TECHNICAL SESSION - III

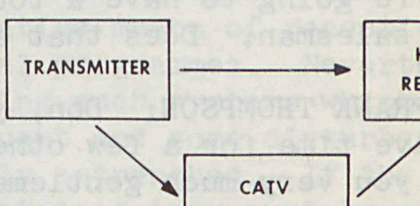
Wednesday Morning, June 29, 1966

CHAIRMAN HUBERT J. SCHLAFLY: Gentlemen: I would like to welcome you, on behalf of the NCTA, to the technical program for Wednesday morning. The weather has cooperated greatly by being miserable outside, and we are happy to have you here with us. I have been looking forward to this session; there are many interesting papers that I will be most interested in listening to and perhaps asking questions about. I think perhaps your presence here shows that you have the same type of feeling.

Because we have a long session this morning with many very prominent speakers, I would like to get underway now. The first speaker is Mr. Gaylord Rogeness. Mr. Rogeness has a Bachelor of Science and a Master of Science degree in electrical engineering from the University of Illinois. At Interstate Electronics Corp. in Anaheim, California, he designed and developed equipment on fixed price contract for custom instrumentation and telemetering systems, which were used both in the military and by NASA. In a consulting position with Goodyear Aerospace Corporation in Litchfield, Arizona, he designed and developed a systems in circuits for airborne reconnaisance mapping radars. One model of the Goodyear Radar Set is presently employed in the RF4C aircraft and is operational in the Vietnam area. In 1965 he joined AMECO. And for the last 3 months has functioned as the director of engineering of AMECO Engineering Corporation. Mr. Rogeness' paper is on Transient Response Testing of CATV Systems.

MR. GAYLORD ROGENESS (AMECO ENGINEERING CORPORATION): Ideal CATV system performance requires that the TV signal delivered to each subscriber be equal in quality to the signal received by the CATV antenna. In order to approach ideal performance, the CATV equipment must be designed to meet certain minimum standards, and then it must be tested under operating conditions in the field to insure that it is meeting its design goals.

The intent of this paper is to discuss a test which can supplement the number of tests already being performed on CATV systems. Use of a transient response test to evaluate system performance provides a dynamic test which simulates the actual TV picture signals.[1] It provides a more direct means to test the phast characteristics of the system. It provides an additional objective test of system performance which augments the final subjective test of viewing a TV receiver picture fed by CATV equipment. It provides a direct means for making critical alignment adjustments which are difficult to make with existing techniques.



TV PICTURE TRANSMISSION PATHS

Fig. 1

Figure 1 shows a block diagram of alternate TV signal transmission paths.

The TV picture signals travel either directly over the airways to the home receiver, or the TV signals are received by a CATV system and delivered to the home receiver via cable.

Many years of engineering study and design were required to develop transmitter and receiver characteristics, within certain tolerances, which are complementary. The overall transmission characteristics between television scene and home receiver, therefore, allow reproduction of acceptable color and black and white pictures. If no picture degradation is to occur, any system placed between transmitter and home receiver, such as a CATV system, must not alter the characteristics of the transmitter-receiver path.

Critical CATV system performance specifications are listed in Table I. The items listed are those which would have the greatest effect on picture quality, if they were not within acceptable limits. The specifications listed apply to both head end and line equipment.

Also listed in Table I, opposite the performance specifications, are the tests usually performed on CATV equipment which guarantee that the equipment is in the best possible operating condition. In essence, test number six checks the sum total of all of the system characteristics. However, note that no direct test is made to check the envelope delay response of the equipment. A qualitative test of the system envelope delay response can be made through use of the $\sin^2$ pulse.

TABLE I

CRITICAL CATV PERFORMANCE SPECS	TESTS TO INSURE OPTIMUM PERFORMANCE
1. Noise Figure	1. Noise Figure and/or S/N Ratio
2. Linearity	2. Cross Modulation and Spurious Signals
3. Amplitude Response	3. Sweep Amplitude Response
4. Delay Response	4. No Direct Test
5. Impedance Match	5. VSWR or Return Loss
	6. Observation of Picture on TV Receiver

The $\sin^2$ pulse has been chosen as a test signal for testing television transmission systems for a number of reasons. It is described in many articles and reports.

Some of the general considerations given for the choice of the $\sin^2$ pulse as a test signal are:

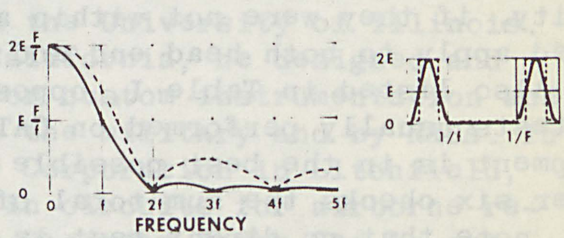
1. Convenience for practical measurement;
2. Ease of reproducibility; and
3. A relatively simple mathematical function that can be used in theoretical studies.

