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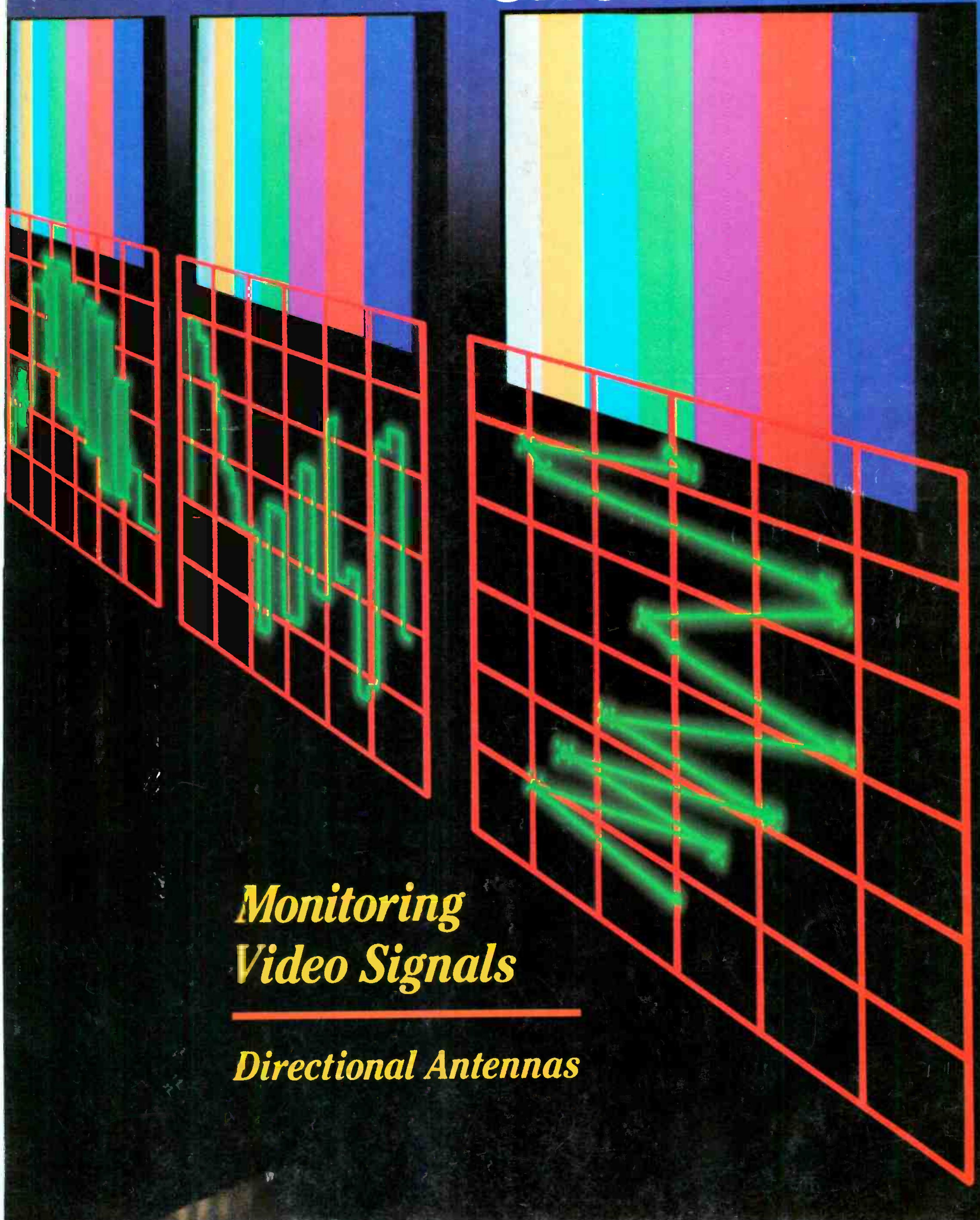
July 1985/$3



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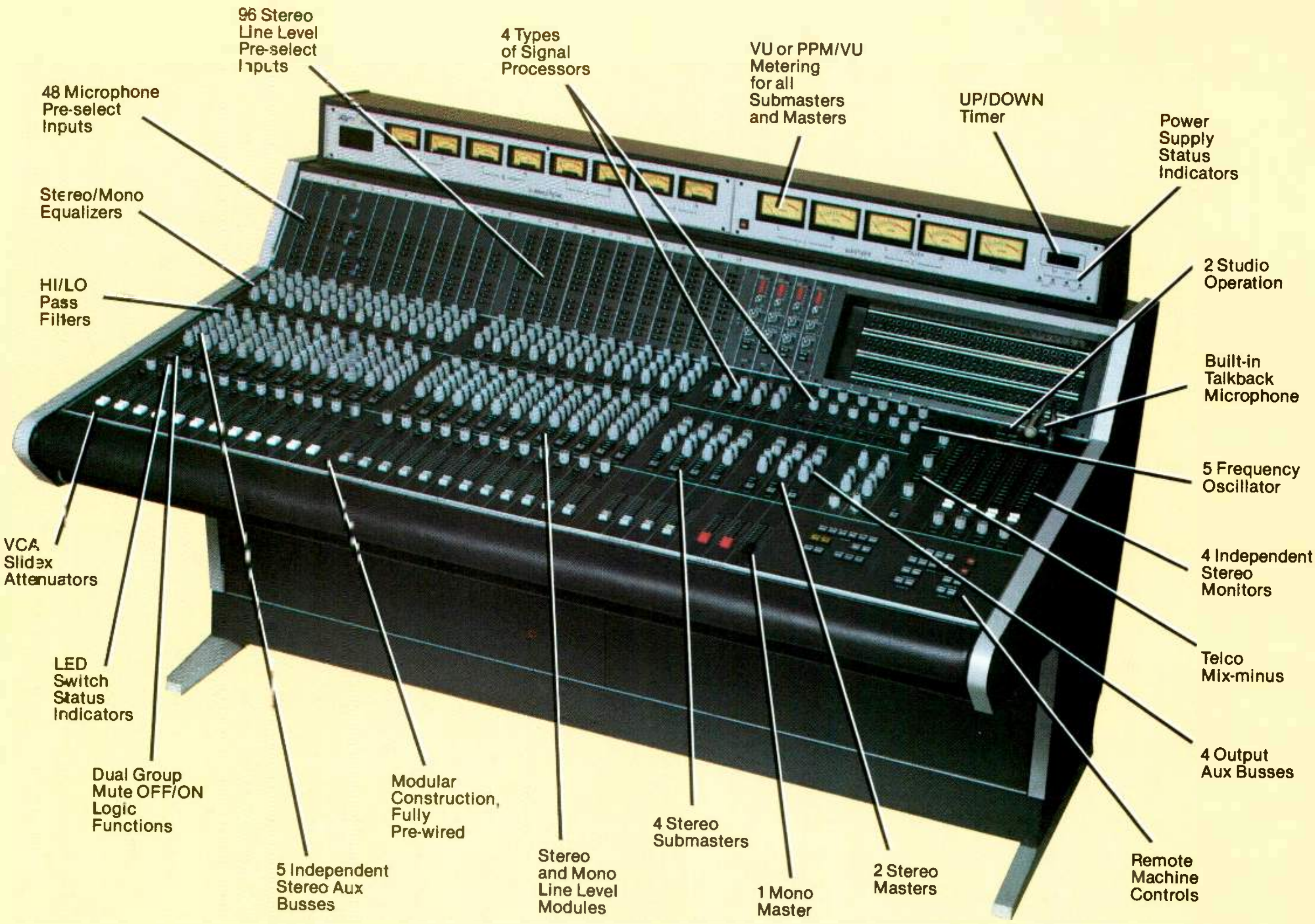

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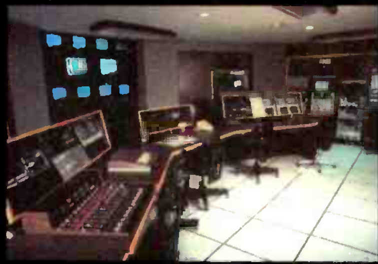






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Contents

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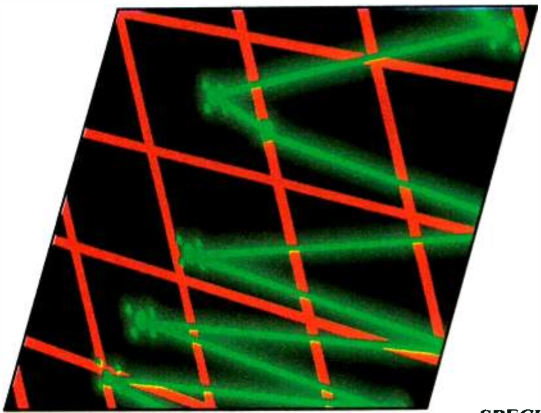
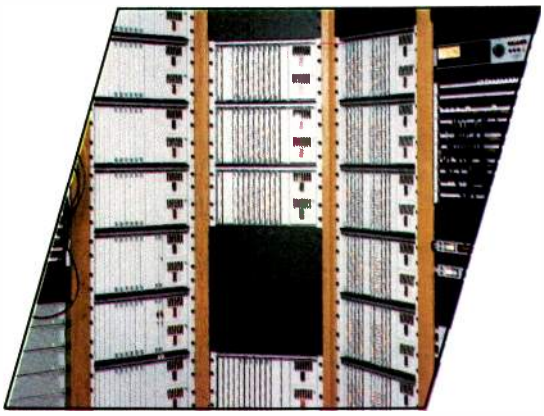
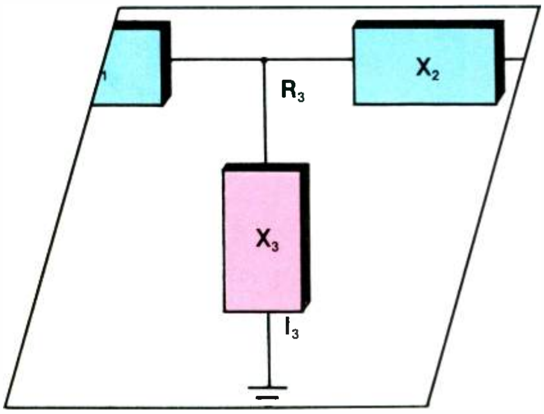


Page 18

BROADCAST engineering



Page 28



Page 64

SPECIAL REPORT: VIDEO SUPPORT EQUIPMENT

Sync, processing and distribution equipment are key links in the TV broadcast chain. This hardware, coupled with video test and monitoring gear, make up the support system that keeps television in step. We examine these aspects of the video plant in two detailed articles:

18 Video Monitoring After Deregulation
By Dane Ericksen, P.E., systems design consultant
An examination of the current FCC monitoring requirements for TV facilities. Important measurements to ensure adherence to standards of good engineering practice are also outlined.

28 Keeping In Step
By Elmer E. Smalling III, TV systems consultant
A discussion of the use of sync, processing and distribution equipment at TV stations and production facilities. The basics of signal routing and synchronization are presented.

OTHER FEATURES

50 Monitoring Directional Antennas
By Elton B. Chick
How to install and maintain a directional antenna monitoring system for reliable operation. The effects of environmental conditions on monitoring equipment are also examined.

64 Designing AM Coupling Networks
By Grant Bingeman, Continental Electronics
A detailed look at impedance matching techniques for AM broadcast antenna systems. The benefits and drawbacks of various matching networks are discussed.

ON THE COVER

The quality of TV broadcasting depends on accurate monitoring of the video signal. Shown on our cover this month are methods that may be used to perform this work. A new approach to *component* monitoring, *Lightning* (shown at right), combines three separate Y, B-Y and R-Y signals into a single CRT presentation. The center waveform illustrates a *parade* display (luminance and color-difference amplitude vs. time). The waveform on the left shows a typical composite waveform for comparison. (Photo courtesy of Tektronix, which developed the Lightning concept.)

DEPARTMENTS

4 Business
6 Editorial
8 FCC Update
10 Strictly TV
12 re: Radio
14 Satellite Technology
16 Troubleshooting
84 People
86 New Products

NYU awards media contract to Boston firm

Lake Systems, Newton, MA, was recently awarded a media equipment and design contract totaling more than $3.5 million. This agreement was granted by New York University to support the new Tisch School of the Arts under construction in Manhattan.

Included in the equipment package are three state-of-the-art TV studios, film production and post-production facilities, audio recording studios, and ancillary systems for teaching media production.

TFT negotiations result in an agreement

Joseph C. Wu, president of *TFT,* Santa Clara, CA, has announced the conclusion of negotiations with the Zhang Jia Kou Factory, People's Republic of China, resulting in an Economic-Technology Cooperation Agreement, valued at approximately $2 million.

Under this contract, TFT will supply studio-to-transmitter links and modulation monitors to the factory, followed by kits for the same items. The contract also calls for the local training of technicians and the transfer of associated technology and documentation. TFT will also assist Zhang Jia Kou Factory in supporting the TFT equipment in the PRC by providing adequate laboratory test equipment and associated items from a variety of U.S. sources.

Tektronix announces support IC services

The Integrated Circuits Operation (ICO) of *Tektronix,* Beaverton, OR, has announced that it will sell high-performance integrated circuit foundry services for analog application specific designs and state-of-the-art custom charge-coupled devices (CCDs) for imaging and signal processing applications to outside customers.

Bipolar ICs, associated CAD/CAE services and E-beam lithography services will be available to customers on a contract basis. Devices are presently fabricated using a high-performance silicon process producing transistors with unity gain frequencies (f_T) of typically 6.5GHz. Silicon CCD imagers are also available with sizes of more than four million picture elements (pixels) with pixel dimensions of 27x27 microns. Custom arrays with smaller pixels can also be fabricated.

Laser wafer trimmable resistors are also available on QuickChip devices for precision analog applications. ICO will offer the bipolar IC designer a total solution approach requiring a circuit schematic and specifications to initiate a design.

Harris inks contract with China

Representatives of Tianjin Broadcast Equipment Company, the People's Republic of China, finalized details of a contract negotiated and signed in China in December 1984. The order includes a large number of 1kW, 5kW and 10kW transmitters to be delivered within a 6-month period by *Harris Broadcast Group,* Quincy, IL.

Telcom signs contract for earth stations

Telcom General and *Spectrum Planning* signed a contract covering the frequency coordination and FCC filing preparations for a minimum of 400 C-band earth stations. Each of the earth stations, which are owned by the Associated Press, will be equipped with the spread spectrum electronics developed and sold by Telcom General under the terms of a joint venture existing between the two companies.

Continued on page 82

BROADCAST engineering

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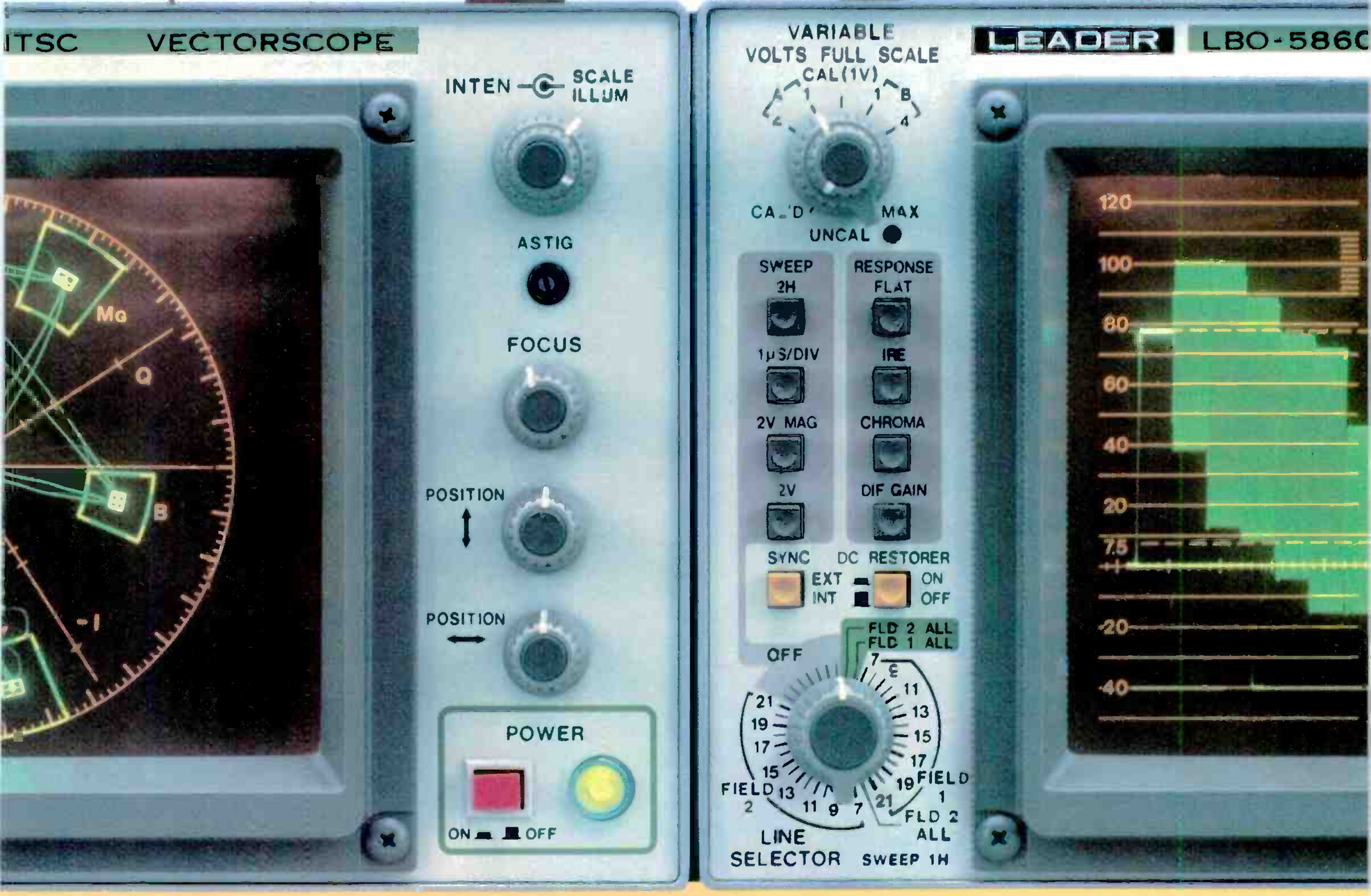

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Editorial

When too much is not enough

Unless you came to the 1985 NAB convention in Las Vegas looking for it, you may have missed it. It wasn't a new product. It wasn't even an old product that the manufacturer finally got to work. You might have detected a clue about it if you attended some of the engineering and management sessions, but you really had to be watching for it. What in the world could *it* be?

Why, *it* was the FCC's spectrum policy, of course. It's a policy based on the concept that broadcasters and other spectrum users are not making efficient use of the spectrum they currently have. The FCC is saying we have too much spectrum. From our point of view, however, the commission's definition of *too much* is really *not enough.*

You say you know about deregulation, 80-90 and the FCC's real-life version of "Let's Make a Deal" that unfolds daily before us. What more could there be to spectrum policy than that?

Spectrum is the cornerstone of broadcasting. It is the key commodity in the marketplace philosophy of the FCC. The commission's Office of Science and Technology, under the direction of chief scientist Dr. Robert Powers, has been charged with the task of devising ways to allocate remaining spectrum, and to make existing spectrum use more productive.

At the NAB convention, Powers spoke of a mixture of services throughout the spectrum controlled by "careful engineering" so that everyone, including broadcasters, will have sufficient spectrum for their needs. The luxury of having "too much" spectrum is a relic of the past, he said.

Here are some of the moves announced before and during the convention that prove those "good old days" of abundant spectrum are gone forever:

- Commissioner Mimi Wayforth Dawson said that broadcast interests should not expect any more auxiliary spectrum, that they may indeed have too much, and may have to share it in the future.
- The FCC (in Docket 82-334) allowed private microwave licensees access to the 13GHz band as a partial solution to the problem of the spectrum refugees displaced under the DBS decision. The commission asked the Society of Broadcast Engineers (SBE) to help in this joint band-coordination process.
- During the SBE National Frequency Coordinating Committee meeting at the NAB, an FCC staff member said the commission might attempt to blanket-license Part 73 users for appropriate Part 74 channels, and depend on local coordination efforts to sort out problems.
- The FCC is considering opening TV and radio ENG channels below 13GHz to programming entities that have previously been unable to gain access to Part 74 spectrum.

As changes come tumbling out of the commission office, our world becomes less familiar and secure. Not only are we in competition with each other for ratings, but now we are being asked to compete with newcomers for the right to occupy Part 74 spectrum to support an on-air operation.

How will such a policy affect our industry? Consider some of the factors that set broadcasting apart from other services regulated by the FCC:

- Unlike other commercial aural or visual services, there is currently no such thing as an exclusive channel for broadcasters who use Part 74 for the *backstage* needs of the industry. Frequency coordination in some markets, where the number of stations that are active in TV ENG exceeds the number of channels, is like trying to teach table manners to a school of hungry sharks.
- Unlike other commercial services, broadcasting serves the entire population. Given the fact that, as a nation, we have developed a strong reliance on the electronic press, any move that tends to limit news gathering can be viewed as a threat to the foundations of journalism.
- Although many markets enjoy ample Part 74 spectrum, the major markets, where large numbers of licensees are clustered, do not have enough.

The history of frequency coordination in our industry is rather short. Because of the unique nature of broadcasting, its success stories have been built on trust and based on sound engineering. The coordination effort simply facilitates licensee-to-licensee contact. The non-exclusive nature of Part 74, the intense congestion in many major markets and the real fear of accusations of restraint of trade have made Part 74 coordination an art that marries diplomacy with physics.

Will the FCC continue a pattern that pits different services against each other and forces broadcasters to fight each other for ENG spectrum? Will the level of trust built carefully since 1976—the kind of trust that made possible the coverage of major events like the 1984 Olympics—be undermined? Will technology rise to the occasion and solve all our spectral woes? Will antitrust lawyers have to learn Ohm's law?

For the answers to these and many other intriguing questions, tune in again. Or better yet, write the commissioners and Mass Media Bureau chief Jim McKinney and tell them that—in our case—too much is not enough.

Prepared by Richard A. Rudman, president of the Society of Broadcast Engineers, and **BE**'s consultant on spectrum management.

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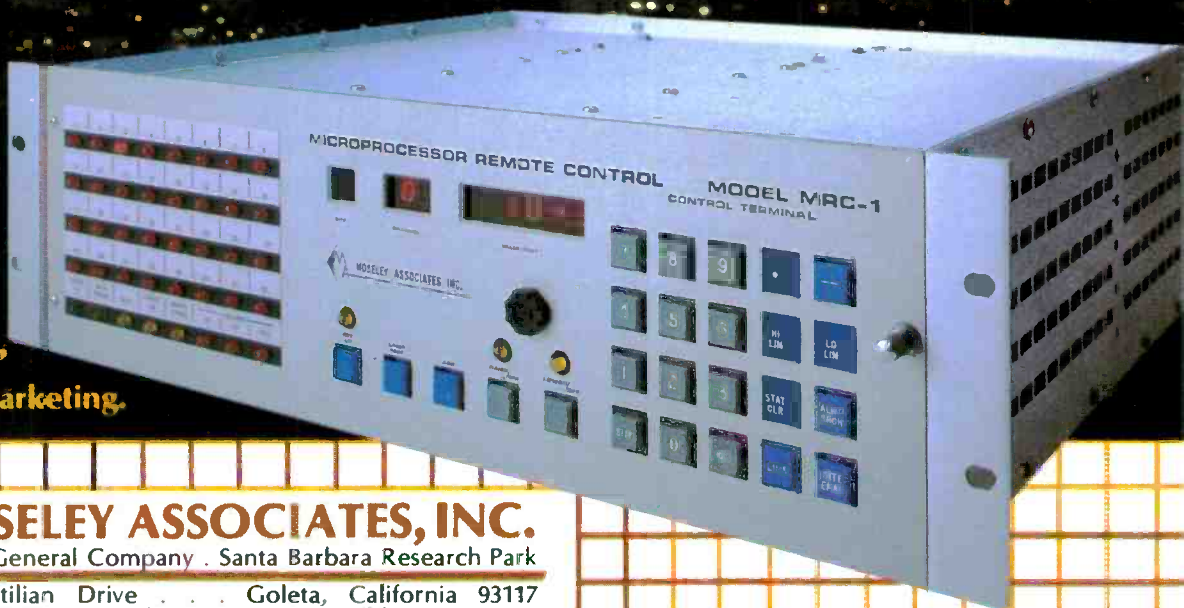

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Opening windows, saving steps

By Harry C. Martin

"It is the commission's goal to open an average of 19 communities to applications each month..."

On May 6, the FCC established, by lottery, a sequential order by channel number in which its 689 Docket 80-90 FM allotments will be made available for applications (see Table 1).

The commission will assign a *window* application filing period to each of the channels shown in Table 1. Applications will be accepted for filing for a channel only during its window filing period. Frequencies still vacant after a window period closes will be available on a first-come, first-served basis.

According to the information we have, the first window will open in September or October. The first available channel, Channel 243A, has been assigned to 14 separate communities across the country. We have been advised informally that the first window will include only this single channel. Subsequent monthly windows will include one, two, or possibly, three channels, depending upon the number of communities involved. It is the commission's goal to open an average of 19 communities to applications each month in order to implement its plan to open all 689 availabilities within three years. Whether this schedule can be adhered to will depend upon the numbers of applications filed, particularly during the first several window periods.

The commission opened its *universal window*—for the approximately 150 still-vacant channels in the pre-80-90 FM allocation table—on June 13. Parties wishing to apply for these unoccupied channels must have filed on or before July 12 to be considered along with other applicants who have filed within the universal window period.

Existing stations seeking protection against restrictions on future changes in transmitter location may wish to file *defensive* modification applications within the filing windows for the channels they see as possible threats to relocations. This applies to the universal window as well as subsequent windows.

Streamlined rules

The FCC has adopted a new application procedure for stations in the Cable Television Relay Service (CARS) and has streamlined several reporting and filing requirements for the service.

Under the new rules, a single license application replaces the former 2-step construction permit and license procedure. The new rules require licensees to make their stations operational within one year and notify the FCC by letter or post card when operations commence.

The following additional changes in filing and reporting requirements also were adopted:

- In cases of assignment or transfer of multiple CARS stations, the commission will require the filing of only one application form (FCC Form 327) that identifies all the stations to be affected by the action. Under certain limited circumstances, CARS licensees no longer will be required to file for approval of ownership changes.
- CARS stations no longer will be required to list all cable facilities served on Schedule E of FCC Form 327. Applicants will now be required to certify only that the station will provide service to at least one authorized program distribution facility.
- Annual reporting requirements for CARS licensees have been eliminated for stations that supply program material without charge or on a non-profit, cost-sharing basis.

Martin is a partner with the legal firm of Reddy, Begley & Martin, Washington, DC.

Table 1. The application processing order for the 689 new commercial allocations created under Docket 80-90.

1.)	243	21.)	298	41.)	280	61.)	271
2.)	266	22.)	267	42.)	260	62.)	292
3.)	221	23.)	300	43.)	258	63.)	229
4.)	225	24.)	273	44.)	257	64.)	287
5.)	245	25.)	272	45.)	244	65.)	248
6.)	251	26.)	233	46.)	263	66.)	276
7.)	264	27.)	279	47.)	254	67.)	269
8.)	286	28.)	232	48.)	282	68.)	235
9.)	238	29.)	297	49.)	259	69.)	284
10.)	252	30.)	290	50.)	230	70.)	227
11.)	255	31.)	246	51.)	299	71.)	228
12.)	261	32.)	270	52.)	234	72.)	262
13.)	275	33.)	231	53.)	256	73.)	249
14.)	250	34.)	239	54.)	291	74.)	293
15.)	294	35.)	288	55.)	268	75.)	265
16.)	274	36.)	278	56.)	296	76.)	285
17.)	224	37.)	223	57.)	226	77.)	295
18.)	241	38.)	289	58.)	222	78.)	242
19.)	253	39.)	240	59.)	236	79.)	247
20.)	281	40.)	237	60.)	277	80.)	283

Lightning strikes

By Carl Bentz, technical editor

Analog components have taken the video world by storm—in recording formats, in effects units and even in satellite transmission systems. The reasons for their popularity are visibly obvious. We experience improved resolution, less noise and, of course, no degradation from the 3.58MHz subcarrier. Still, there is something missing. How does one monitor a component signal?

Over the years, an array of measurement instruments has been developed to monitor NTSC, PAL and SECAM signal quality. Waveform monitors and vectorscopes are used in control rooms throughout the world. Even automatic test systems help to keep track of many signal parameters. Most of these products, however, are designed for monitoring the composite, rather than the component, signal.

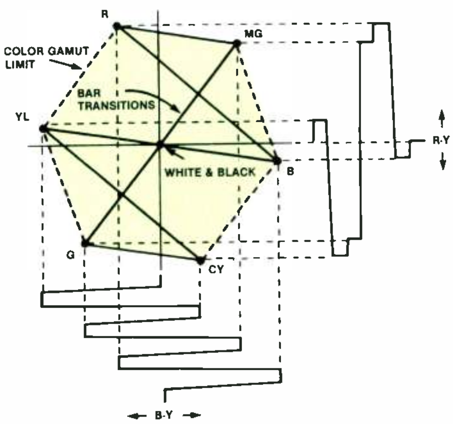
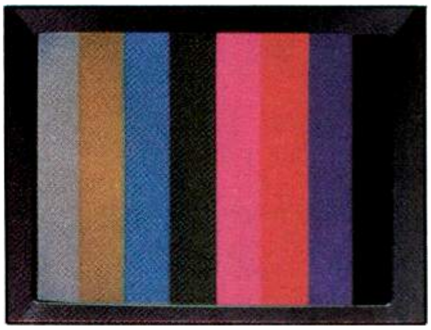


Figure 1. An R-Y vs. B-Y display of color bars.

Actually, three and even four components have been monitored in the past with waveform monitors. An RGB sequential parade display allows checking of amplitude, transient response and frequency response in signals from a camera. Overlays of the components allow relative level and timing error to be measured, but the observer must understand how to interpret the overlay. With Y, R-Y and B-Y, monitoring becomes even more complex.



Color on the TV screen is associated with relative magnitudes of the R-Y and B-Y (or I/Q) components, which, in turn, relate to the phase of the color subcarrier. In order to observe this phase properly, we use a vectorscope. Special marks on the graticule help us to line up the six colors correctly. And as we balance a camera, there are two spots in the center of the display—one for white, one for black—that can be used to zero in to proper balance.

What we see on the vectorscope, however, is actually an X-Y plot of the color difference signals. (See Figure 1.) Demodulation of the composite signal develops V_x (B-Y) and V_Y (R-Y) vectors. The circular display combines the two, similar to what we may have done in math and physics classes, to develop the well-known pattern.

Between the various dots is some information that is difficult to understand. Traces connecting the six dots represent signal transient responses and filter circuit responses. For most of us, only the dots are of concern. If filtering were more closely controlled, the paths between the six outer dots and the center dots would become more meaningful. Still, the vector display represents only two color signals.

