MUTUAL EFFECTS OF BTSC STEREO AND RF SYNC SUPPRESSION SCRAMBLING

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ABSTRACT

This paper deals with the interaction of BTSC stereo and RF scrambling systems. Both gated and sine-wave sync suppressed systems are examined. The results of separation measurements at various points in the system using both commercial and consumer stereo decoders are presented. Also presented is a subjective evaluation of both video and audio quality variances due to interaction.

INTRODUCTION

In response to the growing anxiety over BTSC Stereo vs cable television scrambling systems, Wegener Communications has been conducting a series of tests over the past months to determine the effects of stereo on a scrambled channel and vice versa. The results of these tests are the subject of this paper.

The video source for this testing was a satellite feed while the audio source changed depending on whether subjective or objective testing was being conducted. Stereo program audio was used for subjective testing; an audio signal generator provided tones for separation tests. Separation was measured by terminating the input to one channel into 600 ohms while injecting audio tones into the other channel and comparing the outputs on an oscilloscope.

A measurement base was established by measuring separation of the composite baseband output of the Wegener Model 1791-02 BTSC Encoder with a Belar BTSC Reference Monitor which was verified to follow the BTSC standard. Measurements were then made at 4.5 MHz using a precision Wegener 4.5 MHz demodulator. Finally, a CATV modulator and converter were added and full system data was taken.

TEST SPECIFICS

Set-up

Initial benchmark testing was conducted to establish a basis of comparison. These tests were performed at baseband - back to back from the composite audio output of the Wegener BTSC encoder to the input of the Belar reference decoder. Separation measurements indicated an average of 38dB between 50Hz and 12KHz. Greatest separation was 49dB at 3KHz while minimum separation measured was 32dB at 12KHz. Next, measurements were made at the RF output of the BTSC encoder. A precision Wegener subcarrier demodulator was used to demodulate the 4.5 Mhz output of the BTSC encoder. The demodulated BTSC encoded stereo signal was input to the Belar reference decoder to make the measurements. Average separation of 33dB was measured between 50Hz and 12KHz with greatest separation of 38dB at 2KHz and minimum separation of 29dB at 12KHz. Finally, the subcarrier output of the BTSC encoder was used as the input to an Scientific-Atlanta 6350 modulator with channel 26 output modules installed. The modulator output was attenuated to present a level of 0dBmv to a non-descrambling 36 channel cable TV converter. The connecter's output was looped through a Recoton consumer-grade channel 3 stereo decoder and a Scientific-Atlanta 6250 channel 3 demodulator before being terminated at the 75 ohm RF input of a TV/Monitor. The subcarrier output of the channel three demodulator was routed to the input of the 4.5 MHz subcarrier demodulator whose output, in turn, fed the Belar reference decoder. The video output of the channel three demodulator was terminated at the video input of the TV/Monitor. Figure 1 depicts a block diagram of the system. Average separation through the entire RF chain measured 33dB over the 50Hz to 12Khz band. Maximum separation of 36dB occurred at 3, 9, and 10KHz with minimum separation of 31dB at 50Hz and 2KHz as measured with the Belar reference decoder. The consumer decoder averaged 21dB in the same band with a maximum of 26dB at 9 and 10KHz and a minimum separation of 10dB at 12KHz. Figure 2 is a graph of separation measurements observed at the various points in the system.

