Considerations in The Operation of CATV Headends Carrying BTSC Stereo Signals

BY

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Important parameters in the proper operation of a cable television headend carrying BTSC stereo audio signals are discussed, and the reason for their importance is presented. The reason for not adjusting aural carrier modulation levels with a program BTSC stereo signal is presented. Methods of adjusting a headend for BTSC stereo transmission are presented, as well as some basic considerations in generating a BTSC stereo signal.

INTRODUCTION

The use of the BTSC stereo transmission method in cable television systems has generated much controversy. The BTSC format, however, has been universally accepted by television receiver manufacturers as the stereo sound transmission standard to be used in the United States. If a cable system operator decides that he will carry signals in the BTSC format, it is important that he understands the requirements for operating such a system. In addition to hardware changes, the manner in which the cable system is operated will have to be changed. This article addresses some of the more important issues in operating a system which carries a BTSC stereo signal. It will be assumed that the cable television system operator has studied the technical issues involved in selecting a stereo transmission method (i.e., set top converter compatibility, scrambling, etc.) and has determined that the BTSC format is suitable for his system.

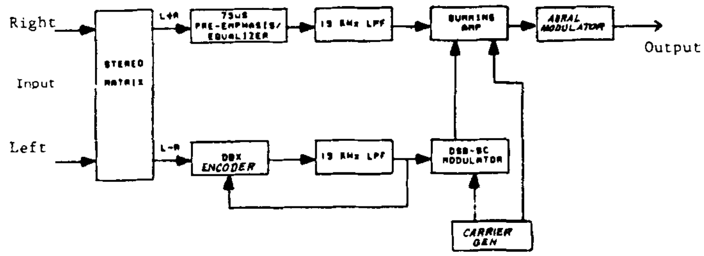
BASIC BTSC THEORY

In order to help understand the problems associated with the BTSC signal, a cursory review of the system is in order. The system is conceptually similar to commercial broadcast FM stereo. As with commercial FM stereo, the BTSC stereo signal consists of a baseband signal which is the sum of the right and left audio channels and a double sideband suppressed carrier (DSB-SC) subcarrier which is modulated by a signal which is the difference between the left and right audio channels. The carrier frequency of the DSB-SC signal is twice the horizontal scan frequency of the video signal. A pilot carrier that is used to demodulate the DSB-SC subcarrier and to indicate the presence of a stereo signal, is transmitted at a frequency equal to the horizontal scan frequency. Figure 1 shows a basic block diagram of the system and an illustration of the baseband spectrum of the encoded signal. Note that an additional subcarrier is shown. This is the Second Audio Program (SAP) subcarrier which is used for bilingual broadcasts. This subcarrier is FM modulated. The maximum deviation of the main carrier by each component is indicated in the figure. Because of the wider baseband bandwidth (100KHz) and the higher peak deviation (±73KHz) of the aural carrier, the stereo compatible CATV headend must have wider baseband and RF aural carrier bandwidths than those required for monaural operation.

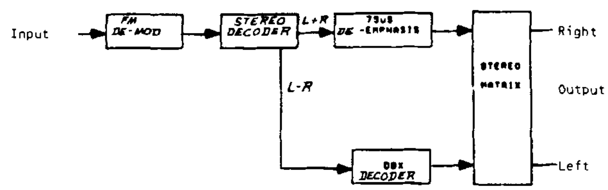
In order to achieve a good signal to noise ratio in areas of poor signal quality, it was determined that some noise reduction method was required for the difference subcarrier and the SAP subcarrier. The noise reduction system chosen was the DBX companding system, which consists of wideband compression and variable pre-emphasis in the encoding process, and a complementary wide band expansion and variable de-emphasis in the receiver.

It is important to note that for good stereo separation the gain in the sum signal path must be the same as the gain of the difference signal path. Note that ideally the DBX encoder at the modulator (transmitter or headend) and the DBX decoder in the television receiver are totally complementary and have no overall effect on the difference signal level and frequency response.

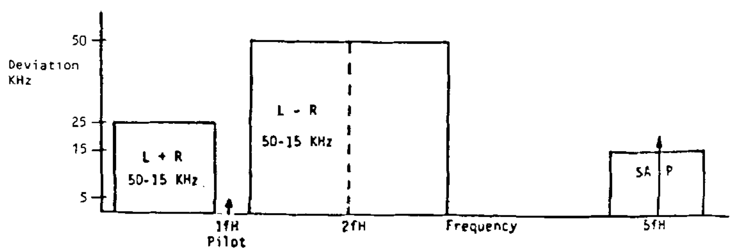
In order for the DBX decoder in the television receiver to properly track the DBX encoder at the transmitter (or CATV headend), the deviation of the aural carrier must be accurately set to the levels specified for the BTSC System. If the proper deviation levels are not maintained, the stereo separation of the system will be reduced. If the deviation is being set, there must be some reference signal from the BTSC encoder which corresponds to a specific deviation. Since there is no reference signal when the input to the encoder is a program audio signal, there is no way to correctly adjust the aural modulator deviation when the modulator input is program audio in the BTSC stereo format.