Figure 2 shows the frequency spectrum envelope of a repetitive $\sin^2$ pulse and square pulse. The repetitive square pulse has the well known $\frac{\sin x}{x}$ frequency spectrum, whereas the frequency spectrum of the $\sin^2$

pulse is $\left[\frac{\sin x}{x}\right]\left[\frac{1}{1-x^2/\pi^2}\right]$. Note that most of the energy of the $\sin^2$ pulse is contained below twice the fundamental frequency f.

The $\sin^2$ pulse very closely resembles the electrical pulse from a television camera corresponding to a scanned white line. This type of pulse has definite advantages as a test signal for the high-frequency end of the band. It provides a stringent test of the ringing characteristics of the transmission path. Any phase and delay distortion in the system will cause direct asymmetry of the $\sin^2$ pulse about its ordinate through the peak amplitude point. Hence, the $\sin^2$ pulse provides a means to evaluate the system response.

The $\sin^2$ 2T-pulse is shown in Figure 3 after passing through a system with an ideal characteristic. The 2T-pulse has a half amplitude duration of 0.25 μsec and should pass through the 4.2 mc bandwidth TV channels with minimum distortion.

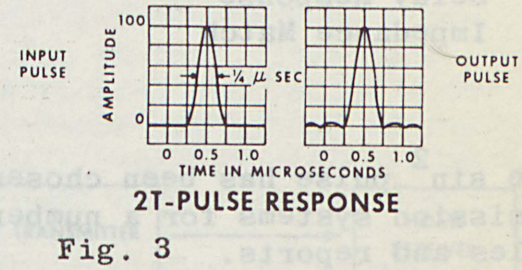


SPECTRUM ENVELOPES - RECTANGULAR PULSE AND SINE-SQUARED PULSE

Fig. 2

The $\sin^2$ pulse is used most often to test the 4.2 mc bandwidth TV transmission system. The T-pulse has a half amplitude duration of 0.125 μsec and is shown in Figure 4 before and after passing through an ideal system. The effects of one type of delay distortion on the T-pulse response are shown in Figure 5. Note that delay distortion causes the $\sin^2$ pulse to be assymmetrical about its ordinate.

The delay distortion characteristic shown in Figure 5 causes ringing on the trailing edges of narrow pulses and after rapid transitions in luminance level. In some instances, the visual effects of ringing are similar to those produced by reflections caused by impedance mismatch. Seriousness of the ringing is measured by the amplitude and duration of the "rings".



2T-PULSE RESPONSE

Fig. 3

If the frequency axis of Figure 5 were reversed, low frequency components of the signal would experience greater delay than the high frequency components. As a result, it is possible to produce echoes or ghosts which precede the desired image. For this condition the T-pulse response would have anticipatory undershoots and overshoots which precede the main pulse.

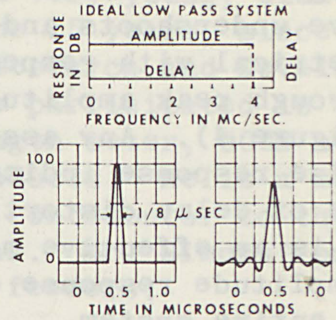
One of the most obvious and disturbing effects of delay distortion is misregistration of color on the image. Color can either precede or follow the desired image, depending upon the overall delay characteristic of the transmission pulse.

A block diagram of a test setup to check a CATV system is shown in Figure 6. The sin^2 pulse and VITS signal (to be described later) appear to be most useful in testing the CATV head end equipment. However, waveforms can be checked along the amplifier cascade to insure that optimum transmission is maintained. The effects of noise and crossmodulation products are more prevalent in the repeater amplifier cascade. Phase and amplitude distortion in any one 6 mc band are more prevalent in the head end equipment.

Two options for obtaining test signals are noted in Figure 6. One test method requires the use of a sin^2 generator and a modulator for each channel to be tested. The second source of test signals is the Vertical Interval Test Signals (VITS) which are transmitted by the networks[6] and therefore available off the air. The VITS occur during the vertical blanking intervals. The VITS format is shown roughly in Figure 7 for the first field. Line 18 of a frame contains a multi-burst signal and Line 19 contains the sin^2 pulse. The VITS are used by the three major networks and provide a good source of in-service waveform monitoring.

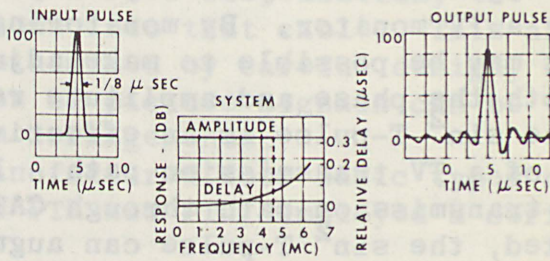
The presence of VIT signals can be seen on any TV receiver by rolling the picture with the vertical hold control. The VIT signals manifest themselves as white dashes and dots in a single line in the vertical blanking area above the top of the picture.

