SMATV headends, not in CATV headends serving 3,000 to 5,000 subscribers. ■

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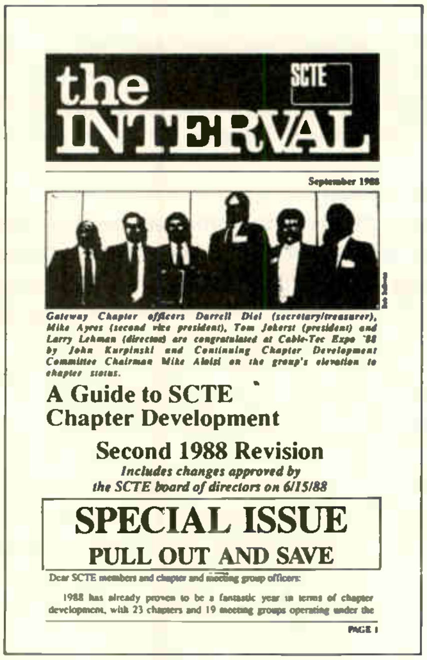

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September 1988

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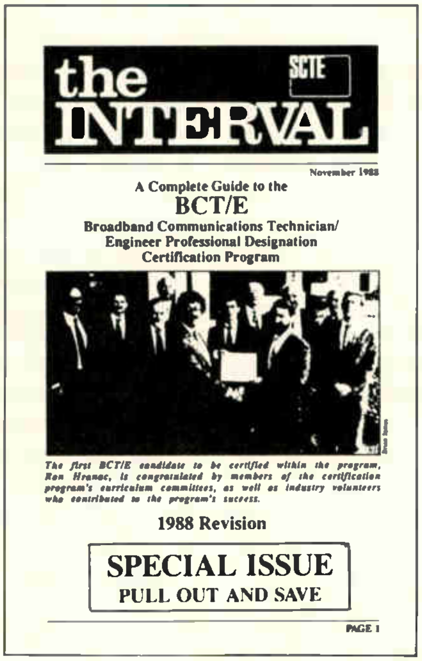

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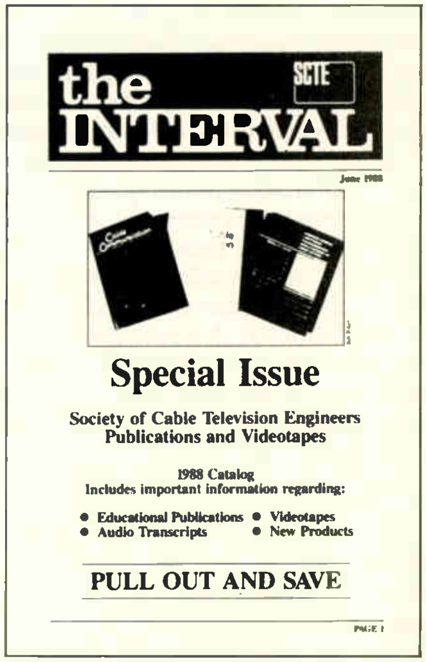

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The Society of Cable Television Engineers, Inc.

Reader Service Number 11.

Recommended practices for consumer interfacing

This is the second part in a series on connecting consumer electronics products in the subscriber's home. Part I considered FCC technical standards.

By the NCTA Engineering Committee's Subcommittee on Consumer Interconnection

Ingress and egress can be found at any device between the cable drop and the viewer, including the TV receiver itself. *Ingress*, also known as "direct pickup" (DPU), can be defined as any undesirable signal induced on the cable from an electromagnetic environment outside the cable system. *Egress* is defined as any signal originating within the cable being radiated to the outside environment from the cable or any device connected to it.

Ingress: Sources and measurements

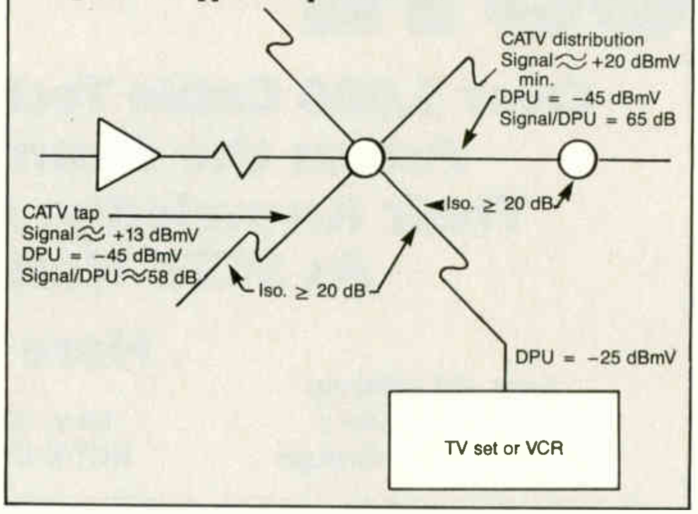
Ingress is not limited to the near proximity of TV transmitting sites; it has been observed more than 50 miles from the source of the signal. Sources of ingress can be many, but high-power TV transmitting stations, amateur radio and private and public safety land mobile radio operations are the most common sources of ingress. Field intensities in excess of 1 volt/meter have been recorded within two miles of TV stations. Cable Channels 2-13 and 18-21 are most often affected. Early TV receivers offered virtually no protection from ingress; this led cable operators to use converters to overcome the effects of DPU.

More recently, TV receiver manufacturers began offering "cable-ready" receivers for sale; these are distinguished by the ability to tune the unique cable channels in the mid- and superbands. While the 300 ohm twin-lead, used between the antenna terminals and the tuner in earlier sets, was often replaced by F fittings and coaxial cable, the shielding was often not adequate to operate satisfactorily in most urban environments.

A test to measure the amount of ingress has been developed. All connections are removed from the device to be tested. A signal level meter is connected to the input connector of the device. The level of ingress can be measured directly on the SLM while the tuner on the device under test is operated over all channels. The highest level observed should be recorded; the relative impairment can be determined by taking the ratio of signal on the cable to the level recorded from the meter. For example, if the signal from the cable is 0 dBmV and the level recorded from the meter is −30 dBmV, the carrier-to-ingress ratio is 30 dB. If the interfering signal is another TV signal, the interference should be suppressed at least 45-50 dB. If the interfering signal occupies a narrow band of frequencies, such as from a two-way radio, the interference should be suppressed at least 55-60 dB.

Measurements like those just described have been made on 1984 and 1985 model receivers, VCRs and CATV converters. The ambient field intensity ranged from 133 mV/m to 1.2 V/m. Ingress on the TV receivers ranged from −44 to −2 dBmV, VCRs ranged from −30 to −20 dBmV and CATV converters ranged from −46 to −32 dBmV. In spite of the foregoing, experience has shown VCRs are more likely to experience ingress as a result of their poorer shielding integrity. Older receiving equipment, especially that employing 300 ohm twin-lead for the antenna connection, experiences ingress to a much greater degree.

Figure 1: Typical tap isolation



Levels from nearby transmitters have been recorded as high as +50 dBmV on some equipment. FM tuners that have built-in antennas or are coupled to the power line for an antenna are especially prone to high levels of ingress. When connected to a cable system, this equipment causes backfeeding of the signals into the cable system.

In some instances, ingress in the home has been so severe that not only is the affected subscriber's viewing disrupted, but signals are back-fed into the distribution system. In these cases, everyone downstream from the affected subscriber also experiences the effects of ingress. In these cases, the operator will often try to use a converter as an isolation device to prevent backfeeding. Where this is not practical, special amplifiers that exhibit good back/front isolation can be installed in the line to reduce or eliminate backfeeding.

CATV operators selecting components for installation between the subscriber tap and the receiver should take care to select products with adequate protection from the effects of ingress. In addition to the usual care in choosing cable and connectors, the operator also should take care in selecting A/B switches, two-way splitters, VCR switch units and converters.

Ingress can occur from standard broadcast radio stations operating in the 550-1,620 kHz band. This ingress can be exacerbated when CATV distribution and drop cable shields act like long wire antennas increasing signal intensity at the connected devices. Interference has been observed in both TV sets and VCRs. Although this type of interference is hard to eliminate, its effects can be minimized by good local grounds at the affected equipment.

