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Official trade journal of the Society of Cable Television Engineers

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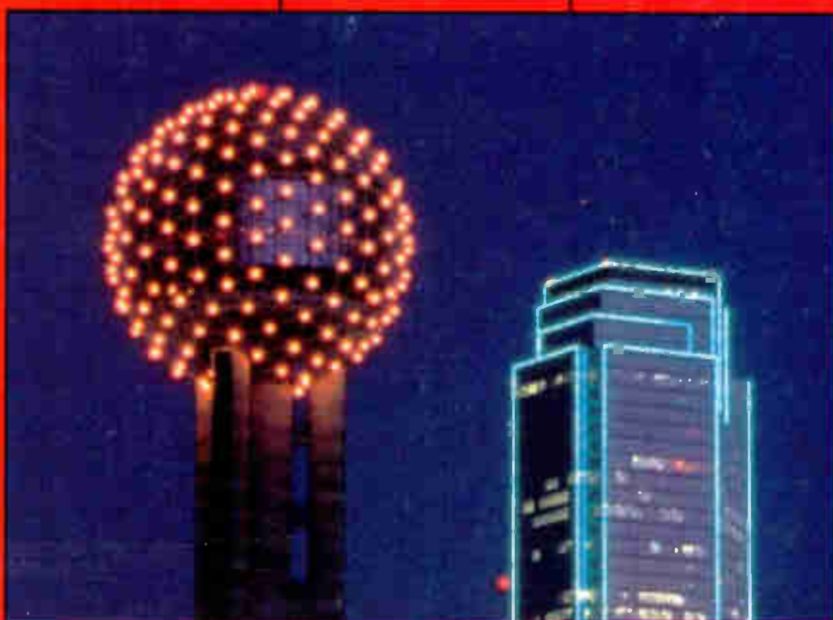

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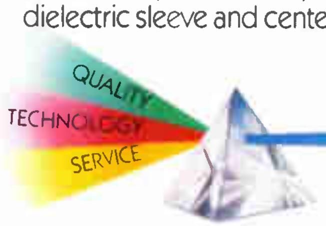

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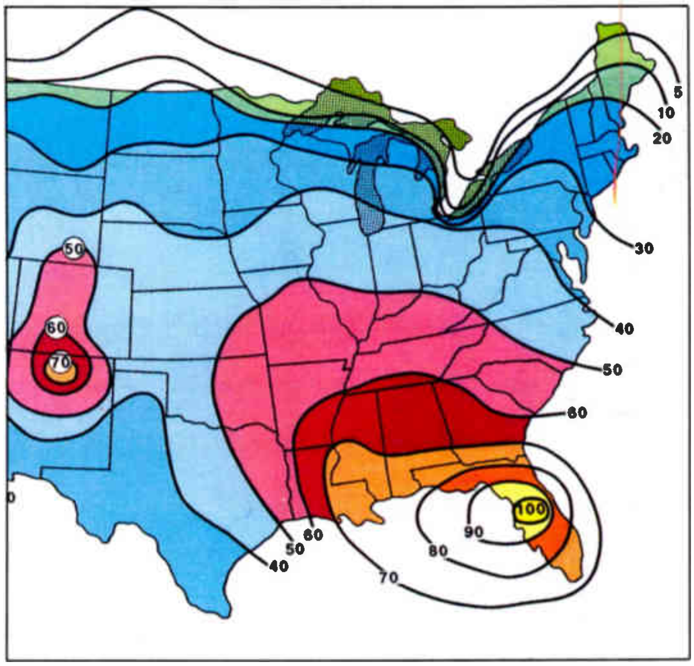

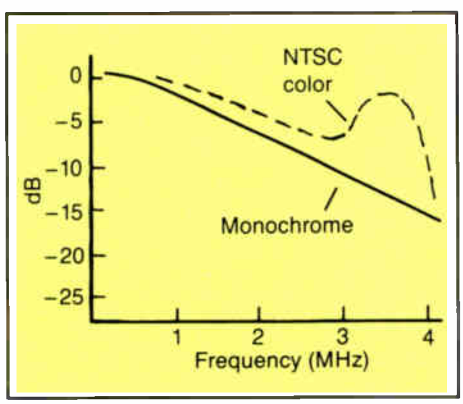

Features

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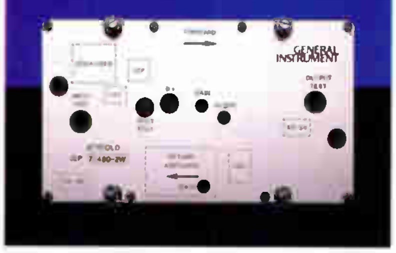
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EDITOR'S LETTER

Notes from all over

Some of our roving (and one raving) staff members have been out and about. Here are their reports:

Dateline: Englewood, Colo.—The SCTE Rocky Mountain Chapter presented a seminar on fiber optics April 19. And while we usually don't report on local events, this one was somewhat special. For perhaps the first time anywhere, representatives of some of the major MSOs gathered in one room at Jones Intercable to present what their companies were doing (or planning to do) vis a vis fiber. Speakers included Jim Chiddix, Dave Pangrac and Dave Maholick (ATC), Richard Rexroat (TCI), Bob Luff (Jones) and Paul Barth (United). Among the over 80 attendees were visitors from New York, Chicago and elsewhere.

Dateline: Manlius, N.Y.—Marty Laven (our vice president of sales and marketing) and I received a personal invitation to tour the facilities of Magnavox CATV Systems. We also had plans to take a sneak peek at the Spectrum 2000 amplifier housing, to be unveiled at this month's National Show. The ways in which Magnavox emphasized quality control made quite an impression on us, as did the SMD (surface mount device) machine. But it was the people who made the difference. Thanks go to Dennis Horowitz, Dieter Brauer, Dick Swingen, Keith Weil, Walt Srode, Jeff Cox, Al Kernes, Yvonne Jordan and everyone else at Magnavox for an eye-opening experience.

Dateline: Old Bridge, N.J.—Blonder-Tongue Laboratories' Chairman Ike Blonder and President Ben Tongue recently sold the company to a closely held investment group. The group will retain the Blonder-Tongue name and rights; it intends to continue to operate and develop the business from its headquarters here. James Luksch was named president and Robert Palle Jr. became executive vice president.

Dateline: Dallas—The National show aka Cable '89 (and this year's second Texas show) convenes here May 21-24 at the convention center. This is the really big one, where conventioneers roam the exhibit floor asking, "Is this new?" Several vendors have promised some exciting additions to their product lines, including breakthroughs in expanded bandwidth and AM transmission over fiber.

Of course, there are the technical sessions, always insightful and never boring. Some of the topics for the 10 sessions (held two at a time) are: Cable Labs, HDTV transmission, addressability and pay-per-view technologies, audio, fiber architectures, system powering, HDTV testing and signal leakage. At the NCTA/SCTE booth, you'll get another chance to see the IS-15 multiport in action. And don't forget to stop by the NCTA membership and publications booth to buy a copy of the *1989 NCTA Technical Papers* and other useful reference materials.

Dateline: Orlando, Fla.—It's not too late to make plans for the Cable-Tec Expo June 15-18 at the Orange County Convention Center (even though you might have missed the May 12 preregistration deadline). This year's expo will be extra special because the SCTE will celebrate its 20th anniversary during Expo Evening at Sea World.

Here's the rest of the lineup: On Thursday, June 15, the Annual Engineering Conference will feature a panel on high definition TV and guest speakers to discuss digital video, cable vs. telco and fiber optics. The annual membership luncheon, also on the first day, will feature guest speaker Paul Weitz, deputy director of Johnson Space Center.

Expo workshops and exhibits will take place Friday and Saturday. Workshop topics will include fiber-optic test measurements, signal level meter basics, data transmission techniques, supervisory and management fundamentals, signal leakage and CLI, local origination, AM fiber transmission, and installer certification. During exhibit hours, several vendors will present product-specific equipment usage classes. (And CT Publications will presents its first "Painless Technical Writing" workshop Saturday afternoon; call us for details.)

Finally, on Sunday, the SCTE will offer BCT/E Certification Program testing. Tours of local fiber-optic installations—BellSouth's Heathrow and Cablevision of Central Florida—also are planned for the last day.

No fooling this time

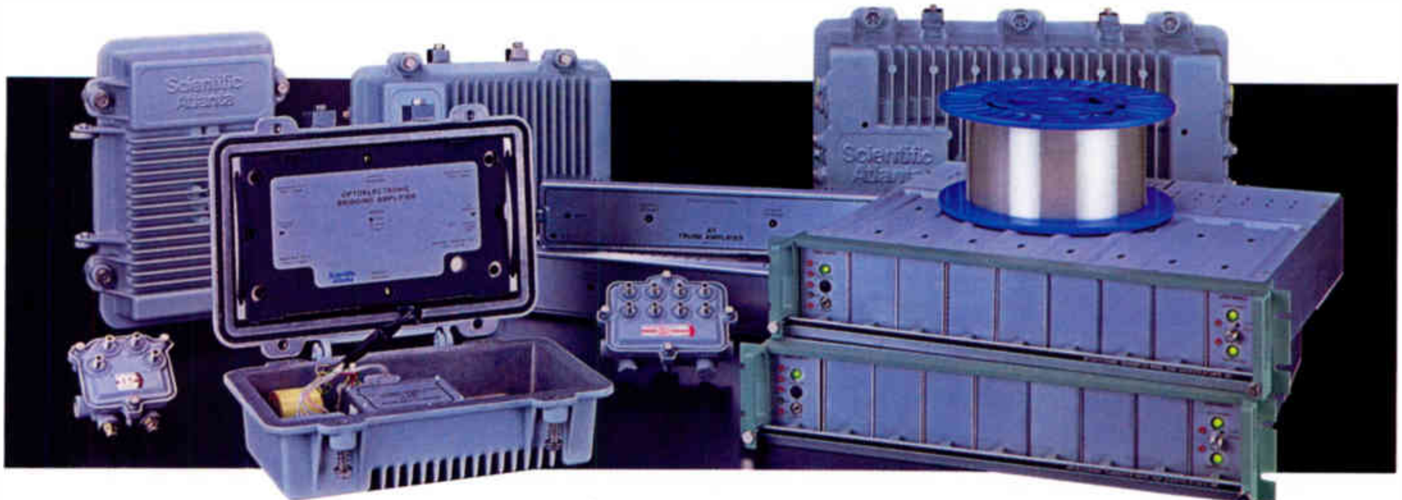
'Fess up: Weren't you just a bit unnerved at last month's "News" story: "Congress repeals Cable Act of 1984"? Right, the one you were relieved turned out to be an April fool's joke. And to everybody who panicked and phoned us before reading through to the punchline, we're sorry. We've learned our lesson; we won't pull a fast one on our readers again (perhaps until next April).

Since we're on the subject of hypothetical headlines, try this one (from our September 1990 issue): "FCC shuts down system due to excess leakage." As we all know, the deadline to report the results of your cumulative leakage index testing is July 1, 1990. And CLI is a hot topic these days, possibly hotter than fiber and HDTV. Usually, seminars about CLI and signal leakage (like the recently concluded NCTA series) pack 'em in.

Here's the irony: If your system is a fairly large one and if you were to start today to implement your ground-based CLI program, you might just meet the deadline. In any case, be sure to catch our annual leakage issue in July. We'll discuss flyovers, software, help from ham operators, FCC guidelines and much more. After all, your business will depend on what you do (or don't do) about leakage in the next 12 months or so.

Rikki T. Lee

Do You Know The Difference Between Telephone And CATV Fiber?



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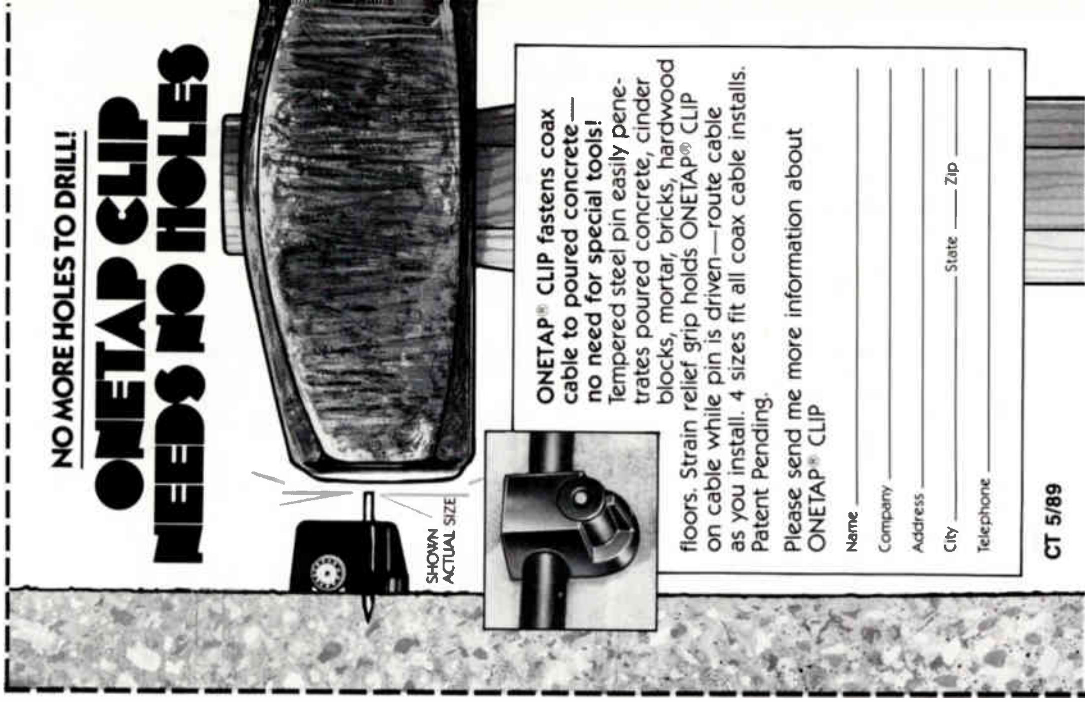

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Cable '89 to feature 10 technical sessions

DALLAS—Cable '89, the 38th annual convention of the National Cable Television Association, will be held here at the Convention Center May 21-24. Ten technical sessions will run two at a time from Monday, May 22 through Wednesday, May 24 in Rooms A and B of the West Ballroom, as follows:

Monday, May 22
2-3:30 p.m., Room A
● Cable Labs
Moderator: Walt Ciciora (American Television and Communications Corp.). *Speakers:* Jim Chiddix (ATC), "Fiber-optic issues"; Tom Elliot (Tele-Communications Inc.), "Operation issues"; Nick Hamilton-Piercy (Rogers Cablesystems), "Advanced television system testing"; Tom Jokerst (Continental Cablevision of St. Louis County), "A review of the Cable Labs consumer electronics interface subcommittee"; and Ed Callahan (United Cable Television Corp.), "Technologies for new businesses."

Room B
● HDTV transmission implications
Moderator: Wendell Bailey (NCTA). *Speakers:* Gerald Robinson (Scientific-Atlanta), "Selected topics on HDTV: A tutorial on the basics"; Joseph Waltrich (Jerrold Applied Media Lab), "The pros and cons of maintaining NTSC compatibility for advanced television systems"; Ron Horchler (Warner Cable Communications), "Relative cost implications for implementing ATV proponent systems in a CATV system"; and Carl Eilers (Zenith Electronics Corp.), "Simulcasting with the Spectrum-Compatible ATV System."

4-5:30 p.m., Room A
● Addressable and PPV technologies—Special deliveries
Moderator: Ed Callahan (United Cable). *Speakers:* Richard Merrell (Zenith), "An autodialer approach to pay-per-view purchasing"; Lamar West (S-A), "Off-premises technology comparisons"; Marc Kauffman (Jerrold Applied Media Lab), "Timing considerations in RF two-way data collection and polling"; Jim Chiddix (ATC), "Off-premises broadband addressability: A CATV industry challenge"; and Yili Zhao (TDF Lorraine Research Center), "A digital coding system for video signal to distribute video monitoring images on coaxial networks."

Room B
● Operational improvements in existing cable systems
Moderator: Michael Jeffers (Jerrold). *Speakers:* Blair Schodowski (S-A), "Improved method for video inversion scrambling systems"; Patrick McDonough (United), "The technical performance review—What needs to be done?"; Reed Burkhart (Hughes Communications Galaxy), "Cable headend polarization alignment concerns during peak sunspot cycle"; and Mark Adams (S-A), "Advanced system upgrade requirements and design."

Tuesday, May 23
7:30-9 a.m., Room A
● Audio—Alive and well and getting better!
Moderator: Frank Ragone (Comcast Cable Communications). *Speakers:* Ned Mountain (Wegener Communications), "Audio 101—Television audio—A *systems* issue for cable"; Joseph Stern (Stern Telecommunications Corp.), "A flexible spectrum efficient transmission system for digital cable audio"; James Green (Jerrold Applied Media Lab), "Delivering digital audio"; and Alex Best (Cox Cable Communications), "BTSC stereo measurement techniques and operating practices."

Room B
● Fiber-optic architectures
Moderator: David Large (Raynet). *Speakers:* Nick Hamilton-Piercy (Rogers Cablesystems), "Rogers fiber architecture"; John Mattson (S-A), "A fiber-optic design study"; John Fox (British Telecom Research Labs), "Evolution of the British Telecom switched-star cable TV system"; Lemuel Tarshis (Jerrold), "An economic assessment of AM fiber-optic applications"; and David Robinson (Jerrold Applied Media Lab), "Switched-star fiber-optic architectures for cable TV."

9:30-11 a.m., Room A
● System powering
Moderator: Bert Henscheid (Texscan Corp.). *Speakers:* Larry Lindner (Alpha Technologies), "Establishment of battery standards for CATV standby powering"; Jeffrey Cox (Magnavox CATV Systems), "Data collection for status monitoring systems"; Peter Deierlein (Magnavox), "CATV system powering considerations"; and Tom Osterman (Alpha), "New approaches to CATV system powering."

Room B
● HDTV testing
Moderator: Ted Hartson (Post-Newsweek Cable). *Speakers:* Rene Voyer (Communications Research Centre, Government of Canada),

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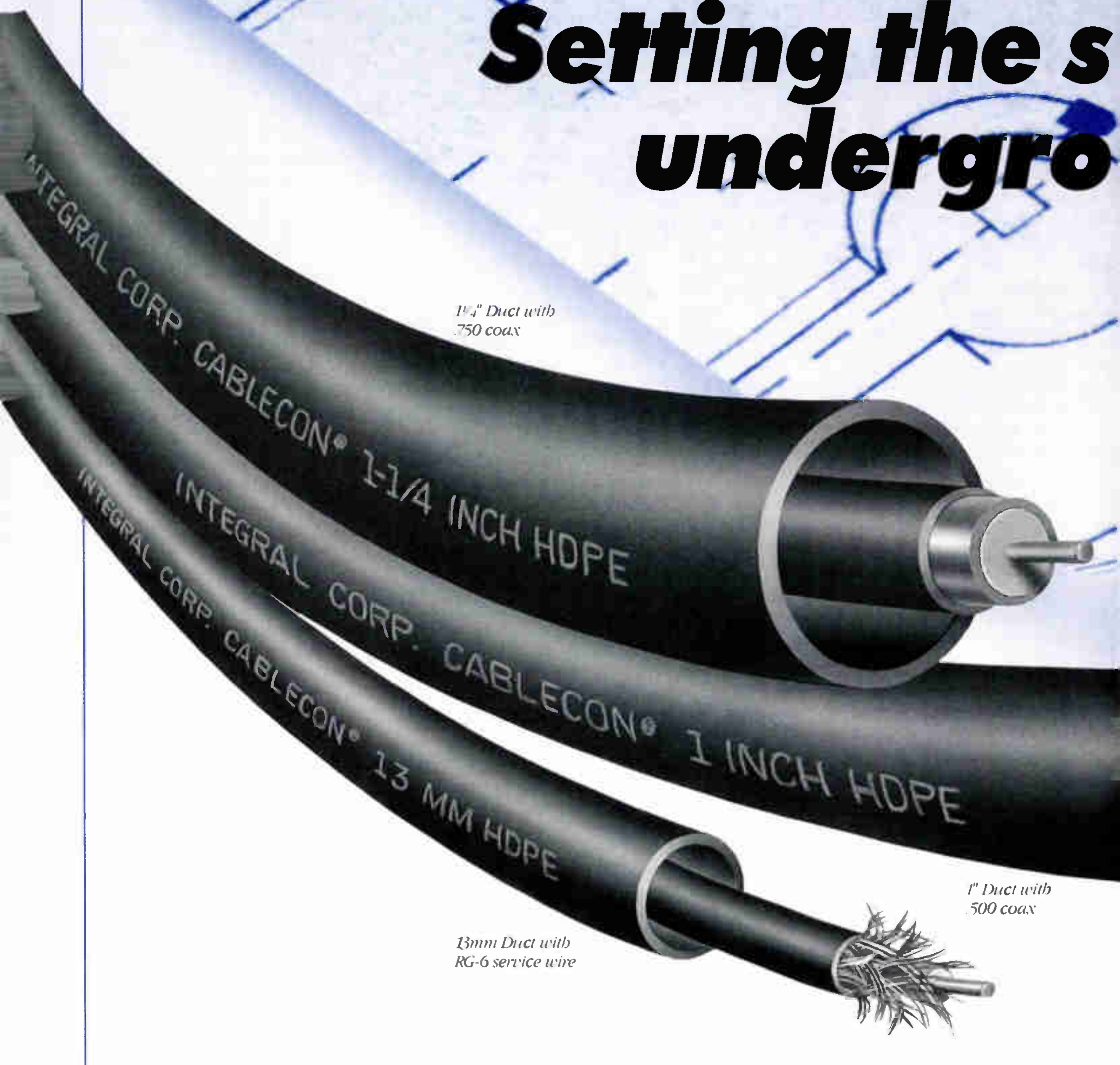

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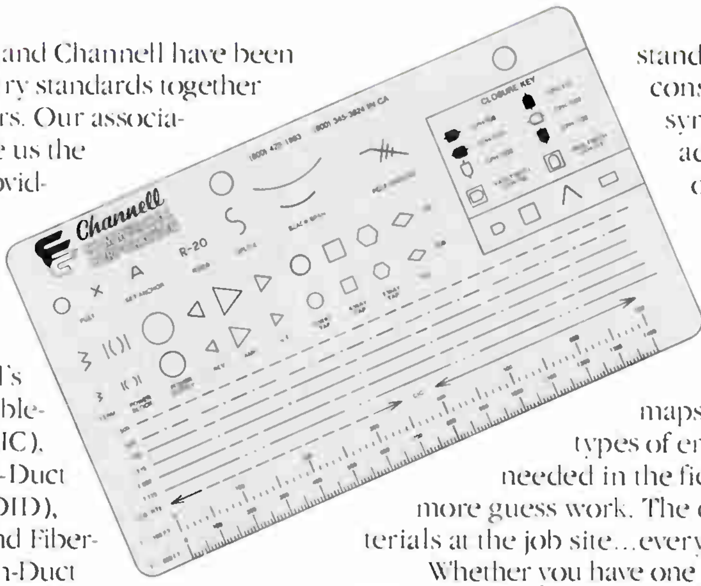

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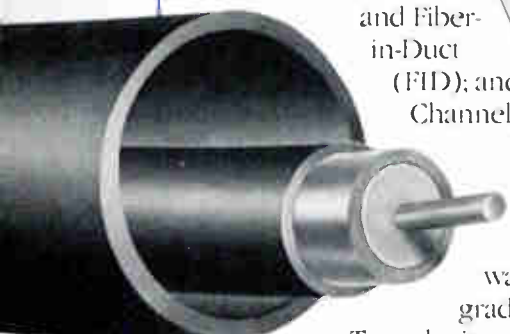

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"HDTV cable tests: Method of measurement"; Dave Wachob (Jerrold Applied Media Lab), "Design considerations for an advanced TV test facility"; Tim Homiller (Jerrold Applied Media Lab), "Noise measurements for a CATV system—C/N, S/N, phase noise"; Dan Pike (Prime Cable), "The effects of reflections"; and Brownen Jones (ATTC/Cable Labs), "HDTV picture quality tests: Methods of measurement."

Wednesday, May 24
9-10:30 a.m., Room A

- Measuring cable system leakage

Moderator: Robert Dickinson (Dovetail Systems Corp.). *Speakers:* Ted Dudziak (Wavetek RF Products), "Antenna considerations for controlling cable system leakage"; Chris Duros (CableTrac), "Interpretation of airborne leakage data"; Steven Biro (Biro Engineering), "Advances in CLI flyover measurements—The helicopter approach"; and Bob Saunders (Sammons Communications), "CLI measurements for large systems."

Room B

- Recent developments in AM fiber

Moderator: Joseph Van Loan (Consultant). *Speakers:* Rezin Pidgeon (S-A), "Performance of AM multichannel fiber-optic links"; David Grubb III (Jerrold Applied Media Lab), "AM fiber-optics trunks—A noise and distortion analysis"; Carl McGrath (AT&T Bell Laboratories), "Multichannel AM fiber-optic CATV trunks—From lab to reality"; Ernest Kim (TACAN Corp.), "Method for including CTBR, CSO and channel addition coefficient in multichannel AM fiber-optic system models"; and David Pangrac (ATC), "Fiber backbone: Multichannel AM video trunking."

Cable '89 agenda

Monday, May 22
7:30 a.m.-5:30 p.m.—Registration open
9-11 a.m.—Opening general session
11 a.m.-5 p.m.—Exhibit hall open
11 a.m.-2 p.m.—Exclusive exhibit hours
2-3:30 p.m.—Technical sessions
4-5:30 p.m.—Technical sessions
5-6:30 p.m.—Welcome party

Tuesday, May 23
7:30 a.m.-6 p.m.—Registration open
7:30-9 a.m.—Technical sessions
9 a.m.-5 p.m.—Exhibit hall open
9:30-11 a.m.—Technical sessions
11 a.m.-2 p.m.—Exclusive exhibit hours
2-3:30 p.m.—General session
5:30-8 p.m.—System ACE celebration

Wednesday, May 24
7:30 a.m.-3 p.m.—Registration open
9 a.m.-1 p.m.—Exhibit hall open
9-10:30 a.m.—Technical sessions
10:30 a.m.-1 p.m.—Exclusive exhibit hours
1-3 p.m.—Closing general session and lunch
6:30 p.m.—Gala dinner dance and awards

Society membership elects new directors

EXTON, Pa.—The Society of Cable Television Engineers recently filled seven open seats on the national board of directors as a result of ballots received from SCTE members. Re-elected were At-Large Directors Richard Covell (General Instrument/Jerrold Division) and Bob Luff (Jones Intercable), Region 1 Director Pete Petrovich (Petrovich and Associates), Region 2 Director Ron Hranac (Jones) and Region 6 Director Bill Kohrt (Kohrt Communications). Newly elected to the board are Region 9 Director Jim Farmer (Scientific-Atlanta) and Region 11 Director Pete Luscombe (TKR Cable).

More than 1,500 returned their ballots, 30 percent of total membership. For a comparison of this and previous Society elections, see "President's Message" on page 100.

TCI proposes plan for new digital HDTV

WASHINGTON, D.C.—At a recent hearing of the Committee on Science, Space and Technology of the U.S. House of Representatives, John Sie, senior vice president of Tele-Communications Inc., suggested that the country set a goal of achieving processed digital TV by the year 2000. This would include reliance on 6 MHz NTSC-compatible analog-based high definition TV (HDTV) until then.

(Continued on page 124)

A critical look at CLI

By Isaac S. Blonder
Chairman, Blonder-Tongue Laboratories Inc.

One of these days, newspapers from coast to coast could feature in big, black front-page headlines: "Head-on crash high in the skies—hundreds dead—spurious cable radiation, says FAA," or, "Plane overshoots runway—10 killed, 30 survivors—pilot blames cable interference." What will be the reaction to these events by the public and the regulators? No doubt about the answer; the Federal Aviation Administration, who has absolute authority over the frequency bands between 108-136 MHz and 225-400 MHz, will order the immediate shutdown of every cable system in the country until it has proof positive that no excessive emissions in the aircraft bands emanate from the cable system.

Impossible? Don't bet on it; would the regulator rather face the reaction of the cable industry or that of the general public screaming at its congressional representatives? Will the FAA be satisfied with the present CLI (cumulative leakage index) rules about to be enforced on July 1, 1990? In my opinion it will declare Docket 21006 incapable of preventing further disasters and will demand absolute abdication of the aircraft frequencies until an infallible monitoring program is proposed, tested and installed. Years could pass under this agenda.

What's wrong with CLI as specified by the Federal Communications Commission? To a simple question, a simple answer—it is shot full of holes and permits excessive leakage.

Hole #1: Only 75 percent of the cable plant has to be inspected.

Hole #2: A flyover inspection of the entire plant need be commissioned only once a year, which allows leakage 364 days in the year a chance to interfere with the aircraft communications.

Hole #3: If I had to visualize an imprecise, unreliable measurement technology, nothing beats the FCC cable van proceeding at an illegal speed of 20 mph on a heavily traveled road, unable to maintain the prescribed distance of three meters from the cable, certainly violating the requirements to rotate the antenna in order to maximize the signal level, plagued by other vehicles and variable ground reflections. (At this point, I will take a deep breath and confess that in my six years as president of a small MSO, I could never find electronic technicians who could be lured from their TV repair business to endure the drudgery of the cable world. We would have been unable to staff the survey vehicles with sufficiently skilled operators to have any confidence in the readings. Since 17 years have passed, maybe you lucky chief engineers can rest easy in your office, knowing that your well-trained and dedicated scientists can convince the FCC and the FAA that your CLI is "bombproof"!)

"According to Docket 21006, no leakage measurements or frequency shifts need to be made if signals are set below 38 dBmV."

Hole #4: A system's CLI figure of merit could be 64 or more just from one large emission reported by one of the technicians, but left uncorrected for days at a time.

Overcoming the holes

The bottom-line price to conduct a year-round FCC quality CLI and leakage monitoring program for a 10,000 subscriber cable system seems to be around $200,000. This figure could be considered as the rough equivalent of a $2 million capital expenditure. Thus, I would like to propose two alternative methods for overcoming the holes in the FCC surveillance plan, utilizing the sum of $2 million, more or less.

Plan I: Set up permanent monitoring antennas at the highest points in your system. Each position consists of a high-gain, dual Yagi capable of an excellent front-to-back ratio in each of the two aeronautical bands. The antenna is mounted on a rotator that digitally transmits its polar position. Low noise figure receivers also transmit digitally coded signal levels into a modem that is connected to the cable or telephone. A central computer is programmed to instruct each antenna in turn to complete a 360° search pattern. Each antenna, depending on height, could monitor up to a radius of two miles. As many as 50 such sites may be advisable. Once it is programmed with the location and signal strengths of each antenna, the computer can then deliver a relatively precise measurement of all leaks and their triangulated positions. It should take no more than one hour to deliver the map at a negligible cost compared to the flyover or the instrument-equipped van. Good solution?!

Plan II: According to Docket 21006, no leakage measurements or frequency shifts need to be made if signals are set below 38 dBmV. A typical CATV trunk level is usually safely below 38 dBmV, so there is no change here. The bridger amplifiers and line extenders will need to be limited to 38 dBmV. Obviously, more stations will be needed, but I doubt that any of the vital signal-to-noise figures and distortion levels will suffer. In fact, I vaguely remember the time when 9 dB gain amplifiers were promoted as the means to deliver the highest quality cable TV picture. If the rebuild doesn't cost more than $2 million, the chief engineer is a hero, the human resources manager can take a vacation and the FCC crosses you off their books. Happy days are here again!

Too much hype over optics?

By Gary Kim
Special Correspondent

As the CATV industry gathers for what is bound to be the most technically exciting National Show in more than half a decade, top CATV technologists are urging that our excitement for truly promising new tools be tempered by a healthy dose of realism and continued respect for time-tested RF techniques that are far from obsolete.

Indeed, top engineering minds in CATV are a bit divided on the promise of fiber optics, although they are united on what makes it interesting. While some are convinced that optical technology can revolutionize CATV's business prospects, others worry we may be rushing headlong into a trap. There's some apprehension about just how fast AM (amplitude modulation) technology can advance, how soon digital modulation techniques may begin to challenge FM (frequency modulation) on both the signal quality and cost parameters and whether we may be inadvertently falling into a public relations trap.

To summarize the positions, optical technology proponents rightly target fiber's most interesting physical property: transmission line loss about 90 percent less than coaxial cable. That makes possible achievement of certain other technical goals that almost certainly will be key business requirements in the days ahead: delivery of more reliable, higher quality signals and possibly (although this isn't the current driving force) more channels to customers. Optical technology also may facilitate newer system architectures that achieve these goals, while allowing for a flexible migration to switching topologies if and when these make business sense.

But some experienced technical leaders are worried, not about CATV's ability to incorporate optics—because it's just a tool. Rather, they question the political implications of a rapid and uncritical embrace of optical technology. They aren't sticking their heads in the sand, either. They were around when the industry jump-started the TVRO business within a period of two to three years, becoming the nation's largest user of earth stations after the military.

So it isn't the technology they object to; it's the hype. Here's the basic line of argument: Telephone industry lobbyists have done a rather good job of convincing governmental leaders and most of the popular press that optical technology is up-to-date, modern, the technical foundation for economic progress in the 21st century, the key to unlock untold communications treasures for the average consumer and the only way to carry high definition television (HDTV). Part of this public relations campaign has involved the portrayal of RF technology delivered over coax as old-fashioned, technically obsolete and incapable of carrying either HDTV or the higher channel capacities that fiber optics allows.

Rushing madly and uncritically into optical technology plays right into this "RF is obsolete" trap, some fear. With the possible exception of a cascade failure caused by the first amplifier, the best mainstations of today don't fail very often. The mean time between failure can be 12 years or better. So outage control may not be a terribly good reason to deploy fiber.

And some contend that if the industry is better served by 600 to 700 MHz technology, we can expect to achieve this using RF. It wouldn't take much to push the technology along. Annual sales of hybrids in CATV probably run in the $7 million to $8 million range. How much investment would it take to get 1 GHz hybrids, based on existing microwave technology, into the field? Not nearly as much as the industry already is spending to push optical technology along, the reasoning is. Are we abandoning scientific rigor in a mad rush to beat off a "fiber is glamorous" challenge and keep investors happy? Some think so.

