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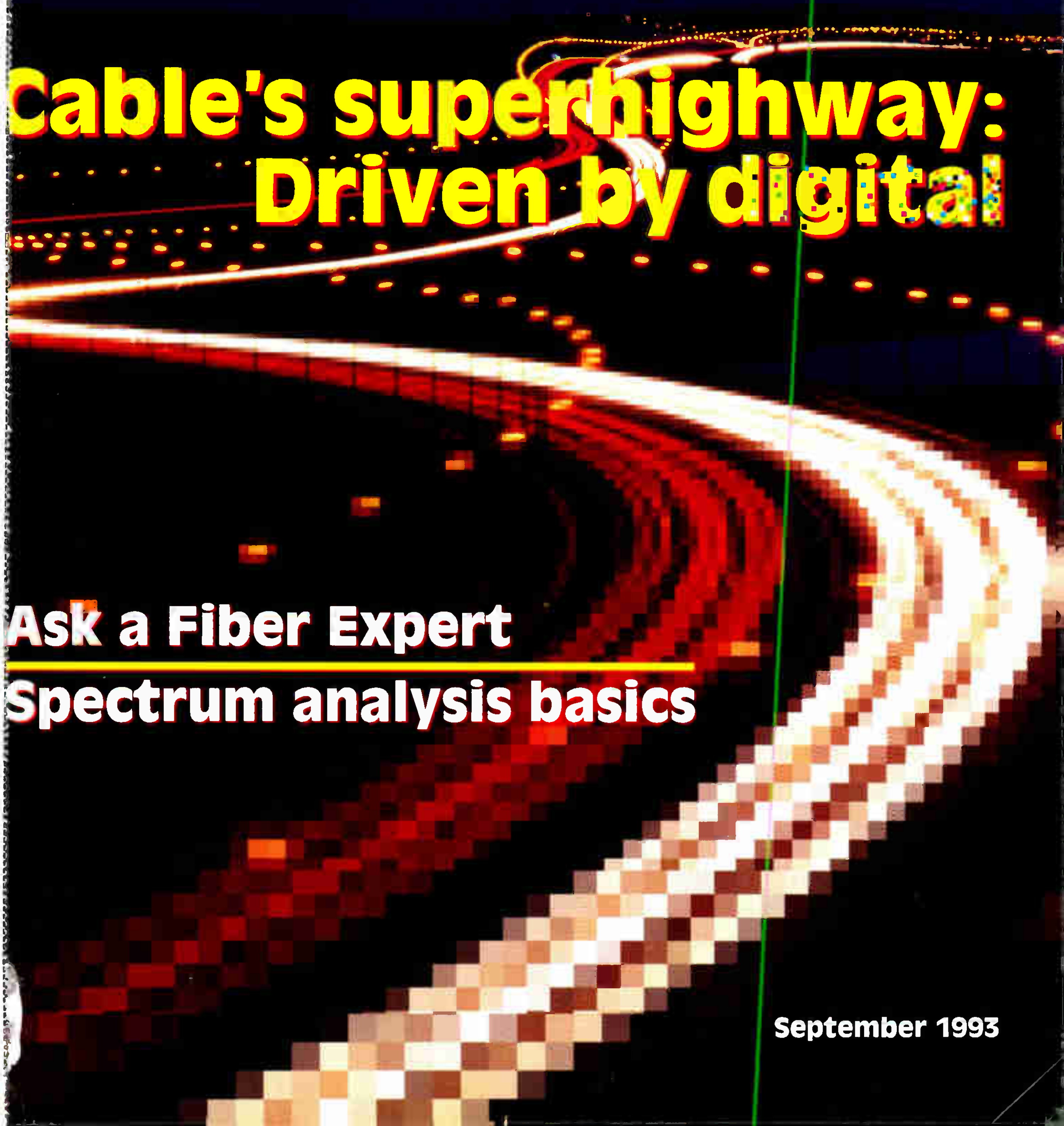

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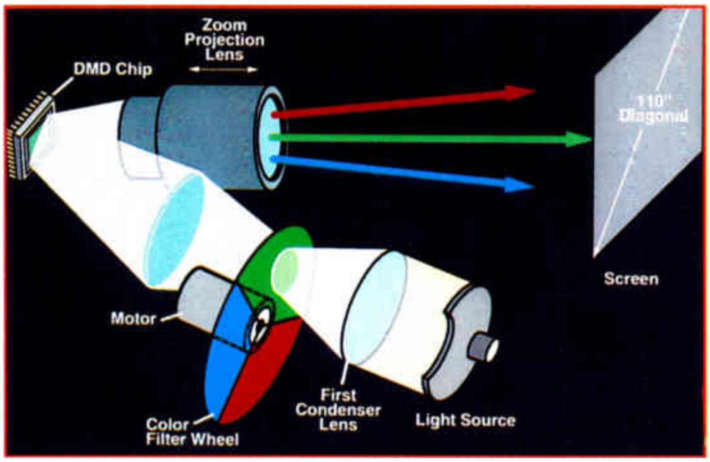

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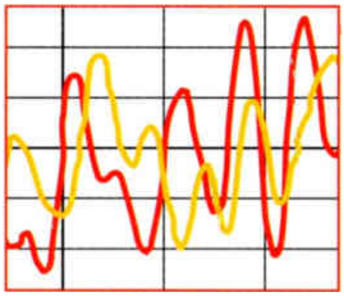

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NEWS

Suppliers report financial results

Several hardware suppliers reported financial results recently.

Compression Labs Inc. reported revenues for the second quarter ending June 30, 1993, of $35.6 million, an increase of 33% from the same quarter last year. The company reported a loss for the quarter of $986,000 or 9 cents per share compared to a loss of $2.2 million, or 19 cents per share in the second quarter of 1992.

Zenith Electronics Corp. reported a net loss of $24.7 million, or 79 cents per share for the second quarter of 1993, compared to a net loss of $15.2 million, or 52 cents per share, for the second quarter of 1992. In other news, the company entered into an agreement for the sale of 750,000 to 1.2 million shares of newly issued common stock to Fletcher Capital Markets Inc.

Raychem Corp. reported earnings for fiscal 1993 of $10 million, or 23 cents per share, compared to a loss of $25 million, or 64 cents per share, in fiscal 1992. Revenues grew to $1.4 billion from $1.3 billion in the previous year.

AM Communications Inc. announced sales for fiscal year 1993 ending April 3, 1993, reached $2.88 million, compared to $2.05 million for the previous year ending March 28, 1992. The net loss for fiscal year ending April 3, 1993, decreased from $725,000 to $500,000.

General Instrument reported net income of $12 million, or 20 cents per share, compared to a net loss of $10 million, or 23 cents per share, from the second quarter of 1992. In other news, GI filed three related lawsuits against manufacturer/distributors alleged to have sold preprogrammed cable signal decoder units, components and other electronic devices nationwide that enable consumers to fraudulently obtain cable signals and services from cable operators. The complaints were lodged against Sun Coast Distributors Inc. of Silver Springs, FL; Lake Sylvan Sales Inc. of Burnsville, MN; and Nu-Tek Electronics & Manufacturing Inc. of Cedar Park, TX. Also, GI announced a $250 million agreement with Primestar for direct-to-home service with the company's DigiCipher digital compression technology.

☛ U.S. Electronics has brought a counter-suit against General Instrument, charging it with antitrust violations for restraint of trade. The counter-suit stems from litigation filed by General Instrument in January 1993, alleging that a remote control unit marketed by U.S. Electronics uses copyrighted software and data for generating infrared signals for the remote operation of various brands of TV sets.

☛ The Supreme Court upheld the Federal Communications Commission ruling that a satellite master antenna TV system is subject to the Cable Act's franchise requirement if its wires or cables interconnect separately owned and managed buildings, or if its lines use or cross any public right-of-way. This overturns the ruling by the United States Court of Appeals for the District of Columbia Circuit.

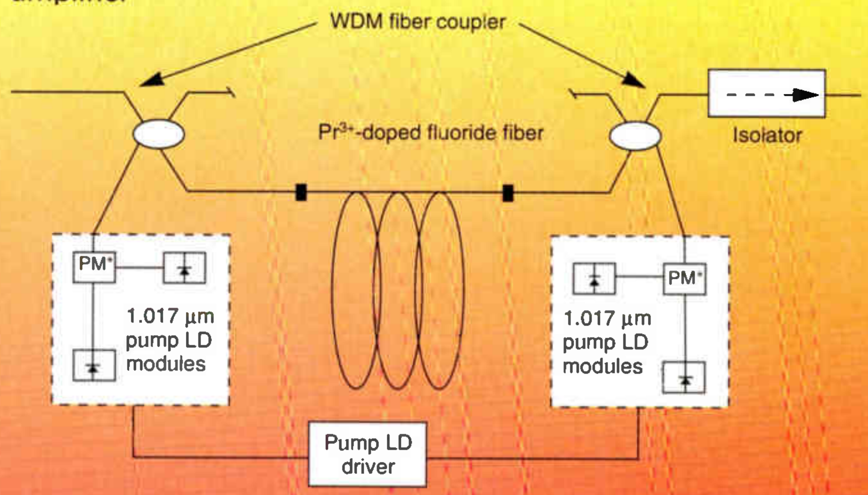
New developments

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

There has been progress in some areas that have been addressed in previous columns. Here we will look at developments in fiber-optic amplifiers

"A 60-inch rear projection HDTV receiver could be constructed ... in a cabinet only 18 inches deep."

Figure 1: Schematic diagram of a praseodymium-doped fiber amplifier



*PM refers to a polarization-multiplexing device

last described in the May 1992 issue — "What is the status of a 1,310 nm fiber-optic amplifier?" — and advances in flat panel displays described in the December 1992 issue — "New developments in flat panel displays." Additionally, a new display scheme from Texas Instruments that appears *very* attractive for high definition TV (HDTV) use is reviewed.

Praseodymium fiber-optic amplifiers

As was described in the May fiber amplifier column, a fiber-optic amplifier is the ultimate in system simplicity. A fiber amplifier is essentially inserting a short length (a few meters) of a special fiber in the fiber-optic transmission system. This special fiber is "doped" with specific materials that accomplish the light amplification of the laser light carrying the desired signal when the doped fiber is "pumped" by a laser contained in the fiber-optic amplifier — i.e., the pump laser is coupled into the doped

Figure 2: Microtip configuration

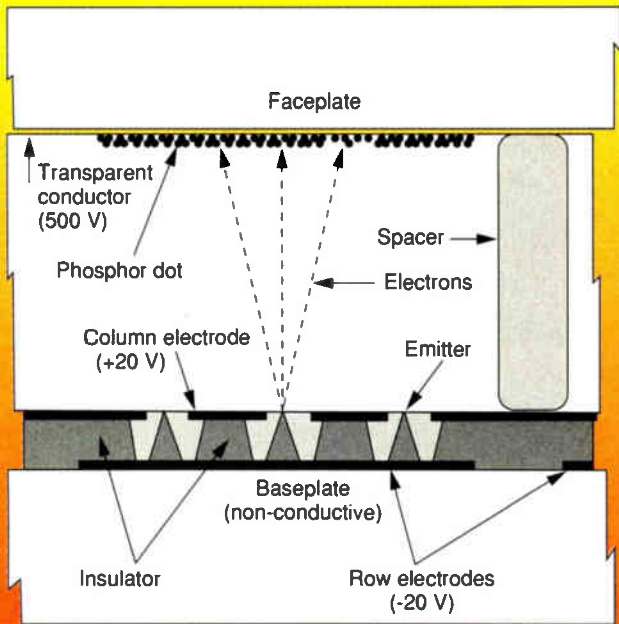
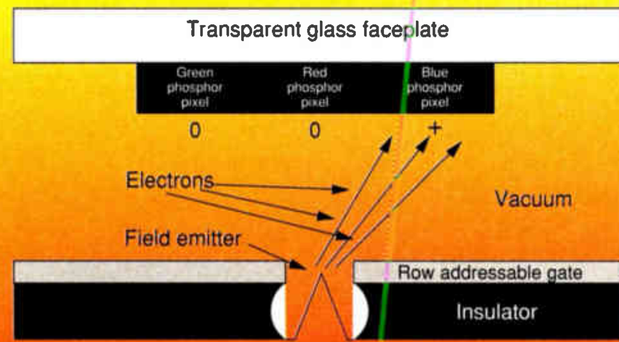


Figure 3: Color FED



fiber to provide the energy used by the dopant material in the amplification process. The doping material used in 1,550 nm fiber-optic amplifiers is the rare earth element erbium (Er) and there has been a great deal of experimentation using the rare earth element praseodymium (Pr) for 1,310 nm amplification.

At a recent Optical Fiber Conference in San Jose, CA, Makoto Shemizu and co-workers at Nippon Telephone and Telegraph (NTT) described their progress in praseodymium fiber-optic amplifiers for 1,310 nm transmission. They used a 40-meter length of Pr-doped fiber using two 1,017 nm InGaAs diode-laser modules in a ridged-type strained quantum well configuration as bidirectional pump sources, each generating about 110 mW of output power. (See Figure 1.)

Total fiber gains of as much as 28.3 dB were obtained at 1,310 nm with a 3 dB optical bandwidth of about 20 nm — which in frequency is about 3,500 GHz. While this performance isn't quite as good as has been demonstrated from Er-doped amplifiers (>30 dB gain and >30 nm bandwidth), it is quite good enough to cause system designers to rethink the value of Pr-doped fiber amplifiers.