To properly monitor Y, R-Y and B-Y, it has been suggested, a display must involve all three components simultaneously. Because a 3-dimensional approach is impractical, we must revert to the X-Y Cartesian plotting method and switch signals to create our display.

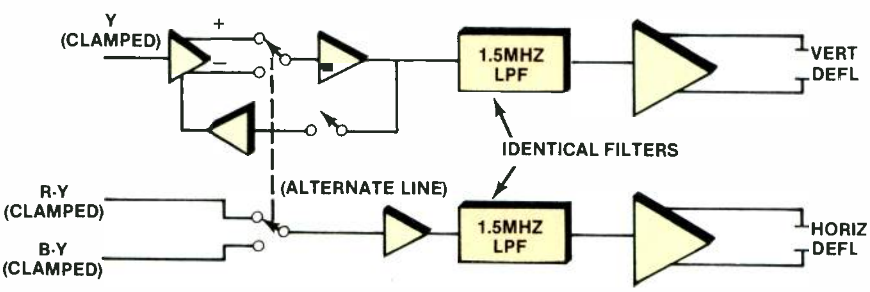


Figure 2. Block diagram of a monitoring method for component video signals.

Looking at the block diagram shown in Figure 2, suppose the Y luminance signal is clamped, with zero representing the back porch of the video signal. It is passed through a lowpass filter and applied to the vertical deflection plates of the CRT. This Y signal is inverted *line sequentially* (every other line). Two clear-cut segments result.

The color components are clamped similar to luminance and passed through lowpass filtering identical to that in the luminance circuit. First, R-Y is routed through the filter and applied to the horizontal deflection plates during positive luminance time. While luminance is inverted, the B-Y portion is switched through the filter to the deflection circuitry. The result is a jagged trace across the screen that somewhat resembles a lightning bolt (Figure 3).

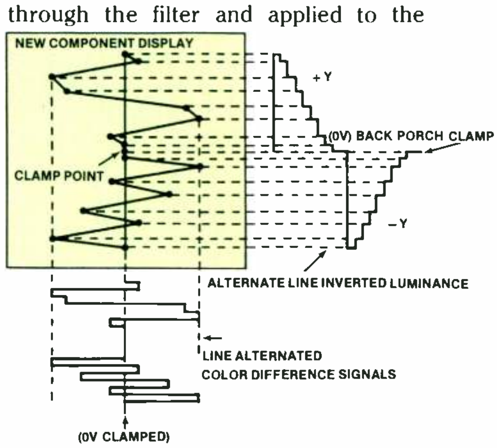


Figure 3. The generation of a proposed new display of Y, R-Y and B-Y components (75% bars with setup).

Lightning is the name that has been given to this suggested approach to analog component video monitoring. Although the method may appear rather unorthodox, the arrangement can show much more than previous waveform and vector displays, as all three components emerge from the darkness to show unequal signal delays, color balance and even S/N ratios.

In next month's "Strictly TV," we will discuss the proper interpretation of Lightning and its use in component video monitoring.

Editor's note: The assistance of Dan Baker, Tektronix, is appreciated in the preparation of this column.

More about AM data transmission

By Bob Streeter

Last month in this column, we examined some of the possibilities for AM subcarrier operation, and the problems that go along with them. For monophonic stations, subcarrier operation using envelope modulation is basically limited to slow-speed subaudible data transmission. This will reduce main-channel modulation by a percentage equal to the amount of subcarrier injection and, consequently, adversely affect main-channel coverage to some extent.

Mono stations that plan to operate a subcarrier using angular modulation of the carrier have a few more options. Restricted band voice transmission may be possible on the angular (L–R) signal, but don't expect too much in terms of performance. Tests performed by this company have shown that medium band voice transmission of reasonable quality is unlikely on the L–R channel because of the interference that it can cause to main (L+R) channel reception on AM radios using envelope detectors. Medium-speed data may be possible, if the bandwidth is limited and the modulation level is kept fairly low.

AM SUBCARRIER OPERATION

ENVELOPE MODULATION CONDITIONS:

- SLOW-SPEED DATA ONLY (SUBAUDIBLE)
- REDUCED MAIN-CHANNEL MODULATION
- REDUCED MAIN-CHANNEL COVERAGE AREA

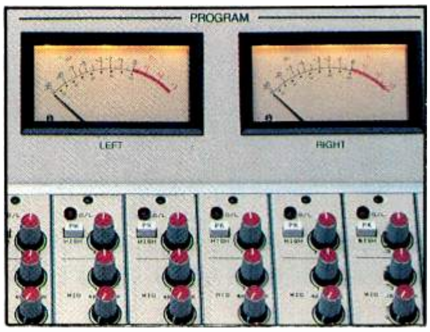
ANGULAR MODULATION CONDITIONS:

- SUBAUDIBLE SLOW-SPEED DATA
- LOW LEVEL MEDIUM-SPEED DATA MAY BE POSSIBLE
- REDUCED DIFFERENCE CHANNEL (L–R) MODULATION
- REDUCED STEREO COVERAGE POSSIBLE
- POSSIBLE INTERFERENCE WITH STEREO PILOT TONE RECEPTION

Because no broadcast signal is absolutely pure, some degree of interference between the program and non-broadcast signals is acceptable. The FCC did not define, as part of the non-broadcast signal rules, the degree of interference that would be unacceptable. Only the existing rules for mono and stereo broadcast are available to define the legal interference limitations. The station's own interests will prevent serious degradation of the main broadcast signal.

Stereo receivers

Another problem concerns the effects of angular modulation on AM stereo receivers. The non-broadcast service must not trip the receivers into the stereo mode, because the listener would hear a mixture of the monaural program audio and the non-broadcast (L–R) signals. Because all of the stereo pilot tones are subaudible, protection is easily accomplished with proper signal filtering of the non-broadcast signal. AM stereo receivers that can be *forced* into the stereo mode are a different matter, however, because the listener can choose to hear the "stereo" signal and gain access to your non-broadcast transmission.



Pacific Recorders and Engineering

Stereo transmission

For AM stations broadcasting in stereo, subcarrier operation is still possible, with some restrictions. The only place that you can put the non-broadcast signal is in the subaudible regions of the L+R and/or L–R components. If you choose the subaudible region of the L–R channel, the non-broadcast signal will be mixed with the AM stereo pilot tone. This method will not present any problems at the transmission end, but AM stereo receivers may experience trouble differentiating between the pilot and non-broadcast signals. Existing monaural receivers will not be affected.

The non-broadcast signal may be placed *above* the pilot tone frequency, but it may suffer interference from the L–R audio signal or the pilot tone (depending on the amount of separation and filtering provided). In such a situation, the subcarrier bandwidth must be narrow enough that it does not create stereo audio signal interference. Also, the modulation level must be consistent with reasonable coverage of the non-broadcast service being offered. As with envelope modulation, the overall L–R (angular) modulation level must be shared. In this case, it is shared with the stereo pilot tone, the non-broadcast signal and the stereo audio signal. Excess modulation can cause the transmitter modulator or receiver detector to clip and cross-modulate the L–R components.

Placing the non-broadcast signal lower in frequency than the pilot tone will greatly reduce the potential transmission rate. This mode of operation eliminates the possibility of audio interference, but may interfere with proper detection of the stereo pilot tone at the receiver.

Data format

If subaudible digital data is transmitted, it should prove helpful to encode the information. The transmission of raw slow-speed baseband signals requires dc continuity in the communications circuit. Most AM stereo receivers use phase locked loop synchronous detectors for the L–R channel (as would be probable for any future data receivers). These detectors will track out any long term constant-level signals, and could make a mess of baseband data under certain conditions. Encoding should also help with error detection and control.

If the data is transmitted in the subaudible region, it must be restricted in bandwidth, and, hence, speed. There are many applications that will not accept this mode of operation—cases in which a great deal of information must be transmitted rapidly, or time is critical to the task being performed.

There are many applications, however, in which the data is repetitive, or the time element is not critical to the task. Such services are likely candidates for the use of slow-speed data transmission. The use of digital storage systems would enhance the operating potential of such applications because the primary information can be stored, with the new data merely updating the device memory. This has the effect of greatly increasing the communications rate.

Streeter is with the consulting firm of AM Stereo, Fort Wayne, IN. This information is provided courtesy of Continental Electronics.

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1

The SPP 800, STEREO PREPARATION PROCESSOR.

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2

The SEP 800, SPECTRAL ENERGY PROCESSOR.

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Circle (9) on Reply Card

New video networks tailor the telecast

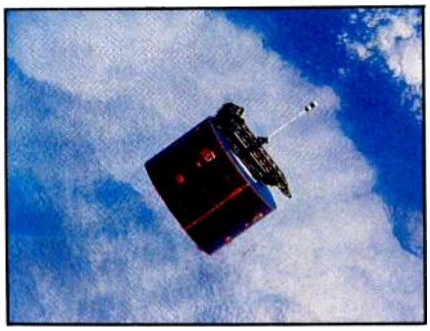
By John Kinik

Today's video networks, addressing a wide variety of TV market needs, are benefiting from the unique features of modern satellite technology and the trend toward deregulation of communications. A new breed of satellite video networks is emerging, that no longer fits neatly into any one category.

One of the earliest of these new networks was established when Wold Communications, a Los Angeles-based company, became the first major satellite transponder wholesaler by realizing the potential in owning multiple transponders and leasing them to occasional-use customers. This new approach made it possible, by the late 1970s, to transmit television from anywhere in the country much more easily, via fixed or transportable uplink earth stations. The transmission could be a point-to-point cross-country feed by one of the major broadcasting networks or it could be a national feed that delivered the signal to a group of receive stations all over the country.

A second company, San Francisco-based Netcom, also has flourished in this new market in the past few years, and like Wold, is primarily C-band satellite-based. Netcom started out in the teleconferencing business, then migrated into the video distribution market, where it competes with Wold, Bonneville Telecommunications and Hughes Television. The company now leases multiple C-band transponders on a full-time basis, and provides uplink and downlink earth stations. Netcom specializes in point-to-point distribution of entertainment, news, religious, sports and syndicated programming for broadcast and cable customers, and continues to provide teleconferencing services.

Kinik, BE's satellite correspondent, is a senior systems engineer for a satellite carrier service.



NASA

New services via Ku-band

Ku-band satellites have opened up a new variety of video network opportunities as well. The same low-cost technology employed by United Satellite Communications Inc. (USCI) last year, in its ill-fated attempt to establish the first DBS system, has been applied to video teleconferencing by New York-based Private Satellite Network (PSN).

PSN's success stems from the fact that the video teleconferencing market has never developed as expected by some industry forecasters, who based their projections for massive transponder demand in the mid-1980s on the anticipated growth of corporate needs for customized teleconferencing. However, the high cost of this type of service discouraged many potential customers, so the PSN service, a low-cost alternative based on simple broadcast-type FM transmission into 4- to 8-foot receiving antennas, has been welcomed.

The cost-effectiveness and small antenna size offered by Ku-band technology promises to make it the predominant delivery mode of video networks in the latter half of this decade. Satellite carriers, particularly SBS and RCA, also figure to be much more active in offering new services based on the small earth station technology. This is true not only because of the advantages of Ku-band distribution, but also because of a new freedom to compete in the market, a result of the FCC's decision to allow carriers to lower their rates for video distribution services. SBS has announced it will offer Video Network Services, utilizing FM transmission, uplinking services, small antenna receive earth stations and optional features, such as return audio feed, scrambling and receive end addressability. RCA also is expected to begin to pursue the market aggressively after its Ku-band satellites (Satcom Ku-1, Ku-2) are launched.

One company already committed to heavy use of the new RCA satellites is Conus Communications, a Minneapolis-based company specializing in satellite news gathering services to member broadcasting stations. Conus has been in operation since last summer, leasing an existing Ku-band transponder, but has recently announced a multiple Ku-band transponder lease arrangement on Satcom Ku-2, through an affiliated organization, United States Satellite Broadcasting (USSB). Conus offers the Ku-band receive earth stations to participating broadcasters virtually free of charge as part of its package of services, and has experienced a rapid growth in demand for its new SNG service because it is able to get news feeds on the air in a very short time, using more compact and easily transported uplink earth stations than would be possible with C-band satellites.

In and out of classrooms

Another new video network development is aimed at education. The potential market for *electronic universities* is large, comprising the campus market as well as the continuing education market. National Technological University (NTU), based in Fort Collins, CO, recently completed a 2-week preview series using the new SBS Video Network Services delivery technique to televise courses from various locations to classes at universities and companies.

The entertainment of college students is an angle that is being pursued by yet another company via Ku-band satellite delivery. The New York-based Campus Network is installing receive earth stations now, with an expected eventual network of more than 200 receive locations, and is experimenting with original program packages for students.

NETWORK	SATELLITE FREQUENCY BAND	EIRP (DBW)	RECEIVE ANTENNA SIZE RANGE	SINGLE CHANNEL RECEIVE EARTH STATION COST RANGE
WOLD, NETCOM	C	33-36	3M-5M	$3000-10,000
SBS RCA PSN	KU	45-50	1.2M-2.5M	$1000-3000
NTU	KU	45-50	1.2M-2.5M	$1000-3000
CAMPUS NETWORK	KU	45-58	2.5M-3.7M	$3000-5000

Table 1. *These figures reflect the trend toward the use of receive earth terminals that are smaller and lower in cost.*

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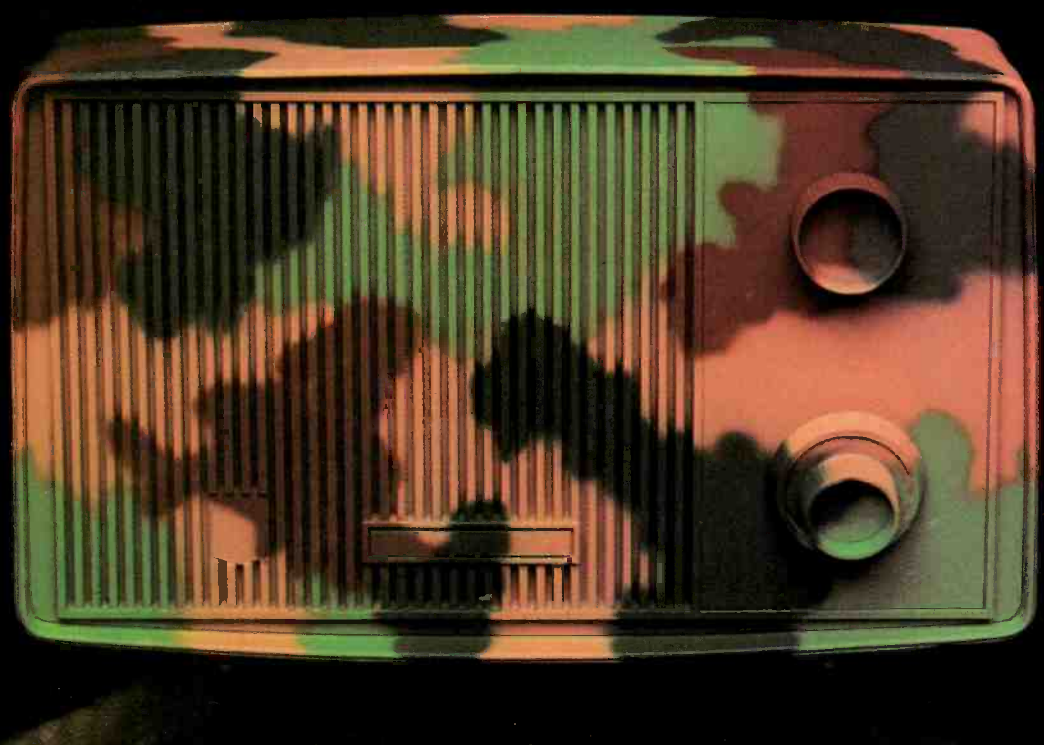

Inside the PA cavity

By Jerry Whitaker, editor

One of the things that makes troubleshooting a cavity-type power amplifier stage difficult is the nature of the major component elements. The capacitors don't necessarily look like capacitors, and the inductors don't necessarily look like inductors. It is often difficult to relate the electrical schematic diagram to the mechanical assembly that exists within the transmitter output stage. At FM and TV frequencies—the domain of cavity PA designs—inductors and capacitors can be formed out of some strange-looking mechanical devices and hardware.

Consider the PA cavity schematic diagram shown in Figure 1. The grounded-screen stage is of conventional design. Decoupling of the high-voltage power supply is accomplished by C1, C2, C3 and L1. Capacitor C3 is located inside the PA chimney (cavity inner conductor). The RF sample lines provide two low-power RF outputs for a modulation monitor or other test instrument. Neutralization inductors L3 and L4 consist of adjustable grounding bars on the screen grid ring assembly.

Figure 2 shows the electrical equivalent of the PA cavity schematic diagram. The ¼-wavelength cavity acts as the resonant tank for the PA. Coarse tuning of the cavity is accomplished by adjustment of the shorting plane. Fine tuning is performed by the PA tuning control, which acts as a variable capacitor to bring the cavity into resonance. The PA loading control consists of a variable capacitor that matches the cavity to the load. There is one value of plate loading that will yield optimum output power, efficiency, PA tube dissipation and dependable operation. This value is dictated by the cavity design and values of the various dc and RF voltages and currents supplied to the stage. The assembly made up on L2 and C6 prevents spurious oscillations within the cavity.

The logic of a PA stage often disappears when you are confronted with the actual physical design of the system. As shown in Figure 3, many of the components take on an unfamiliar form. Blocking capacitor C4 is constructed of a roll of *kapton* insulating material sandwiched between two circular sections of aluminum. PA plate tuning control C5 consists of an aluminum plate, of large surface area, that can be moved in or out of the cavity to reach resonance. PA loading control C7 is constructed much the same as the PA tuning assembly, with a large-area paddle feeding the harmonic filter, located external to the cavity. The loading paddle may be moved toward the PA tube or away from it to achieve the required loading. The L2-C6 damper assembly actually consists of a 50Ω resistor mounted on the side of the cavity wall. Component L2 is formed by the inductance of the connecting strap between the plate tuning paddle and the resistor. Component C6 is the equivalent stray capacitance between the resistor and the surrounding cavity box.

From this example, you can see that many of the troubleshooting techniques that work well with low-frequency RF and dc do not necessarily apply in cavity stages. Therefore, it is critically important that you study how your particular transmitter operates, and what each

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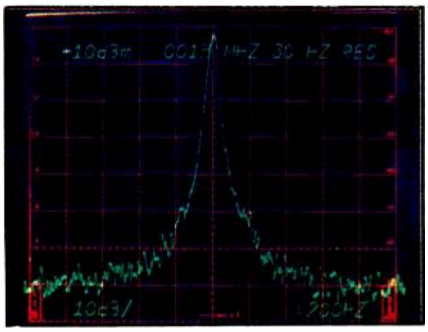


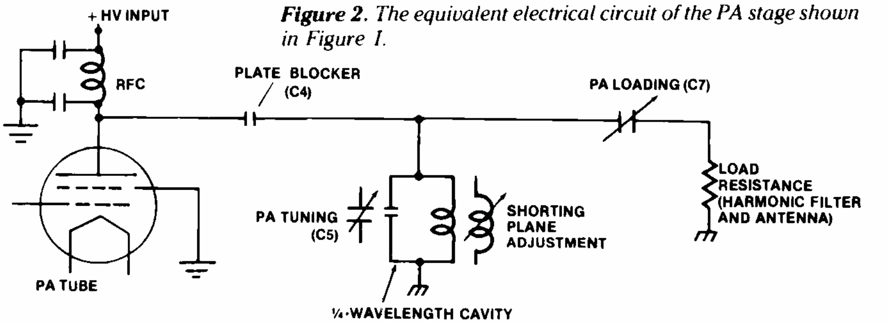


Figure 2. *The equivalent electrical circuit of the PA stage shown in Figure 1.*

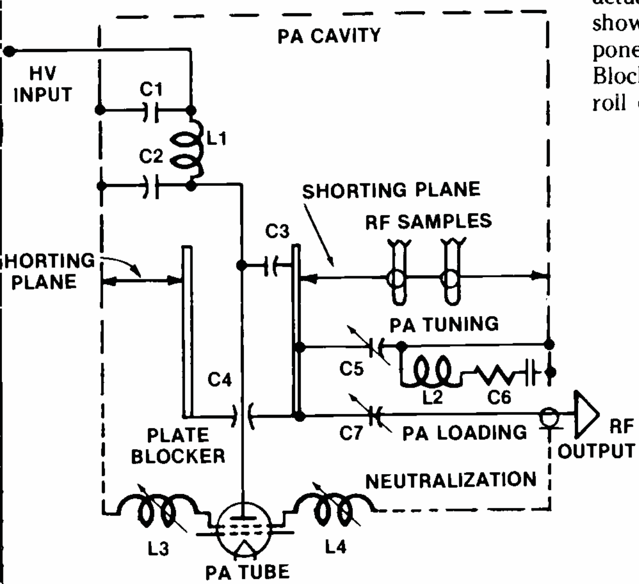


Figure 1. *An FM transmitter PA output stage built around a ¼-wavelength cavity with capacitive coupling to the load.*

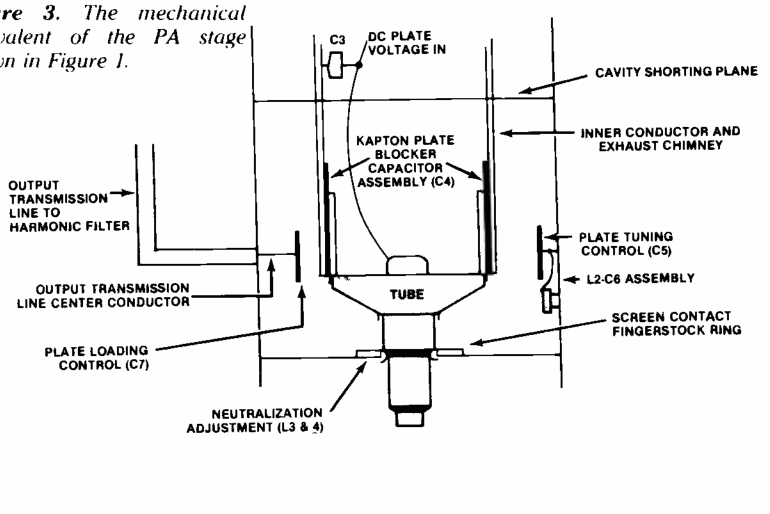


Figure 3. *The mechanical equivalent of the PA stage shown in Figure 1.*

Video monitoring after deregulation

By Dane E. Ericksen, P.E.

New freedom regarding TV system monitoring brings with it new responsibilities for station engineers.

With the deregulation of TV remote control on Dec. 1, 1984, virtually all FCC conduct rules defining acceptable minimum monitoring practices for TV stations have been eliminated. Combined with the 1982 elimination of mandatory vertical interval test signals and the 1983 elimination of type-approved aural modulation monitors, the relaxed remote control rules present tremendous latitude on how TV stations achieve compliance with the remaining performance rules. However, with this freedom comes increased responsibility for meeting those bottom-line requirements, and a much greater likelihood of penalties if the transmitted signal is not in compliance with the commission's technical standards.

This article will review the proper use of equipment for monitoring the video waveform. Accurate monitoring will help ensure that the viewing public will not tune out because of poor picture quality, will give the FCC monitoring van no reason to select your station for inspection, and just might earn your station an FCC *good guy* notice.

Monitoring techniques

A TV demodulator can either be fed from an RF probe in the transmission line or from an antenna. Advantages of transmission line sampling are freedom from a receiving antenna and immunity from the perils of the RF path, such as ghosting or electrical noise. The disadvantage, however, is the necessity for all components downstream of the probe to be transparent. If they are not transparent, the display seen on the waveform monitor may be deceiving.

Ericksen, BE's consultant on systems design, is with the consulting firm of Hammett and Edison, San Francisco.

You should remember that the FCC monitoring trucks use the direct off-air signal, as does the viewing public (those viewers not on cable, anyway). Therefore, the prudent TV station will use both methods. If the video signals obtained using each method do not closely match, further investigation is warranted.

"What is our philosophy on technical deregulation? It is basically as follows: Get rid of all rules which pertain to the quality of the broadcast signal. I don't care what the picture looks like, I don't care what the sound sounds like. We'll get rid of those rules that pertain to quality. It is up to the station to maintain its quality. If the station chooses not to maintain good quality, people won't watch, people won't listen. We need not be involved."— *James C. McKinney, NAB, 1985*

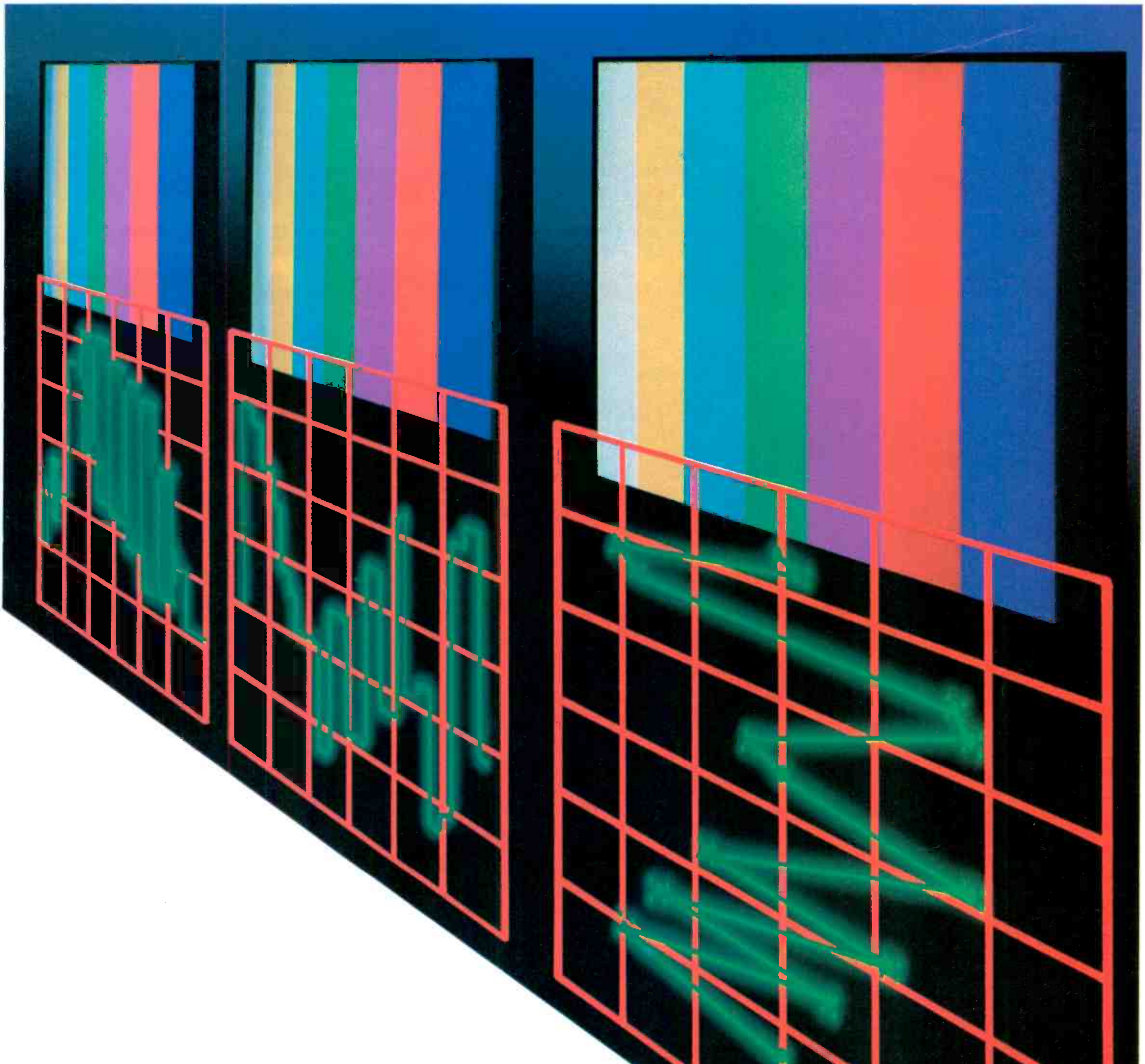
The early practice of using a simple diode detector as a demodulator has almost universally given way to the modern TV demodulator. However, even a precision demodulator will give distorted information if the signal path has not been given sufficient attention.

The antenna used to feed the demodulator should be as directive as possible to minimize pickup of reflected signals. The antenna gain should be flat across the TV channel, and proper care should be taken to ensure a proper impedance match among the antenna, downlead and demodulator.

Consider the arrangement used by the FCC monitoring trucks. (See Figure 1.) The commission uses the antenna shown because of its flatness (within 1dB across any single channel) and its directivity over the VHF and UHF TV bands. Because a TV station usually only needs an antenna with desirable characteristics across a *single* channel, a large, multi-element single-channel Yagi antenna should be used to obtain optimum directivity and flatness for the channel of interest. The coaxial cable connecting the antenna and demodulator should be swept to confirm flatness, and the cable should feed just the demodulator.

Demodulator accuracy

Assuming proper care has been given to antenna selection, placement and installation, the demodulator must next accurately reproduce the video signal. One important parameter is depth of modulation. Valid modulation measurements require an accurate *zero carrier reference.* The EIA standard for TV broadcast demodulators, RS-462, specifies that the zero carrier reference shall be accurate to within 1%. The accuracy of the zero carrier chopper and demodulator linearity can be checked by carefully comparing the *white flag* VITS level measured with a conventional demodulator/waveform monitor pair and the level seen with a quality RF spectrum analyzer used as a tuned receiver.