Bandwidth improvements

But if you listen carefully, proponents of fiber also are tying its introduction to new bandwidth improvements in RF amplifiers, HDTV-compatible passives (basically, devices that will pass 1 GHz) and optical-to-RF conversion at various distances from the home. If, in fact, there's been too much hype, it's coming more from telephone industry PR types and honest but possibly misguided journalists than from top industry technologists.

But this month's NCTA convention may offer comfort for almost everybody. Mainstation vendors will be announcing platforms for pushing RF technology from the current 550 MHz to 750 MHz or 1 GHz, while taps are being retooled to handle 1 GHz. All coaxial cable manufactured over the past five years or so already is swept out to 1 GHz, although it may be certified only to 600 MHz. Systems may have to be redesigned to run with more headroom, at higher levels, with shorter cascades and be fitted with components having better return loss, but there seems to be no particular reason why RF technology cannot and will not be upgraded to meet higher channel loading and better signal requirements.

You'll see more RF equipment designed to interface with optical gear and continued advances in AM optical and codec technology, which over time will pressure our traditional FM optical technology from both ends. Digital will challenge FM on quality while AM pressures FM on cost. Designers will continue to experiment with evolutionary architectures for tree-and-branch while further thinking on how to secure and control services at the subscriber level continues.

So make no mistake; RF technology isn't dead yet. It isn't as limited as some of its detractors make it out to be or the tidal wave we journalists sometimes make it out to be. But CATV operators would be silly to rip out vast investments in plant because of a drumbeat of publicity. And they won't. Fiber is a great tool for maximizing the value of investments we've already put into the field. Especially as RF technology is pushed to match it. And fiber optics that work with RF will increasingly make its way into actual products,

"There seems to be no particular reason why RF technology cannot and will not be upgraded."

some of which will be on the floor at the National Show.

But the industry also has demonstrated its commitment to pushing technology and operations forward on a number of fronts, not limited to fiber. We should be more aggressive about telling that story while we experiment with fiber technology on a quicker pace.

There still may be lots of people who believe the industry should roll over and play dead since it can't compete technically in the 21st century. Not that we'll escape unscathed. There are bound to be some disappointments along the way. Things won't work as well as we want or cost what we want, at least at first. There are bound to be twists and turns and we're going to stumble now and then. That may be part of the price we pay now to build 21st century networks that serve 21st century customers.

I believe we'll get there in good shape, having already survived a few scrapes and bruises. But we all should understand that the game we're

Courtesy Times Fiber

playing is for the long term. The so-called "telco threat" is nothing more than life in this competitive world we all live in. It is not nearly as dangerous tactically, in the short term, as some have painted it. But it is important strategically because no business is immune from competition anymore.

That doesn't require rolling over and playing dead or running hysterically to and fro, screaming and shouting. Competition doesn't require that the industry react to everything a potential competitor or ally does. It does require that you know where you want to go and have a plan for getting there—then do it.

In the good ol' summertime

This is the first of a two-part series on preventing lightning-related outages in CATV plant. Part II will discuss tower protection.

By Roy Ehman
Director of Engineering, Jones Intercable Inc

For many people, the "good ol' summertime" conjures up visions of lazy, carefree sunny days in pleasant surroundings like the countryside, a river or a beach by the sea. For a dedicated CATV engineer or technician, it's a very different picture. By the time May has run its course, Mother Nature will start to throw some "tantrums." These will be in the form of lightning of increasing violence and frequency, peaking in most parts of the United States in July and August. However, according to a spokesperson for the National Center for Atmospheric Research in Boulder, Colo., "lightning can occur at any time."

In many cases lightning will cause outages due to burnt amplifiers and fuses. Since outages are (by most surveys) the first or second cause of subscriber dissatisfaction, they have to be repaired as rapidly as possible under the worst conditions by regular or standby personnel. This becomes a real nightmare when the outages occur in several different places at once and the storm is of long duration.

So what is lightning?

Lightning is a physical phenomenon that exists because of the parameters inherent in the creation of the atmospheric system. In order to deal with those parameters we must understand them, then design a system that will either eliminate them altogether or prevent the damage from them. The lightning stroke characteristic is a statistical function that varies over a wide range of values as typified in the accompanying table.

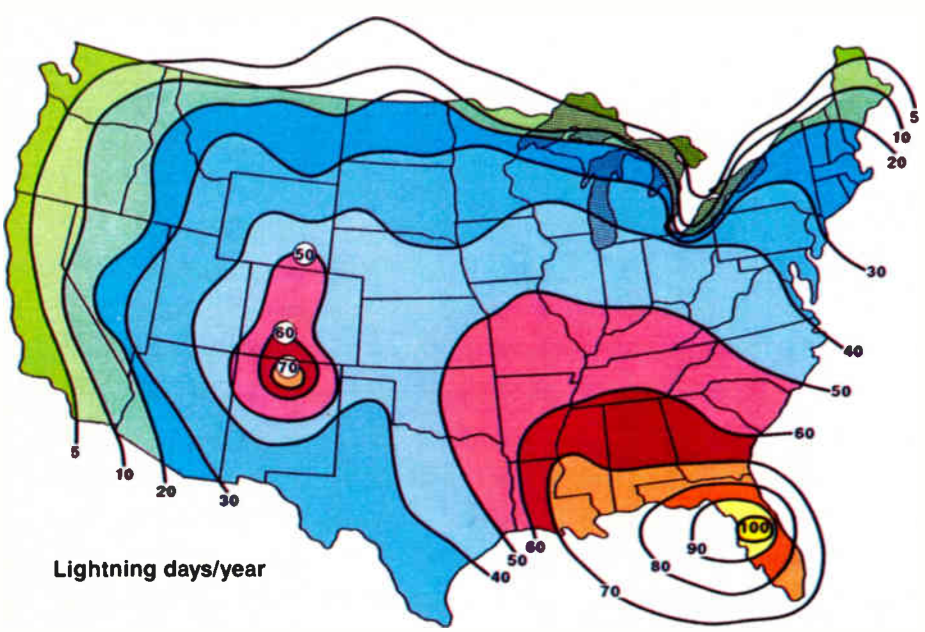
"When you are talking thousands of amperes or volts, there is really no such thing as a ground."

Lightning strike statistics

Total charge transferred	2 to 200 coulombs
Peak currents	200 to 400,000 amperes
Half value time duration	10 to 250 μs/stroke
Current rise time to 90 percent	4 or 5 ns to 30 μs
Time between strokes in one flash	3 to 100 ms
Number of strokes per flash/strike	1 to 26 (average < 4)

Note: A *flash/strike* is defined as the ionized channel resulting from the lightning discharge. It may conduct from one to 26 or more strokes before it clears.

Figure 1: U.S. isokeraunic map



Designed by Chris O'Neil, Jones Intercable

The exposure to lightning hazards is given by a parameter called the "keraunic number." The higher the number, the greater the exposure for the area under consideration. For instance, the keraunic number in the United States varies from a low of 1 around Alaska to a high of 100 in central Florida (the lightning capital of the country). In the tropical parts of Africa and Central America it gets as high as 260! The isokeraunic map (Figure 1) is like the topographical maps with which we are all familiar except that the equal magnitude contours indicate the statistical number of lightning days per year. Typical values for the bulk of central United States are from 40 to 60 (which means 40 to 60 lightning days per year).

There are an average of 30 storm days per year for the United States and, of course, many strokes can occur during a single storm. Studies have shown that there can be between eight and 11 strokes per square mile, increasing to between 28 and 37 strikes per square mile in central Florida. Using this type of information the IEEE Subcommittee on Lightning[1] calculated that a 50-mile stretch of high voltage transmission line in central Florida should receive 1,500 strokes to the line phase conductors and/or static wire, of which 225 will exceed 80,000 amperes—all in one year.

There are two ways to protect your systems. 1) Remedial: Protect the plant from the effects of strikes or the pulses induced into the plant from nearby strikes. 2) Prevention: Design to prevent the charge building up and therefore prevent the possibility of a stroke. In the case of outside trunk and distribution plant, this is not only impractical because of the huge distributed area but it is also unnecessary since the power lines are above us.

Under the remedial approach we need to consider the mechanism of how the plant gets burned up, then find a way to eliminate or neutralize it. This has been previously studied[2] so let us review it very briefly.

First, it must be made clear that we are not talking about direct strikes to the plant. Thank goodness, as long as we are below the power and telephone wires it very seldom happens. When it does it is catastrophic and the game is over. (I have seen a 1-foot section of 3/8-inch stranded copper ground wire completely vaporized.)

In Part II, you'll see a dramatic shot of lightning striking a tree. Tree sap is a good conductor and is instantly vaporized to a large volume

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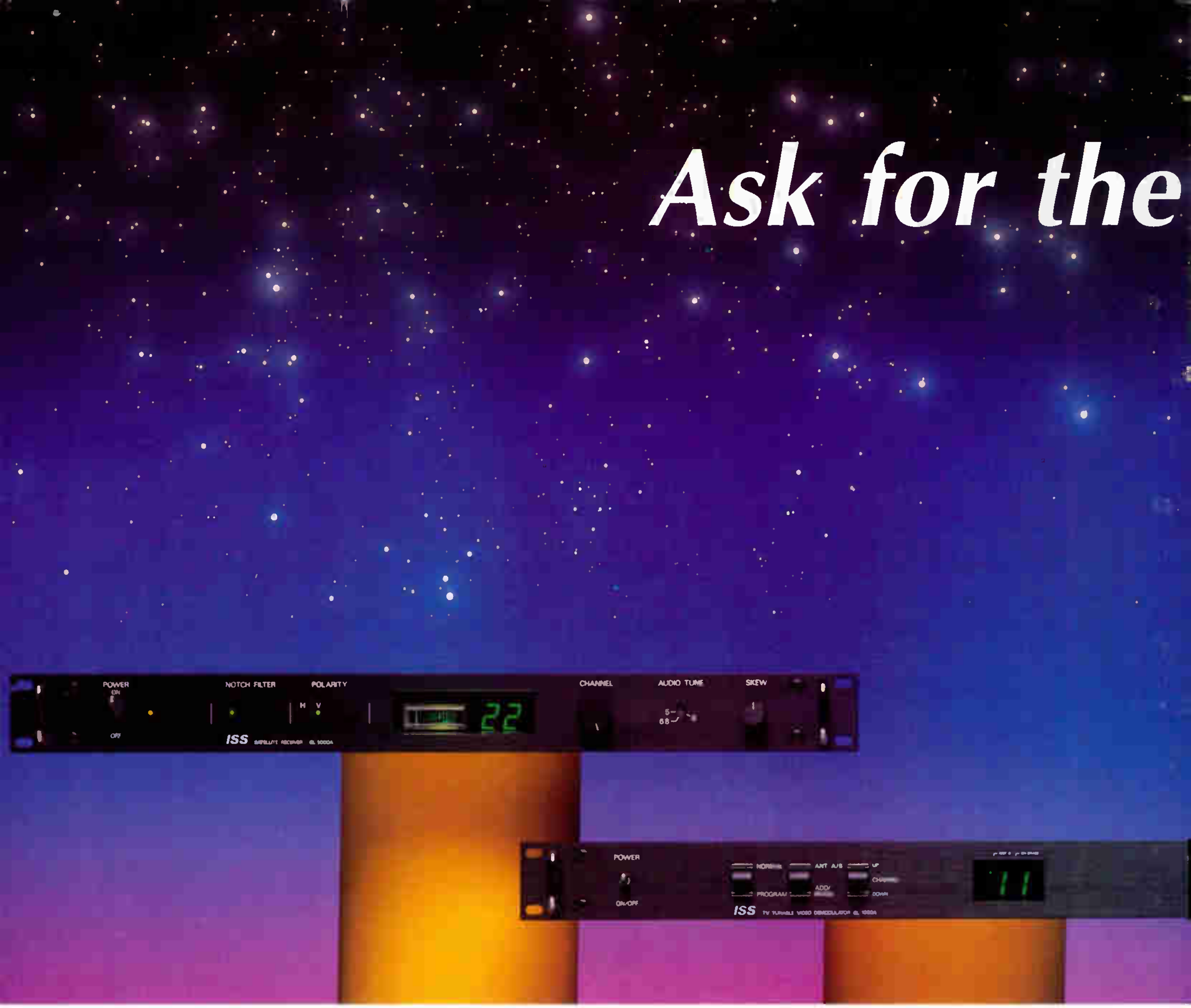

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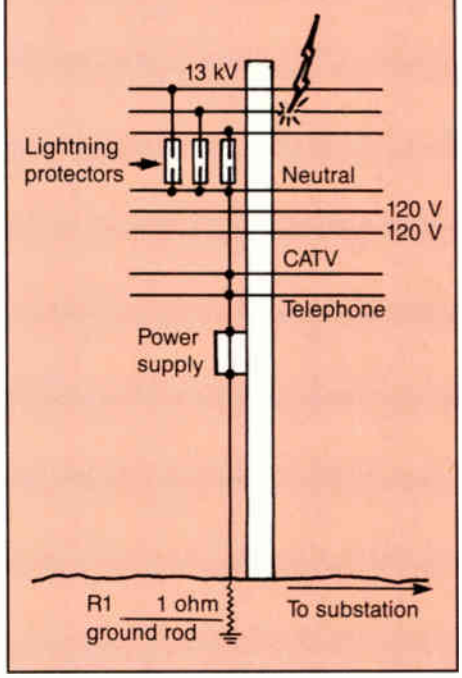
Figure 2: Lightning strike directly to the plant



of steam, frequently causing the tree to explode. If you were standing too near you would be filled with "bark shot." In this picture appears a "streamer" (or "leader," as it is more properly called) going upward from the power line. This leader is the precursor of the actual strike; it is busy forming an ionized path for the lightning to come down.

This leads us to one mechanism for plant damage that is easy to follow. The lightning strikes the power line (Figure 2) and jumps the horn-gap protectors, forming an ionized conducting arc that the power immediately follows. The lightning stroke itself tries to find ground by whatever path it can and the power tries to find a way back to the power substation or power plant. The fact that the system and/or power company has an 8-foot ground at the pole makes little difference. When you are talking thousands of amperes or volts there is really no such thing as a ground.

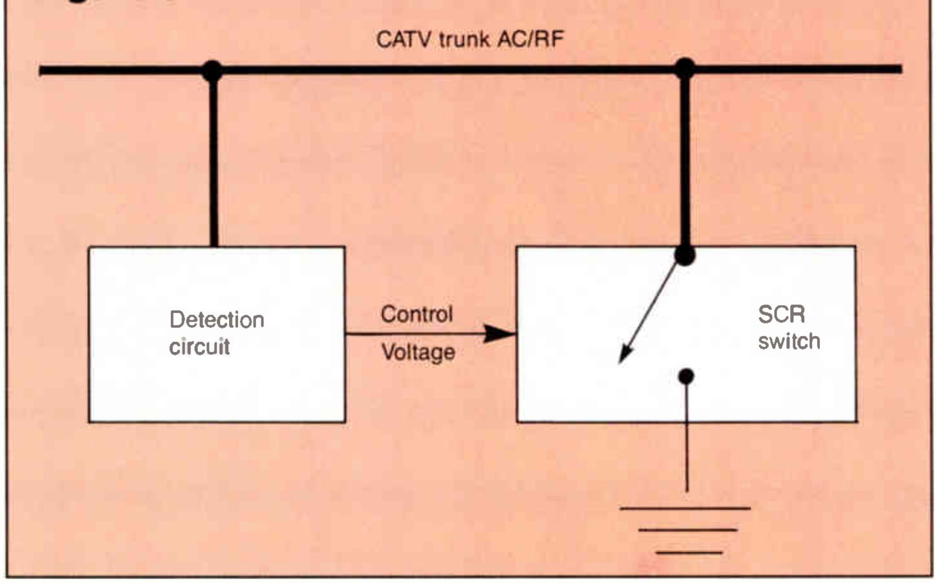
Suppose you had an absolutely marvelous ground of 1 ohm (which you probably don't); try thinking about 10,000 amperes going to "ground" through that 1 ohm and you will start to get a feeling for what is happening out there. Typical 8-foot grounds, unless very special types[3], run anywhere from 10 to 100 ohms or more. To this must be added the substantial impedance of the ground wire itself due to the rapid rise time of the lightning stroke. We will be further ahead by thinking of plant grounds as tapping points on a low value resistor. The special grounds referred to are capable of achieving low resistances over long periods of time in difficult soils. (This will be discussed in Part II.)

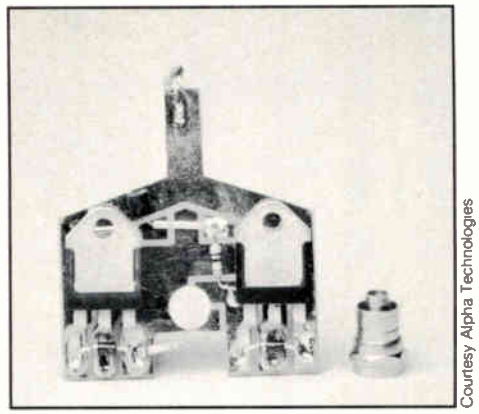
Where does the current go?

So where does all this high current driven by high voltage go? It splits between all the available conductors, including our strand and cable, which are about equally conductive. The coax ends up conducting anything up to 2,000 amperes for as much as 16 to 160 ms until the power company circuit breakers can break the power arc. Small wonder that fuses and amplifiers burn up. This way of getting into the coax has nothing to do with the 60 volt power supply, standby or otherwise; it is completely bypassed. Regardless of the way dirty power, spikes, transients or just plain gross overvoltage enters the plant we end up with one very clear fact: Our center conductor carrying our power now has continuous or instantaneous overvoltage, which can and does blow fuses and amplifiers. What to do?

Well, since that overvoltage has to exist between the center conductor and the sheath in order to damage plant components, we could insert a device symbolized by a switch as in Figure 3. This device would monitor the instantaneous voltage on the center conductor and within nanoseconds of an overvoltage of, say, 90 to 100 volts occurring it would switch the center

Figure 3





The AmpClamp shunts coax to sheath within a few nanoseconds.

conductor to ground for the rest of the 60 Hz half-cycle. Under these conditions no harmful voltages can exist. But doesn't that short the power supply out? Doesn't that eliminate the power going to the amplifiers? The answer to both questions is yes. Let's talk about each question separately.

First, the power supply doesn't care. All presently available 60 volt power supplies can operate indefinitely into a short circuit whether on standby or not. (If your supplies won't do that, you have the wrong kind.) Since the power supply is a ferroresonant unit with a saturated core, a 15 ampere supply limits at about 22 amperes and operates that way into a short forever. Full service comes back the instant the short is removed.

Second, one of two things will happen:

a) The transient overvoltage will go away within two or three cycles. Since amplifiers will operate for about 100 ms on their stored energy, the dip in power will probably not be noticeable.
b) If the flashover persists beyond, say, 100 ms, the power company breaker will interrupt the power. Then the 60 volt power supply will flip to standby in about 4 ms or, if it is not a standby type, the plant will die anyway. In either event the question becomes academic. Even if there were a bump in the pictures, wouldn't this be far better than a one-hour outage to be fixed in foul weather, not to mention the repair bills?

In our example we talked about a direct strike to the power line. In actual fact there need not be a direct strike. If lightning strikes within one-fourth to one-half mile there will be anything from four to 26 pulses of current of from 10,000 to 400,000 amperes (from accompanying table). This situation can properly be considered a gigantic one-turn air core transformer. Large potentials and currents are actually induced into every single conductor in the vicinity, including our cable plant. These minor pulses may not always knock out the plant but semiconductor junctions may be partially perforated. After this occurs, the junctions continually erode—causing increasing impairments—and finally fail some hot summer day for what appears to be no apparent reason.

Enter the AmpClamp

The AmpClamp was built for my company by

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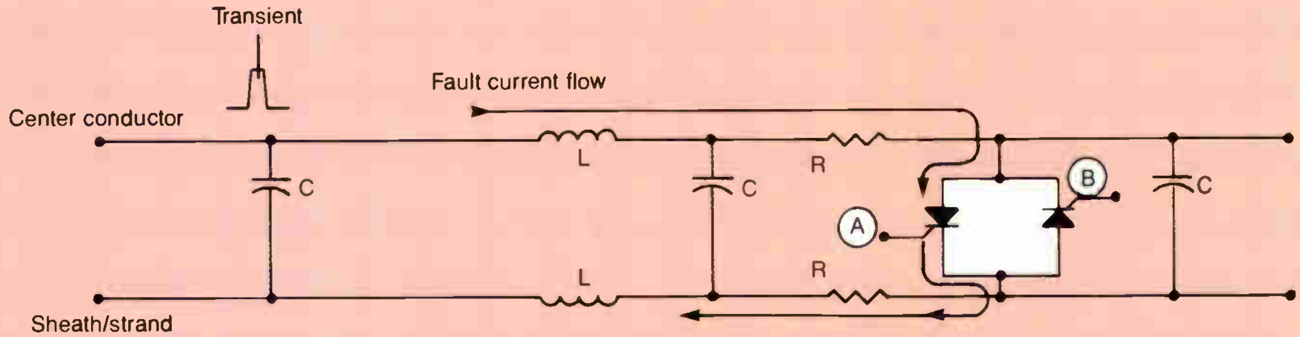
Figure 4: Fault current sensed and taken to ground



L, R and C illustrate the resistive and reactive properties of the cable; points A and B go to the voltage-sensitive trigger circuit.

Alpha Technologies in 1986 when we were having lightning and other power-related problems with a 2,500-mile system in Chesterfield County, Va. The storms were so bad that you could actually plot their path by the trail of burned amplifiers and fuses left behind. This was a first test with two handmade units. It was an outstanding success since the plant protected by those two units was not harmed, although equipment on either side continued to be wiped out. Twelve more units were subsequently installed in known lightning-prone areas; the plant is now almost "bulletproof."

This first success and our reorders led to the AmpClamps being made in quantity—already

Figure 5: AmpClamp with power inserter

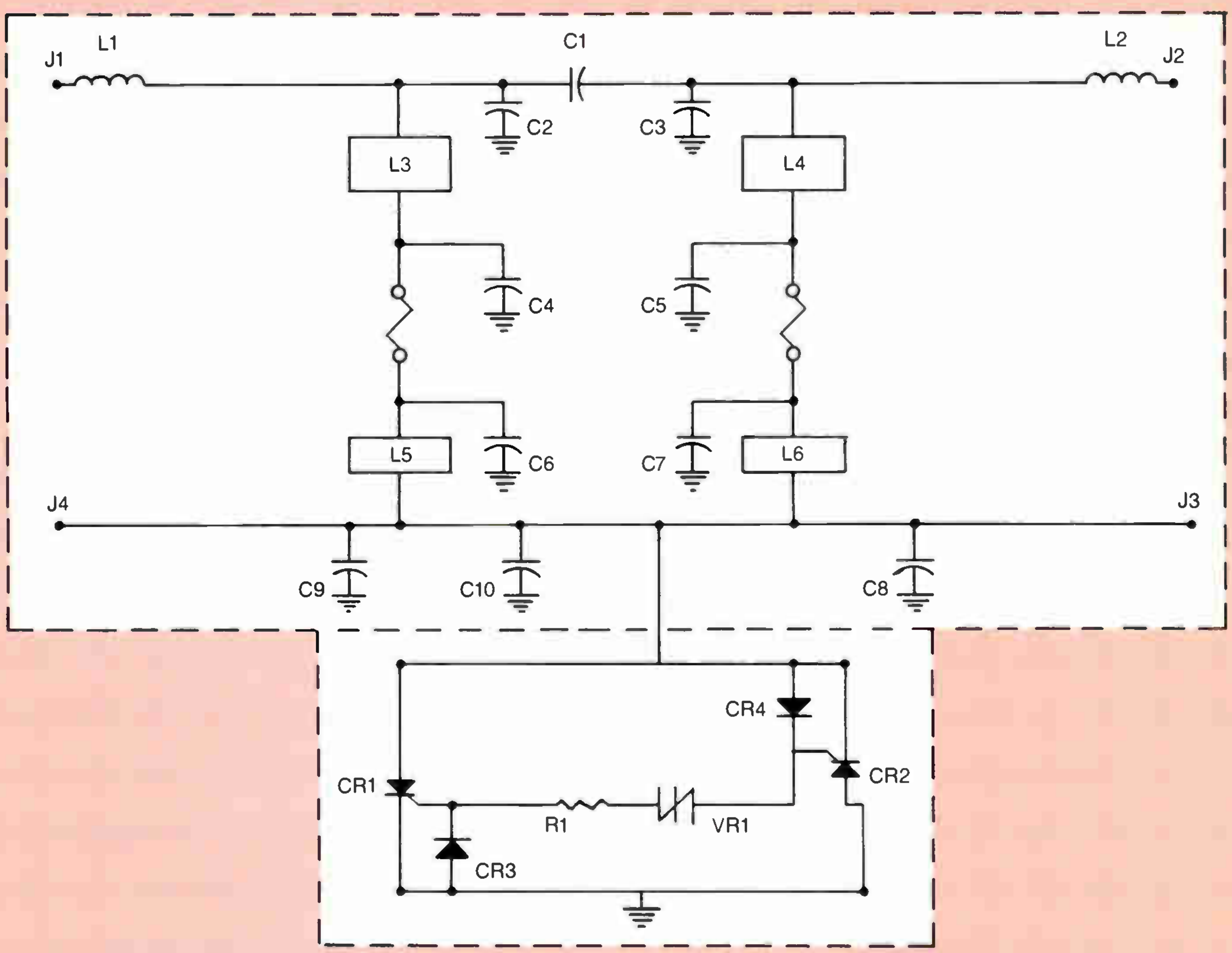


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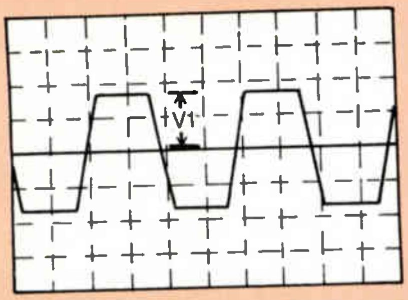
Figure 6: I^2R losses in zener-type clamping circuit



built into complete C-COR, Jerrold, RMS and Scientific-Atlanta power inserters or as a small module (sometimes referred to as the "Amp-Eater," which can be retrofitted to existing power inserters of these manufacturers). The AmpClamps shunt coax to sheath within a few nanoseconds, which is fast enough for even the steepest lightning pulse travelling in the coax. They are robust enough to sink 35 amperes to ground continuously or 500 amperes over one full AC cycle.

We tried in a primitive way to test them—first with a Variac, then with 110 volts AC straight from a power plug and finally with 240 volts AC. All this did was pull the breaker. So Alpha took them to a lab equipped to run the ANSI/IEEE C62-41-1980 (formerly referred to as the IEEE 587 test). This lab setup was used to repeatedly "zap" some production samples with up to 6,000 volts at up to 200 amperes. They seemed to be indestructible. (If anyone has a failure I would very much like to have an opportunity to examine it to try and determine the failure mechanism.) As well, a power inserter with an AmpClamp fitted shows no change in insertion loss or return loss.

Figure 4 shows in a little more detail how the fault current is sensed and taken to ground. Figure 5 shows how the unit integrates with a power inserter.

Since July 1988 we have retrofitted a few hundred in our systems and are looking forward to vastly improved outage performance during the coming summer storms. New and rebuilt systems are installing the power inserters with the protection already built in. We would be foolish not to have this protection at the negligible incremental cost of about $20 per strand mile.

Nick Worth, vice president of engineering at TeleCable Corp., heard about the AmpClamps and had trial quantities installed in several systems. Not all of them were in time for a full summer. But Larry Schutz, TeleCable's engineering manager, working with Worth on this project said that the AmpClamps were installed in the Broward, Fla., system. While it is difficult to get hard data on a subject like this there is no doubt that the outages and related repairs in the areas where they were installed were substantially reduced.

This story just in from Mike Scott, chief engineer at the Jones 1,200-mile Augusta, Ga., system: He had a section of trunk with splits in the vicinity of some power company substations. The system nearly always got knocked out during storms. He managed to get 12 AmpClamps installed just in time for the last major storm of the year and the system wasn't affected by lightning. Scott has already tried enhancing his grounds and installing "Florida jumpers," with very little effect.

Fuses are meant to be the weakest link in the chain and so it is very effective to change to "slow blow," then incrementally increase the ratings one step at a time when replacing them. Manufacturers tend to underfuse, presumably to protect the reputation of their products. If you get to a stage where you blow a few modules, then back off one fuse value. This will then be the optimum between excessive burnups and nuisance outages. This has been tried with rewarding results by several systems. One engineer from Florida told me this one simple technique, costing nothing, cut down his nuisance outages by one-third.

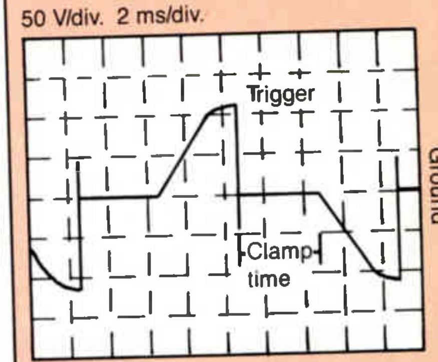
What's the secret?

What is it that makes the AmpClamp technology so effective as compared to MOVs (metal oxide varistors), zeners and the little gas discharge pellets? The SCR-type switches used can sink much more current much faster than MOVs, including the new MOV-2s. Also, MOVs exhibit a tunnelling effect ultimately leading to their own self-destruction.

Regarding zeners, these have to clip and maintain a large voltage across their terminals at high currents (Figure 6). The I^2R losses are therefore many times greater, which severely limits the amount of power that a zener of the same bulk could get rid of. The voltage across the SCRs when conducting is only 0.3 volts. It does not even show as such in Figure 7 where you can see an overvoltage of about 220 V instantaneous taken to within 0.35 volts of sheath ground in a matter of nanoseconds.

Figure 7

50 V/div. 2 ms/div.



As for the radioactive gas discharge pellets, these can shunt high amperages to ground but only for microseconds. They have no bulk. Under sustained or continuously recurring hits they either burn to a short (making an outage difficult to find and fix) or burn open, leaving the operator with a false sense of security thinking the system is protected when it is not.

Probably one of the most dramatic stories that merits repetition comes from the Jones Spacelink system in Panama City Beach, Fla. This is a 123-mile system with a high keraunic number of about 85 (Figure 1). Chief Tech Bill Dorsey said that he was going nuts with outages; it seemed to him that he had outages even if the weather only got cloudy. He tried everything he knew, including beefing up grounds in the very poor Florida dirt and strapping heavy gauge copper wire from strand to strand around the amplifiers. It helped a little but did not cure the problems. In desperation he ordered seven AmpClamp-protected power inserters and had them installed in the worst areas in between the summer lightning storms of last year.

The results were nothing short of phenomenal. There were no further outages in that area through three major storms. Dorsey called me about it in June. Then a day later he called again to say that he had just had a fourth—and by far the worst storm ever—and still no outages, although another cable system adjacent to his was so extensively burned up, it was still out the following morning.

No doubt there will be many more varied stories before "the good ol' summertime" is done. Next time we will discuss how to completely eliminate lightning strikes to your tower or other facilities.

References

[1]"A Method of Estimating Lightning Performance of Transmission Lines," *Rep. Transmission & Distribution CTE*, Volume 69, 1950, AIEE.

[2]Roy Ehman, "Outage management," *Communications Technology*, October 1988.

[3]Lightning Eliminators and Consultants, Boulder, Colo.

Reducing outages in the plant

By Austin S. Coryell
Vice President of Engineering, Mile Hi Cablevision

CATV plant requires continuous good, clean and tight electrical junctions at all grounding and bonding points to avoid poor performance over time. Failures at the electrical connections generate all kinds of system-related problems. All of these junctions must be made correctly and protected from the environment throughout the life of the plant.

Environmental corrosion of unprotected grounding and bonding junctions will develop high impedances across these junctions over time, creating the following conditions:

1) Each time there is a high potential developed across these high impedance junctions caused by induction and/or switching transients, flashover will occur. This causes the metallic evaporation of the metals and eventually loses electrical connections altogether.

2) With high impedance junctions, flashover also can occur in electronic equipment, causing failure of components and blown fuses, which produce outages and aggravations to subscribers.

3) Electrolysis at exposed junctions of dissimilar metals is inevitable. How well a system protects these junctions through good construction and operational practices will determine the severity of this catalytic reaction. Sheath currents are the greatest contributor to severe electrolytic action in a highly corrosive environment. Rectifications of these sheath currents take place at the junctions of dissimilar metals. The greater the amplitude of sheath currents in a plant, the faster the electrolysis process. The most severe problems with electrolysis are in the house drop connections at the directional taps, grounding blocks and outdoor splitters. All house drops have some amount of sheath currents; the greatest amounts are where house drops are bonded to the power company grounds.

To reduce the corrosion of metal parts in a system, protective practices (such as using a rust inhibitor) and procedures should be established. In addition, an ongoing inspection is necessary to ensure employees are complying and that your practices and procedures are adequate for the environment you are working in. Different types of environmental contaminants will require different corrective measures. It is important you know what kinds of chemicals you are dealing with and what their reactions are to the metals you use in hardware and coaxial cable junctions.

The problem with many rust inhibitors is that personnel must revisit all connections periodically and reapply the compound. This can be handled by procedures whereby everyone, when working on a pole, applies rust inhibitor to all metal-to-metal contact hardware. This should include hinges to amplifiers and also to power supply and MDU (multiple dwelling unit) cabinet hinges and security locks.

Bonding to parallel plant

Common bonding to utility companies should comply with their local and state and/or National Electrical Safety Code (NESC) requirements. It is best to study your pole line agreements and discuss bonding issues with your local utilities. At the same time, you should keep in mind your system architectural bonding plan, which should be directed to a) maintaining common bonding where possible, to ensure safety of your people working on plant; b) minimizing longitudinal sheath currents; c) avoiding the transfer of high current surges from the power company primaries to the cable plant caused by induced currents from lightning strikes; and d) reducing the transfer of high potential transients from the power company primaries and secondaries to the plant caused by rerouting of power, switching in and out capacitor banks to maintain in-phase power currents and voltages and switching on and off large motors such as in factories and large air conditioners.

In Section 9 of the NESC covering protective grounding, there are three paragraphs that are important:

"The point of grounding connection on a wye-connected three-phase four-wire system or on a single-phase three-wire system shall be the neutral conductor." This is where the power companies attach their vertical grounds that we commonly bond to.