Flat panel display developments

The fundamentals of a microtip flat panel display (also known as a field emission display, or FED)[1] were outlined in the December 1992 column. An FED uses a large array of microscopic tips (see Figure 2) that emit electrons. The electrons are accelerated toward phosphors across a vacuum. The principle is the same as that of conventional CRTs but the electron flight distance is greatly decreased and the number of electron guns is greatly increased. The entire panel is only 2 or 3 mm thick. In most respects, FEDs have the same operating characteristics as their CRT cousins: very wide viewing angles, high contrast levels, frame rates that easily handle video and very high resolution levels. A concept of the size of an individual microtip is gained by considering that the goal for resolution is 1,000 pixels/inch and having 100 emitters per pixel (for redundancy).

Figure 3 depicts a color FED that has been demonstrated. In order to obtain a full-color picture, each of the three primary colors is scanned in sequence — that is, there are three frame scans for each full-color picture. This is analogous to the old CBS color wheel, frame sequential technique. (Incidentally, this was the system used in all the color TV from the moon in the Apollo program.)

A new projection scheme

Texas Instruments caused quite a stir with its demonstration of a new high definition color TV projection system at the Spring Conference of the Society for Information Display. An example of the display is shown in Figure 4 on page 17. The display

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Figure 4: TI color TV projection

is 110 inches diagonally with a contrast ratio of 50:1.

Dr. Jeffrey Sampsell, the manager of TI's Digital Imaging Systems organization, provided the technical information of this new display technology. The system is based on an electromechanical structure called a digital micromirror device (DMD). A micromechanical silicon chip, the DMD measures less than 5/8 of an inch on each side, yet it contains more than 300,000 tiny movable aluminum mirrors and electronic logic memory and control circuitry packaged in a 96-pin ceramic package.

The micromirrors are 17-micron squares of a highly reflective aluminum alloy. (See Figure 5.) Each mirror is attached at two diagonally opposite corners to support pillars; the attachments are highly flexible, extremely durable torsion bars. Each torsion bar is approximately 5 microns long and 1 micron wide. The support pillars suspend each mirror approximately 2 microns above the surface of the silicon addressing circuitry. The DMD can be mass produced in standard semiconductor wafer-fabrication facilities — using standard processes and materials.

The micromirrors are arranged in an x-y array, and the chip also contains row drivers, column drivers and timing circuitry. The addressing circuitry under each mirror pixel is a memory cell that drives two electrodes under each mirror with complementary voltages. The electrodes are arrayed on opposite sides of the rotational axis that runs through the torsion bar attachments. When the electrode on one side of the rotational axis is driven to a high logic level, the electrostatic attraction on that side of the axis rotates the mirror around the axis until the unattached mirror corner on that side touches a metal landing pad on the surface of the chip (about 10°). When the high logic level is applied to the other electrode, the mirror rotates in the other direction. In one direction, light from a projection lamp is reflected to the screen and in the opposite direction no reflection to the screen.

Mirror transit time from "tilted left" to "tilted right" is on the order of 10 µs. This speed combined with parallel addressing allows the DMD to achieve frame rates orders of magnitude beyond video rates. Such frame rates allow the DMD to be refreshed fast enough that each pixel can be turned on or off (bright or dark) with very fine video temporal resolution. As an example, for a system with 8 bits of grey scale resolution, each pixel can be in the "bright" state for the entire frame,

Figure 5: Digital micromirror device element

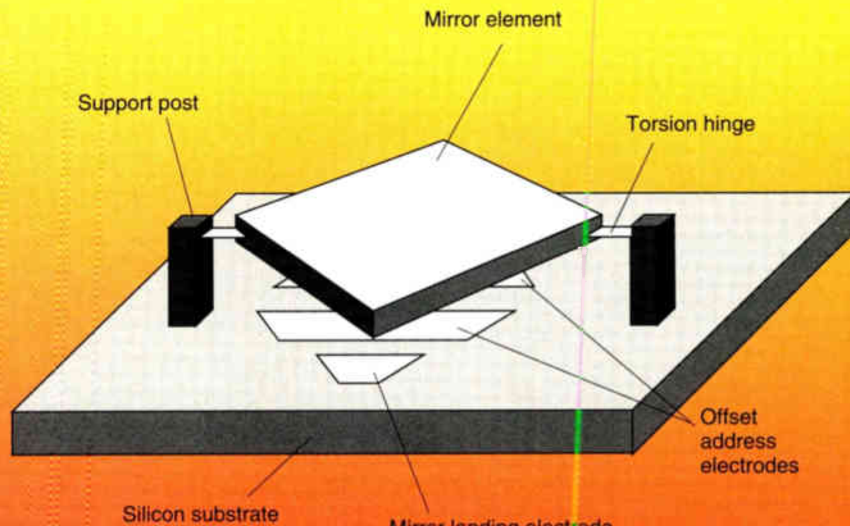
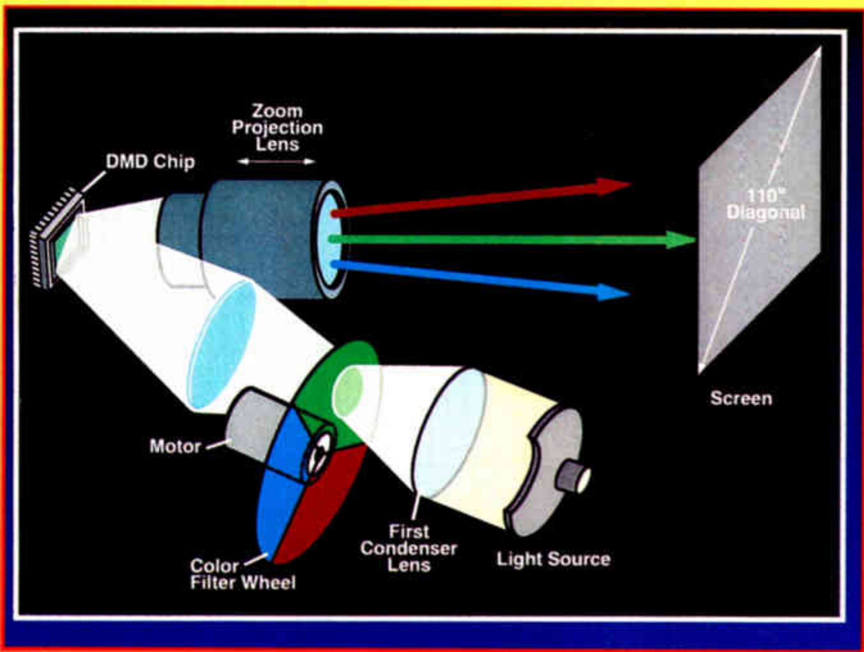


Figure 6: DMD color TV projection system



255/256ths of the frame time, 254/256ths of the frame, ..., 1/256ths of the frame time or none of the frame time. The integration of these temporally encoded brightness levels into a grey level at each pixel takes place in the eye of the viewer. In this way a completely digital display has been created.

The color display system consists of a xenon arc lamp bulb that directs white light through a condenser lens and a motor-driven wheel with red, green and blue (RGB) color filters on the surface of the DMD chip. Again we have a variation on the CBS frame sequential color system. (See Figure 6.)

The projector displays video from an unmodified NTSC video source, such as a videodisc player. Using the 240 lines in the first NTSC interlaced field, the electronic portion of the system interpolates a progressive scan field of 480 lines for each 16.67 millisecond frame. The signal is separated into its RGB components, and each line is run through an analog-to-digital (A/D) converter and digitized 640 times. This data is stored in three 640 x 480 memory arrays.

The 16.67 ms frame is divided into three, 5.55 ms periods that correspond to the time that the filter is shining red, green or blue light on the DMD chip. During each color period, the system reads from the appropriate memory an 8-bit word that indicates each pixel's intensity. This value determines the portion of the period that the corresponding mirror will be turned on, and the pulse-width-modulation control circuitry activates the mirror. This cycle is repeated for each portion of the color wheel for each successive frame.

"The progress in performance capabilities of 1,310 nm praseodymium fiber-optic amplifiers appears now to be edging into the area of serious consideration in the real world of system design and use."

Sampsell said, "TI's DMD-based display provides excellent resolution and brightness, high contrast and color fidelity, and in comparison to CRTs used in HDTV receivers, a DMD-based display is flicker-free, provides better color convergence and produces less visual noise." He reported that TI plans to have a DMD chip for HDTV projection by this December. He said it will be 2,048 x 1,152 pixels and slightly larger than the current NTSC chip — about 1-1/4" x 3/4" as opposed to 1/2" x 3/8".

Sampsell then a made a startling announcement that should *really* interest HDTV system developers. He stated that a 60-inch rear projection HDTV receiver could be constructed with DMD in a cabinet *only 18 inches deep*.

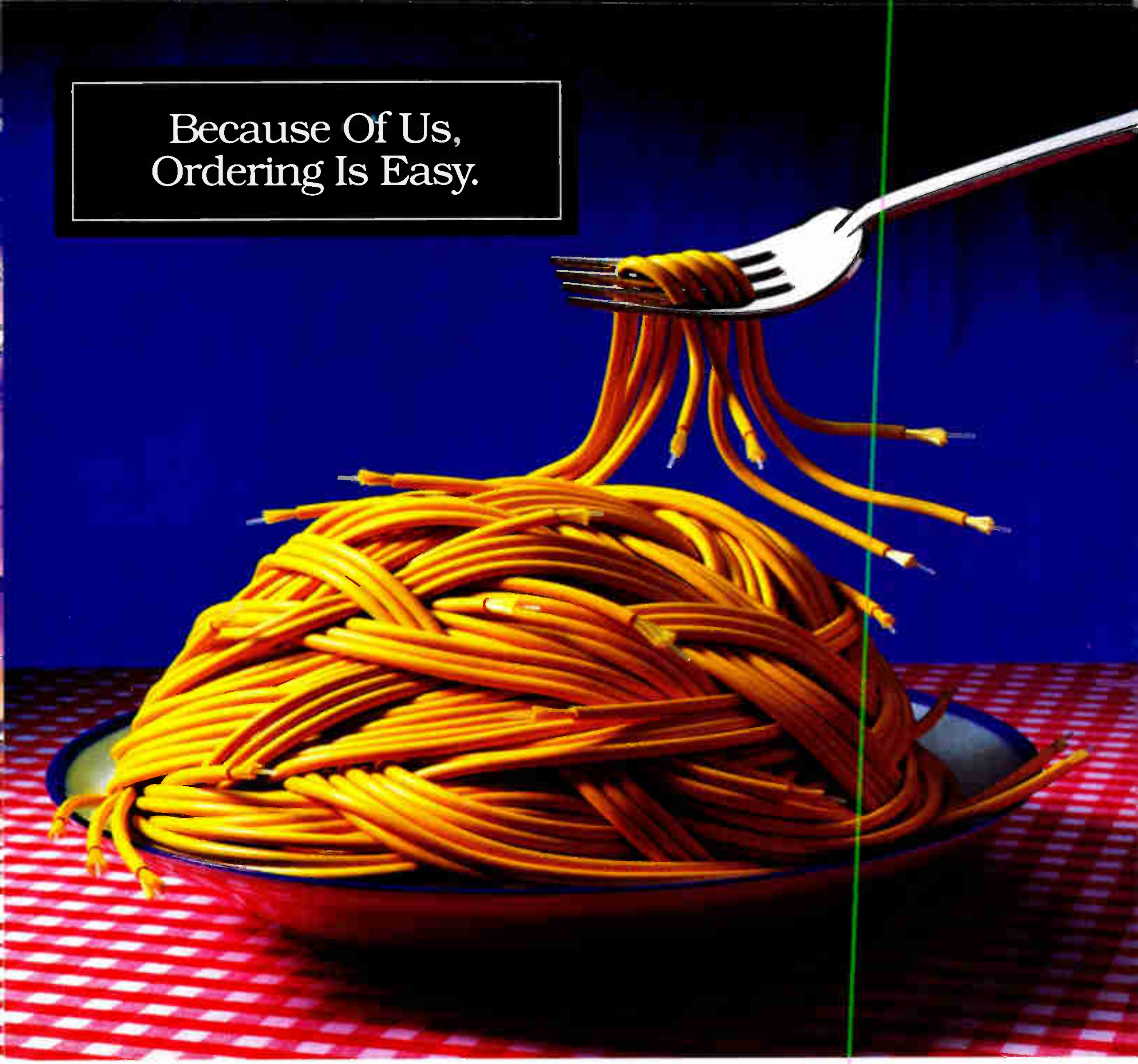
Conclusions

The progress in performance capabilities of 1,310 nm praseodymium fiber-optic amplifiers appears now to be edging into the area of serious consideration in the real world of system design and use. And there seems to be no end to variations being developed for displays that may be suitable for HDTV — progress in microtip displays and a unique new technique for projection display reviewed here are but two of many schemes undergoing feverish development.

Although individual progress in the several systems reviewed here since last examined has been significant, more progress and change is inevitable. The ancient Greek philosopher Herucli-tus had it right — "there is nothing permanent except change." **CT**

References

[1] "A field-emitter display," H. Gray, *Information Display*, March 1993.
[2] "A revolution is in store for flat-panel displays," J. Shandle, *Electronic Design*, April 15, 1993.



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Multirate all-digital modems for compression

The following is adapted from the "1993 NCTA Technical Papers."