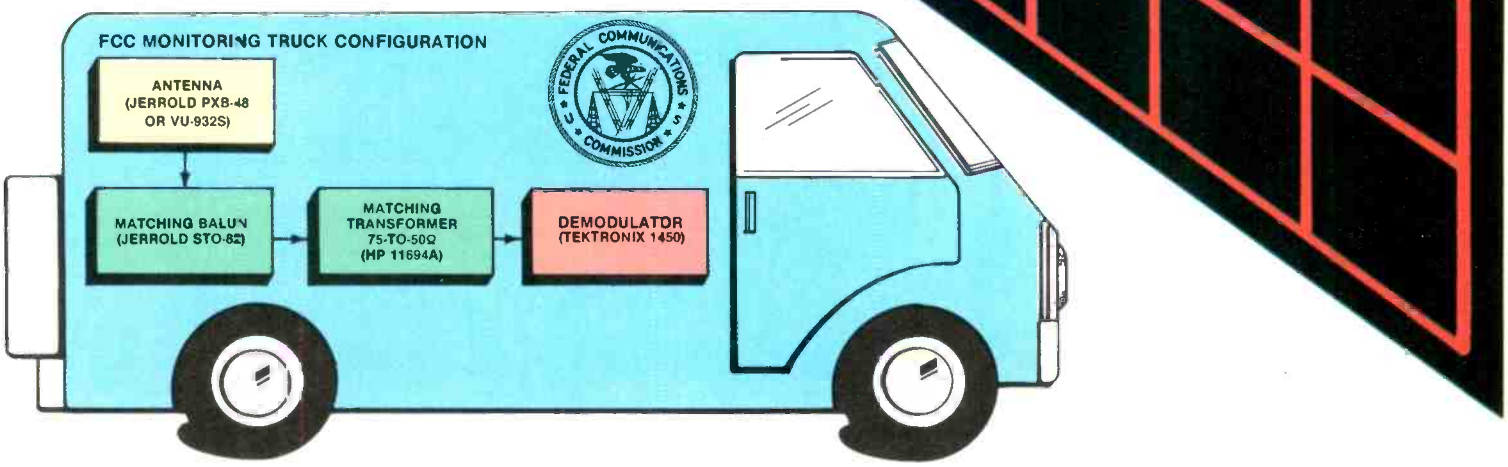
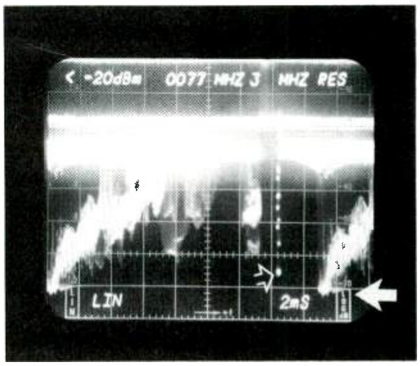
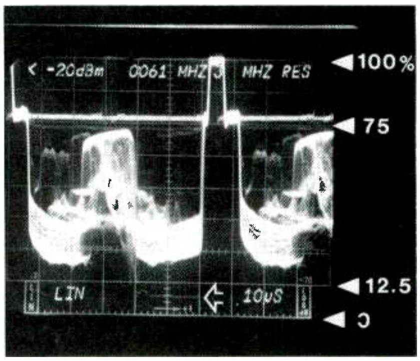


Figure 1. *A typical FCC monitoring truck equipment configuration.*



Checking the depth of modulation using a spectrum analyzer (Tektronix 7L13). The white flag VIT signal is at 17% of peak carrier level, and the luminance portion of the video signal is at 10% of peak carrier level.



A line rate display of depth-of-modulation measurement using the spectrum analyzer noted in the previous photo. The white flag VIT signal can be seen at 7.5% of peak level. If luminance components match this level, sync buzz probably will be experienced on some TV receivers.

Typical displays from such an arrangement are shown in the photos above. The first photograph demonstrates the technique with a field rate display, and the second shows a line rate display. Note that the white flag portion of the VITS is clearly visible in both photographs. If the reference white level or sync level differs by more than 2% from the demodulator/waveform monitor method, check the accuracy of the demodulator's zero carrier chopper.

Synchronous or envelope detection?

If the demodulator offers both synchronous and envelope detection, measurements should normally be made in the synchronous mode. The synchronous mode will give a more accurate rendition of the video waveform because of the reduced quadrature distortion. It would be a mistake to utilize the envelope detection mode believing that this mode most closely matches the characteristics of consumer TV receivers. Most TV receivers process the luminance and chrominance signals separately, so that a flat receiver response is not necessary. In contrast, a precision demodulator has flat frequency response over the entire video baseband. As noted in RS-462, a precision demodulator in the envelope detection mode does not accurately simulate a typical consumer TV receiver.

For the special case, in which transmitter incidental phase modulation (ICPM) of greater than 5° exists and cannot be corrected, adjustments for minimum differential phase and envelope delay are appropriate using envelope detection rather than synchronous detection. This is because the majority of commercial TV receivers (and many cable TV head-end demodulators) utilize envelope detection.

Pulse width considerations

Although TV stations are no longer required to have a waveform monitor capable of displaying the vertical interval test signals or to make a vectorscope available to the operator on duty, the transmitted signal still must conform to the technical standards in *sections 73.682, 73.687* and *73.699*, as referenced in *Figure 6*. Despite the elimination of FCC standards for maximum horizontal and vertical blanking, on March 14, 1985, the remaining pulse widths are fully in effect. Figure 2 is a summary of current requirements. Note that the FCC requirement is not identical to proposed EIA standard RS-170A. For example, RS-170A defines pulse widths at the half-amplitude points, whereas *section 73.699, Figure 6,* defines the pulse widths at the −4 IRE points (that is, 10% into H-sync).

For stations with good pulse rise times (less than 200ns), the difference between half-amplitude pulse widths and −4 IRE pulse widths is insignificant; however, when rise times are poor, the FCC method will yield different results than the RS-170A method.

Monitor time base accuracy

If a TV waveform monitor is used to measure pulse widths, care should be taken to check the time base accuracy. Failure to do so may result in precise measurements but not *accurate* measurements. For example, a monitor with a −5% time base error in the 1μs/division mode could show an apparently within-tolerance 7.8 divisions for the sync-to-end-of-burst interval, whereas the actual duration would be 8.2μs, an out-of-tolerance condition.

The time base accuracy can be checked by expanding the sweep rate to 0.2μs/cm (0.005H for 529 users) and noting whether each cycle of color subcarrier exactly overlays the 1/3.58MHz graticule marks located at the −30 IRE level. If the subcarrier cycles are not coincident, the time base error can be determined by dividing the number of

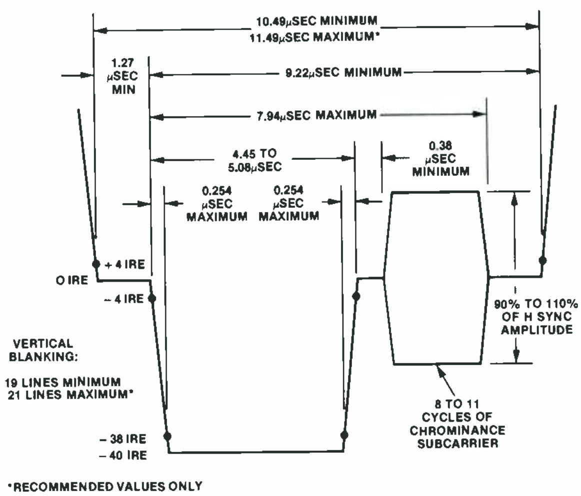
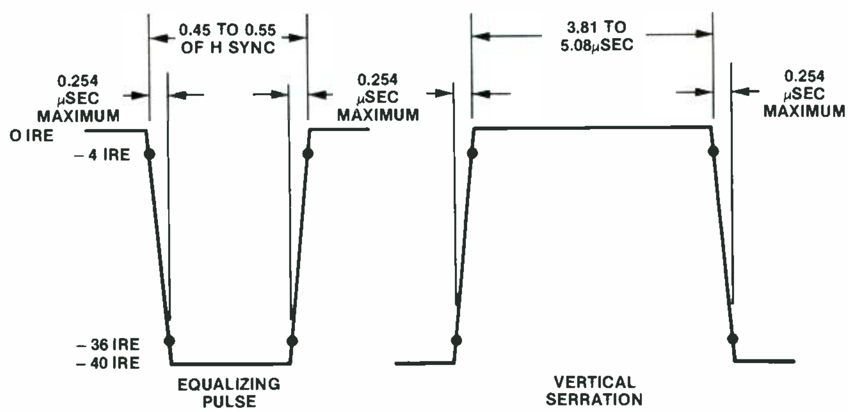
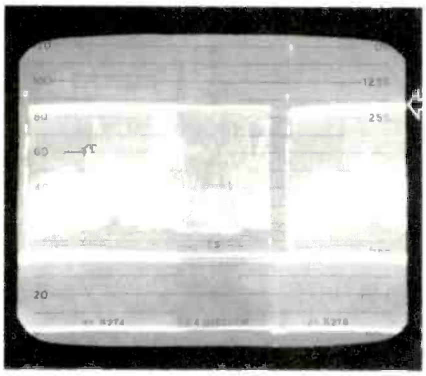
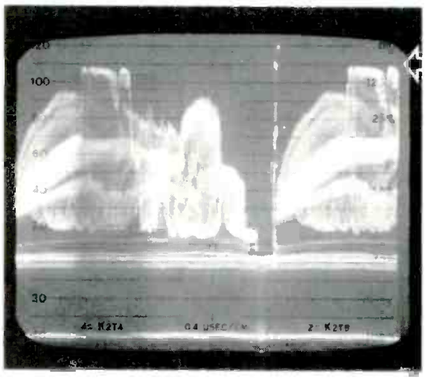


Figure 2. The FCC pulse width requirements as of March 14, 1985.





An example of visual undermodulation. The white flag VIT signal is at only 17% of peak carrier level, and program video is white-clipped at 20% of peak carrier level (88 IRE). The result is degraded picture contrast.



Don't let this happen to you! The luminance signal is exceeding 100 IRE units. Luminance components are within 6% of carrier cutoff. This will cause excessive contrast and sync buzz on some TV receivers.

1/3.58 graticules by the number of cycles of color subcarrier. For example, if nine cycles of burst occupy only 8.7 divisions, the time base error is $-0.3/9$, or -3.3%.

Low whites and high setup: a gray area

FCC rules require that the reference white level of the luminance signal be maintained at $12.5\% \pm 2.5\%$ of peak carrier level (or 100 ± 4 IRE units), and require that the setup level be maintained at 7.5 ± 2.5 IRE units. Though excessive whites or insufficient setup are always clear-cut violations of the rules, low whites or high setup are gray areas.

If low whites or high setup are due to improper modulation of the visual transmitter, picture contrast is degraded and the viewer loses the dynamic range intended by the producer. If, on the other hand, the producer intends the scene to contain only grays instead of saturated white or reference black, then no modulation error exists. However, the amount of contrast should be a conscious decision by the producer, and not be caused by inaccurate (or sloppy) monitoring of visual depth of modulation. (See photos at left.)

The chief of the Mass Media Bureau has made it clear that all FCC rules relating to broadcast quality are targeted for elimination, and several of the Field Operations Bureau inspectors who concentrate on TV monitoring and inspections have informally indicated to this writer that the enforcement of existing quality standards are a low priority. However, the viewing public and those who pay to have carefully produced commercials broadcast may not be so lenient. Visual undermodulation, or even excessive whites and zero setup may no longer upset the FCC, but if they cause poor contrast, sync buzz, unstable pictures and other degradations, dissatisfied viewers and unhappy advertisers are likely to result.

The *good guy* program

The commission began its *good guy* program about four years ago. The program allows Field Operations Bureau FM/TV specialists to issue a good guy notice to any TV station monitored and found to comply with all FCC technical standards. Because an unexpected letter from a regulatory agency is generally

Continued on page 26

It takes a unique graphics look to stand out from today's look-alike news productions. So we've built some unique graphics tools into our new ESS-3 Still Store that you won't find anywhere else.

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And, to make your news preparation fast and effortless, the ESS-3 displays 12 stills at one time for you to browse through and edit. Compare *that* to any description-only index system.

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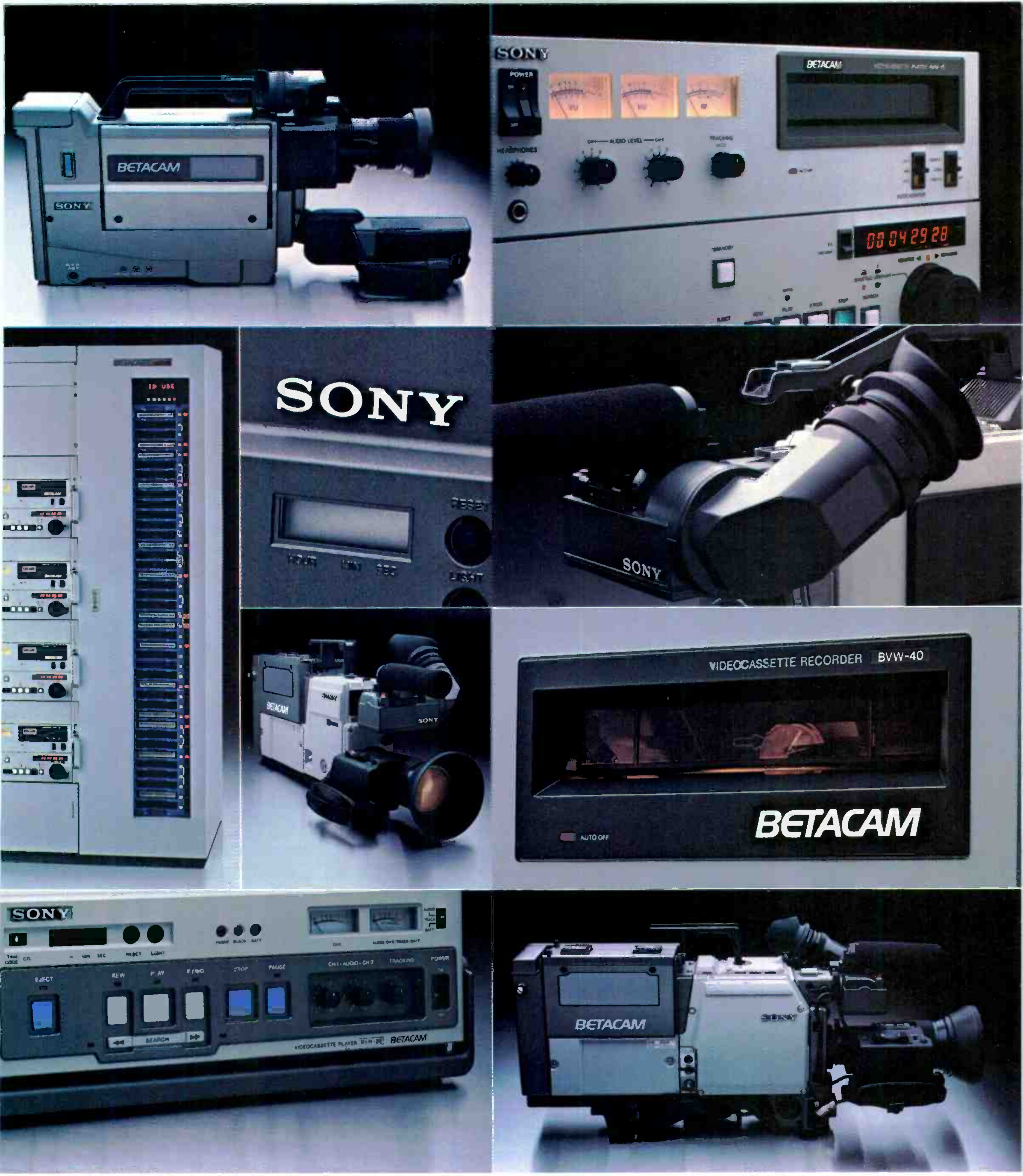

that demonstrated the Betacam format's strength beyond the newsroom, beyond the studio, and beyond field production.

At the same time, Sony also unveiled the world's lightest camera/recorder, the BVW-2 Newsmaker.™ And a prototype coder/decoder system that will make it possible for Betacam to be transmitted by microwave.

Each of these products is the result of Sony's dedication to the needs of the ENG and EFP industry. Work which has earned the Betacam format widespread acceptance by television stations and production companies around the world.

Which only makes sense. After all, in this business you don't win sales on the merits of your arguments. You win them on the merits of your products.

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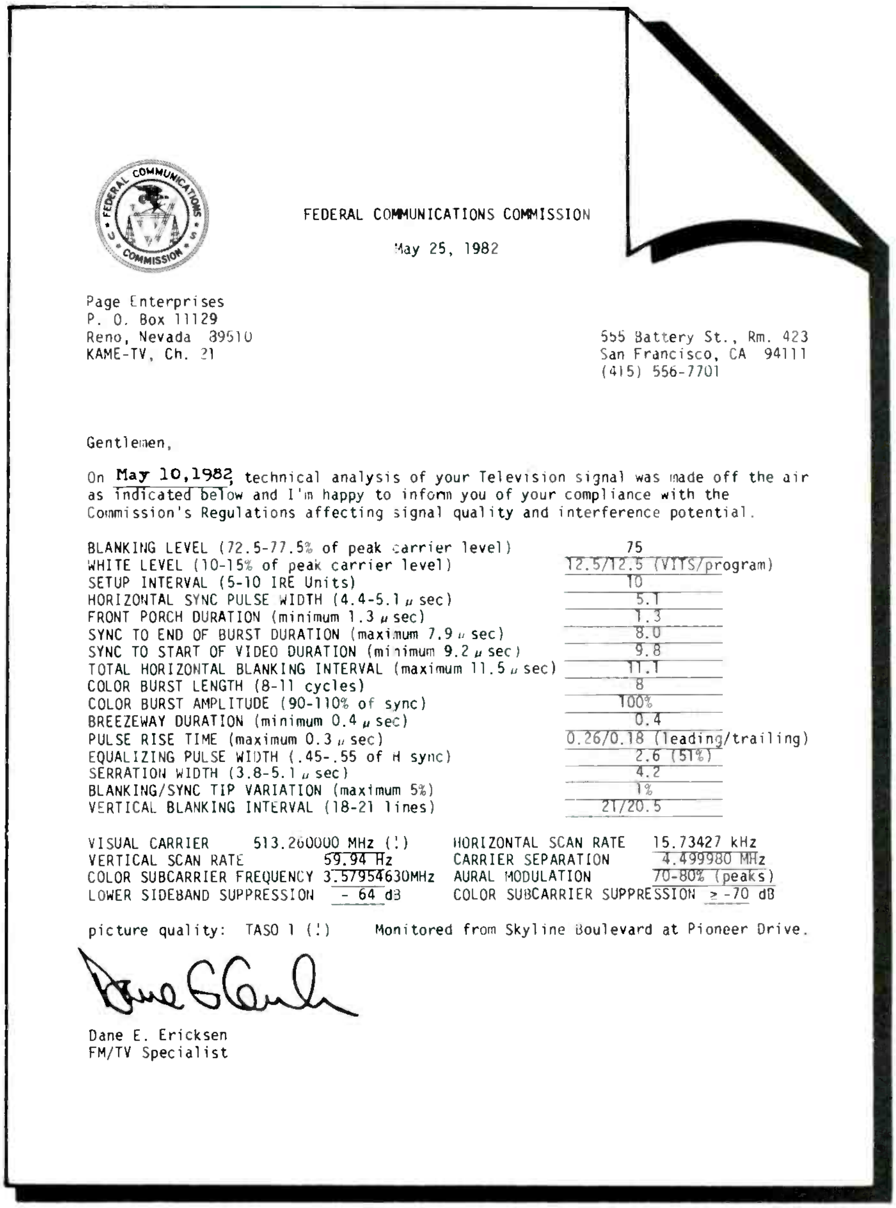

FEDERAL COMMUNICATIONS COMMISSION

May 25, 1982

Page Enterprises
P. O. Box 11129
Reno, Nevada 89510
KAME-TV, Ch. 21

555 Battery St., Rm. 423
San Francisco, CA 94111
(415) 556-7701

Gentlemen,

On May 10,1982 technical analysis of your Television signal was made off the air as indicated below and I'm happy to inform you of your compliance with the Commission's Regulations affecting signal quality and interference potential.

BLANKING LEVEL (72.5-77.5% of peak carrier level)	75
WHITE LEVEL (10-15% of peak carrier level)	12.5/12.5 (VITS/program)
SETUP INTERVAL (5-10 IRE Units)	10
HORIZONTAL SYNC PULSE WIDTH (4.4-5.1 μ sec)	5.1
FRONT PORCH DURATION (minimum 1.3 μ sec)	1.3
SYNC TO END OF BURST DURATION (maximum 7.9 μ sec)	8.0
SYNC TO START OF VIDEO DURATION (minimum 9.2 μ sec)	9.8
TOTAL HORIZONTAL BLANKING INTERVAL (maximum 11.5 μ sec)	11.1
COLOR BURST LENGTH (8-11 cycles)	8
COLOR BURST AMPLITUDE (90-110% of sync)	100%
BREEZEWAY DURATION (minimum 0.4 μ sec)	0.4
PULSE RISE TIME (maximum 0.3 μ sec)	0.26/0.18 (leading/trailing)
EQUALIZING PULSE WIDTH (.45-.55 of H sync)	2.6 (51%)
SERRATION WIDTH (3.8-5.1 μ sec)	4.2
BLANKING/SYNC TIP VARIATION (maximum 5%)	1%
VERTICAL BLANKING INTERVAL (18-21 lines)	21/20.5

VISUAL CARRIER	513.260000 MHz (!)	HORIZONTAL SCAN RATE	15.73427 kHz
VERTICAL SCAN RATE	59.94 Hz	CARRIER SEPARATION	4.499980 MHz
COLOR SUBCARRIER FREQUENCY	3.57954630MHz	AURAL MODULATION	70-80% (peaks)
LOWER SIDEBAND SUPPRESSION	- 64 dB	COLOR SUBCARRIER SUPPRESSION	≥ -70 dB

picture quality: TASO 1 (!) Monitored from Skyline Boulevard at Pioneer Drive.

Dane E. Ericksen
FM/TV Specialist

Courtesy of KAME-TV, Reno, NV.

Figure 3. An FCC good guy *notice. FCC inspectors have the option to issue this notice if all parameters are found to be within tolerance.*

Continued from page 22

dreaded (and not likely to contain good news), the good guy program is a refreshing change. Surprisingly, it has received little publicity.

The program provides independent verification of the accuracy of station monitors and alerts both management and technical staff that the commission is out there monitoring. Figure 3 is a likeness of an actual good guy notice that was issued to KAME-TV in Reno, NV. Receipt of a good guy notice speaks well of the station's chief engineer and demonstrates to station management that funds for test or monitoring equipment have been well invested.

Future trends

It is likely that the commission will eventually carry out its avowed goal to eliminate all quality and conduct rules. Whether this deregulation will ultimately benefit the public and the American broadcasting industry, and vindicate chairman Fowler's marketplace approach, remains to be seen. It is clear that much greater freedom, as well as responsibility, has been handed to TV licensees and broadcast engineers. Both the FCC and the public will be watching the results.

Bibliography:

1. Electronic Industries Association standard RS-462, "Electrical Performance Standards for Television Broadcast Demodulators," May 1979.
2. Electronic Industries Association Tentative Standard No. 1, "Color Television Studio Picture Line Amplifier Output Drawing," December 1976 (interim standards pending release of RS-170A).
3. Tektronix, application note, "Television Operational Measurements," March 1984.
4. 47 CFR, Part 73, Subpart E (Television Broadcast Stations).

The mic mixer you would have designed yourself–The Shure M267.

In the space of just two years, the Shure M267 has become one of the most well-known and widely used mixers in the broadcast industry. One look at it will tell you why.

The M267 gives you the improvements you've told us were most important. Every channel has a mic line level switch for maximum flexibility. There's also a built-in limiter to keep the M267 from overloading at critical moments. The unit contains a built-in battery pack that utilizes three standard 9-volt batteries. Simplex (phantom) power and a peak LED are standard, too.

The M267 oscillator provides a clean 1 kHz tone, and is located on the front of the unit for simple access. The headphone output is also on the front and includes a level control. IC design, along with active gain controls, provides greater headroom and quieter operation.

For location work or even studio post-production, the M267 carries on Shure's reputation for reliability and ruggedness.

For more information on Shure's complete line of mixers, call or write Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, IL 60202, (312) 866-2553.

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BREAKING SOUND BARRIERS

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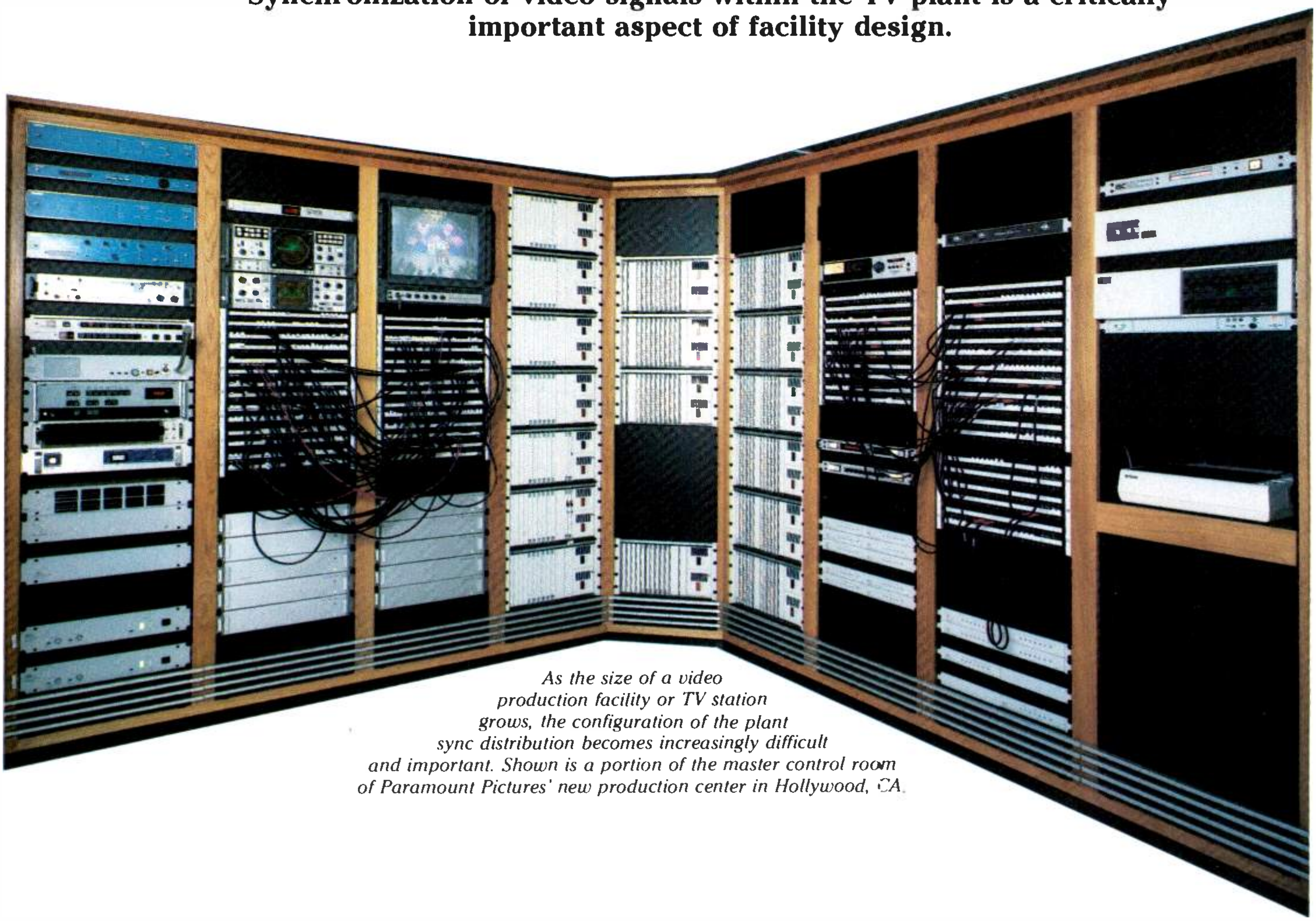
Keeping in step

By Elmer E. Smalling III

Synchronization of video signals within the TV plant is a critically important aspect of facility design.



As the size of a video production facility or TV station grows, the configuration of the plant sync distribution becomes increasingly difficult and important. Shown is a portion of the master control room of Paramount Pictures' new production center in Hollywood, CA.

Courtesy of Centro

Let's say you're shooting with one camera and a portable VTR, or that you're playing back to a monitor from a single videotape player. You have no reason to use a TV synchronizing system. However, as soon as you employ more than one camera, videotape machine, a special effects generator or a switcher, you must make certain that video timing (synchronization) is correct in order to produce quality pictures of proper hue that do not roll or jump.

Synchronizing information is included in the portions of the video signal that are not seen on a monitor—the horizontal and vertical intervals (during which the picture disappears from the screen from right to left and from bottom to top). This synchronizing information consists of *pulses* that are the electronic analog of the sprocket holes on motion-picture film. A number of individual components form the composite synchronizing (most often called sync) signal. These components include blanking, horizontal sync, vertical sync and color burst.

- *Blanking* is used primarily by camera systems to "blank out" video during the time the scanning beam traces from the bottom line of a completed picture to the top line of the next picture, and from the end of each line on the screen at the right-hand side to the beginning of the next line on the left. Without blanking, the picture would resemble a spider web of retrace lines.
- *Horizontal (H-) sync* occurs at the beginning and end of each horizontal line. H-sync pulses indicate where the lines of a picture start on the left and end on the right-hand side of the screen.
- *Vertical (V-) sync* occurs at the beginning and end of each vertical picture field, marking the bottom and top of the picture.
- *Color burst* is a sample (eight to 11 cycles) of color subcarrier located after each H-sync pulse. The sample of color subcarrier allows equipment in the system to display the proper phase (or

Smalling, **BE's** consultant on television systems, is president of Jenel Systems and Design, Dallas.

TEK'S NEW 1710B: THE BRIGHTEST IDEA IN WAVEFORM MONITORING.

One-of-a-kind capability in a new waveform monitor that's easy to use and afford! The Tek 1710B has all the essentials for reliable, consistent monitoring of your video signal. For example, it includes the first-ever burst phase indicator found in a waveform monitor. This special new color display indicates if burst is properly set: a green light means it's right!

Operating simplicity anyone will appreciate. The front panel controls of the 1710B are logically grouped and labeled for fast, easy handling. And the high quality Tektronix CRT offers a sharp, bright trace so it's easy to see.

You get outstanding versatility and Tek quality in a convenient, compact package that fits in half a rack. DC power operation can be installed and used with a battery pack for fully portable operation in the field.

If you see a place for a cost-effective waveform monitor in your operation, you owe it to yourself to see the 1710B. Available in both NTSC and PAL versions, the 1710B is our most economical answer yet to improving picture quality through video waveform monitoring.

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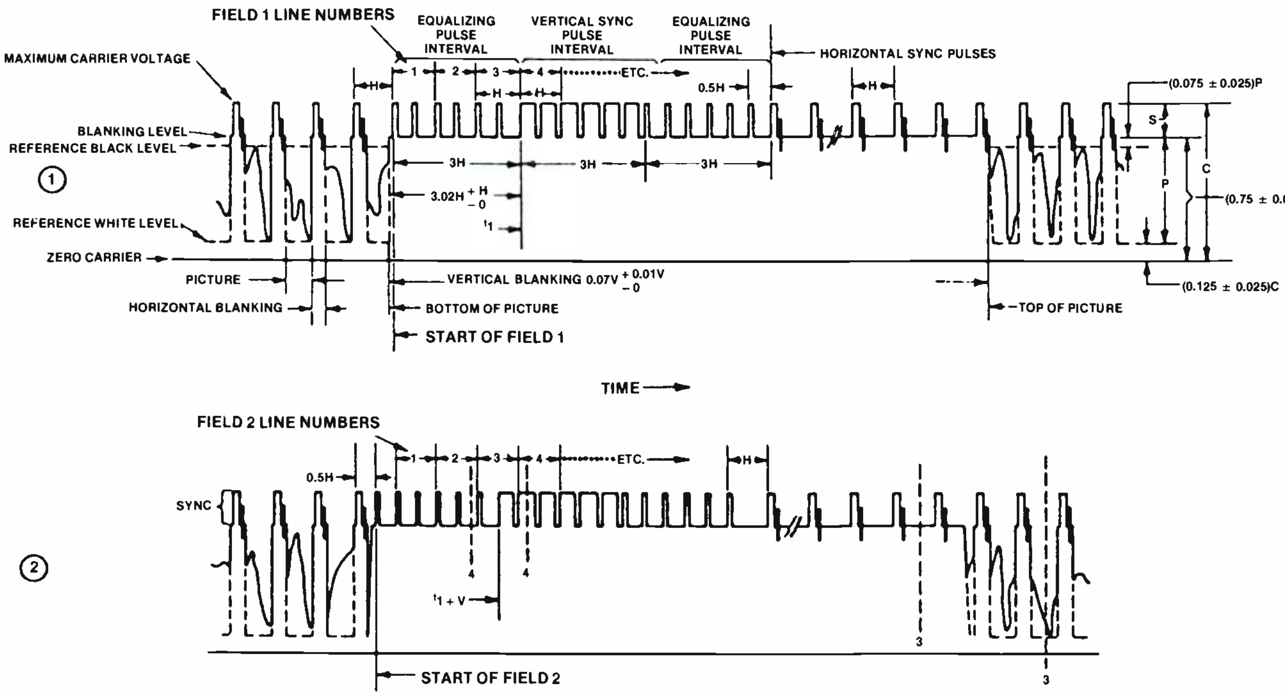


HORIZONTAL DIMENSIONS NOT TO SCALE IN 1, 2 AND 3

Figure 1. *The RS-170A standard sync waveforms.*

hue) of color information in the video signal.