Egress: Isolating the sources

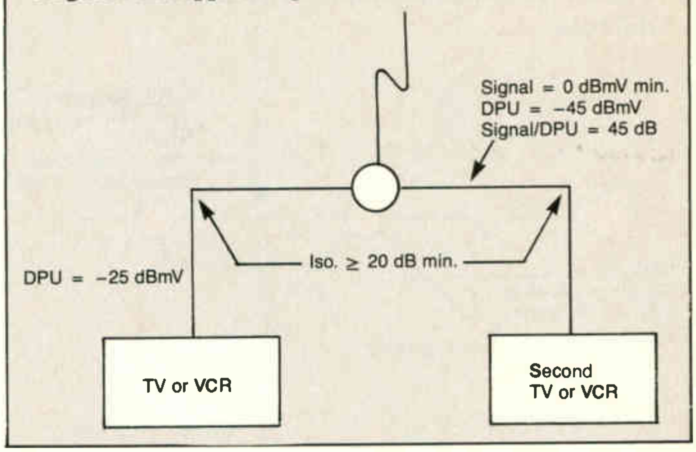
Egress can result from inadequate shielding, either from equipment provided by the cable operator or from subscriber-owned equipment. In general, emissions from CATV systems must be limited to 20 μV/m at three meters. Any operator using channels in the aeronautical bands (108-137 MHz and 225-400 MHz) is required to monitor all portions of the cable system annually; any egress in excess of 20 μV/m must be identified and corrected. Under certain conditions and after 1990, operators must monitor all portions of the system on a quarterly basis.

Even though the subscriber might be responsible for correcting problems with subscriber-owned equipment, the cable operator is faced with the often difficult task of isolating the source of egress. If the cause of egress is inadequate shielding in a TV receiver or VCR, the owner is often precluded from using the equipment as it was intended; e.g., a "cable-ready" TV receiver or VCR that cannot be connected directly to the cable. Generally, as ambient signal levels increase, ingress will become a problem before egress will. This is true because taps and splitters used by the cable industry have inherent isolation, usually at least 20 dB. Therefore, DPU will become visible on a customer's TV set before it gets high enough to affect the neighbors.

Systems will sometimes provide converters to some but not all subscribers. Those subscribers' TV sets not using a converter are usually connected directly to the cable. In cases where shielding in the TV sets is poor, cable signals radiated by the receivers can and do cause interference to licensed radio services such as amateur radio operators, fire, police and forestry services. CATV maintenance personnel need to be especially vigilant to find and control or eliminate this type of egress. If necessary, the offending drop should be disconnected until the egress can be eliminated.

Surveys have shown the number of cable-compatible sets have increased exponentially in recent years; we estimate about one-third of our customers now own a receiver capable of tuning most or all of our non-scrambled channels. These sets are selling at a rate of 10 million per year. So we expect the number of customers desiring to connect directly to the cable will increase substantially in the next few years. Concurrently, the number of VCRs sold has increased remarkably. CATV converters and converter/descramblers are a barrier to using the features of these consumer devices. We desire to accommodate and help our customers in using their own equipment to tune CATV channels whenever possible. At the same time the CATV operator can reduce investment in owning and maintaining converters.

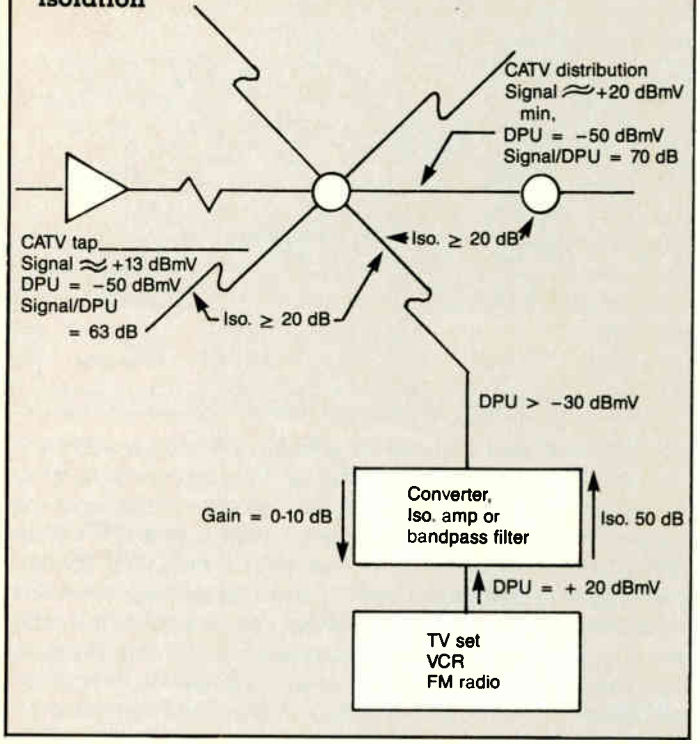
Figure 2: Typical splitter isolation



However, in accommodating direct connections to the cable we must establish policies and procedures to protect the quality of the service we provide. These guidelines are intended to protect the customer and the CATV network from service problems and picture impairment that could be caused by the direct connection of inadequately shielded equipment.

While a converter/descrambler or a descrambler will continue to be necessary for anyone receiving scrambled signals, use

Figure 3: Isolation amplifier or converter for isolation



of plain converters can be reduced and perhaps eliminated in the future. Based on survey data, we believe one-third of our basic customers may not require a converter to receive our service.

Unfortunately, only a few of the cable-compatible TV receivers and VCRs are completely satisfactory for direct connection to the cable system. While more present day consumer products designated as "cable-ready" can tune most or all CATV channels, few if any have adequate shielding for signal ingress and egress. Egress can result in reradiation of CATV signals in excess of FCC limits.

The most common problem results from signals from TV stations and mobile radios entering the equipment and disrupting customer viewing. Disruption can take two forms: echoes and other interference and/or beats in the connected television set or VCR. This can have an impact on the owner of the equipment. The more disturbing effects occur when DPU is so intense so as to feed DPU back into the cable system from poorly shielded equipment. Not only can this impair reception for the equipment owner, but for every other customer downstream from that location. Diagnosis and elimination of this "back-fed" DPU can be very difficult and time-consuming, especially if there is more than one location where DPU is being introduced on the system.

Identification and prevention of backfeeding

Most CATV passive devices have at least 20 dB isolation between any two ports; this is depicted in Figures 1 and 2.

DPU from TV stations, which is manifested as a sync bar or echo in the picture, should be suppressed at least 45-50 dB if DPU is not to produce visible echoing. If the passive components provide a minimum of 20 dB isolation, then DPU levels from sets and VCRs should be less than -25 dBmV. This assumes drop levels are 0 dBmV. Beats caused by other services such as land mobile radios and TV stations off frequency from cable channels should be suppressed 50-55 dB if they are not to cause visible beats in the picture. In these cases, levels at receiver and VCR connectors must be less than -30 to -35 dBmV if they are not to cause harmful backfeeding.

When DPU at the antenna terminals exceeds the limit, a converter or isolation amplifier (Figure 3) is needed to reduce the amplitude of the DPU signal back-fed into the CATV system. The amplifier has modest forward gain (approximately 10 dB), but has at least 45 dB attenuation from the output port to the input port. It should be understood that the isolation amplifier only protects the CATV network from backfeeding; it will have minimal or no effect in reducing echoing in the receiver or VCR. If echoing is present as a result of DPU in the VCR or receiver, only a converter will eliminate the phenomenon.

It should be mentioned that single sources on a given trunk or distribution cable can be difficult to locate and isolate; multiple sources of backfeeding can be very difficult to isolate. Technicians will necessarily have to use TV sets to observe and clear sources of backfeeding. As more customers begin direct connection, the number of backfeeding incidents can be expected to increase substantially.

- Remove all cable connections and connect an SLM to the input terminal of the receiver to be connected directly to the system. Keep the test lead as short as possible and do not use push-on connectors.
- Measure the amplitude of all local VHF off-air channels and note highest level.
- If a VCR is to be connected directly to the cable, also measure its levels at the input terminal.
- If the measured level exceeds -25 dBmV on any channel(s), the direct connection to the CATV system should not be made. A converter or isolation amplifier must be connected between the customer's equipment and the CATV system.
- Repeat the procedure for each outlet not using a converter.

If an amplifier is installed, the preferred location is on the input side of any splitters that may be installed. With an amplifier located at the splitter input, it would be possible to connect equipment directly to any outlet without installing additional amplifiers. If the splitter is installed in a location where an amplifier connected to its input would be exposed to the elements, then the amplifier should be installed between the splitter output and the television set. This will necessitate the use of a separate amplifier for each outlet.