"Ground connection points shall be so arranged that under normal circumstances there will be no objectionable flow of current over the grounding conductor. If an objectionable flow of current occurs [which we refer to as longitudinal sheath currents] over a grounding conductor due to the use of multiple grounds, one or more of the following should be used:

1) Abandon one or more grounds.
2) Change location of grounds.
3) Interrupt the continuity of the conductor between ground connections.
4) Subject to the approval of the administrative authority, take other effective means to limit the current." (This would in most cases be your local power company and/or city regulatory body.)

"On multiple-grounded systems, the primary and secondary neutrals should be interconnected according to Rule 97B. However, where it is necessary to separate the neutrals, interconnection of the neutrals shall be made through a spark gap or a device which performs an equivalent function. The gap or device shall have a 60 Hz breakdown voltage not to exceed 3 kV. At least one other grounding connection on the secondary neutral shall be provided with its grounding electrode located at a distance not less than six feet from the primary neutral and surge arrestor grounding electrode in addition to the customers' grounds at each service entrance."

As can be seen from the intent of these paragraphs, it is possible for a system to strategically place bonds at points that meet its architectural design plan and still maintain compliance with local, state and NESC requirements. What is meant by "strategically placing bonds" is the concept of determining the placement of bonding points in a system that will minimize possible operational problems and at the same time, complying with the local state and NESC requirements. Some situations you may encounter while bonding plant are:

1) Power poles with a spark gap or lightning arrestor shunted between each primary power phase and the vertical ground: These spark gaps

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and arrestors discharge at 12,000 volts and are primarily used to dissipate induced surges on these primaries, caused by thunderstorm activity and static discharge between the earth and clouds, to earth via the vertical ground system. Any CATV plant bonded to these particular vertical grounds can expect to experience 3 to 6 kV at the junction point each time there is a discharge. The surges caused by these discharges can damage the system's electronic and electrical components and blow fuses, causing outages.

These vertical grounds should be avoided at all times. Should it be necessary to install a ground at this pole, it is suggested you install your own vertical ground wire and attach to the power ground rod at earth. If you also have longitudinal sheath current develop due to direct connection at the power ground rod, then install your own ground rod. This will alleviate the sheath currents due to the soil resistance at low potential differences but will provide a near short between the two ground rods during a high current surge putting both plants at the same potential at earth.

2) Power poles where the utility company has a high current imbalance between the phases of the primary and/or secondary circuits: These current imbalances show up on their neutral conductors and vertical grounds and will seek another parallel current path to its reference source if possible. Any time a cable system is bonded to these types of vertical ground situations, these imbalance currents will conduct onto the cables and strand. It is possible to measure 30 to 40 amperes of current on a cable plant in severe imbalance situations, but normally current measurements in the range of 5 to 15 amperes are not uncommon.

3) Power supply locations where, when bonding to the power company service entrance neutral, great amounts of imbalance currents are transferred to the cable system through the power supply cabinet and 30 or 60 volt power inserter lead: With this type of situation, it is suggested to separate the power supply ground rod from the utility company ground and install individual ground rods. An isolator should be installed between the two grounding systems at the power supply cabinet to ensure safe working conditions in the event of a power line surge or transient. This isolator will clamp at 10 volts so you could possibly expect no more than a 30 volt potential difference between these two grounds during a discharge.

Frequent use of positive grounds are essential for maintaining a reliable system and for providing a safe working environment for those exposed to the plant. Just because a cable plant is bonded to the utility company's vertical grounds and its own grounding system per established practices such as the standard listed in the NESC (every first, last and every 10th pole) does not necessarily ensure the cable plant has a positive grounded system.

The NESC recommends the ground resistance of a driven electrode shall not exceed 25 ohms, but this is intended as a guide since lower ground resistances are desirable and essential in most situations. The most efficient way to determine the effectiveness of a positive grounded system is to make earth resistance measurements at all ground rod locations (including the utility company's) and conduct a thorough inspection of all the vertical bonding junctions for tightness of clamps and for non-corrosion. Analysis of grounding systems has indicated that each ground location requires individual attention. The general requirements of a positive grounded system are relatively simple but the testing of each ground is essential to assure all system design criteria is met.

Longitudinal sheath currents

Longitudinal sheath currents are present on CATV plants as a result of common bonding with the local power company's neutral: The resultant distribution of current flows back to the power company's reference ground, which is in most cases their substation. These sheath currents can and will travel for many miles and as a result will induce an electromagnetic field between the inner and outer conductors of the coax. Furthermore, CATV system electronic and electrical components are subject to overvoltages not only during extraordinary circumstances (storms, power surges, transients, etc.), but even during normal day-to-day steady state operation.

Power company verticals should be avoided if possible at locations where high imbalance currents are transferred to the plant when a physical bond is made. This condition can be determined by a) using an ammeter connected between the power company vertical and the cable plant before a #6 copper wire is attached or b) clamping an ammeter transformer around the #6 ground wire after a bonding connection is made between the two systems.

If it is necessary to provide an earth ground at this pole, a separate vertical wire and ground rod can be installed or an isolator can be shunted between the cable plant and the power company neutral. By installing separate vertical wires and ground rods, imbalance currents are limited due to the earth resistance between the two ground rods and the low voltage differential of less than 1 volt. By installing an isolator between the power company vertical and the cable plant, the imbalance currents are limited through the isolator. This isolator will still provide safety for persons working on the plant in situations where surges and transients occur. This isolator is a 1 ohm 50- to 100-watt resistor with a high power MOV (metal oxide varistor) shunted across it that discharges at 10 volts. During transient and surge discharges, the greatest potential between the power company's vertical and the cable plant will be less than 30 volts.

In many cases, where the cable systems use .750, .875, and 1.000 trunk cables or dual-cable plant, the resistance of these parallel paths are considerably less than the power company's neutrals; consequently, the majority of these imbalance currents are conducted onto the cable plant. A fully jacketed coax plant can and will complicate the grounding process. The coaxial cables are the predominant carriers of surge and sheath currents because their resistances are considerably lower than the strand resistance. Since these jacketed cables (especially the trunk cables) are insulated from the strand, the only locations that sheath currents and surges can be bled off to ground are at amplifier and passive housings.

With the strand resistance considerably higher than the trunk cable's sheath, it is important to bond at amplifiers and passives for maximum dissipation of sheath and surge currents. There are alternative options to solve the problem: a) Remove the jacket from the trunk cables and do a bond directly to the aluminum sheath. This could be done through a special splice with a ground lug or an aluminum alloy strap clamped to the aluminum sheath. In both cases, emphasis needs to be put on waterproofing and moisture inhibitors to prevent oxidation and electrolysis. b) When designing and building cable plant, put passives at points where bonding will take place. This will require, in many cases, running parallel trunk and feeder cables back to the passives' outputs because they do not fall at optimum power split points such as intersections.

Extensive power company imbalance current and cable plant sheath current measurements were made in Florida systems on the strand, coax, power company neutrals and the vertical bonds both before and after lifting these grounding wires from the power company neutrals. In every case, the total current distribution on the coaxial cable plant was less when these bonds were removed. We did not see drastic sheath current changes on the coaxial cable plant even though there were drastic reductions of imbalance currents on a specific vertical when it was lifted from the cable plant. There are two logical reasons: a) There are complex current waveforms on the strand, cables and vertical bonds that are contributed by the imbalance currents from all three phases of the power company's primaries, consequently giving us the vectoral sums and differences of currents on the various plant components. b) By blocking or disconnecting these imbalance currents from the cable plant at a specific location, these imbalance currents seek other paths of low resistance that could be another location where cable plant and power plant are common-bonded. This was proved by viewing the current waveforms on a dual-trace oscilloscope connected to the cable plant through clamp-on current transformers.

Our findings, through these measurements and testing, showed that the predominant carrier of the power company's imbalance currents is on the .750 and larger trunk coax. The predominant source of these imbalance currents is caused by common bonding of our power supply cabinets to the power company service entrance neutral. Very little current was measured on the strand and guy wires. The highest level measured was 2.1 amperes; in the majority of cases, no currents were greater than 0.1 amperes on any of the vertical bonds between our plant and earth grounds. The reason for these low imbalance currents on the strand and guy wires is that the strand's resistance is 10 times as great as .750 coax and 4.5 times as great as .500 coax.

Many house drop cables were checked throughout the distribution system. In the majority of cases, where the house drops were bonded to the power ground, there were sheath currents anywhere from 0.05 to 3.2 amperes. Due to the inaccuracies of the clamp on current transformers

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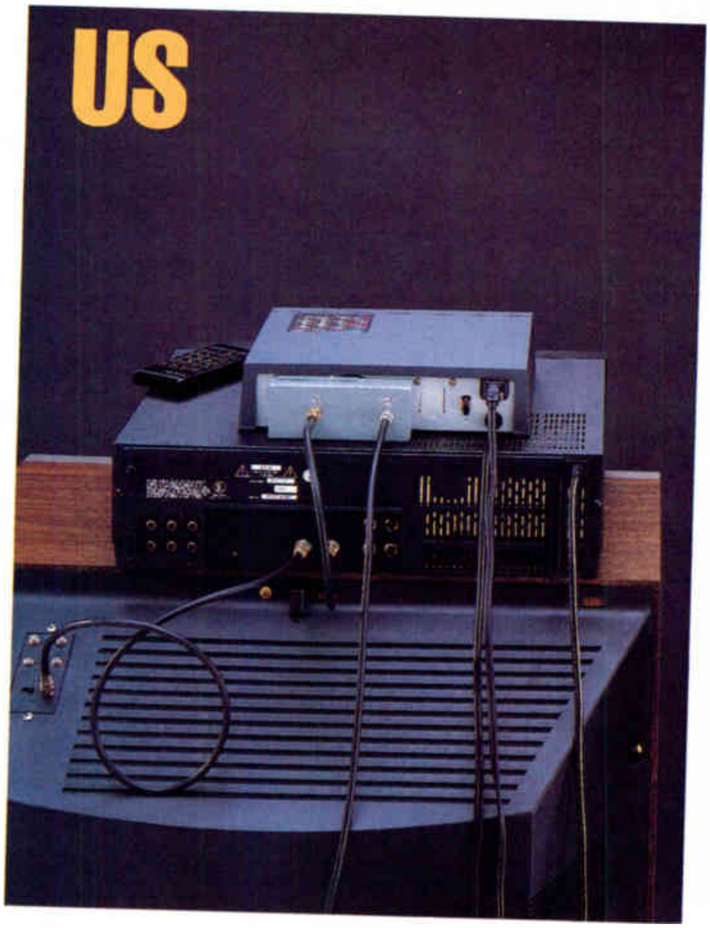

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measuring around the 0.2 amperes range, it was necessary to coil the house drop up into a five-turn coil and divide the current readings by five. Again, the contribution of sheath currents on the coax and strand was the vertical sums or differences of all the sheath currents from the house drops. In some cases, the sheath current on one drop would be transferred to another house drop at the directional tap. This was proved by disconnecting and reconnecting house drops while taking measurements.

Great emphasis should be put on the reduction of longitudinal sheath currents. This will improve reliability of the system and reduce electrolysis at all dissimilar metal junctions caused by corrosion of metals and rectification of the sheath currents at these junctions.

Surges and transients

Surges and transients are more destructive on a short-term basis, whereas corrosion, electrolysis and sheath currents are the long-term concerns that a system operator must contend with through good plant design and active preventive maintenance programs.

Destructive surges and transients come from four sources: thunderstorm activity, static discharge cloud to earth, power company load and phase switching and industry and heavy power equipment turn-on/turn-off. In all cases, the CATV plant should have as low a resistance to earth ground as possible to keep the potential difference low during high currents generated from these sources.

Transients are less than 8 ms in duration and are characterized by sinusoidal or exponential wave shapes. These transients are normally associated with high impedance sources, and voltage levels can range from a few millivolts to 18,000 volts in a normal operating environment. Surges are usually greater than 8 ms and are characterized by a square wave or exponential wave shapes. These surges are normally associated with low impedance sources.

AC power line disturbances generally fall into two classifications: 1) disturbances of short duration less than 8 ms contributed mostly by thunderstorm and static discharge activity and 2) disturbances of larger duration greater than 8 ms, contributed by load and phase switching transfers and industrial heavy electrical equipment turn-on/turn-off activity.

There are two classes of lightning strikes: 1) The impulsive strike creates most damage to electronic systems since it embodies a large percentage of high frequency energy. The rate of rise exceeds 10,000 amperes per microsecond (A/μs) and can achieve rates over 100,000 A/μs; and 2) The non-impulsive or hot strike rises much slower than the impulsive strike, as slowly as 500 A/μs. However, it usually lasts much longer, extending out to as long as 10 μs to the 40th percentile.

To protect against all destructive forms of induced surges and transients, regardless of their cause, the protective equipment or components must be designed to satisfy the worst-case situation, at least 99 out of 100 possible events. There are numerous types of surge and transient protective devices on the market. Some are low impedance, others are high impedance devices. Some will handle large joules of energy, others less. Some will handle high voltages for sustained periods of time, some will not. Some have positive temperature coefficients, others negative. Some have good clamping characteristics, others don't. Each has a specific place in protecting CATV electronics and electrical components. It is not the intent of this article to recommend surge and transient protective devices but only to make you aware of the complexity of protecting your plant.

All electronic and electrical equipment should have some kind of protection to alleviate damages caused by surges, transients, sustained over- and undervoltage conditions, shorts, etc. Places that should be considered for protective devices are: power company service entrances at all system power supplies, headends and hubs, and office buildings; system power supply locations AC input and output (output protection could be at the power inserter); power packs in the amplifiers; gas tubes in all amplifiers; all computer and microprocessor equipment including modems and terminals (many systems have the computers protected but leave their data systems wide open through the terminals and modems causing damage to the main computer); and locations where expensive test equipment is plugged into the power system on a continual basis.

The author would like to give credit to Kirk Getz of Paragon Cable in St. Petersburg, Fla., and Ariale Paradoa of the ATC Florida Division who graciously gave their time and their staff's time in conducting extensive tests and experiments on sheath currents, bonding and grounding.


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Lightning protection and the grounding interface

By Roy B. Carpenter Jr.
Consultant, Lightning Eliminators and Consultants Inc.

Lightning protection has become one of the most demanding support functions for the communications industry. Electronic equipment is becoming more sensitive to any form of transient; lightning produces many forms of transient phenomena. These are the result of the associated electrostatic fields, electromagnetic pulses (EMP), earth currents and induced voltages. Equipment produced a few years ago could tolerate transients of 100 volts peak; some modern equipment can fail under transients of as little as 10 volts.

Protection methods adequate only two years ago are now unsatisfactory for many applications. The single greatest threat is lightning-induced transients. Historically, lightning damage has been limited through "adequate" grounding. The standards in use even today call for grounding resistances of 5 to 10 ohms; a few use even higher resistances.

Consider the impact on a 5 ohm ground by an average lightning strike (20,000 amperes at peak). From this we find that 100,000 volts could be developed across this ground interface. The effect can, of course, be minimized through use of a common point ground (CPG) or ground window (Figure 1). However, two other factors also must be considered:

1) the surge impedance of any interconnection. Note that as little as 10 feet of interconnecting wire can impose enough impedance to permit the development of dangerous transients.
2) paths that tend to bypass the CPG. These include coax from the top of the tower into the building, the power source neutral and sometimes the conduit.

All of these add up to a concern over the potential inadequacy of protection methods that permit lightning to strike a communications site. To

Figure 1: Recommended grounding technique

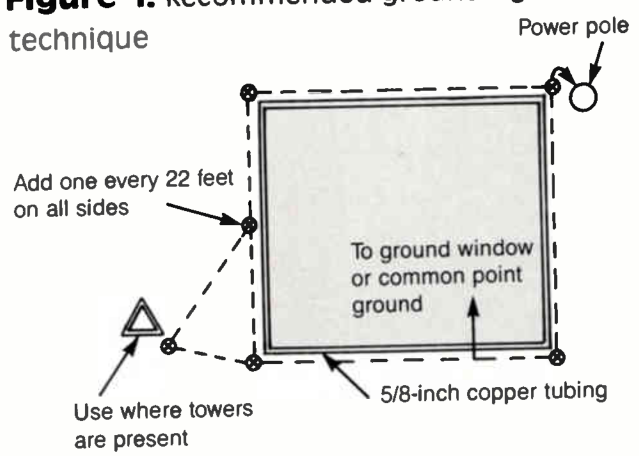


Figure 2: Grounding resistance as function of soil resistance and number of 10-foot rods

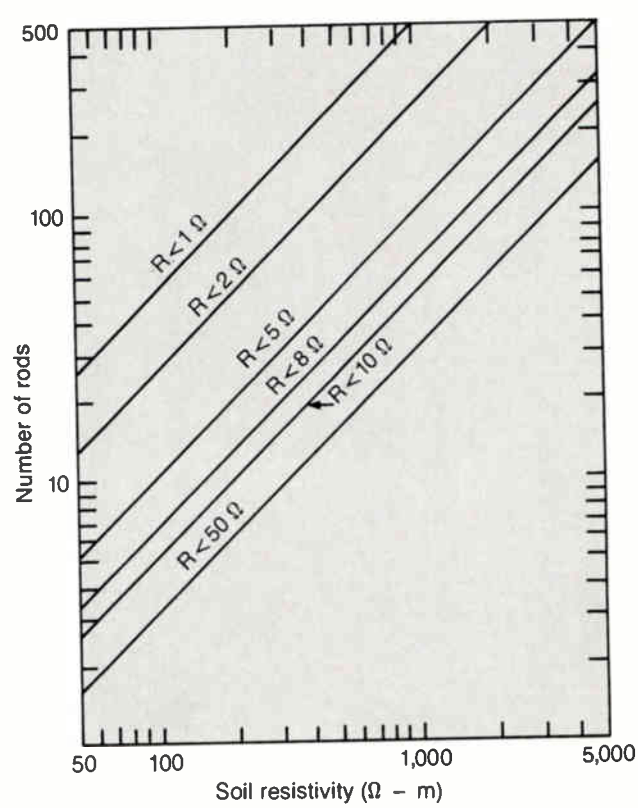
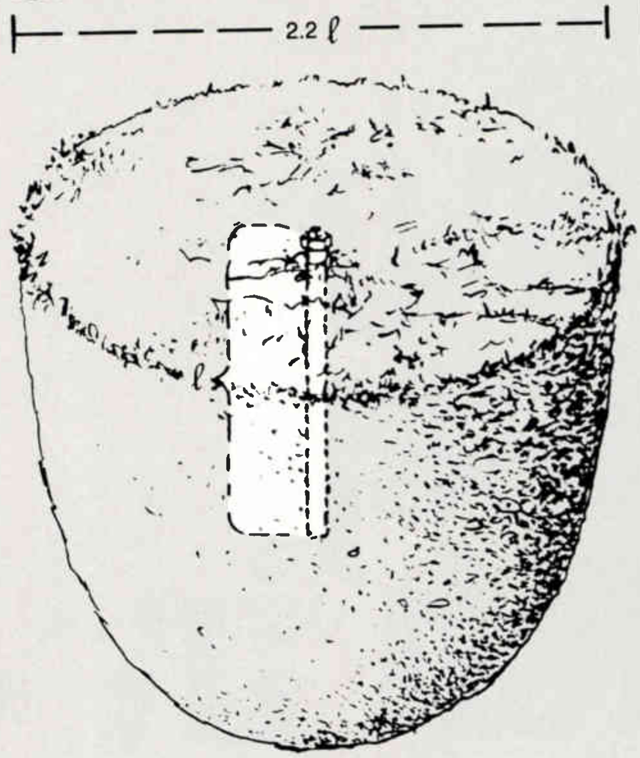


Figure 3: Interfacing hemisphere



permit the strike to enter the area of concern is to encourage damage. To prevent the strike is to eliminate the risk and all side effects. Reducing the grounding resistance often lowers the risk of lightning damage but seldom eliminates it. Further, the EMP threat actually increases. The cost of reducing the grounding resistance is usually exponentially related to the change in resistance required: the lower the required resistance, the higher the cost to achieve it.

Grounding resistance constraints

In "The art of reducing grounding resistance" (August 1988, *CT*), the use of conventional techniques was discussed; the limits in grounding resistances were presented as a function of soil resistance. Figure 2 is a summary of what can be expected from a conventional grounding system. This is based on the premise that the rods are ¾-inch diameter by 10 feet long and are separated by no less than 22 feet. From these data, for a typical communications site of about 10,000 square feet, the following resistivities may be considered the lowest practical under ideal conditions:

Soil resistance (ohm-meters)	Grounding resistance (ohms)
50	1.1
100	2.3
500	10
1,000	55
5,000	250

These estimates are based on the presumptions that the soil contains the required amount of moisture and that the temperature is well above the frost level. Actual resistance for a conventional ground system will vary by about 250 percent from best- to worst-case conditions throughout an average year, due to variations in moisture and temperature. Improper measurement techniques often create the impression of lower resistivity because the technique itself is not exact. An improper measurement will invariably indicate a lower resistance than the true resistance.

Resistivities can be lowered below the conventional limits through unconventional methods, such as automated soil treatment. There are two factors to be considered:

1) The effective soil resistance must be lowered, since soil resistance determines the ultimate grounding resistance.
2) The soil within the "interfacing hemisphere" (Figure 3) will exercise 90 percent of the influence on the ultimate grounding resistance of that ground rod. It takes the rest of the earth to influence the remaining 10 percent.

From these two factors, it becomes obvious that the soil within the interfacing hemisphere must be made more conductive, since only that soil is of any real significance. This, then, limits the scope of the conditioning process to a relatively small volume. From Figure 4, it can be observed that through the addition of a 10 percent solution of salt (NaCl) to that soil, the soil resistivity can be lowered from 10,000 to as low as 100 ohm-meters,

Figure 4: Influence of metallic salts on resistivity

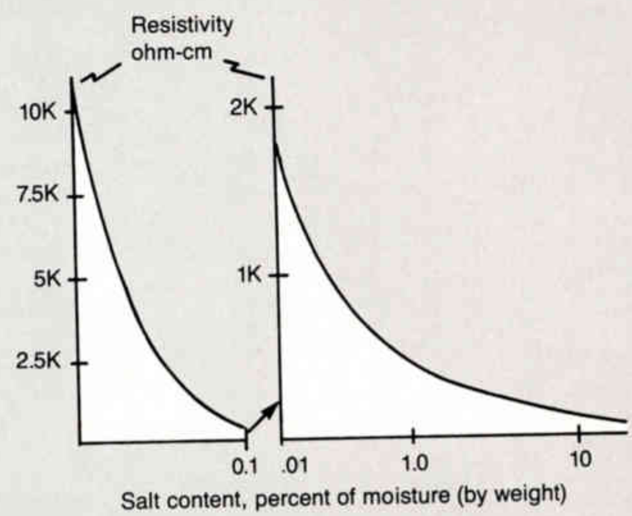
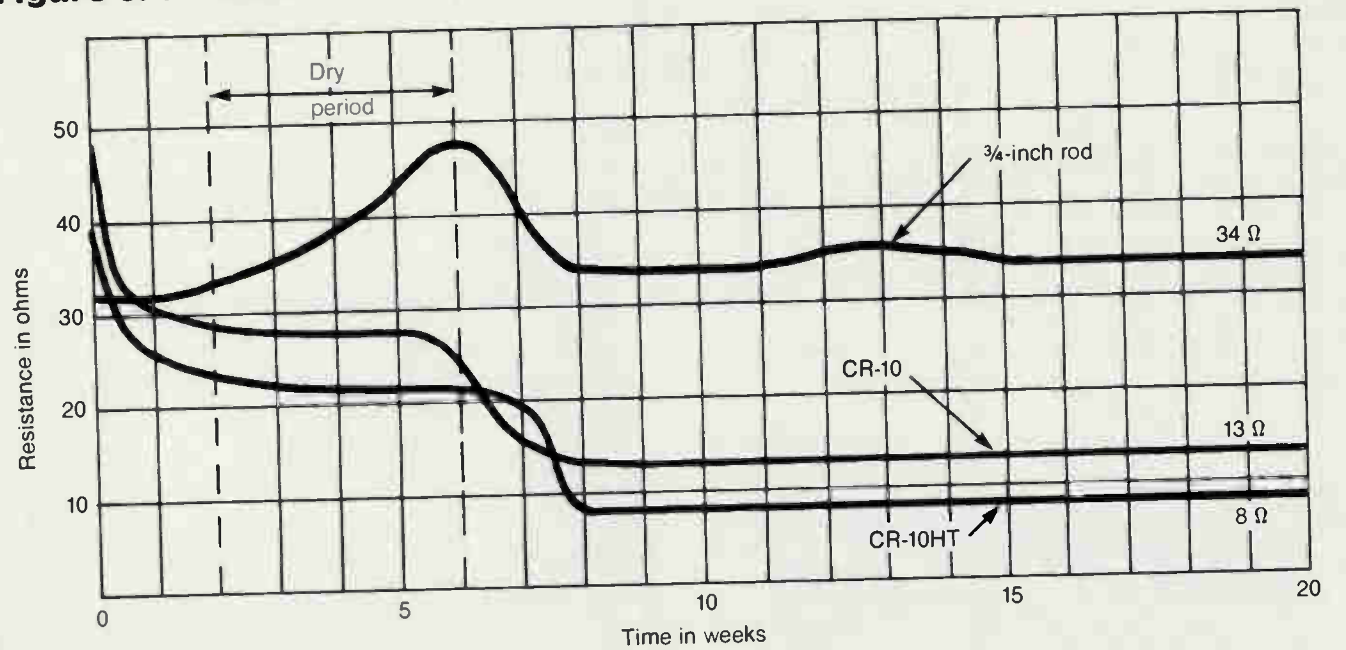


Figure 5: Chem-Rod test data



assuming the proper moisture level.

A recent development, the Chem-Rod, has made it possible to automatically "condition" the soil within that interfacing hemisphere. By using local moisture (or providing its own), it forms a saturated solution of metallic salt that in turn infiltrates the surrounding soil, raising the mineral content and thereby lowering the surrounding soil resistivity significantly. Figure 5 illustrates the results of tests comparing a horizontal and vertical Chem-Rod to a conventional 10-foot rod. The horizontal model provided a lower resistance, but both rods provided significantly lower resistance.

Lightning strike prevention

The article "Lightning strike prevention: A 15-year history" (March 1987, *CT*) described an approach, the Dissipation Array System (DAS). Since then, DAS has been used to protect several key facilities in high lightning areas, under close evaluation.

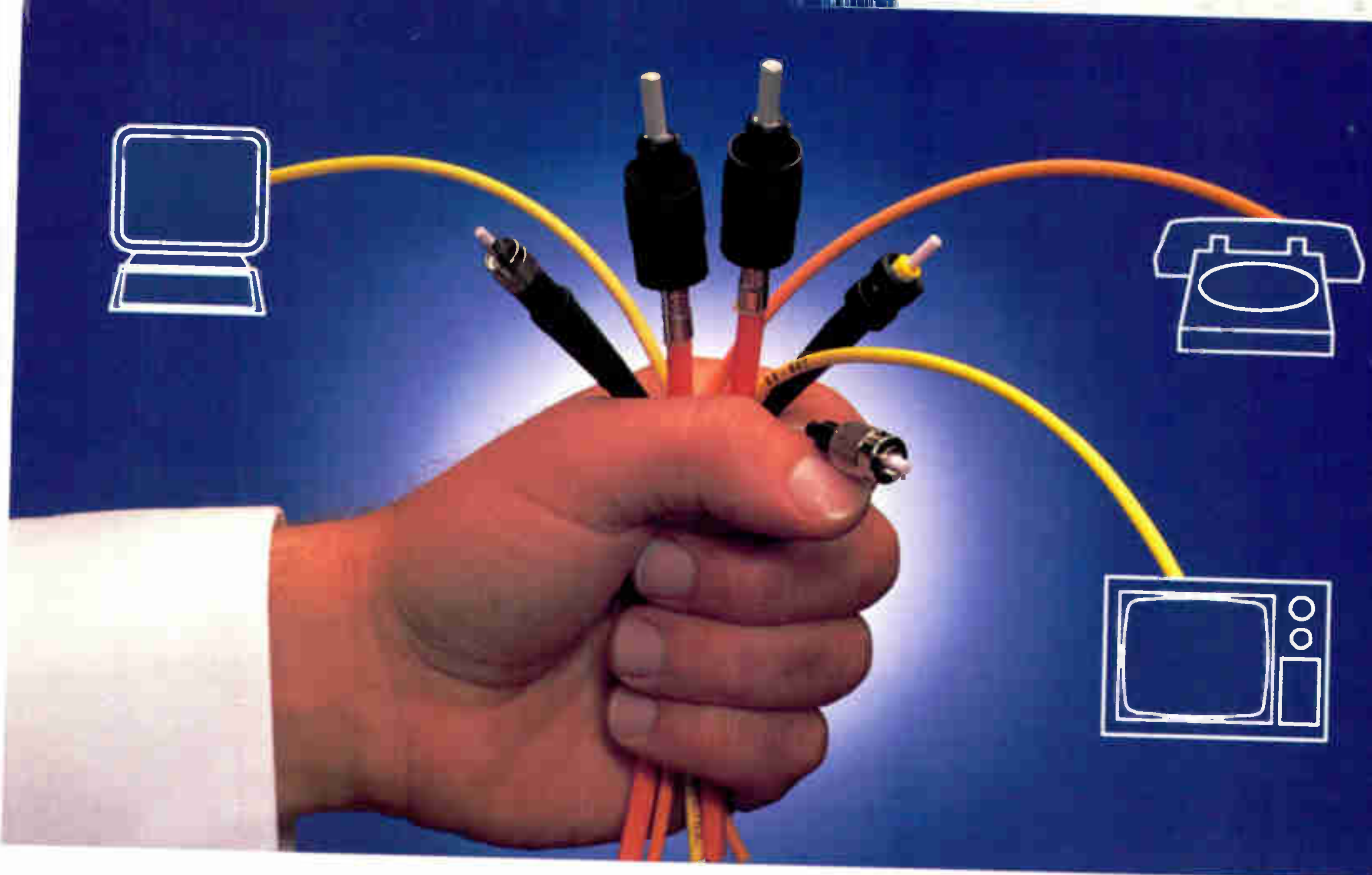
Prior to the DAS installation, the Louisiana State Police were subjected to numerous communications systems outages each year from lightning activity. Early in 1988 it completed the installation of a new 800 MHz communications system—far more sensitive to lightning. The decision was made as the result of a three-year test program to install a DAS at the headquarters site. The state elected to install the DAS at the 33 sites as each was activated. As a result, the 1988 season passed without a single strike to any of the sites where the protection systems were installed.

Early last year the Federal Aviation Administration elected to use the DAS to protect its facilities at the Tampa, Fla., airport; included were five communications towers. The FAA contracted with another firm to install a wire brush assembly in Orlando, Fla., and installed its most sophisticated grounding system at the Sarasota, Fla., facility. A consulting firm was then hired to evaluate the performance of all three systems. The results were spectacular. TV cameras recorded 13 strikes within the survey area at Sarasota; 12 strikes at Orlando and none at the Tampa facilities. Tampa has the highest lightning rate in the United States and within the FAA system, but 1988 was the first year that there were no lightning strikes to an FAA facility at the airport.

The DAS provides a safe environment for communications systems. It reduces the electrostatic field in the area around the tower through corona discharge. But, in doing so, it also reduces the corona noise potential normally emitted by any tower during a storm. The end result is no lightning strikes and much lower "radio noise" coupled into nearby receivers.

No lightning damage

No strikes means no damage from lightning. Grounding systems will never eliminate all of the lightning-related side effects. Grounding resistances can be reduced significantly through automated conditioning, which may require both moisturization and mineralization. Strike prevention systems do not depend on low resistance grounding interfaces. Therefore, for difficult sites, it is the only safe protection. Seventeen years of history vindicates this premise.



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Reader Service Number 33.

CATV power supply characteristics

By Jerry D. Schultz
President, Power Guard Inc.

Almost all normal power supplies for CATV use are ferroresonant (FR). An FR transformer regulates by operating in saturation at all times. If the output does not call for sufficient current to saturate the core, there is an internal resonant winding that circulates current in a tank circuit to complete saturation. This article briefly explains various operating parameters.

The *input requirements* are determined by the available power at the power supply location and usually are not determined by the cable operator. Most manufacturers will furnish their products for any required input. These requirements include input voltage (usually 115 or 220 V), input frequency (either 50 or 60 Hz) and sometimes input current.

The *output voltage* is normally 30 or 60 volts RMS. Some supplies can provide either voltage by selecting the proper tap on the output winding of the transformer. Both input voltage and output current must be stated if output voltage tolerance (usually 1 percent) is to be meaningful.

The required *output current* rating of the supply is based on an expected load in the system and should range from 5 to 18 amperes or more. The actual output capability of a given rated supply may vary somewhat from one manufacturer to another due to the ranges of input conditions that the supply is designed to operate over. In selecting an FR power supply you should pick a current rating as close to the system design current rating as possible. This is because the coolest and most efficient operation of an FR transformer is at the supply's rated output (if the transformer is properly designed).

FR power supplies have an inherent current-limiting capability that will limit *short-circuit current* from about 100 to 200 percent of the rated output current. Some supplies have special devices that will drastically limit the short-circuit current duration, keeping average short-circuit power at a very low level. This will protect passives and other line equipment from damage.

Overload current: Usually, FR power supplies under short-circuit conditions will exhibit some degree of "fold back limiting." This means that the short-circuit current may not be the maximum current a supply can furnish. Since most shorts occur at some distance from the supply, there will be some unknown resistance (load) in the short-circuit path. The overload current can therefore be determined by gradually increasing the load beyond the supply's rated output until the output current begins to drop. This maximum current point or knee is the overload current. Since higher current supplies will exhibit higher overload currents, this also could be used to determine if a supply has a marginal current rating.

The *output waveform* of an FR power supply should approach a square wave shape at zero or light loads and then become more rounded with higher peak voltage as the load is increased. The output waveform of some FR supplies (especially those claiming over 90 percent efficiency) may be close to a sinusoidal output waveform even under light loads. With these supplies, the system efficiency may suffer due to reduced efficiency in the linear regulator of the amplifier supplies and, to a lesser degree, in the switching regulator supplies.

Crest voltage is the maximum peak voltage measured under any load condition. Since the waveform of most FR power supplies becomes more rounded as the load is increased, this peak will usually happen at or near full load. Lower crest voltages will generally give you better operating efficiency in the voltage regulator of the amplifier power supplies.