By Fred Harris
Systems Engineer
And Tony Wechselberger
Executive Vice President
TV/COM International

Figure 1: Generic view of modem

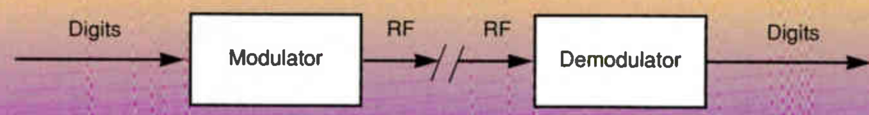


Figure 2: Modem sub-block partition

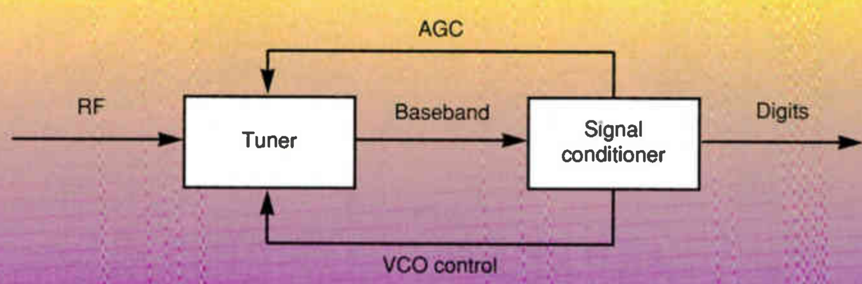
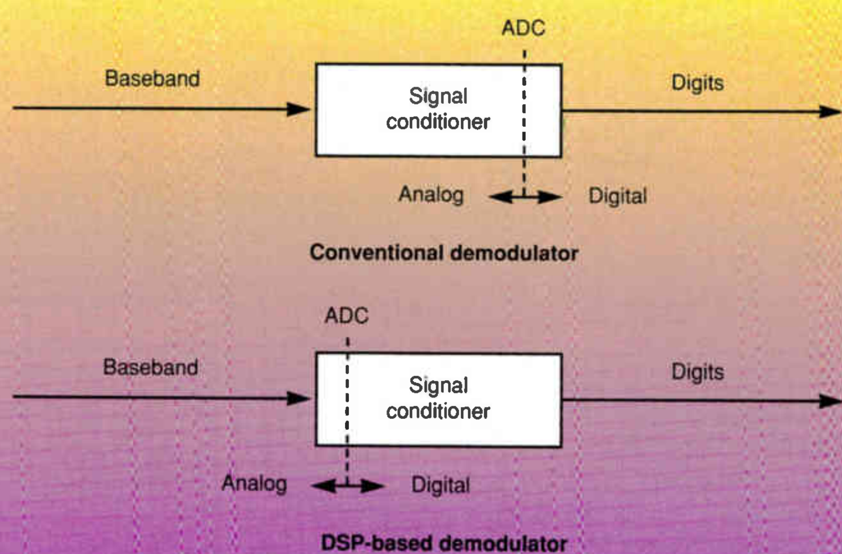


Figure 3: A/DC insertion (conventional and modern modem)



Video and audio signals can be compressed to obtain varying levels of quality extending through the progression of SIF, VHS, NTSC, CCIR-601 and HDTV, via successively increasing bit rates. Data streams from a number of video and audio signals (compressed at data rates required for their specified quality) will be transported in a number of ways. They can be merged in a full bandwidth (TDM) data transport, which requires a versatile multiplexing scheme, or transmitted in a single carrier per channel (SCPC) mode using bandwidths appropriate to each selected data rate.

It would be advantageous to have a flexible system modulator/demodulator arrangement such that equipment (especially receivers) could be easily reconfigured to operate across a wide spectrum of data rates. Such a modem must be capable of operating with transponder signals of full bandwidth as well as with the unique bandwidths of the different SCPC signals that may, during operation, be reassigned to different center frequencies by the satellite carrier in response to changes in transponder loading.

An all-purpose modem required to support delivery of digital video and other services can be characterized by the following requirements:

- Capable of rapidly switching and acquiring carrier frequencies.
- Capable of (automatically) varying the occupied bandwidths.
- Capable of varying the data processing (throughput) rate.
- Operate in the presence of multiple adjacent channels.
- Operate in the presence of terrestrial interference.
- Must yield throughput performance equal to the maximum capacity of present and planned transponders.
- Must be low-cost.

The modem

Generally, as in Figure 1, modems can be visualized as RF-to-digital transducers operating at the lowest layer of a transport system. This transduction process entails two distinct transformations: RF-to-baseband and baseband-to-digits. To aid in understanding, it is convenient (as in Figure 2) to partition the modem into two main sub-blocks: a tuner and a baseband

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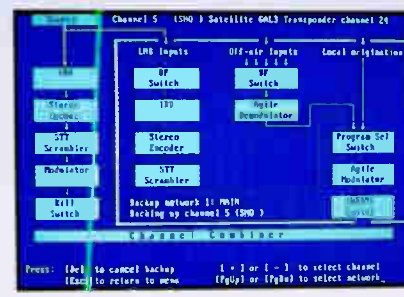

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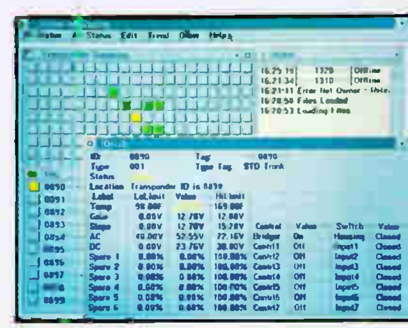

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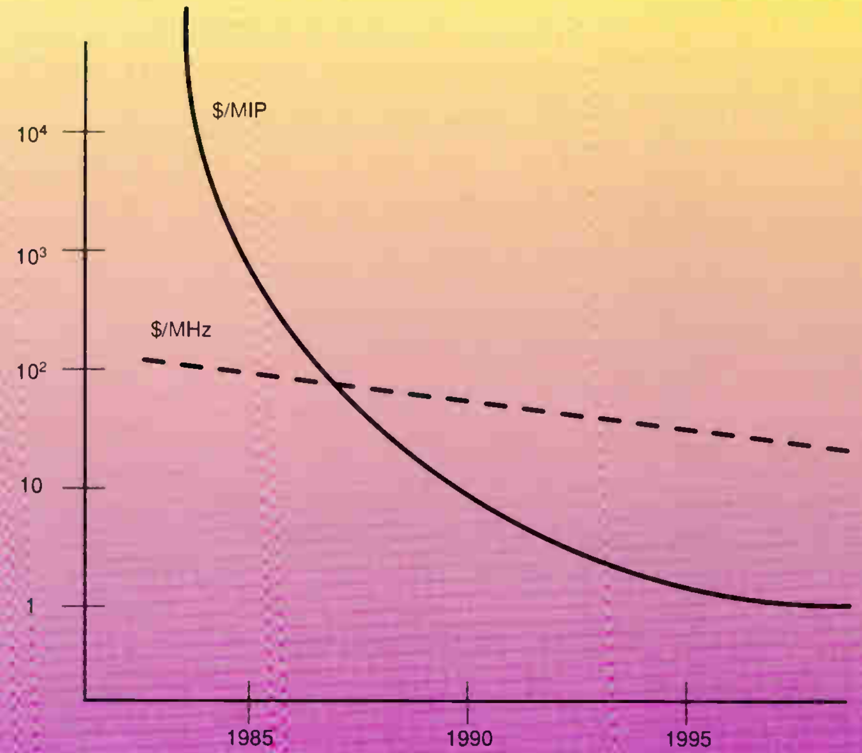
Figure 4: Cost performance of analog and digital processing components



"signal conditioner." The tuner isolates and extracts the signal bearing carrier from the channel and performs the RF-to-baseband transformation.

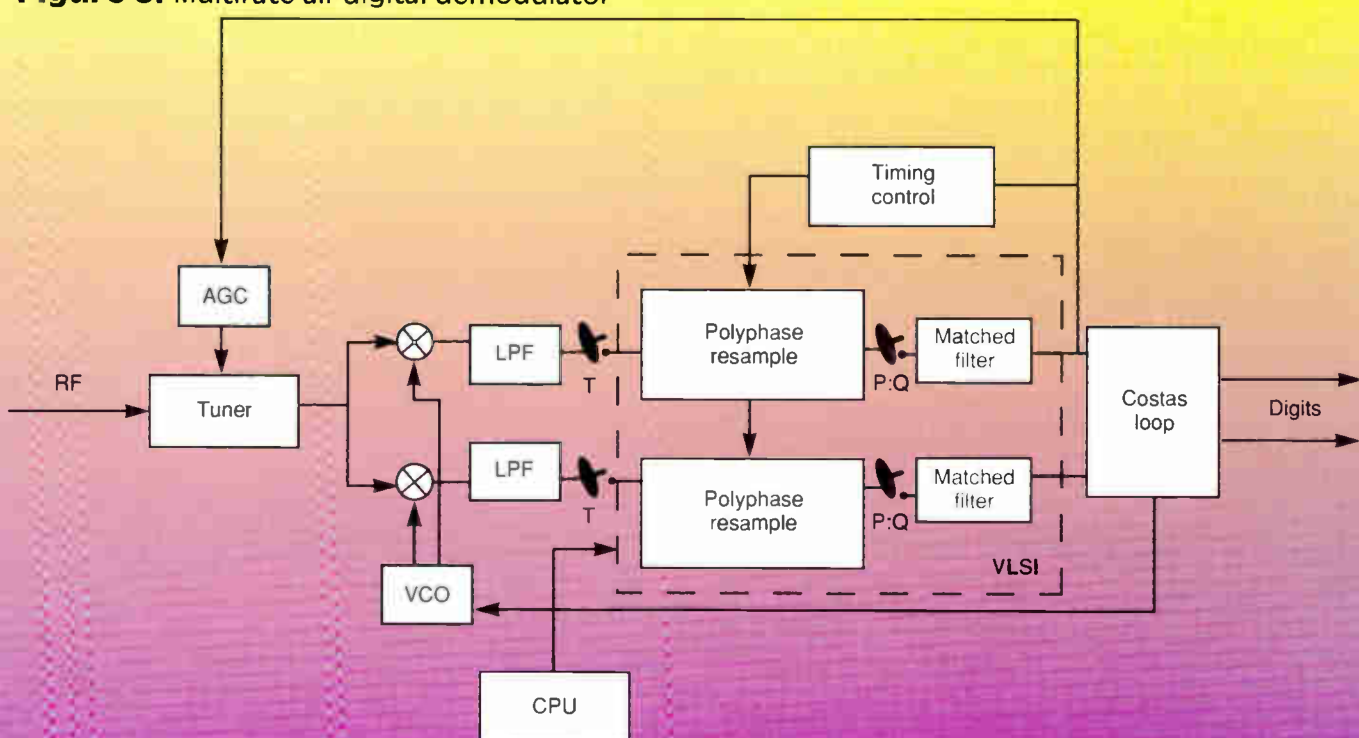
The baseband signal conditioner processes the analog waveform extracted from the channel (by the tuner) and performs synchronous demodulation with the aid of carrier and timing information derived from the received waveform. The digital output of the baseband signal conditioner is the quantized (soft decision) sample values formed at the output of its matched filters. In developing DSP-based solutions, this transformation (baseband-to-digital) is accomplished by an analog-to-digital converter (A/DC) located in the signal conditioning processing chain. The A/DC is the boundary between the analog processing and the digital processing performed by the signal conditioner. Traditionally, as in Figure 3 (page 20), this boundary is near the end of the baseband signal conditioning chain. In light of cost reductions in A/DC and digital signal processing (alluded to in the next section), there are advantages to moving this boundary toward the beginning of the chain. By placing the A/DC at the very beginning of the sequence, we have a full DSP-based signal conditioner modem, and solutions to the requirements characterized above in developing an all-purpose demodulator become available.

The DSP modem

The cost of signal conditioning by digital signal processing techniques, measured for instance in dollars per million integer operations, has fallen two orders of magnitude in the last five years. This rate

(Continued on page 34)

Figure 5: Multirate all-digital demodulator



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Measuring digital carriers

(Continued from page 25)

mixed down to baseband using a 44 MHz local oscillator. Two mixers are used, one for the I channel and another for the Q channel. The local oscillator also is split and phase-shifted by a 90° splitter to derive the Q channel. Next, the I and Q channels are low-pass filtered to remove any local oscillator leakage. The low-pass filters are sufficiently wide to allow the filtering function to be done solely by the SAW filter.

Note that since a noncoherent carrier is used, the signal's vector diagram will almost certainly be spinning. In this state, data demodulation can be done only with sophisticated DSP techniques, but the two baseband signals are still useful for instantaneous power measurement. This is because the instantaneous voltage, V(t), has the same magnitude, even if the signal's trajectory is rotating around the zero volt origin. Neither the 44 MHz local oscillator nor the local oscillator in the downconverter need to be of the low phase noise type. This technique is tolerant of phase noise.

Next, the I and Q data are sampled by a two-channel digital oscilloscope. The sampling rates available on common digital oscilloscopes are well within the requirement of this measurement technique, since a sampling rate of greater than 6 megasamples per second is sufficient, assuming a SAW bandwidth of less than ±3 MHz. The I and Q data in the oscilloscope's memory are read out for analysis by a computer. The analysis consists of finding the vector sum of many data pairs of I and Q data, putting these many samples into the bins of a histogram, then calculating the peak and RMS power from the histogram data. If the oscilloscope is sufficiently smart, it can do much of the analysis by itself. In the case of the test done, the oscilloscope was fairly powerful, and no computer software had to be written to obtain a histogram. The instantaneous sampled voltage is:

$$V(t) = \sqrt{V_i(t)^2 + V_q(t)^2}$$

Where:
$V_i(t)$ = sampled in-phase voltage,
$V_q(t)$ = sampled quadrature voltage,
$V(t)$ = desired sample to be accumulated into a histogram.

The instantaneous power P(t) is given by:

$$P(t) = \frac{V(t)^2}{R}$$

Where:

R = the system's impedance, usually 50 or 75 ohms.