Identification and elimination of DPU

This phenomenon will be the one most often encountered since the inherent isolation of the system passives provide at least 20 dB of protection to other equipment connected to the cable. Measurements have shown the worst victims of DPU in present-day equipment will be VCRs.

Unlike VHF broadcast television signals, which are ubiquitous, amateur radio and mobile service signals tend to be localized to an area in the near vicinity of the transmitter. Isolation of signals from mobile radios can be made by observing the picture when the offending unit is transmitting. This is almost impossible when the offending transmitter is in a vehicle. While DPU from TV stations should be suppressed at least 45-50 dB below the carrier, other types of interference need to be suppressed at least 55-60 dB.

- Disconnect all inputs from receivers under test and terminate input connector if possible.
- Tune the receiver's channel selector to each local VHF channel and look for the presence of a picture.
- If a picture is observed on any channel, remove the terminator, connect the cable directly to the receiver and look for a sync bar, echo or co-channel in the picture.
- If no sync bar, echo or co-channel is present, then the cable

can be connected to the receiver; if an echo is observed, proceed to the next step.

- Measure the drop level; if it is less than +5 dBmV, then connect an isolation amplifier between the drop and the television receiver. This is to prevent overloading of the amplifier and/or the receiver.
- Look for a sync bar, echo or co-channel in the picture. If it is still present, it will be necessary to use a converter.
- If a VCR is also connected, the preceding test should be repeated with the VCR output connected to the receiver and the VCR input terminated.

Other types of equipment connected to the cable system also can cause DPU problems. Often, equipment designers are not cognizant of potential DPU problems from inadequate shielding. FM receivers, burglar alarm equipment, modems, VCR switch boxes, computers and games are examples of equipment often connected directly to the cable and can cause problems.

Some of this equipment subjects CATV service personnel to two types of problems: DPU, associated backfeeding and egress. In many instances, device shielding is so poor, emissions from the device exceed the 20 μV/m at three meters limit. While Part 76.617 of the Federal Communications Commission Rules holds the customer responsible for emissions from most or all customer owned equipment, cable maintenance personnel are faced with the difficult task of finding and isolating the offending equipment.

Use of special bandpass filters and/or isolation amplifiers can help reduce or eliminate backfeeding to other outlets on the same dwelling and the cable distribution plant. With their inherent 10 dB gain, use of isolation amplifiers can make the signal leakage problem worse. If this is found to be the case, consideration should be given to installing attenuator pads to reduce levels to the offending device. However, care should be taken to keep levels well above the minimum needed for reliable operation of the equipment.

If the equipment to be connected is to be used with a receiver or VCR (such as A/B switches, VCR switches or games) use the procedures to be described in Part III. If the equipment to be connected is used for other services, such as FM radio or data receivers (like X Press), the procedures should be as follows:

- Disconnect all inputs from the equipment to be measured and connect an SLM to the input connector. Keep the test lead as short as possible and do not use push-on connectors.
- Measure the amplitude of all local VHF off-air channels and measure the highest level.
- If the highest level exceeds −25 dBmV on any channel, direct connection to the cable system should not be made; an isolation amplifier should be connected between signal splitter or tap and the equipment to be connected. If the equipment is an FM receiver or will receive signals in the FM band, then an isolating bandpass filter can be used to reduce or eliminate backfeeding.
- If the recorded levels exceed −25 dBmV, then the potential for harmful backfeeding exists. If the recorded levels exceed the −25 dBmV limit by only a small amount, television receivers serviced by the same splitter or tap should be checked for a sync bar, echo or co-channel. If it is observed, then the equipment being measured should not be connected to the cable system.
- Alternatively, an isolation amplifier with 60 dB or more isolation could be tried if available. ■

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

Basic electronics theory

By Kenneth T. Deschler
Cable Correspondence Courses

This month we will cover the characteristics and principles of operation of inductors (coils) and transformers. We also will explore the property of inductors and transformers known as inductance.

An *inductor* is a coil of wire that exhibits the property of inductance. *Inductance* is a characteristic of inductors that opposes a change in the direction of current flow. In a previous lesson we saw that when current flows through a conductor an electromagnetic field is built up around that conductor. When the current is reversed, as it is when using AC, the collapsing field opposes this change. As we saw, this field induces a voltage in the conductor causing current to flow in the direction that it was originally flowing. This property of inducing a voltage within itself is known as *self-inductance.* This effect is summarized by Lenz's law, which states: "the induced voltage in any circuit is always in a direction opposite to the effect that produced it."

The symbol for inductance is the letter L and its basic unit is the *henry* (H). One henry is equal to the inductance required to induce 1 volt in an inductor by a change of current of 1 ampere per second.

Figure 1 shows the schematic symbols for three types of inductors. The factors that affect inductance are length of the winding, permeability of the core material, cross-sectional area of the coils core, number of turns and layers and type of winding.

Figure 2a shows a circuit containing a DC source, a two position switch (S1), and a resistor and inductor in series. When S1 is in position B, the resistor-inductor is short circuited. When switch S1 is placed in position A, all of the applied voltage is felt across the inductor because of its large opposition to current flow. As the amount of opposition decreases due to the weakening of the field, more current flows in the circuit, causing less voltage to be dropped across the inductor and more across the resistor. This is shown occurring between time T_1 and time T_2 of Figure 2b. Figure 2c shows the decay of voltage across the resistor and the increase across the inductor when switch S1 is placed in the B position. The opposition to current flow caused by an inductor is called *inductive reactance.*

L-R time constant

An *L-R time constant* is the amount of the total current that the inductor will pass within a specific amount of time. As shown in Figure 3, the current will increase 63 percent of the maximum value within the first time period known as one time constant (1 TC). Each time constant after that the current will increase 63 percent of the difference between the value of the last time constant and the maximum current value. This continues until the fifth time constant, when the current is considered to have reached the maximum value.

The same thing occurs when switch S1 of Figure 2c is in position B, except that the current value decreases 63 percent of the difference between the maximum value and zero for each time constant until the fifth time constant, when the current value is considered to be zero. The amount of time necessary to complete each time constant is determined by the following formula:

$$T \text{ (in seconds)} = \frac{L \text{ (in henrys)}}{R \text{ (in ohms)}}$$

As an example, the amount of time to complete three time constants of the circuit in