These components must be positioned precisely on the video signal. (See Figure 1.) Usually, they are formed in a single piece of equipment—the sync generator—to ensure that they remain in time with themselves and with the video signal. Of all signal generators at the station, the master sync generator is probably the most important.

Any system more complicated than a single VTR and monitor requires sync. The more complex the system becomes, the more critical the timing becomes. To simplify matters, sync-generator circuits are included in many modern cameras, character generators, switchers, etc.

Sync generators come in two varieties: analog or digital. The analog generator develops sync signals by dividing down from a local crystal-controlled oscillator. This method, which has been used for years, is acceptable if the oscillator frequency stability approaches an error of about one part per trillion (1×10^{12}).

Digital sync generators use counters that are triggered from a highly stable crystal oscillator source. Binary counters tend to be self-correcting and usually exhibit less drift than analog frequency generators. Today, a digital sync generator can be built into a single integrated circuit.

At one time, a master sync generator required at least two 6-foot-high equipment racks and demanded constant attention from engineering personnel. The TV equipment then required most of the common sync pulses to be added to the video signal. These included horizontal and vertical sync, composite blanking, horizontal and vertical drives, burst flag and subcarrier. Each signal was distributed to almost every piece of equipment at the station.

Today, with built-in sync generators, a *black burst* reference signal produced by the master generator carries all the necessary information. Black burst consists of composite sync and color burst. From this signal, on-board generators develop pulses required for the specific device. Black burst is sometimes called *crystal black, color black* or *the color reference signal.*

Sync requirements

Most TV systems use many pieces of electronic equipment that require synchronizing signals. Typically, this includes the following devices:

Small system (small production facility or LPTV station)

- 3 cameras
- 1 switcher
- 2 VTRs with time base correctors
- 1 character generator
- 1 videotape editor
- 1 time code generator

Large system (large TV station or production facility)

- 3 switchers
- 2 digital video effects systems
- 9 VTRs with time base correctors
- 2 character generators
- 3 videotape editors
- 2 time code generators
- 1 electronic graphics system
- 1 routing switcher

All of these devices require sync signals in order to work together. However, only one sync generator is used to keep all of the equipment locked to the same timing reference. Without a common source, wipes, cuts or edits without rolls or jumps would be impossible. With only one or two outputs provided on the typical master generator, a need for multiple sync signals calls for a sync distribution system.

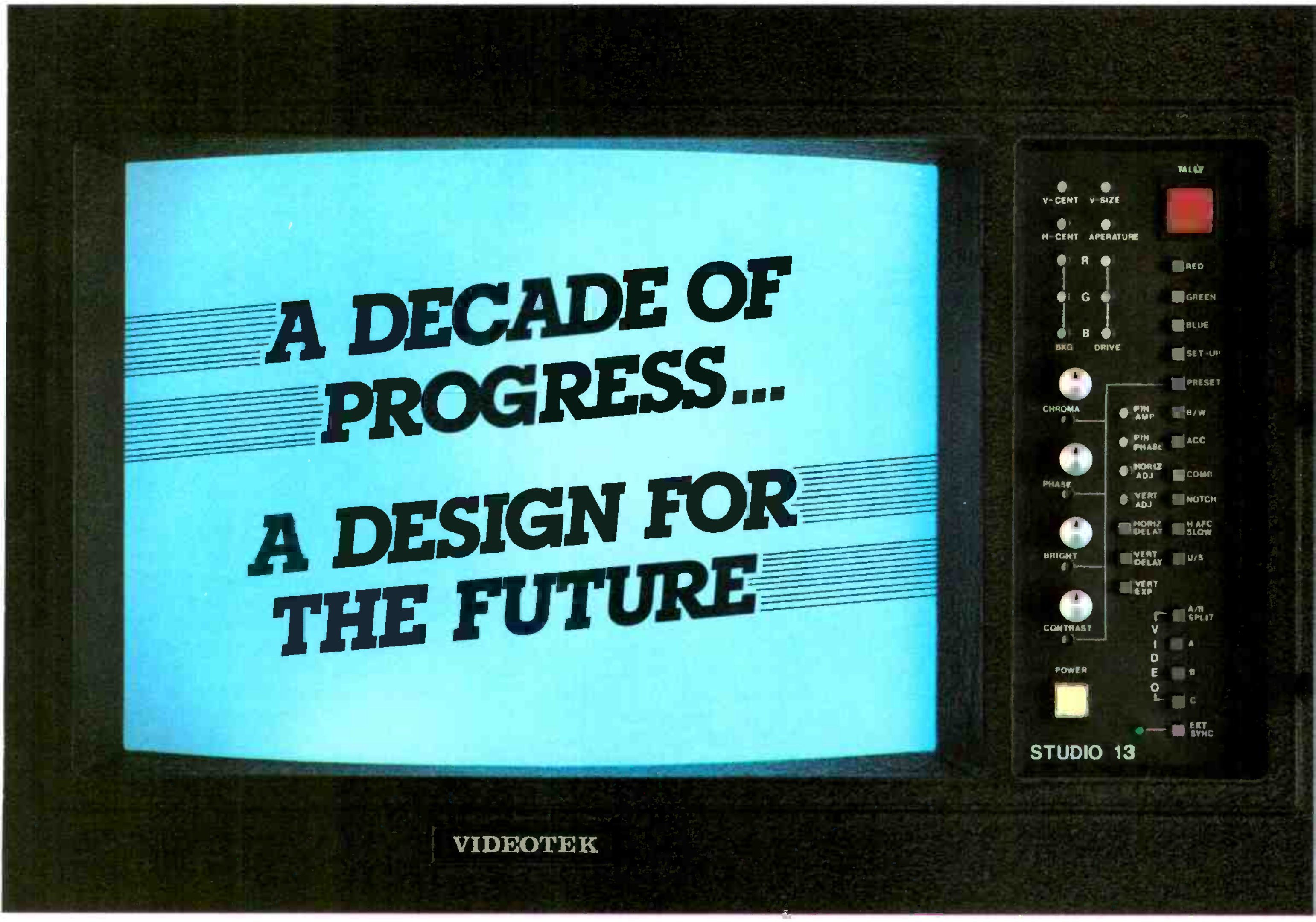
Taking a count

When planning a TV system, determine exactly what types of signals are required. One brand of a device may require input signals that another brand does not. The equipment instruction book or specifications should spell out the exact drive requirements. As an example, consider the following list of equipment and necessary signals:

- Camera .... 1 black burst each
- Video switcher ... 1 black burst
  1 blanking
  1 composite sync
  1 subcarrier
- Time base corrector .... 1 black burst
  1 composite sync
- Editing controller . 1 black burst
- Time code generator .... 1 black burst
- The maintenance shop .... 1 black burst
  1 composite sync
  1 blanking

For the small system profiled at left, a total of 17 sync drives is required:

- Black burst 10
- Composite sync 4
- Blanking 2
- Subcarrier 1



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The Studio 13 is the latest example of this Progress by Design, incorporating more features and a higher level of quality than any color monitor in its class.

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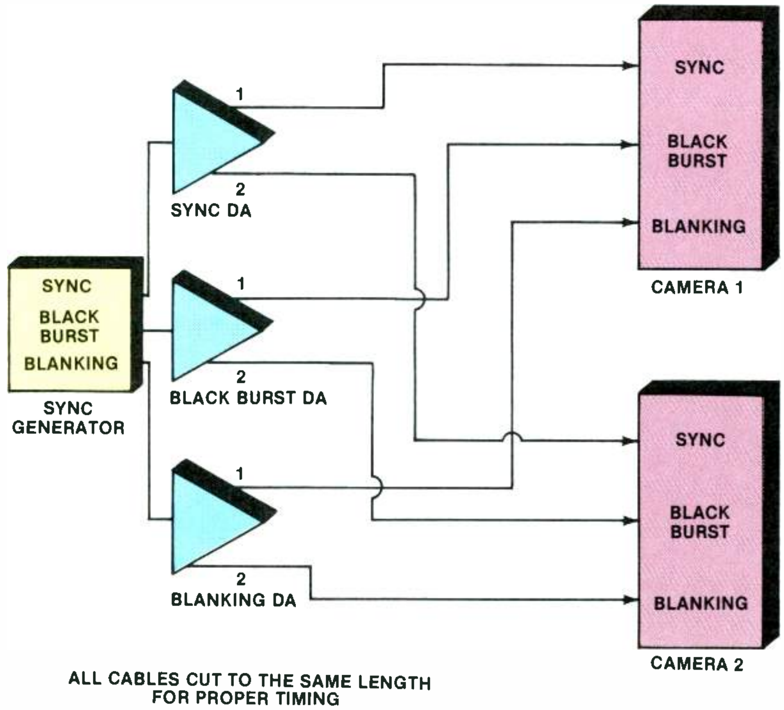


Figure 2. *A sync distribution system using separate DAs and individual, trimmed cables that have all been cut to precisely the same length.*

As the list of equipment grows, the need for sync throughout the facility increases rapidly. In a network center—with multiple studios, production and on-air switching equipment, production and on-air VTRs, graphics, still-stores and editing suites—the number of required sync drives could run into the hundreds.

Passing pulses around

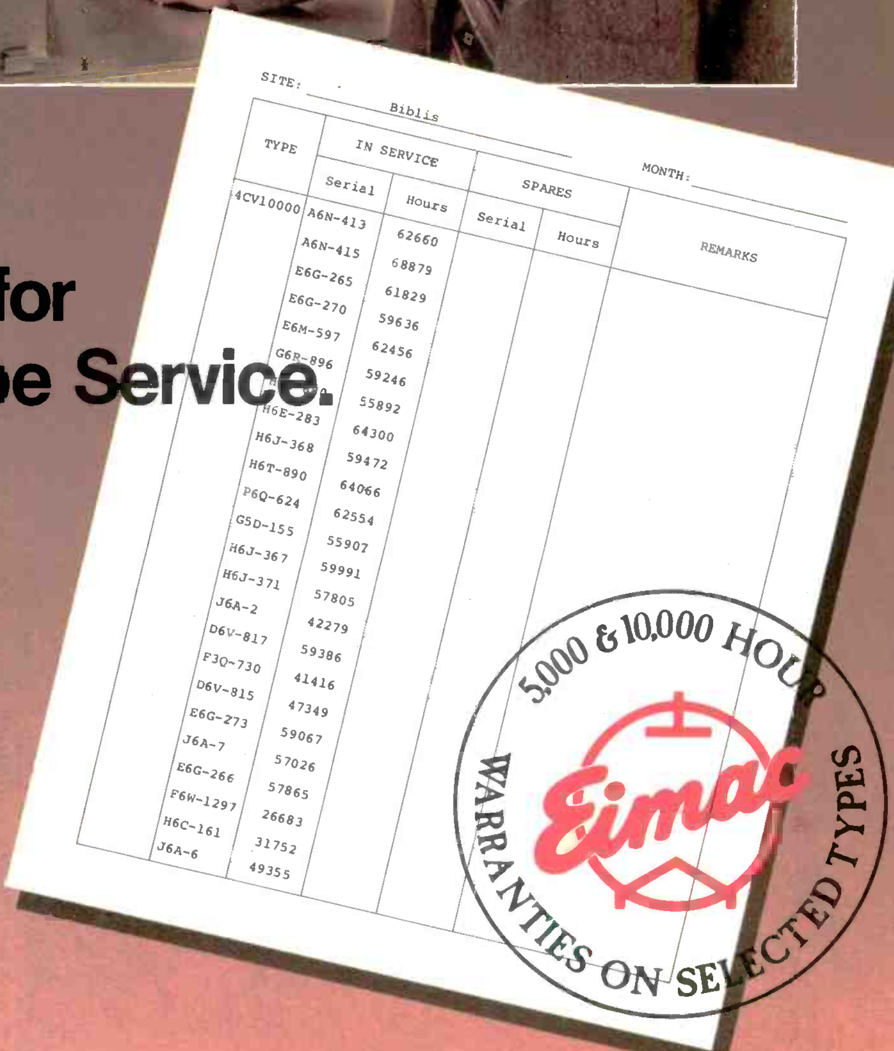
There are various ways that signals may be distributed. Many TV products include *looping* inputs. An input signal is applied to a device, which provides a second looping output. A short cable is then used to connect the signal to another device. Looping sync from the master control waveform monitor to the vectorscope (located side by side) should present no problems. Looping signals through devices in different parts of the facility, however, is not desirable. The timing of the signal from one device to another is affected by the length of cable that connects the two units.

Another method of distributing sync signals is through the use of distribution amplifiers (DAs). The DA amplifies a signal and splits it into multiple outputs, as shown in Figure 2. Each output is a copy of the input signal. From the outputs, discrete lines supply each device that requires the particular signal. This method proves less flexible, however, as the physical plant and production requirements dictate change.

Another method of distribution uses a master sync generator with slave generators located at each piece of equipment to be driven, or in each area of a large facility (Figure 3). Controls on the slave generator allow fine adjustment of system timing. The cost of this

Continued on page 36

Hugh Fallis, VP Engineering, Radio Free Europe, Munich, stands beside CE 100 kW HF transmitter using EIMAC 4CV100,000C tube.



SITE: Biblis MONTH:

TYPE	IN SERVICE		SPARES		REMARKS
	Serial	Hours	Serial	Hours	
4CV10000	A6N-413	62660			
	A6N-415	68879			
	E6G-265	61829			
	E6G-270	59636			
	E6M-597	62456			
	G6R-896	59246			
	[illegible]	55892			
	H6E-283	64300			
	H6J-368	59472			
	H6T-890	64066			
	P6Q-624	62554			
	G5D-155	55907			
	H6J-367	59991			
	H6J-371	57805			
	J6A-2	42279			
	D6V-817	59386			
	F3Q-730	41416			
	D6V-815	47349			
	E6G-273	59067			
	J6A-7	57026			
	E6G-266	57865			
	F6W-1297	26683			
	H6C-161	31752			
	J6A-6	49355			

EIMAC tubes provide long life for Radio Free Europe Service.

Radio Free Europe transmitters in Biblis and Lampertheim, West Germany, use EIMAC 4CV100,000C power tubes in 12 Continental Electronics 100 kW HF transmitters.

The station logbook shows most tubes have over 50,000 hours of service, and many tubes logged over 60,000 hours! And EIMAC tubes are still running strong—that's long life!

These figures are representative of the long life EIMAC tubes log in a variety of high power broadcast applications.

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Midwest puts on a great show because it uses the best components

One of the reasons that the Midwest M-40 Series is the most advanced class of large mobile teleproduction units available today is our policy of only using the finest components. This "no compromise" design philosophy ensures a system of superior quality and reliability. Our M-40 units give you up to 47 feet of unparalleled technical and creative capacity. Because we only use the best components . . . from companies like Ikegami.

Ikegami HK-322 automatic color cameras make Midwest picture perfect

In the M-40, we wanted the ability to produce the best possible pictures. So we selected the HK-322 as a basic building block of the system. When the position as the world's most popular field camera passes from the Ikegami HK-357A, it will be to the HK-322. This fully automatic color camera sets the new standard for picture resolution, signal-to-noise ratio and registration accuracy. Standard computer set-up takes much of the hassle out of preparing for remote telecasts. With the Ikegami HK-322, the Midwest M-40 delivers perfect pictures everytime.

Ikegami HL-79E Series plays dual role for Midwest units

The Ikegami HL-79E Series camera was selected for use aboard the Midwest M-40 because it can handle two separate functions with superlative results. Although it's renowned as the perfect hand-held camera, the HL-79E Series can easily be converted into a field camera that produces higher quality images than many other manufacturers' top-of-the-line studio models.

Ikegami delivers super performance in

This exceptionally fine performance is due to Ikegami's painstaking attention to detail. Designed to meet the most rigorous performance standards, the HL-79E Series also offers optional automatic set-up, either via its own set-up computer or by interface into the HK-322 set-up computer for total system integration. With the HL-79E Series, Midwest's M-40 offers you the versatility required to produce network quality productions in any circumstances.

Ikegami 9-Series color monitors give Midwest "true to life" pictures

Ikegami 9-Series Color Monitors are standard in the Midwest M-40 mobile unit because of their superb resolution and ability to reproduce colors that are amazingly life-like. This performance is unmatched by any other monitor in the world. Since the 9-Series monitors use In-Line Gun CRTs, they provide more than excellent colorimetry and

fantastic resolution. They also offer high stability, unit interchangeability, low power consumption, and convenient pull-out circuit panels. By using the Ikegami 9-Series, the Midwest M-40 can reproduce colors that are true to life.

Midwest road shows

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Indianapolis, IN 317-872-2327	Bristol, TN 615-968-2289	Miami, FL 305-592-5355
Detroit, MI 313-689-9730	St. Louis, MO 314-569-2240	Tampa, FL 813-885-9308
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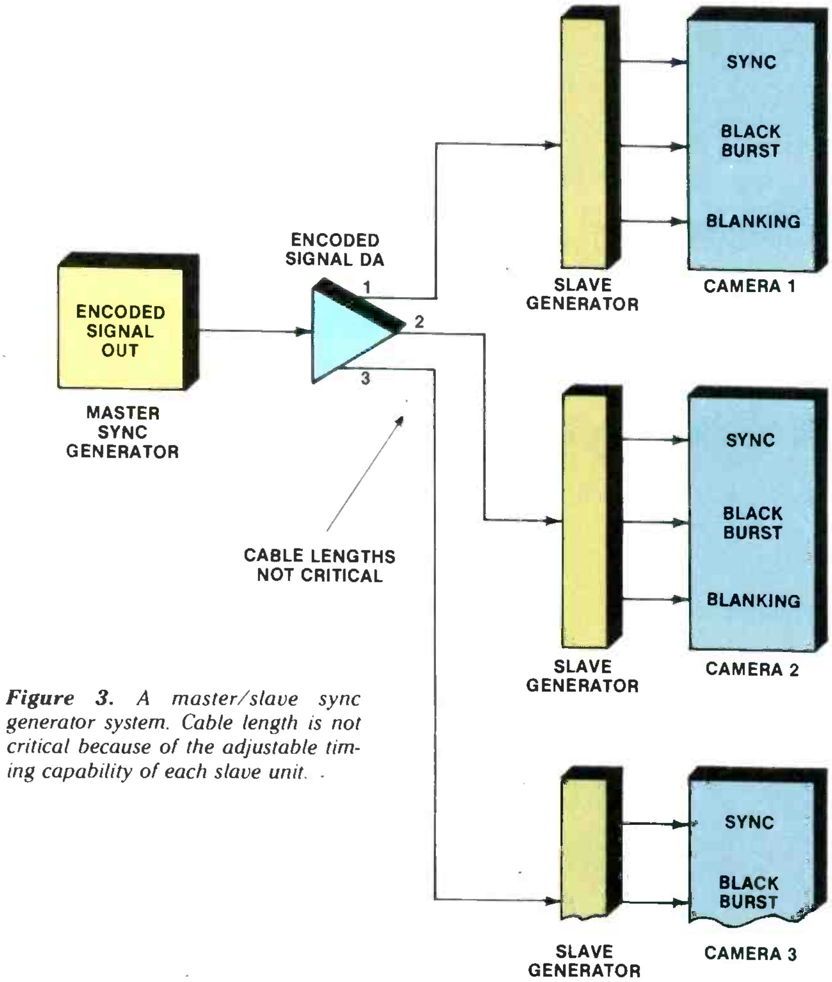

Figure 3. *A master/slave sync generator system. Cable length is not critical because of the adjustable timing capability of each slave unit.*

Continued from page 32

convenience, however, is usually greater than the DA approach.

Unlike distribution of audio and general monitor video signals, the distribution of video to any devices driven by house sync requires extra care. Because video and sync signals take a finite amount of time to travel through cable, unequal cable lengths will cause signals to arrive at the equipment out of time (or phase) with one another.

Ideally, all cables will be the same length. In early TV installations, the length of cable for the longest physical run was calculated, and all other cables were then cut to the same dimension. For devices located near the generator, the extra-long cables were spooled up behind the equipment. It was common to see rolls of coax stacked in equipment areas. Figure 4 illustrates the concept.

Replacing cable

In the early 1960s, video and pulse delay lines became available that could replace hundreds even thousands of feet of coaxial cable with delay boxes, each about the size of a pack of cigarettes. One could calculate the longest run and then add appropriate delay units to the shorter runs. Rolls of cable could be eliminated and replaced with delay panels in the equipment racks. (See Figure 5, page 42.)

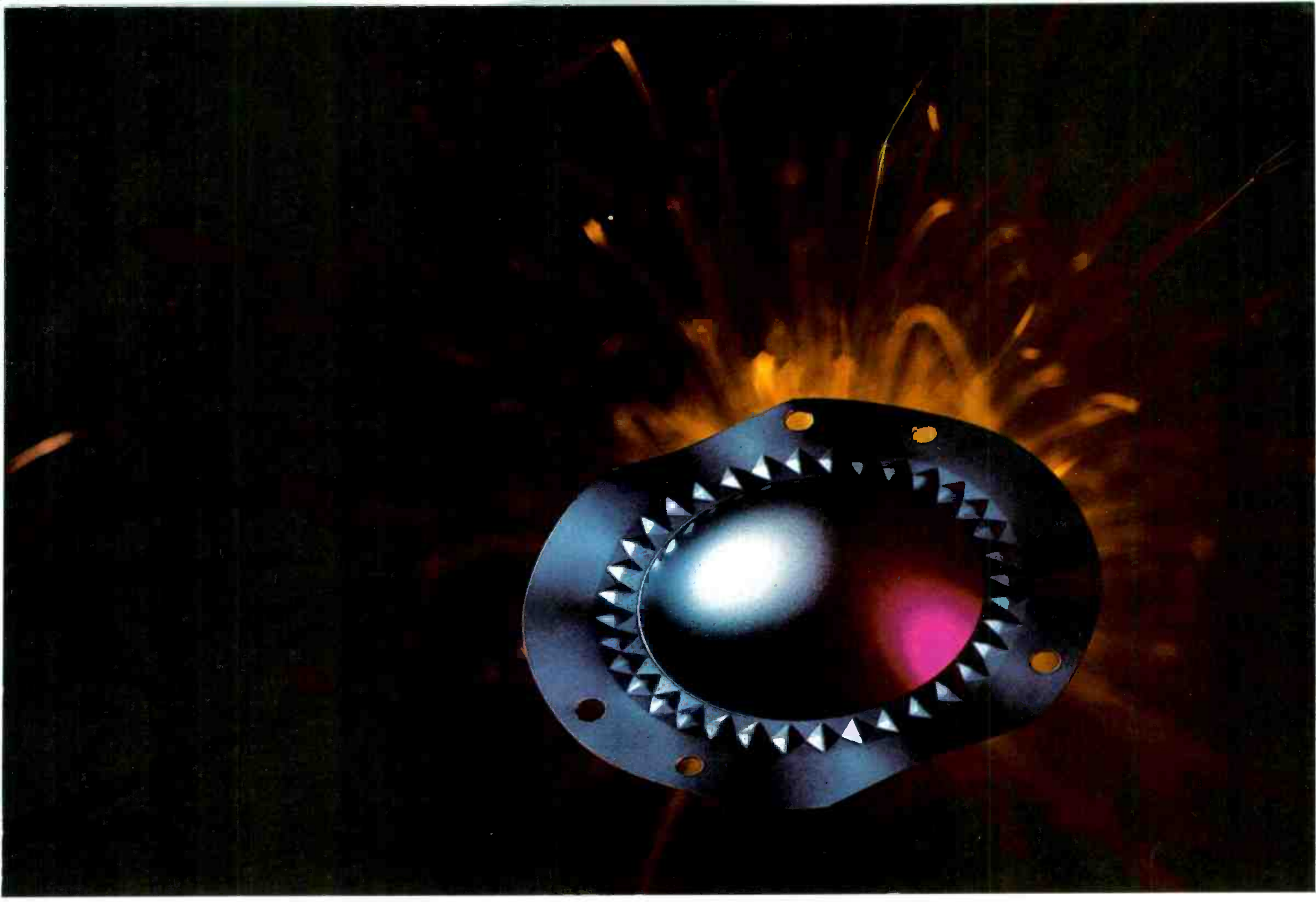

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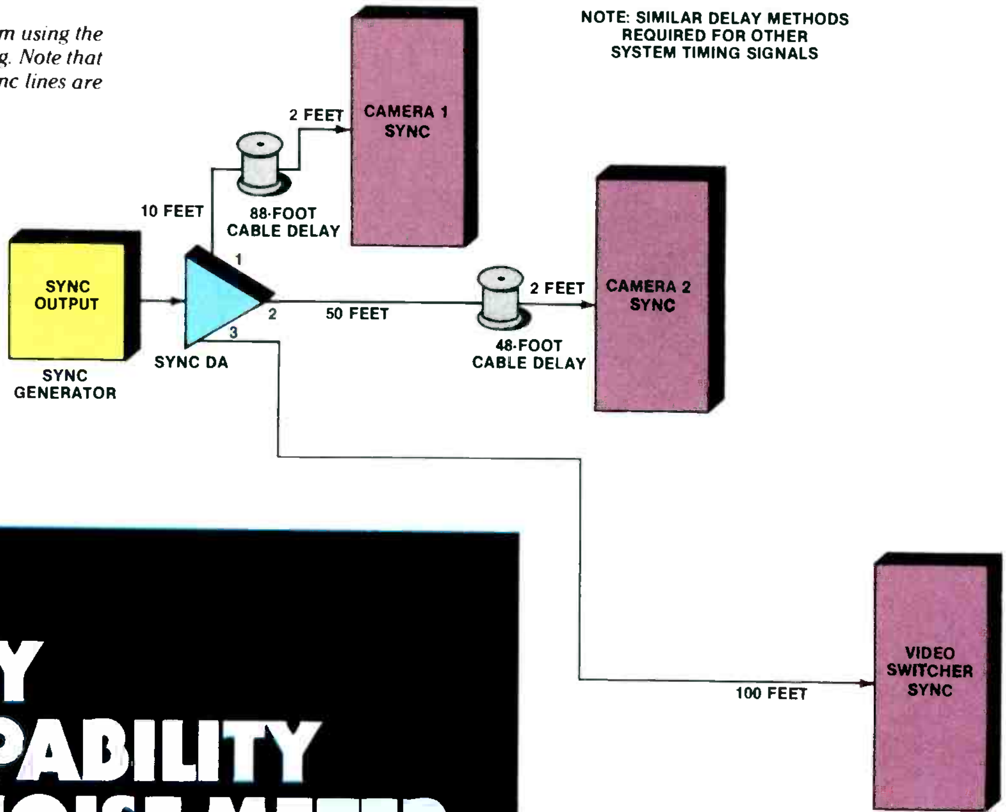
Figure 4. A sync distribution system using the cable delay method of signal timing. Note that with the cable rolls in place, all sync lines are exactly the same length.



A problem still existed, however. If the initial longest path changed, the plant was to be expanded or a production required retiming, a good deal of engineering and wiring effort was needed to make rather simple production requirement changes. The ultimate solution, it was realized, would be a device that could advance—as well as delay—video and sync pulses.

Such synchronization systems became available in the early 1970s. These systems, commonly called *slave sync* systems, eliminated the rolls of cable and racks of delay lines, and allowed users to advance, as well as delay, video and/or synchronizing signals. From the master sync generator, one encoded output is routed to all slave units. Each slave uses the timed, encoded input to develop its own set of sync signals as required by the local equipment it will drive.

Where time is important

Of all TV equipment, video switcher and effects units have the most critical timing requirements. If input signals are offset in time by even a small amount, shifts in hue will be noticeable when you fade or switch the out-of-time input to any of the other in-time inputs. Some switchers will not take an out-of-time (or non-synchronous) signal, but will flash a light or simply revert to the original bus.

Signals that are badly out of time (or phase) cause the picture to roll or tear during switching or fading. Such non-synchronous signals are disastrous with special effects and split-screen presentations. Potential editing problems include color shifts and horizontal jumps.

Continued on page 42

HITACHI PUT AUTOSETUP EXACTLY WHERE IT BELONGS.

"Not only does the SK-970 have complete autosetup, but it's a genuine studio camera that's lightweight enough to send into the field."

I. Jay Azimzadeh, President
Video-Pac Systems, Ltd.
Hollywood, CA

The largest producer of live concert videos in the U.S., VPS requires lightweight, low-maintenance broadcast cameras it can put on the road for long stretches.

Azimzadeh considers the SK-970 the only studio camera with 2/3-inch mobility and EFP handling. So it can meet the demands of often makeshift stadium facilities, while delivering the broadcast images that are needed for larger-screen multiple projection.

Since each of the four SK-970s and two SK-97s in the travelling package has complete self-contained autosetup, a separate box isn't needed. And any potential problems are confined to one head.

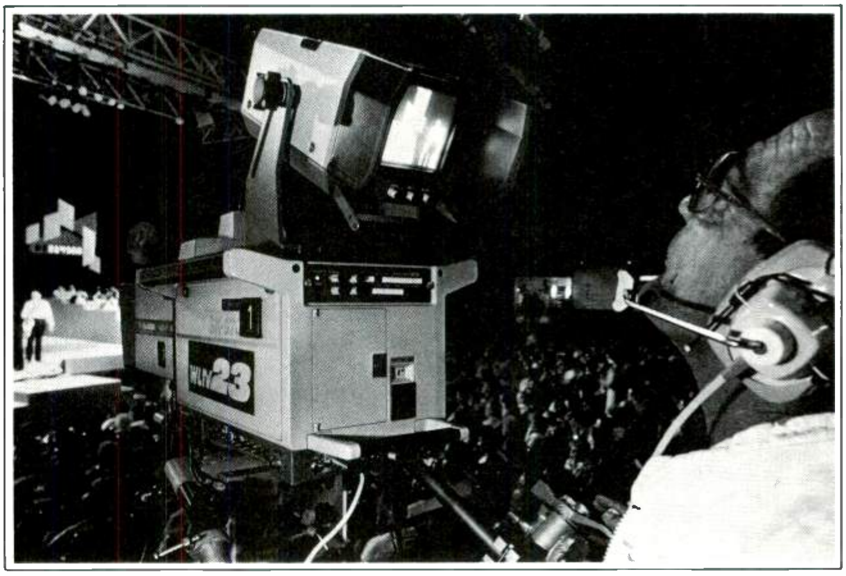
Although VPS earmarks two SK-97s and SK-970s for studio use, the ability to use both wherever they are needed is a welcome economy. Still, the greatest asset of the SK-97 and SK-970 is rockbottom reliability. To Azimzadeh, concerts are just like live TV—no one can afford any slip-ups, or an equipment failure.