The next step is to determine the RMS voltage from the histogram data. The RMS voltage (V_{RMS}) in an analog system is:

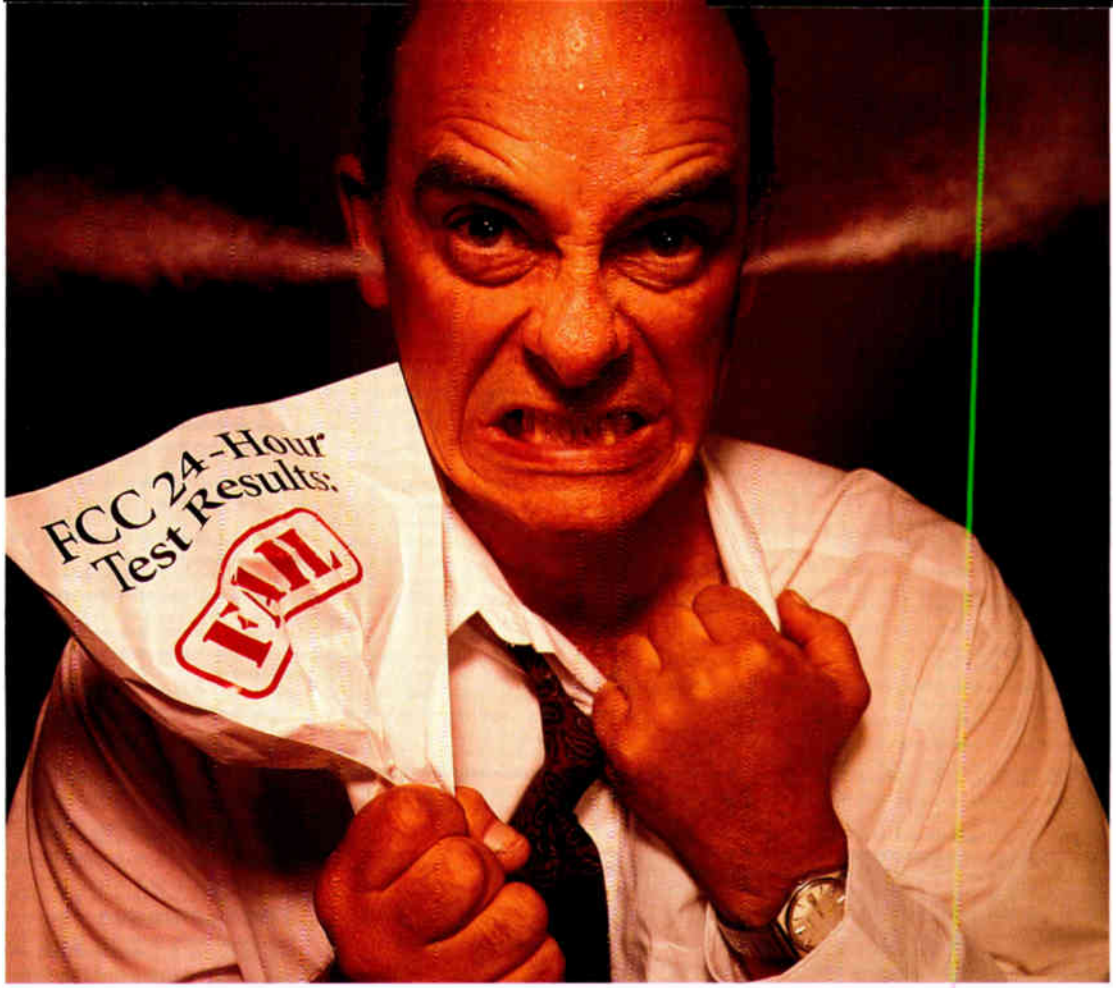
$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T V(t)^2\,dt}$$

Where:
T = period of integration.

In this case, which is a sampled system, the RMS voltage is:

$$V_{RMS} \cong \sqrt{\frac{1}{N}\sum_{k=1}^{K} V_{bin}(k)^2 \bullet x(k)}$$

Where:
$V_{bin}(k)$ = voltage of a the k^{th} bin, →



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WAVETEK

Reader Service Number 32

Long pull construction

(Continued from page 27)

vides an example of the software projections.

Another feature of the software is the ability to adjust pull force projections based on actual measured tensions. The program will "back-out" a coefficient of friction from field information. This assures accurate projections when duct, cable or lubricant coefficient of friction data is not known.

Working the plan

Productivity depends on good preparation. The underground dips were the biggest source of concern. The first innerduct run was prepared the day before. Pull lines were checked, lubricant was added and excessive bends were corrected wherever possible. The aerial crew was scheduled to start placing cable to the south as soon as the underground section was complete.

Riser A1 was taken down from the pole and secured to guide the cable directly to the capstan winch. The first half of the underground section went very quickly. The distance from the cable reel at Vault 1 to the winch at the riser (A1) was about 1,500 feet. The measured tension was within ±10% of the 212-pound projection shown in Table 1 on page 27. The low pulling force requirement allowed pulling cable at 125 feet per minute. The first section was pulled and 7,000 feet overpulled and put in a figure eight ready for the aerial crew in about 90 minutes.

The worst part of the job was turning the heavy 8-foot diameter reel. Three men assured that the cable was properly lubricated and entered the innerduct with no back tension. After removing the remaining cable from the reel, equipment was set up for the pull in the opposite direction.

Table 2 on page 27 demonstrates a comparison of tension increase over a 1,452-foot section of this route and the tension rise over a truly straight section of an equivalent length. In Table 1, output from the software provides the tension at the end of each section. Tension at the end of Section 39 is 173 pounds. Notice that after Sections 40 and 41, with repeating undulations of 1-inch amplitude and a period of 12 feet, the tension has risen to 360 pounds.

Table 3 describes the appropriate tension multiplier for the products used on this job at various degrees of bend. Looking at Table 1 again, you will see the 45° bend inside MH9A (Section 42) created a tension increase to 402 pounds. The pull force measured at the primary winch fluctuated within ±10% of this predicted value.

The intermediate assist winch used has a unique automatic speed control feature. One man, rather than two or three, sets up and operates the machine. On this job, coordinating pulling speed with our end puller was an im-

Table 3

Bend angle	Multiplier (percent increase)	Starting tension	Ending tension
90°	1.246 (124.6%)	350 lbs.	436 lbs.
90°	1.246 (124.6%)	35 lbs.	44 lbs.
270°	1.934 (193.4%)	350 lbs.	677 lbs.
270°	1.934 (193.4%)	35 lbs.	68 lbs.

Table 4

TENSION FORECAST WITH A MIDDLE PULL

PULL IDENTIFICATION	SAMMONS ATLANTIC CITY DUCT ROUTE: FIBER 3	NUMBER OF PULL SECTIONS: 13	
CONDUIT INSIDE DIAMETER	1.394 inches	CABLE DIAMETER	0.843 inches
FRICTION COEFFICIENT	0.14	CABLE WEIGHT	0.283 pounds
MAXIMUM CABLE TENSION	500 pounds		
MANHOLE NUMBER AT CABLE REEL	A3	LENGTH OF FORWARD PULL:	898 feet
CABLE REEL BACK TENSION	50 pounds		
CAPSTAN BACK TENSION	10 pounds		

Location Ident	Pull Section Number	Type of Pull	Straight Length (feet)	Bend Angle (degrees)	Straight Slope (° or %)	Undulation Period (feet)	Undulation Amplitude (inches)	Radius (feet)	Section Ending Tension (pounds)	Cable Reel/ Winch Location
A3									50	Cable Reel
	1	Concave Curve Down	2	90				1.5	62	
	2	Down Slope Angle	15		90°				58	
	3	Concave Curve Down	5	90				3	71	
MH101	4	Horizontal Straight	8						71	
	5	Horizontal Bend	7	270				1.5	137	
	6	Horizontal Straight	600			12	1	108	195	
	7	Long Horizontal Arc	50	20				143	205	
MH102	8	Horizontal Straight	62			12	1	108	212	
	9	Horizontal Bend	7	270				1.5	410	
	10	Horizontal Straight	120			12	1	108	431	
A4	11	Concave Curve Up	5	90				3	538	
	12	Up Slope Angle	15		90°				542	
A5	13	Concave Curve Up	2	90				1.5	676	Primary Winch

portant feature. The small end puller had force-limiting and a recorder but lacked a large diameter capstan drum for overpulling the cable needed for the splice and backfeeding into Vault 2. When the cable arrived at MH9A, word was sent to the assist location at MH6 to overpull the slack necessary for splicing at Vault 2. The assist operator then moved his setup to Vault 2 and completed the pull.

The software quantifies the impact of back tension

While the underground crew finished the first dip, the aerial crew placed about 4,000 feet in rollers. They "jigged-out" cable right up to the remaining underground dip. At the end of the aerial section the tension was about 50 pounds. Throughout the build, pull tension was monitored with a boom-mounted force measuring and recording device. Replacing the pre-installed polypropylene pull-line with a suitable winch line, the aerial crew prepared to pull cable through the remaining underground dip. The tension monitor indicated an excessive force requirement when pulling the underground dip with the 50 pounds of back

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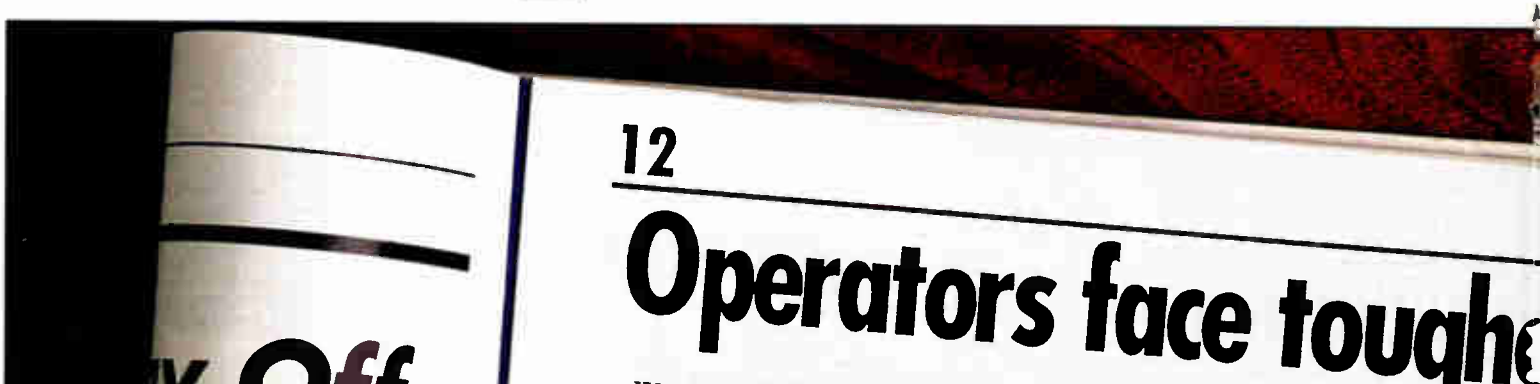

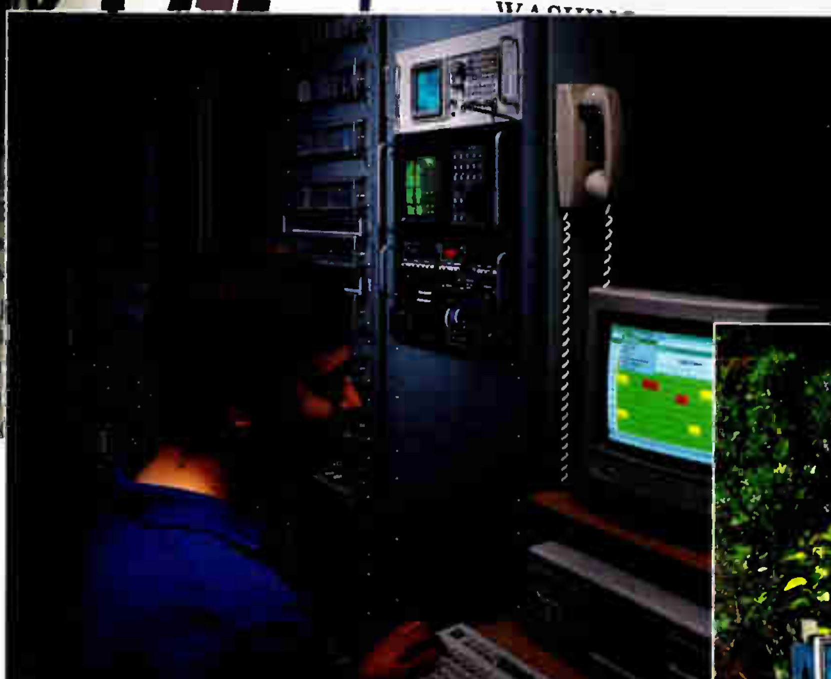

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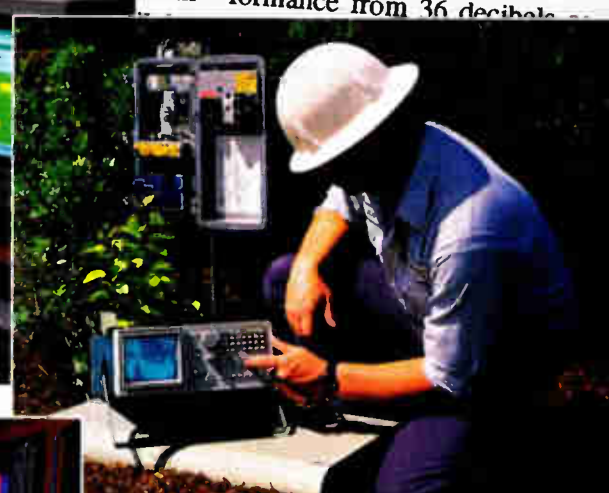