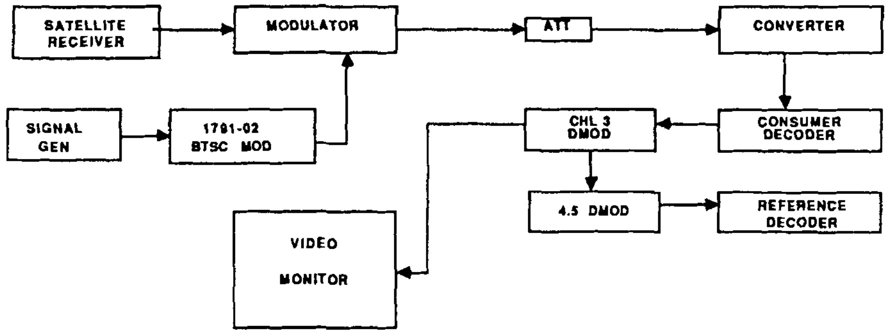

FIGURE 1

SYSTEM BLOCK DIAGRAM - NO SCRAMBLING

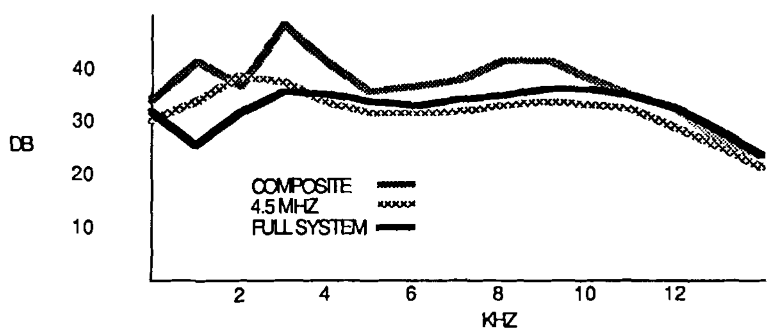

FIGURE 2

NON-SCRAMBLED SYSTEM SEPARATION MEASUREMENTS

Sine Wave Sync Suppression

An Oak Mark V Encoder and Model M35B converter/descrambler were used in this porion of the test. After installing the the encoder/decoder as in figure 3, separation measurements were made. In both the scrambled and non-scrambled modes, separation averaged 23dB in the 50Hz to 12KHz range from the consumer decoder and 25dB from the reference decoder. From the data observed, it was apparent from this data that sine wave sync suppression has very little effect on separation. As was expected with this system however, there were some audio components perceptable in the video. To determine how much of this interaction was due to BTSC, a switch was installed on the rear panel of the BTSC encoder which could select either a stereo or mono output. By switching between stereo and mono audio while observing the video, a qualitative evaluation of BTSC-related video degradation was made. Worst-case degradation occurred when video and the 4.5MHz audio subcarrier were combined at the video input of the modulator and the audio source was a constant tone. The audio interaction in this configuration was plainly visible when observing the effect using program video demodulated by a consumer grade television receiver. In comparison, when program audio was used and the video applied to the modulator separately from the 4.5MHz audio subcarrier the interaction was barely perceptible when observed using a flat field video signal and viewed on a video monitor. This may imply that a system utilizing this scrambling system would be advised to separate the video from the audio subcarrier if at all possible.

Gated Sync Suppression Scrambling

Both Pioneer and Scientific-Atlanta scrambling equipment were tested. As data taken were similar, and to avoid product- specific performance, the results are presented as an average of the two.

Again, scramblers were installed as in figure 3. Measurements were made in both scrambled and non-scrambled modes. In the non- scrambled mode separation averaged 33dB in the 50Hz to 12KHZ range on the reference decoder and 20dB using the consumer decoder. In the scrambled mode separation averaged 22dB with the reference decoder and 19dB with the consumer decoder. Please refer to figure 4 where the measurements are graphed. The data clearly indicates that gated sync suppression scrambling does degrade separation. However, according to Philys Kurtz, in her article "Maximum Separation" in the September issue of Television Broadcast, a delivery of 18dB of separation to the home is the broadcast industry target with a typical figure in the low 20's. Therefore, even though separation is dimminished somewhat by this scrambling technique, the separation is still in a range to compete effectivley with "off-air" delivery and present acceptable stereo to the subscriber.