"Since each SK-97 and SK-970 has its own on-board computer, I can set everything up at the same time automatically."

Terry McIntyre, Remote Supervisor
F&F Productions, Inc.
St. Petersburg, FL

As a mobile production facility covering sports and large outdoor events for local and network TV, F&F needs broadcast quality on location.

They also need fast, independent setup. So they keep three handheld SK-97s and four compact studio SK-970s permanently stowed on one of their trucks. And with complete computerized autosetup on-board each camera, the crew can set all of them up at the same time from parameters stored in memory without having to worry about drift or last minute adjustments.



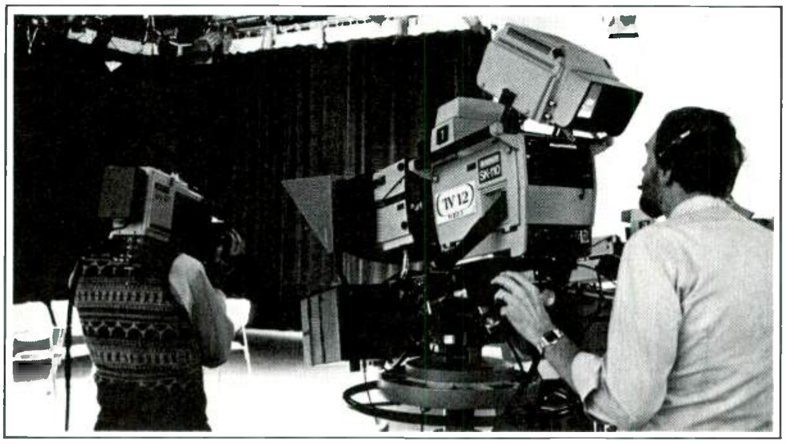
The SK-97 and SK-970 also perform superbly under low-light conditions. As a result, notes Chief Engineer Dennis Lusk, both can use very large lenses. And with real-time registration compensation automatically correcting for any changes throughout the travel of zoom lenses, the cameras are ideal for the demands of sports coverage. Resolution and colorimetry are also unsurpassed, according to Bill McKechnie, another Remote Supervisor. In fact, the SK-97 is often run by F&F as a "hard" camera, in place of the SK-970. Location recording is done on two Hitachi HR-230 1-inch VTRs.

Most important, however, is the almost complete interchangeability of both cameras. Not only are they easy to work with, but they are also easy to link up. And so similar electronically, a single set of spares can cover any potential emergency.

"The SK-97 is a real mini-cam that can be completely integrated into a total studiowide autosetup system."

Bill Weber
Vice President for Engineering
WHYY Television
Philadelphia, PA

WHYY has extensive production facilities at Independence Mall and more studios on the drawing board. To plan for this rapid growth, WHYY sought a family of broadcast cameras that was as flexibly integrated as it was advanced.



While evaluating computerized camera systems, Bill Weber and his staff found that the Hitachi SK-110 studio unit and the portable SK-97—with the same basic complete autosetup—were so perfectly matched in colorimetry, in definition, and in resolution that pedestal and handheld work could be combined without a hitch. And because the SK-97's autosetup is also completely self-contained, both cameras are as electronically independent as they are geared toward common console control.

Staffers like Senior Video Engineer Bob Miller consider the SK-97's autosetup easy-to-use, as well as accurate and reliable. And the on-board lens and scene files give operators instant filter and lighting control at each camera head, in addition to the console. So the staff looks upon the Hitachi SK-97 as a studio camera that they can shoulder.

As facilities grow, WHYY's Weber knows that he will have the flexibility to configure and reconfigure SK-110s, SK-970s, and SK-97s to meet production requirements of most any complexity without encountering technical snags. In fact, with Hitachi cameras at other sister stations in the Eastern Educational Network, joint productions can even be assured of a common look.

For a demonstration of the SK-97 and SK-970 in your studio, contact Hitachi Denshi America Ltd., Broadcast and Professional Division, 175 Crossways Park West, Woodbury, NY 11797; (516) 921-7200, or (800) 645-7510. Canada: Hitachi Denshi Ltd. (Canada), 65 Melford Drive, Scarborough, Ontario M1B 2G6; (416) 299-5900.

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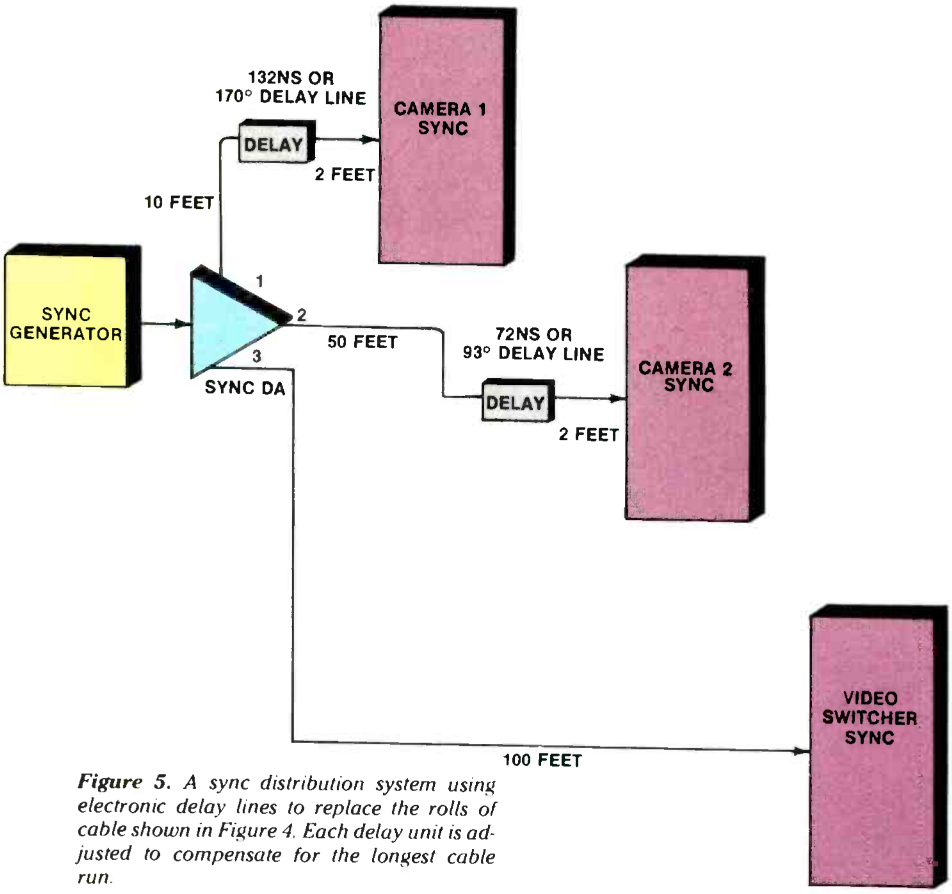

Figure 5. *A sync distribution system using electronic delay lines to replace the rolls of cable shown in Figure 4. Each delay unit is adjusted to compensate for the longest cable run.*

Continued from page 38

Six inches of coaxial cable will shift a color signal by 1°. A shift of 3°, particularly in red hues, begins to be noticeable to the human eye. A 6-foot difference in cable lengths from the routing switcher to the production switcher will cause a noticeable 12° phase shift. (See Table 1.)

To simulate equal cable lengths, delay lines can be added to any cables that are shorter than the longest run from the routing switcher or sync generator to any timed device. However, a pulse-advancing unit, such as the slave sync system, must be used when a given input is changed because of system reconfiguration, and must be advanced beyond existing cable-length limits.

Cable length is not the only element that can delay video or sync. DAs, encoders, switchers or any active device path has a particular delay that must be considered when designing a timed plant. Delays or advances that are added to the system must be calculated after all active devices are in-line. A color-timed plant, especially a large one, is no place for *haywiring*.

Specify RS-170A

The number and types of outputs vary with each brand of sync generator, so it must be chosen with your design needs

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in mind. Make certain that your sync generator complies with RS-170A. Units that conform to the old RS-170 criteria may not meet today's requirements for precise phasing in editing.

RS-170 is a technical standard established by the Electrical Industries Association (EIA) that describes the pulses and their interrelated timing in the sync system. RS-170A goes a step further to state that a precise relationship must be maintained between the phase of H-sync and the subcarrier. The result of this provision is that edits will occur in-phase, and hue shifts or horizontal jumps will be avoided (or, at least, minimized). Although RS-170A may not yet be officially written into the EIA standards, it has been accepted by the industry, and nearly all manufacturers offer products that comply with it.

Operating environment

The sync generator, like all sensitive electronic hardware, should be mounted in a well-ventilated equipment rack. Maintaining a temperature in the rack between 65°F and 78°F will allow the generator to operate at peak efficiency and stability. Operation at higher temperatures may cause the system to drift, or fail completely. Changes in sync generator operation may manifest themselves as hue shifts or, in extreme cases, drifts in system timing that may cause non-standard or non-repeatable edits or recording.

You can't avoid downtime in a commercial station, so it is advisable to have a second, standby generator that connects to the system through an automatic changeover switch. This device could sense a loss of signal and immediately switch generators so that no glitches or tears are seen by the viewer. The cost of an automatic changeover system can be easily offset by the saving of valuable air time and production time.

Intra-facility links

We have emphasized the importance of timing within the plant. But what about foreign signals—those feeds from the network, satellite relays, the remote-production vehicle or a portable ENG microwave link? If they are to be used in conjunction with in-house video, they must also be synchronized.

The best way to time foreign signals is with a frame synchronizer. This unit accepts the outside video signal and clocks it out using house sync. Although similar to a TBC in action, synchronizers do not have to deal with varying TV line lengths. The incoming signal will, ideally, have standard sync that is merely offset from local sync. Everything in the incoming signal is delayed by a fixed amount of time. The result is a signal that may be fed to time devices and used in

8" COAXIAL CABLE = 1NS
6" COAXIAL CABLE = 1° AT 3.58MHZ

EQUIVALENTS

1NS	1.28°	7.9"
2NS	2.56°	15.7"
3NS	3.84°	23.6"
4NS	5.12°	31.5"
5NS	6.40°	39.4"
6NS	7.68°	47.2"
7NS	8.96°	55.1"
8NS	10.24°	63.0"
9NS	11.52°	70.9"
10NS	12.80°	78.7"

EQUIVALENTS

1°	0.775NS	6.1"
5°	3.875NS	30.3"
10°	7.75NS	60.6"
15°	11.625NS	7'6.9"
20°	15.50NS	10'1.3"
25°	19.375NS	12'7.6"
30°	23.25NS	15'1.9"
60°	46.50NS	30'3.8"
90°	69.75NS	45'5.7"
180°	139.50NS	90'11.3"
270°	209.25NS	136'5.0"
360°	279.00NS	181'10.7"

Table 1. *The time and phase delays that will occur with RG59 coaxial cable. This table can be used to calculate cable lengths or delay values.*

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split screens, fades, effects or editing.

Gen-lock can sometimes be used as a low-cost alternative to the frame synchronizer. Almost all sync generators can lock to an outside signal. The foreign signal drives the local oscillator or internal frequency-control component. All station equipment is then under control of the remote sync source.

Gen-locking can cause problems, however, if something goes awry with the foreign video signal. Most ENG projects are of short duration, so a gen-lock problem with the ENG camera is unlikely. But, during long-duration remote productions, a power failure may occur at the remote location. Or Telco lines carrying the video may be interrupted. Or a sun outage may occur with the satellite link during a network feed. The possibilities of signal interruption are numerous. If any of these situations arise, the loss of lock will appear momentarily throughout the plant.

Glitches in gen-lock

Many sync generators are designed to revert to the internal crystal with a minimum of disturbance if the gen-lock source fails. Because the local oscillator is operating in step with the remote source, loss of the foreign signal should not cause any major breakup of an on-air local camera. At most, the viewer may see a slight blink.

If the remote signal returns, however, a major disruption in the sync signal is likely. The disturbance may last only milliseconds, but it can cause obvious tearing and rolling, even from a local studio camera. Gen-locking requires synchronous operation of H-sync and V-sync, as well as in-phase color subcarrier, and a finite amount of time is needed to reset all three.

VTRs will be most affected by a momentary loss of lock because of the number of servo systems that depend upon the consistency of proper sync. The VTR, like a camera, might not react obviously to the loss of lock, but the return of the gen-lock source will result in a major disturbance. The VTR will sense the instability as the gen-lock generator is reorganizing its operation to the foreign source. The VTR then must reorient its own servo systems to the return of lock. The effect could last for several seconds, depending upon the machine and the conditions.

Recordings in progress at the time of gen-lock failure will lose lock when the tape is played later. The effect will be similar to any other momentary loss of signal on the tape. An editing project in progress at the time of loss of lock will also show obvious effects and may need to go back to the edit suite.

Gen-lock is a quick and inexpensive way to tie two facilities together. However, its cost benefits must be weighed against its potential dangers.

Time out for timing

Signal timing should be checked before and during each production or edit session. A timing check also should be part of a well-planned maintenance program at the facility. The check requires a waveform monitor and vector display unit to compare each signal with a standard house signal, such as color bars.

Signals that are out of time, or noncoincident, may be adjusted using phase controls on TBCs, frame synchronizers, camera-control units or, perhaps, a slave sync generator. Once a system has been timed, the only thing that may require routine adjustment will be the subcarrier or system phase.

Adjustment of system timing is a project that should be undertaken only after carefully reading the equipment operating manuals. Study the proper setup procedures and follow the instructions closely.

The sync distribution system is a critical part of any TV facility. Proper measurement and adjustment of system timing should be learned by every member of the engineering staff. By paying careful attention to synchronization within your TV station or facility, you can do away with a major source of potential problems.

Glossary of terms

Asynchronous
The property of being without synchronization. A foreign signal is asynchronous before it is treated by a local frame or field synchronizer. This term is normally used to denote foreign or non-standard sync, rather than distorted or incomplete sync.

Back porch
That area of the synchronizing signal immediately following the negative-going sync pulse and before the color burst. A video signal without a back porch will have color and locking problems. Loss of the back porch can result from careless edit phasing and improper sync timing.

Black burst
The universal color-timing signal in NTSC TV facilities. It consists of a signal that contains sync and color burst. Most modern broadcast equipment can derive its own sync pulses from it. Black burst is also used on the heads of videotapes and as the number one input on most switchers.

Blanking
Blanking pulses are part of the complete synchronizing signal, used by TV monitors and cameras to cut the beam as it retraces the camera tube or screen while traveling to the next line or field.

Burst flag
A pulse, generated by most sync generators, that tells system encoders where to insert the color burst on the back porch of each horizontal sync pulse. Under normal operating conditions, an operator will not have to deal with burst flag pulses.

Coherent
A condition that exists when the subcarrier (color) components are tightly locked to the sync components. Normally, all signals generated by a common master sync generator are coherent. However, signals that pass through non-NTSC standard videotape players or non-standard encoders will be non-coherent.

Color bars
A universal encoder test signal found in every TV plant. This test signal may be used to check the fidelity of system equipment, but should not be used for setting up color picture monitors. The color bar test signal contains all of the saturated primary and secondary colors, as well as gray, white, and encoder I and Q signals. Color bar signals that do not contain the I, Q and white signals at the bottom are called full field *signals. Those that do contain I, Q and white signals at the bottom are called* split field *color bars.*

Color burst
A small sample (eight to 11 cycles) of the subcarrier, located on the back porch of every horizontal sync pulse, that tells equipment in the video system where to set the hue or phase of the color portion of the video. Without color burst, there is no color.

Crystal black
An early term for the black burst signal.

DA
The common abbreviation for distribution amplifier.

Delay line
A device that simulates a long piece of coaxial cable for the purpose of delaying sync or video signals.

Frame/field synchronizer
A device that accepts a foreign video signal and processes it, field by field or frame by frame, by clocking the video portion of the signal into memory using the video's own sync, and then clocking the video out of the synchronizer using the local house sync. This assures a signal will be in time with the house sync generator. Frame/field synchronizers are used on network and remote feeds, as well as in-plant feeds, which are difficult to time.

Front porch
That portion of the video signal that follows video, but precedes the negative-going sync pulse. A front porch that is too narrow or too wide due to improper system timing can cause switching and editing problems.

Glitch
A general term used for a wide variety of signal discontinuities, such as tears, rolls, momentary loss of picture, tracking pulls, etc.

Jitter
A time base distortion of a video signal or sync pulse that appears as rapid back-and-forth horizontal motion when viewed on a waveform monitor or vector display unit. Jitter is normally caused by an unstable videotape recorder/player or by a noisy transmission line. Jitter in sync will manifest itself as line-by-line tearing on a picture monitor or very noisy (granular) color pictures.

Lock
A term used to describe a video signal that is fully synchronous with a system. The more familiar term, unlocked, *is used to describe a picture that is unstable as a result of improper timing or system discontinuities.*

Master sync generator
The main, plant sync generator or a generator that produces an encoded signal to drive any number of slave generators. A plant should have only one active master sync generator to feed timed and phase-coherent synchronizing signals around the facility.

NTSC
An abbreviation for the National Television Standards Committee which, in the 1950s, developed the compatible color standards we use today.

Retrace
A part of the video signal that occurs while the beam sweeps from one edge of the picture to the other, or from top to bottom. All of the sync information is placed in this "invisible" portion of the video signal.

Slave sync generator
A sync generator that receives an encoded signal from the master sync generator and produces all appropriate sync pulses. Slave generators are normally used to feed major areas of the plant, such as videotape machines, cameras, switchers, etc.

Subcarrier
A continuous wave signal that constitutes the color part of every picture. A pure subcarrier has a frequency of 3.58 MHz. The phase of this subcarrier, as determined by the encoder, determines the color of the picture at any given point. A small piece of subcarrier is added to every video line on the back porch as color burst.

Vectorscope
A trademark name that has become the generic description for a vector display unit, or VDU. This test device allows checking of all the color aspects of a video signal. It is normally found in master control rooms and edit suites. Without a vector display unit, it is impossible to determine the quality of a video signal.

Waveform monitor
A device used to examine the video signal and synchronizing pulses. These devices are normally found in master control rooms, edit suites, camera positions and maintenance areas.

Monitoring directional antennas

By Elton B. Chick

A stable, reliable directional antenna monitoring system begins with careful planning and installation of the individual components.

The initial tuning and subsequent operation of an AM directional antenna may, under certain circumstances, be a rather disconcerting experience—especially when the antenna monitoring system is not providing reliable information. Conversely, with reliable monitoring, it is often possible to predict accurately what will happen in the field for a given set of operating parameters.

Monitoring the operation of an AM directional antenna basically involves checking the power level into the system, the relative values of currents into the towers, their phase relationships and the levels of radiated signal at certain monitoring points some distance from the antenna. The equipment required consists of a field-strength meter, phase/current sample pickup elements, an antenna monitor and interconnecting coaxial cables. Figure 1 shows a block diagram of a typical monitoring system for a 3-tower array. For systems with additional towers, the basic layout is extended by adding more pickup elements, sample lines and a monitor with additional inputs.

Chick is a retired radio engineer/manager from Harris, Quincy, IL, and Rounsaville Radio, a group station operator, Atlanta.

Phase/current sample loop

FCC rules allow the use of two types of phase/current sample pickup elements. The most common has been the sample loop. This device is a single-turn, unshielded loop of rigid construction, with a fixed gap at the open end for connection of the sample line. The device must be mounted on the tower near the point of maximum tower current, and may be used on towers of both uniform and nonuniform cross section. It must operate at tower potential, except for towers of less than 130° electrical height, in which case the loop may be operated at ground potential. In no case shall the loop be mounted less than 10 feet above ground. A typical sample loop with insulators for mounting at ground potential, where permitted, is shown on page 52.

When the sample loop is operated at tower potential, the coax from the loop to the base of the tower is also at tower potential. In fact, the outer conductor should be electrically connected to the tower at the loop and at the low end of the tower. This line must be well-supported and protected to avoid any movement. In order to bring the sample line across the base of the tower, a sample line isolation coil must be used. Such coils are usually constructed of a piece of sample line coax, perhaps 70 feet or more in length, wound on a large form of proper dimensions and turns to produce an inductor of about 50μH or more. The coax used for this isolation coil must meet the same specifications as the sam-

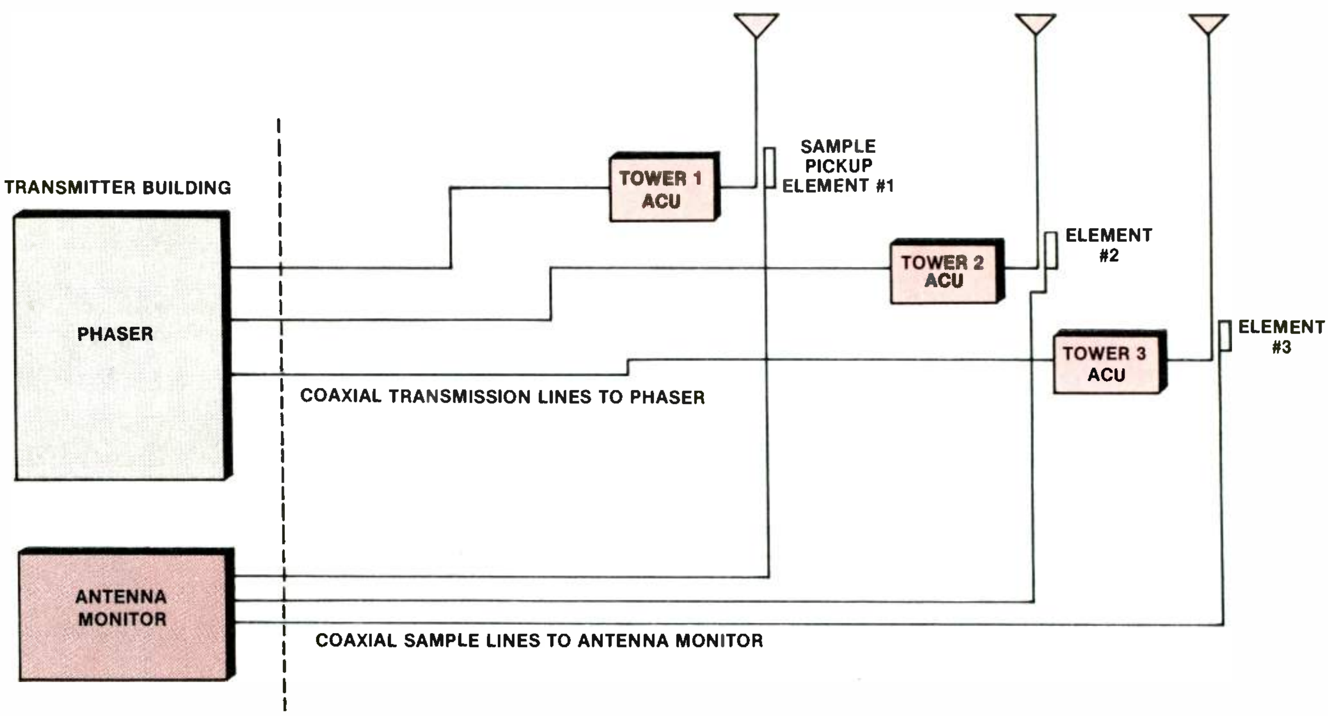

Figure 1. A typical 3-tower directional antenna monitoring system.

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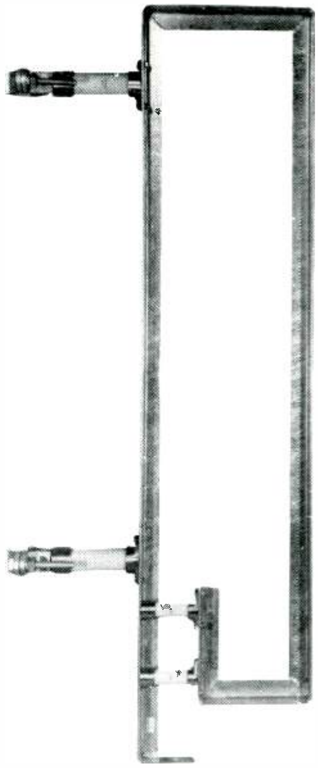
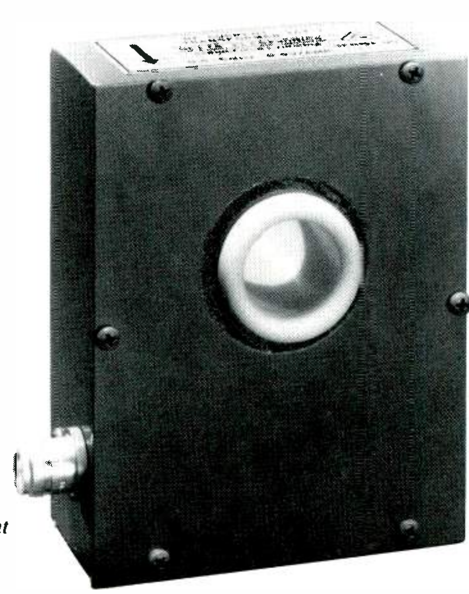
ple lines and should be phase-stabilized.

The isolation coil inductance across the base of the tower will affect the base impedance. In cases in which such an effect is considerable (and undesirable), a parallel-resonating capacitor (either fixed or variable) is used. If fixed, a capacitance value is selected so that resonance can be accomplished by placing one terminal of the capacitor at ground potential—at the lower end of the isolation coil—and connecting the other terminal of the capacitor (by a flexible lead) to some tap point below the top of the isolation coil. Such tap adjustments are best made with an RF bridge. At resonance, the coil and capacitor become a high impedance, having little effect on the tower's base impedance.

A more convenient and easier-to-adjust arrangement involves the use of a vacuum-variable capacitor across the isolation coil. The electrical effect of this method is the same and the accuracy of the adjustment is likely to be better.



Above, a fixed, non-shielded RF sampling loop.



Courtesy of Delta Electronics

At right, a typical torroidal current transformer for AM applications.

Torroidal current transformers

A shielded torroidal current transformer (TCT) may also be used as the phase/current pickup element. Such devices offer several advantages over the sample loop, including greater stability and reliability. Because they are located inside the tuning unit cabinet or house, TCTs are protected from wind, rain, ice and vandalism.

Unlike the rigid, fixed sample loop, torroidal current transformers are available in several sensitivities, ranging from 0.25 to 1 V/A of tower current. Tower currents of up to 40A may be handled, providing a more usable range of voltages for the antenna monitor. The photo at left shows a typical TCT. Note that the arrow atop the housing should point toward the antenna; otherwise, a reversed phase reading will result.

Figure 2 shows the various ar-

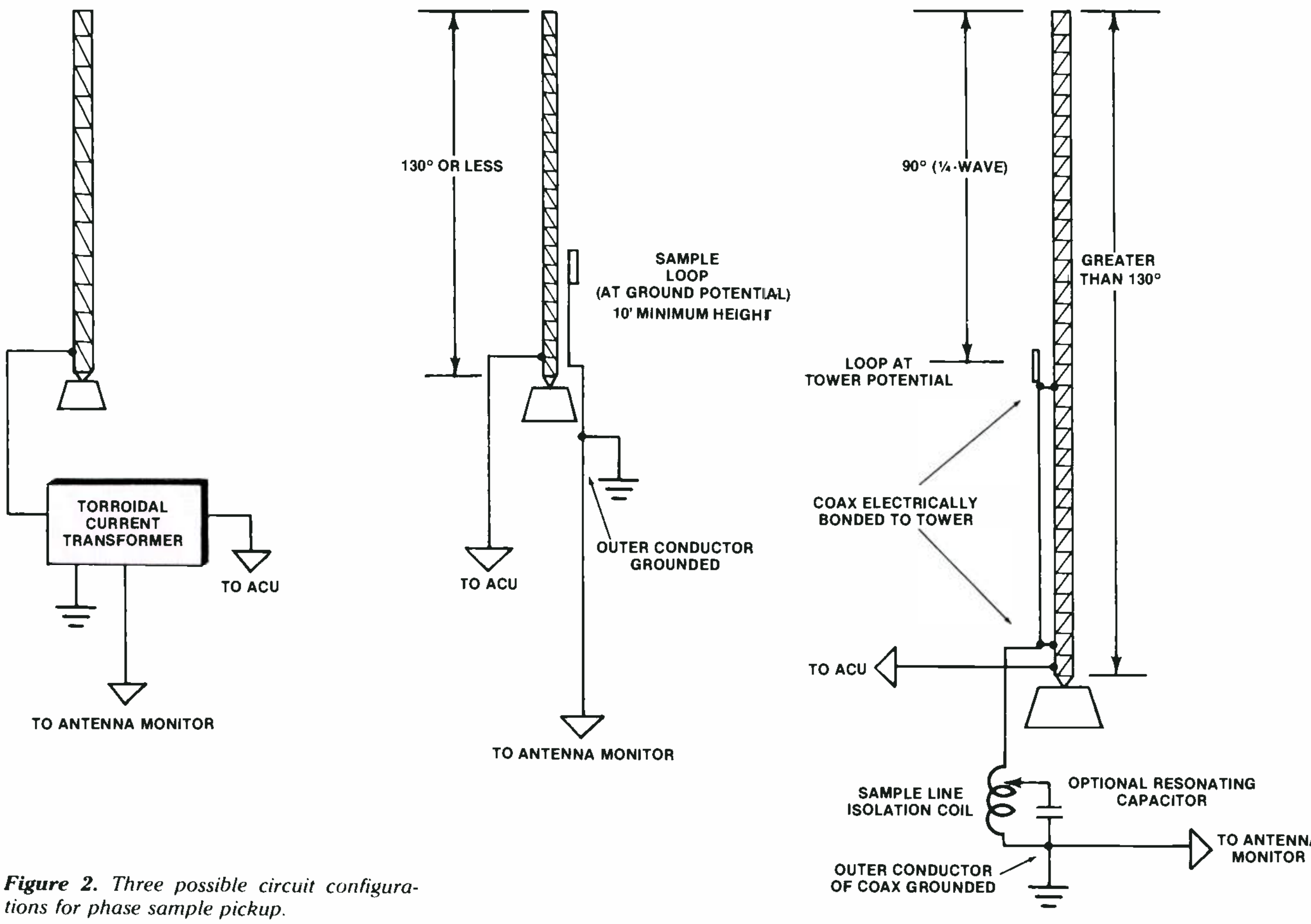


Figure 2. *Three possible circuit configurations for phase sample pickup.*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rangements that may be used for phase/current sample pickup elements. To determine tower height in electrical degrees, the following equation may be used:

$$H^\circ = \frac{Ht\,(Fo)}{2733}$$

Where: H° = tower height in electrical degrees
Ht = tower height in feet*
Fo = frequency of operation in kilohertz

*Where the tower height is in meters:

$$H^\circ = \frac{Ht\,(Fo)}{833.23}$$

Example: Find the electrical height of a tower 200 feet tall at 1230kHz.

$$H^\circ = \frac{200\,(1230)}{2733} = 90^\circ$$

Where top loading is used, or communications antennas are mounted on the tower, the effective electrical height will be altered somewhat.