Figure 1: Types of inductors

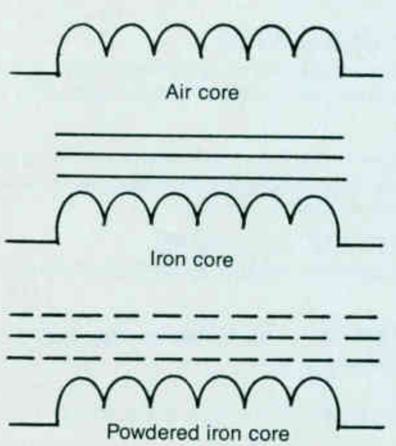


Figure 2: Circuit growth and decay

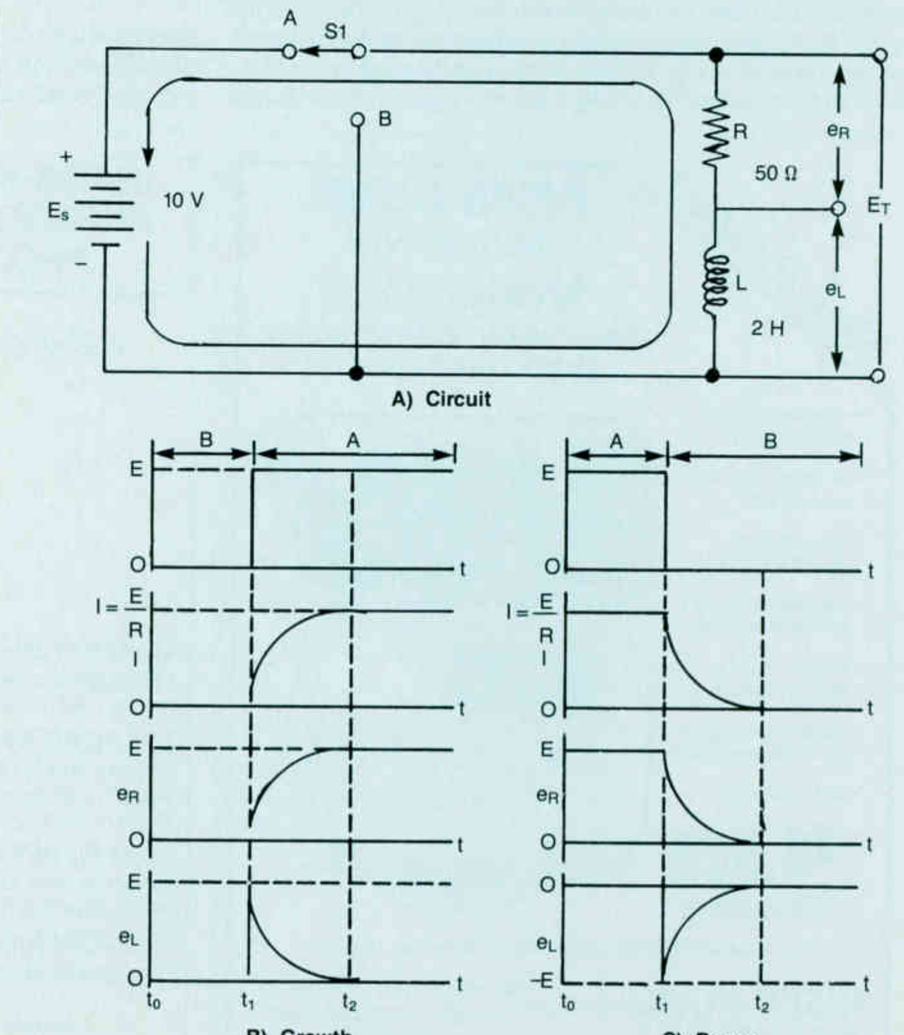


Figure 2 would be:

$$1\ TC = \frac{2}{50} = 0.04 \text{ seconds}$$

Therefore, in three time constants, the time is $3 \times 0.04 = 0.12$ seconds or 120 ms.

The three primary losses in inductors are:

1) Copper losses (power lost due to the DC losses in ohms)
2) Hysteresis losses (power lost due to the reversing of the electromagnetic field)
3) Eddy current losses (power lost due to eddy currents flowing within an iron core)

When inductors are placed in either series or parallel their total inductance is determined the same as resistors in series or parallel.

$$L_T = L_1 + L_2 + L_3, \text{ etc. (series)}$$

$$L_T = \frac{1}{1/L_1 + 1/L_2 + 1/L_3, \text{ etc.}} \text{ (parallel)}$$

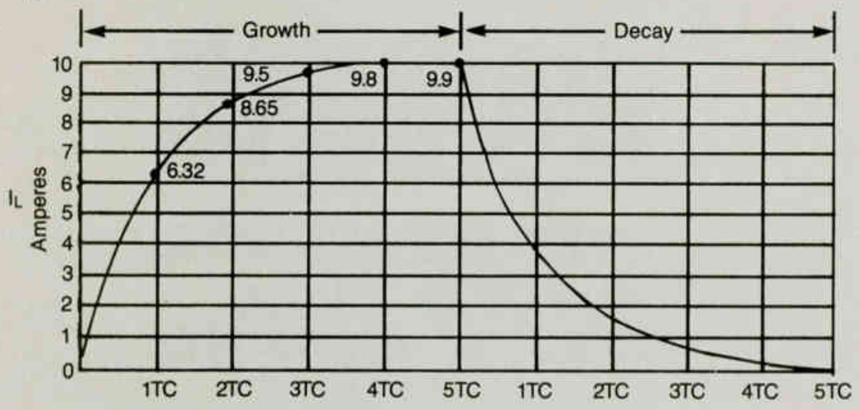
Whenever two coils are located close to each other, the field of one coil cuts across the turns of the other and induces a current in the second coil. This is known as *mutual inductance*. The percentage of the field of the first coil that cuts across the winding of the second coil is known as the coefficient of coupling between the two coils. The coefficient of coupling is always less than unity (one).

Transformers

A *transformer* is a device that transfers electrical power from one circuit to another through mutual inductance between two or more coils. The coil that originates the electromagnetic field is called the *primary* and the coil (or coils) that receives energy from the field of the primary is called the *secondary*. The two windings are placed on either a non-magnetic form (air core) or on a laminated steel form (iron core). Air core transformers are used at very high frequencies while iron core transformers are used at much lower frequencies. Figure 4 shows the schematic symbol for an air core transformer. Notice that the field generated by the current in the primary winding is cutting the turns of the secondary winding.

Figure 5 shows an iron core transformer. Notice that three parallel lines are placed between the windings to denote that an iron core was used. The phase relationship between the primary and secondary voltages of a simple transformer is dependent upon the direction of the

Figure 3: L-R time constant



windings and the arrangement of the connections. To indicate whether a phase reversal exists, dots are placed above or below the respective windings. Figure 5 indicates that there is no phase reversal between the primary and secondary windings. The absence of dots on the schematic symbol indicates a 180° phase difference between windings.

Because the coefficient of coupling between windings approaches 1, the power entering the primary winding is approximately the same value as the power exiting the secondary of a transformer. With this in mind, the secondary voltage or current may be stepped up or stepped down by simply adjusting the ratio of the turns between the primary and secondary windings of a transformer. This relationship is expressed by the following:

$$E_s = \frac{N_s E_p}{N_p}$$

or

$$I_s = \frac{E_p I_p}{E_s}$$

where:

N_p = turns in the primary winding
N_s = turns in the secondary winding
E_p = voltage in the primary winding
E_s = voltage in the secondary winding
I_p = current in the primary winding
I_s = current in the secondary winding

For example, what is the output voltage and current of a transformer having 10 turns in the primary and 20 turns in the secondary when 100 volts at 2 amperes is applied to the primary winding? Also show that the power in the primary is approximately equal to the power in the secondary.

1) $E_s = \frac{N_s E_p}{N_p}$

$= \frac{20 \times 100}{10}$

$=$ 200 volts

2) $I_s = \frac{E_p I_p}{E_s}$

$= \frac{100 \times 2}{200}$

$=$ 1 ampere

3) Power in = power out
2A × 100 V = 1A × 200 V
200 W = 200 W

The three most common types of transformers used in the electronic field today are:

1) *Radio frequency* (RF) transformers: These are used to couple circuits that operate above 20 kHz. They are wound

(Continued on page 42)

Figure 4: Air core transformer

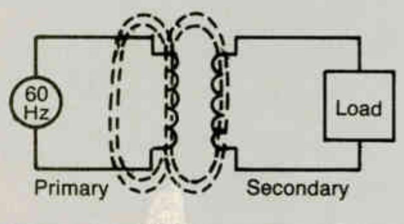


Figure 5: Iron core transformer

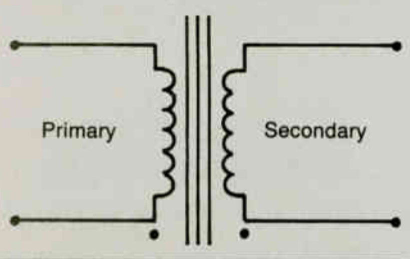
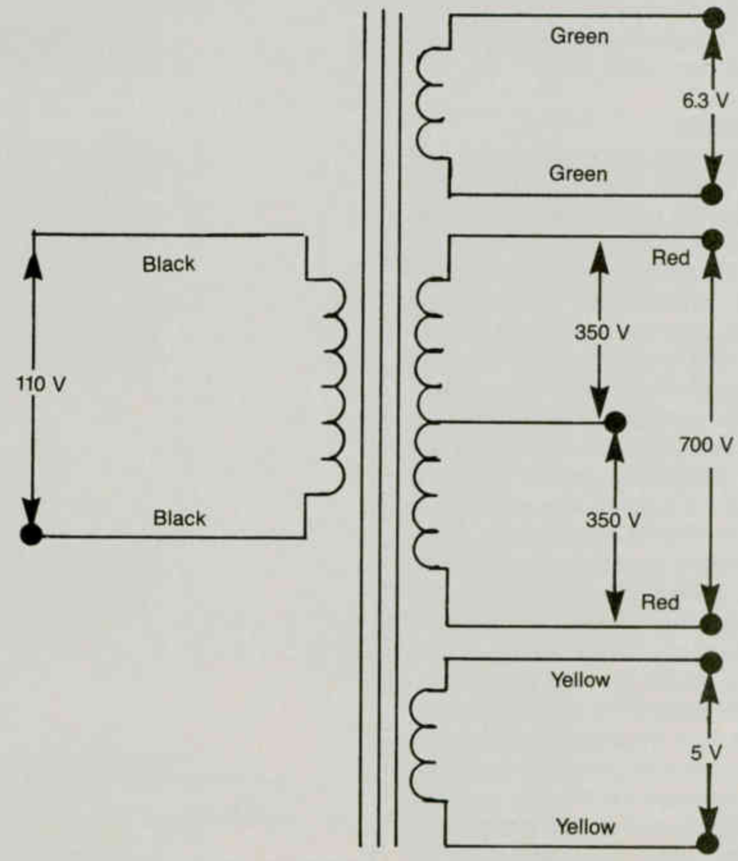


Figure 6: Power transformer with three secondaries



Installer Input

Sweeping and balancing a system

By Darrell Severns
Bench Repair Supervisor, United Cable of Colorado

A common scenario in the CATV industry is of an individual starting with the local cable company as an installer. After proving himself as an installer, he is offered the opportunity to become a service technician. With a minimal amount of training he is able to do a pretty good job by working hard and doing whatever is required to keep the system working to acceptable limits.