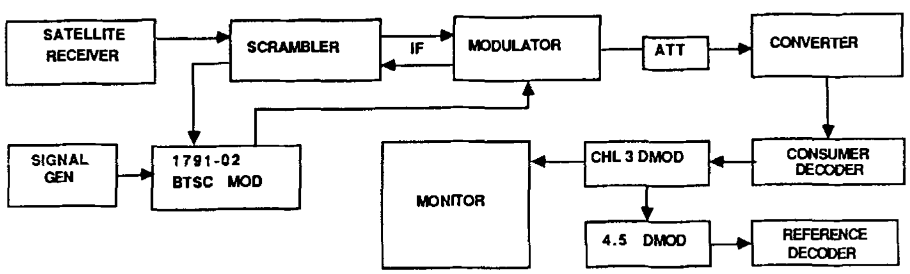

FIGURE 3

SYSTEM BLOCK DIAGRAM - WITH SCRAMBLER

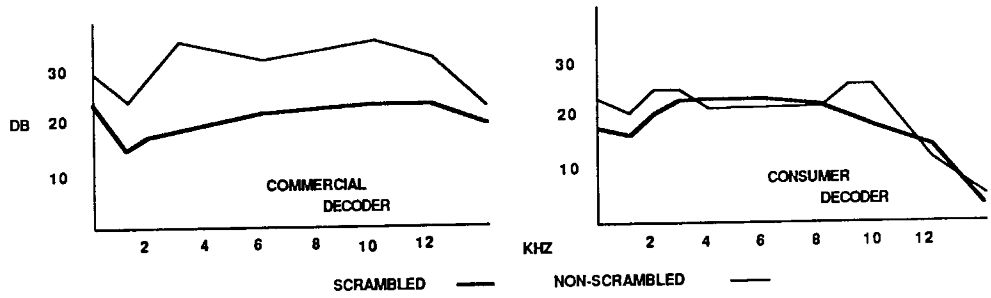

FIGURE 4

SEPARATION MEASUREMENTS IN SCRAMBLED AND NON-SCRAMBLED MODES

Video quality is not perceptibly impaired when BTSC stereo is introduced into the gated sync suppressed system. Pictures were stable - no descrambler "break-up" was observed. And, video quality did not perceptbly change when the audio programming was alternated between stereo and mono.

The most obvious detriment in a gated sync suppression system is sync-buzz. However, this phenomenon is more rightly associated with the scrambling system rather than BTSC stereo. The observed data did not significantly change when alternating between stereo and mono. There was a significant difference observed in sync- buzz level when non-scrambled mode was compared to scrambled mode. This measurement was made by setting a reference tone level at the output of the stereo decoder. The input of the encoder was terminated and the noise floor measured. this test was repeated at 1KHz, 5KHz, and 10KHZ in both scrambled and non- scrambled modes. Intuitively it would seem that the lower frequencies would be most affected. And, the data indicated this to the the case. At 1KHz in the non-scrambled mode, signal to noise measured 45 dB while in scrambled mode signal to noise dropped to 37 dB implying an 8dB noise contribution due to scrambling. At 5KHz and 10KHz signal to noise in and out of scrambling mode measured within 2dB.

CONCLUSION

After consideration of the observed data it is concluded that BTSC stereo present's no insurmountable obstacles to implementation. Inherent constraints of the scrambling techniques examined here brought to light concerns particular to each. In the case of sine wave sync suppression the major concern is video quality, which can be assured through careful treatment of the video/audio subcarrier relationship. It is recommended that the BTSC encoded audio be introduced to the modulator as a 4.5 MHz subcarrier separate from the video. On the other hand with gated sync suppression the primary concern is noise on the audio, some of which is introduced by direct modulation of the audio carrier by video. However, the major contributor in this case is the descrambling pulse. Here depth of video modulation, scrambler set-up and audio input levels are the critical parameters. All three of these will have an effect the apparent noise contribution.

Finally, a couple of general statements about BTSC. One, leave as many adjustments as possible to the factory (in particular audio deveation which is critical to separation). Two, in order to reduce interaction keep co-processing of video and audio to a minimum (ie., don't mix the audio subcarrier with the video until it's necessary). Keeping these two generalities in mind, the following order of preference can be stated for the BTSC encoder/CATV modulator interconnect.

1. 4.5MHz audio subcarrier separate from video
2. Video and 4.5MHz combined
3. Encoded baseband directly to the modulator audio inputs

BTSC stereo is compatible with the scrambling techniques tested and easily implemented in a cable television system. Neither is absolutly transparent; however both will co-exist very well. Cable systems employing these scrambling systems should have no problem enhancing the services offered with the addition of BTSC stereo.