CATV TECHNICAL STANDARDS

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"CATV Picture Performance Standards"

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The tremendous growth of the cable industry has placed increased demands on the technical quality of the picture signals carried by a cable system. Simultaneously, a technical "renaissance" has been occurring in both the Broadcasting technology and in home receiver performance.

Much has been said about inadequacies of the NTSC Color Television Standards, but the significant fact is that most problems for which the system is blamed are equipment or hardware limitations not remotely related to the transmission standards.

Let us review, in a broad sense, some of the progress that has been made recently.

Transmission Equipment

New color cameras having a far better signal-to-noise ratio, with increased resolution and increased sensitivity are now being heavily used by the Broadcasters. The color from these cameras is much more natural and the total picture tonal and chromatic content made much more pleasing than ever before. Even the Monochrome signals from these new cameras have excellent tonal quality. Transmitters and studio signal processing equipment have been greatly improved, particularly the signals from the major networks and from the new UHF or Educational stations.

Receiving Equipment

Here as in the transmission equipment, noteworthy improvements have been made in the color shadow mask cathode ray tube available Brightness and in the rendering of more accurate colors. Other areas of improvement for the receiver have been in more accurate tuning, often fully automatic in nature, AGC of the Chroma circuits, and better overall color stability.

With the increased public acceptance of color television, there has been a corresponding increasing clamor for better picture quality which is now being felt by the cable industry. To progress a cable system must keep pace with this technical upsurge. The large technical burden of supplying high quality cable television is rapidly becoming the principal factor by which the large market areas can continue their growth.

Need For Better Standards

The Long Lines department of AT&T and the Networks have at various times used a variety of test signals that could be passed along with video signals to enable continuous transmission system performance monitoring. Most Engineers are familiar with the standard picture test signals or patterns. These test signals are broadcast either before or after normal programming. This of course limits their usefulness to record keeping and transmitting facility checks that are useful only to the Broadcaster.

For on the air performance checking, the VITS (Vertical Interval Test Signal) is becoming indispensable. These test signals are switched into Lines 18 and 19 of both Fields #1 and #2. They are useful to us as cable test signals since they are transmitted simultaneously with the program to be viewed and are therefore subject to the same distortion as the standard picture signal. Both networks and the intercity carriers make extensive use of these test signals. Comparison of these VITS signals can be made at various points along a cable system, from Head End to the furthest subscriber drop. Since these signals are so readily available their basic parameters will be briefly reviewed.