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Table 5

TENSION FORECAST WITH A MIDDLE PULL

PULL IDENTIFICATION	SAMMONS ATLANTIC CITY DUCT ROUTE: FIBER 4		NUMBER OF PULL SECTIONS: 13
CONDUIT INSIDE DIAMETER	1.394 inches	CABLE DIAMETER	0.843 inches
FRICTION COEFFICIENT	0.14	CABLE WEIGHT	0.283 pounds
MAXIMUM CABLE TENSION	500 pounds		
MANHOLE NUMBER AT CABLE REEL	A3	LENGTH OF FORWARD PULL:	889 feet
CABLE REEL BACK TENSION	10 pounds		
CAPSTAN BACK TENSION	10 pounds		

Location Ident	Pull Section Number	Type of Pull	Straight Length (feet)	Bend Angle (degrees)	Sraight Slope (° or %)	Undulation Period (feet)	Undulation Amplitude (inches)	Radius (feet)	Section Ending Tension (pounds)	Cable Reel/ Winch Location
A3									10	Cable Reel
	1	Concave Curve Down	2	90				1.5	12	
	2	Down Slope Angle	15		90°				8	
	3	Concave Curve Down	5	90				3	8	
MH101	4	Horizontal Straight	8						9	
	5	Horizontal Bend	2	90				1.5	11	
	6	Horizontal Straight	600			12	1	108	42	
	7	Long Horizontal Arc	50	20				143	45	
MH102	8	Horizontal Straight	62			12	1	108	49	
	9	Horizontal Bend	2	90				1.5	60	
	10	Horizontal Straight	120			12	1	108	68	
A4	11	Concave Curve Up	5	90				3	85	
	12	Up Slope Angle	15		90°				89	
A5	13	Concave Curve Up	2	90				1.5	112	Primary Winch

tension from the aerial. The aerial crew decided there may be a problem with the duct that would have to be resolved by the underground crew the following day.

On day two, the underground crew opened MH101 and MH102. The "pass-through" in each manhole was rebuilt. Reducing the degrees of bend in the innerduct transitions has a dramatic effect on the pull force requirement. While we converted the manhole transitions from 270° to 90°, an operator used the winch to move the aerial figure eight to the span before the riser. The back tension dropped from 50 to about 10 pounds. The pull force requirement for the 858-foot dip decreased from over 550 pounds to about 110 pounds. Tables 4 (page 42) and 5, respectively, show the software output before and after the changes in the duct "horizontal bend" and reduction in "cable reel" back tension.

After winching the cable to the intermediate assist winch, the cable was routed over the "dancer arm" then up to the force measuring device on the bucket truck. The winch can move cable at speeds up to 200 feet per minute to follow the speed of the aerial crew as they jigged-out the remaining 1,400 feet.

Conclusions

Sammons Communications encourages its contractors to provide a plan for cable placement with their bid packages. Thorough knowledge of the duct route geometry is fundamental for planning. This complicated build was completed successfully and on schedule with effective preparation, proper use of manpower and efficient equipment placement. The ability to forecast pull force requirements accurately takes the guesswork out of deciding where to set up the cable reels and assist winches. **CT**

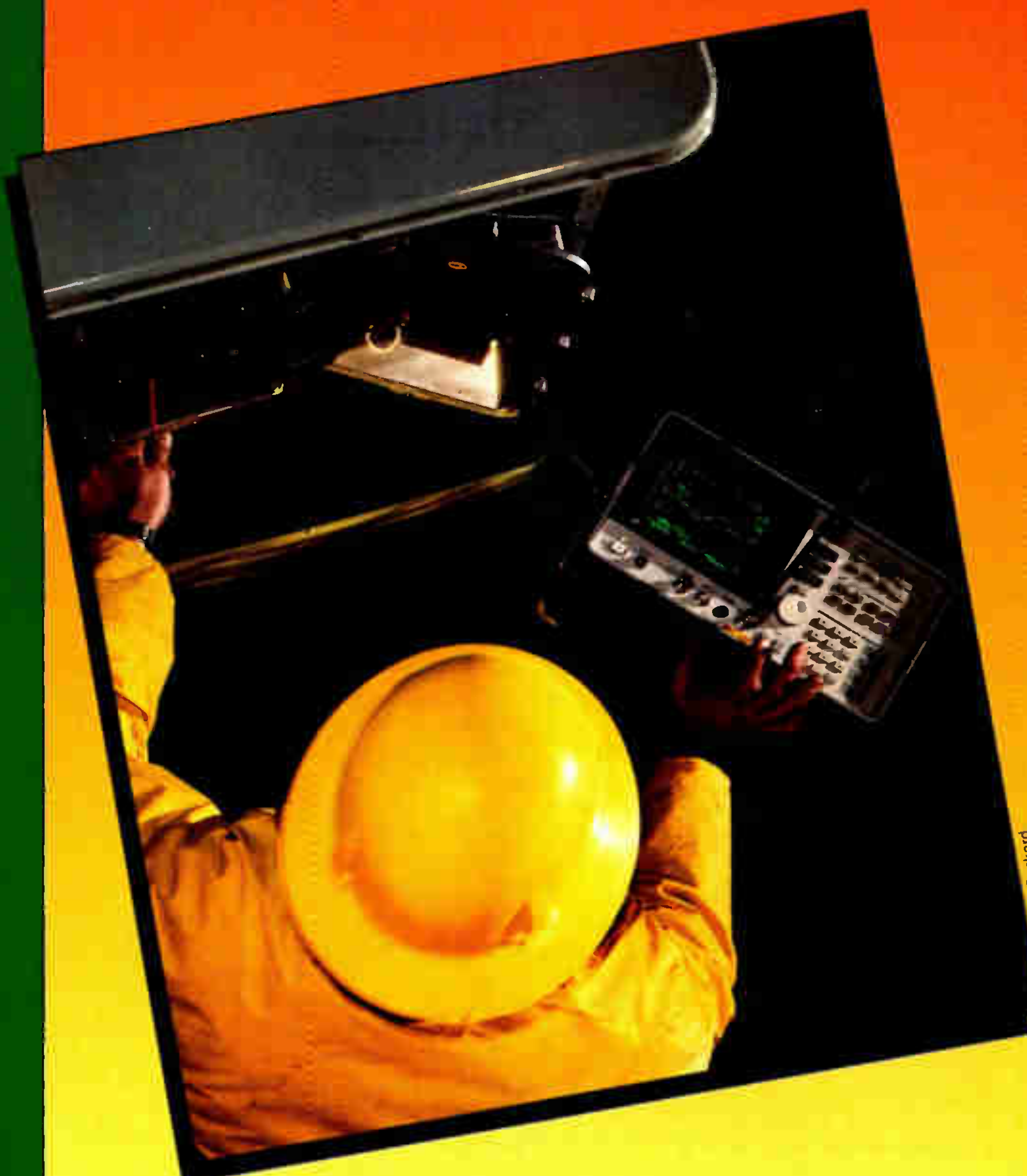
For information on the software program discussed in this article, contact Duct Plus Industries, P.O. Box 1409, Midlothian, TX 76065-1409; phone (214) 228-2504.

September 1993

Inside spectrum analysis

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.



Courtesy Hewlett-Packard

Table of Contents

Basic measurements using a spectrum analyzer

By Jeff Noah
Technical Writer
Tektronix Television Division

Spectrum analyzers are among the best all-around measurement tools for cable TV systems because of their wide input frequency range, excellent resolution, wide dynamic range and great sensitivity. Low-cost analyzers are now available that enable you to view your entire system at a glance, or to select a single channel or complex signal for close scrutiny. Look at Figures 1-4 to get a general idea of a spectrum analyzer's varied measurement abilities. Signal amplitudes as low as -90 dBmV can be measured with some analyzers, and signals differing in amplitude by as much as 80 dB can be viewed simultaneously. System calibration and maintenance are easier because the effects of most adjustments can be observed instantly and precisely.

In any heterodyne spectrum analyzer, sweep speed, resolution bandwidth, video filter bandwidth, and span/division are related. On some analyzers, all but the span/division have automatic (Auto) modes. Auto modes enable you to select the fastest sweep speed for given span/division and filter bandwidth combinations.

Figure 1: 50-300 MHz spectrum

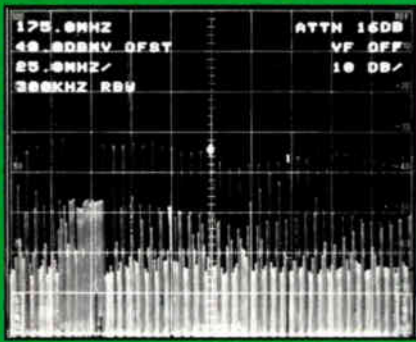


Figure 2: Ch. 2 signal analog spectrum

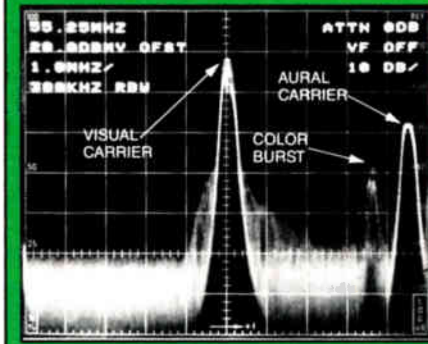


Figure 3: Ch. 2 signal spectrum in Min/Max mode

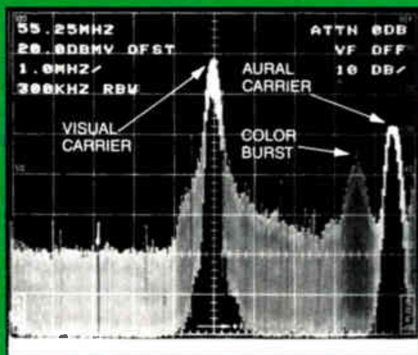
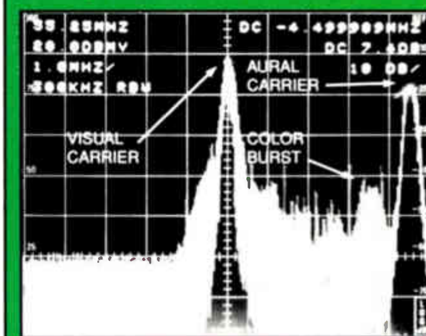


Figure 4: Difference between visual and aural carrier amplitudes



Protect your analyzer

The signal amplitude you wish to measure must not exceed the rated input level of the analyzer. Some analyzers can accept signal amplitudes as high as +67 dBmV (+20 dBm) and DC voltages up to 100 volts. Higher level signals require external attenuation. Note: Exceeding the maximum input signal amplitude, which may be printed near the RF input connector on your analyzer, can permanently damage the instrument. Do not connect your analyzer directly to a cable TV trunk carrying 60 VAC power.

Most spectrum analyzers cannot tolerate a DC input voltage. If yours cannot, use an external blocking capacitor when DC is present. Alternately, you can use a 75 ohm/50 ohm minimum loss pad with a built-in capacitor. It can be used with any 50 ohm analyzer that has a BNC connector. It serves the dual purpose of blocking DC and matching the analyzer's 50 ohm input to the cable system's 75 ohm impedance.

Connecting signal to the spectrum analyzer

You should be certain the signal source you are connecting to your analyzer contains no signal or combination of signals that exceeds the maximum rated input of the analyzer. Even if you think signal amplitudes are acceptable, it is good practice to begin a new measurement session by setting the reference level and span/division of the analyzer to maximum before connecting the signal. This displays the entire range of input signals while ensuring full RF attenuation and maximum protection to the analyzer. Then cautiously approach the analyzer input connector with the signal cable while observing the display for any large signals.

Signals can be directly connected to the input of most analyzers via a cable fitted with an N-type RF connector or through suitable connector adapters. Although most have 50 ohm input impedances and cable drops are usually 75 ohm, in most cases you'll be able to make measurements on a 75 ohm source without problems. *(Editor's note: Some analyzers are available with 75 ohm inputs.)* However, to minimize standing waves when making absolute measurements and to provide maximum flatness in broadband measurements, you need to present a matched load to the cable.

Do this by inserting a matching minimum loss pad between the source and the analyzer. If in doubt whether the pad is needed, compare the same measurement made with

and without the pad. (Don't forget to take into account the 5.7 dB of external attenuation from the pad.) If no significant difference occurs, eliminate the pad. In cases where the use of a pad may drop the system noise below the analyzer noise floor, such as carrier-to-noise (C/N) measurements, the pad cannot be used. Removing the pad does not distort C/N measurements.

Making measurements

The primary function of a spectrum analyzer is to accurately measure signal amplitude and (if equipped with an internal counter) signal frequency. Since the amplitudes and frequencies of the visual and aural carriers on a cable TV system are important system parameters, we will use them to illustrate the procedure for measuring signal amplitude and frequency in general.

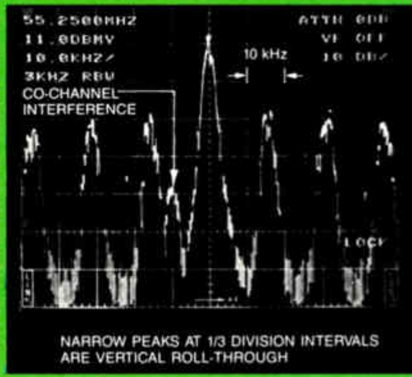
In the example that follows, we will quickly scan all the carriers in the 50 MHz to 300 MHz range and then measure the visual and aural carrier amplitudes of Ch. 2. This relatively simple procedure can be used to measure the amplitude and frequency of any signal.