This was standard operating procedure for a number of years until one day system management decided to rebuild or to simply stop putting out fires by preventing them. The end result is the same—somebody needs to sweep and balance the system. The service tech is chosen because he is most qualified and, after all, he is able to learn quickly with a minimal amount of additional training.

So off he goes into the system with his trusty field strength meter and his new sweep equipment to sweep and balance the system. The only training he has received is instructions regarding input and output levels of amplifiers and which buttons to push on the sweep receiver to give him the display he needs. He doesn't ask what "sweep and balance" means because "sweep" seems obvious; the sweep equipment is used to sweep the system to determine its frequency response. The other part of the expression, "balance," eludes him, but he doesn't consider it significant as he eagerly goes about his new job.

It is unfortunate the tech described didn't have balancing explained to him, as an understanding of this concept would help him do a better, more effective job of setting up amplifiers. The balancing of an amplifier involves setting its operating levels to a point where carrier-to-noise (C/N) and distortions such as cross-modulation and composite triple beats are minimized. For every 1 dB increase in the operating level of an amplifier, C/N will improve by 1 dB. Conversely, with this improvement in C/N the distortions will become 2 dB worse. The input of an amplifier will have the same effect: For every 1 dB of increased input the C/N will improve by 1 dB but the distortions will become 2 dB worse.

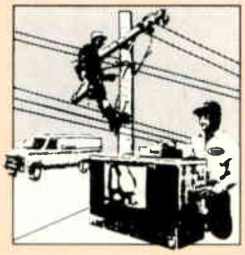
Typical C/N for a single station at recommended inputs is generally about −60 dB and distortions will be about −85 dB. Because of the way C/N and distortions add in cascade, it is possible to minimize their effect on the system by properly balancing each amplifier.

Operating trunk stations at their specified levels will provide high quality pictures as long as the input and output levels remain the same. Unfortunately, cable has more loss at high temperatures than at lower temperatures, so amplifier manufacturers must provide for some type of automatic gain control/automatic slope control (AGC/ASC) to compensate for changes. An AGC/ASC station properly set up will provide a constant output for a varying input due to temperature swings of 180° (−40 to 140°F). Thus, service calls related to temperature variations affecting the amplifier's distortions are minimized.

"Operating trunk stations at their specified levels will provide high quality pictures as long as the input and output levels remain the same."

The key to setting up an amplifier station is in selecting the proper pads and equalizers. This is even more important when setting up an AGC/ASC station. The different manufacturers have different methods of selecting pads and equalizers, so it is important to check the operator's manual for recommended procedures. Generally, the equalizer chosen should compensate for the amount of cable loss between stations. When added to the flat loss (pads, splitters or directional couplers), total loss at the highest frequency should equal the operating gain of the trunk station.

By not being fully informed, a technician could introduce bad pictures into subscribers' homes when his intent is the opposite. By knowing the causes and effects of improperly setup amplifiers, a technicians can make improvements instead of spinning his wheels. ■



Tech Tips

Do you get tired of searching through your work belt pouch for fittings, transformers, roka clips, etc.? A good way to keep these items at hand and organized is with a small plastic box with dividers like those used for assortments of nuts and bolts or fishing hooks. You also can purchase one that is empty. This box keeps several different fittings, a couple of transformers and roka clips separate and close at hand when you need them.

—Terry Leitschuck

Technical Review Committee

By Ray Rendoff
Technical Training Director
National Cable Television Institute

In this column last May I asked for volunteers to act as technical advisors, reviewing new technical course material on behalf of the industry. At the time I felt confident that many of you would step forward to share your knowledge and experience. And you didn't let me down. I've received numerous responses and have added many of you to our Technical Review Committee. Since you have been so gracious with your assistance, I thought it would be a good time to tell you a little about the committee, who the current members are and how they fit into our effort to create new lessons and update existing materials.

One of the overall objectives of the Technical Training Department at NCTI is to keep our current lessons up-to-date with cable TV's ever-advancing technology and actual field practices and procedures. To accomplish this my staff and I are constantly reviewing our existing courses and lessons, revising or deleting sections that are out of date and adding sections and lessons when changes warrant it.

In making these changes we face two primary challenges. First, the material has to be technically accurate. Second, it must reflect the way things can be done and are being done in the field. The latter is particularly tricky because company and system policies, electrical codes and the equipment and tools available to do your jobs all vary. In order to overcome these challenges we rely on input from a wide variety of general sources before turning the process over to the Technical Review Committee for its input.

The typical lesson production process begins with our Technical Training Department researching the subject and contacting any relevant manufacturers if the lesson covers a particular type of equipment or hardware. We request technical specification sheets, demonstration units, instruction manuals, black-and-white photos and names of technical support staff. At this stage we also begin soliciting input from system technical personnel with special expertise in the subject being covered. We also may take trips to local cable systems to take photos of installed equipment, actual installation or troubleshooting procedures, and to interview technical field staff. In this initial research phase we touch base with every available source to gather information on the subject. In a sense, all of these sources are technical advisors to us, in addition to those who comprise the Technical Review Committee.

Once the preliminary research is completed, Howard Newell, our instructional designer, organizes the material and prepares a draft of the lesson text, photos, illustrations, review questions and a glossary. This, too, is a crucial phase in the process. The best, most technically accurate material is worthless if it doesn't instruct well, easily, simply and in an interesting way.

Once the first draft is on paper and I've carefully reviewed it for completeness, accuracy, relevancy, grammar and instructional design, the Technical Review Committee is mobilized. Committee members receive a copy of the draft, copies of the accompanying illustrations and photos and an outline of the lesson. They, too, are asked to review it for clarity, accuracy, completeness, practicality and relevance. They mark the draft with their comments and corrections and return it to us. We incorporate the group's changes and, when time permits, return a second draft to select committee members before completing production and printing.

The production element in each of these steps has become easier recently due to desktop publishing. We now produce all of our course material, from initial text to final pages, including photos and illustrations, on two MacIntosh desktop publishing systems. This technology reduces the amount of time it takes to produce a lesson, thus lessons are more current when students receive them. It also allows us to send the Technical Review Committee second drafts that are very similar to the final look of the course. They can see the material the way a student will see it with nothing lost in the translation.

Jim Neil, plant manager for Multimedia Cablevision Inc., one of the most active members of the Technical Review Committee, said that incorporating input from actual field personnel makes the material feel more like "it's written by a technician for a technician." Neil said that when the NCTI sends him a draft of an installer-

(Continued on page 42)

Technical Review Committee Members

Neil Alexander
Production Test Supervisor
ComSonics

David Andrews
Regional Trainer
Warner Cable Communications

Ted Dudziak
Project Engineering Manager
Wavetek RF Products

Mike Holland
President
Pico Macom

Jim Kuhns
Owner
Broadband Services

Gerald Landis
Instrument Production Manager
Texscan Instruments Division

Jim Neil
Plant Manager
Multimedia Cablevision

Tom Prichard
Regional Engineer
Continental of St. Louis County

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Instrument Engineering Group Manager
Texscan Instruments Division

Barry Smith
R&D Lab Technician
Tele-Communications Inc.

Michael Smith
Director-Technical Services
Warner Cable Communications

Jerry Trautwein
General Manager
Prestige Communications

Steve Windle
Instrument Products Application Engineer
Wavetek RF Products

Temporary marking of underground facilities

By Ron Hranac
Jones Intercable Inc.

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidental damage or service interruption by contractors, utility companies or any others working on or near those underground facilities.