Figure #1 **Multiburst Signal**

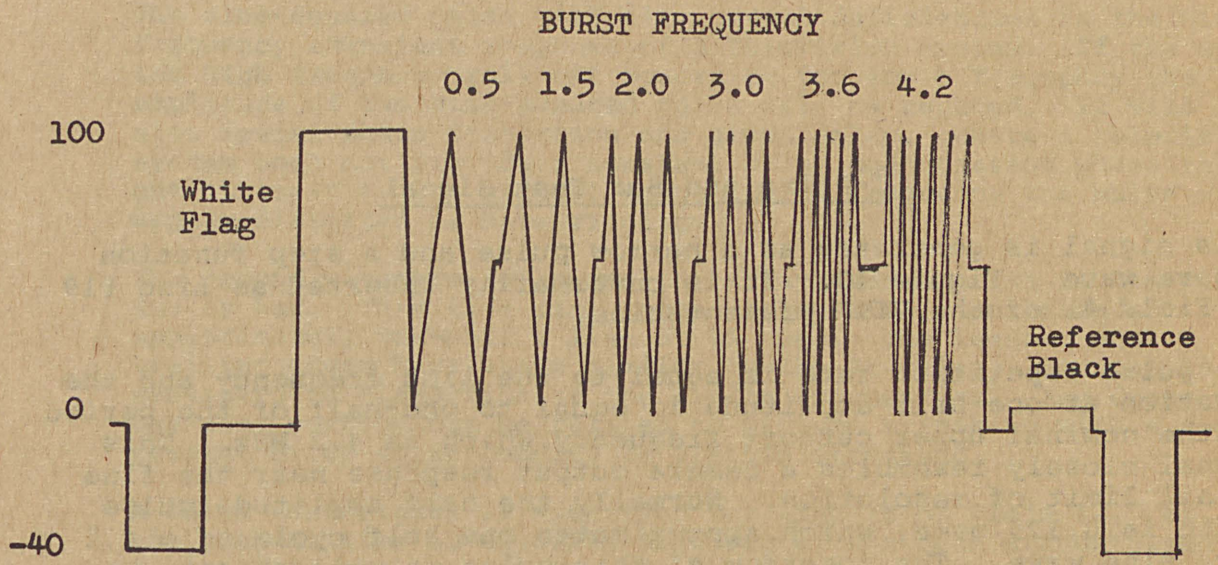

Figure #1

Multiburst Test Signal

The Multiburst signal usually occupies Line #18 of Field #1 and consists of; reference white level, a series of signals equal to reference white levels having the following frequencies: 0.5, 1.5, 2.0, 3.0, 3.6, 4.2MHz , and reference black level.

The Multiburst signal will test frequency response as well as show areas of frequency selective distortion. A low pass filter is often used at the measuring oscilloscope to filter out the high frequency burst signals leaving the average value or burst base line, Figure #2. If amplitude non-linearity exists at any of the burst frequencies, the filtered base line will shift since the net value is no longer zero.

Figure #2 Multiburst Test Signal Passed Through a Low Pass Filter After Detection

T-Pulse and Bar Test Signal

This signal is generated as a narrow pulse and a step function square wave. Figure #3. It is customarily inserted as Line #19 of Field #1 of the VITS presentation.

The pulse repetition rate is equal to the line frequency and the duration at one-half amplitude is equal to one-half of the period of the nominal upper cut-off frequency which is 4.2 MHz. This signal closely resembles a camera output response near the fine detail limit of resolution. Normally the half amplitude pulse width is 0.125 usec. which approximates one half cycle of a 4.2 MHz sine wave. The spectrum of this pulse is well chosen, being half amplitude at 4 MHz and diminishing to almost zero at 8 MHz. Most of the spectral energy is contained in the higher video pass band near the color sub-carrier frequency. The pulse width is set at 2T with half amplitude width of 0.25 usec. for evaluation of the region between 0.5 and 2.0 MHz. A T/2 pulse of 0.625 usec. is used to observe the low frequency region although the accompanying bar pulse normally will provide the same results.

