TESTING VIDEO SIGNAL TO NOISE RATIO USING A MODIFIED STAIRCASE WAVEFORM

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ABSTRACT

Video noise measurements usually require specialized test equipment to obtain accurate results. A method is presented which uses a modified staircase test signal generator at the transmit end and requires only an oscilloscope and low pass and weighting filters at the measurement location. The measurement is direct reading in dB, requires no calibration of equipment, and is fast and simple.

I. INTRODUCTION

While there are several measurement techniques that are used for measuring video signal to noise ratio, they generally require specialized test equipment. Broadband RMS voltmeters have been used to measure the noise level of a system in the absence of a test signal. Rhode and Schwarz produces an excellent video noise meter that measures the noise on a flat field waveform but it is not common in the CATV field. Tektronix has an instrument which strips the noise from part of a line of video (Fig. 1); calibrated noise from this instrument is then inserted by the operator until the noise inserted appears on an oscilloscope to be equal to the noise on the signal (Figs. 2 and 3). Lenco manu-

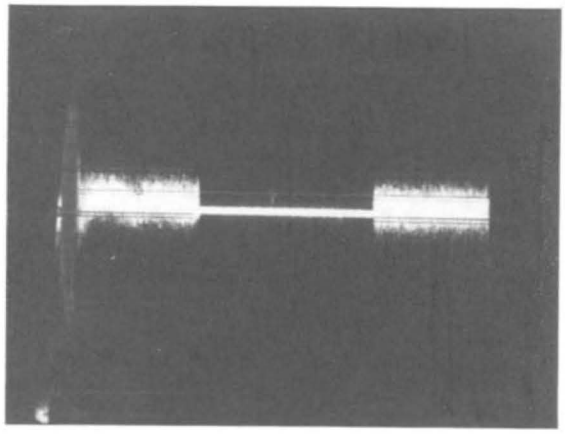

Fig. 1

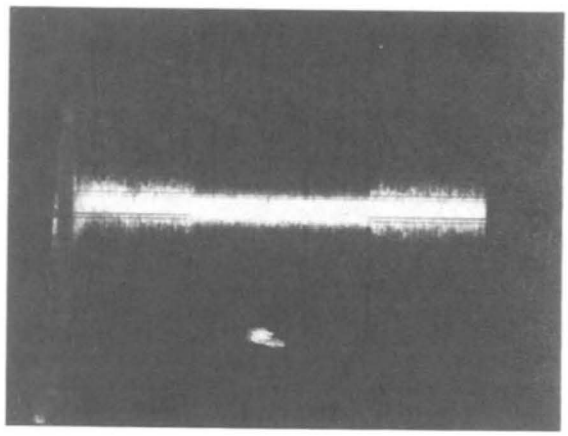

Fig. 2

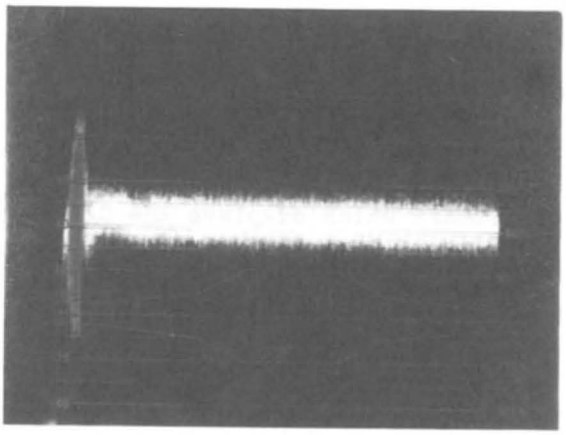

Fig. 3

factures a device which uses a tangential noise measurement technique. This measurement is made by displacing the waveform vertically by a variable voltage; the traces are then brought together until the dark band observed between the two waveforms disappears (Figs. 4 and 5). The