Line regulation is a measure of output voltage variation as a result of input voltage change. An input voltage range of about 90 to 130 V is common with a resulting change in output voltage of 1 to 3 percent.

Load regulation is a measure of the output voltage change caused by a zero to full load output current draw on the supply. Poor load regulation is sometimes the result of using insufficient wire size in the transformer windings, which will lead to higher temperature operation and shorten transformer life. →

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Stabilization time: FR supplies under no-load conditions sometimes have a tendency to be unstable at turn-on. This causes the output to flutter momentarily but will usually stop in a second or two. Since all supplies that are operated in the system will be under load, this is usually not a problem and is seldom actually specified.

Efficiency is a ratio of output power to input power and must take into account the phase angle between current and voltage (power factor) to be accurate. Inefficiency in an FR transformer is due primarily to core losses (caused by alternating flux in the core) or copper losses (caused by the IR drop in the windings). It will manifest itself as heat in the transformer. The efficiency rating of a CATV power supply is usually stated in percent and can be anywhere from less than 80 to 90 percent or more. The actual efficiency of the supply in your system may, however, be significantly less and depends on the system design.

Efficiency specifications are always stated at full load conditions and will be less as the load is reduced. For the maximum efficiency it is therefore important to design your system to operate as close to full load as possible. If operated at or near full load a properly designed supply also will run cooler and have a longer life.

Temperature rise, although seldom specified and very difficult for a cable operator to accurately measure, is one of the best indications of good transformer design. It is a measure of how much heat is generated in the transformer as compared to how fast it is conducted or radiated away from the transformer. This characteristic is stated as the difference in temperature at turn-on (ambient) as compared to temperature after stabilization (about three hours) and is usually taken at a number of different load levels from no load to full load. In most transformers the windings are in physical contact with the lamination; the wire and lamination temperature will be close to the same temperature after stabilization. In some high quality transformers the copper losses are reduced to the point that it becomes advantageous to insulate the winding from the core. This will prevent the core from transferring excess heat to the winding.

Because transformer life is based on the temperature of the wire and not the core, a method of checking wire temperature must be used to obtain an acceptable degree of accuracy in projecting the life of the transformer. About the only way to do this is by measuring the resistance change in the windings and calculating the wire temperature. Since this test requires experience, equipment and a somewhat difficult setup, it is seldom done in the field.

On a power outage, the *time delay* option will prevent power from being applied to the cable system for a period of time after the AC line power has been restored (usually about 10 seconds or as specified by the system engineer). This delay will allow the line voltage to stabilize before connecting power to the system and therefore keep transients from damaging line equipment. For maximum protection of line equipment, the time delay should get its power from the secondary side (60 V) of the transformer. It also should switch power on the secondary side. This configuration will give the added advantage of limiting the duration of short-circuit current in the system, should a short occur. This will prevent damage that would otherwise be caused by excessive heat in the system components.

Surge protection and other devices

Input surge protection is usually provided by some type of metal oxide varistor (MOV) across the AC line and, in some cases, from the line to ground. MOVs come in a range of ratings from about 40 to over 200 joules. The smaller units come standard on most supplies and will provide adequate protection in some areas. The MOV exhibits a soft-limiting characteristic, which means that the clamping voltage increases as the surge voltage increases. MOVs will not take repeated high energy surges due to their inability to conduct heat away from the internal junction point of the device.

Input circuit breakers: Although almost all power companies require external breakers, most power supply manufacturers provide internal input breakers as standard equipment. FR supplies are inherently current-limited; therefore, a short in the system will usually not trip the circuit breaker. As a result most input breakers are used only as a convenient switch for disconnecting power.

Some types of zener diodes (transzorb, PIP-60, etc.) are typically used for *output surge protection*. Unlike the MOV, zener diodes are hard-limiting devices, which means they will clamp at their rated voltage and hold that voltage until the surge is terminated or the zener junction is destroyed. Zeners will conduct heat away from the internal device junction and therefore can handle repeated surges within their ratings without damage.

Various *hybrid surge protectors* are available from a number of manufacturers with a multitude of claims and specifications. It is difficult at best to predict the nature of surge voltages. Therefore, these devices should be checked out thoroughly prior to purchasing.

Since the FR supply is current-limited, *output circuit breakers* are seldom used other than to limit the duration of the short-circuit current. If used, they should be self-resetting to prevent prolonged outages when tripped.

Voltage and/or current *meters* are available from most manufacturers and may be standard on some models. Either meter (voltage or current) would normally be monitoring output conditions. When specifying meters, it should be remembered that a defective meter could cause a power outage. Since test points are usually provided, meters may not be desirable in the remote locations where power supplies are generally found.

Standby power supplies are battery operated and furnish power to the system in the event of an input power failure. Maximum standby time varies with different supply designs but is usually about two hours at full load. After input power has been restored, the standby supply will automatically recharge the batteries and be ready for the next outage. There are three types in common use today: the saturating inverter, the driven inverter and the driven FR. Standby power may be desirable in trunk runs, locations with two or more local power grids and any situation where a power outage to the power supply may cause loss of signal in areas not affected by the electrical outage. Standbys are much more complex than normal FR supplies. They are therefore more troublesome to maintain. The biggest problem, however, is the batteries used to power them. As a result, properly maintained batteries can substantially reduce the maintenance problem.

Physical factors

In the past, power supplies were known to be big and bulky. This was necessary to allow the excessive heat generated by inefficient transformers to dissipate into free air. Efficient transformer design, combined with the practice of heat sinking transformer laminations directly to the housing, allow for much smaller and more compact power supply designs. Outside case temperature of these smaller supplies will run higher since the primary heat transfer from the transformer to the outside air is through the housing. Size may be an important factor due to recent focus on pole space and attachment rights in some areas.

Modularity is a must for easy maintenance and quick restoration of power after a failure. Most manufacturers claim to have modularity even if they do not. True modularity will allow the cable operator to remove the electronic parts from the housing without disconnecting wires or removing excessive screws or other fastening devices. Modularity is also important when your local codes require that all connections to power be inspected. Some supplies have modular wiring harnesses that allow one to change all wiring in a matter of minutes if damage is due to lightning or mechanical abuse. In order to realize the full benefit of a modular system, the modules should be available in a variety of output current ratings. This will permit choosing a rating that will give the most efficient operation at the lowest possible cost in equipment and utility fees.

To summarize, there are many things to consider in the selection of a power supply that will fulfill your needs. If initial cost is important, you may select a lower efficiency, non-modular supply. If operating cost is a prime consideration, a high efficiency supply is the answer. For the lowest cost operation, a modular supply with a range of output settings is a must. This will allow you to pick a module that will operate at close to the full load rating (maximum efficiency) for each power supply location. Surge protection also can offer a wide range of choices and can add substantial cost to a supply if both input and output protection is used in addition to a time delay relay.

Finally, the reliability of any supply is important in order to prevent frantic phone calls from subscribers, especially when it's Super Bowl Sunday, fourth quarter, fourth down, long yardage and the score is tied.

The author wishes to thank Dave Cushman (for help in technical content) and Monia Bos.

Field powering of test equipment

By Bret Peters
Field Engineer, Tulsa Cable Television

It seems that 120 VAC can be had in a variety of flavors when it is obtained from somewhere other than the local power company. Spectrum analyzers, monitors and other types of gear designed for commercial 120 VAC power may not work on non-standard power sources. Sometimes, the devices fill the immediate area with the noxious odor of fried silicon then break down. Therein lies the challenge: deciding which of the available substitutes will operate test equipment with a minimum of side effects.

Accompanying this article are six groups of oscilloscope photos representing six types of 120 VAC power under three different load conditions. (See accompanying chart for specs of each waveform.)

- The top row refers to commercial power that has been through a magnetic type of regulating transformer. These are our reference waveforms.
- The second and third rows refer to two different 12 V input dynamotors (generators that use a DC motor to drive an AC alternator). One was rated at 500 VA, the other at 1,500 VA.
- The fourth row refers to a gasoline engine-driven generator rated at 1,600 VA.
- The fifth and six rows are inverters. The first unit, an improved inverter, is rated at 250 VA with a short duration overload capability of 500 VA. The second unit, a square-wave inverter, is rated at 400 VA continuous. Neither inverter is frequency regulated.

Test conditions

The three load conditions tested were *no load* (first column), *60 watt resistive* (second column) and *test equipment load* (third column).

- The "no load" waveforms show what might be produced by a given supply as well as provide a reference voltage to indicate regulation. Dynamotors were at 12 VA, the lowest load that would trigger the automatic turn-on circuits.
- The 60 watt resistive load was simply a light bulb. The purpose of the bulb was to see what the high frequency components would do when presented with a low impedance, non-reactive load. At ½ ampere, none of these units were strained to operate.
- The test equipment load consisted of a digital spectrum analyzer, its printer and 12-inch amber monitor, and an apartment-type CATV amplifier. Total load was 120 VA. The spectrum analyzer had a switching power supply; the other devices had transformered linear supplies.

While examining the photos, you will notice that peak-to-peak voltages reach as high as 670 volts. The "120 VAC" refers to RMS values, which are a function of peak-to-peak voltage and duty cycle (power under the curve). The duty cycle varies for different waveshapes. A true sine wave has a duty cycle of 70.7 percent, a perfect square wave is 100 percent and a triangle is 50 percent. Other waveforms will have duty cycles that are functions of their area in the same way. In order to estimate the duty cycle of these rather odd waveforms, the photos were enlarged and the

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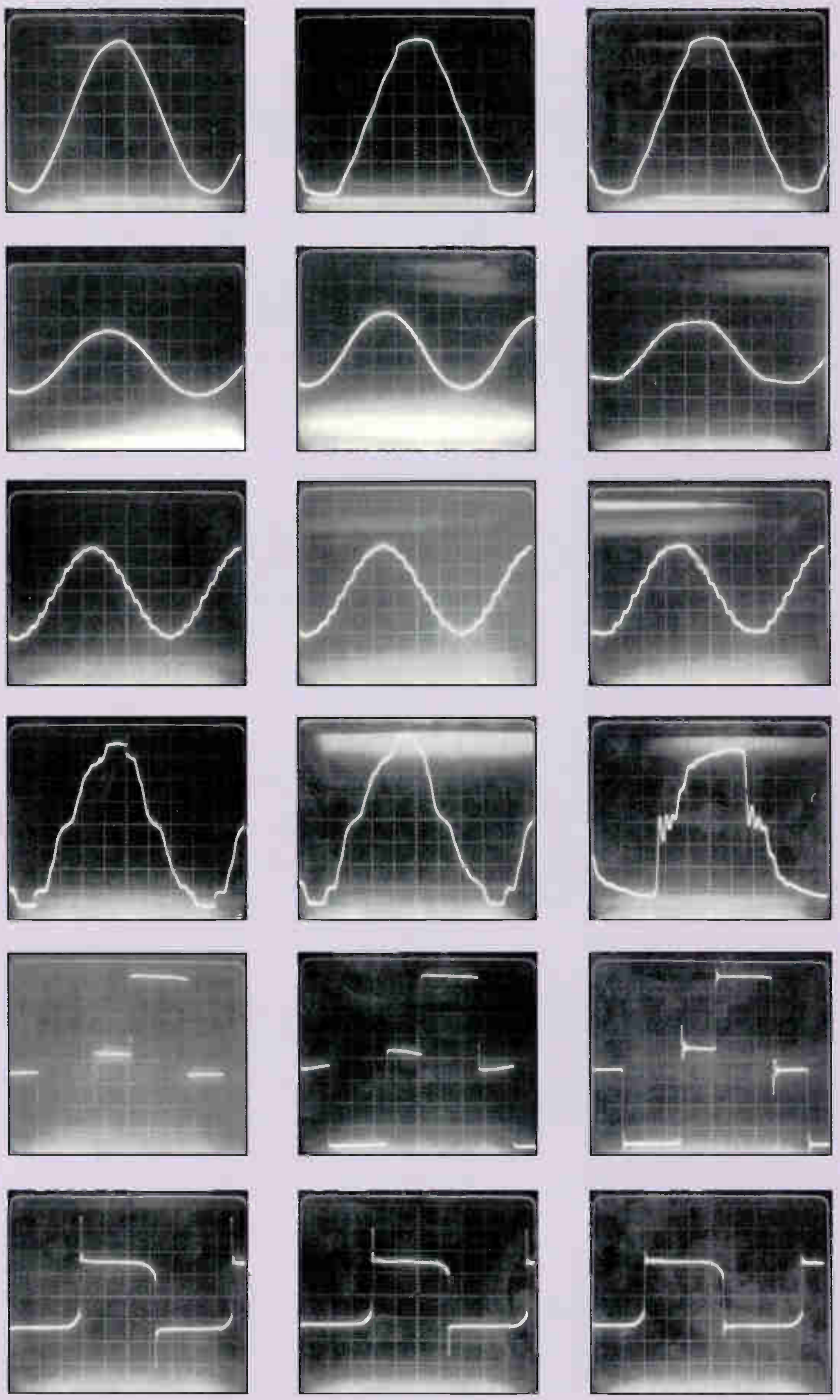
Oscilloscope waveforms of generators



area calculated against an imaginary square wave with the same peak value and zero crossings.

The two dynamotors provided the closest approximation of a sine wave of all the units tested. Both units tended to flatten out the peak of the waveform as they were loaded (increasing the duty cycle). The RMS value of the voltage also changed with load. The larger unit apparently was rated at something other than a light load, and this constant overvoltage condition eventually took its toll on the test equipment that had been previously used with it. The small dynamotor has given no trouble in service, but the low RMS value under load may cause problems when used with some types of gear.

The gasoline generator also approximates a sine wave. The duty cycle is slightly lower than 70.7 percent. Some types of equipment may have a hard time digesting the "chatter" at the zero crossings that developed under load.

The more sophisticated inverter has a square wave that pauses at the zero crossings briefly. This is designed to give a duty cycle and peak voltage approximating commercial power. It still is a square wave, with the associated high energy, high frequency components. The inexpensive inverter provides a pure square wave. Note the large spike in the output as the transistors in the multivibrator circuit "handoff."

What does it matter?

So what is the issue? As long as the RMS value is about 120 VAC, what does it matter what the duty cycle or peak-to-peak voltage is? Lower duty cycles mean higher peak-to-peak voltages for a given RMS value. These peak voltages can exceed the maximum voltage of the rectifier diodes in the power supply and will be especially true of switching supplies that have no power transformer.

Higher duty cycles mean lower peak voltages for a given RMS value. However, these lower peak voltages can fail to bring some types of high voltage power supplies to their normal operating level. TV sets in particular may show symptoms such as reduced raster size or foldover.

A general rule has emerged from this: A transformerless switching supply will have an easier time with higher duty cycle waveforms (those that have more power under the curve). The input diodes don't have to work as hard and the switch transistors may spend more time off. Also, transformer input supplies tend to prefer triangle waveshapes, since maximum power is transferred to the secondary when the input voltage is changing. A triangle wave is always changing—unlike a square wave, which pauses at peak value.

All of the mechanical generators develop fairly smooth waveforms, free of large damaging spikes and high frequency transitions. Line regulation is poor, however. As the load is increased, RMS voltages drop. Frequency regulation also is poor. The gas unit lags considerably due to hysteresis in the governor. If several devices are being operated at once and one is turned off, a surge will result that can damage the remaining equipment.

The test setup that served as the load for the third column of pictures did not work with the

Key to oscilloscope photos

Waveforms	No load	60 watt resistive	Test load
Reference waveform 50 V/vert. div. 2 ms/horiz. div.	Commercial power 340 p-p VAC 70.7 percent 120 RMS VAC	Magnetic regulator 340 p-p VAC 71 percent 120 RMS VAC	Magnetic regulator 340 p-p VAC 71 percent 120 RMS VAC
Dynamotor (500 VA rated) 100 V/vert. div. 2 ms/horiz. div.	320 p-p VAC 70.7 percent 113 RMS VAC	280 p-p VAC 70.7 percent 99 RMS VAC	260 p-p VAC 73 percent 95 RMS VAC
Dynamotor (1,500 VA rated) 100 V/vert. div. 2 ms/horiz. div.	400 p-p VAC 70.7 percent 141 RMS VAC	390 p-p VAC 70.7 percent 138 RMS VAC	380 p-p VAC 71 percent 135 RMS VAC
Gasoline generator (1,600 VA rated) 50 V/vert. div. 2 ms/horiz. div.	360 p-p VAC 69 percent 124 RMS VAC	380 p-p VAC 67 percent 127 RMS VAC	330 p-p VAC 62 percent 102 RMS VAC
Improved inverter (250/500 VA rated) 50 V/vert. div. 2 ms/horiz. div.	390 p-p VAC 66 percent 129 RMS VAC	380 p-p VAC 36 percent 125 RMS VAC	370 p-p VAC 66 percent 122 RMS VAC spikes 500 Vp-p
Square wave inverter (400 VA rated) 100 V/vert. div. 2 ms/horiz. div.	290 p-p VAC 92 percent 133 RMS VAC spikes 670 Vp-p	280 p-p VAC 92 percent 129 RMS VAC spikes 560 Vp-p	280 p-p VAC 92 percent 129 RMS VAC spikes 370 Vp-p

large dynamotor. An autotransformer had to be used to reduce the voltage.

Notice that as the load is increased, one of the inverters developed spikes and the other lost its spikes. The spikes could trigger the surge arrestor in equipment and, since these usually short to ground, could damage the inverter.

The inverters are affected by turn-on surges more than the mechanical ones, which flywheel. A small TV set pulled several amperes at turn-on due to the built-in degausser around the face of the picture tube. Both frequency and voltage were affected.

An inexpensive 13-inch color TV was used as a monitor. All of these generators degraded the picture in some form. The gasoline generator gave a sparkling hum bar (presumably from the sparkplug). The dynamotors put a low level, broad, light/dark hum bar in the picture. The inverters threw in about four lines, evenly spaced, that were darker than the surrounding video and traveled like a hum bar. The solution? Try another brand of TV set altogether. In this case, the replacement set did not show any of these defects.

Some practical notes

If you are using a truck with an open bed, then the fumes and noise from the gasoline generator will not be a large problem. If using a van, then you will have to set the generator out of the truck every time you use it. If you use the DC-to-AC converters, then these can be placed in the vehicle (follow the manufacturer's directions and warnings).

The DC-to-AC converters (both inverters and dynamotors) have large DC current requirements. If we stick to the VA measurement method, then estimation of these requirements is fairly straightforward and can be done mentally. Assuming 120 VAC RMS as an output and 12 V as an input then, neglecting losses, the DC current requirement will be 10 times the AC requirement. For example:

120 RMS VAC × 1.5 ampere = 180 VA
= 12 VDC × 15 amperes

In this example, we have ignored the efficiency of the generator. The DC current requirements will be increased by the inverse of the efficiency rating.

It was proposed that the large dynamotor be loaded down with lights or a heater to get the voltage down to a usable level. If 750 VA was used as a load (one-half the rated load), then we would have needed at least 75 amperes on the DC side. If you're thinking of using these for standby powering during storms and so on, then at the full-rated load of 1,500 VA the DC requirement will be over 150 amperes.

It was then proposed that another battery be added to the vehicle. This is similar to making a dam larger: We could drain the lake at a faster rate than the river flows for a while but soon we would have only the water provided by the river (alternator), since the reserve would be gone.

Obviously, the alternator on the vehicle will be called on to supply all of the current. As a practical matter, the vehicle will probably have an alternator rated at about 65 amperes. The limit that you can really expect to draw continuously from this is about 40 amperes. This leaves 25 amperes to run the vehicle accessories. If it's nighttime, raining and cold, then the accessories will be very greedy. Hence, the largest DC-to-AC converter that will be useful with an unmodified vehicle will be in the 400 to 500 VA range. This loading problem is why a full-rated load test of the converters was not done; we would very quickly bump into the limitations of the vehicle's ability to supply power.

Use commercial power

If you look at waveforms yourself, a tip is to power the oscilloscope from a commercial source. This will allow you to trigger from the line and see easily how far off the frequency of the alternate power source is and how much it changes with load.

We ended up using the most inexpensive inverter in the group. The test equipment didn't have a problem with it and neither did the new test TV. The spikes reduce to negligible under load; also, the set is quiet. More sophistication didn't appear to yield appreciably better results.

When selecting your power supply, ask your supplier for a trial period. You may need to step up or try another type with the equipment you are using. Last, ask your test equipment manufacturers for their recommendations before you power your gear from any source other than commercial.

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Reliability of high efficiency switched mode power supplies

By Peter Deierlein
Senior Engineer, Magnavox CATV Systems Co.

The switched mode power supply (SMPS) has proven itself for years in the computer industry. It appears to be useful for CATV applications because of its wide input voltage range, high potential efficiency and excellent power density. While it has been demonstrated the substantial cost savings possible by using high efficiency SMPS technology, quality and reliability concerns have led some operators to rely on linear technology. As will be shown, SMPS is potentially much more reliable than linear technology in the CATV environment.

Because components of CATV systems are typically well-shielded, grounded and interconnected with high quality shielded cable, it is easy to presume that all of a system's internal components are protected from external influences. However, as many a system operator can tell you, a significant proportion of unscheduled trunk line maintenance can be traced directly to the effects of lightning storms and power disturbances. Much work has been done to both describe the elements of these disturbances and their subsequent effects and the measures that may be taken to minimize them.

Since CATV systems must be coupled with a main power distribution network, electrical disturbances cannot be eliminated. In many practical cases, little can be done to significantly reduce surge voltage amplitudes, particularly those resulting from longitudinal sheath currents due to unbalanced loading of the power distribution system. Because power supplies are closely coupled to the power distribution network, they are generally most vulnerable to the effects of the disturbances.

A practical power supply must be rugged, reliable and designed for efficient operation under all conceivable worst-case conditions. To achieve this objective, all critical reliability factors must first be defined, with specific emphasis placed on those related to voltage surges. These factors can then be compiled with established performance goals and practical factors to yield an overall design specification. The ultimate objective is the realization of the best possible efficiency at reasonable cost while meeting goals.

Reliability factors

Quality components are important, but even "perfect" components will fail if they are subjected to conditions that exceed specified limits. For power supplies, there are three areas to consider: environmental conditions (temperature, humidity and other physical stress), load characteristics and source characteristics.

Environmental conditions can be the most critical reliability factor in the design of any electrical device, but they are relatively simple to determine. Ambient temperature range limits are specified, humidity can be anywhere from 1 to 99 percent (operation while submerged is generally not considered) and physical stress is predictable in most CATV applications. Individual component operating temperatures are calculated based on device dissipation under worst-case source and load conditions, thermal resistance and ambient temperature limits.

Load characteristics are also predictable. Worst-case short- and open-circuit conditions must be anticipated; load impedance is presumed to be anywhere between zero and infinity. The power supply output must therefore be current-limited and stable over this load impedance range. The reactive load component must be considered, but it is generally not critical to the reliability of a DC supply capable of handling a wide load impedance range. Since most modern SMPSs employ load current sensing for control reasons, extending their capabilities to manage worst-case load conditions is relatively simple. For use in CATV systems, power supplies also should allow the application of external voltage to the output terminals as well as offer protection from overvoltage transients.

Source characteristics are affected by many variables considered uncontrollable from the designer's point of view. For any power supply operating from the power company mains, worst-case source analysis concentrates on characterization of input voltage variations, known as transients, surges, spikes, sags, dropouts, brownouts and others. For the purposes of this analysis, this group of input voltage variations (often collectively referred to as "transients") will be broken down into two distinct areas: high amplitude, short duration pulses and low amplitude, long duration voltage surges and sags.

The characteristics of short duration transient pulses and their effects on electrical equipment have been well-documented. IEEE Standard 587 defines three classes of exposure and three basic types of pulse waveforms for devices connected to the mains. But since CATV DC power supplies are not connected directly to the mains, the standards cannot be directly applied.

IEEE 587 Class C, however, applies to outdoor service drops and overhead lines and may therefore be applied to the input of the line power supply (LPS), used to provide power to the cable system. Class C specifies a peak voltage of 10,000 volts for 50 microseconds into a high impedance load and a peak current of 10,000 amperes for 20μs into a low impedance load. These amplitudes would be expected if the mains were struck directly by lightning; they reflect a source impedance of 1 ohm and a sparkover voltage of 10 kV.

"A practical power supply must be rugged, reliable and designed for efficient operation under all conceivable worst-case conditions."

When this pulse passes through the LPS, the amplitudes are reduced considerably due to the LPS internal impedance and to the cable sparkover voltage. Based on the output rating of the LPS and the physical characteristics of the cable, the total source impedance at the LPS output would be approximately 5 ohms, sparkover voltage would be no greater than 5 kV, and peak current would be expected to be under 2,000 amperes. This peak current value is in line with the highest pulse voltage recorded on the cable under actual field conditions of 3,600 volts. It is lower than the maximums of 6 kV and 3 kA specified by IEEE Standard 587 Class B, which applies to major feeders and short branch systems in residential and light industrial applications.

CATV technicians have observed low amplitude, long duration AC voltage surges for some time. Potentials of over 100 volts (RMS) have been recorded for periods exceeding one second and sometimes lasting for hours or days. J.C. Herman and J. Shekel identified the source of these surge voltages in 1975 as due to longitudinal sheath current, or AC current flowing in the cable sheath.[1] In a three-phase balanced "Y" power company distribution circuit, single-phase loads are applied between earth ground and each phase. Since the power company only balances the system within 20 percent (as seen by the source), current flow in the neutral wire results. The cable system is frequently routed parallel to the mains and is usually bonded to the neutral wire either directly or through ground cables and drops, resulting in significant current flow in the cable sheath. The resulting AC voltage potential may add to or subtract from the cable voltage supplied by the LPS, depending on its phase and distance from the LPS. While the earth ground resistance varies widely depending on soil moisture, composition and ground rod penetration, earth ground resistance is generally much higher than the neutral wire resistance; therefore, its influence is minor.

According to Herman and Shekel, four power companies surveyed limit their maximum neutral currents to between 5,000 and 10,000 amperes for a maximum of six cycles, with typical values between 200 and 3,500 amperes for periods exceeding one second; circuits are limited to these values by fuses and relays. Based on a worst-case resistance of 0.28 ohm per 20 dB span at 300 MHz for .500 cable in parallel with #6 copper neutral wire (ground resistance ignored), voltage potentials of up to 2,800 volts are possible for short periods (0.1 second). Potentials between 56 and 980 volts are possible for periods over one second. These maximum amplitudes could be expected any time a severe overload occurred in the power network, such as a short circuit caused by wind or an auto accident. Since these values are only valid for one cable span, much higher amplitudes would be possible at stations

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In November 1988, JONES INTERCABLE of Madison, Wisconsin purchased a RISER BOND Model 2901B+ TDR. We were a little skeptical of an instrument that sells for under $800.00 that supposedly will do the same thing (locating faults in cable) as an instrument that sells for over $6,900.00.

We at JONES INTERCABLE in Madison are impressed! The instrument totally surpassed our expectations. We have found the instrument to be invaluable. It is safe to say, IT HAS PAID FOR ITSELF FIVE TIMES OVER IN ONLY FOUR MONTHS.

Case #1: In an 800 ft. span of .500 cable, we were experiencing a higher than normal attenuation of RF, as well as a large loss in AC. A JONES technician put the 2901B+ to the test. He put .500 to F fittings on the cable and took readings from each end. He proceeded to dig-up the fault at the distance indicated by the TDR, found the problem, and restored full service in less than three hours!

Case #2: We had a similar situation with a 1300 ft. .750 trunk run. After pinpointing the fault with the 2901B+, we went in with a slit trencher and a back hoe. We were off by only 6 inches! The cost savings is multiplied when I explain that this was done in 24-30 inches of frost. This is a scenario where being off can cost $100.00 per foot! With wind chills of 20-40 below zero, no one wants to be on a roadside any longer than necessary.

We have more examples, but so far, all have been happy endings thanks to the RISER-BOND INSTRUMENTS Model 2901B+.

Although the Model 2901B+ is simple to operate, we opted to purchase the instructional video tape for only $35.00, again, some of the best money we ever spent. This gave our JONES technicians the confidence to trust the instrument, as well as giving them a good understanding of the principal of a TDR. Did we need the video tape? NO, but it did help.

For a very cost effective, easy to operate, dependable, highly accurate cable fault locator, you can't beat the RISER-BOND 2901B+!

Thank you.

Joe Browning

Joe Browning
Chief Engineer

2984 Triverton Pike Road, Madison, Wisconsin 53711-5897 (608) 273-4800

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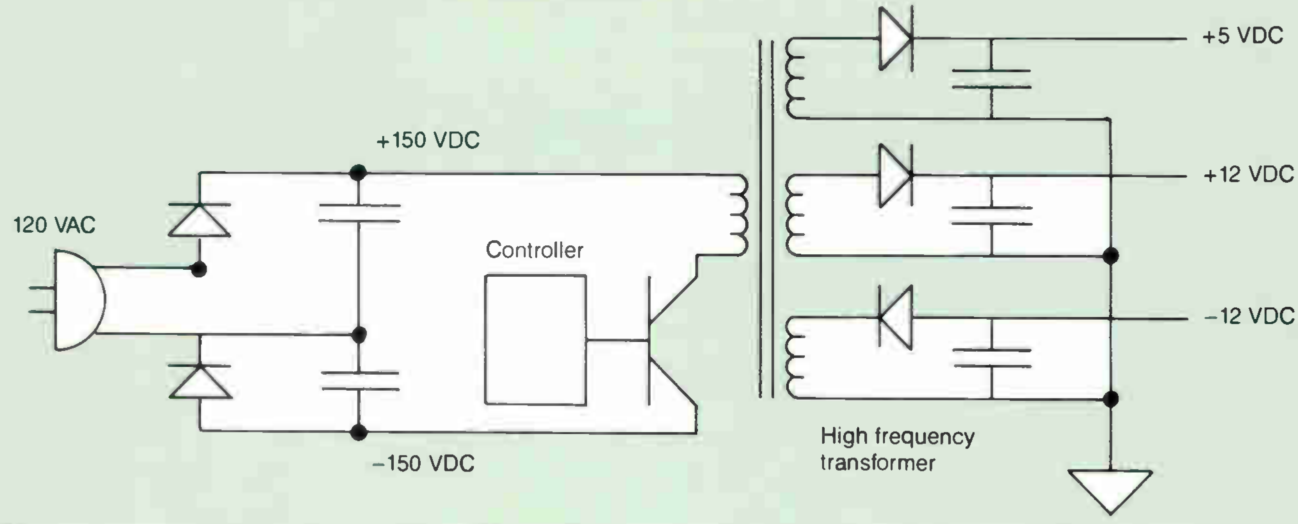
Reader Service Number 44.

Figure 1: Off-line switched mode power supply



more distant from the LPS.

It is clear that the transient surge and pulse amplitudes present a substantial hazard. CATV equipment designers have traditionally relied on the gas discharge surge arrestor (GDSA) for protection. Under surge conditions, the impedance of the GDSA in its arcing condition drops to less than 0.1 ohm, which means that the majority of the surge energy is dissipated in the cable and in the LPS.

Commonly used GDSAs are rated for breakdown voltages between 145 and 150 volts, with a typical tolerance of ±20 percent. They also have maximum current ratings of up to 20,000 amperes for short pulses and 200 amperes for longer surge durations. While 180 volts is therefore the highest worst-case continuous surge voltage at the power supply input—because GDSAs are slow to respond to fast transient pulses—additional protection is required. This protection can be provided by a standard clamping device such as a varistor.

Complexity: Relative complexity is a very significant reliability factor. It directly affects the impact of many quality factors in manufacturing and testing such as component quality, workmanship and process control. If a design employs many additional circuits to minimize the effects of other stress factors, overall reliability will decrease due to the increase in components and in process requirements. An important design objective, therefore, is to meet the reliability, ruggedness and performance goals with a minimum number of components.

Most performance goals and practical factors are fixed by the physical and electrical requirements of the application. For a typical CATV mainstation application, a modern SMPS is generally required to deliver a highly filtered DC output current of 2.5 amperes or more at 24 volts. Unless it is intended for a totally new application, the SMPS must fit into the space occupied by the unit it replaces. Its minimum input voltage must be compatible with the system design, and conducted and radiated noise levels must be below the existing equipment's susceptibility limits. The new unit also must meet requirements of worst-case environmental, source and load characteristics.

The ultimate performance goal is to optimize efficiency, reliability and ruggedness of the power supply. Recent advances in SMPS technology promote significant reductions in circuit complexity and dissipation, both of which affect reliability. Since additional increases in efficiency can be achieved through further reduction or elimination of component dissipation (known to be a major factor in component failure), increases in efficiency can have a major positive impact on reliability.

SMPS technology

The SMPS has recently become a competitor in the overall power supply market, primarily because the common "off-line" variant eliminates the requirement for a heavy AC power transformer. This power supply also can deliver more than one regulated output voltage using only one regulator circuit. The off-line power supply converts the 120 VAC line power directly to high voltage DC through simple rectification and filter (thus its name). A high speed switching circuit drives a special high frequency power transformer with a separate secondary winding for each output voltage (Figure 1).

The switching circuit regulates one output by varying the pulse width sent to the transformer; the other outputs are regulated through tight coupling of the secondary windings. Well-insulated from the primary windings, these secondary windings provide the required isolation from the AC line. Since there is no lossy linear regulating element, the efficiency of this arrangement could easily exceed 90 percent. But copper and core losses in the high frequency transformer reduce the overall efficiency to between 70 and 80 percent—a considerable improvement over the typical 50 to 70 percent efficiency of conventional linear types. Early units were very susceptible to failure as a consequence of power line surges. Recent units have relatively good reliability because of higher voltage ratings on critical parts and better protection through the use of inexpensive MOV (metal oxide varistor) surge arrestors.

CATV manufacturers quickly recognized the advantages of excellent efficiency across a wide input voltage range. Most CATV SMPS versions, however, retained the AC power transformer and converted the rectified secondary voltage directly to the single output voltage without the loss of the high frequency transformer. Retaining the AC transformer allows use of the "crowbar" secondary surge limiting method; it permits the use of low cost, low voltage switching circuitry (Figure 2). Overall efficiency, however, is limited to between 65 and 75 percent because of transformer dissipation and normal switching loss.