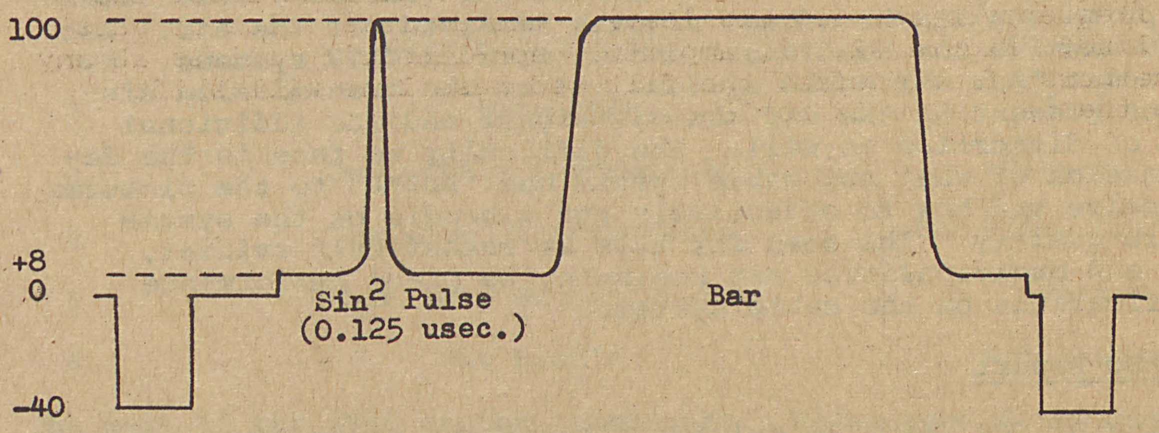

Figure #3 SIN ^{2} PULSE and BAR TEST SIGNAL

The sine-squared pulse will also reveal deficiencies in the high frequency transient response of a television system. If the system high frequency roll-off occurs at too low a frequency the amplitude of the sine-squared pulse will be reduced. It will also reveal phase distortion and group delay. Where a television system does not provide a constant delay and constant phase shift out at least to the highest transmission frequency the pulse will appear distorted or have ringing.

The second waveform following the sine-squared pulse is the window or bar. This is a flat topped pulse with a duration of approximately one-half a line or 25 usec. The leading and trailing edges have shape similar to the 2T pulse. The bar is sensitive to distortion at the middle frequencies. Any droop of the flat portion can be related to picture streaking with a few percent droop corresponding to visible streaking.

A color test signal is specified for Line 18 of Field #2. At the present time no specific test signal has been standardized. Various fixed phase color sub-carrier frequencies providing reference I, Q, R-Y, B-Y and alternating phase signals have all been used.

The last signal of the VITS series is the stair-step. This signal is used as a standard stair-step and with 20% 3.58 MHz modulation on each step. With the 3.58 MHz modulation the signal provides a test of the small signal gain variation as the luminance component is stepped from black to white. Any fault in the differential gain characteristics will result in a change of either the amplitude of the stair-steps or of the impressed 3.58 MHz modulation.

We have examined the built in test factors generally associated with prime quality broadcast signals received off the air. Let us now examine the conditions encountered in CATV systems. We must admit that our cable systems add to the transmission distortion present in the off the air signal and add additional forms of distortion as well. The difficulty we face is the determination of what our cable system has "ADDED" to the pictures we receive and how to objectively put a handle on the system picture quality. The need for this is rather self evident, towns and municipalities are beginning to place performance specifications on the cable systems.

The TASO Report

A review of the TASO (Television Allocations Study Organization) report of Panel 6 entitled "Levels of Picture Quality" indicates that the psychophysical aspects as well as the technical tests were considered important to the objectives of the panel. As part of the test run and reported on by this panel a total of 63 different test conditions were used.

Of these 49 test conditions were for single sources of interference and 14 were for two or more sources. The following general grouping can be made for the 63 tests:

Test Type	Number of Tests Made	Elements Varied Between Tests
Adjacent Channel	12	Upper and lower adjacent channel, interfering frame rate, scene.
Co-channel	29	Offset frequency, interfering frame rate, and scene.
Random Noise	8	Scene.
Co-channel and Random Noise Simultaneously Present	14	Offset frequency, level of random noise, frame rate, and scene.

A total of four receivers, two monochrome and two color receivers were used for the foregoing tests. The two color receivers were "good" chassis table models.

A six number rating scale was established for these measurements:

Grade	Reception Faults	Merit of Reception
1	Not Perceptible	Excellent
2	Just Perceptible	Good
3	Definitely Perceptible	Passable
4	Somewhat Objectionable	Not Quite Passable
5	Definitely Objectionable	Poor
6	Not Usable	Not Usable

The work of the TASO groups represents a milestone of achievement in the art of television. What is needed now is an extension of this fine work with more of the cable television parameters.

Conclusion

Good subjective Picture Quality standards are sorely needed by the cable industry. Accordingly, I make the recommendation that the cable industry through the NCTA, set up an Ad Hoc committee to determine the specific standards needed and make recommendations how such a series of standards might be implemented. If field tests are required, these too should come from the recommendations of this committee.

Thank you,
Walter S. Wydro