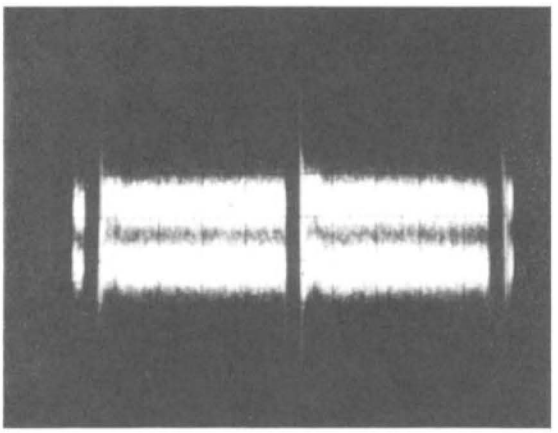

Fig. 4

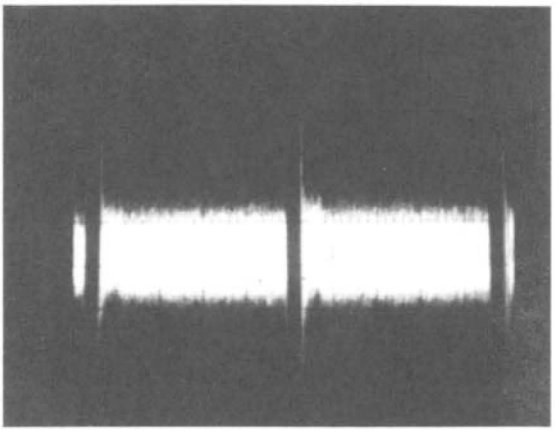

Fig. 5

displacement voltage which is directly related to S/N ratio, is measured by a logarithmic digital voltmeter in the instrument which displays the S/N ratio directly in dB. Another approach (described in the NTC Report Number 7) uses an oscilloscope and low pass and weighting filters. The technique requires estimation of the quasi-peak-to-peak amplitude of the noise at blanking level; quasi-peak-to-peak being defined as "the average level [of the noise] ignoring large occasional spikes of noise." The measured voltage is converted to the video S/N ratio by referring to a graph.

II. OTHER APPROACHES

It would be quite helpful to develop a measurement technique which would eliminate the cost of specialized test equipment and would be simpler and more accurate than the NTC-7 approximation method.

Methods which require only a TV set would be ideal, but at this time there does not appear to be an accurate way to do this, although several approaches were investigated. The next approach was to rely on a wideband (10 MHz) general purpose oscilloscope with low pass and weighting filters.

III. PROPOSED METHOD

If a full field 10 step staircase test signal is viewed on an oscilloscope such that a full field is displayed, the trace appears as 10 horizontal lines of equal spacing. If noise is added to the waveform as in a transmission system, the space between the horizontal lines will be filled in just as in the tangential method. Of course,the steps in the standard 10 step staircase are too widely separated for the S/N ratios which are generally encountered. The generator can be modified to produce steps with closer spacing, but a staircase with equally spaced steps would be useful to measure only one specific S/N ratio. If however the spacing between steps is changed every 1.4 msec across a video field (Figs. 6 and 7),

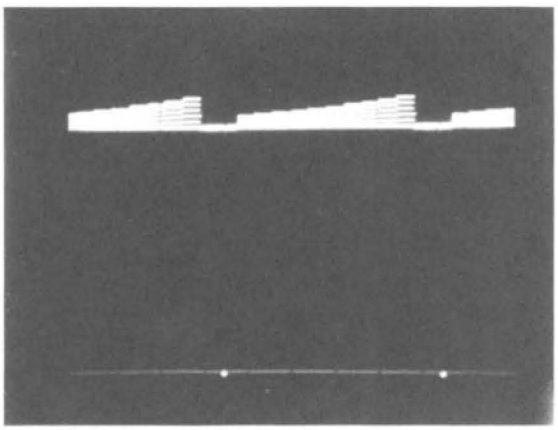

Fig. 6

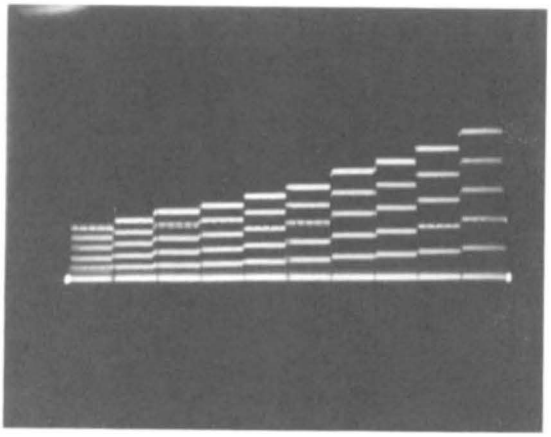

Fig. 7

then 10 S/N ratios could be measured. In this case 1dB increments were chosen and adjusted to cover the range of 47dB to 56dB S/N ratio.

IV. MEASUREMENT TECHNIQUE

In order to make a satisfactory S/N measurement a low pass filter is required to remove noise energy which may be present above the desired video bandwidth. In addition, A CCIR Weighting Filter is used to "shape" the noise over the frequency band to correspond to the response of the human eye. It should be noted that all S/N measuring techniques use these filters to obtain a weighted S/N ratio. The oscilloscope used in the measurement should have a bandwidth which is flat in the area of interest which means that it should have about a 5 MHz to 10 MHz bandwidth. Sensitivity should be about 20mv/division minimum, and DC coupling is desirable although not necessary.

The S/N ratio measurement is made by setting the horizontal sweep to display one field of the test waveform. If the scope sweep has a vernier control the display can be adjusted to have each of the 10 groups of steps fill one horizontal division; therefore each horizontal division will correspond to a specific S/N ratio. The S/N of the system corresponds to the last step which is completely filled by noise of uniform brightness.