Use of markings: Use color-coded surface marks (paint or similar coating) to indicate the location, change in direction and dead ends of buried lines. To increase visibility, color-coded vertical markers (temporary stakes or flags) should supplement surface marks. All marks and markers should indicate the name, initials or logo of the company that owns or operates the line and the width of the facility if it is greater than two inches. If the surface over the buried line is to be removed, supplemental offset marking may be used. Offset markings should be on a uniform alignment and must clearly indicate that the actual facility is a specific distance away.

Location tolerance zone: Usually an excavation within the location tolerance zone must be performed with hand tools until the marked facility is exposed.

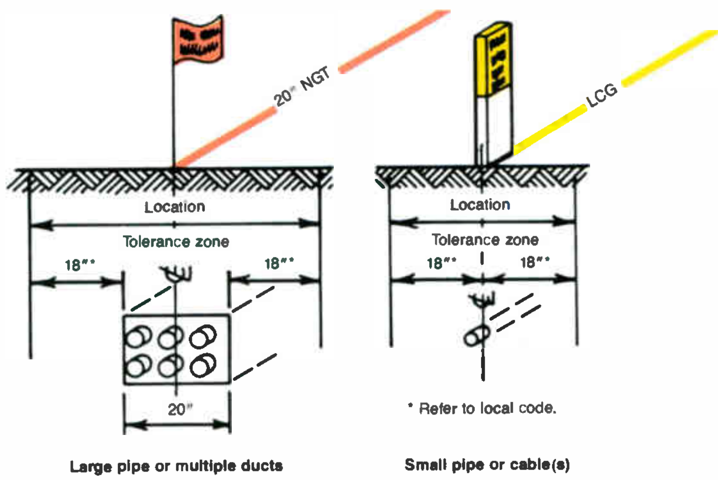
Proposed excavation: The location or the boundary of proposed excavations should be indicated in a color (usually white) that does not conflict with the Uniform Color Code.

One-call damage prevention systems: Existing one-call systems should be used to minimize damage to buried lines. Establishment of such systems is highly recommended.

Adopt uniform color code: The American Public Works Association encourages all its members to urge public agencies, utilities, contractors, other associations, manufacturers and all other groups involved in underground excavation to adopt the ULCC (Utility, Location and Coordination Council) Uniform Color Code shown below.

ULCC Uniform Color Code

Red: Electric power lines, cables, conduit and lighting cables.
Yellow: Gas, oil, stream, petroleum or gaseous materials.
Orange: Communication, alarm or signal lines, cable or conduit.
Blue: Water, irrigation and slurry lines.
Green: Sewers and drain lines.



Typical marking

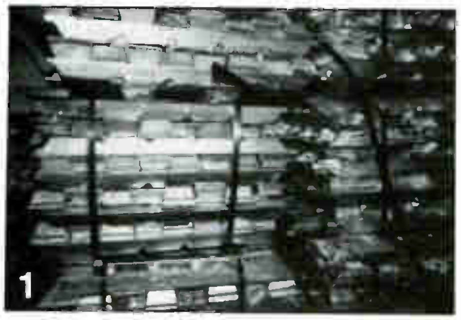
Data courtesy of APWA/ULCC Standards Committee. Pocket-size plastic cards with the above information may be obtained from American Public Works Association, 1313 E. 60th St., Chicago, Ill. 60637.

From the Manufacturer's Side

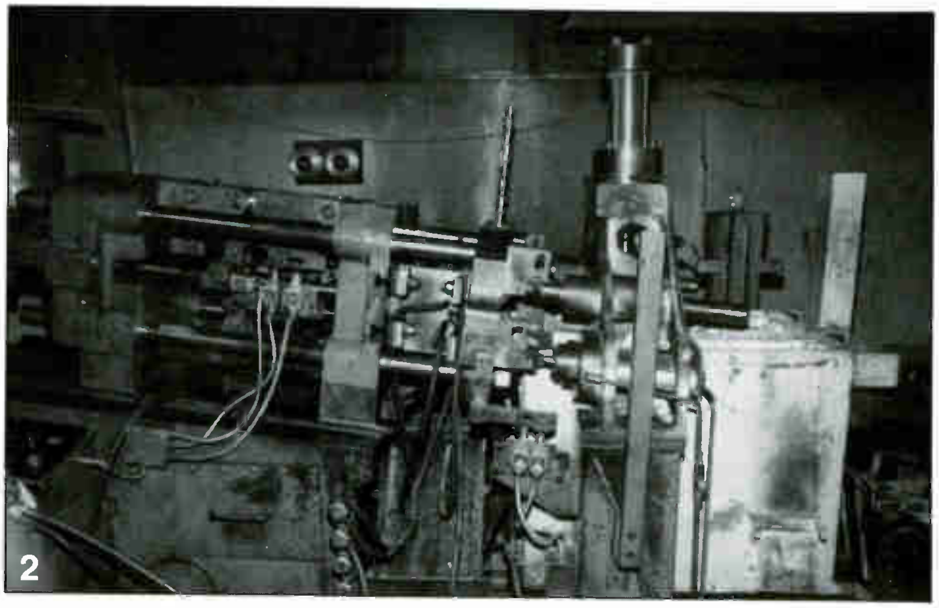
Production of splitters and directional couplers

By Michael Holland
President, Pico Macom Inc.

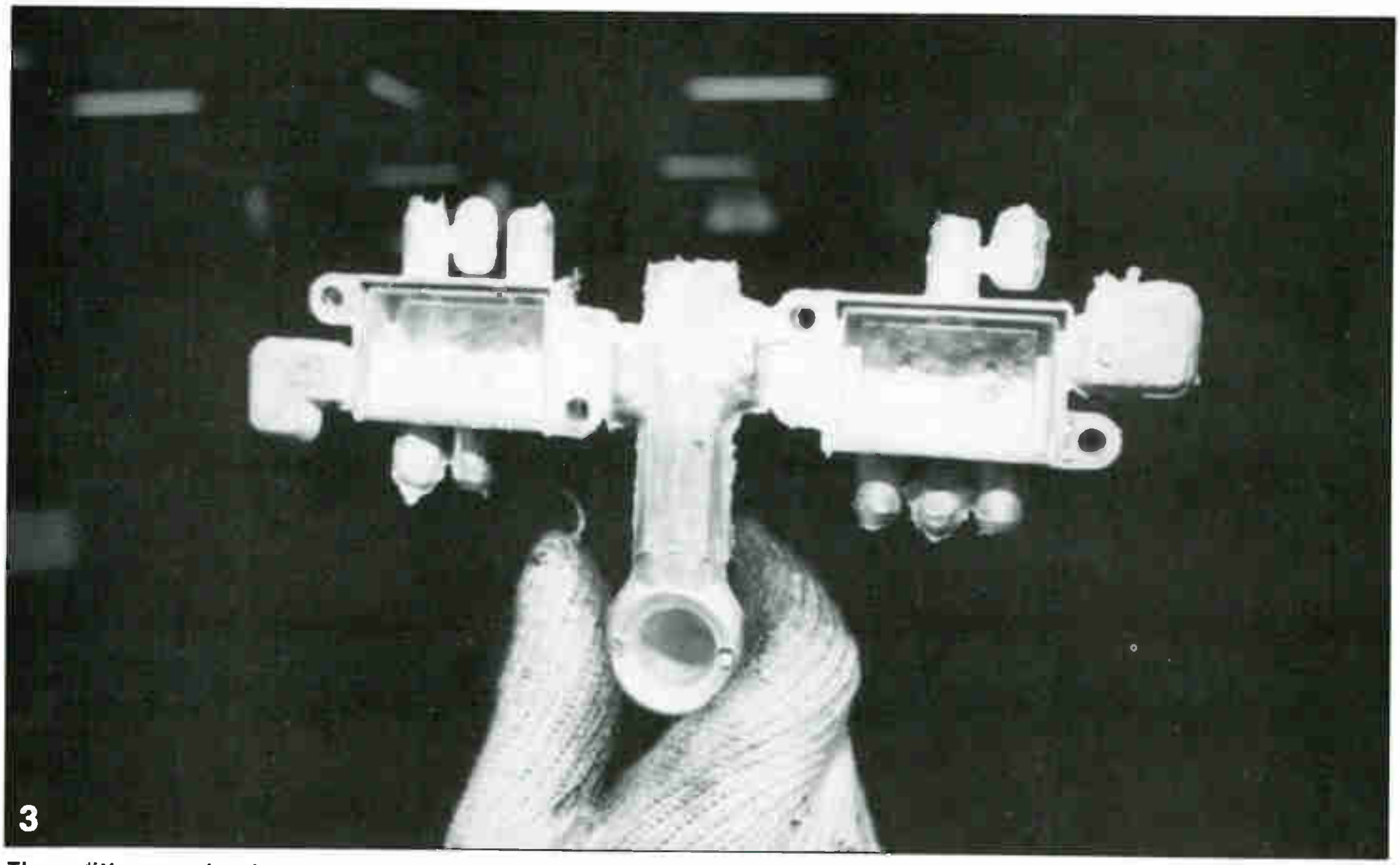
As was discussed in the two-part series on RF splitters (October and November 1988), passive devices are an often overlooked but an essential part of the CATV distribution system. These photos provide a look into the manufacturing process of splitters and directional couplers.