Since this is a broadband measurement, or measurements of absolute signal amplitude, it is important to minimize the effects of standing waves. Therefore, insert a minimum loss pad between the signal and the analyzer, unless already equipped with a 75 ohm input.

Set the span/division control to 50 MHz, center frequency to 250 MHz, reference level to 20 dBmV, resolution bandwidth (BW) to 300 kHz, video filter to 300 kHz, vertical scale to 10 dB/division, sweep speed to 50 ms/division, and trigger mode to free run. If you have a digital spectrum analyzer, you will need to set the acquisition mode to capture the upper and lower excursions of the signal (Max/Min or equivalent). The resulting display enables you to view all the visual and aural carriers in the band at a glance. Adjust the reference level so the carrier peaks are at a convenient height.

The example in Figure 4 (page 48) displays cable Chs. 2 through 36 and the FM broadcast band. This display is particularly useful for observing the relative amplitudes of the carriers as a function of frequency. Any "tilt" to the spectrum or gross misadjustment of the visual to aural carrier amplitudes is easily observed.

Figure 5: Co-channel interference before video filtering



Reset the following spectrum analyzer controls:

Center frequency: 55.25 MHz
Frequency span/division: 1 MHz
Reference level: 20 dBmV
Resolution BW: 300 kHz
Sweep: 20 msec/division

Note: If the resolution bandwidth is reduced below 300 kHz, instantaneous changes in carrier amplitude will not pass through the filter and you will get an erroneously low result. In general, the resolution BW used should be equal to or greater than the bandwidth of the signal being analyzed. On the other hand, do not use the 5 MHz RBW filter to measure carrier amplitudes because it is so wide that energy from the aural carrier of the next lower channel is included in the measurement. This gives a value that is about 1 dB too high.

The Ch. 2 visual carrier is the signal peak at the center of the screen. By alternately turning display storage on and off on a digital analyzer, you can see how the digital Max/Min display resembles the analog spectrum. On page 48, Figure 2 shows the analog spectrum and Figure 3 shows the same spectrum in Max/Min mode. Although the analog spectrum shows more detail, it is easier to make signal amplitude measurements using the digitally stored spectrum.

Adjust the reference level until the Ch. 2 visual carrier is within 10 dB (one major division) of the top graticule line. As a rule, amplitude measurement errors are minimized when the signal is near the reference level. Some analyzers with a built-in frequency counter also feature an automatic centering and frequency measuring routine. By initiating the center/measure routine, the signal nearest center screen (the visual carrier in this example) is measured and its frequency is made the new center frequency, which is typically displayed on the screen.

Counter readouts provide the most accurate frequency determination available on a spectrum analyzer. Counter resolution on some analyzers can be set to 1 Hz, and accuracy can be as good as 0.5 ppm plus or minus just a few hertz. The signal amplitude indicated by the graticule may differ slightly from the amplitude readout. However, the readout is more accurate because it contains no display non-linearities.

Some analyzers have a delta counter mode that calculates the amplitude and frequency difference between two cursor positions. To use that capability, turn on the marker and place it near the Ch. 2 aural carrier. Run the center/measure routine. This time the signal nearest the marker (the aural carrier) is measured and centered. The readouts are interpreted the same as before. Then, without moving the marker, enter delta marker mode. Place the movable marker on the visual carrier and again initiate the center/measure routine.

The visual carrier is recentered, as shown in Figure 4. The readouts in the upper right corner of the display represent the difference in amplitude and frequency between the two marker positions (an intercarrier measurement). The same procedure is used to measure any other carriers.

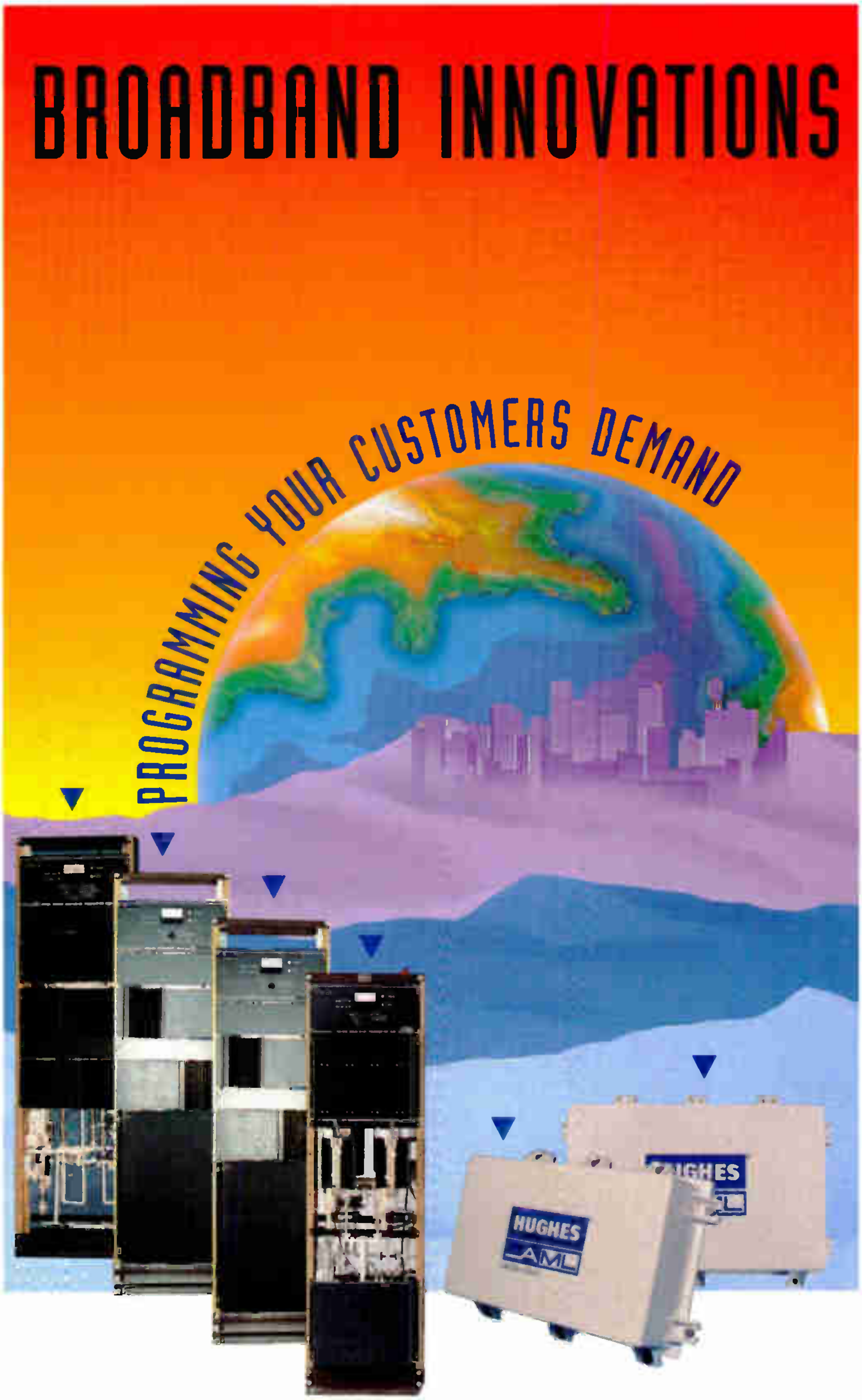
Co-channel interference

When off-air signals on the same channel — but from different transmitting antennas (as from neighboring cities) — overlap, the Federal Communications Commission requires a carrier frequency offset of ±10 kHz. If a headend is located in the overlap area, it is possible that its receiving antennas may pick up both signals. When this happens, the co-channel signal appears as an interfering signal displaced by 10 kHz or 20 kHz from the desired carrier. The spectrum analyzer is an excellent tool for identifying this type of interference.

Reset the following spectrum analyzer controls:

Center frequency: carrier frequency of interest
Frequency span/division: 10 kHz
Resolution BW: 3 kHz (Auto)
Sweep: 50 msec/division (Auto)
Display storage: Max/Min in register D

Figure 5 illustrates how the display might appear if co-channel interference



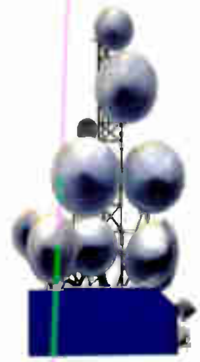


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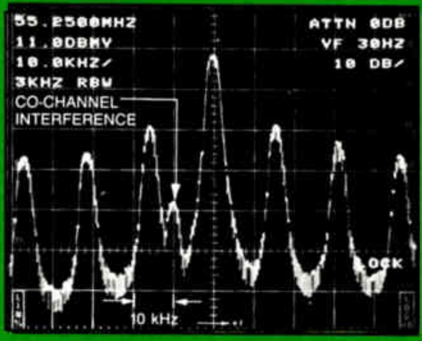
Figure 6: Co-channel interference after video filtering



were present 10 kHz from the carrier. (Co-channel interference also can occur at 20 kHz.) Video filtering clears up the display and is very effective for this measurement. Activate the video filter and set it to 30 Hz, and reset the sweep speed to 500 msec/div.

The display will resemble Figure 6. Carefully examine the areas near ±10 kHz and ±20 kHz from the visual carrier for signs of interfering co-channels. Signals at 15 kHz intervals are the horizontal sync pulses of the visual carrier. The video modulation on the visual signal limits detection of co-channel interference to about 60 dB below the carrier of the desired signal.

Hum, low frequency disturbance

Hum and low frequency disturbances are undesired signal modulations related to the power line or the video vertical sync frequencies. Variations in the visual carrier amplitude at the power line frequency or its harmonics are known as hum. It is difficult to separate video-related disturbances from hum when a channel is in-service. Consequently, a CW signal is usually substituted for an in-service carrier when hum alone is to be measured.

The following procedure is used to measure either hum or hum and low frequency disturbances. The only significant difference is the substitution of a CW carrier for the normal modulated signal when hum alone is to be measured.

Connect the equipment as in Figure 7. Use the in-service carrier to measure combined hum and low frequency disturbances. Use the CW signal generator to measure hum only. Adjust the CW signal so its amplitude is the same as the unmodulated visual carrier amplitude. You can make the hum measurement by inserting the CW test signal in an unallocated carrier slot.

Reset the following spectrum analyzer controls:

Center frequency: To the carrier or test signal of interest
Frequency span/division: 1 MHz
Reference level: 20 dBmV
Resolution BW: 300 kHz (Auto)
Sweep: 20 msec/division (Auto)
Display storage: Off

Do not reduce the resolution BW below 300 kHz because it will reduce the horizontal sync pulse amplitudes. Adjust the reference level so that the signal is approximately at the reference line and then enter the zero span mode. Activate the linear vertical display mode and readjust the reference level so that the peaks of the signal just touch the top graticule line. Each minor division of the display now represents 2.5% of the signal amplitude.

Increase the sweep speed to 5 msec/division and switch to line trigger mode (not TV line). If an in-service channel is used, the screen should resemble Figure 8. The vertical intervals slowly slip across the screen while line frequency disturbances remain stationary.

Hum and low frequency disturbances occur at intervals of 16.67 msec, 8.33 msec, etc. Turn off the on-screen readouts for a better view of the display. A good reason for starting this measurement in analog display mode is to view the amplitude of the sync tips changing in response to the video modulation on the signal. This is an excellent indication that the low frequency disturbance is related to video rather than power line.

Watch the signal for a minute or two to be certain you are seeing the worst case, since the low frequency disturbances can vary with time. Count the number of minor divisions that the peak signal amplitude varies between vertical intervals. (Do not include spurious peaks due to overshoot from the vertical interval pulses.) Multiply by 2.5 to get the percent disturbance.

This measurement is often easier to make using display storage. Turn on peak acquisition mode to obtain a display similar to Figure 9. Hum and low frequency disturbance measures about 4% in Figures 8 and 9.

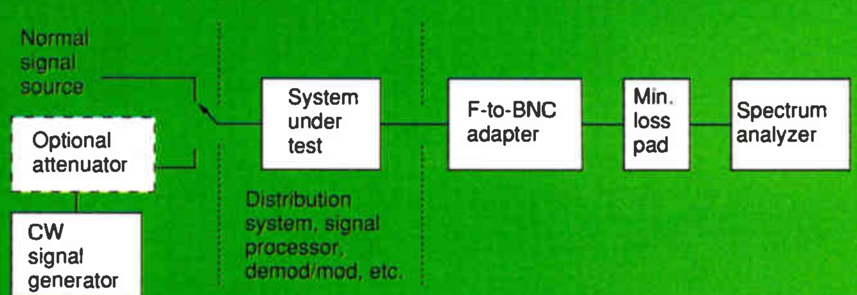
CSO, CTB

Composite second order (CSO) and composite triple beat (CTB) distortions result from essentially the same cause: non-linearities in signal processing equipment, especially distribution amplifiers. CSO beat results from second order intermodulation distortion whereas composite triple beat is the result of third order intermodulation distortion. Each is the sum of the intermodulation products of the many carriers on the system, which combine two or three at a time to produce sum/difference beats at the measurement frequency.

The size of the CSO or CTB is usually expressed as a ratio of the visual carrier amplitude to the beat amplitude in decibels below the carrier (dBc). Triple beats tend to occur at the visual carrier frequencies, while double beats tend to occur at or near ±0.75 and ±1.25 MHz relative to the visual carrier frequencies.