Sample lines

Probably the most critical steps in planning the installation of an accurate, reliable monitoring system are selecting the type and lengths of coaxial cable to be used, and deciding how they should be installed. The cable must have a solid outer conductor and uniform physical and electrical characteristics. The dielectric must be either predominantly pressurized air (or other inert gas, such as dry nitrogen) or foamed polyethylene. Connectors to be used outdoors must be weatherproof, and designed for use with the specific cable you select.

Although not required by FCC rules, another highly desirable feature that is well worth the modest increase in cost is *phase-stabilization* of the line. This is a process performed by the manufacturer whereby the cable is heated and cooled through a number of cycles to minimize phase changes resulting from temperature extremes in the field. Phase-stabilization occurs normally over a number of years with common coax, as a result of annual temperature changes. In the meantime, however, phase changes resulting from temperature variations make it difficult to accurately monitor the antenna system.

Sample lines may be ordered cut to equal electrical lengths, with a minimum physical length specified. Typical sample line sizes are 1/4-, 3/8- and 1/2-inch, available from a number of manufacturers.

With critical arrays (antennas requiring operation within limits specified in the station license), all sample lines must be of equal electrical length and must be installed in such a manner that corresponding lengths of all lines are exposed to equal environmental conditions. For non-critical arrays, lines of unequal

DA computer program

The author has developed a PC-based computer program that may be used in making minor maintenance adjustments on a directional antenna system. Simplicity of the program for ground plane patterns has been achieved by reducing the design equations to plane geometry and trigonometry. The maintenance engineer, of course, is primarily concerned with the ground plane pattern, leaving the higher angles to consultants and allocations specialists.

Because of the length of the computer program and supporting data, it will not be presented here. You may obtain a copy of the program and data, however, by circling number 300 on the Reader Service card at the back of this issue.

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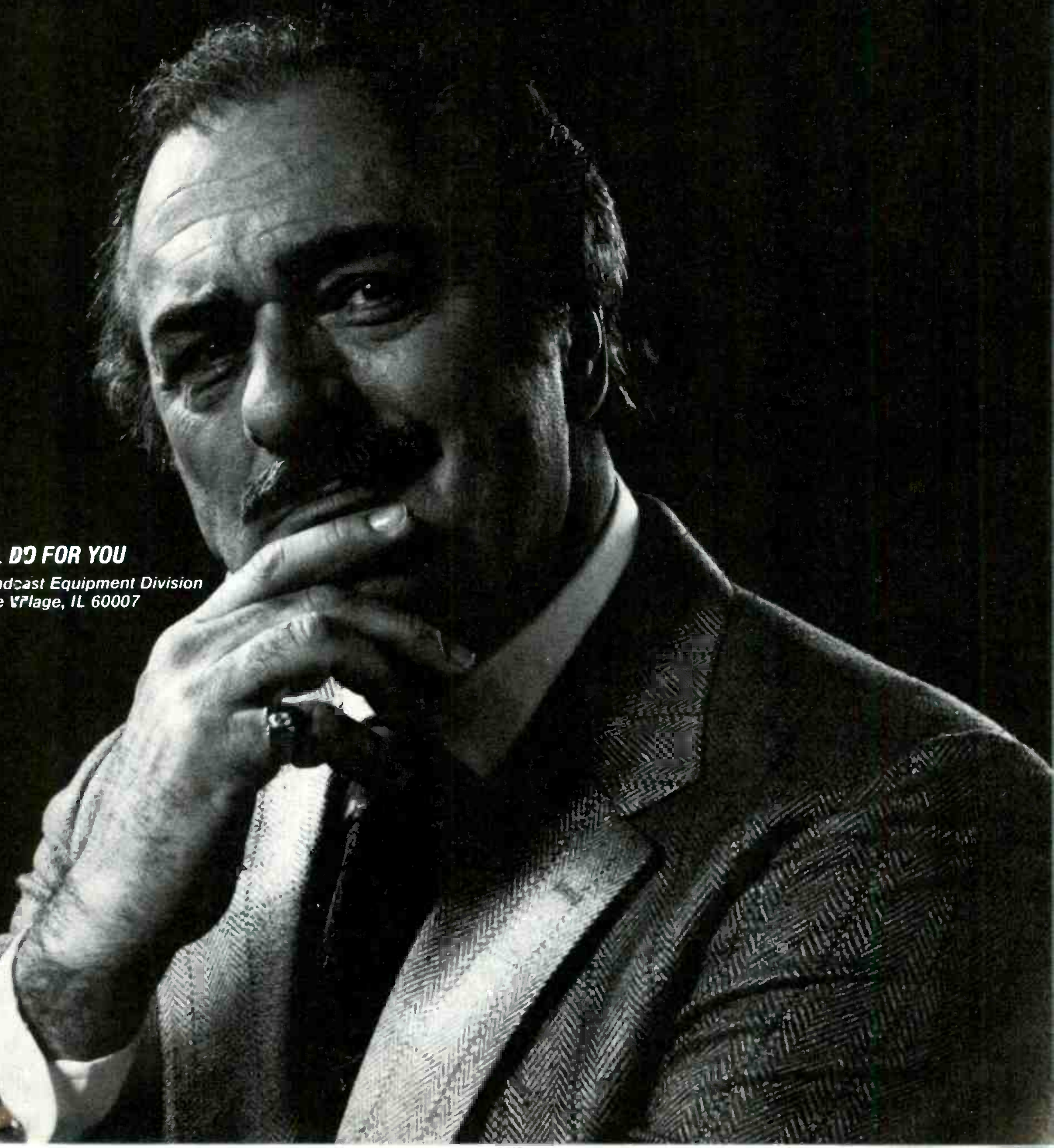

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length may be installed, providing the temperature-phase error is less than 0.5° as a result of the unequal lengths. When such an installation is planned, be prepared to demonstrate that the errors resulting from temperature variations will not exceed 0.5°. Providing this proof requires some special considerations regarding the line and the manner of installation.

In many cases, the use of equal-length lines results in only a modest increase in system cost. Such installations offer a considerable convenience, in that direct relative-phase readings can be obtained. However, if the transmitter building must be located in an inconvenient place for sample line considerations (such as at the end of a large, in-line array), it may be desirable, for economic reasons, to consider unequal-length lines.

To many engineers and owners, using equal-length lines, if not required, seems a waste. Why have all that line coiled up and going nowhere? Let's explore the question.

Consider the antenna/transmitter building layout (Figure 3, page 59). The shortest line length is only 350 feet, but the longest is 1990 feet. To make all of the lines 1990 feet long would require that about 4000 feet of extra line be coiled up someplace—and probably buried—at considerable cost. To avoid such a situation, phase temperature coefficient specifications are available (depending on the manufacturer and cable type) that provide a means of calculating the expected phase errors resulting from temperature changes. Armed with this information, you can determine if the expected phase change would exceed the 0.5° limit.

Assume that 3/8-inch phase-stabilized line is chosen and that the station is located where the average annual temperature variations range from a low of −12°F to a high of 97° (a range of 109°). From Figure 3, we find that the difference between the longest and the shortest line is 1640 feet. The question is, with this wide temperature range and the long line, will the phase shift resulting from temperature changes exceed 0.5°?

To answer this question, use the following formula:

$$\text{Phase change (degrees)} = 3.66 \times 10^{-7}\ P\ L\ F\ T$$

Where: P = Phase temperature coefficient (PPM/°F)
L = Length of cable in feet
T = Temperature range in degrees Fahrenheit
F = Frequency in megahertz

The 3/8-inch line chosen for this example has a phase coefficient of ±5 PPM/°F over the range −22°F to +104°F. The frequency is given as 600kHz (0.6MHz) and the line in question is 1640 feet in length. The solution:

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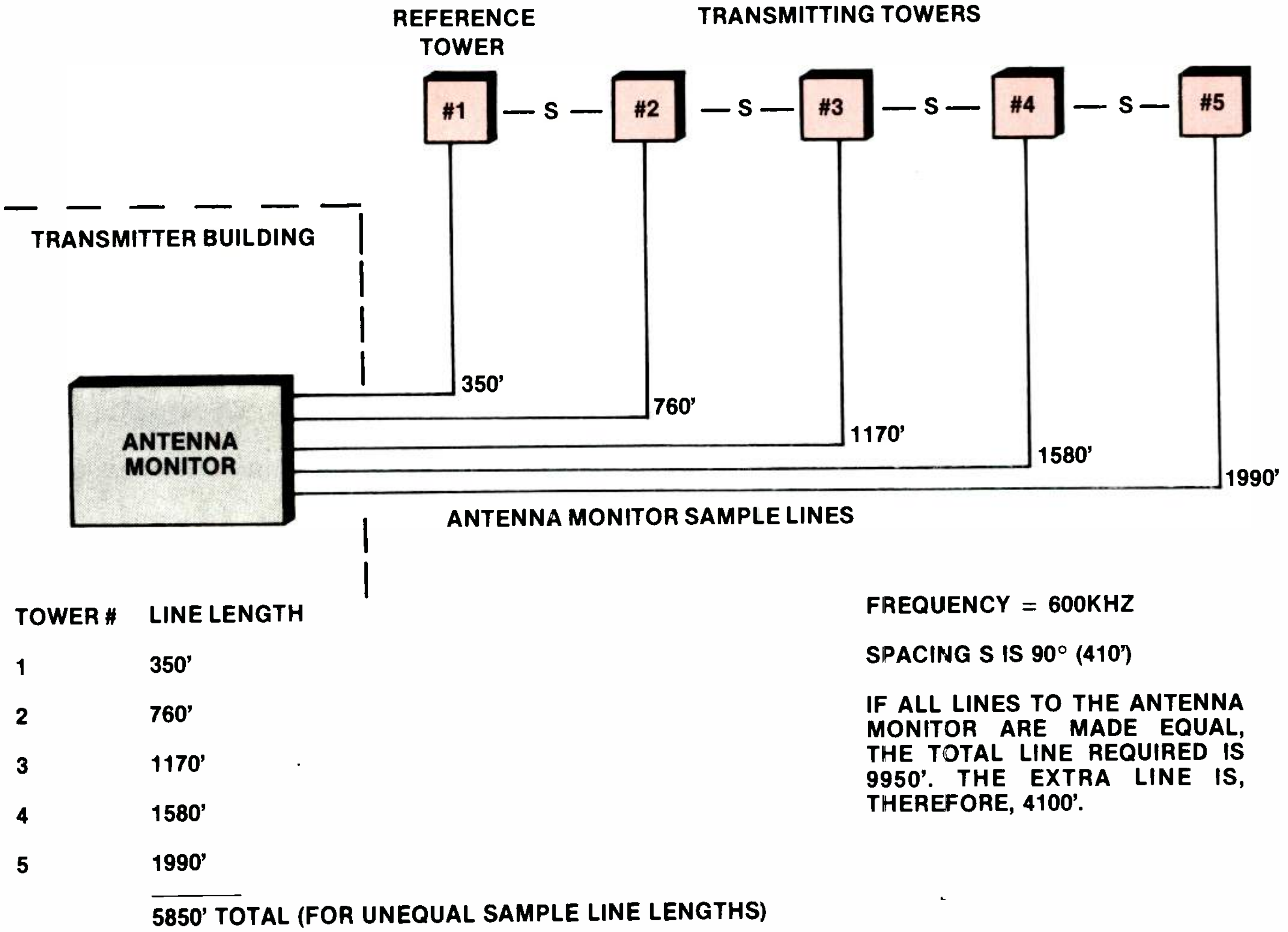


Figure 3. *A 5-tower array configured so that sample lines of unequal lengths are necessary.*

$$\text{Phase change (degrees)} = 3.66 \times 10^{-7} (\pm 5)(1640)(109)(0.6)$$

$$\text{Phase change} = \pm 0.196° \text{ (worst case)}$$

This phase change, below the 0.5° maximum, is permissible. Computations of this nature should be made as a part of the antenna system planning process.

The FCC rules were recently amended to permit the use of a sampling line switching box located within the antenna field so that only two lines to the monitor are required. This arrangement can provide a considerable cost savings over using equal-length lines, particularly if the transmitter building is located a considerable distance from the center of the antenna array. Alternatively, the monitor itself can be located in a protective enclosure near the antenna center with the indications remoted to the transmitter building for use in adjusting the phaser.

Although sample lines may be run above ground on supports (if protected and properly grounded), the most desirable arrangement is direct burial using jacketed cable. Burial of sample line cable is almost a standard practice because proper burial offers protection against physical damage and provides a more stable temperature. Buried line should be placed well below the local frost line. Below this level, the temperature may vary no more than 15° to 20° all year, depending on the geographic location and the nature of the soil.

For an underground installation, trenching machines, used by building contractors for installing buried wires and pipes, can provide a straight, uniform-depth trench, provided the antenna-site soil does not contain rocks or other debris.

When planning the installation of sample lines, it is necessary to have accurate scale drawings of the site. In determining the lengths of cable to be used, allowances must be made for routing inside the transmitter building, equipment racks and antenna-coupling unit enclosures. Careful measurement of each cable run (with a few additional feet allowed) is a good protection measure. Cables that are slightly long are much easier to install than cables that are a few inches short.

You'll save time and avoid frustration during installation if you've ordered the sample lines shipped on separate reels, properly labeled, with end connectors installed. Correct end connectors should be specified to the cable manufacturer; this, in itself, requires careful planning.

Antenna monitors

The choice of an antenna monitor should take into account the basic requirements of the directional system and the overall operating specifications of the unit. When ordering an antenna monitor, consider the following points:

- Number of towers (day and night)
- Number of patterns (DA-1, DA-2, etc.)
- Reference towers (by number for both day and night)
- Critical array requirements
- Readouts, digital or analog

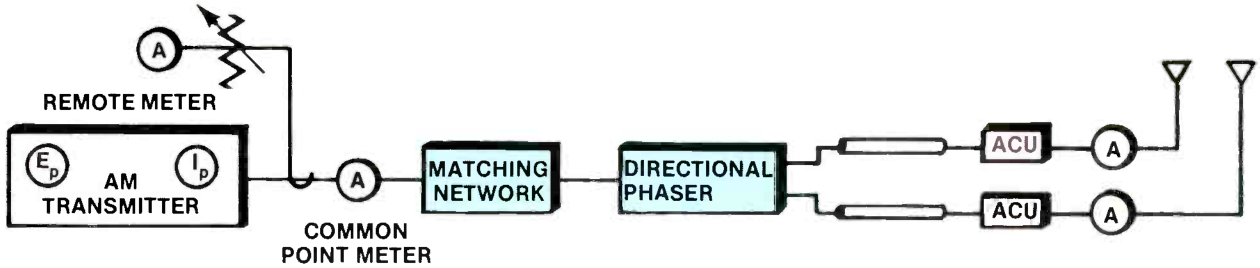


Figure 4. *Power output metering for a simple 2-tower directional antenna system. RF ammeters are placed at the base of each antenna and at the common point.*

- Remote control provisions
- Remote control interface
- Sample line impedance (50Ω or 75Ω)
- Input connectors (UHF, type-N, etc.)
- Other special requirements or conditions

Normally, the antenna monitor is rack-mounted near the phaser control panel so that readings may be easily observed when adjustments are made to the system. Keep in mind that coaxial cables have a limited bending radius. It may, therefore, be desirable to use coaxial elbows at the monitor inputs or short flexible *pigtail* leads for connecting lines to the monitor.

The common point

The power input to the directional antenna should be measured at the phaser common point (see Figure 4). Power is determined by the direct method:

$$W = I^2R$$

Where: W = power in watts
I = the common point current in amperes
R = the common point resistance in ohms

To allow for losses in the phaser and antenna-coupling units, the rules allow some additional power (more than the nominal power) to be fed to the common point. For stations of 5kW or less nominal power, the allowance is an extra 8%. For nominal powers greater than 5kW, the allowance is 5.3%.

For example, consider a 5kW station. The nominal power is 5000W and the allowable input to the common point is 5000 x 1.08 = 5400. This power must be maintained within −10% to +5%. The common point resistance is often adjusted to 50 + j0Ω. The common point current (Icp) is found by the formula:

$$Icp = \sqrt{\frac{W}{R}} = \sqrt{\frac{5400}{50}} = 10.39A$$

This current, however, is a difficult value to read on most common point ammeters. By adjusting the common point resistance to 54 − j0Ω, the current required becomes:

$$Icp = \sqrt{\frac{5400}{54}} = 10A$$

The same approach may be used for other powers and common point impedances, taking into account the percentage allowance for loss, as mentioned earlier.

The common point power should be measured without modulation. The com-

On October 15, 1984 at KTLA's Mt. Wilson transmitter site, Ira Goldstone performed the final acceptance checks on the Modulation Sciences T.V. Stereo Generator.

mon point ammeter reading will increase by 22.5% with 100%, single-tone sine wave modulation. Because of this, the ammeter must be selected with sufficient range so that normal program modulation will not cause an offscale reading.

Although not required by FCC rules, another monitoring element of considerable convenience and value is the operating impedance bridge. This instrument will allow rapid measurement of the common point impedance during initial adjustment, and later, will serve as a valuable maintenance aid. The common point bridge is often mounted in the phaser control panel. Alternatives include the use of an unmounted instrument with a plug-in jack arrangement or an RF bridge, signal generator and null detector setup. The latter combination of instruments will allow impedance measurements at sideband frequencies, as well as the carrier.

The bridge would also be available to measure other lines and components of the antenna system, including the sampling lines. When a new antenna system is installed, it is a good idea to measure the impedance of all transmission lines and sample lines and record them in the maintenance log. With this background data, future problems can be diagnosed more easily.

Monitor points

The final step in routine monitoring of the directional antenna is measurement of field intensity at certain locations away from the antenna, called *monitor points.* These points are selected and established during the initial tune-up of the antenna system. Measurements at the monitor points should confirm that radiation in prescribed directions does not exceed a value that would cause interference to other stations operating on the same or adjacent frequencies. The field-strength limits at these points are normally specified in the station license. Measurements at the monitor points may be required on a weekly or a monthly basis, depending on several factors and conditions relating to the station.

Careful measurements and the logging of field-intensity readings will not only satisfy FCC rules for routine maintenance, but can be of special value in dealing with antenna problems arising from component failures. Such data also can aid in examining long-term stability or unexplained or seasonal drift in the monitor-point readings.

The level of maintenance required for a given directional antenna system is closely related to the care with which the system is designed and assembled. You might say that good maintenance begins before the system is installed. If, however, the system gets off to a careless or poorly planned start, accuracy and reliability may never really find a place in the operation.

Designing AM coupling networks

By Grant Bingeman

Matching the elements of an AM antenna system is easy, once the basic principles involved are understood.

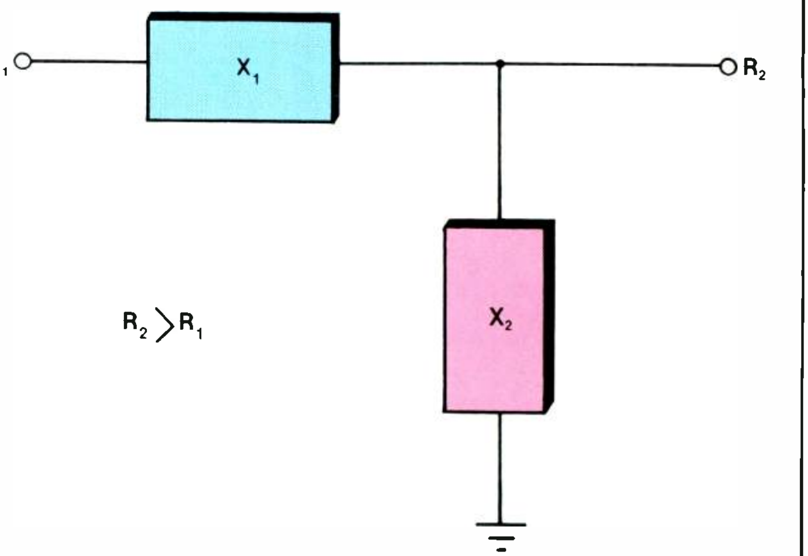
Two sign conventions for phase shift are used in electrical engineering. In the broadcast industry, most people use the negative sign convention. That is, if a network delays or retards a signal by Θ degree, we say that the phase shift across the network is minus Θ degrees. For example, a ¼-wavelength of transmission line, if properly terminated, has a phase shift of −90°. Thus, a lagging or lowpass network has a negative phase shift, and a leading or highpass network has a positive phase shift. This convention is consistent with the sign convention used for tower current phases in a directional array, as understood by the FCC and the broadcast industry as a whole.

There are three basic network types that can be used for impedance matching: *L*, *pi* and *tee*. Beginning with the L network (Figure 1), we can define the loaded Q of that network from Equation 1. Equation 2 defines the shunt leg reactance, which is negative (capacitive) when Θ is negative, and positive (inductive) when Θ is positive. The series leg reactance is found using Equation 3, the phase shift via Equation 4 and the currents and voltages via Ohm's law. Note that R_2 (the resistance on the shunt leg side of the L network) must always be greater than R_1. An L network cannot be used to match equal resistances, or to adjust phase independently of resistance.

A tee network, shown in Figure 2, can be used to match unequal resistances. An added feature of the tee network is that its phase shift is independent of its resistance transformation ratio. We can consider a tee network simply as two back-to-back L networks. Note that there are two loaded Qs associated with a tee network: an input Q and an output Q. In order to gauge the bandwidth of the tee

Bingeman is a senior design engineer at Continental Electronics, Dallas.

Figure 1. L NETWORK



Equation 1:

$$Q = \sqrt{\frac{R_2}{R_1} - 1} = \left|\frac{X_1}{R_1}\right| = \left|\frac{R_2}{X_2}\right|$$

Equation 2:

$$X_2 = \frac{\pm R_2}{Q}$$

Equation 3:

$$X_1 = \frac{-R_1 R_2}{X_2}$$

Equation 4:

$$\Theta = \text{TAN}^{-1}\left(\frac{R_2}{X_2}\right)$$

Where: R_1 = L network input resistance (ohms)

R_2 = L network output resistance (ohms)

X_1 = Series leg reactance (ohms)

X_2 = Shunt leg reactance (ohms)

Q = Loaded Q of the L network

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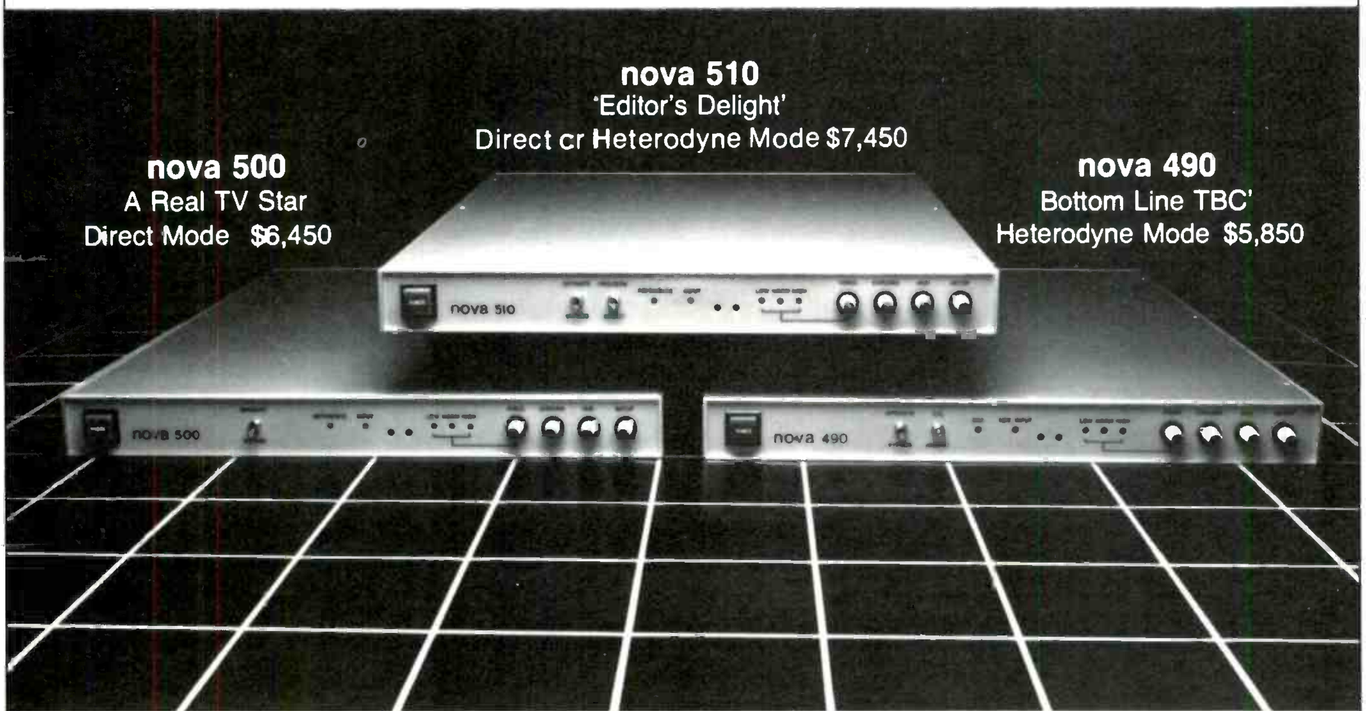

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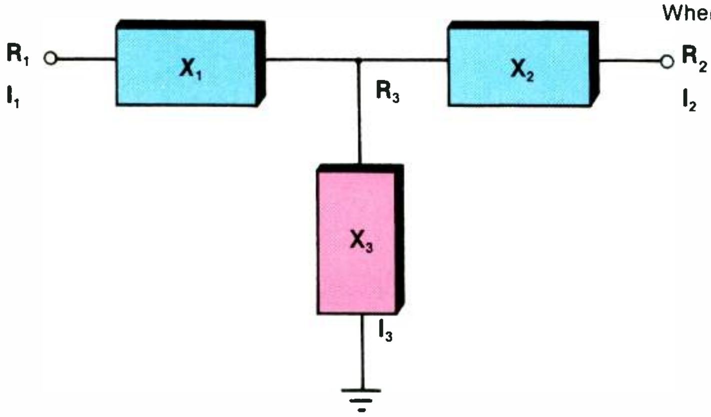
Figure 2.

TEE NETWORK



Where:
- R_1 = Tee network input resistance (ohms)
- R_2 = Tee network output resistance (ohms)
- I_1 = Tee network input current (amps)
- I_2 = Tee network output current (amps)
- I_3 = Shunt element current (amps)
- X_1 = Network input element reactance (ohms)
- X_2 = Network output element reactance (ohms)
- X_3 = Network shunt element reactance (ohms)
- P = Input power (watts)
- Q_1 = Input loaded Q
- Q_2 = Output loaded Q
- R_3 = Midpoint resistance of the network (ohms)

Equation 5:
$$X_3 = \frac{\sqrt{R_1 R_2}}{\mathrm{SIN}(\Theta)}$$

Equation 6:
$$X_1 = \frac{R_1}{\mathrm{TAN}(\Theta)} - X_3$$

Equation 7:
$$X_2 = \frac{R_2}{\mathrm{TAN}(\Theta)} - X_3$$

Equation 8:
$$Q_1 = \left|\frac{X_1}{R_1}\right|$$

Equation 9:
$$Q_2 = \left|\frac{X_2}{R_2}\right|$$

Equation 10:
$$I_1 = \sqrt{\frac{P}{R_1}}$$

Equation 11:
$$I_2 = \sqrt{\frac{P}{R_2}}$$

Equation 12:
$$I_3 = \sqrt{I_1^2 + I_2^2 - 2(I_1)(I_2)\mathrm{COS}(\Theta)}$$

Equation 13:
$$R_3 = (Q_2^2 + 1)R_2$$

Equation 14:
$$\Theta = \mathrm{TAN}^{-1}\left(\frac{X_1}{R_1}\right) \pm \mathrm{TAN}^{-1}\left(\frac{X_2}{R_2}\right)$$

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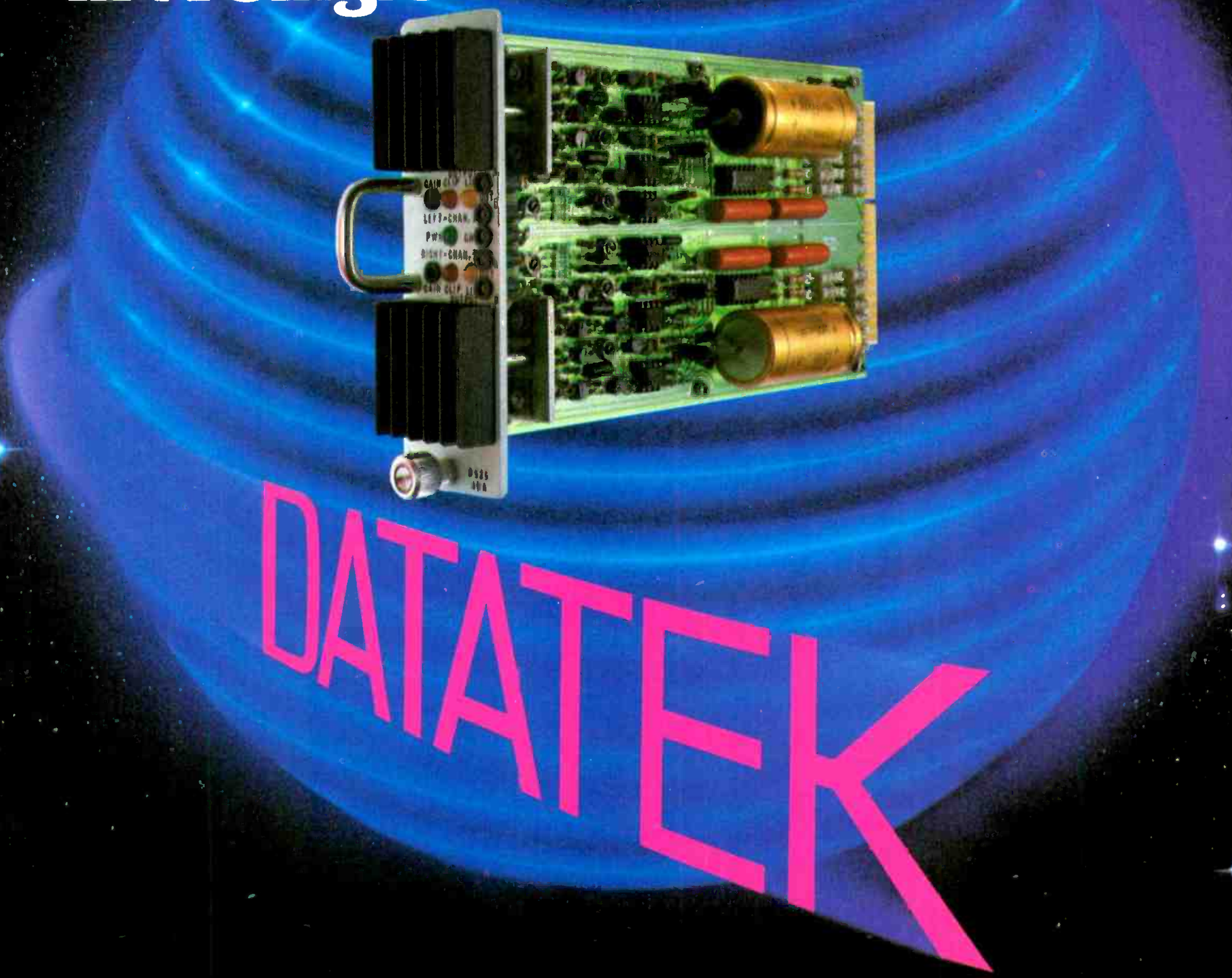

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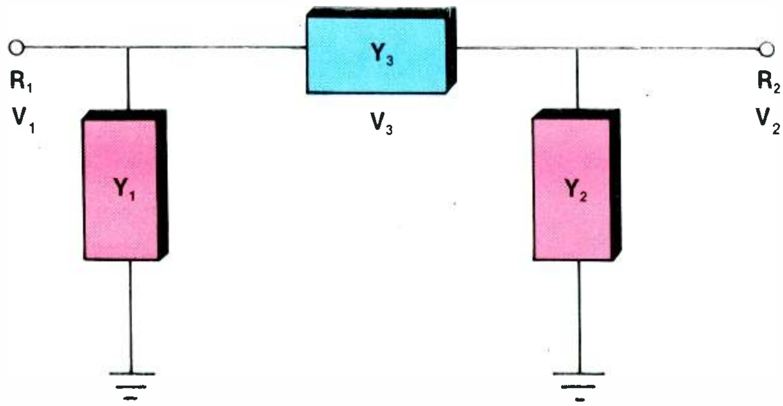
Figure 3. **PI NETWORK**



Equation 15:

$$Y_3 = \frac{1.}{-\mathrm{SIN}\,(\Theta)\sqrt{R_1R_2}}$$

Equation 16:

$$Y_1 = \frac{\mathrm{TAN}\,(\Theta)}{R_1 - Y_3}$$

Equation 17:

$$Y_2 = \frac{\mathrm{TAN}\,(\Theta)}{R_2 - Y_3}$$

Equation 18:

$$Q_1 = |R_1Y_1|$$

Equation 19:

$$Q_2 = |R_2Y_2|$$

Equation 20:

$$V_1 = \sqrt{R_1P}$$

Equation 21:

$$V_2 = \sqrt{R_2P}$$

Equation 22:

$$V_3 = \sqrt{V_1^2 + V_2^2 - 2(V_1)(V_2)\,\mathrm{COS}\,(\Theta)}$$

Equation 23:

$$R_3 = \frac{Q_2^2 + 1}{R_2}$$

Where: R_1 = Pi network input resistance (ohms)
R_2 = Output resistance (ohms)
V_1 = Input voltage (volts)
V_2 = Output voltage (volts)
V_3 = Voltage across series element (volts)
P = Power input to pi network (watts)
Y_1 = Input shunt element susceptance (mhos)
Y_2 = Output shunt element susceptance (mhos)
Y_3 = Series element susceptance (mhos)
Q_1 = Input loaded Q
Q_2 = Output loaded Q

network, you must ignore the lower value of Q. Note that the Q of a tee network increases with increasing phase shift.