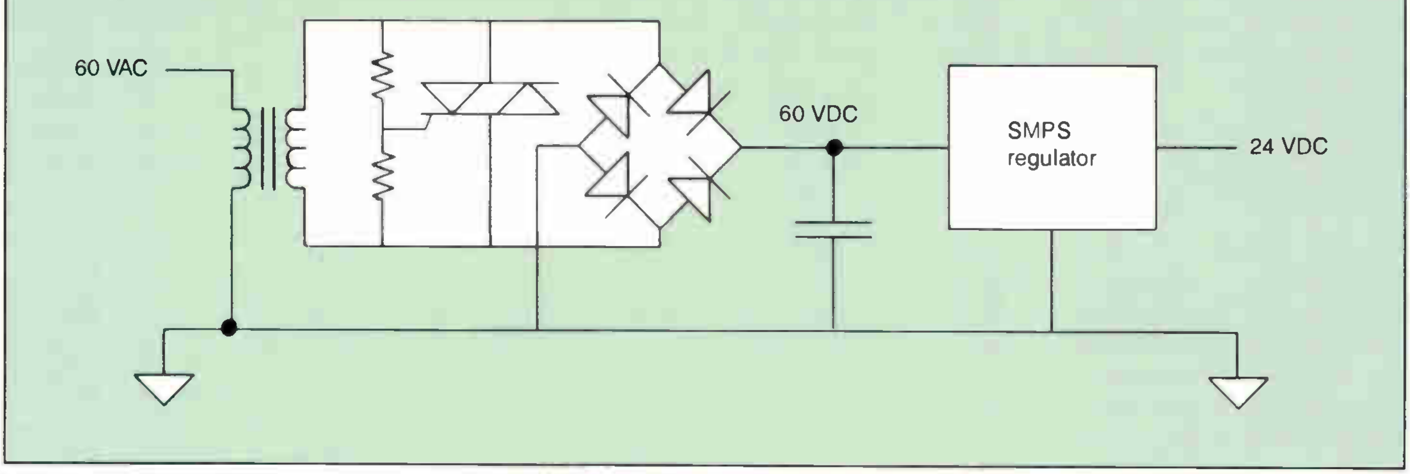
Since the CATV application does not require isolation between AC and DC grounds (in fact, they are required to be connected), a lossy transformer is not required and over 90 percent efficiency is attainable using a high efficiency "buck" SMPS circuit. A voltage doubler is required to raise the unregulated DC buss voltage to 120 volts (nominal) for wide input voltage range operation. This is true because while a buck converter is capable of step-down ratios of over 20:1, it is not capable of step-up operation (Figure 3).

Referring to our discussion on source characteristics, it is apparent that high voltage rectification, filtering and switching components are required if the circuit is to survive worst-case surge conditions, particularly those due to longitudinal sheath current. While use of a GDSA will limit surge amplitudes to 180 volts, many components have to withstand a minimum of 360 volts because of volt doubler action.

Similar conditions encountered in off-line SMPS use have made components rated for operation to 500 volts readily available at reasonable prices. To handle the much higher amplitude short duration pulses, a standard MOV rated for IEEE 587 Class B 120 VAC residential environments will limit the voltage of any pulse whose rise time is too fast to be clamped by the GDSA.

In early SMPS designs, control circuits were made almost entirely of discrete components; many additional protection circuits were necessary to maintain control under worst-case conditions. As a result, well over 100 parts were

Figure 2: Transformer type CATV SMPS with "crowbar" surge limiter



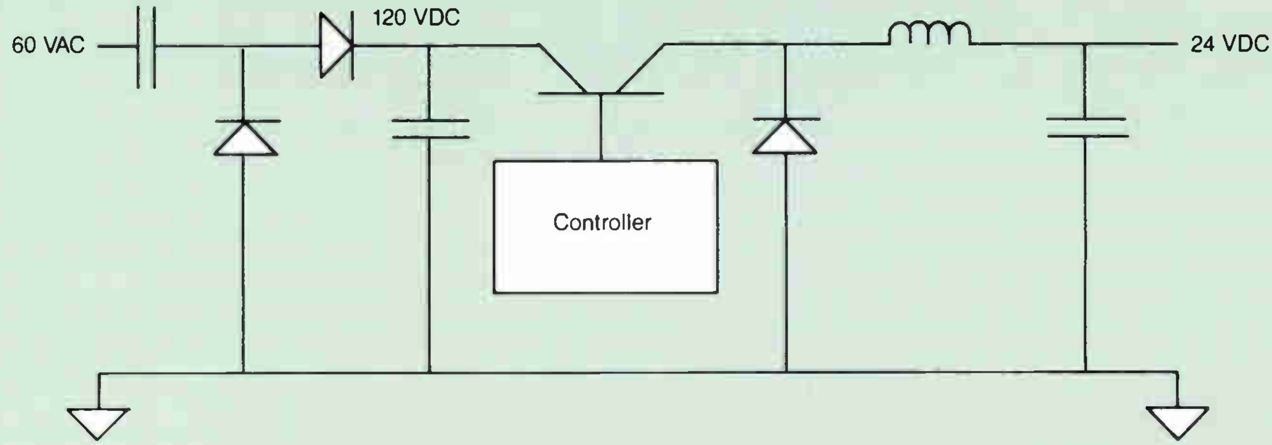
typically required, circuits were complex, critical parameters were difficult to control in mass production and many adjustments were required. Today, SMPS technology has begun to mature. Fourth generation monolithic devices have appeared (requiring only two or three additional components to form a complete regulator circuit), with complete protection from worst-case conditions and no adjustments required. Unfortunately, these devices are typically rated for maximum input voltages of only 40 to 70 volts; they are not suitable for CATV or off-line use. While the IC manufacturers are now working on monolithic processes that will permit "high voltage" operation, even the most optimistic designers are not claiming capabilities over 200 volts in the near future.

There are also a number of new general purpose ICs capable of driving discrete high voltage transistors directly. Built into these ICs are nearly all the circuits required for state-of-the-art performance. With proper isolation, they may be used to control most CATV or off-line SMPS units with the addition of only 10 to 15 external components.

Lower dissipation

Transformerless switched mode power supplies can be designed to operate under the most critical worst-case conditions present in CATV applications. Compared to conventional linear power supplies, SMPS units have considerably lower dissipation under normal operating conditions and far lower dissipation under surge conditions. SMPS dissipation is a design consequence, while dissipation of linear units is primarily a function of the voltage difference between the unregulated DC buss and the output. A 60 watt (output), 90 percent efficient SMPS dissipates less than 7 watts while a 75 percent efficient unit would dissipate 20 watts. A series-regulated linear power supply would dissipate

Figure 3: Transformerless CATV "buck" SMPS



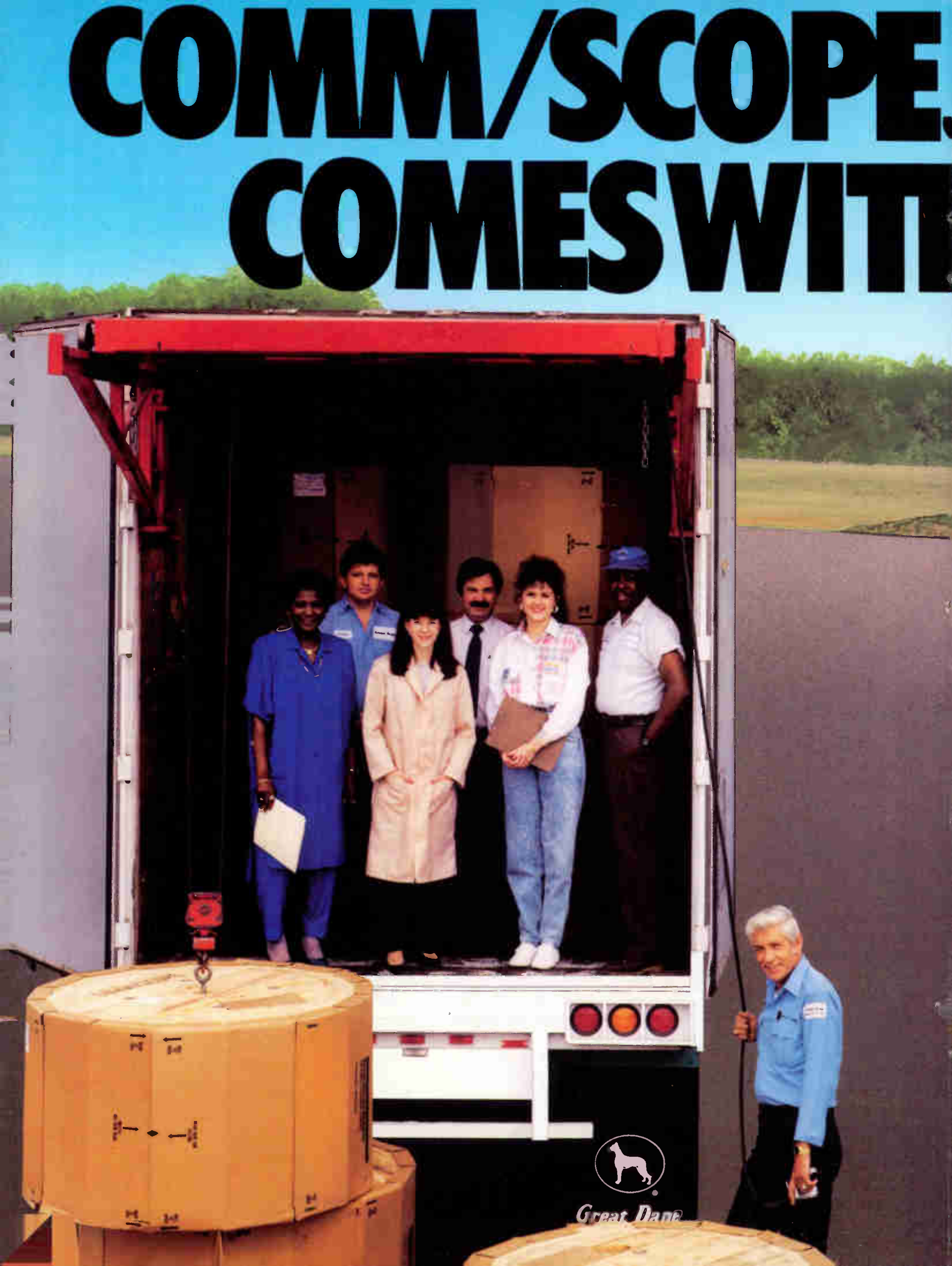
25 to 60 watts under the same operating conditions and substantially more if the wrong primary tap was selected. Under 150 volt surge conditions, dissipation of the 90 percent SMPS unit would be expected to increase only slightly to around 10 watts, while dissipation of SMPS units with AC transformers would increase much more due to core saturation in the transformer. Dissipation of series-regulated linear types can increase to well over 300 watts during the same surge conditions.

Many linear and SMPS units with AC transformers use secondary crowbar circuits to limit internal dissipation and consequent damage under surge conditions. This approach causes very high primary currents and transformer dissipation; it often results in service interruption due to blown fuses or damaged equipment. Because the transformerless SMPS can convert the surge energy directly to load power with minimal additional dissipation, stress to the SMPS, the LPS, the amplifier and all components of the cable system is avoided. Thus, overall reliability is enhanced.

Reference

[1] Herman, J.C. and J. Shekel. "Longitudinal Sheath Currents in CATV Systems," *IEEE Transactions on Broadcasting*, Volume BC-21, Number 4, December 1975.

Acknowledgements: The author would like to acknowledge the guidance provided by the following people in the conception and preparation of this article: Gordon Lehman, James Godwin, Dieter Brauer, Willem Mostert and Larry Richards.



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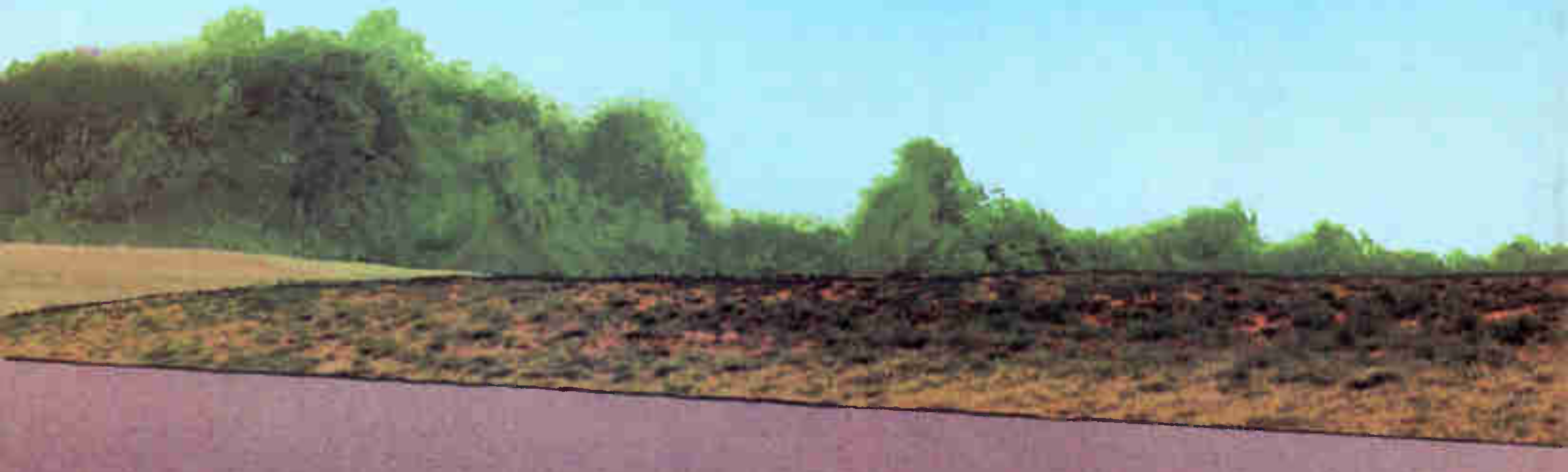

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Reader Service Number 46.

Lightning damage susceptibility of fiber

As the growth of fiber-optics technology continues in the CATV industry, greater emphasis is being placed on cable reliability. One of the most common concerns is the optical cable's ability to withstand a lightning strike. This article presents a practical outlook on the lightning damage susceptibility of some of today's optical cable designs. The objective of this study was to establish upper limits of performance for these designs. These results are intended to give users insight as to the long-term reliability aspects of installed cables and fiber-optic systems.

By Richard E. Clinage
Supervisor of Marketing Support

And James J. Scott
Senior Product Specialist-Cable TV, Siecor Corp.

Concerns first began in the communications industry when statistics showed that many system breakdowns were due to lightning damage. Copper cables suffered pair-to-pair and pair-to-ground faults. These electrical installations also contained very sensitive solid-state devices that were vulnerable to even low levels of surge current caused by lightning. The introduction of fiber cables has relieved some of these concerns; however, some manufacturers have been unable to take full advantage of their all-dielectric nature in all cases. Faced with a lack of alternatives, manufacturers often utilize metallic components to provide for low-cost strength elements or optimum mechanical/rodent protection. As with copper cables, lightning is attracted to these metal components because of their effective ground potential.

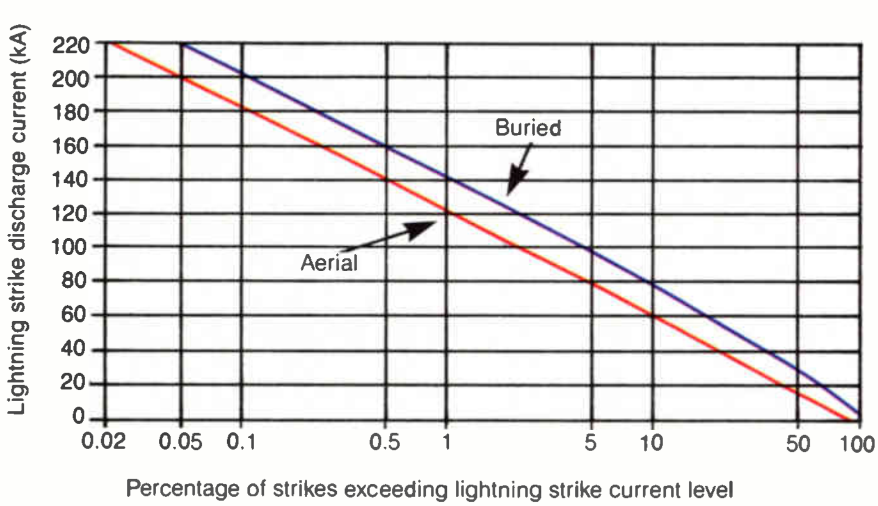
Cable lightning damage was originally expected to occur only in aerial installations; however, it was soon recognized that buried applications were not completely immune. In principle, lightning arcs to cable when the resistance of the surrounding air or soil is greater than the resistance of the cable system. The potential for lightning damage is expected to increase as the number of lightning strikes, the duration of the strike, strike current and the surrounding air or soil resistivity increase.

The single most important lightning parameter is the level of current discharged during a strike. Most lightning discharges range from a few hundred amperes in strength up to several hundred thousand amperes. The average lightning strike is between 20 and 40 kA. Ninety-five percent of all lightning strikes occur at less than 100 kA (Figure 1). A map of the most susceptible lightning areas across the United States is shown in Figure 2.

Lightning can cause extensive damage to cables, resulting in immediate system failure or a slow degradation of optical and mechanical performance. Since one of the benefits of fiber technology is the improvement in system reliability, lightning-induced failure should be a major concern. The easiest way to avoid lightning problems is to use an all-dielectric cable design wherever possible. If an armored cable is required, such as in direct buried applications or aerially where there is a known rodent problem, the cable's ability to withstand lightning damage must be considered.

Lightning causes cable damage in two ways. First, intense heat is often generated during the strike, causing both plastic and metallic components to be severely burnt or instantaneously vaporized. Secondly, lightning can result in severe mechanical crushing forces capable of crushing fiber cables and even metal pipe.

Figure 1: Distribution of maximum current discharged during lightning strikes



History of lightning testing

For many years, numerous studies have been performed in an attempt to understand the fundamental behavior of lightning. To date, three methods have been developed to evaluate the performance of cable. They are the magnetic crush test, the longitudinal current test, and the arc discharge or "sand box" test.

A review of the principles of these three tests yields two basic scenarios. Lightning damage occurs due to either a direct strike or by a strike in the vicinity of an object. Previous studies have shown that crushing and burning of buried cables can result from magnetic field effects caused by lightning. The magnetic crush test simulates a lightning strike in the vicinity of a cable; i.e., not a direct strike. The degree of physical damage to the cable is a function of the electrical and circumferential conductivity of the sheath and crush resistance of the cable core design. The higher the conductivity of the shield or armoring, the greater the crushing effects.

The longitudinal current test simulates the ability of a cable (with metallic components) to with-

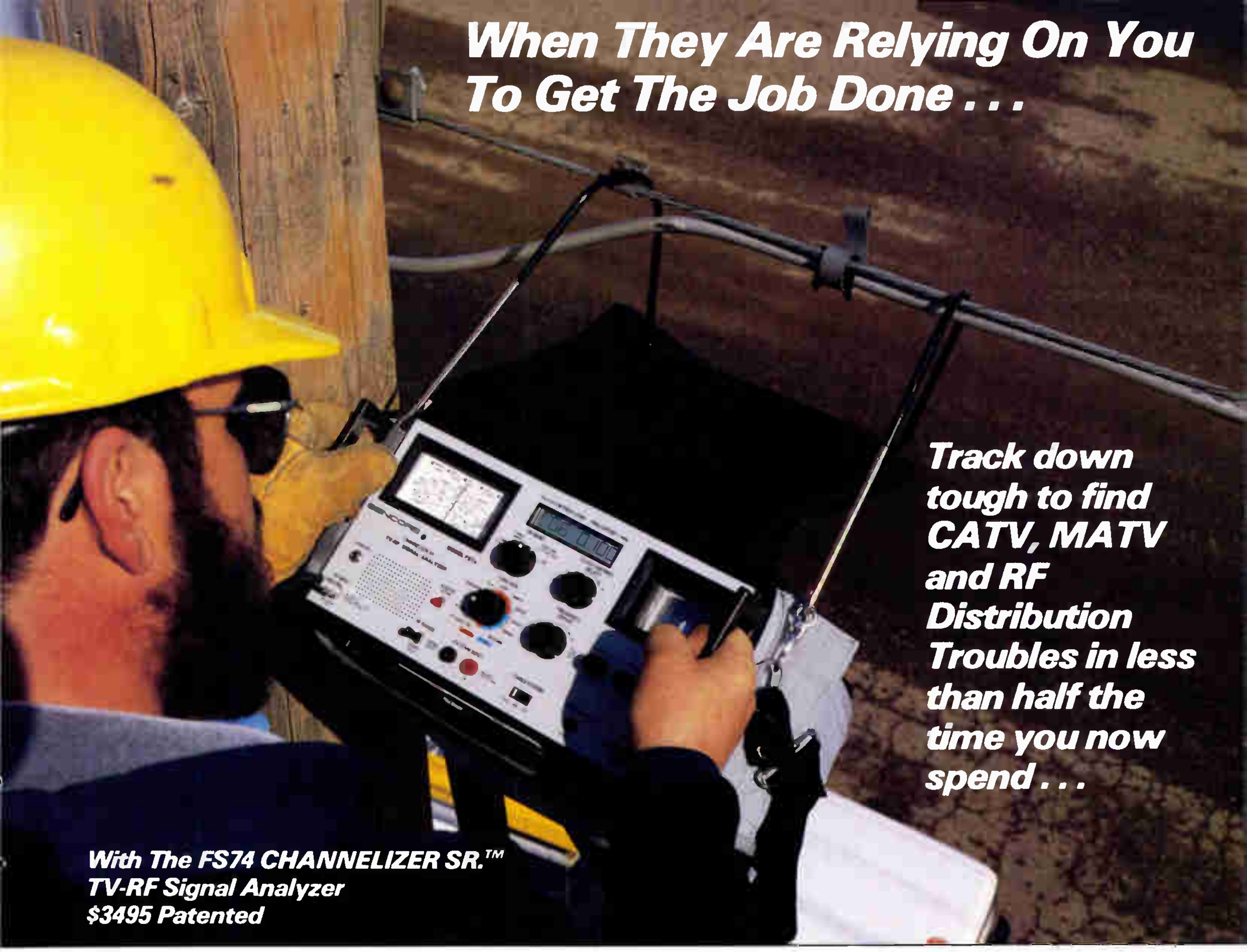


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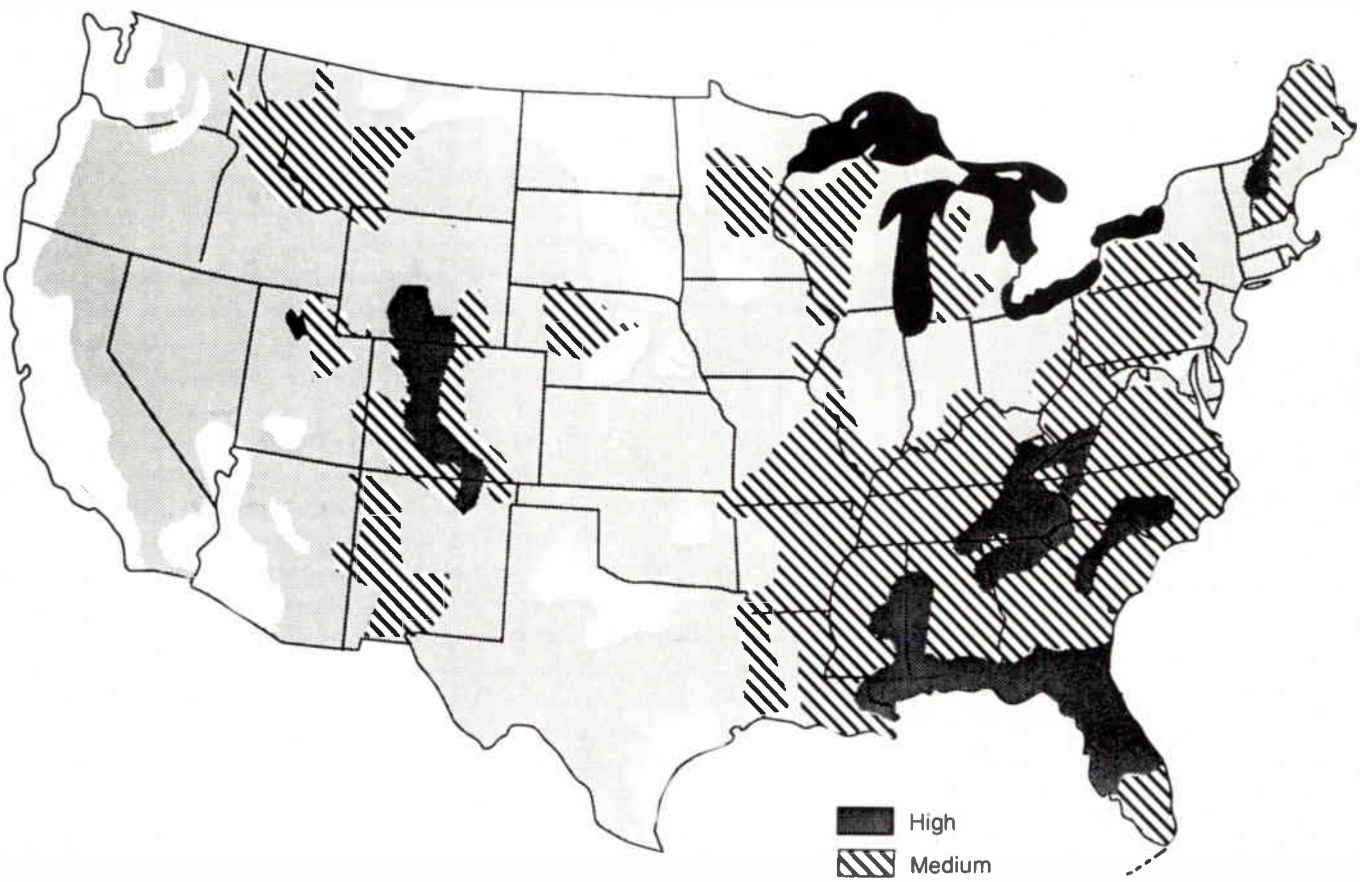
Figure 2: Estimated lightning exposure factor for buried cable



Lightning exposure factor = $\sqrt{\rho_{soil}}$ × annual thunderstorm days

stand very high levels of surge current. The cable's ability to quickly dissipate this current following a lightning strike helps to minimize the damage caused by further arcing, burning or charring.

The arc discharge or "sand box" test simulates a direct lightning strike to cables. Both the cable's ability to withstand extremely high crushing forces and carry high levels of surge current are evaluated in this test. Although there is still much discussion as to the accuracy of these tests and how they relate to the real world, there has been a consensus in the cable industry that the proposed sand box test is the most difficult test to pass even with today's best cable designs. Based on this fact, the sand box test was chosen for our evaluation.

The sand box test was originally developed by Bell Laboratories in the 1960s. Since then, Bellcore and various standards organizations, such as the Electronic Industries Association (proposed EIA FOTP 181) have adopted this method to characterize fiber cable performance. A schematic of the test setup is shown in Figure 3.

The sand box test utilizes a 0.75-meter (30-inch) square box filled with 20-40 mesh damp, packed sand. The depth of the electrode within the box is approximately 30 cm (12 inches). Cable specimens are 1 meter (3.3 feet) in length. Cables are placed horizontally within the box such that the end of the electrode (within the box) is approximately 2.5 cm (1 inch) from the cable sheath. Both ends of each specimen are stripped back and all metallic components are electrically shorted to ground. A small pinhole is burnt in the cable's sheath to ensure that the arcing occurs at the point directly facing the electrode. During the test, the arc discharges its energy from the electrode to the cable where it then flows through the cable to ground.

Two of the most common concerns today in the outside plant are lightning and mechanical/rodent protection. It is our position that all-dielectric cable eliminates concerns of lightning damage because it does not contain the metallic components that attract lightning. So aerial applications should use an all-dielectric cable when possible. Because of this relative immunity to lightning damage, all-dielectric cable designs were omitted from our study.

When additional mechanical/rodent protection is necessary, in either buried or aerial environments where squirrels, birds or gophers are known to cause problems, field results have shown that the best rodent protection is provided by a steel tape armored design. Unfortunately, lightning, seeking a path of least resistance, occasionally arcs to these metal components.

The objective of this study was to evaluate currently available metallic cable sheath constructions and establish upper limits (maximum lightning strike current levels) for their practical use. Previous studies of this kind have concentrated on the performance of the outer cable sheath only. Cables with longitudinally applied copolymer-coated (steel) armor have consistently shown superior lightning performance to other sheath armor options in lightning test evaluations. Failure criteria is typically based on whether the fibers break during the lightning strike. From a more practical standpoint, this study examined the total damage incurred as a result of the strike, including the outer cable sheath and core materials as well as fiber damage (breaks).

Results of testing

Testing ranged from 50 kA (lightning strike current) to 229 kA, which accounts for greater than 99.9 percent of the recorded lightning strikes to aerial or buried objects. For each sample tested, every layer of outer sheath (polyethylene jacket and armor) was removed and photographed following the strike. Close examination of the cables revealed that the damage mechanisms were both severe mechanical crushing and burning effects located at the point where the arc's energy was transferred to the metallic components of the designs tested. As expected, the damage to cables became slightly greater as the current levels were increased. →

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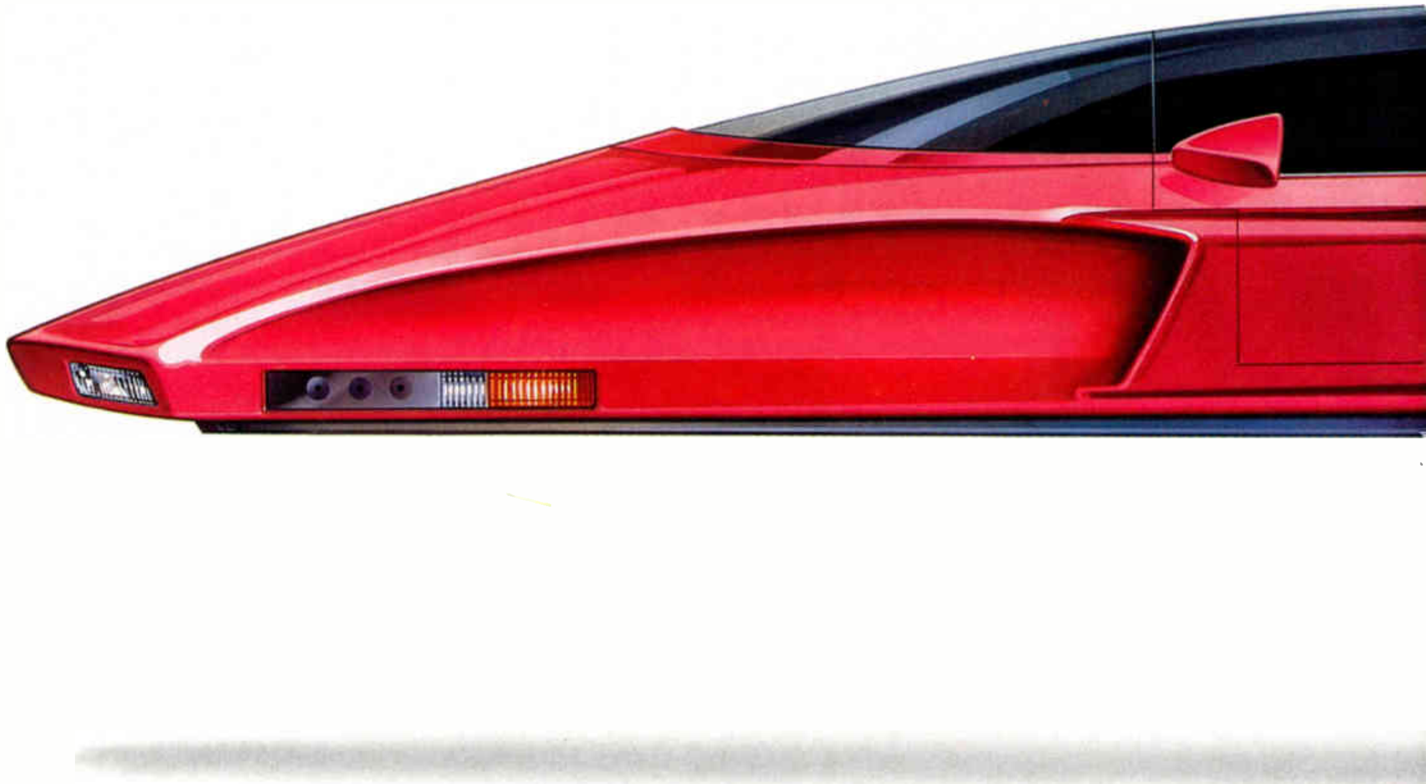


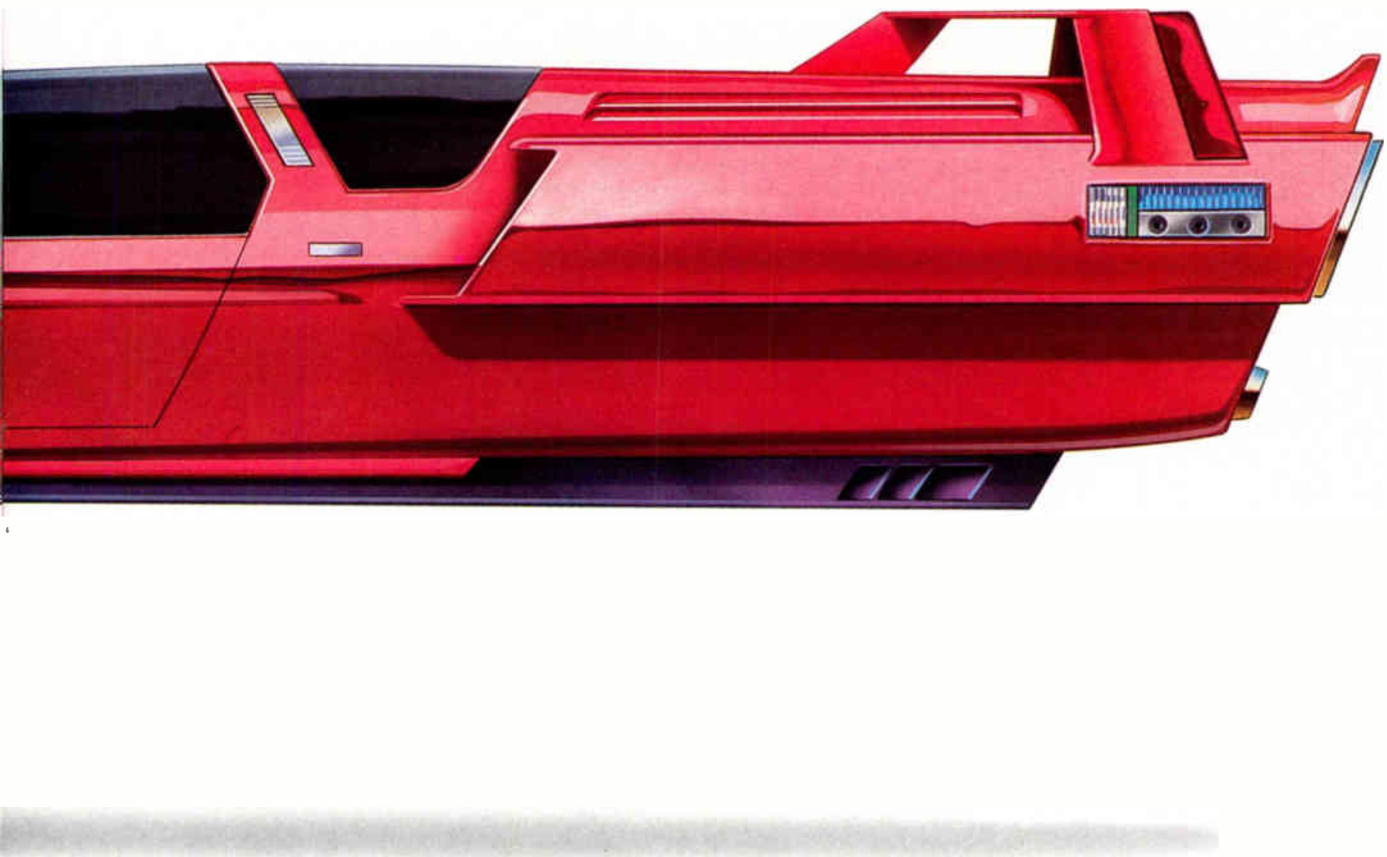
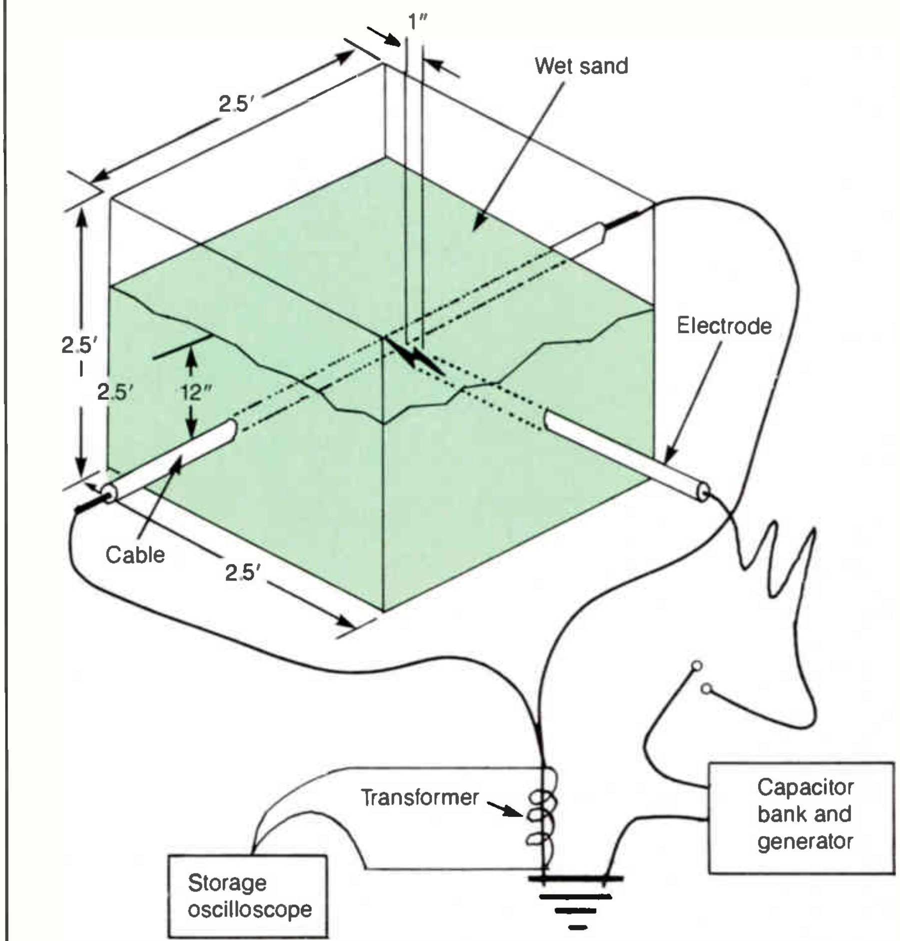


Figure 3: Arc discharge sand box test



Siecor armored Mini-Bundle cable (copolymer-coated ECCS steel armor): No significant damage occured to the inner sheath and no core damage occurred on this design tested to 115 kA. Only the outer jacket and armor was penetrated at current levels as high as 150 kA. At higher levels, to 229 kA, only minor damage occurred to the inner jacket and again no core damage occurred.