System performance can be measured by comparing the signals into and out of the CATV system on a waveform monitor. Multi-burst and T-pulse waveforms at the output of a test signal generator are shown in Figure 8.



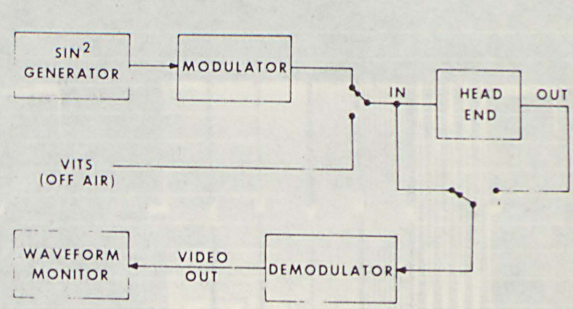
T-PULSE RESPONSE

Fig. 4



EFFECT OF IN-BAND DELAY DISTORTION

Fig. 5

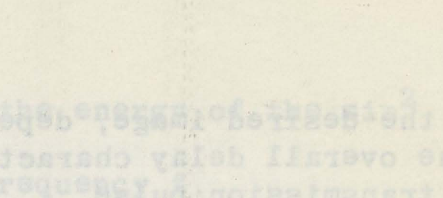


TEST SETUP FOR OBSERVING TRANSIENT RESPONSE OF HEAD END EQUIPMENT

Fig. 6

The $\sin^2$ T-pulse waveform is displayed on a wideband oscilloscope and if passed through a band limited system, it would have undershoots and overshoots symmetrical with respect to its ordinate through peak amplitude (refer to Figure 4). Any assymmetry in the T-pulse response indicates the presence of delay distortion. The multi-burst is an effective means to check the amplitude response of the head end or entire system.

At the present time, most equipment is aligned for a specific amplitude response. The phase and delay response which result from the given amplitude response is then accepted. It is difficult to optimize the phase response of a system by only viewing a TV monitor. By monitoring the $\sin^2$ T-pulse on a waveform monitor, it may be possible to make adjustments in the equipment which optimize both the phase and amplitude response simultaneously.



VERTICAL-INTERVAL
TEST SIGNALS (VITS)

Fig. 7

The $\sin^2$ T-pulse is an effective test signal for evaluating the response of a TV transmission path. It provides a means to evaluate the TV signal transmission path through CATV equipment. Properly applied and interpreted, the $\sin^2$ T-pulse can augment the number of tests already performed on CATV equipment to insure optimum performance.

The $\sin^2$ pulse is included in the VIT signals which are available off the air. Other signals included in VIT are also useful in checking CATV equipment alignment.

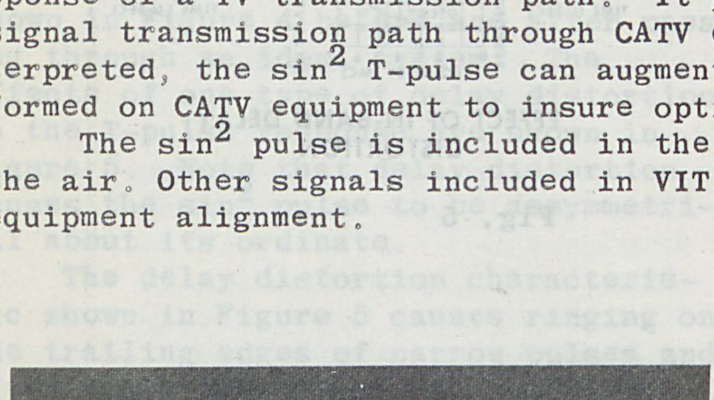
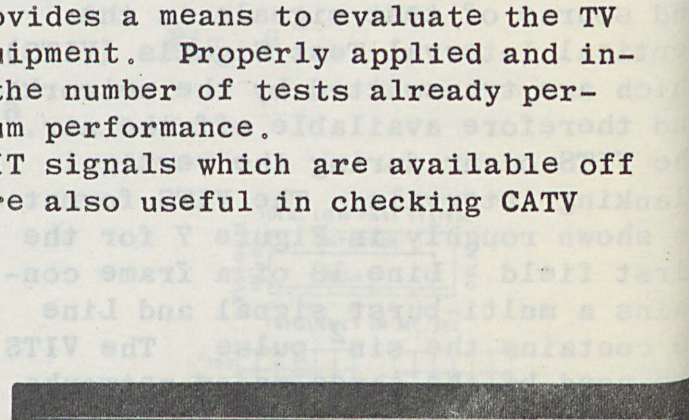


Fig. 8



Multi-burst and $\sin^2$ T-pulse at Test Signal Generator Output.