The National Cable Television Association suggests two procedures for measuring CTB. One method substitutes CW test signals for all carriers except the one at which the measure-

Figure 7: Setup for measuring hum and low frequency disturbances



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System integrity begins with leakage detection and measurement.

And nobody offers the cable television industry *more* ways to detect and measure RF leakage than ComSonics.

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THE INDUSTRY STANDARD....PLUS.

SnifferLite enters the field as part of the New Generation of Test Equipment. Through modularity, the SnifferLite easily snaps onto the back of our WindowLitePLUS signal level meter, adding the flexibility of multiple testing functions to our already liteweight, portable SLM.

The exceptional sensitivity of both Sniffer II and Sniffer III allows monitoring of rear-easement plant or subscribers' homes set back from the road.

For the most complete system, however, use Sniffer in the field together with our crystal-controlled transmitter at the headend. Powerful squelch and mute and narrow IF bandpass enable Sniffer to tell the difference between your signal and other RF interference.

Or use our low-cost installer usable device, the hand-held Sniffer Jr., to locate leaks at their source.

COMSONICS LEAKAGE LEAK BUSTERS

Detection, of course, is only part of the solution. Using our SniffWare® computer software turns your field data into a comprehensive leakage management program.

These patented technologies, and the knowledge and experience that produced them are at the very heart of all our signal leakage detection products.

If your system has a leak, ComSonics has a way to find it. To learn more about the world standard in RF leakage detection, call us today.

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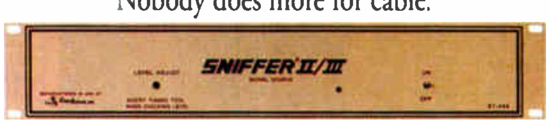


"WindowLitePLUS" is a registered trademark of ComSonics, Inc.

to receive a ghost-free picture from standard, over-the-air broadcasts.

The set includes one 72-tap digital filter and two 288-tap digital filters, the highest tap count of any ghost cancellation digital filter currently on the market, according to the company.

The chip set, consisting of one ZR33072 72-tap video-rate filter and two ZR33288 288-tap video-rate filters, is compatible with the ghost canceler reference (GCR) pulse that has been selected by the FCC.

By comparing the broadcasted GCR with a reference stored in the TV set's memory, a TV receiver determines the number and severity of ghosts present in the TV signal. TV sets equipped with the chip set use this comparison to calculate the digital filter coefficients required to cancel the unwanted ghost signal. The product also can be used in cable TV headend equipment to eliminate ghosts from TV images before they are retransmitted by cable operators to individual subscribers.

No additional glue logic to implement a 648-tap video-rate digital filter is required. Round-off error, which can be introduced when bits are truncated after each internal calculation, is minimized by the internal accuracy in the chip set.

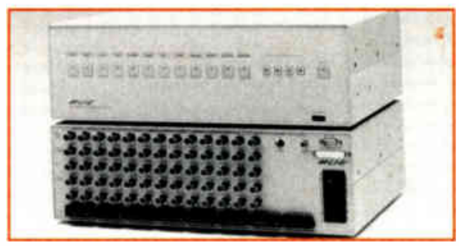
Reader service #206

Fiber-optic switch

DiCon Fiberoptics Inc. announced what the company says is the smallest 1xN switch available. The Low-Profile 1xN fiber-optic switch is less than one inch tall and offers the same specs as the company's 19-inch rack-mount units.

The switch is expandable from 1x3 to 1x32 configurations and offers low insertion loss (0.5 dB), low back reflection (-55 dB), low polarization sensitivity (0.08 dB) and precise repeatability (0.005 dB). The unit is TTL controlled, can be printed circuit board mounted, and has been designed for easy integration into optical test systems.

Reader service #201



Presentation switchers

Inline Inc. unveiled the IN3800 Series of presentation switchers. S-video, composite video, RGBH&V and balanced audio are easily routed from up to 12 inputs to three or four audio and video outputs. Multiple formats can be simultaneously routed through the units. All models offer video delay switching, which allows seamless transitions between outputs by making sure that the new display device is locked on to the signal before the video portion of the signal switched. The units can be controlled by the front panel, contact closures, RS-232 and even an optional IR remote. In addition, they control most video projectors.

Reader service #200

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6	32	58	84	110	136	162	188	214	240	266	292
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13	39	65	91	117	143	169	195	221	247	273	299
14	40	66	92	118	144	170	196	222	248	274	300
15	41	67	93	119	145	171	197	223	249	275	301
16	42	68	94	120	146	172	198	224	250	276	302
17	43	69	95	121	147	173	199	225	251	277	303
18	44	70	96	122	148	174	200	226	252	278	304
19	45	71	97	123	149	175	201	227	253	279	305
20	46	72	98	124	150	176	202	228	254	280	306
21	47	73	99	125	151	177	203	229	255	281	307
22	48	74	100	126	152	178	204	230	256	282	308
23	49	75	101	127	153	179	205	231	257	283	309
24	50	76	102	128	154	180	206	232	258	284	310
25	51	77	103	129	155	181	207	233	259	285	311
26	52	78	104	130	156	182	208	234	260	286	312

A. Are you a member of the SCTE (Society of Cable Television Engineers)?
01 ___ yes
02 ___ no

B. Please check the category that best describes your firm's primary business (please check only 1):
Cable TV Systems Operations
03 ___ Independent Cable TV System
04 ___ MSO (two or more Cable TV Systems)
05 ___ Cable TV Contractor
06 ___ Cable TV Program Network
07 ___ SMATV or DBS Operator
08 ___ MDS, STV or LPTV Operator
09 ___ Microwave or Telephone Company
10 ___ Commercial TV Broadcaster
11 ___ Cable TV Component Manufacturer
12 ___ Cable TV Investor
13 ___ Financial Institution, Broker, Consultant
14 ___ Law Firm or Govt. Agency
15 ___ Program Producer or Distrib.
16 ___ Advertising Agency
17 ___ Educational TV Station, School or Library
18 ___ Other (please specify)________

C. Please check the category that best describes your job title:
19 ___ Corporate Management
20 ___ Management
21 ___ Programming
Technical/Engineering
22 ___ Vice President
23 ___ Director
24 ___ Manager
25 ___ Engineer
26 ___ Technician
27 ___ Installer
28 ___ Sales
29 ___ Marketing
30 ___ Other (please specify)________

D. Do you plan to rebuild/upgrade your system in:
31 ___ 6 months
32 ___ 1 year
33 ___ 2 years
34 ___ 5 years

E. In the next 12 months, what cable equipment do you plan to buy?
35 ___ Amplifiers
36 ___ Antennas
37 ___ CATV RF Distribution/ Distribution Electronics
38 ___ CATV Passive Equipment Including Cable
39 ___ Cable Tools
40 ___ Compression/Digital Equip.
41 ___ Computer Equipment
42 ___ Connectors
43 ___ Converters
44 ___ Controllers
45 ___ Descramblers
46 ___ Fiber-Optic Cable
47 ___ Fiber-Optic Electronics
48 ___ Headend Equipment
49 ___ Interactive Software
50 ___ Lightning Protection
51 ___ MMDS Transmission Equip.
52 ___ Microwave Equipment
53 ___ Other Security Equipment
54 ___ Receivers and Modulators
55 ___ Remotes
56 ___ Safety Equipment
57 ___ Satellite Equipment
58 ___ Splitters
59 ___ Subscriber/Addressable Security Equipment
60 ___ Telephone/PCS Equipment
61 ___ Power Suppls. (Batteries, etc.)
62 ___ Vehicles
63 ___ VideoCiphers
64 ___ 2-Way Radio

F. What is your annual cable equipment expenditures?
65 ___ up to $50,000
66 ___ $50,001 to $100,000
67 ___ $100,001 to $250,000
68 ___ $250,001 to $500,000
69 ___ $500,001 to $1,000,000
70 ___ over $1,000,001

G. In the next 12 months, what cable test & measurement equipment do you plan to buy?
71 ___ Fiber Optics Test
72 ___ Oscillators
73 ___ Service Monitors
74 ___ Signal Level Meters
75 ___ Spectrum Analyzers
76 ___ Sweep Tester
77 ___ CATV RF Test Equipment

H. What is your annual cable test & measurement equipment expenditures?
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82 ___ $500,001 to $1,000,000
83 ___ over $1,000,001

I. In the next 12 months, what cable services do you plan to buy?
84 ___ Consulting/Brokerage Services
85 ___ Contracting Services (Construction/Installation)
86 ___ Technical Services/ Engineering Design

J. What is your annual cable services expenditures?
87 ___ up to $50,000
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89 ___ $100,001 to $250,000
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CALENDAR

1993

September

8: SCTE Badger State Chapter meeting, Installer and BCT/E exams administered, Fondulac, WI. Contact Brian Revak, (608) 372-2999.

8: SCTE Mid-South Chapter meeting. Contact Bob Allen, (901) 365-1770, ext. 4110.

9: Society of Cable Television Engineers Satellite Tele-Seminar Program, *Fiber Optics: A Practical Approach (Part Two)* to be shown on Galaxy I, Transponder 14. Contact SCTE national headquarters, (215) 363-6888.

9: SCTE Chesapeake Chapter meeting, Installer and BCT/E exams administered, Arlington, VA. Contact Scott Shelley, (703) 358-2766.

9: SCTE Penn-Ohio Chapter seminar, video and audio measurements, Installer and BCT/E exams administered, Sheraton Hotel, Warrendale, PA. Contact Marianne McClain, (412) 531-5710.

9-10: Scientific-Atlanta training session, 8580 System operation and maintenance (System Manager 4/5), Atlanta. Contact Bill Brobst, (404) 903-6306.

13: Tektronix seminar, RF and baseband measurements, Sheraton Hotel, New Orleans. Contact Kathy Richards, (503) 627-1555.

13-16: ONI Fiberworks seminar, cable TV fiber-optic system training, Denver. Contact 1-800-FIBER ME.

14: SCTE Cascade Range Chapter seminar, Holiday Inn, Wilsonville, OR. Contact Cynthia Stokes, (503) 230-2099.

14: SCTE New York City Chapter seminar, digital compression, video servers, personal communications, AT&T Bell Labs, Murray Hill, NJ. Contact Rich Fevola, (516) 678-7200.

14-15: Scientific-Atlanta training session, fiber optics, Pittsburgh. Contact Bill Brobst, (404) 903-6306.

14-16: C-COR seminar, fiber-optic basics, Charlotte, NC. Contact Kelly, (814) 231-4422.

14-16: Philips Broadband Networks Mobile Training Center seminar, RF and video distortions, headend basics, amplifier applications and operation, and record keeping and maintenance, Minneapolis. Contact (800) 448-5171.

14-17: Siecor training course, fiber-optic installation, splicing, maintenance and restoration for cable TV, Hickory, NC. Contact 1-800-SIECOR1, ext. 5539 or 5560.

15: SCTE Bluegrass Chapter seminar, video testing, waveform monitor, vectorscope, demod or calibrated method, BCT/E exams administered, Howard Johnsons, Lexington, KY. Contact Alan Reed, (502) 389-1818.

15: SCTE Golden Gate Chapter seminar. Contact Mark Harrigan, (415) 358-6950.

15: SCTE Great Lakes Chapter seminar, Holiday Inn, Livonia, MI. Contact Jim Kuhns, (313) 445-3712.

15: SCTE Piedmont Chapter seminar, alternate technologies, Installer and BCT/E exams to be administered, Greensboro, NC. Contact Mark Eagle, (919) 477-3599.

15: SCTE Snake River Chapter seminar, data networking, transportation systems, Weston Plaza, Twin Falls, ID. Contact Mike Dudley, (708) 377-2491.

15: SCTE South Jersey Chapter seminar, VideoCiphers and interactive converters, Ramada Inn, Vineland, NJ. Contact Mike Pieson, (609) 967-3011.

15: Tektronix seminar, RF and baseband measurements, Marriott West, St. Louis. Contact Kathy Richards, (503) 627-1555.

16: SCTE Bluegrass Chapter seminar, video testing, Lexington, KY. Contact Alan Reed, (502) 389-1818.

16: SCTE Gateway Chapter seminar, antennas, earth stations and headends, Overland Community Center, Overland, MO. Contact Bill Mullen, (314) 272-2020.

16: SCTE Greater Chicago Chapter seminar, troubleshooting, Quality Inn, Palatine, IL. Contact Bill Whicher, (708) 362-6110.

16: SCTE Hawaii Chapter seminar, Ritz Carlton, Maui, HI. Contact Fred Gerstl, (808) 625-8412.

16: SCTE Lake Michigan Chapter seminar, basics. Contact Karen Briggs, (616) 941-3783.

16: SCTE Mount Rainier Chapter seminar, Martha Lake, WA. Contact Gene Fry, (206) 747-4600, ext. 107.

16: SCTE Rocky Mountain Chapter seminar, plant equipment. Contact Ron Upchurch, (303) 790-0386, ext. 403.

17: Tektronix seminar, RF and baseband measurements, Holiday Inn International Airport Hotel, Bloomington, MN. Contact Kathy Richards, (503) 627-1555.

18: SCTE Big Country Chapter seminar, fitting installation and selection, Sunday House, Sweet Water, TX. Contact Robert Amo, (915) 655-2276.

18: SCTE Cactus Chapter seminar, system troubleshooting, powering and design. Contact Harold Mackey, (602) 352-5860.

18: SCTE Cascade Range Chapter meeting, BCT/E exams administered, Paragon Cable, Portland, OR. Contact Cynthia Stokes, (503) 230-2099.