Siecor Maxi-Bundle cable (copolymer-coated ECCS steel armor): At current levels of between 50 and 150 kA, no significant cable core crushing or thermal damage occurred. At levels above 150 kA, some tests showed minor tube crushing and burning. No fiber continuity failures occurred at levels as high as 205 kA. Throughout all of this testing, 100 percent of the fibers remained unbroken.

Single-core tube design/multiple wire strength member sheath: Two designs were tested, one containing a copolymer-coated steel armor and the other containing a copper/stainless steel armor. The first design showed severe core damage and fiber breakage occurring at current levels as low as 60 kA. The second design tested showed severe core damage occuring at current levels of 80 kA with fiber breaks occurring at approximately 100 to 110 kA.

Discussion of results

Results show that the dominant damage mechanisms of lightning strikes are both severe mechanical crushing and thermal effects. Given this, a well-designed fiber cable must have good compressive strength and high temperature resistance properties in both the sheath and the cable core. At high current levels, the outer sheath and armor contribution to the cable compressive strength are overwhelmed by the material properties and the geometric design of the cable core. Consequently, more crush resistant, higher temperature cable core designs will provide the best lightning performance characteristics.

Traditional evaluations of cable crush resistance do not adequately address the crush resistance of the core only. For designs with little or no core crush resistance, all of the cable crush resistance must be placed solely in the outer sheath. While this technique is useful in providing an acceptable level of overall cable crush resistance, it does little to protect the cable core and fibers from damage due to the crushing effect that results from a lightning strike. In addition, because all of the crush resistance is present in the outer sheath, the cable can be stiff and very difficult to handle and strip. The optimum design is to spread the overall cable crush resistance across both the core and the outer sheath. This results in a cable that offers superior lightning protection, high cable crush resistance, as well as a cable that is easy to strip and work with in the field.

Using fiber in rebuilds and upgrades

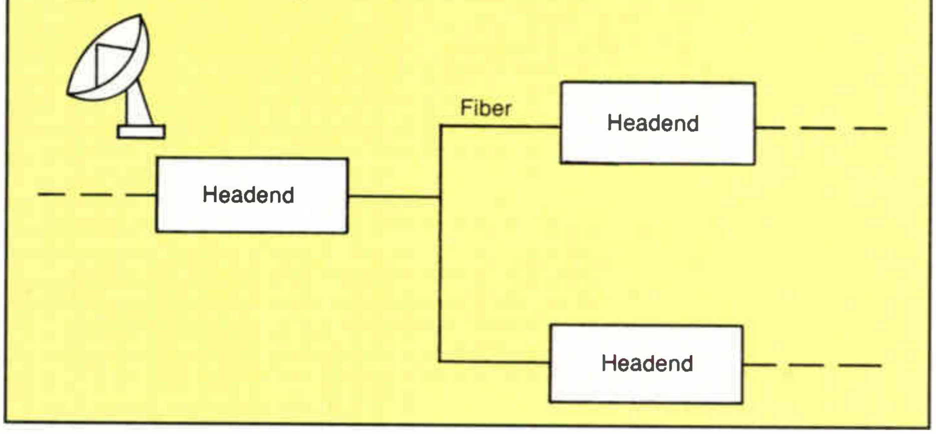
By Geoff Roman
Vice President of Marketing
Jerrold Distribution Systems Division, General Instrument Corp.

Fiber-optics technology has a variety of applications in rebuilding and upgrading cable systems. The list of possible situations where the technology can be employed might seem endless.

Perhaps the easiest place to see the application of fiber is in the reduction of long amplifier cascades. There are some instances where cascades of 60 or more amplifiers are now in operation. A simple calculation is all that's needed to show that the picture quality at the end of the cascade is less than that desired. For example, with a 70-amplifier cascade providing 36 channels and using power doubled trunk and bridger amps and conventional line extenders, subscribers at the end of the line would see approximately 43 dB carrier-to-noise (C/N) and −55 dB composite triple beat (CTB).

FM fiber supertrunking (Figure 1) offers a potential performance solution at a cost of about $3,800 per channel and 75 cents per foot of fiber cable. Two alternatives are available for the deployment of FM supertrunking. The simplest is to divide the cascade in half at the midspan amp (36th amp in the previous example). A supertrunk link is virtually transparent so that for all practical purposes the performance at the input of the 36th amp is the same as that of the headend. At the end of the line C/N has improved to 46 dB, with CTB improved to nearly −59 dB.

Figure 1: Fiber-optic supertrunk

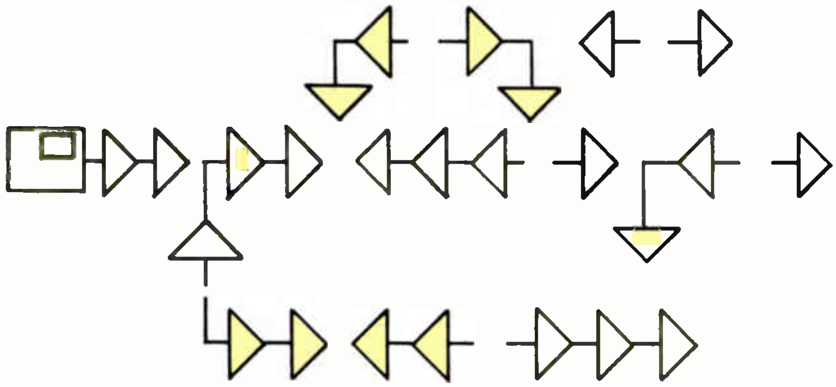


An alternative approach is to extend the supertrunk to a point two-thirds the distance of the cascade from the headend. The amps between one-third and two-thirds the headend distance are then reversed. This approach for the example discussed earlier yields a maximum cascade of 24 amps and a corresponding C/N of 48 dB and a CTB of −60 dB at the tap.

Each approach has its advantages, but the first is easier to implement. If the fiber cable is installed in a different route than the coax it replaces, the coax can be used as a backup path in the event of a break in the fiber. The second approach yields the most significant signal quality improvement but requires the direction of 23 amps (in the example) to be reversed.

Replacement of amplitude or frequency modulated microwave links with the optical supertrunk is another straightforward application. FM fiber links having a signal-to-noise (S/N) greater than 60 dB can provide performance improvement when compared to all but the best micro-

Figure 2: Fiber-optic backbone overlay of CATV system



wave links. Further, fiber links are immune to rain fade and terrestrial interference.

Increased bandwidth

HDTV and its transmission requirements are subjects of much concern and discussion today. The situation is worsened by the fact that there is no HDTV standard and several of the proposed systems are not developed to the point that a transmission scheme has been identified. However, despite this uncertainty there are a number of things we do know: 1) HDTV will require more information to be transmitted, 2) it is likely to be received on large-screen TV sets that tend to amplify the effects of noise and 3) the Federal Communications Commission has ruled that HDTV transmission must be NTSC-compatible.

The fact that HDTV will require additional information transfer is a subject of universal agreement. This requirement may be accommodated with additional bandwidth using an augmentation channel. A precise time relationship is likely to be required between the two channels, creating the need to minimize or at least predict and control group delay. We can probably look to increased signal processing capability in the receiver to help handle this requirement. Some of the additional transmission needs may be accommodated in the existing 6 MHz channel. Such transmission is likely to increase sensitivity to reflections and noise.

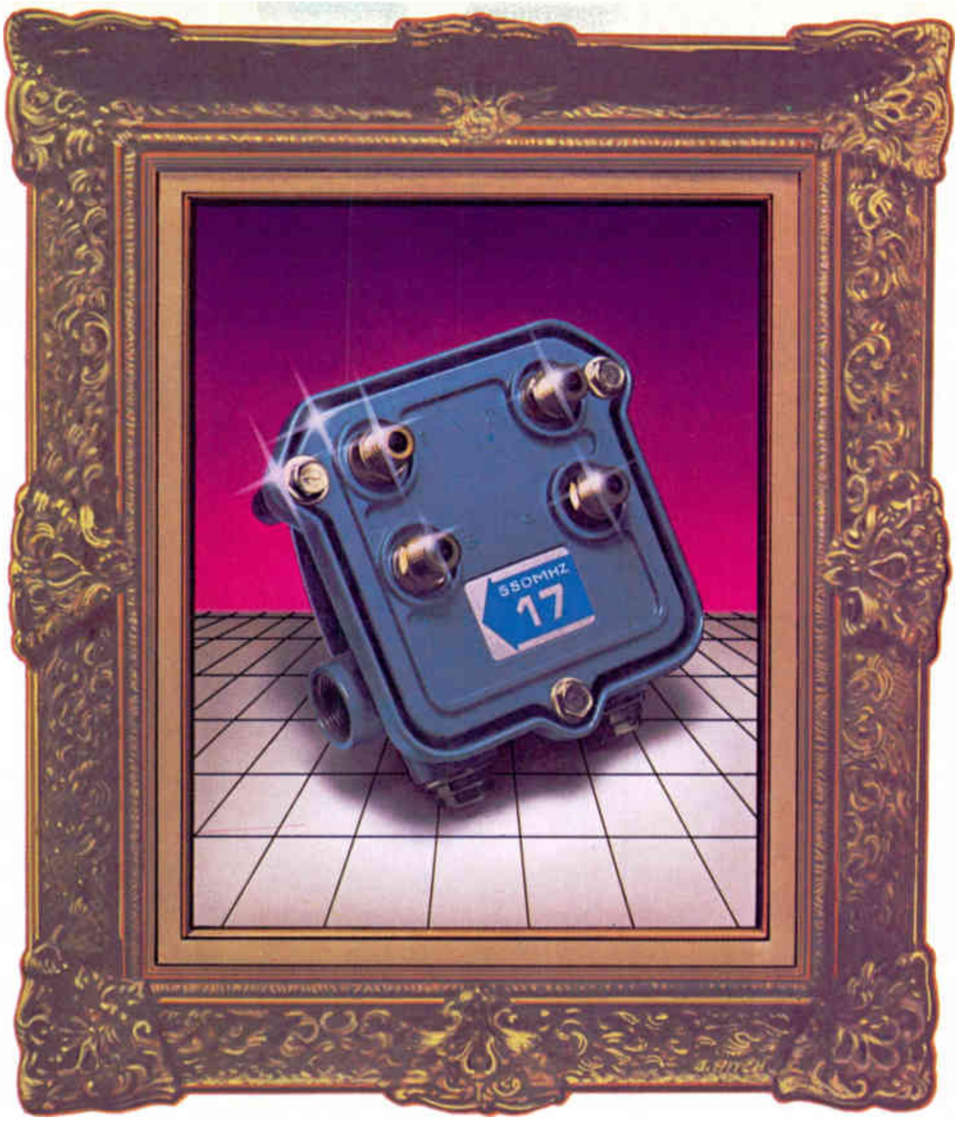
Most cable operators have learned through experience that subscribers are far more sensitive to picture imperfections when large screens (over 20-inch) are used. Tests have shown that subscribers with projection TVs find picture quality objectionable with C/N as high as 47 dB. Other studies have shown that viewers don't see the advantages of HDTV unless large screens are used. Thus, it seems likely that any HDTV format will increase viewer sensitivity to noise.

The FCC ruling on compatibility between HDTV and NTSC means that viewers with existing TV sets must be able to continue receiving NTSC signals from the new HDTV signal. Capability should include no significant changes in existing Grade A and B service contours. It also means that the inherent redundancy of a NTSC signal, which consumes bandwidth, must remain.

Further, any HDTV information introduced in the original 6 MHz of spectrum must not degrade the NTSC signal. The net result of this requirement for compatibility probably makes the cable operator's life easier, with the exception of the demand for increased bandwidth.

Fiber optics has the capability to transport the needed amount of bandwidth with minimum signal quality degradation. It is immune to ingress and can provide excellent S/N performance. It allows shortening of cascades, reducing the accumulation of group delay, noise, frequency response rolloff and distortion characteristics of traditional cascaded amplifier architecture. The technology will readily accommodate HDTV as a system evolves.

Channel addition, which results in an increased bandwidth requirement, is another driving force toward the use of fiber optics. As bandwidth is increased, the maximum frequency used increases. Thus, the loss of the coax between amplifiers increases. We can address this loss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by respacing the amps. However, this is a costly exercise and may result in the need to replace the cable. Also, it lengthens the cascade that is probably already longer than desired. Another alternative is to use higher gain amps at existing locations. This approach limits the bandwidth expansion to one step or, in some shorter cascades, two steps. This is due to the fact that the higher gain amps force the use of lower input levels that increase system noise, higher output levels that increase distortion or some combination of both.

Today, use of fiber-optic AM backbone trunking (Figure 2) can transport high quality pictures to locations of seven to eight miles from the headend or hub site, replacing a cascade of 15 to 20 trunk amps. The remaining distance to the subscriber can then be traversed successfully with a reduced cascade, avoiding the problems associated with a long cascade of high gain amps as previously described. Furthermore, as improvements continue in laser diode technology, economical upgrades are expected to yield further performance improvements using the same fiber cable in the near future.

Consolidation and improved performance

Yet another application of fiber is headend consolidation. Fiber supertrunks allow the elimination of duplicate antenna sites and consolidate backup equipment to increase system availability. Such consolidation also permits the insertion of commercial and local origination signals at a single point for multiple systems, reducing total hardware requirements and operating costs. The employment of FM supertrunks results in a signal quality at each hub site virtually indistinguishable from that of the main headend. Since only one antenna farm needs to be built, the operator can use the best available equipment at an affordable cost.

Finally, fiber also can yield an improvement in the utility of the return path. Many operators have built a subsplit return capability to allow two-way communication within their systems. It has often been found that such return paths require a high level of maintenance due to the summing nature of the reverse tree-and-branch architecture. The noise contribution of all active elements plus any ingress is summed at the headend, creating a high baseline noise level. Any misalignment of amplifiers further reduces the return C/N.

The fiber backbone approach reduces the effect of this summation by transporting the signals from a relatively small number of trunk amps and the associated line extenders back to the headend on a dedicated optical fiber. This results in a dramatic improvement in C/N and increases the tolerance of the system to any misalignment. Further, the summing of ingress is reduced to contributions from a smaller geographic area, giving the operator the ability to isolate the cause and more easily implement a solution.

We have just begun to exploit the capability of fiber to enhance today's CATV architecture. As the technology is employed on a more widespread basis, performance improvements and cost reduction of components are likely, further increasing the utility of fiber optics.

International dimensions of CATV

By Patrick K. McDonough
Corporate Chief Engineer, United Cable Television Corp.

The widespread use of cable TV as a delivery medium is a relatively recent development in Europe. CATV has been available in some countries, such as Ireland, for many years but only in the past two to three years has it really become viable in most of Europe. The reasons behind this change are somewhat complex and can have an effect on the type of system that is required in a particular country. Whatever the motivation behind the change, the fact is that CATV is becoming increasingly visible around the world.

Existing systems range from very small SMATV applications to large systems with most of the "bells and whistles" associated with modern American plants. Systems carry anything from two or three channels up to 40. Newer plants are being designed with bandwidths from 450 to 860 MHz. European operators take full advantage of the technical advances made in the United States and Canada over the past 20 years and manage to avoid a number of the mistakes. This, of course, is a tremendous advantage as new systems come on-line and programming choices increase.

An important consideration in any foreign country is the perception of television by the residents. It must be pointed out that in many countries television has been a state-owned or state-controlled medium. Reception in several nations has been limited to only one or two channels for many years. As a result, the people who live there do not always perceive a need for additional TV programming. Many times they cannot conceive of how they might be able to use more than a half-dozen channels. Beyond this, there is a vast difference in the way Americans and Europeans use television. Here in the United States we are conditioned to having a large number of channels 24 hours a day even in areas not wired. We also are quite used to being entertained by television.

It is the way television is perceived as a method of recreation in America that sets us apart from Europe. European subscribers are at first stunned by the sheer number of programming choices; they literally do not know how to take advantage of cable. It thus becomes part of the operator's job to educate the subscribers in this regard.

One of the most dramatic recent changes in Europe is the advent of satellite-delivered programming. Similar to American systems, the introduction of additional programming has been the key element in fostering the growth of cable. For the first time, system operators can offer product beyond the available off-air channels and locally produced efforts. Further increases in satellite capacity are planned and the addition of still more channels will give another boost to cable in Europe.

System configurations

There are three basic system configurations in use in European plants. These are tree-and-branch, switched star and a variation of the switched star that is built in the star architecture but does not employ active switches at the node points. Again, government regulations have a great deal to do with the type of plant configuration employed in specific areas. Beyond this, the density of the housing and existing infrastructure are determining factors in how systems are designed and built.

Some countries, most notably the United Kingdom, actively promote the use of one configuration over another. The reasons for this can range from the pragmatic to a reliance on what outside "experts" have claimed to be the best system architecture. In the specific case of Great Britain, as an example, the story started with British Telecom (BT), the government-owned telephone company. As part of a growing trend in Europe, the British decided to denationalize the phone company and let it compete on the free market as an independent entity.

At the same time, however, the government decided that there was a need for something for BT to compete with. Thus, it created a structure governing the development of alternate telecommunications systems such as cable TV. The idea behind this was to foster the growth of independent systems that can compete with the phone company and avoid monopoly control of communications within the country. In their desire to promote alternatives to BT and to avoid the situation where *only* TV service is being offered, the governing rules are structured so as to promote the use of a switched-star system. The hope is that operators will eventually offer services other than just television, such as telephony, data communications and so forth. The incentive for this is an eight-year extension to the 15-year license or franchise for operators who build an active switched system.

The switched-star configuration is based on the use of neighborhood nodes that feed the subscribers. This is similar in configuration to the off-premise converter systems that have been tried in the United States, but with more capacity. Systems built in the star configuration, whether switched or not, offer a great deal of flexibility to the operator. If properly built and maintained, they can provide an extremely reliable plant.

The other factors mentioned—density and existing infrastructure—also affect the final build structure. Densities in many areas of Europe are quite high compared to the United States. Homes passed on a per-mile basis can often exceed 300 and in some instances 1,000 or more. It should be noted that per-mile comparisons can be somewhat misleading in the cases where star configured plant is being used. Star systems have about 30 percent less active plant than tree-and-branch topology, so per-mile figures are skewed upward. The star configuration is particularly well-suited to very high density situations, especially when the vast majority of construction is extremely expensive underground build.

For example, let us say we will install nodes so that on average there is one node per two blocks of houses. This can be visualized by imagining a capital H with the node at the center of the crossbar. The legs of the H represent the drops that run down the streets past the homes. In this configuration there is only one pedestal that houses the node equipment. The bulk of the plant is conduit for future drop feeds. There is no need to install taps and pedestals at many locations and expensive street crossings are minimized. There are problems with this approach, too. Subscriber installations become more difficult and time-consuming, for instance, but overall the star configuration is a very efficient method.

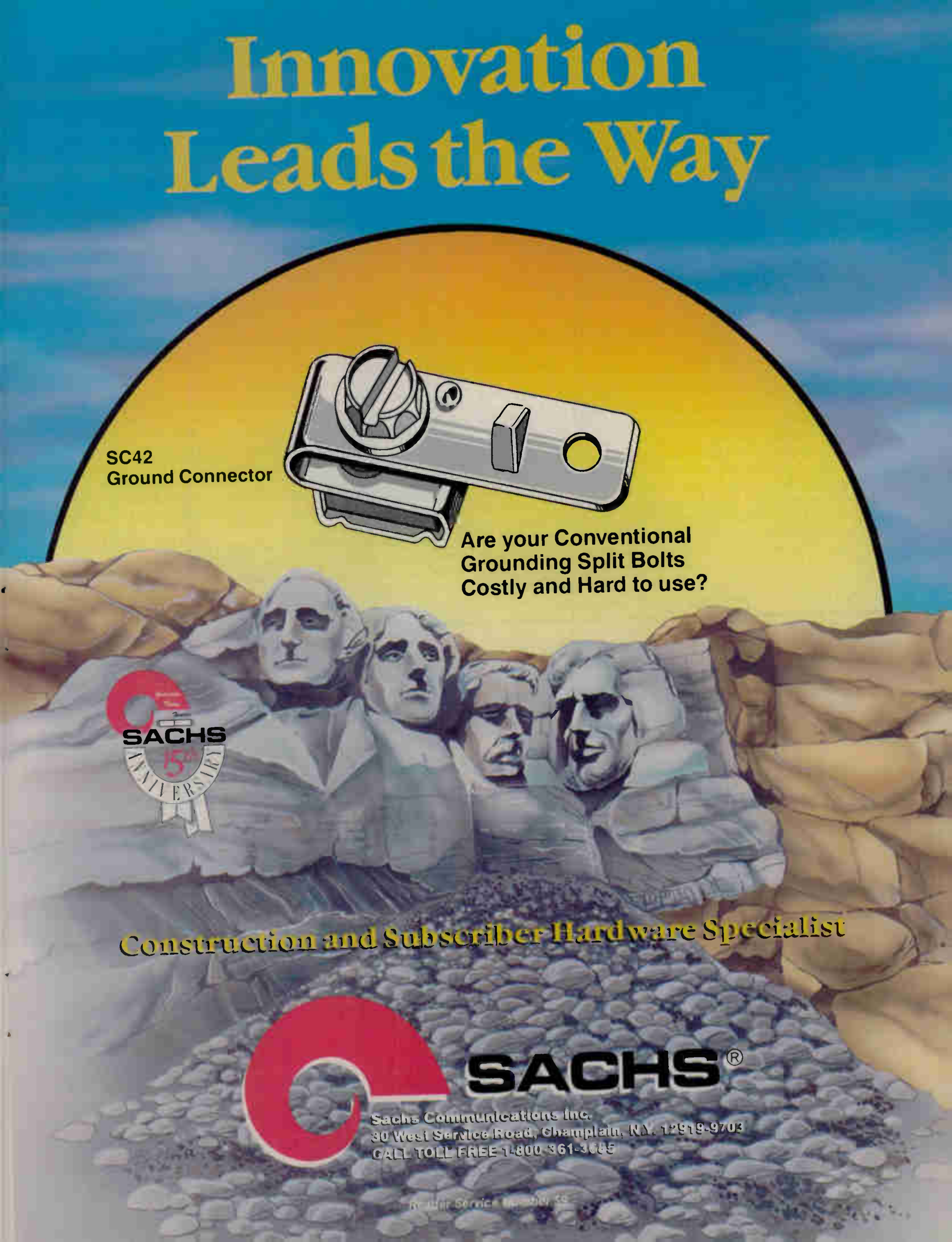
The existence or non-existence of usable conduit, the complexity and location of the other utilities and the accuracy of underground structure maps also contribute to the determination of how a plant is built. In most of the areas I have seen, all of the services (electric, phone, gas, etc.) have been 100 percent underground. There are exceptions to this but they are rare and, in any case, all new service is required to be underground anyway.

Because the existing infrastructure has been in place for a very long time and has been rebuilt, modified and changed along the way, it is not unusual to find that there are no records that will allow the operator to determine exact locations for the existing services. In some instances this is complicated by the fact that many service feeds, even natural gas, are enclosed in plastic pipe, which means metal detectors are useless for locating underground structure. It may be that the best an operator can do is determine that phone and power are both on one side of the street, in which case the CATV plant can be built on the other side. The location of the other utilities being even partially known can be the deciding factor in determining where CATV facilities need to be placed and thus become the ultimate method of fixing on a system architecture.

In other areas, notably Sweden, the topography and demographics of the cities themselves will determine how a system must be constructed. Many Swedish cities consist of large areas of MDUs, sometimes 3,000 or 4,000 units, separated by relatively small areas of single-family dwellings. In these cases the structure of the system will be determined by the most efficient method of reaching the greatest number of passings—the MDUs—and picking up the rest later. This can lead to plants with fairly long super-trunk runs followed by relatively short feeder systems supplying signal to a small area with a large number of dwelling units. This kind of layout falls naturally into a tree-and-branch type of design for the system backbone.

The MDUs are fed from centralized splitter locations, a type of star configuration. TV drop wiring is in place in most of these large apartment buildings in internal conduit systems. The normal method of connecting the units is a loop system, where each unit is connected in series, rather than individual homerun drops. This can impose limits on the options available to the operator to provide tiered service levels and/or pay channels. Because of government regulations requiring that each unit be able to receive the national channels, the operator is usually faced with providing a universal service to all dwellings as well.

One other unusual aspect, at least to most American engineers, is the



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way systems are defined by layers or networks. The best analogy to describe this feature is to use typical U.S. terminology to illustrate the different plant categories. Typically, a European plant is described as being composed of three separate networks—called D-1, D-2 and D-3—plus the headend and hubs. (In some areas the headend itself is considered a distinct layer of the system; supertrunk or other interconnect methods can constitute an additional layer. The most common description is for three layers.) The D-1 network is roughly analogous to the main trunk in a U.S. system. The D-2 network can be compared to the feeder and the D-3 net is the subscriber system. There are specific points identified as being the turnover spot between networks.

The most important issue here is that n many countries, the D-3 net is owned by the subscriber, not the operator. The operator is responsible for the signals only up to the point at which they are placed on the D-3 net. It is interesting to note that the subs usually have to pay for the D-3 net themselves. The fact that the subs (or apartment house owners) own the final part of the system is another limiting factor in CATV design in Europe.

Technical comparison of European and American systems

There are very few countries outside of North and South America that use the NTSC system of TV transmission. Most European and Middle East countries have adopted either the PAL (phase alternation line) or SECAM (sequential with memory) systems. The PAL system utilizes 625 lines interlaced 2:1 at a rate of 50 fields per second. It uses a 4:3 aspect ratio and the sound carrier is frequency modulated. Most commonly, PAL signals are either 7 or 8 MHz wide, depending on frequency.

PAL and SECAM systems differ mainly in the way color signals are processed. Both systems are alike in that they separate the chrominance and luminance information and transmit the chrominance in the form of two color difference signals. These are used to modulate a color subcarrier, which is transmitted within the bandwidth of the luminance signal. In the PAL way of doing this, the phase of the color subcarrier is changed from line to line. This necessitates sending a line switching signal along with a color burst. In SECAM, the color subcarrier is frequency modulated, alternately, by the color difference signals. This also requires the inclusion of a line switching signal within the channel. Both of these systems produce picture quality that, as a rule, is superior to that of the NTSC signal. Signals in many areas also include teletext information in the vertical interval.

The main difference as far as CATV is concerned is the wider bandwidths of European signals. As a general rule (although this is not entirely accurate) channels at lower frequencies, comparable to the VHF band, are 7 MHz wide. Higher frequency channels, UHF band, are 8 MHz wide. There are five bands of broadcast signals arranged to include both TV and FM radio signals. Band I ranges from 41 to 68 MHz, Band II from 87.5 to 100 MHz (FM radio) and Band III from 582 to 960 MHz. Cable systems utilize bandwidths starting at 40 to 50 MHz and extending to 450 or 550 MHz. There are some designed to operate up to 860 MHz but these are the exception.

Both VHF and UHF frequencies are utilized for broadcast, although in Great Britain only UHF is allowed. Because there were until recently only a few channels available, most of the older TV sets are limited in the number of channels they can receive through their tuners. Newer sets, made in the last five years or so, can receive more.

The combination of UHF-only reception and limited tuner capacity in the United Kingdom presents the operator with the need to provide a UHF input signal to the receiver. In switched-star systems this can be handled by either sending a low frequency UHF signal down the drop or by sending down a VHF signal and installing a VHF/UHF upconverter in the subscriber's home. Systems that use converters must install an upconverter on the output of the box. The use of the upconverter is complicated by the fact the U.K. signals contain teletext information that must be delivered to the set in a usable state. The specifications of the upconverter are therefore fairly strict. Operators who have chosen to send UHF signals down the drop avoid the use of upconverters but find drop lengths limited by attenuation factors. This in turn can place restrictions on the node locations.

System operating specifications are generally comparable to those dictated by good engineering practices here in the United States. Composite triple beat and cross-modulation are usually expected to be in the −53 or −54 dB range. Carrier-to-noise is specified for a 43 to 46 dB ratio. Group

delay, differential gain and differential phase, system response, hum modulation and other parameters are also very similar to U.S. standards. Some differences arise in leakage specifications, which tend to be a little stricter in Europe and in some specific areas such as port-to-port isolation in subscriber taps. Isolation requirements in some countries can place severe restrictions on the tap values available to the system designer and complicate amplifier placement and levels.

The other factor that must be included in considering the European systems is the layer of network distinctions. As noted previously, the systems are often defined in specific networks. The operator must be aware that each portion of the network has its own related set of technical specifications. These standards are specific to each layer and are generally not additive. That is, the D-2 net is expected to meet certain criteria regardless of how the D-1 net is operating. The only point where a general set of specs apply is at either the subscriber outlet or at the defined turnover point to the D-3 net.

In general, European technical specifications are reasonable and a well-engineered system will meet these standards easily. The fact that there are few channels carried, due to the higher bandwidth per channel, means that engineers can define system specifications to run at the high levels necessary to meet noise and isolation regulations. This can be done without running into severe distortion effects usually associated with high level operation. From an overall technical standpoint, the European systems, if built according to the standards, will compare quite favorably with those in America.

Technical considerations for European applications

As in any system, here in the United States or overseas, the principles of solid, well-understood engineering practices apply. Systems should be designed so that the end-user receives the highest possible quality picture available. There should be extremely little or no degradation present and the system as a whole must have a very high degree of reliability.

European systems differ from their American counterparts in several areas. Governmental regulations apply one set of considerations to system design as noted previously. System topography, as dictated either by regulation or demographics, applies another layer of consideration. Local conditions, such as the UHF requirement in England, add yet another aspect to the whole situation.