The next step(s) which corresponds to a lower S/N ratio(s) will have a dark space (or "banding") between them. If banding appears between all steps the S/N ratio is 57dB or better; if the spaces between first steps are filled with noise the S/N ratio is 56dB. If the first and second steps are filled, then the S/N ratio is 55dB and so on down to the last step. If the tenth step is filled, then the S/N ratio is 47dB or worse.

Figs. 8 through 11 show S/N ratios

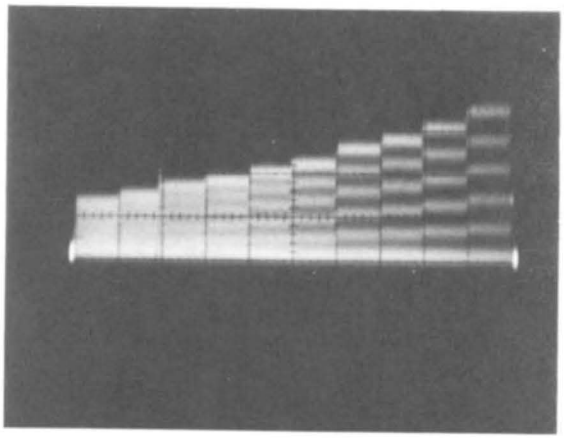

Fig. 8

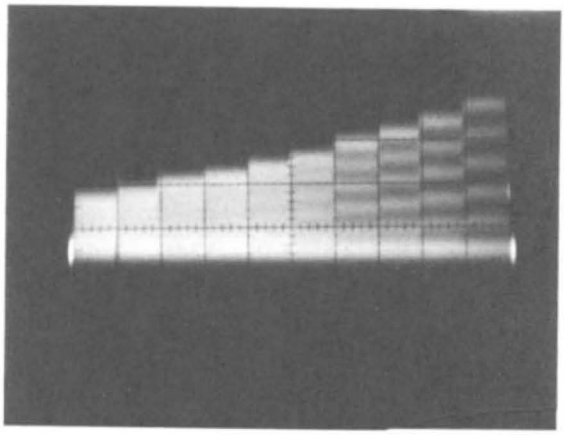

Fig. 9

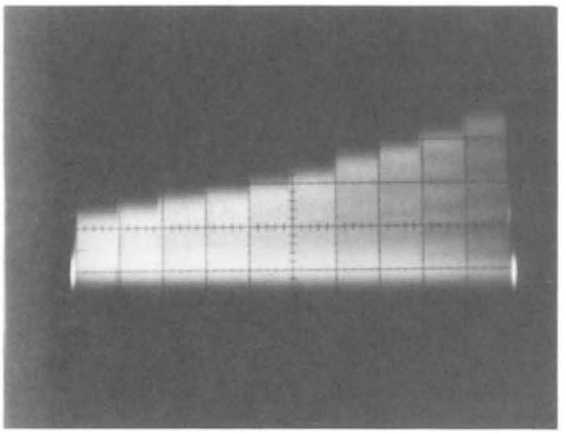

Fig. 10

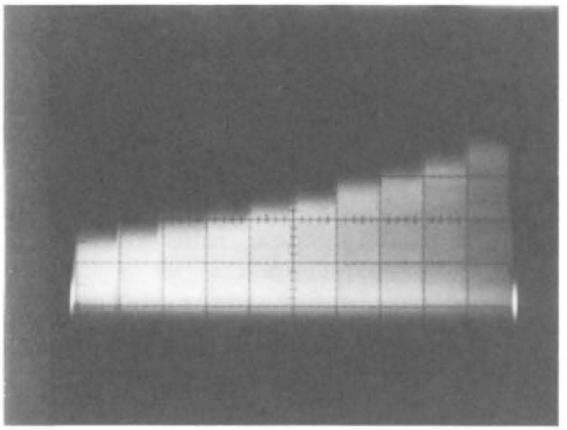

Fig. 11

corresponding to 55dB, 52dB, 49dB, and 48dB respectively. The oscilloscope should be set up for "normal" brightness and focus although the measurement is not very sensitive to these variables.

V. ACCURACY AND RESOLUTION

The accuracy of the technique is dependent on the accuracy of the level of the test signal going into the system to be tested as well as the accuracy of the level between the steps. Resolution appears to be about 1dB. The measurement accuracy does not depend on the accuracy of levels at the receive end nor does it require a calibrated oscilloscope.

VI. FIELD TESTS

While this technique has been tested in a lab environment, further tests will be conducted to determine whether any difficulties occur in a field environment.

VII. APPLICATIONS

The primary application for which the S/N measurement technique was developed is satellite earth stations. Other applications include microwave transmission systems or possibly the cable system itself. The test signal could also be recorded at the beginning of a video tape so that the overall record-playback S/N ratio can be monitored. The test waveform can be set up to accommodate whatever range of S/N ratios that might be required for a given application.

VIII. ACKNOWLEDGMENT

A special note of thanks is due to Jim Demetrius for his invaluable assistance in the construction, testing and criticisms of this technique.