Equations 5 through 14 describe the tee network. It is a simple matter to find the input and output currents via Ohm's law, and the shunt leg current can be found via the cosine law (Equation 12). Note that this current increases with increasing phase shift. Equation 13 describes the midpoint resistance of a tee network, which is always higher than R_1 or R_2.

Equation 14 is useful when designing a *phantom* tee network; that is, where X_2 is made up only of the antenna reactance, and there is no physical component in place of X_2. Keep in mind that a tee network is considered as having a lagging or negative phase shift when the shunt leg is capacitive (X_3 negative), and vice versa. The input and output arms can go either negative or positive,

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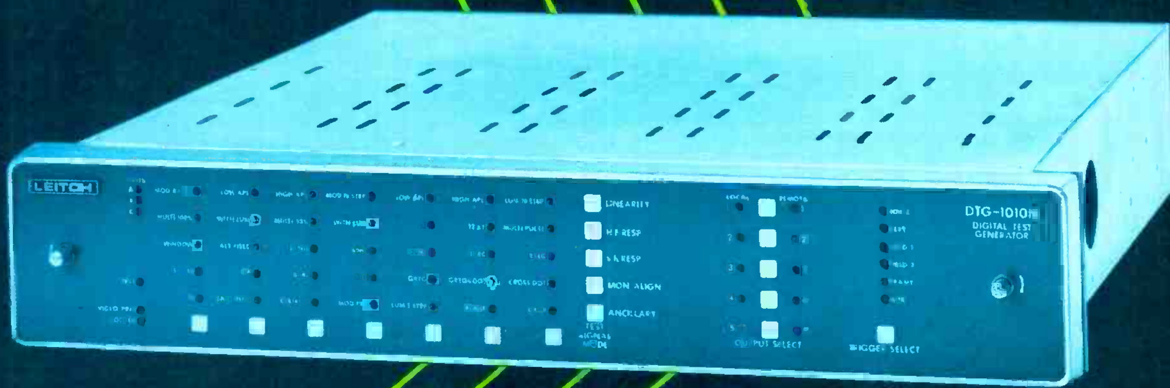

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depending on the resistance transformation ratio and desired phase shift.

The pi network (Figure 3) can also be considered as two L networks back to back and, therefore, the same comments about overall loaded Q apply. Note that susceptances, rather than reactances, have been used in Equations 15 through 19, in order to simplify calculations. The same conventions regarding tee network currents apply to pi network voltages (Equations 20, 21 and 22). The midpoint resistance of a pi network is always less than R_1 or R_2. A pi network is considered as having a negative or lagging phase shift when Y_3 is positive, and vice versa.

When we say impedance, we do not simply mean resistance, but resistance *and* reactance. An antenna, for example, usually has a fair amount of reactance that must be tuned out. This reactance is normally series-resonated. If it is parallel-resonated, the resistance is transformed, and we have a phantom L network. Note that the transformed resistance will be higher than the original resistance.

Some people recommend 2-stage matching when the resistance transformation ratio is greater than about 10. This approach, although requiring more components, has lower total losses, better bandwidth and is said to make adjustment easier. These all may be valid points in the case of a non-directional system, but in the case of a low-power tower in a directional array, the arguments lose their validity. The reason is that the common-point and antenna monitor of a directional array are least affected by the networks between the power divider and the bases of the lower power towers. If a tower's base operating resistance is low compared to the other towers, its power (I^2R) will be low.

Poor bandwidth in a low-power coupler in a phased array will not significantly degrade system bandwidth, as seen at the common-point. Therefore, 2-stage matching is not always warranted when a high resistance transformation is required. When 2-stage matching is warranted, however, use the geometric mean of the two resistances as the middle resistance (Figure 4 and Equation 24).

System bandwidth

It is often assumed that a high carrier VSWR on a transmission line will degrade the overall system bandwidth. Many directional arrays have surprisingly high standing waves on their transmission lines, especially on the lower power lines. But we know that the lower power lines have the least effect on the common-point; from this argument alone, we can conclude that mismatch on lower power lines may not be too significant to overall performance.

In a non-directional system that has a line stretcher (see Figure 5), a high carrier VSWR can exist on the transmission

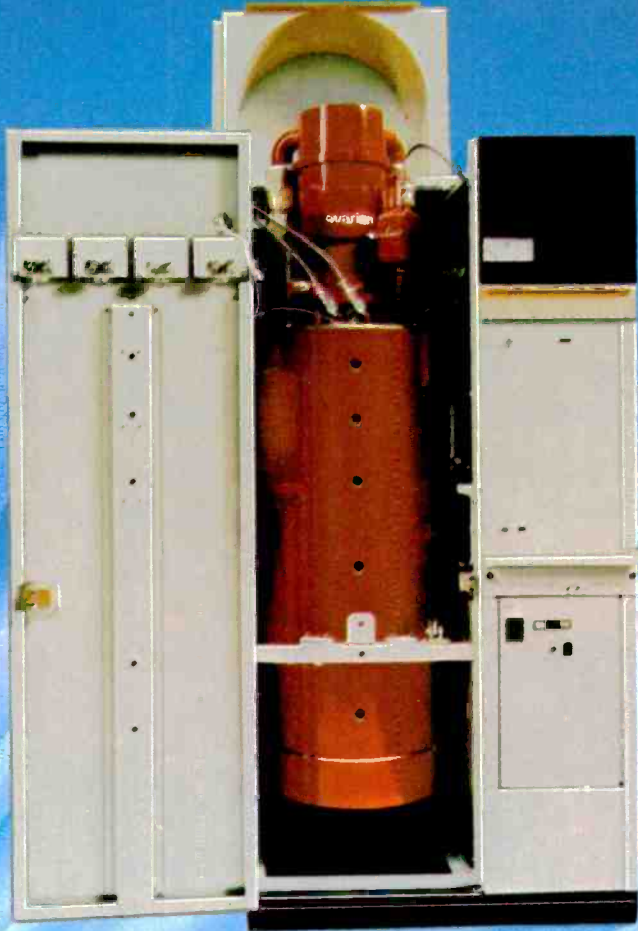

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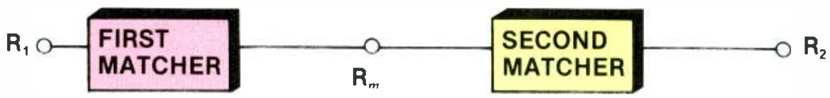
Figure 4.

2-STAGE MATCHING



Equation 24:

$$R_m = \sqrt{R_1 R_2}$$

Where: R_1 = Input resistance (ohms)

R_2 = Output resistance (ohms)

R_m = Resistance at midpoint (ohms)

line. This author considered several cases in which the carrier VSWR was about 2, but found none in which the bandwidth was affected. Mismatch, in even the higher power lines of a phased array, does not by itself degrade bandwidth. Of course, the components must be able to withstand the higher current and voltage stresses that a mismatched system creates. But unless there is excessive heating or component failure, there is little incentive to readjust a phasing and coupling system simply to reduce the transmission line VSWRs.

A line stretcher makes the transmission line look longer or shorter in order to produce sideband impedance symmetry at the transmitter PA. This is done

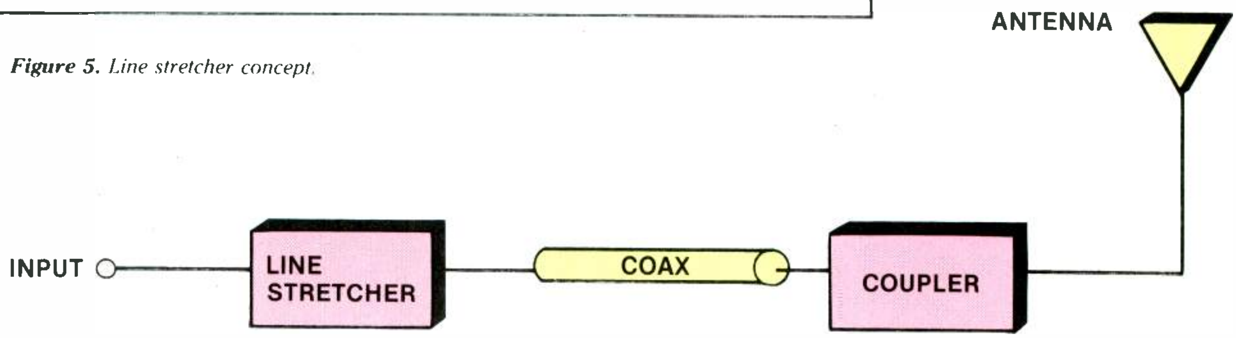


Figure 5. Line stretcher concept.

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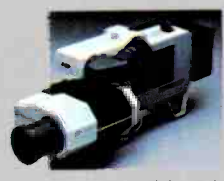

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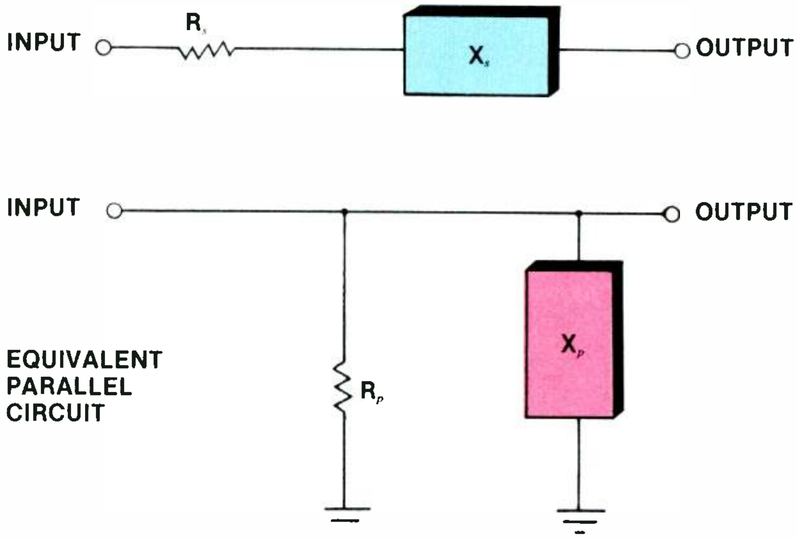
Figure 6. LINE STRETCHER CONFIGURATION



Equation 25:

$$R_p = \frac{R_s^2 + X_s^2}{R_s}$$

Equation 26:

$$X_p = \frac{R_s^2 + X_s^2}{X_s}$$

Where: R_s = Series configuration resistance (ohms)
R_p = Parallel configuration resistance (ohms)
X_s = Series reactance (ohms)
X_p = Parallel reactance (ohms)

in order to reduce audio distortion in an envelope detector—the kind of detector that most receivers employ. Symmetry is defined as equal sideband resistances, and equal (but opposite sign) sideband reactances.

There are two possible points of symmetry, each 90° from the other. One produces sideband resistances greater than the carrier resistance, and the other produces the opposite effect. One side will create a pre-emphasis effect, and the other a de-emphasis effect.

Depending on the Q of the transmitter's output network, one point of symmetry may yield lower sideband VSWRs at the PA than the other. This results from the Q of the output network opposing the Q of the antenna in one direction, but aiding the antenna Q in the other direction. This author has measured a 10kHz sideband VSWR of 2 one way, and 1.2 the other way. The difference was simply a 90° change in the phase shift of the line stretcher. The air signal was, not surprisingly, much better with the 1.2 sideband VSWR.

Keep in mind that different transmitters have different phase shifts across their output networks. If this phase shift is a multiple of 180°, then an RF *voltage* sample at the output of the transmitter is representative of the PA voltage waveform (if the output network is wideband). If this phase shift is an odd multiple of 90°, then an RF *current* sample at the transmitter output is representative of the PA voltage waveform. If the output network is not wideband, or its phase shift is not a multiple of 90°, the only reasonable place for an RF sample is right at the PA (but after any third-harmonic waveshaping). If we consider the PA as a voltage source, then we want it to see a constant parallel resistance. (See Figure 6 and Equation 25.)

Of course, if you can accomplish the desired line stretching by adjusting the phase shift of the coupler, a separate network is not required. The same is true of the common-point matching network.

Sometimes, audio performance can be improved by placing a high-loaded-Q, series-resonant circuit in front of a coupler in order to cancel the antenna sideband reactances, thereby reducing sideband VSWR and improving bandwidth. A typical improvement might be

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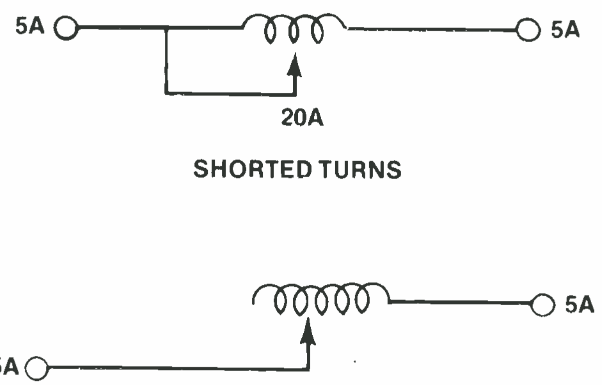
Figure 7. Transformer connections



reduction of a 2 sideband VSWR to 1.5. The voltage stresses and I^2R losses in a high-loaded-Q coil and capacitor can be significant, so consider them carefully when contemplating such a broadbanding network.

Another type of broadbanding configuration works on the sideband resistance as well as the reactance. This is typically accomplished in four steps:

- First, the antenna impedances are transformed down by 3 or 4 to 1 and rotated to equivalent series resonance.
- A parallel-resonant circuit is placed in shunt to transform the resistances across the channel to a constant value.
- A series-resonant circuit is placed in series to cancel the sideband reactance.
- Finally, the pure resistance remaining is stepped back up to the overall system value (typically 50Ω).

Such networks are quite large, costly and lossy. They are warranted only in special circumstances.

Inductor tuning

Most network adjustment is physically accomplished by moving a tap or roller on a coil. If the *inactive* turns of the coil are shorted, high circulating currents can develop (there is an auto-transformer effect). This author has measured 20A in a shorted turn when only 5A were entering and leaving a coil (Figure 7). The use of open turns is, therefore, recommended in almost all circumstances. There is a voltage step-up effect at the open end of a coil, but the amount is not usually significant. An exception would be when high-level harmonics are present, such as in a class C amplifier.

Sometimes, the shunt stray capacitance of a coil (Figure 8) can cause an appreciable amount of resistance transformation. In the case of a high impedance tower, it is a good idea to measure the resistance at the input to the base tuning coil and use this value to recalculate the

320.

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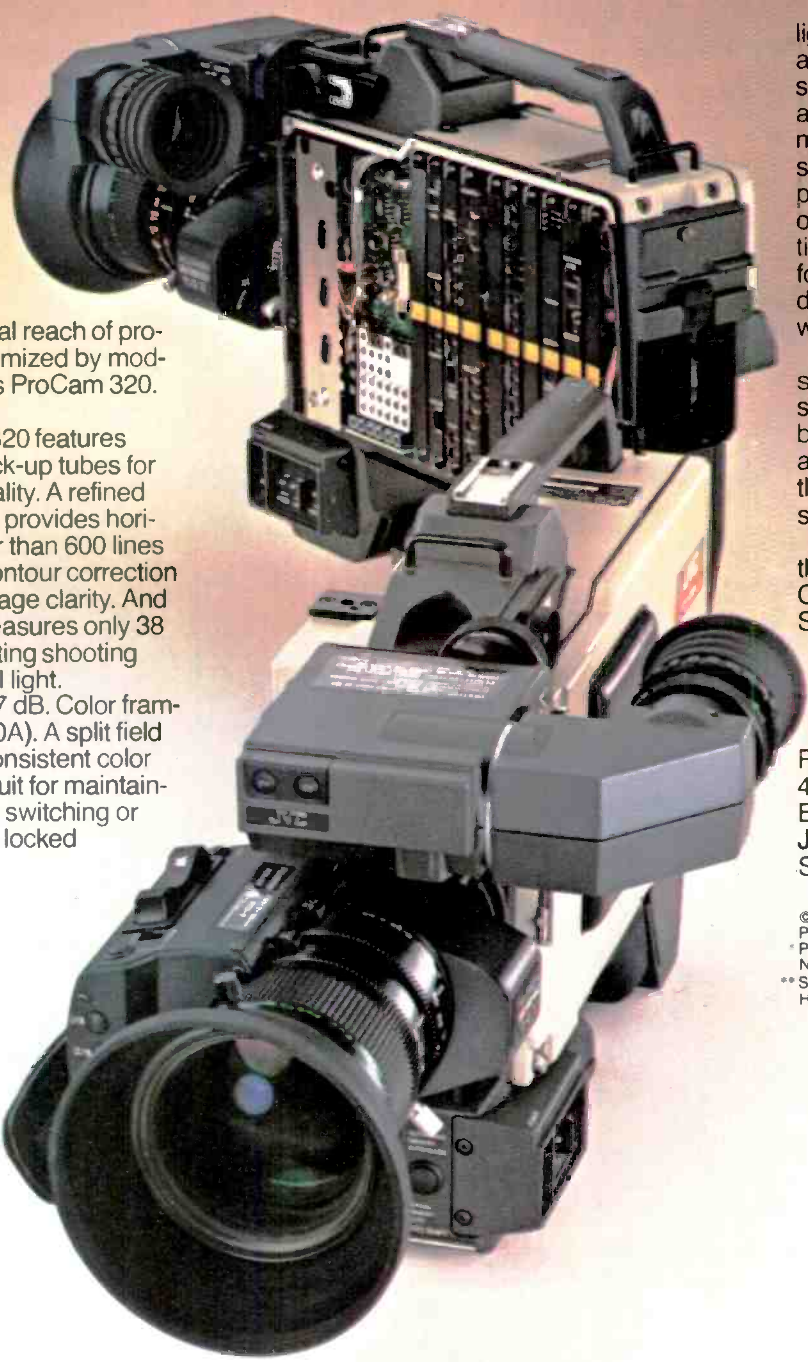

JVC's experience—and success—in designing the highest quality and reliability into compact video production cameras is unmatched. Now, continuing this tradition of high performance at an affordable price, JVC has brought a "high-end" teleproduction camera within the financial reach of production people often victimized by modest budgets. This time, it's ProCam 320.

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Professional Video Division
41 Slater Drive,
Elmwood Park, N.J. 07407
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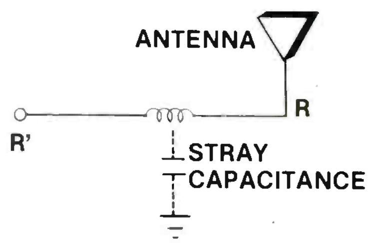
network leg reactances, because R' may differ substantially from R.

Figure 8. - STRAY CAPACITANCE EFFECT



R' = BASE RESISTANCE DUE TO EFFECTS OF STRAY CAPACITANCE

R = ANTENNA BASE RESISTANCE

At times, an impedance bridge is not available, but a network must be adjusted anyway. When this is the case, the network can be set up by simply counting the number of active turns in the coils. You can find the desired number of turns from Equation 27 if you know the desired reactance or inductance. Any necessary trimming can be accomplished by adjusting for minimum reflected power as measured by the transmitter reflectometer.

Equation 27:

$$N = \frac{5SL + \sqrt{25S^2L^2 + 9R^3L}}{R^2}$$

Where: L = Desired inductance (μH)

S = Turn-to-turn spacing (inches)

R = Mean radius of coil (inches)

By understanding the mechanics of matching network operation, you can clear up the mystery that often surrounds antenna- and phaser-tuning. The process of transforming AM signals from one impedance to another is simple, if taken step by step.

Editor's note: The author has prepared some examples of impedance matching using the formulas presented in this article. Because of space limitations, they will not be presented here. However, a copy may be obtained by circling number 301 on the Reader Service card at the back of this issue.

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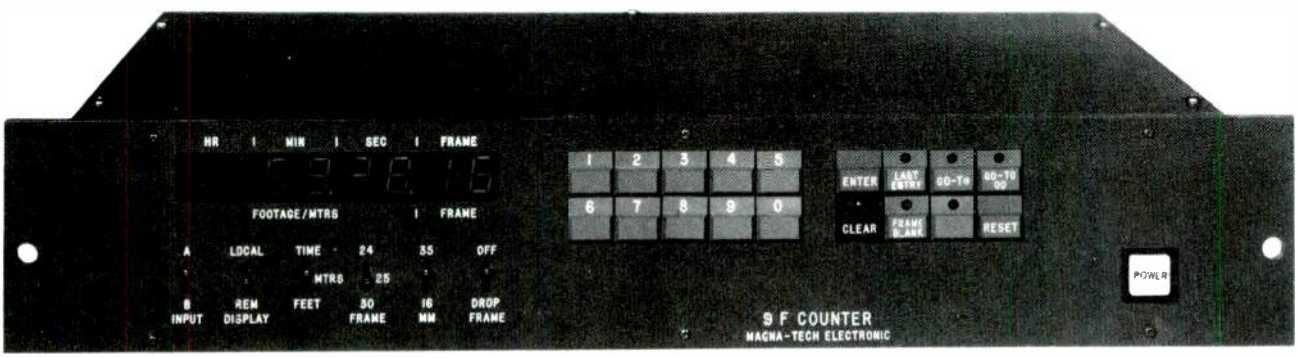

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Continued from page 16

component does. Because many of the cavity components—inductors and capacitors—are mechanical elements more than electrical ones, troubleshooting a cavity stage generally centers on checking the mechanical integrity of the box.

Most failures resulting from problems within a cavity are the result of poor mechanical connections. As we have stressed before, all screws and connections must be kept tight at all times. Every nut and bolt in a PA cavity was included for a reason. There are no insignificant screws that don't need to be tightened. But, don't overtighten. Stripped threads and broken component connection lugs will only cause you additional grief.

When a problem occurs in a PA cavity, it is usually difficult to determine which individual element (neutralization inductor, plate tuning capacitor, loading capacitor, etc.) is defective from the symptoms the failure will display. A fault within the cavity is usually a catastrophic event because it will take you off the air, and leave you there until the problem is corrected. It is often impossible to bring the transmitter up for even a few seconds to assess the fault situation. The only way to get at the problem is to shut the transmitter down and take a look inside.

Closely inspect every connection, using a trouble light and magnifying glass. Look for signs of arcing or discoloration of components or metal connections. Check the mechanical integrity of each element in the circuit. Be certain the tuning and loading adjustments are solid, without excessive mechanical play. Look for signs of change in the cavity. Do any parts look different now than the last time you cleaned the transmitter?

Check areas of the cavity that may not seem like vital parts of the output stage, such as the maintenance access door fingerstock and screws. Any failure in the integrity of the cavity, whether at the base of the PA tube or on part of the access door, will cause high circulating currents to develop and will prevent proper operation of the stage.

If a problem is found that involves damaged fingerstock, replace the affected sections. Failure to do so will likely result in future problems because of the circulating currents that are present at any discontinuity in the cavity inner or outer conductor.

Whatever you do, resist the temptation to do a "quick fix" on a damaged element in the cavity. Experience has shown that the quick fix only results in additional problems farther down, the road. When working on high-power RF equipment, take as much time as the job requires. Ignore the desperate phone calls from the studio. In the long run, good maintenance is always good business.

When the FCC changed the rules, EIMAC was prepared for continuing HAM operations.

The FCC changed the allowable output power for linear amplifiers in amateur radio service. Hams can now run at 1500 watts PEP into an antenna. EIMAC was right there to meet requirements with its 3CX1200A7 tube.

Low-cost replacement for small spaces.

RF cabinets of many linear amplifiers currently use the EIMAC 3-500-Z tubes. The new 3CX1200A7 for design takes size into consideration and, by design, is recommended as a single, low-cost replacement for a pair of EIMAC 3-500-Z tubes for new amplifier designs.

General Specifications

The EIMAC 3CX1200A7 is a high-mu, compact, forced air cooled triode for zero-bias class AB2 amplifiers.

- 2.9″ dia. x 6.0″ long
- Plate dissipation: 1200 watts
- Glass chimney SK-436 available
- Standard EIMAC SK-410 socket available

More information is available on the new EIMAC 3CX1200A7 tube from Varian EIMAC, or any Electron Device Group worldwide sales organization.

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1678 S. Pioneer Road
Salt Lake City, Utah 84104
Telephone: 801 • 972-5000

Varian AG
Steinhauserstrasse
CH-6300 Zug, Switzerland
Telephone: 042 • 23 25 75

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Continued from page 4

Formic receives communications grant

Formic Videotex Systems, Montreal, has been awarded a grant from the Quebec Ministry of Communications for the development and marketing of an advanced micro-videotex system. The goal is to develop a videographic work station with an integrated information management system that will reduce the overall costs of producing videotex/ NAPLPS information, as well as increase the productivity related to the gathering, creating and managing of this information through a local area networking of microcomputers.

Formic also has announced the sale of a turnkey electronic information system to the city of Quebec for its municipal convention center. The system includes a public access network with three interactive terminals on-site, and the capability of supporting several more throughout Quebec.

Modulation Associates uplinks Dodger Network

Modulation Associates, Mountain View, CA, has been awarded a contract to supply the SCPC satellite transmission equipment for the new Dodger Satellite Radio Network. The initial order calls for 24 MC-SAT receivers to be installed at Dodger affiliate stations. Satellite uplinking will be provided by IDB Communications, using Modulation Associates uplink hardware.

USSB leases space from RCA Americom

United States Satellite Broadcasting, a division of Hubbard Broadcasting, has agreed to lease four transponders on RCA American Communications' Satcom K-2 satellite. RCA Americom, Princeton, NJ, has received authority from the FCC to launch three Ku-band satellites, each carrying 16 transponders with 45W of power. Satcom K-1 is scheduled for launch in November, Satcom K-2 in December and Satcom K-3 sometime in 1987.

TBS purchases Scientific-Atlanta uplink

Turner Broadcasting Systems has purchased TV uplink equipment from *Scientific-Atlanta,* Atlanta, that will allow TBS to offer its Cable News Network to European broadcasters on a 24-hour basis. The equipment includes an 11m antenna with 4-port circularly polarized feed, redundant exciters and monitoring equipment, which will be installed this spring. The system will transmit a signal from the United States to the Intelsat V satellite at C-band, where it will be cross-strapped to Ku-band and retransmitted by the satellite at Ku-band into Europe.

EN Group Canada chooses Wegener

Wegener Communications, Norcross, GA, has received an order for audio and data satellite communications subcarrier equipment from EN Group Canada. EN Group, Canada's broadcast-industry-owned satellite distribution company, has ordered 100 downlinks for the first phase of providing news gathering and data distribution to its affiliates. Each downlink consists of two 15kHz and two 7.5kHz audio demodulators, one 115.2kB QPSK data demodulator, a microprocessor-controlled network controller and two audio routing switches.

Canadians get Rank Cintel telecine

The National Film Board of Canada (NFB), in the first phase of a project to offer Canadian filmmakers access to state-of-the-art video post-production facilities, has purchased a *Rank Cintel* telecine suite. The system, located at the NFB's headquarters in Montreal, consists of a Mk 111C with Amigo computer and Varispeed, plus a Rank Cintel FeRRIT for high-quality separate magnetic sound in Dolby stereo.

Camera Mart moves office

The Camera Mart, New York, has relocated its Syracuse office to 305 Vine St., Liverpool, NY 13088. The expanded facility will allow for additions, as well as a demo room and servicing center. The new phone number is 315-457-3703.