A good example of the type of complexity that can arise from a combination of all these factors can be illustrated by looking in detail at a typical application in Sweden. The example area is a group of MDUs numbering 2,000 units requiring about 4 km (2.5 miles) of plant to feed all the buildings. Construction must be done underground and the headend will be located within the complex. In this area, as in many areas in Sweden, there are three off-air channels available, all of which are must-carries. There are also several satellite channels available, ranging from Russian broadcast TV to a French language channel and a couple of English language channels. The apartment owners recently (within the last two or three years) rewired all of the apartments in accordance to the Swedish regulations. The internal wiring, the D-3 net, is all looped from unit to unit with the feeds coming from the basement.

The operator wants to offer a basic tier of service, consisting of the three must-carry channels, to all of the units. Also planned are a second tier—an expanded basic level to subscribers willing to pay for it—and a pay service. The headend and earth station installation will be fairly straightforward and familiar processes. The first decision comes in deciding which trunk cable to use. Swedish standards call for these cables to have a copper outer conductor and a solid copper center conductor. The reason for this requirement is the feeling on the part of the authorities that copper cable will not corrode as much as aluminum cable in similar circumstances.

There are a number of cables available, commonly built in a fused disk construction. The next decision involves the routing of the D-1 and D-2 cables to feed the 40 or so buildings in the complex. Strict attention must be paid to the specs for each portion of the plant up to the point where it is turned over to the D-3 net. Most of this process is familiar CATV engineering and design.

However, once inside the buildings the differences become more significant. The typical subscriber outlet in use in Sweden contains an FM splitter so that there are actually two feeds into the apartment, one for TV and the other for radio. The drop, coming from the apartment or basement below, is connected to the outlet and then loops on the next apartment. Because of the FM trap it will be difficult to use an American-type addressable converter that typically needs data carried in the FM band; the data will have been trapped out before it can reach the box.

Likewise, traps present problems. Negative traps, which might be used to protect the upper tier and pay channel, can only be installed in the apartment itself because of the loop system. Obviously, this is not the most secure situation to have. Positive traps could be used on the pay channels, but not for more than one or two because their size will soon become objectionable behind the set. The operator does not own the D-3 net thus cannot change the configuration to homerun; the owners will be reluctant to do so since they rewired a few years ago. Since he must provide the three must-carry channels to every unit, the operator must find a way to secure these services without spending huge amounts of capital.

One of the solutions to this dilemma is to use a modified addressable box that will receive data at a lower frequency. Another possible approach might be to use a combination of a blockconverter for the expanded basic tier and a positive trap for the pay channel. This last solution would certainly be viable and may represent the most economical approach, but what happens when additional programming becomes available or the operator wants to try pay-per-view? Again, the addressable converter seems to be the best bet. The issue of PPV also runs into complications. A two-way converter could be used, but the subscriber outlet again causes problems. This piece does not use F connectors; instead, the connections internally are made with screw contacts on the center conductor and shield.

These devices have higher losses and are more prone to ingress/egress than similar parts in America. This means that the return data may not have the strength to get back to the system at a reasonable level or in a non-corrupted state. Faced with this, the operator still has a couple of options available: 1) a phone-in approach to PPV event ordering or phone-return-type of two-way converter or 2) a converter that can be downloaded with prepaid credits that are used up as events are watched. The problems, while numerous, are not such that with a little ingenuity and thought cannot be overcome.

Construction methods

Most if not all of current CATV construction in Europe is underground. Actual construction methods are very similar—as they must be—to those in the United States. The use of concrete saws, trenchers and rock saws is common. In some instances, because of the uncertainty about other utility locations or extreme congestion, hand digging is employed to minimize damage to other facilities.

Construction in the street is rare. Most of the underground in the United Kingdom, for instance, is placed underneath the sidewalks in front of the dwellings. Density and traffic play a large role in the complexity of construction in urban areas like London. A good deal of time is spent in clearing parked vehicles, controlling pedestrian and traffic flow and maintaining a safe construction site.

Local regulations can add to the complications. Some municipalities require that all the spoil removed from trenches be hauled off-site. Trenches are then filled with a slurry mix and the sidewalks refinished. Restoration of the sidewalks can be quite complicated as well. Asphalt sidewalks merely need a hot asphalt fill, sometimes following a cold patch. Sidewalks made of flagstones need to have a layer of sand put down and the paving blocks reset (or replaced if they have been damaged). Some sidewalks are made of concrete topped with a mastic coating. In these cases the concrete must be poured and, when cured, the mastic must be redone. This requires hand-finishing of the hot mastic substance and is not only time-consuming but expensive as well.

The age and density of the areas leads to a good deal of congestion in the underground plant. The lack of accurate records indicating utility locations, as noted earlier, can lead to incredibly complex coordination problems. Damage to existing underground structure is not uncommon and must be considered as part of the cost of construction.

The capital required to build plant is higher because of all these factors. In relatively clean areas, costs should be about $70,000 to $80,000 per mile. Areas with extremely high density or unusually difficult construction can experience even higher costs. Because of the density, even very high per-mile costs can translate into pretty reasonable costs on a per-passing basis.

Because CATV is relatively new in most areas of Europe there is not a pool of experienced people to draw from to build, maintain or operate a system. There are few people who have worked with earth stations and SMATV systems and have done MDU wiring, but often they are unfamiliar with the stricter requirements of cable.

The operator faces a decision regarding the makeup of workers. Should one import experienced people or try and train local workers? The exclusive use of non-residents is often resented and can serve to the operator's disadvantage. On the other hand, trying to make a system successful with inexperienced people also can lead to severe problems.

A system operator can use one of several courses to resolve this dilemma. The most obvious is to import a small number of experienced cable people and utilize their experience to train a local work force. This has the benefits of keeping overall costs down (it is very expensive to move people to Europe and keep them there) and building up a good community identity. Once local workers have been trained and have gained some practical experience they will be in high demand because of the scarcity of such personnel. Fair labor practices and good wages become a must to retain qualified people and avoid the costs of constant retraining.

One other training method involves sending a small group of local people to the United States (or another country with many cable systems) and having them train there.

Operational considerations

Doing business in Europe can be extremely complicated. There are numerous currencies, fluctuating rates of exchange and high taxes to deal with. Importing hardware is a complicated process with many potential pitfalls along the way. Operators must think in terms of 20- or 40-foot containers of material; planning is necessary several months in advance to ensure that needed equipment is received on schedule. Cost planning must take into account the import duties for each nation. Depending on the type of equipment being imported, and classifications vary from country to country even for the same gear, import duty can range anywhere from 15 to 150 percent of the value of the equipment. Naturally, the rates of exchange also affect this process. If possible an operator should attempt to lock in a rate of exchange for some period, such as a year or 18 months.

The operator also is faced with starting up or somehow modifying existing billing systems for use in European systems. The whole area of computerized billing service and addressability require a detailed analysis of local requirements. For instance, some people prefer to pay bills monthly by coupon at their bank (this is common in the United Kingdom). In other countries, quarterly or even annual billing is common.

Future trends

The future of CATV in Europe can be viewed from a number of standpoints. There appears to be a need for additional services in most areas but penetration levels, at least in some new systems, are somewhat disappointing. This relates to the cultural differences in how television itself is used and the subscriber's perception of the new services. The high density of many areas is a compelling reason to investigate European CATV but this must be balanced by realistic expectations in penetration and a full realization of high construction costs involved.

Europe as a whole is much more interested in DBS than is the United States. Several DBS satellites have been planned and at least one has been launched. DBS could pose a real threat to the development of CATV as could MMDS. The window of opportunity for CATV is about two to three years before DBS becomes major competition. The opinion of European operators is that the greater diversity and lower cost of cable will eventually prove to be the deciding factors.

Newer technologies also are beginning to make themselves felt in Europe. France has done a tremendous amount of research and development in the area of fiber-optic plant. The end results of this could affect future cable system configurations in a major way. Likewise, the development of HDTV is of concern to operators. They will be faced with the same questions that now confront U.S. CATV systems. What bandwidths will be needed to accommodate HDTV channels? How much will system technical criteria need to change? Will shorter cascades be necessary? How will converters be adapted to handle the new signals?

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Small systems—The last frontier

This is the fourth in a series of articles designed to help the small system operator or entrepreneur avoid some basic (and perhaps fatal) mistakes. It continues a discussion on designing and operating small systems. Editor's note: Opinions expressed belong to the authors, based on their experiences.

By Bill Grant
President, GWG Associates

And Lee Haefele
President, Haefele TV

The accumulation of noise and distortion in a string of amplifiers is governed by the laws of physics and the transmission performance of any particular cascade of units—whether trunk, feeder or single-cable applications. This accumulation is established by the characteristics of the amplifiers themselves, the number in cascade and the input and output operating levels maintained.

If sound engineering practices are employed, the transmission performance of a cascade of units in a single-cable system can be determined just as precisely as that of a trunk/feeder system. The end-of-system performance can equal or even surpass that of a conventional trunk/feeder design. There is no inherent limitation to system bandwidth or transmission capacity in a single-cable design that does not apply equally to a trunk/feeder system; in both cases the penalties are largely economic or may involve some restrictions on physical system length.

If all amplifiers are operating at identical input and output levels in a system, then we could utilize identical equipment at every location. This would significantly reduce the problems of stocking spare parts. Even if we utilize two different types of equipment—say, manual and automatic units—this is still logistically simpler than the five or six different types required in a trunk/feeder system.

We do not transition system transmission levels anywhere within the plant as we did between trunk and feeder subsystems. So, we need not have any equipment with two gain modules in one housing, such as the trunk/bridger amplifiers we had to use in the trunk/feeder plant. All units in the single-cable system will be one-module amplifiers using smaller and less costly housings; they will consume less operating power as well. A trunk/bridger unit in a sophisticated urban system can cost anywhere between \$800 and \$900. The single-cable amplifiers may only cost between \$200 and \$500.

Certainly a major cost advantage will be the complete elimination of a second cable throughout the plant. Not only is the cost of the cable itself reduced, but the cost of plant construction also is lower. This economy may be applied to the use of larger cable or lower loss cable in some instances. Or it can translate to more plant built, serving more subscribers for the same amount of money.

In the long term, the operation and maintenance of a system where all transmission levels are identical and where only one or two different types of equipment are employed permits the effective use of lower levels of technical competence in operating personnel. This is because much simpler maintenance procedures may be used. In a small operation with a distinctly limited revenue base this is extremely important. Such operations cannot support sophistication in either personnel or operating practices; fortunately, the single-cable design does not require these.

Disadvantages of single-cable design

If it's true that "there's no free lunch," what are the shortcomings of a single-cable approach? Most of these are somewhat academic, but it can be argued that the system may be more susceptible to outage. This can be due to the fact that so many devices and cable connectors are serially connected in a long run. But in trunk and feeder we cannot entirely limit this condition in an extended system. In many instances, the single-cable design may actually require fewer active units such as amplifiers.

Our experience has been that the mechanical hardware (e.g., fittings and taps, etc.) are so much improved now. If careful attention to quality workmanship is applied during construction, single-cable plant may well be more reliable than conventional systems and certainly should not be

less so. Remember that the conventional amplifiers are by nature more complex and sophisticated. Consequently, they could be considered inherently more fragile or less reliable; they will require more—or more sophisticated—attention over the long term.

There are no unique construction practices required with single-cable plant but there may be some alternatives worthy of consideration. Since in most small systems the amount of plant is distinctly limited and costs must be aggressively reduced, the use of self-supporting cable may be advantageous. Such plant does not require the use of a lashing machine at all and pole attachment hardware is a bit less expensive. But perhaps most significantly, self-supporting cable can often be placed with a smaller construction crew. In these smaller systems there will be many situations where the cable must be cut at every pole to insert a tap anyway. Therefore, there will be fewer long cable runs to be placed. The use of self-support could more efficiently utilize cable reel ends, perhaps even facilitating the construction of single-cable spans.

A word of caution is in order for those who may have no experience with self-support construction. When pole line spans are long in length (perhaps 300 or 350 feet) self-support plant can experience high rates of mechanical vibration during periods of high wind. This "dancing" can actually cause cable failures in extreme cases. Under heavy ice loading (and even during normal circumstances, in some cases) self-support cable also may tend to slip through the pole support clamps to equalize cable tension between adjacent pole spans of different length. Some care must be taken with this type of construction. Sometimes even the addition of extra or false dead ends in the plant may be prudent. However, self-support cable can be employed effectively if good construction practices are followed.

One technique that has been used effectively in smaller systems particularly lends itself to the use of self-supporting cable. In one case where the plant served a rural community, many short side leads were possible, most of which only extended one-fourth of a mile or so to reach perhaps three or four homes. In urban systems the common practice is to construct plant so as to be able to service all existing residences. This is done even though the plant placed may not actually produce revenue either initially or even at a later date. The smaller system cannot absorb the cost of non-productive plant quite as well, so we developed the following practice to minimize this:

We designed the system to service the entire area and completed the layout for all such side lead extensions (including tap values, splitter or coupler signal feed, etc.). We simply did not construct the side lead plant at all. The system operator did not forego the potential service revenues but deferred the construction until a sale of service was completed.

Self-support cable plant can be easily and quickly constructed. Since the design, bill of materials and even labor estimate for each side lead was already available, the operator could still offer a two- or three-day service response to sales out on the side lead.

In practice the operator aggressively pursued sales on all such extensions, particularly when one service order developed on a lead that had three or more potential subscribers. But by deferring some construction in this manner, the operator was able to significantly reduce the amount of non-revenue producing plant that was built without limiting or restricting the system potential for subscriptions. The extensions of plant in these cases required no additional layout or engineering at all. Thus, it presented no technical complications for the originally constructed plant that was already in place and in service.

One unique construction practice restricted to small telephone companies in rural areas but is perfectly sound and practical is to construct the coaxial plant by simply overlashing the new cable to existing aerial telephone messenger and cable. This is quite inexpensive.

It is suggested that during the system design and layout phase of any project the system operator include all possible future system extensions (however improbable such extensions might appear to be). The cost of the additional design work is very nominal if done at this time. Subsequent extensions can be easily and rapidly constructed with no danger of compromising the system specifications. More importantly, given the design and layout, the actual cost of such extensions can be determined with some precision. This may be a factor in a subsequent business judgment of whether or not to actually construct the plant.

Plant damage claims

By Mike Mayberry
Construction Coordinator, Continental Cablevision

Read the title of this article literally: Damage to underground or aerial facilities eats away at your profits. But for some time this problem has been looked upon only as a slight annoyance. Damage "claims" the monies destined for new-build and consistently tuned systems, not to mention misspent manpower. Up to now, the attitude was "temporary it and move on." Today reality has set in; we have to go back and fix it before we can go on. This costs time and money.

Our personnel operate like a detective agency when damage occurs. Installers and technicians who find cut underground or downed aerial cable immediately start researching the problem. They obtain information on who did the damage and where it occurred. How much time our personnel spent addressing the problem and what equipment was used to repair it also are noted.

All this data is placed on a billing invoice and transferred to a damage claims/billing record book. Addresses of the damage location and the persons responsible are listed. A billing number is assigned, the amount charged for the repair is assessed and any additional notes or special information are provided in the report.

At least three notices are sent to the offending party, but usually retribution is made prior to any notices being sent out. Utilities are the best when it comes to paying damage claims; non-utilities, on the other hand, are blissfully ignorant. In the case of damage caused by a non-utility, the dispatch department researches to locate the perpetrator. Just like other claims, all information is pursued.

Then we invite all concerned parties for a discussion of the damage and possible claims. For example, we recently discovered a backhoe operator responsible for damage, then researched the business and its insurance company. The operator refused to pay, so we called in the insurers for a visit. Our chief tech, dispatcher and I sat down with the claims representative from the insurance company. With enough documentation to convict Santa Claus, we were paid over $1,800 for the repairs by the claims rep.

Preventive claims

Our approach also involves preventive claims. These include house movers, relocation of pole lines and cable facilities, and incorrect assumption of easement.

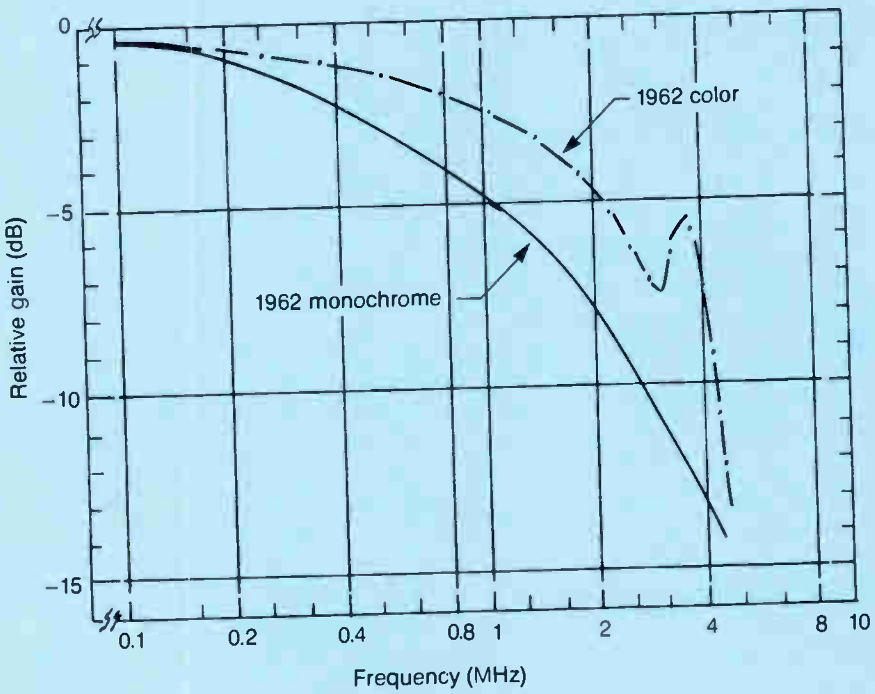
Actively pursuing damage claims is one of the best insurance policies you can have. And word has gotten around: Cut underground cable caused by utilities has dropped off about 40 percent, about 21 percent with non-utilities. While these figures are encouraging, the ultimate goal of no damages is not entirely impossible. Contractors, subcontractors and the individual home owner must be instructed on a large scale to call for locates.

"Contractors, subcontractors and the individual home owner must be instructed on a large scale to call for locates."

After all, damage claims not only money but attitudes and reputations as well. We are in the business of entertaining and building good attitudes and reputation. The only claims department we should have are for claiming new subscribers!

"The baseband S/Ns are more nearly a measure of the true quality of the TV picture delivered to the customer than the RF S/Ns."

Figure 2: Subjective noise weighting



Relation between NCTA C/N and other S/Ns

$S/N_{TASO} = C/N_{NCTA} - 1.8$ dB
$S/N_{EIA} = C/N_{NCTA} + 0.1$ dB
$S/N_{CCIR} = C/N_{NCTA} - 0.2$ dB
$S/N_{BTL} = C/N_{NCTA} + 2.7$ dB

Straus, *IEEE Transactions on Broadcasting*, September 1974.
[3]EIA Standard RS-250-A, 1967; RS-250-B, 1976.
[4]"A Comparison of Three MAC TV Transmission Formats," L.C. Palmer, *Comsat Technical Review*, Fall 1986.
[5]"CCIR Characteristics of Systems for Monochrome and Colour Television Recommendations and Reports," Recommendation 470-1 (1974-1978) of the XIVth Plenary Assembly of CCIR, Kyoto, Japan, 1978.

(Views expressed here are the author's and do not necessarily reflect those of Contel.)

Vital statistics

By Ron Hranac
President, Society of Cable Television Engineers

"Since May 1988, 1,047 new members have joined our ranks, representing a 25 percent increase."

The results are in! SCTE's 1989 elections are over and the ballots have been counted. The winners are: at-large directors—Richard Covell and Robert Luff; regional directors—Pete Petrovich (Region 1), Ron Hranac (Region 2), Bill Kohrt (Region 6), Jim Farmer (Region 9) and Pete Luscombe (Region 11). Proposed changes to national SCTE bylaws were passed.

Membership participation in this year's elections is up from last year, too. Overall, 30 percent of SCTE's national members voted, in contrast with 1988's 29 percent (compare these figures with 1984; only 2 percent of the membership voted then). And, for the first time, here is a breakdown of the percentage of members in each region who voted in this year's elections: Region 1—32 percent, Region 2—35 percent, Region 6—39 percent, Region 9—29 percent and Region 11—27 percent.

My term as president of the SCTE is near its end. I can honestly say it has been a pleasure to be involved in the mainstream of the Society's activities and incredible growth. Since May 1988, 1,047 new members have joined our ranks, representing a 25 percent increase. Our membership directory and yearbook grew from 116 pages (1986/1987 issue) to 168 pages (1988/1989 issue). Six new chapters and meeting groups sprang up in the past 12 months (up 14 percent) and 30 additional certified BCT/E candidates—a whopping 400 percent increase.

In 1988, the Scholarship Committee awarded SCTE's first college tuition assistance to Daniels & Associates' Jane Lode. Another important milestone was the creation of SCTE's Hall of Fame; Cliff Paul was its first inductee.

The board of directors passed two important but voluntary resolutions at last year's Cable-Tec Expo, encouraging chapters and meeting groups to 1) devote at least three meetings per year to combination BCT/E preparation and examination and 2) devote at least one meeting per year to technical seminars for the non-technical. Many of our chapters and meeting groups have adopted one or both of these suggestions. The first has provided members several opportunities to participate in the BCT/E program throughout the year. The second has involved those in operations, marketing and management in Society activities.

Headquarters expansion

The SCTE has grown sufficiently to warrant the purchase of the office next to 669 Exton Commons, allowing expansion of our national headquarters. This effectively doubles the size of our headquarters, a move that has been needed for some time.

But the area that has been most exciting to me is the development of good relationships with other professional organizations. These efforts really began with a Rocky Mountain Chapter meeting in September 1987; the subject of that meeting was "Interfacing with Local Broadcasters," and featured a panel of local TV station engineers (SBE members) and CATV engineers (SCTE members). That relationship blossomed into one enjoyed at the national level: Last year, SBE donated booth space at their annual convention to our Society and SBE will have a booth courtesy of SCTE at this year's expo. SCTE also will have a booth at the National Association of Broadcasters convention this year.

Of course, the most recent development in this area has been our relationship with the British SCTE (see "Building bridges, Part II" in the December 1988 issue of *CT*). Tom Hall, secretary of the U.K. Society, will be visiting both the NCTA convention in Dallas and our own expo in Orlando, Fla.

The bottom line, though, is that this growth and activity is because of you, the 5,274 members of the premier technical organization in cable television! This has been a team effort that shows no sign of slowing down. My hat is off to each and every one of you, with a heartfelt thanks—keep up the good work.

Spectrum analyzer

Avcom introduced a portable spectrum analyzer that covers frequencies through 1,000 MHz in one sweep with a sensitivity greater than −90 dBm at narrow spans. The Model PSA-65A is either battery or line operated, lightweight (18 pounds) and is available with a carrying case for portability. Options include frequency extenders to enable the unit to be used at Satcom and higher frequencies, audio demod for monitoring and log periodic antennas.

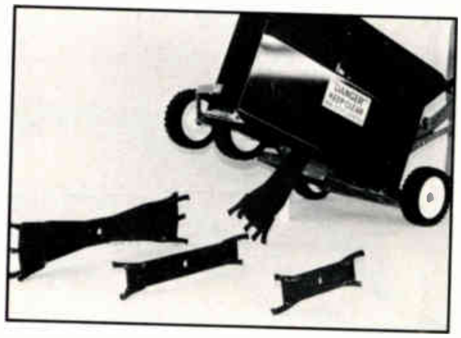
For further information, contact Avcom of Virginia Inc., 500 Southlake Blvd., Richmond, Va. 23236, (804) 794-2500; or circle #124 on the reader service card.

CAD maps

Maps for the entire continental United States in AutoCAD format are being offered by American Digital Cartography. Each map covers a geographic quadrangle of 7.5 minutes of latitude high by 7.5 minutes of longitude wide, an area of approximately 60 square miles. Translated from the U.S. Geological Survey's National Cartographic data base, the maps can be used on a computer workstation. The user can display, modify and plot them out as necessary.

Pertinent information is delineated on separate layers that permit the user to select information needed for a specific use. Available layers include roads, rivers, pipelines, geographic names, contours and an elevation grid. The maps are said to be ideal for cable system planning and design, detection of terrestrial interference or use as a strategic marketing tool.

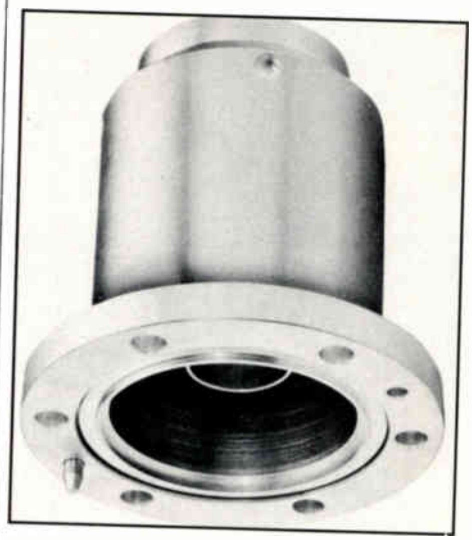
For further information, contact American Digital Cartography, 715 W. Parkway, Suite A, Appleton, Wis. 54914, (414) 733-6678; or circle #119 on the reader service card.



Trenching blades

New carbide blades from E-Z Trench are said to reduce drag by 40 percent; they are especially effective with roots and hard soils. According to the company, the blades have a life span of up to 10 times that of conventional blades.

For more information, contact E-Z Trench Manufacturing Co., Rt. 3, Box 78-B, Loris, S.C. 29569, (803) 756-6444; or; or circle #129 on the reader service card.



Flange connectors

Andrew Corp. is introducing two 3$^1/_8$-inch EIA flange connectors for its 2¼-inch Heliax air dielectric coaxial cable. The connectors interface

(Continued on page 109)

Off-air Ch. 5

By Steven I. Biro
President, Biro Engineering

This is the fourth in a series of maps with technical and program parameter listings for off-air Channels 2-69, designed to be used when the cable system experiences co-channel interference. With this information, the headend technician can pinpoint the closest (i.e., the most probable) offenders, determine their directions and start the verification process with the rotor-mounted search antenna. Based on the tabulated technical information, the search can be concentrated on the most powerful stations or those that have the highest transmitting antenna towers.

The computer program for the maps was developed and data for the listings was collected by the staff of Biro Engineering, Princeton, N.J. The information is accurate as of Sept. 1, 1988.

Key to listing

Call letters: Ch. 5 station identification

City: Station location or the area served by the station

Network affiliation:

A/C	ABC and CBS programming
C/N	CBS and NBC programming
A/N	ABC and NBC programming
ACN	ABC, CBS and NBC programming
ED	Educational station (PBS)
IND	Independent station
CBC	Canadian Broadcasting Corp.
CTV	Canadian Television Network
RRQ	Reseau Radio Quebec
TVA	Canadian Independent Programming
SRC	Societe Radio-Canada
SP	Spanish language programming

Power: The effective visual radiated output power (in kilowatts)

Offset: The offset frequency of the station

0	No offset
–	–10 kHz offset
+	+10 kHz offset

HAAT: Transmitting antenna height above average terrain (in feet)

Call letters	City	Network affiliation	Power	Offset	HAAT
WKRG	Mobile, Ala.	CBS	100	+	1915
KYES	Anchorage, Alaska	IND	100	0	350
KPHO	Phoenix	IND	100	–	1770
KFSM	Fort Smith, Ark.	CBS	100	–	1260
KTLA	Los Angeles	IND	50	0	3000
KPIX	San Francisco	CBS	100	+	1660
KREX	Grand Junction, Colo.	C/N	13	–	1
KOAA	Pueblo, Colo.	NBC	100	0	1306
WUFT	Gainesville, Fla.	ED	100	–	860
WPTV	West Palm Beach, Fla.	NBC	100	0	990
WAGA	Atlanta	CBS	100	–	1070
WMAQ	Chicago	NBC	41	0	1307
WOI	Ames, Iowa	ABC	100	0	1850
KALB	Alexandria, La.	NBC	100	0	1590
WABI	Bangor, Maine	CBS	39	+	1310
WCVB	Boston	ABC	100	–	980
WNEM	Bay City, Mich.	NBC	100	–	1036

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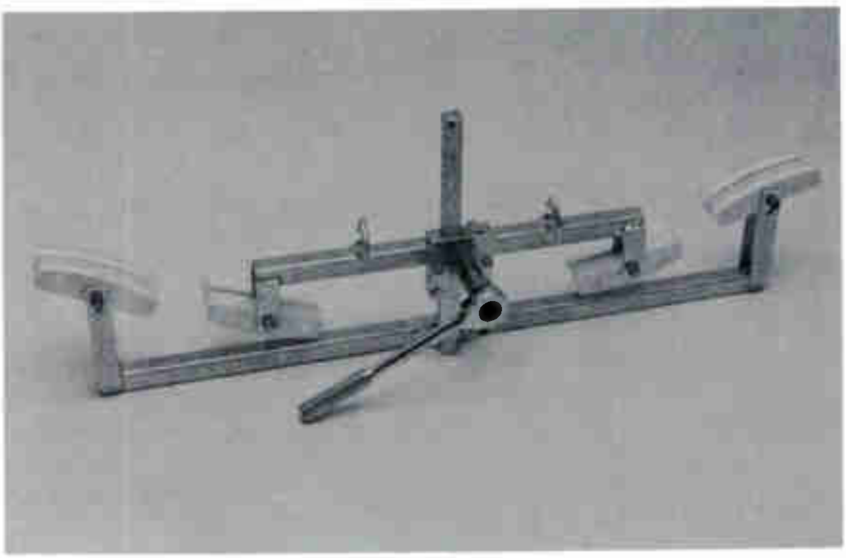
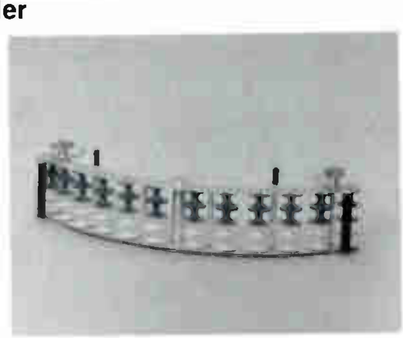


Bender

Cable Block

Corner Block



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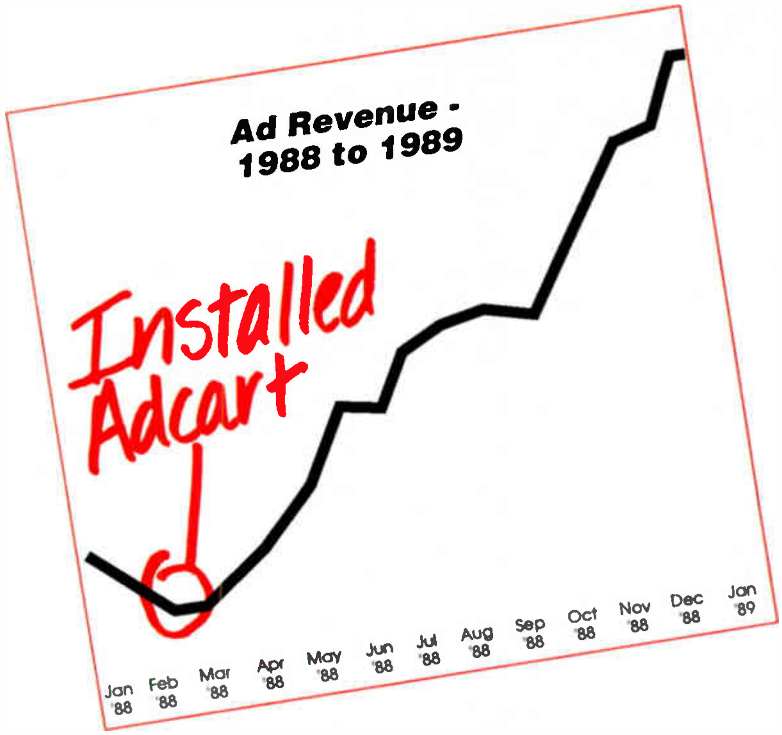
Reader Service Number 75.

Call letters	City	Network affiliation	Power	Offset	HAAT
KSTP	St. Paul, Minn.	ABC	100	–	1430
KCTV	Kansas City, Mo.	CBS	100	+	1131
KSDK	St. Louis	NBC	100	–	1090
KXGN	Glendive, Mont.	C/N	15	+	513
KFBB	Great Falls, Mont.	ABC	100	+	590
KHAS	Hastings, Neb.	NBC	100	–	730
KVVU	Henderson, Nev.	IND	100	+	1190
KNBP	Reno, Nev.	ED	5	0	460
KNME	Albuquerque, N.M.	ED	28	+	4230
WNYW	New York	IND	18	+	1688
WPTZ	North Pole, N.Y.	NBC	25	0	2000
WTVH	Syracuse, N.Y.	CBS	100	–	950
WRAL	Raleigh, N.C.	CBS	100	0	1990
KFYR	Bismarck, N.D.	NBC	100	0	1402
WLWT	Cincinnati	NBC	100	–	1000
WEWS	Cleveland	ABC	93	+	1020
KOCO	Oklahoma City	ABC	100	0	1520
KOBI	Medford, Ore.	NBC	60	0	2700
WCSC	Charleston, S.C.	CBS	100	+	1970
KIVV	Lead, S.D.	NBC	100	–	1850
KDLT	Mitchell, S.D.	NBC	100	+	1510
WMC	Memphis, Tenn.	NBC	100	+	1013
WTVF	Nashville	CBS	100	0	1394
KXAS	Fort Worth, Texas	NBC	100	+	1685
KTXT	Lubbock, Texas	ED	100	–	800
KENS	San Antonio	CBS	100	0	1392
KRGV	Weslaco, Texas	ABC	100	–	950
KSL	Salt Lake City	CBS	34	+	3780
WCYB	Bristol, Va.	NBC	85	+	2230
KING	Seattle	NBC	100	+	820
WDTV	Weston, W. Va.	CBS	100	0	884
WFRV	Green Bay, Wis.	ABC	100	+	1120
KGWN	Cheyenne, Wyo.	C/N	100	+	620
KGWL	Lander, Wyo.	CBS	100	0	270
WTTG	Washington, D.C.	IND	100	–	770
CBXT	Edmonton, Alberta	CBC	318	+	669
CFCN	Cranbrook, British Columbia	CTV	1	+	3430
CJDC	Dawson Creek, British Columbia	CBC	5	0	1026
CHKL	Kelowna, British Columbia	CTV	7	–	1672
CFJC	100 Mile House, British Columbia	CTV	1	0	1900
CBCH	Smithers, British Columbia	CBC	1	+	800
CKX	Brandon, Manitoba	CBC	100	+	1254
CBWG	Jackhead, Manitoba	CBC	7	0	600
CBHT	Aspen, Maritime Provinces	CBC	1	–	420
CJCH	Halifax, Maritime Provinces	CTV	100	0	822
CBAF	St. John, Maritime Provinces	CBC	60	0	641
CBIT	Sydney, Maritime Provinces	CBC	54		468
CBYT	Corner Brook, Newfoundland	CBC	11	0	490
CBYT	Hawkes Bay, Newfoundland	CBC	1	+	215
CBNT	Marystown, Newfoundland	CBC	23		800
CBWC	Fort Frances, Ontario	CBC	96	0	660
CBCC	Hearst, Ontario	CBC	8	+	485
CHRO	Pembroke, Ontario	CBC	100	+	1150
CJIC	Sault Ste. Marie, Ontario	CBC	78	0	600
CICI	Sudbury, Ontario	CTV	100	0	1075
CBLT	Toronto	CBC	100	0	1520
CHAU	Carleton, Quebec	TVA	88	0	1615
CFER	Gaspe Nord, Quebec	RRQ	100	+	933
CKMI	Quebec	CBC	14	–	460
CKBI	Prince Albert, Saskatchewan	CBC	100	0	900
CJFB	Swift Current, Saskatchewan	CBC	14	–	511
CKOS	Yorkton, Saskatchewan	CBC	14	–	534
XHFI	Chihuahua, Mexico	SP	23	–	5
XEJ	Ciudad Juarez, Mexico	SP	10	0	205
XEJ	Juarez, Mexico	SP	63		991
XHAQ	Mexicali, Mexico	SP	54	0	300
XHRE	Saltillo, Mexico	SP	4	+	225
WORA	Mayaguez, Puerto Rico	SP	100	–	2000



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Maximum fixed-position schedules mean increased revenue. 19,200 spots, 2,400 events, 16-schedule capacity per channel, tailored for your market and budget needs. We have made over 5,000 channels pay for themselves countless times over.