Splitter and directional coupler cases begin as solid ingots of zinc.



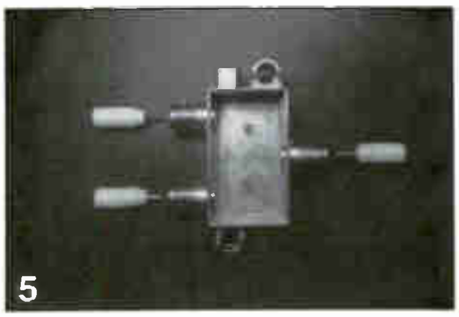
The zinc ingots are fed into a heated machine that melts the zinc and pours it into various molds shaped as splitters and directional couplers.



The splitter case begins as a piece out of a mold similar to that found in model airplane kits.

4

Each port of a splitter or tap needs to be threaded so the proper connector can screw on.



5

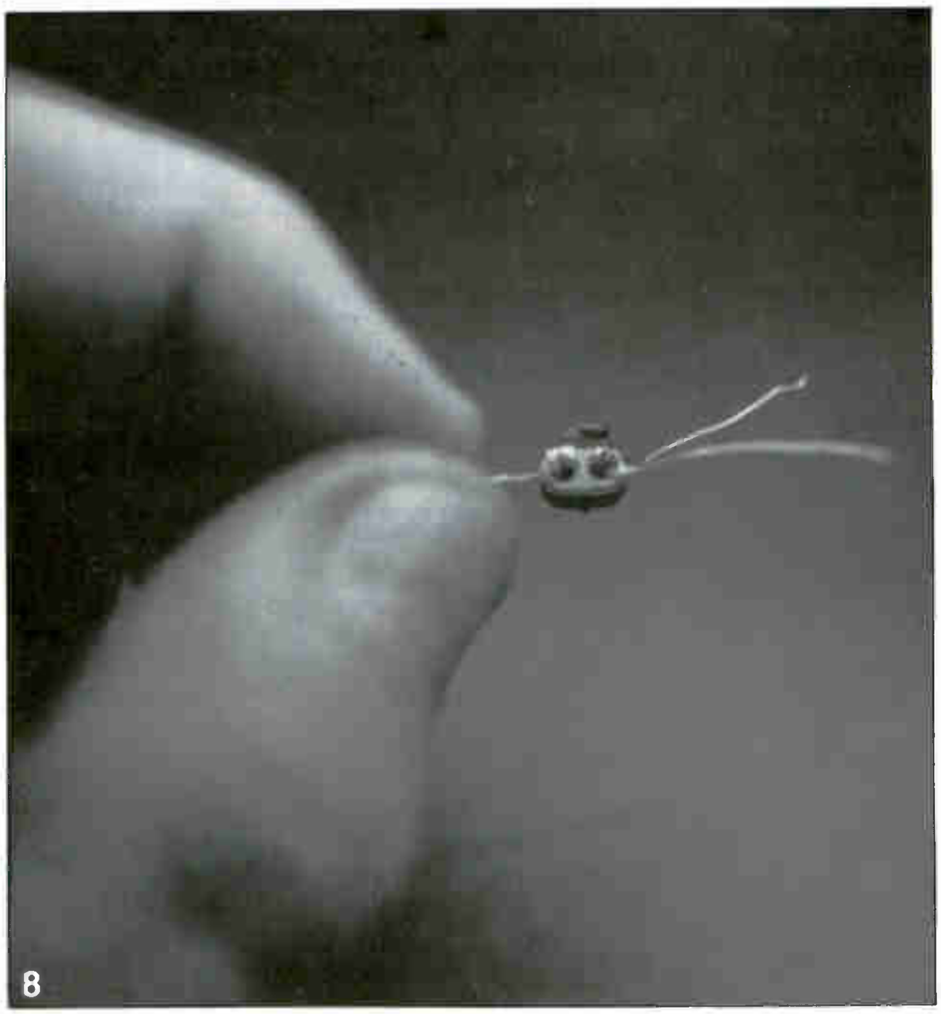
The pin and insulator are inserted into the open port hole of the diecast case.

6

After the inserts and pins are installed the ends of the splitter are staked down to hold them firmly in place.

7

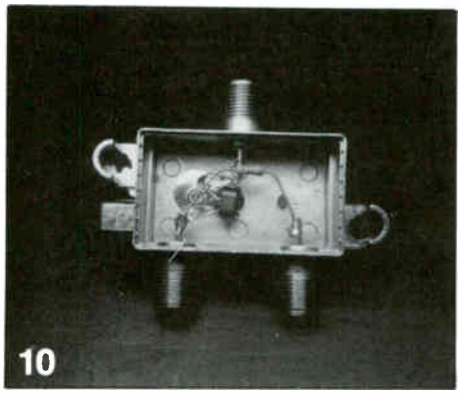
Assembly line workers install inserts into the cases.



8

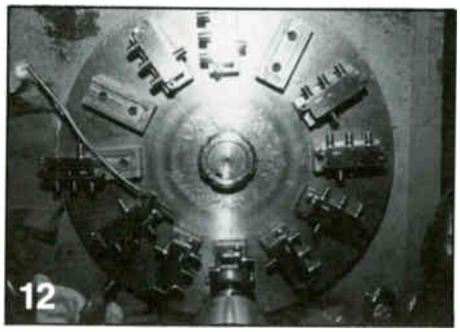
All splitters and directional couplers consist of ferrite beads or cores that are hand wound with many turns to provide the proper transformer action. →

The components for splitters and couplers are then soldered into the plated open diecast case.

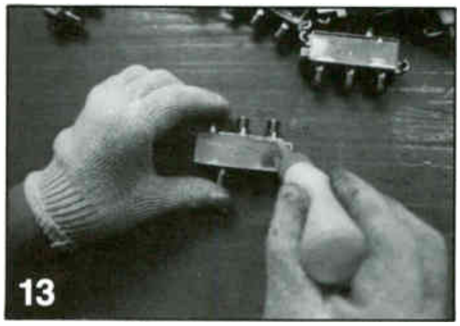


A completed discrete two-way splitter.

A higher quality printed circuit board two-way splitter.



After all the electronics are inserted a cover is staked on for firm physical and RFI fit.



Once the splitters have been tested and the cover staked, a final epoxy is placed for hermetic sealing between the cover and case.

Finally, the splitters are tested and aligned. ■

Business Directory

Products

Return loss bridge

Viewsonics introduced its new line of test equipment, including a return loss bridge. It has a frequency of 5 to 600 MHz, impedance of 75 ohms, a direct reading, directivity of 40 dB, bridge loss of 12.5 dB and short-open error of 1 dB maximum. It also comes with an RF termination, which has a frequency of DC-600 MHz, 75 ohm impedance and return loss of 40 dB minimum.

For additional information, contact Viewsonics, 170 Eileen Wy., Syosset, N.Y. 11791, (800) 645-7600; or circle #126 on the reader service card.

Drop saddle

Telecrafter Products introduced its Owsley drop saddle that replaces up to eight ty-wraps to improve the visual appearance and serviceability of drop cables exiting taps. The product is designed to keep drops organized for accuracy in audit control and to reduce time spent in service calls. It accepts RG-6, RG-59 and RG-59 quad cable and allows for expansion and contraction of cable without pinching or binding.

For more details, contact Telecrafter Products, 12687 W. Cedar Dr., Suite 100, Lakewood, Colo. 80228, (303) 986-7700; or circle #132 on the reader service card.