California Microwave receives USAID contract

The Satellite Transmissions Systems subsidiary of *California Microwave,* Sunnyvale, CA, has been awarded a contract funded by the U.S. Agency for International Development. The project calls for upgrading of an Intelsat Standard A satellite earth station in Khartom for Sudan Telecommunications. STS will be expanding the earth station, increasing the number of countries with which Sudan can communicate.

Bogner announces MDS antenna sales

Recent foreign sales of multichannel MDS transmitting antennas by *Bogner Broadcast Equipment,* Westbury, NY, include Bermuda and Curacao. Similar units have been supplied to San Luis Obispo, CA, and the Chinese community of New York City.

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People

Barrie Hozier, John Child and **Claire Finch** have received new appointments at Soundcraft Electronics, London. Hozier has been named general manager, but will retain his duties as financial director, working out of Soundcraft's new Borehamwood facility. Child has joined Soundcraft as manufacturing manager for the new factory, and will handle all technical and administrative aspects of the manufacturing process. Finch has been promoted to marketing coordinator, and will handle exhibitions, PR and advertising.

Jonathan P. Winsor has been promoted to field service manager for Micro Communications, Manchester, NH. Winsor has worked for MCI since 1982, and was responsible for antenna/transmission line installations in the Sears Tower, the World Trade Center and the Empire State Building, among others.

Jim Black, David Green and **Tom Williams** have received new positions with VideoStar Connections, Atlanta. Black, executive vice president of VideoStar, has been given the additional title of director of sales following the company's restructuring. Green is now the director of marketing, and Williams has been appointed vice president of engineering.

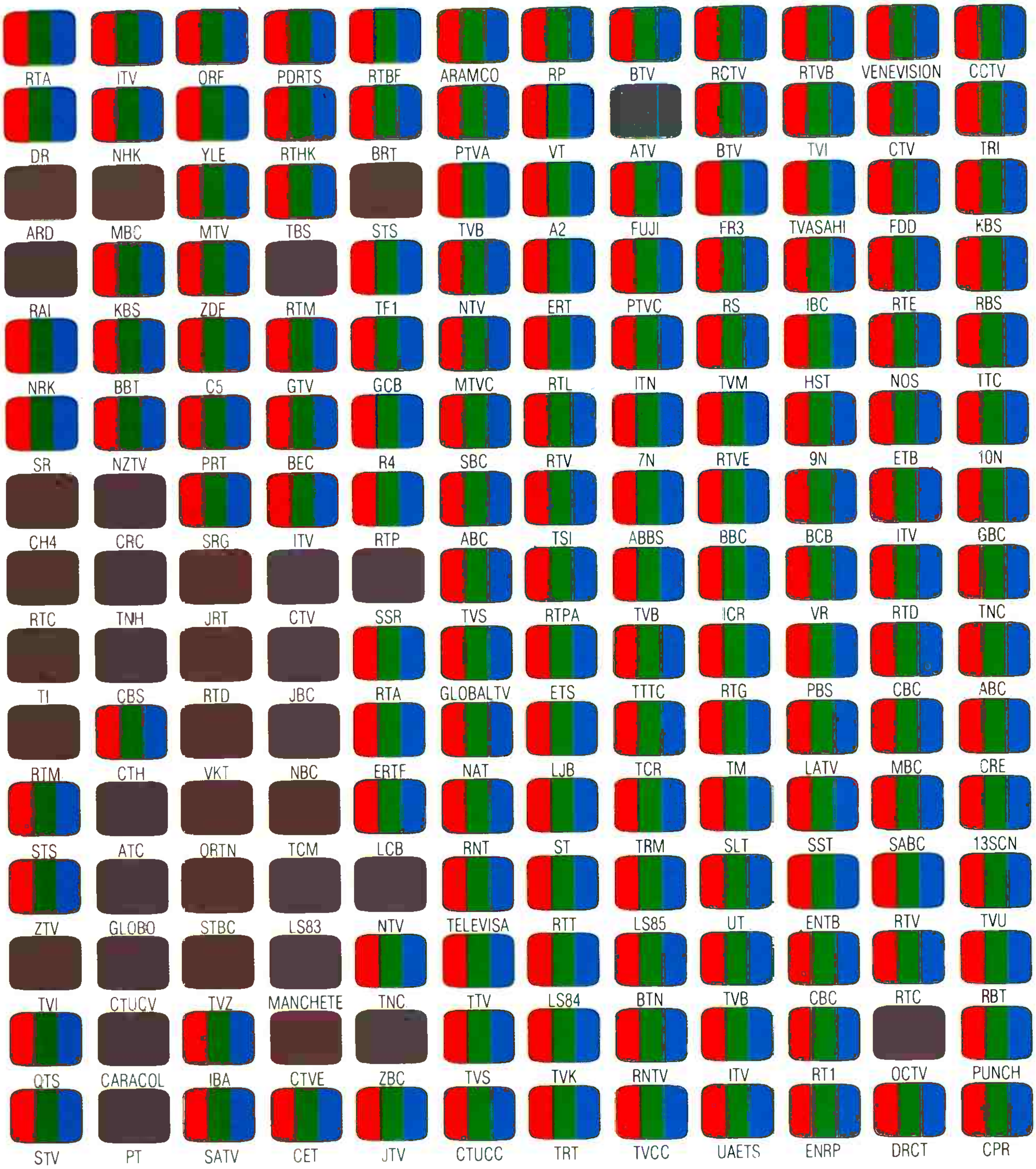
Camille Perillat has joined the magnetic tape division of Ampex, Redwood City, CA, as associate administrator of marketing communications. Perillat will administer the division's national trade show schedule, the Ampex Golden Reel Award program, direct mail and print production.

Joseph L. Scheuer, president of Chyron, Melville, NY, has been named to the board of directors of CMX, joining Chyron's chairman Alfred O.P. Leubert and vice chairman Leon Weissman on the board. Chyron acquired a 39.5% interest in CMX, formerly Orrox, at the end of 1984.

BE names Spec Book Contest winners

Richard W. Johnson, operations engineer at KAKE-TV, Wichita, KS, and **Randy Paul,** production director for WVNA AM & FM, Tuscumbia, AL, were the winners of BE's *Spec Book* Spectacular Contest held in March.

The winners were each awarded a Studer B225 digital audiodisc player valued at $1000.



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New products

Audio mixer

Grass Valley Group has introduced a companion audio mixer for the models 100 and 100CV production switchers. The AMX-100 has a microprocessor-based line output derived from a 12-input, 3-bus crosspoint matrix, an independent full-function monitor output and LED metering for peak and average levels at the line and monitor outputs. Program and preset buses will select eight primary inputs, and the over bus allows any one of the first four primaries, or four separate inputs, to be used as an audio over.

Editing interfaces for the AMX-100 include standard contact closure (GPI) and full serial control of all panel functions. A serial interface-equipped model 100 or 100CV can control the audio mixer for true AFV/master control operation; program and preset buses follow the switcher crosspoint selection and lever arm movements; and voice-overs are mixed by pushing one button.

Circle (250) on Reply Card

FM transmitter

Elcom Bauer has introduced another of its single-tube C-series transmitters. The model 610C is a 10,000W FM transmitter that uses the Eimac 4CX7500A compact ceramic beam power tetrode, and the model 6020 fully synthesized exciter. The 610C requires only 4.9 square feet of floor space, and features soft start, VSWR protection, automatic power control and optional patch-through backup capability.

Circle (251) on Reply Card

Low-frequency FM microwave system

International Microwave has developed a low-frequency FM microwave system that provides interference-free line-of-sight transmission of color video, program audio or data. The heterodyne-type transmitter operates in the 1.7GHz to 2.66GHz range and employs two oscillators that are mixed to produce desired channel frequency. The dual-conversion receiver provides image rejection without requiring critically tuned narrowband microwave filters. The low frequency assures reliable transmission relatively unaffected by rain, fog, snow or other atmospheric conditions.

Circle (252) on Reply Card

Medium-sized EFP/ENG van

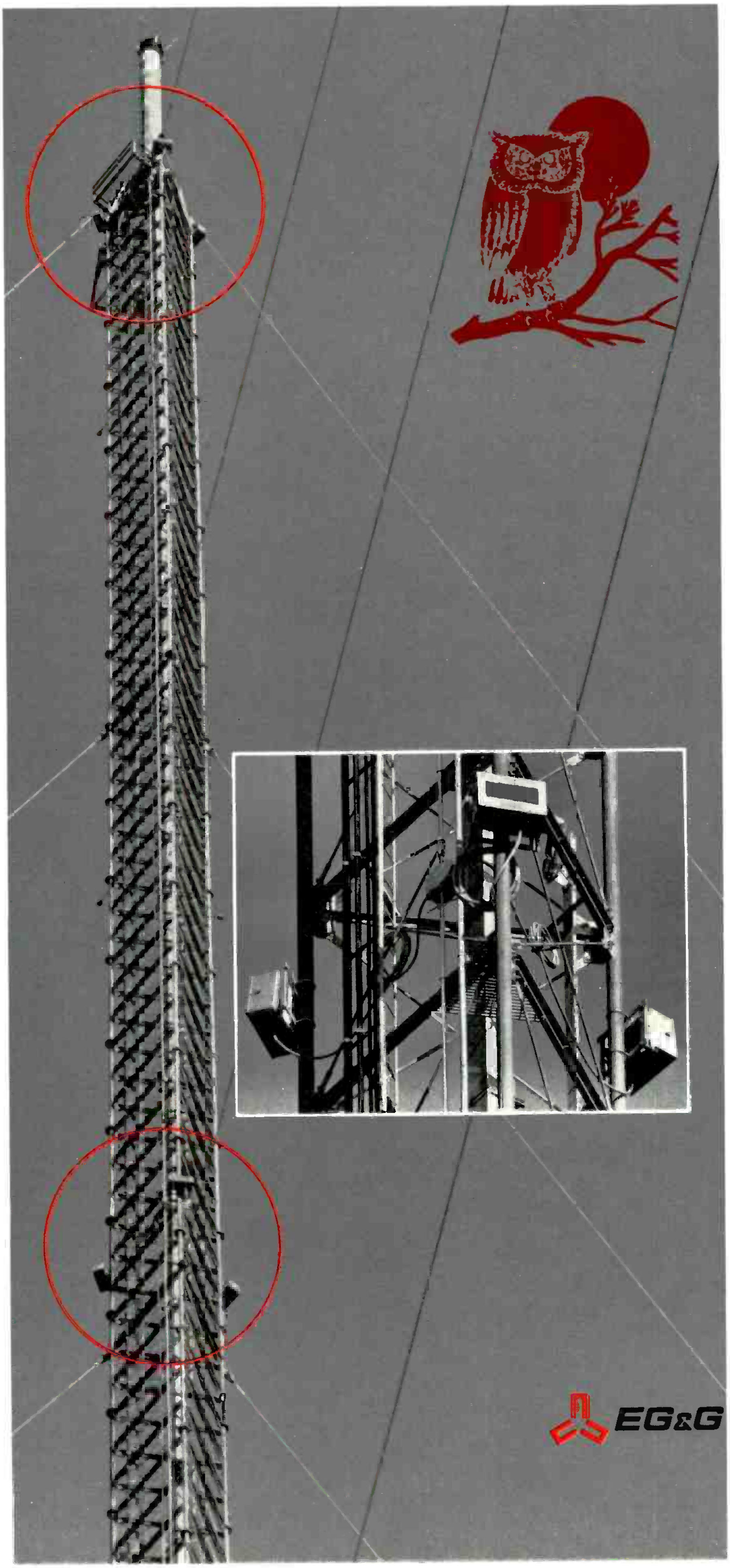
A.F. Associates, designers and fabricators of custom mobile video systems, has begun development of a series of standard-design mobile units. The first in that series is the AF/C-2, a medium-sized EFP/ENG van designed for local stations and field production. The C-2 is based on a 22-foot Gerstenslager vehicle, and includes two camera systems with a choice of either Ikegami or Sharp cameras, a Grass Valley 100 video switcher, a Yamaha stereo audio console and a choice of either Sony or Ampex VTRs in a removable VTR commode. A full complement of terminal equipment is also included, and the C-2 can be provided with a wide range of component video equipment.

Circle (265) on Reply Card

Computer teleprompter

Autoprompter, a microcomputer-based teleprompter program for the Apple II series, has been released by *Beacon Software.* The package supports video-based portable or camera-mounted prompters, and offers more than 1350 lines of stored text, which can be loaded from a data disk in less than 10 seconds. Autoprompter also features a built-in word processor for easy script entry and editing, and an online help screen lists keyboard commands.

Circle (268) on Reply Card



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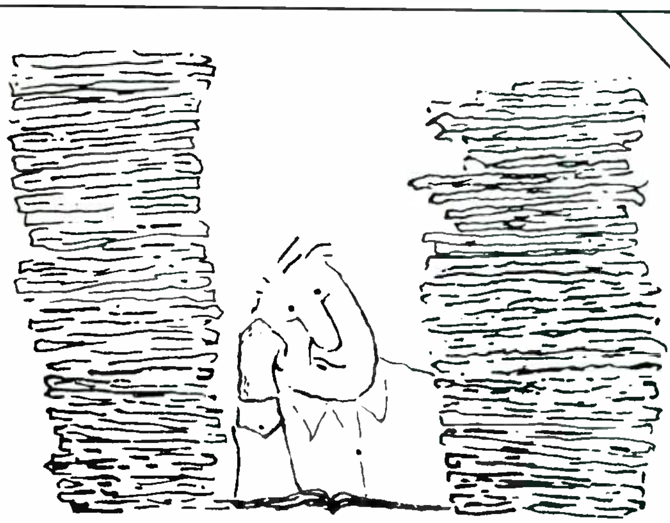

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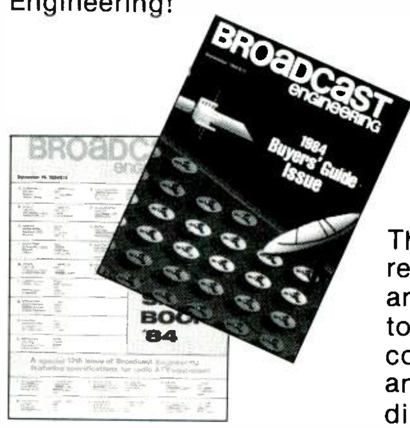

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Photo-quality videotex

The photo videotex from *British Telecom* allows full-color photographic quality images to be displayed along with text and enhanced graphics. The photo capability can be delivered over high-speed lines or more slowly over the ordinary public switched telephone network. The photo videotex is suitable for cable delivery in videotex mode or as a 1-way cabletext, and specifically designed plug-in cards enable IBM PCs to act as photo videotex display or editing terminals.

Circle (269) on Reply Card

Paint system

Chyron has introduced Chameleon, a paint system that is capable of creating lines, filled or outline circles and rectangles and closed figures, and can also be operated by a freehand tablet. The new Chameleon system employs an icon-oriented human interface, and includes features such as area fill, multiple brushes, user definable brushes, cut-and-paste with resizing, layout grids and flexible color selection and modification. Specs include NTSC resolution of 768x482 lines (582 for PAL), 256 displayable colors from a pallette of 4096 and optional 256 levels-of-gray camera capture.

Other new items introduced by Chyron's video products division include an RGB option for both the VP-1 and VP-2, 16-color on-screen display capacity for the VP-2, editing-in-background capability and auto replication of background patterns. Chyron has also increased the memory buffer for rolls so that the VP-2 can now handle 96 lines of text.

Circle (270) on Reply Card

Digital audio mastering tape

Ampex has announced a digital audio mastering tape, Ampex 467. It is designed to perform optimally on all multitrack digital recording systems without requiring individual tape-to-machine realignments. Ampex 467 will be available in ½- and 1-inch formats, and 4600- to 9200-foot lengths. The new tape also features a durable oxide and binder system processed in a super-clean manufacturing environment. Ampex's new total surface cleaning process wipes and then vacuums all surface and free-floating debris, eliminating transient and data errors.

Circle (266) on Reply Card

Rack-mount monitor

Audisar has introduced a rack-mount monitor loudspeaker designed to meet broadcast and industrial audio requirements. The overall design of the model 14K100 is based on Thiele parameters, referenced to vented enclosure systems. Crossover network components are matched to ±5% to ensure symmetrical slope rates, and the network itself exhibits an insertion loss of only 1dB. Crossover frequency is 4.5kHz at 12dB/octave. The low-frequency unit is a cone piston type fabricated from specially formulated polypropylene which exhibits low-density, high internal damping, high impact and tensile strength, and shows less distortion than paper or bextrene transducers.

Circle (267) on Reply Card

Hand-held multimeters

John Fluke Manufacturing has added two members to its 20 series line of high-performance, industrial-grade hand-held multimeters. The Fluke 21 and 23 are high-energy protected and specifically designed to survive in rugged environments. Both feature extensive overload protection and have high-energy fusing built in. The Fluke 21 clears short-circuit faults to more than 10,000A, and uses a 1200V metal oxide varistor (MOV) for volt/ohm protection; the Fluke 23 is 10A fused for protection to 100,000A, and uses a 430V MOV in series with a spark gap.

The Fluke 8060A DMM is a hand-held microcomputer-controlled 4½-digit test instrument that measures frequency

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to 200kHz and relative and decibel measurements with almost any impedance. This DMM also features hertz, decibel and relative measurement functions.

Also being introduced by Fluke is a low-cost, high-performance thermocouple converter, the 80TK. It operates on a 9V battery, and converts microvolt output from a K-type thermocouple into a 1MV per degree signal. The 80TK plugs into any bench or hand-held DMM (standard banana plug input) to allow instant temperature measurement capability.

Circle (273) on Reply Card

Universal video/audio tape degausser

The new MaxERASE-16B introduced by *Christie Electric* is a universal video/audio tape degausser with a phase change switch that can select the precise horizontal or vertical phase to match the recording. It degausses tapes from ¼ inch to 2.6 inches, up to 16 inches in diameter, and erases high-coercivity bulk tape up to 1500 oersted in a 30-second, automatic 1-pass operation. The MaxERASE-16B generates higher than previously available levels of magnetic flux, and rotates tapes through the magnetic field, at varying speed, to prevent spoking and to ensure equal erasure throughout.

Circle (271) on Reply Card

AM/FM stereo tuner

The FM Three AM/FM stereo tuner by *Crown International* incorporates the new Schotz noise reduction circuit (SNR) to clarify previously unlistenable channels. It also features a scan level to set a minimum strength for signals that are locked in, six AM and six FM presets, a multipath indicator and a calibrated signal-strength indicator. The FM Three is a true digital tuner, using a dual-quartz system to improve S/N ratio, a torroidal transformer to reduce hum and noise and an extra RF section for increased AM sensitivity.

Circle (272) on Reply Card

Portable logic analyzer

The LogicScope from *Jensen Tools* combines many of the features and capabilities of sophisticated logic analyzers and oscilloscopes into a lightweight, compact and powerful unit. Designed for servicing digital and electronic circuits and equipment in the field, the LogicScope replaces conventional CRT display with an array of 400 LEDs, permitting simultaneous display of two waveforms. It is operable in either real time or memory modes, with the memory mode permitting acquisition and storage of up to 24 128-bit waveforms. Waveforms can be recalled and logically compared to other stored or input waveforms.

Circle (253) on Reply Card

1:1 output transformer

Jensen Transformers has developed a high-performance 1:1 output transformer with neutral sonic characteristics that still offers ground-loop isolation not possible with direct-coupled circuits. The model JE-11-BM uses a special 80% nickel alloy core that lowers hysteresis distortion and allows use with source impedances from 0Ω to 1000Ω. It has distortion of 0.002% at 20Hz, a bandwidth of −3dB at 10MHz and a phase shift of 0° at 20kHz. Frequency response is −0.02dB at 20Hz/+0.00dB at 20kHz, referenced to 1kHz.

Circle (254) on Reply Card

Real time digital video recorder

Oktel has developed a real time digital video recorder that provides 60 seconds of real time digital imaging, 522x512x10 bits deep, with variable record and playback and random access. The DR 6000 features extensive use of LSI components, a sealed drive with recirculating air flow systems and a proprietary overcoat on the disc media. The recorder also provides for optional expansion of real time storage or increased recording rate.

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Ad index

Advertiser	Page Number	Reader Service Number	
ADM Technology	IFC	1	313/524-2100
Alpha Audio	80	65	804/358-3852
Alpha Video Electronics	76	58	412/923-2070
Ampex Corp. (AVSD)	23		818/240-5000
Ampex Corp. (MTD)	53	34	415/367-3809
Apert Herzog	80	66	408/225-1425
Arrakis Systems	21	20	303/224-2248
Asaca/Shibasoku Corp. America	63	43	800/423-6347
Barco Industries, Inc.	85	85	704/392-9371
Belar Electronic Labs	78	62	215/687-5550
Broadcast Video Systems Ltd.	78	61	416/497-1020
C.O.A.R.C.	84	72	518/672-7202
Calvert Electronics Inc.	22	13	800/526-6362
Camera Mart, Inc.	39	64	212/757-6977
Canare Cable, Inc.	70	45	818/840-0993
Cetec Antennas	68	49	916/383-1177
Circuit Research Labs, Inc.	13	9	800/535-7648
CMC Technology	17	11	408/980-9800
Continental Electronics Mfg. Co.	26	86	214/381-7161
Crosspoint Latch Corp.	96	78	201/688-1510
Datatek, Inc.	67	48	201/654-8100
Delta Electronics	54	35	703/354-3350
Eagle Hill Electronics, Inc.	84	84	301/778-1667
EDX Engineering, Inc.	66	47	503/545-0019
EG & G Electro-Optics	87	74	617/745-3200
ESE	89	76	213/322-2136
Fortel Inc.	91	46	404/449-4343
Gentner Engineering Co., Inc.	76	59	801/268-1177
Grass Valley Group, Inc.	9	7	916/273-8421
Hitachi Denshi America Ltd.	3	3	800/645-7510
Hitachi Denshi America Ltd.	40-41	23	800/645-7510
International Tapetronics Corp.	57	38	800/447-0414
JBL Inc.	37	12	818/893-8411
JVC Company of America	77	60	800/582-5825
L.W. International	84	71	818/522-3284
Lang Video Systems Corp.	84	83	415/364-1287
LEA Dynatech Inc.	62	44	213/944-0916
Leader Instruments Corp.	5	4,5	800/645-5104
Leitch Video Ltd.	69	50	804/424-7290
Lenco Electronics	11	8	314/243-3147
Lerro Electrical Corp.	1		215/223-8200
Magna Tech Electronics Inc.	79	28	212/586-7240
MCL, Inc.	56	27	312/354-4350
Microwave Filter Co., Inc.	90	77	315/437-3953

Advertiser	Page Number	Reader Service Number	
Midwest Communications Corp.	34-35	19	800/543-1584
Modulation Sciences	61	41	718/625-7333
Moseley Associates Inc.	7	6	805/968-9621
Nady Systems Inc.	70	52	415/652-2411
Nalpak Video Sales, Inc.	78	63	213/391-0491
National Video Service	72	54	415/846-1500
NEC America Inc.	86	75	800/323-6656
NEC America Inc.	43	25	800/323-6656
NEC America Inc.	55	36	800/323-6656
Nova Systems, Inc.	65	73	203/677-5252
Opamp Labs Inc.	84	81	213/934-3566
Orban Associates Inc.	83	70	800/227-4498
Orban Associates Inc.	32	17	800/227-4498
Otari Corp.	15	10	415/592-8311
Philips Test and Measuring Instruments	75	57	202/529-3800
Polyline Corp.	82	68	312/297-0955
Potomac Instruments	46	29	301/589-2662
Power Pak Systems	62	51	817/293-1761
QEI	47	22	609/728-2020
Recortec, Inc.	42	24	408/737-8441
Rhode & Schwarz Sales Co. (USA) Inc.	38	21	516/488-7300
Schwem Technologies	73	55	415/935-1226
Sescom, Inc.	84	86	800/634-3457
Sharp Electronics Corp.	58	39	201/265-5548
Shintron Electronics	44	33	212/581-1556
Shively Labs	74	56	207/647-3327
Shure Brothers Inc.	27	14	312/866-2553
Sitler's Inc.	84	80	800/426-3938
Sony Corp. of America (Broadcast)	24-25		
Standard Tape Laboratory, Inc.	84	82	415/786-3546
Stantron/Unit of Zero Corp.	49	30	800/821-0019
Studer Revox America Inc.	IBC	2	615/254-5651
Surcom Associates Inc.	82	69	619/722-6162
Tascam div. TEAC Corp. of America	45	26	213/726-0303
TEC Pro, Inc.	36	42	800/562-5872
Tektronix Inc.	29	15	800/452-1877
Universal Elecon Inc.	60	40	818/846-6220
Utah Scientific Inc.	51	31	800/453-8782
Varian	81	18	415/592-1221
Varian	71	53	415/592-1221
Varian	81	67	415/592-1221
Videotek, Inc.	31	16	215/327-2292
Ward-Beck Systems Ltd.	BC		416/438-6550
Winsted Corp.	44	32	800/328-2962

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CMX has the strongest engineering and customer service organization in the industry, both to support our current products, and to produce new features and products that will link our present systems with the future. Agencies and producers have come to expect the best from CMX products, and expect their programming to be edited on CMX equipment.

FIELD SERVICE ENGINEER

We are looking for an experienced engineer to handle the technical activities in our New York City Office. Ensure that adequate records and systems are maintained. Maintain liaison with field management and specialists in resolving technical problems and train customer personnel in the operation and maintenance of CMX equipment. Qualified candidates should have a BSEE or equivalent and 4 years experience.

If you are qualified to join a winning team in the fast paced television editing equipment industry, we have a job for you.

To apply, please send resume to:

Professional Staffing, Attn: G. Brockett
3303 Scott Blvd., Santa Clara, CA 95050
(408) 988-2000
(800) 538-8092

CMX

Affirmative Action Employer

MAINTENANCE ENGINEER for progressive VHF in South Eastern North Carolina. FCC General license and 10 years broadcast maintenance experience required. Individual should have supervisory abilities and the desire to move up to Assistant Chief and Chief Engineer. Send resume or contact Chief Engineer, WECT-TV, P.O. Box 4029, Wilmington, N.C. 28406, 919-791-8070. An Equal Opportunity Employer. 7-85-1t

DIRECTOR OF ENGINEERING: KGW/KINK, a division of King Broadcasting Company, has immediate opening for newly created position in Pacific Northwest. Responsible for strategic planning, FCC compliance, budgeting and managing department and personnel. Ideal candidate will possess at least five years major market radio broadcast engineering experience, FCC General License and Electronic Engineering degree or equivalent education/experience. Management experience a definite plus. Resume/salary history to Nancy Carnes, 1501 S.W. Jefferson, Portland, OR 97201. EOE M/F. 7-85-1t

ASSISTANT CHIEF ENGINEER needed for Chicago PBS station. Applicant should be experienced with UHF high powered TV transmitters and Harris line experience as transmitter engineer or 3 years broadcast experience as transmitter engineer required. FCC general or 1st phone license required. Chicago residency required. Send resume to: CHANNEL 20, Chicago City-Wide College, 30 East Lake Street, Chicago, Illinois 60601. Equal opportunity employer M/F. 7-85-1t

INSTRUCTION

CASSETTE RECORDED PREPARATION for FCC General Class license plus one week seminar in Washington, Boston, Philadelphia or Detroit. Bob Johnson Telecommunications, 1201 Ninth, Manhattan Beach, Calif. 90266, Phone 213-379-4461. 6-85-tfn.

VIDEO ENGINEER

CBS/FOX VIDEO's visionary development of video cassettes for home entertainment has earned us a dominant position within this fast-growing industry. To help maintain our standards of high quality products, we're seeking an experienced Video Technician.

Reporting to the Director of Engineering, you'll be responsible for supervising the installation of state-of-the-art duplication systems in our new video duplication facility, performing project work on specialized audio, video, and computer systems for the Duplication, Tape Loading, and Quality Assurance Departments, and supervising technicians as necessary for project work.

An Electrical Engineering degree or equivalent plus approximately four to six years' experience working on video processing equipment, VTR's (broadcast) RANK film transfer, video editing systems are required. The capability to design analog and digital circuitry using the best present day technology and the ability to conceptualize audio/video systems are also required.

If you're seeking a growth career with a progressive world-respected industry leader, start the connection by submitting your resume in confidence to: Mark Purcell, Human Resources Department, **CBS/FOX VIDEO, 23290 Commerce Drive, Farmington Hills, MI 48024.**

Equal Opportunity Employer M/F/H/V

CBS FOX VIDEO ™

A Sensible Solution to Your CD Dilemma.

Should you try getting by with a CD player made for home hi-fi use? Or should you invest heavily in a multi-thousand-dollar pro CD system? Fortunately, there is another alternative.

A Practical Professional. The new A725 CD player from Studer makes sense, for the present as well as the future. It gives you a modestly priced yet fully professional CD player for the present – a time when you'll be using CD's alongside other sources. And it also serves as the first building block in a larger, multi-unit, computer-controlled system for the future.

Right On Cue. The Studer A725 has special control software for precise, accurate, and consistently repeatable cueing. Start accuracy is ± 1 frame (13.3 milliseconds), and start from pause takes less than 0.6 seconds. The cueing controls (upper right) are large, so you can't miss them even in a dimly lit studio. No more false starts or dead air. And no more operator errors from hitting the wrong mini-button. Multiple cueing modes and a fader start option provide extra versatility.

More Pro Features. The A725 has three pairs of outputs: balanced XLR ("+4"), fixed level unbalanced, and unbalanced with front panel level control. The A725's disc transport is built on a die-cast chassis for long-term stability, and the rack mount flange is standard.

A Display of Intelligence. The A725's four mode liquid crystal display shows elapsed time of track, elapsed time of disc, remaining time on track, or remaining time on disc. A bar graph gives additional information on tracks remaining or approximate elapsed time, depending on display mode. When indexes are accessed, index numbers are also displayed.

The Programming Department. Programming controls (lower left) may be used to pre-select up to 19 separate steps, including nearly every conceivable combination of repeat, skip, loop, and autostop functions. A protective cover is provided to prevent unauthorized use of these controls. A serial data port allows linkage to external computer control systems.

Critics Choice. The A725 utilizes oversampling (176.4 kHz) and digital filtering as well as proprietary analog filtering circuits. This same combination in our Revox B225 consumer version has earned unanimous praise from audio critics. Because it simply sounds better.

Price Surprise. The A725's professional features and superior performance come with a price you might not expect: $1550.* This is the sensible professional CD player broadcasters have been asking for, and it's available now from your Studer dealer. For more information or dealer referral, please contact: Studer Revox America, 1425 Elm Hill Pike, Nashville, TN 37210; (615) 254-5651.

*Manufacturers suggested retail price.

STUDER REVOX

Track Time Remaining

Disc Time Remaining

Track Time Elapsed

Disc Time Elapsed

Circle (2) on Reply Card

CHARGE
TEST
RANGE
INPUT
HP FILTER
SEL
HOST
(dBm)
WBS
M405D
WBS
M405F