18: SCTE Chaparral Chapter seminar, system design and powering, Installer and BCT/E exams administered, Albuquerque, NM. Contact Scott Phillips, (505) 761-6253.

18: SCTE Rocky Mountain Chapter seminar, equipment calibration and setup, Glenwood Springs, CO. Contact Patrick Kelley, (303) 267-4739.

19-21: South Dakota Cable Television Association annual convention, Sylvan Lake Lodge, Black Hills, SD. Contact Steven, (605) 361-7155.

21: SCTE Pocono Mountain Meeting Group seminar, standby power supplies and grounding, Holiday Inn, Hazelton, PA. Contact Anthony Brophy, (717) 462-1911.

21-23: Philips Broadband Networks Mobile Training Center seminar, RF and video distortions, headend basics, amplifier applications and operation, and record keeping and maintenance, Chicago. Contact (800) 448-5171.

22: SCTE Appalachian Mid-Atlantic Chapter seminar, transportation systems, BCT/E exams administered, Holiday Inn, Chambersburg, PA. Contact Richard Ginter, (814) 672-5393.

22: SCTE North Country Chapter seminar, Sheraton Midway Hotel, St. Paul, MN. Contact Bill Davis (612) 646-8755.

22: SCTE Palmetto Chapter seminar, headend standards and compliance testing, Columbia, SC. Contact John Frierson, (803) 777-5846.

22: SCTE Smokey Mountain Chapter seminar, upgrades and outage control, Days Inn, Kingsport, TN. Contact Roy Tester, (615) 878-5502.

23-24: Scientific-Atlanta training session, 8600 System operation and maintenance (System Manager 4/5), Atlanta. Contact Bill Brobst, (404) 903-6306.

27: Tektronix seminar, RF and baseband measurements, Holiday Inn, Florence, KY. Contact Kathy Richards, (503) 627-1555.

27-29: Society of Cable Television Engineers Technology for Technicians II seminar, hands-on training for broadband industry techs and system engineers, Las Vegas. Contact SCTE national headquarters, (215) 363-6888.

27-30: ONI Fiberworks training seminar, digital networks, New Orleans. Contact 1-800-FIBER ME.

28-30: Philips Broadband Networks Mobile Training Center seminar, RF and

video distortions, headend basics, amplifier applications and operation, and record keeping and maintenance, Nashville, TN. Contact (800) 448-5171.
29: Tektronix seminar, RF and baseband measurements, Ramada Inn Airport, Omaha, NE. Contact Kathy Richards, (503) 627-1555.
30: Society of Cable Television Engineers OSHA/safety seminar for system managers and safety coordinators on maintaining records and developing safety training programs, Las Vegas. Contact SCTE national headquarters, (215) 363-6888.

October

1: Tektronix seminar, RF and baseband measurements, Ramada Hotel, Scottsdale, AZ. Contact Kathy Richards, (503) 627-1555.
5-6: Society of Cable Television Engineers technical sessions, in conjunction with Atlantic Cable Show, Atlantic City, NJ. Contact SCTE national headquarters, (215) 363-6888.
5-6: Atlantic Cable Show, Atlantic City, NJ. Contact (609) 848-1000.
5-7: C-COR seminar, fiber-optic basics, Anaheim, CA. Contact Kelly, (814) 231-4422.
5-7: Philips Broadband Networks Mobile Training Center seminar, RF and video distortions, headend basics, amplifier applications and operation, and record keeping and maintenance, Orlando, FL. Contact (800) 448-5171.
6: SCTE Ark-La-Tex Chapter seminar, back to basics, Installer and BCT/E exams administered. Contact Randy Berry, (318) 238-1361.
7: SCTE Chesapeake Chapter seminar, telephone systems in CATV, Columbia, MD. Contact Scott Shelley, (703) 358-2766.
7: SCTE Great Plains Chapter meeting, Installer and BCT/E exams administered, Courtyard Cafe, Bellevue, NE. Contact Randy Parker, (402) 292-4049.
7: SCTE Upper Valley Chapter seminar, bucket truck operation and maintenance, road regulations, Holiday Inn, White River Junction, VT. Contact Chip Winchell, (315) 682-1446.
7: SCTE Upstate New York Chapter seminar. Contact William Grant, (716) 827-3880.
11-14: ONI Fiberworks seminar, cable TV fiber-optic system training, Denver. Contact 1-800-FIBER ME.
12: SCTE Chattahoochee Chapter seminar. Contact Hugh McCarley, (404) 843-5517.
12: SCTE Desert Chapter seminar, transportation systems and fiber optics, San Gorgonio Inn, Banning, CA. Contact Greg Williams, (319) 640-1312, ext. 277.
12: SCTE Heart of America Chapter seminar, in conjunction with the Mid-America Cable Association Show, Kansas City, MO. Contact Don Gall, (816) 358-5360.
12: SCTE Southeast Texas Chapter seminar, Warner Cable, Houston. Contact Tom Rowan, (713) 580-7360.
12-14: Mid-America Cable Show, Hilton Plaza Inn, Kansas City, MO. Contact (913) 841-9241.
12-14: Philips Broadband Networks Mobile Training Center seminar, RF and video distortions, headend basics, amplifier applications and operation, and record keeping and maintenance, Hickory, NC. Contact (800) 448-5171.
12-15: Siecor training course, fiber-optic installation, splicing, maintenance and restoration for cable TV applications, Hickory, NC. Contact 1-800-SIECOR1, ext. 5539 or 5560.
13: SCTE Delaware Valley Chapter seminar, computers in cable and data transmission, BCT/E exams administered, Willow Grove, PA. Contact Louis Aurely, (215) 675-2053.
13: Scientific-Atlanta training session, digital audio systems, Philadelphia. Contact Bill Brobst, (404) 903-6306.
14: Society of Cable Television Engineers Satellite Tele-Seminar Program, *Digital Compression (Part One)* to be shown on Galaxy I, Transponder 14. Contact SCTE national headquarters, (215) 363-6888.
14-15: Scientific-Atlanta training session, 8600 System operation and maintenance (System Manager 10), Atlanta. Contact Bill Brobst, (404) 903-6306.
16: SCTE Cactus Chapter seminar, OSHA and cable construction. Contact Harold Mackey, (602) 352-5860, ext. 135.
18-20: Society of Cable Television Engineers Technology for Technicians II seminar, hands-on training for broadband industry techs and system engineers, Harrisburg, PA. Contact SCTE national headquarters, (215) 363-6888.
19-20: Scientific-Atlanta training session, distribution, Secaucus, NJ. Contact Bill Brobst, (404) 903-6306.
19-21: Philips Broadband Networks Mobile Training Center seminar, RF and video distortions, headend basics, amplifier applications and operation, and record keeping and maintenance, Baltimore. Contact (800) 448-5171.
20: SCTE Big Sky Chapter seminar, fiber in the system, BCT/E and Installer exams administered, Locomotive Inn, Laurel, MT. Contact Marla DeShaw, (406) 632-4300.
20: SCTE Palmetto Chapter seminar, plant maintenance and outage control. Contact John Frierson, (803) 777-5846.
20: SCTE Rocky Mountain Chapter seminar, outage reduction, data, compression. Contact Ron Upchurch, (303) 790-0386, ext. 403.
20: SCTE San Diego Chapter seminar. Contact Kathleen Horst, (310) 532-5300, ext. 250.
21: Society of Cable Television Engineers OSHA/safety seminar for system managers and safety coordinators on maintaining records and developing safety training programs, Harrisburg, PA. Contact SCTE national headquarters, (215) 363-6888.
21: SCTE Big Sky Chapter seminar, fiber in the system, BCT/E and Installer exams administered, Elk Lodge, Helena, MT. Contact Marla DeShaw, (406) 632-4300.
21: SCTE New England Chapter seminar, communication networks of the future, network applications and deployment, Radisson Inn, Marlboro, MA. Contact James Kelley, (401) 943-7930, ext. 230.
21-22: Scientific-Atlanta training session, headend and earth station, Secaucus, NJ. Contact Bill Brobst, (404) 903-6306.
22: SCTE Greater Chicago Chapter meeting, BCT/E exams administered. Contact Bill Whicher, (708) 362-6110.
25-28: ONI Fiberworks training seminar, digital networks, Phoenix. Contact 1-800-FIBER ME.
26-27: Scientific-Atlanta training session, design considerations, sweep and balance, Atlanta. Contact Bill Brobst, (404) 903-6306.
26-28: Philips Broadband Networks Mobile Training Center seminar, RF and video distortions, headend basics, amplifier applications and operation, and record keeping and maintenance, Boston. Contact (800) 448-5171.
28: SCTE New Jersey Chapter seminar, new technology update, BCT/E exams administered. Contact Linda Lotti, (908) 446-3612.
28-30: Private Cable Show, the Nugget, Reno, NV. Contact (713) 342-9826.

Planning ahead

Dec. 1-3: Western Cable Show, Anaheim, CA. Contact (510) 428-2225.
Jan. 1-5: SCTE Emerging Technologies Seminar, Phoenix. Contact (215) 363-6888.
Feb. 22-24: OFC '94, San Jose, CA. Contact (202) 223-8130.
Feb. 23-25: Texas Cable Show, San Antonio. Contact (512) 474-2082.

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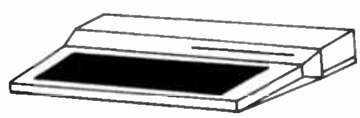

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SCTE salutes its certified technicians and engineers

By Bill Riker
President, Society of Cable Television Engineers

The Society is proud to announce the names of its members who have become fully certified in the Broadband Communications Technician/Engineer (BCT/E) Certification Program during 1993.

First created in 1985, the program recognizes individuals who have demonstrated their technical knowledge through passing a series of examinations in seven areas of cable TV technology. Examinations are administered through the Society's chapters and meeting groups and at most regional cable shows. Over 3,200 industry technicians and engineers are currently enrolled in the program with some 300 candidates having been fully certified. The seven category examinations are:

I Signal Processing Centers
II Video and Audio Signals and Systems
III Transportation Systems
IV Distribution Systems
V Data Networking and Architecture
VI Terminal Devices
VII Engineering Management and Professionalism

Society members who have become fully certified at the Engineer level so far this year are:

Bobbie Dardin, Simmons Cable TV
Michael Giobbi, Armstrong Communications Inc.
Tony Herrman, American Cablevision
Antonio Huerta, TeleCable
Matthew Lambert, Continental Cablevision
L. Massey, Tucson Cablevision
Charles Nydegger, Cardinal Communications
Robert Wallentine, Multimedia Cablevision
Michael Zombek, TCI

Society members who have become fully certified at the Technician level so far this year are:

Kenneth Arellano, Sonic Cable Television
Ronald Arnett, Continental Cablevision
Douglas Barkley, Continental Cablevision
Gregory Bawdon, Heritage Cablevision
Paul Buckley, Warner Cable Communications
Frank Campbell, Multimedia Cablevision
Thomas Carter, Columbia Cable
Rubin Fensterbush, Waymaker Co.
Keith Grunberg, Columbia Cable
Timothy Habiger, Viacom Cablevision
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Clark Holt, Cardinal Communications
Alan Kaiser, Multimedia Cablevision
Mark Larkin, TCI Repair Facility
Doniel Leemans, Cox Cable Quad Cities
Kenneth Long, Viacom Cablevision
Clifford Loreg, Multimedia Cablevision
Randy Love, Viacom Cablevision
Marlon McAlister, Cardinal Communications
Michael Massaro, TCI Cablevision of San Jose
Travis Milsap, Multimedia Cablevision
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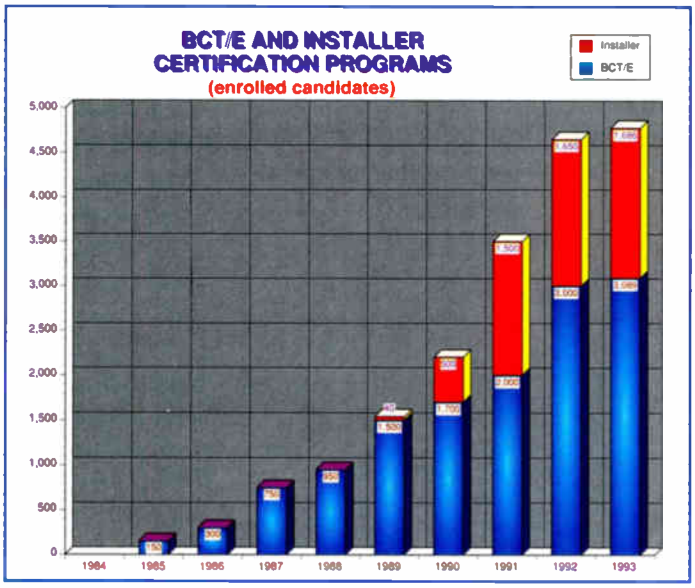

The national SCTE's editorial and promotion department conducted a survey among those who had successfully completed the program at each of the levels indicated. The following are responses to the question, "What was your motivation in becoming certified?":

To further broaden my abilities.

I wanted to keep current with the changes in technology.

It would be a good indication of my qualifications.

For personal satisfaction.

For the challenge of knowing I would succeed.

On further inquiry, candidates were asked "How has becoming certified improved your career?"

I feel I now have credibility as far as my capabilities.

It has given me more career options.

To gain more consideration for promotion within the company.

For greater recognition in the industry, a benchmark of accomplishment.

We at SCTE recognize that this *is* a major accomplishment for each individual. In addition, the companies for which these candidates work will benefit from the time and effort that has been expended in their endeavors. Please join us in congratulating these members and encouraging their continued career development in the broadband communications industry. **CT**