Fault locator

Riser-Bond introduced the Model 1210 time domain reflectometer cable fault locator for testing coaxial, twisted pair or any metallic paired cable. The instrument has adjustable velocity of propagation and output impedance settings. Digitized waveform, auto-distance calculation and fault severity are all displayed simultaneously. Opens, shorts, impedance discontinuities, faulty connectors, water problems and system components can all be tested with this unit.

For further details, contact Riser-Bond Instruments, 505 16th St., P.O. Box 188, Aurora, Neb. 68818, (402) 694-5201; or circle #131 on the reader service card.

Basic electronics theory

(Continued from page 32)

on a non-magnetic form and have a powdered iron core that can be moved in or out of the form to improve the performance of the transformer.

2) *Audio frequency* (AF) transformers: These are used in audio (sound) circuits that operate between 20 Hz and 20 kHz. AF transformers are usually wound as step-up.
3) *Power transformers*: These are used primarily in power supply circuits. A power supply circuit is used to change an AC voltage (usually 110 volts) to a DC voltage either higher or lower in value. Power transformers are generally large in size and have more than one secondary winding. Figure 6 is the schematic diagram of a power transformer with three secondaries.

Next month we will study one of the more common electrical components used in electrical and electronic circuits, the capacitor.

Test your knowledge

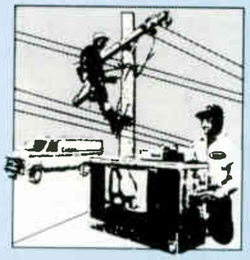
1) Define self-inductance.
2) State Lenz's law.
3) Explain a time constant.
4) What percentage of total current will be reached in four time constants?
5) What is the output voltage of a transformer having an input of 75 volts when the secondary has half the number of turns as the primary? ■

Correction

In last month's installment of "Basic electronics," the value "$I_M = 500\mu A$" in Figure 1 should be "$I_M = 50\mu A$." We regret any confusion caused by this error.

Answers

1) The property of inducing a voltage within itself by an inductor.
2) "The induced voltage in any circuit is always in a direction opposite to the effect that produced it."
3) The time it takes for a change of 63 percent in voltage or current.
4) 98 percent
5) 37.5 volts



Tech Tips

Have you ever gone to tag a drop with the house numbers and couldn't find all of the tag numbers in your tool box or thought you had enough numbers to make it through the day but guessed wrong?

Take 12 same-size cans (such as soup) and make two lines of six side by side. At the top of each can under the rim mark a spot so it lines up with the one behind it and another mark that lines up with the one beside it. Take each can and drill through the marks, making them large enough so wire or pop rivets will fit through them. Arrange the cans so the holes are lined up and fasten them together. When you're done you will have a 12-pack container that fits in your tool box or behind the truck seat and keeps house tag numbers at hand and separate so you always know when you need to stock up.

—Terry Leitschuck

From the NCTI

(Continued from page 34)

related lesson to review he frequently passes copies on to his installers for their comments. According to him: "In the field, people are often told how to do something but often they aren't told why. Learning why makes them better equipped to handle more diverse situations, and just makes them better at their professions."

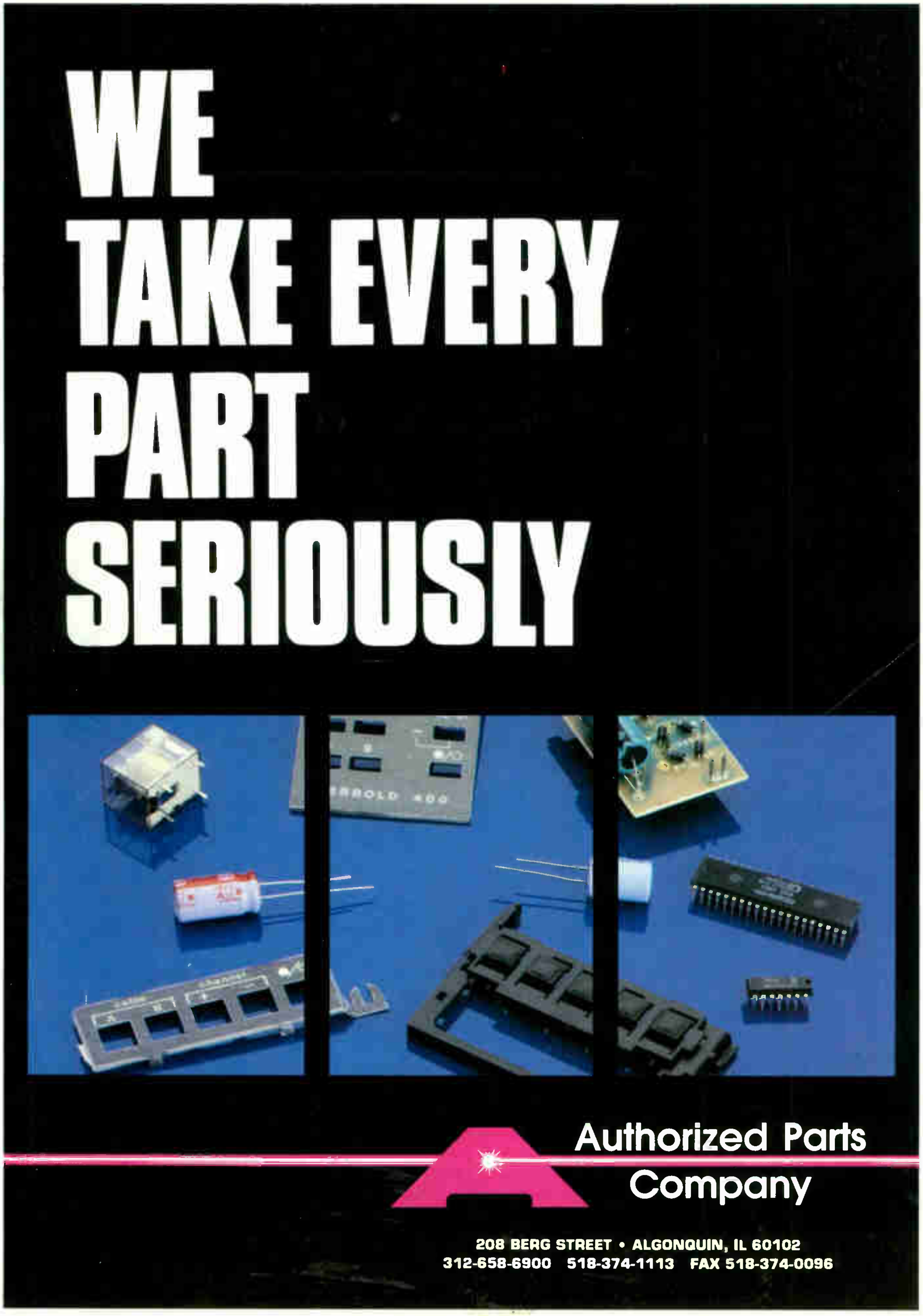
The committee also provides a very unique, day-to-day perspective to the lessons. For example, Neil was recently reviewing a lesson draft on signal leakage. That same day he was involved in a trouble call where a non-subscriber reported diagonal interference lines in the picture that was correctly suspected as being caused by leakage from the cable system. Relating the specifics of the troubleshooting and repair procedures Neil followed allowed us to incorporate that very practical perspective into the material.

For Jim Kuhns, an engineering veteran of several cable systems and currently owner of the contracting and consulting firm Broadband Services, incorporating a variety of input from field sources provides NCTI courses with the perspective of many different ways of performing the same task. "Most things can be done several different ways," Kuhns said. "One may be right in one system in one geographic area but may not be right in another system in another area.

"I've gone from System A to System B and found that System B did 75 percent of the things differently," Kuhns continued. "Local codes can be different. Engineers can see things differently. What's an acceptable procedure for one person may not be acceptable for someone else. By getting a lot of different views of it, the NCTI knows how far it can go without injecting an engineer's personal opinion. From there you can tell students they need to incorporate their own system's procedures on a task."

While there is a tremendous wealth of experience and expertise represented by the current Technical Review Committee, we are always in need of additional volunteers to add their input. Looking ahead to revisions and new lessons planned for 1989, in particular I will need help from people with experience in MDU installation and design, and post-wire and prewire troubleshooting of subscriber drop problems. If you would like to serve on the committee, or to just make yourself available as an informal source, give me a call at (303) 761-8554. Your knowledge and experience can be a valuable resource both for future NCTI students and for the industry as a whole. ■

Ad Index



Reader Service Number 20.