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Increase spontaneous ad sales opportunities with quick, flexible scheduling. With its state-of-the-art software, ADCART operates in full random access, random pod, or random pod sequential mode.

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All you have to know is that you could use more revenue. Let us handle the rest. We've engineered, designed, and installed hundreds of successful ADCART systems. Turn your design over to us and expect results.

Call CHANNELMATIC toll-free and request a demonstration and free catalog. We have over 200 products, including A/V switchers, DAs, custom time/tone switching systems, and much more. In fact, we are the world's largest supplier of ad insertion systems, and we equip whole systems from our own line. CHANNELMATIC knows how to make it all work for you.

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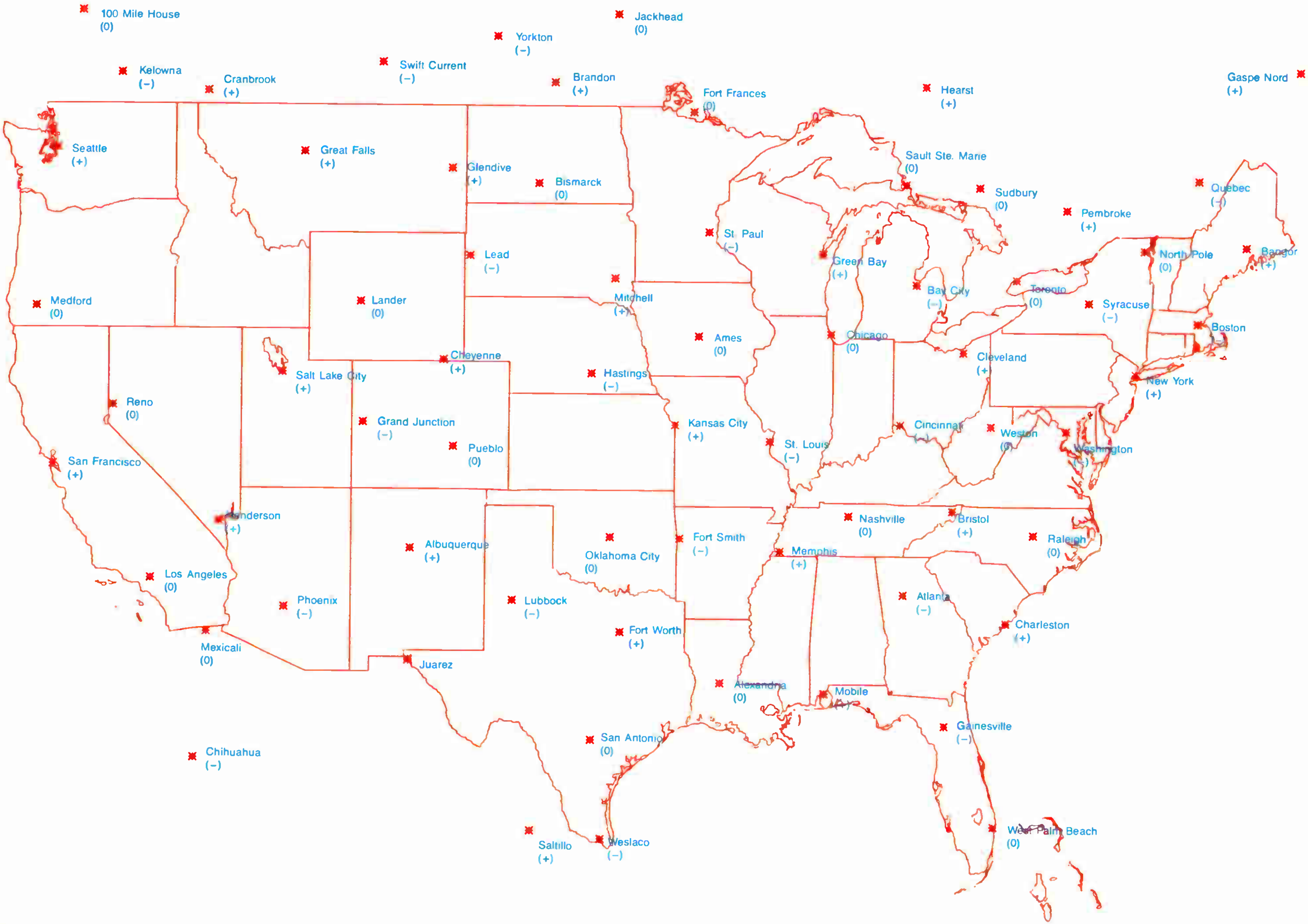

100 Mile House (0)
Jackhead (0)
Yorkton (–)
Kelowna (–)
Cranbrook (+)
Swift Current (–)
Brandon (+)
Fort Frances (0)
Hearst (+)
Gaspe Nord (+)
Seattle (+)
Great Falls (+)
Glendive (+)
Bismarck (0)
Sault Ste. Marie (0)
Sudbury (0)
Pembroke (+)
Quebec (–)
St. Paul (–)
Green Bay (+)
Lead (–)
North Pole (0)
Bangor (+)
Medford (0)
Lander (0)
Mitchell (+)
Bay City (–)
Toronto (0)
Syracuse (–)
Ames (0)
Chicago (0)
Boston
Cheyenne (+)
Salt Lake City (+)
Hastings (–)
Cleveland (+)
New York (+)
Reno (0)
Grand Junction (–)
Kansas City (+)
Cincinnati (–)
Weston (0)
Pueblo (0)
St. Louis (–)
Washington (–)
San Francisco (+)
Henderson (+)
Nashville (0)
Bristol (+)
Fort Smith (–)
Raleigh (0)
Albuquerque (+)
Oklahoma City (0)
Memphis (+)
Los Angeles (0)
Phoenix (–)
Lubbock (–)
Atlanta (–)
Charleston (+)
Fort Worth (+)
Mexicali (0)
Juarez
Alexandria (0)
Mobile (+)
Gainesville (–)
San Antonio (0)
Chihuahua (–)
West Palm Beach (0)
Saltillo (+)
Weslaco (–)

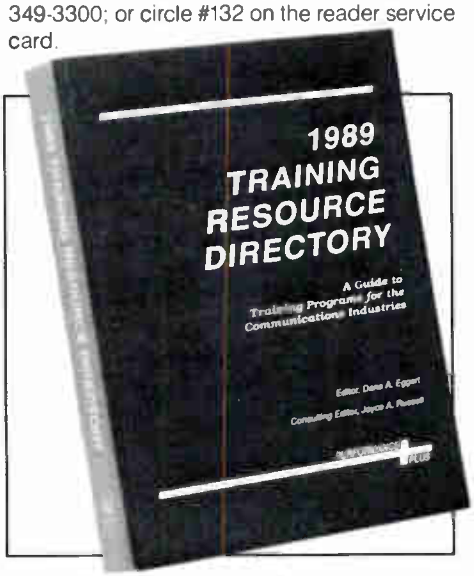
Product News

(Continued from page 102)

the cable with FM transmitters and antennas that commonly terminate in $3^1/_8$-inch flanges, eliminating the need for adapters.

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

For more information, contact Andrew Corp., 10500 W. 153 St., Orland Park, Ill. 60462, (312) 349-3300; or circle #132 on the reader service card.



Training guide

Performance Plus' *1989 Training Resource Directory* contains over 600 individual sources in 11 major categories, including computers and information systems, technical, financial management, project management and safety. Each category is organized into subsections for immediate access to specific training programs. To facilitate training evaluation, each of the individual entries is presented in a one-page format summarizing the topics covered, audience, objectives, delivery system, cost and vendor. It also lists a publications and catalogs section, with over 300 books, newsletters, catalogs and video and audio cassettes.

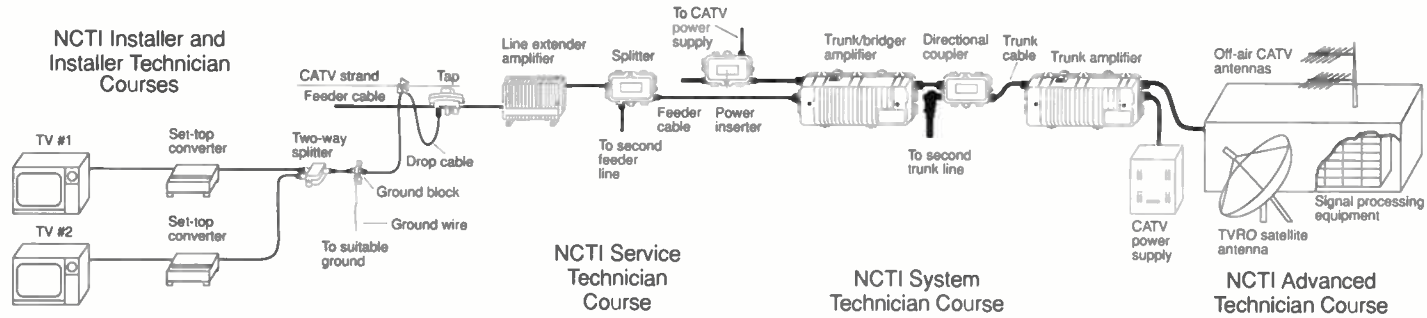
For more information, contact Performance Plus, 1050 Posse Rd., Castle Rock, Colo. 80104, (303) 688-1734; or circle #141 on the reader service card.

Catalog

A 10-page catalog that presents a wide range of electrical testing and precision measuring equipment is being offered by Biddle Instruments. Some of the items included in the catalog are insulation testers, digital low resistance ohmmeters, high-voltage detectors, phase and motor rotation testers, power factor and DC dielectric test sets, and earth resistance testers.

For more information, contact Biddle Instruments, 510 Township Line Rd., Blue Bell, Pa. 19422, (215) 646-9200; or circle #122 on the reader service card.

From Headend to Drop



NCTI is the industry's technical training source

Where is your technical training need?

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Technical Excellence

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

Up To Date

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

Comprehensive

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

Self Paced

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

Easy To Administer

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

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

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

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This is the second of two parts.

Ohio
Ohio Utilities Protection Service
(800) 362-2764

Oklahoma
Call Okie
(800) 654-8239

Oregon
Utilities Underground Location Center
(800) 424-5555
Coverage area: Nine counties
Wasco County Underground Coordinating Council
(503) 298-5152
Coverage area: Wasco County
Linn Benton Utilities Coordinating Council
(503) 752-8631
Coverage area: Benton and northwest Linn counties
Lane Utilities Coordinating Council
(503) 342-6676
Coverage area: Lane County
Douglas Utilities Coordinating Council
(503) 673-6676
Coverage area: Douglas County
Josephine Utilities Coordinating Council
(503) 476-6676
Coverage area: N/A
Rogue Basin Utility Coordinating Council
(503) 779-6676
Coverage area: Jackson County
Central Oregon Underground Utility Coordinating Council
(503) 389-6676
Coverage area: Jefferson, Crook and Deschutes counties
Hood River County Underground Coordinating Council
(503) 386-4505
Coverage area: Hood River County
East Linn Coordinating Council
(503) 259-2992
Coverage area: Eastern Linn County
City of Dallas Utility Coordinating Council
(503) 623-2338
Coverage area: City of Dallas
Malheur Utility Coordinating Council
(503) 889-2468
Coverage area: Ontario, Vale and Nyssa counties
Klamath Utility Coordinating Council
(503) 884-6676
Coverage area: Klamath County
North Lincoln County Utility Coordinating Council
(503) 994-3900
Coverage area: North Lincoln County
South Lincoln County Utility Coordinating Council
(503) 265-7725
Coverage area: Lincoln County
Curry Utilities Coordinating Council
(503) 469-2114
Coverage area: Curry County
Utility Notification Center
(503) 246-6699
Coverage area: Washington, Multnomah and Clackamas counties

Pennsylvania
Pennsylvania One-Call System Inc.
(800) 242-1776

Rhode Island
Dig-Safe
(800) 225-4977

South Carolina
Palmetto Utility Location Service
(800) 922-0983

Tennessee
Tennessee One-Call System
(800) 351-1111

Texas
Texas One-Call System
(800) 245-4545

Austin Area Utility Coordinating Council One Call
(512) 472-2822
Coverage area: Austin area
Texas Excavation Safety System
(800) 344-8377

Utah
Blue Stakes Location Center
(800) 662-4111

Vermont
Dig-Safe
(800) 225-4977

Virginia
Miss Utility of Virginia
(800) 552-7001
Coverage area: Statewide except northern Virginia
Miss Utility
(800) 257-7777
Coverage area: Northern Virginia
Miss Utility of Delmarva
(800) 441-8355
Coverage area: Delmarva Peninsula

Washington
Utilities Underground Location Center
(800) 424-5555
Coverage area: 80 percent of population
Grays Harbor and Pacific County Utility Coordinating Council
(206) 532-3550
Coverage area: Grays Harbor and Pacific counties
Cowlitz County Utility Coordinating Council
(206) 425-2506
Coverage area: Cowlitz County
Locating Inc.
(503) 255-4634
Coverage area: Greater Portland area and parts of Washington state
Chelan-Douglas Utilities Coordinating Council
(509) 663-6111
Coverage area: Chelan and Douglas counties
Upper Yakima Underground Utilities Council
(509) 248-0202
Coverage area: Upper half of Yakima County
Klickitat-Skamania Coordinating Council
(509) 493-3199
Coverage area: Klickitat and Skamania counties (Washington) and Hood River and Wasco counties (Oregon)
Inland Empire Utility Coordinating Council
(509) 456-8000
Coverage area: Spokane County and parts of Stevens County
Palouse Empire Utilities Coordinating Council
(208) 882-1974
Coverage area: Pullman, Wash., and Moscow, Idaho

West Virginia
Miss Utility of West Virginia Inc.
(800) 245-4848

Wisconsin
Diggers Hotline Inc.
(414) 344-5111

Wyoming
West Park Utility Coordinating Council
(307) 587-4800 (answering service)
Coverage area: Cody
Call-In-Dig-In Safety Commission
(307) 682-9811
Coverage area: Campbell, Crook and Weston counties
Fremont County Utility Coordinating Council
(307) 856-7555
Coverage area: Fremont County
Central Wyoming Utilities Coordinating Council
(307) 265-5252
Coverage area: Natrona County
Sweetwater County Underground Coordinating Council
(307) 362-8888
Coverage area: Sweetwater County
Carbon County Utility Coordinating Council
(307) 324-6666
Coverage area: Carbon County area
Albany County Utility Coordinating Council
(307) 742-3615
Coverage area: Albany County
Southeast Wyoming Utilities Coordinating Council
(307) 638-6666
Coverage area: N/A
Converse County Utility Coordinating Council
(307) 358-5536
Coverage area: Converse County

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Miss Utility
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Alberta First Call
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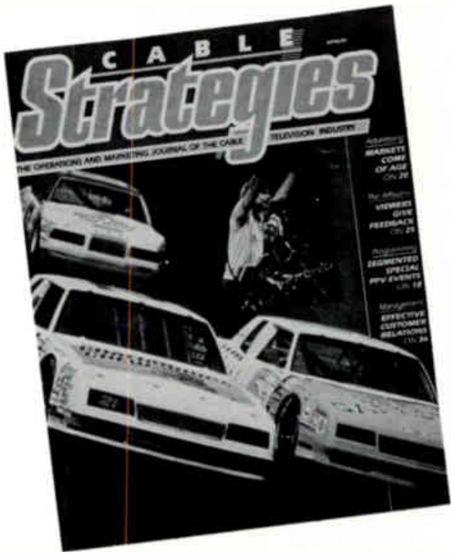

If you are involved with cable system operations and management, you need a subscription to *Cable Strategies* magazine.

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☐ 3. Cable TV Program Network
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☐ 5. MDS, STV, or LPTV Operator
☐ 6. Microwave or Telephone Company
☐ 7. Commercial Television Broadcaster
☐ 8. Cable TV Component Manufacturer
☐ 9. Cable TV Investor
☐ 10. Financial Institution, Broker, Consultant
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☐ 13. Advertising Agency
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CT 5/89

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Conventional wisdom

By Archer S. Taylor
Senior Vice President of Engineering, Malarkey-Taylor Associates

In today's high technology environment, conventional wisdom is, at best, a dubious guide. Forty years ago, conventional wisdom said coaxial cable networks could not carry adjacent channels. Ten years ago, conventional wisdom reported that there was no conceivable need for more than 25 to 35 TV channels. Conventional wisdom convinced many of us that optical fiber could only be used in cable TV networks for limited, point-to-point supertrunks. After all, according to conventional wisdom, lasers are essentially on/off devices that cannot be modulated with sufficient linearity for multichannel AM analog transmissions.

Well, conventional wisdom has often been naive, misleading or just plain wrong.

Now, conventional wisdom seems to be telling us that it is only a matter of time until the legal and regulatory barriers restraining the all-powerful telephone industry will fall. Because of the enormous financial and political resources of the regional Bell Operating Companies (RBOCs), conventional wisdom sees the takeover of the cable TV industry as all but inevitable.

But hold on a moment. A funny thing is happening on the way to the inevitable. While the telcos were proclaiming their invincible superiority in optical transmission technology, Jim Chiddix and his colleagues at ATC were defying conventional wisdom. With help from many sources, they have demonstrated that laser technology can be made sufficiently linear to carry 40 conventional AM analog TV channels over distances up to 15 kilometers (9.3 miles) of optical fiber with technical performance roughly equivalent to a cascade of three or four conventional line amplifiers. This was the breakthrough needed to match the long recognized benefits of fiber-optic technology to the archaic if not obsolete television transmission technology still in use throughout the world. Ever since the late 1930s, all home television receivers—whether NTSC, PAL or SECAM—have been based on vestigial sideband analog AM transmission with virtually no significant change.

For once, the cable TV industry is leading the way. Bell Labs may hold many of the key patents, but the operators who are building or planning to build fiber backbone networks are already way ahead of the telcos in adapting the many advantages of optical fiber to the coaxial "last mile" from the central exchange (or headend) to the ultimate consumer.

"The operators who are building...fiber backbone networks are already way ahead of the telcos."

Since the explosive and highly competitive installation of optical fiber for long-haul and interexchange telecommunications links during the 1980s, the telcos have vigorously moved toward extending the benefits of fiber all the way to subscriber premises. Recently, however, some have begun to worry about justifying the installation of fiber that is capable of transmitting at least a million times more bandwidth than is needed for POTS (plain old telephone service). Why use an elephant gun to swat a fly? What better consumer of bandwidth could they find to use up the spectrum than video, which the cable TV industry has already developed into a profitable market.

Here is where conventional wisdom tends to run amok. The network for delivering POTS must necessarily be based on switched-star topology. A separate dedicated transmission path is required in each direction between a switching center and each subscriber terminal. For this reason, and others, the network is inherently more costly than the tree-and-branch topology used for cable TV. Even if telco's video distribution business were to be unregulated, a growing concern about cross-subsidies is likely to inhibit attempts to allocate costs in such a way as to counteract the excessive real cost of the switched star. Finally, the tree-and-branch configuration required for economical video distribution is inherently incompatible with the star distribution required for POTS, without resorting to such esoteric concepts as packet switching and token passing rings for the full duplex voice and data services.

As a consequence, the telcos are now beginning to talk about analog transmission and cooperative efforts with cable TV operators. Nevertheless, it is hard to see how the essentially switched-star services can realistically be integrated with the economical tree-and-branch video distribution services. Is it only conventional wisdom again that sees two physically separate networks, whether copper, coaxial cable or optical fiber, rather than a single integrated telephone network? For an integrated network, either cable TV services would have to be changed over to a switched star (at great cost and some loss of customer convenience) or the voice and data services would have to be changed over to tree-and-branch (at enormous cost and logistical complexity).

Whether conventional wisdom or not, it is my judgment that for many years to come, the networks used for video services now known as CATV will not be integrated with networks used for POTS and residential data services.

News

(Continued from page 14)

According to Sie, the plan, aimed at fighting foreign HDTV competition, would "benefit the American public with a cost-effective system without disruption and forced obsolescence of current sets." The proposed digital HDTV system is based on digitalization technology more sophisticated than any other proposed to date; it could transmit video signals by broadcast, cable and all other TV distribution media.

● The Wisconsin Cable Communications Association became an active member for the 1989 Great Lakes Expo and will host the show in 1994. The state associations of Illinois, Indiana, Michigan and Ohio also promote the expo, which will take place Sept. 20-22 at the Convention Center in Columbus, Ohio.

● The executive search and consulting firm Future Sense was recently formed to assist the cable and cellular industries. Its headquarters is located at 68 Shoreline Dr., Gulf Breeze, Fla. 32561, (904) 932-2800.

● RMS signed an agreement with Gibraltar Corp. of America for a $3 million revolving line of credit; the agreement was scheduled to close on or before April 30. This follows the recent termination of the RMS credit line by Irving Trust Co.

● At its annual government/industry dinner March 15, the Electronics Industries Association (EIA) presented the 1989 Medal of Honor to Sidney Topol, chairman of Scientific-Atlanta Inc. as well as EIA's Advanced Television Committee chairman. The award is the EIA's highest honor.

● GNB Industrial Battery Co. of Langhorne, Pa., was awarded a contract from Nippon Telegraph and Telephone Co. of Tokyo. In the contract, estimated at over $10 million, GNB will supply its Absolyte lead acid standby batteries.

● Continental Cablevision recently ordered $5 million worth of baseband converters from General Instrument's Jerrold Division. The TOCOM 5503-VIP converters will be used in the upgrade and expansion of the MSO's Los Angeles Metro system.

● Television Technology Corp. and Faroudja Laboratories reached a joint agreement to demonstrate a live, over-the-air transmission of an advanced compatible high definition TV system. The Faroudja SuperNTSC signal would be transmitted from KBLR-TV in Las Vegas during the National Association of Broadcasters convention April 29-May 2.

Correction

In the article "Installation of fiber cable" (April CT), the first paragraph of the second column on page 45 should have read: "With the figure eight design, cable is clipped or bonded to a messenger. The messenger is normally poly-coated and can be steel, Aramid yarn or, more commonly, fiberglass-reinforced plastic (FRP). Figure eight cables typically install quicker and more economical. For short spans, ¼-inch extra high strength steel wire messengers are most often used." We regret any inconvenience this error may have caused.

Cable industry loses two leaders

NEW YORK—March was a sad month for the cable industry as it mourned the loss of two of its leaders, Peter Gilbert and Joseph Connolly Jr.

Gilbert, a multifaceted entrepreneur, had a very diverse background: from serving as the youngest sergeant-major in the British army to running a multimillion dollar company. He began his career in cable with the purchase of Suffolk Cablevision in 1970. More recently, Gilbert had been a managing partner (along with Cox Cable) of Staten Island Cable in New York and owner of the Newark, N.J., cable system. He died March 26 at 62 years of age.

Connolly, 42, was president of the Reading Division of American Television and Communications Corp. He joined ATC in 1980 as general manager of Berks-Cable, the system serving the Reading area. He also was vice chairman of the Pennsylvania Cable Television Association. He died March 14.

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Reader Service Number 82.

Rational expectations for ATV

By Walter S. Ciciora, Ph.D.
Vice President of Technology
American Television and Communications Corp.

Realistically, when can we expect advanced television (ATV) to arrive? When will proponents have hardware to test? When can testing begin and how long will it take? As long as we're exploring our crystal ball, when can we expect ATV to be commercially significant?

Expert opinions

The Federal Communications Commission has created an advisory committee of industry experts to recommend a course of action. Ultimately, the FCC is the only entity in the United States empowered to decide the outcome for terrestrial broadcast. The advisory committee has three subcommittees and a group of working parties. The Systems Subcommittee Working Party 1 (SSWP1) is charged with the initial analysis of proponents. This is the point at which proposals are submitted to the advisory committee for consideration.

SSWP1 conducted a "Hell Week" during which all proponents presented their systems and answered questions. One of the important questions concerned the availability of hardware for testing. Many promised fourth quarter 1989 while some said mid-1990 would be the earliest possible delivery date. Anyone experienced in engineering knows Murphy's law and how it applies to delivery schedules. The well-intentioned promises made by proponent management and the reality of producing the hardware by proponent engineers will likely have some discrepancy. Hardware availability forms an important limiting condition on testing. Testing *cannot* begin without hardware and *should not* begin until a steady flow of proponent hardware is available. Otherwise, costly periods of inactivity will inefficiently consume limited testing budgets.

Cable Labs is scheduling its own mini-"Hell Week" to serve as the mechanism for proponents to indicate their interest in being considered for cable application. These sessions are likely to last one or two days and concentrate on the cable aspects of proponents' systems.

At the 1989 Electronic Industries Association (EIA) Winter Consumer Electronics Show in Las Vegas, there were three panel sessions on high definition television (HDTV). Alex Felker, FCC Mass Media Bureau chief, probably made the most important statement about HDTV standards: "We're already about 18 months into this process...and in many ways we haven't come all that far....We're looking at somewhere around another 18 months, perhaps another two years before testing is complete and the commission would be in a position to select a transmission standard." After testing is complete, a few months will be required by the advisory committee to digest the results and make its recommendations to the commission. The commission can only then make its decision. A year or so longer and the first products will be introduced.

The committee's System Subcommittee Working Party 2 (SSWP2) is charged with the actual testing. Of course, SSWP2 has no budget and is staffed with volunteers. It must be dependent on others to implement the tests. Specifically, the Advanced Television Test Center (ATTC) and Cable Labs are expected to be helpful. SSWP2 produced an interim report in February. It was reported that ATTC expects to be ready for testing this October and that testing will take from 1½ to two years. This is in agreement with the assessment by Felker.

We expect testing to begin in the first or second quarter of 1990. Testing should be complete by middle to end of 1991. The first ATV receivers may be available at the end of 1991 or the beginning of 1992.

Consumer electronics experiences

The growth in penetration of consumer electronics products is a well-understood phenomenon. Experience with radio, black and white TV, color TV and VCRs provides guidance in making predictions on how HDTV will grow. Color TV took seven years after introduction to reach 1 percent of U.S. TV households. Ten percent penetration was reached in 11 years after introduction. This is important information to test the validity of anyone's HDTV penetration projections.

How can we expect the growth of ATV to compare with other consumer electronics products? The difference between black and white TV and radio was tremendous. The difference between color TV and black and white was considerably less. Color TV penetration took more than twice as long than black and white TV penetration. It is believed that the consumer will perceive an even smaller difference between ATV and color NTSC. This means the driving force behind ATV penetration will be less powerful than those behind color or black and white TV. We can expect ATV penetration to be slower than the penetration of either color TV or black and white.

Typically, when first introduced a new consumer electronics product is very expensive and growth is very slow. When the first black and white receivers were introduced, they cost about as much as a compact car. Likewise, when the first color TV receivers were introduced, they cost as much as a compact car of that day. It would be reasonable to expect the first HDTV receivers to cost about as much as a Hyundai. The growth curve for these kinds of products involves a long shallow rise over 10 to 12 years, reaching less than 10 percent of TV households.

Then, a certain price point is reached where consumers generally consider the product a good deal and the penetration curve turns almost straight up. Sixty to 70 percent penetration is achieved in just three to four more years. It is rational to expect that it will be between 12 and 15 years before commercially significant penetration of HDTV receivers is achieved. Any more aggressive projection is out of line with past experience and begs for an explanation of the deviation.

"We can expect ATV penetration to be slower than the penetration of either color TV or black and white."

Large-screen TV

ATV and really large TV screen displays are so synergistic that I believe one can't happen without the other.

All of the early consumer research on ATV has indicated that viewers see little difference between NTSC and ATV if they are more than three or four picture heights away from the display. In normal living rooms, people sit six to eight feet from the screen. For ATV to be noticeably better than NTSC, the screen must be 2 to 3 feet high. Since TVs are normally described in terms of diagonal measure, the screen needs to be 50- to 75-inches for the wider aspect ratio. Less than that and most viewers won't see the difference between NTSC and ATV.

Conversely, anyone who has seen a large NTSC projection set is dismayed at how poor the picture can be. This is due to the shortcomings of NTSC, created at a time when technology had to strain to provide a 12-inch picture. ATV is critical to the volume sale of large screen TVs.

Research on cost-effective, bright, large-screen displays is well under way in Japan and elsewhere. However, consumer products are still about 10 years away. This is very much in concert with the time frames described earlier. Large screens and the growth in penetration of ATV will go hand in hand. Incidentally, the need for a large screen will keep ATV as an upper price point product. It is unlikely that inexpensive receivers in the $200 to $300 range will ever be anything other than good old NTSC.

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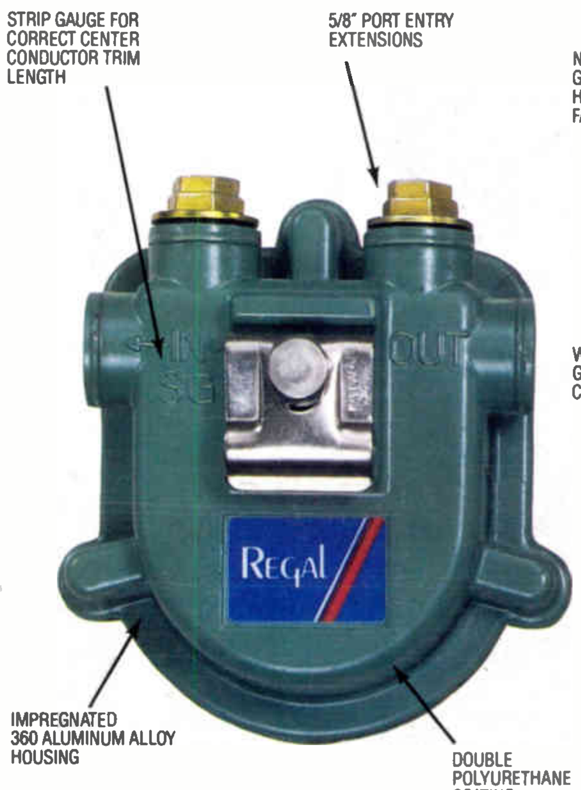

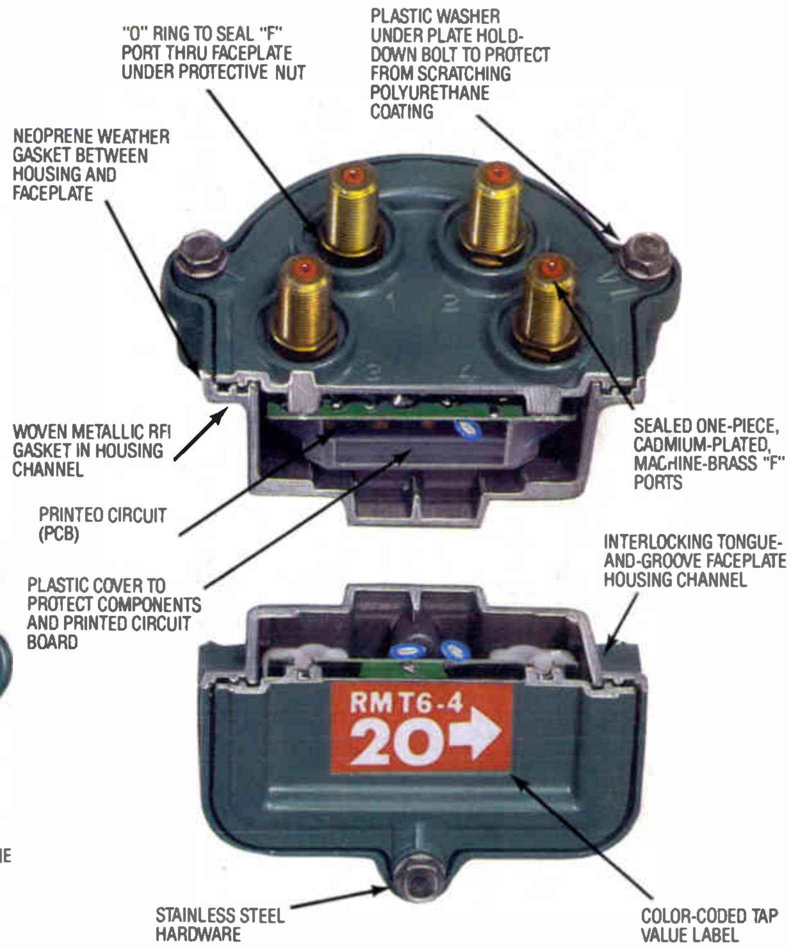

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