BTSC ENCODER/AURAL EXCITER



BTSC RECEIVER



BTSC BASEBAND SPECTRUM

FIGURE 1

SIGNAL PROCESSORS

As television stations start to broadcast BTSC signals, CATV signal processors will be required to process the BTSC signal. Signal processors fall into one of the following categories: heterodyne processors, strip amplifiers, and demodulator/modulator combinations. Of these, strip amplifiers and heterodyne processors are the simplest to use with a stereo signal. As determined by the NCTA studies and subsequent studies, these types of signal processors typically have few deleterious effects on the stereo signal. Since the audio signal is never demodulated, they require little attention in operation. This is not to say that these types of processors will not require modification or realignment to operate with BTSC stereo signals (although, many units will have sufficient bandwidth and passband amplitude flatness to operate satisfactorily with a BTSC signal). However, once these changes have been made, processing a BTSC stereo signal requires no more attention than processing a monaural signal.

If processing is performed with a demodulator/modulator combination, then the manner in which the aural signal is connected between the two units is critical. If the BTSC stereo signal is demodulated to a broadband baseband signal, it must be remodulated in the modulator to the modulation levels of the original signal. Any errors in this modulation level will be detrimental to the stereo separation. In an attempt to determine how critical the modulation level is to system performance, a computer program was written to simulate the BTSC encoder, the FM modulator, and the television receiver. The results from this program are shown in figure 2. As can be seen from the figure, in order to

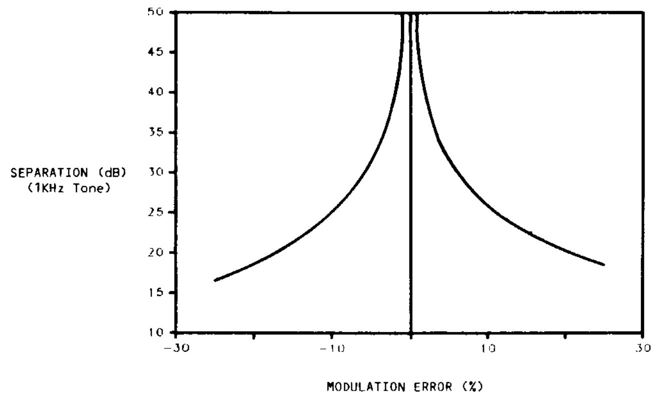


Figure 2

maintain a stereo separation of at least 30dB in an otherwise perfect system, it is necessary to maintain the modulation level to within ±5% of the correct level.

For these reasons it is preferable to interconnect the demodulator and the modulator audio path with a 4.5MHz link. This eliminates the problems associated with adjusting the modulation level since the signal is never demodulated. It is important to note that Scientific-Atlanta and other manufacturers' demodulators and modulators can be connected in this manner and provide satisfactory results with BTSC signals provided that the 4.5MHz path has sufficient bandwidth. There is much standard monaural equipment connected in this manner that when properly aligned, works well with a BTSC stereo signal.

If for some reason it is essential to demodulate a BTSC signal to broadband baseband, it is recommended that the demodulator/modulator combination be aligned in the following manner. Apply a FM carrier, which is modulated by a tone, to the RF input of the demodulator. Using a Spectrum Analyzer, adjust the tone to the correct frequency and level to produce a Bessel carrier null (i.e., a 10KHz tone modulating the carrier to ±25KHz deviation). Set the demodulator audio output to a convenient level or to the level recommended by the manufacturer. The modulator aural modulation level should then be adjusted until the same carrier null is present in the spectrum of the RF output of the modulator. This process will require that the demodulator/modulator be taken out of service while the adjustment is being made. Once the modulation has been set in this manner, it should not be necessary to adjust the demodulator output level or the modulator deviation.

It has been proposed that one way of setting modulation levels in a demodulator/modulator signal processing scheme would be to design a more complex modulation indicator which would have a narrow bandpass filter centered at the pilot carrier frequency. Since the pilot carrier always deviates the main carrier 5KHz, it is conceivable that some modulation indicator, either a peak deviation indicator light or meter, could then be used to measure the deviation due to the pilot. To set the overall modulation to the correct level, the pilot deviation would be set to 5KHz. Although this idea has some merit (and it is the only method which allows the modulation to be adjusted with an active signal), the standards for the BTSC stereo signal as they now exist allow for an error of ±500Hz in the pilot deviation. If the pilot were used to adjust the modulation level there could be as much as a 10% error in the modulation level. As can be seen from figure 2, this would give marginal stereo separation performance.

MODULATORS

Undoubtedly, as the popularity of stereo television grows, many cable system operators will desire to produce a BTSC stereo signal for their pay channels. It will be assumed that left and right audio signals' are available from a satellite earth station or other suitable source. Figure 3 illustrates how such a system might be configured. As can be seen, some form of BTSC encoder will be required. It will be necessary to decide whether the audio modulator portion of the video modulator will be replaced with a stereo-compatible unit or if the encoder will be purchased with an audio modulator. If the encoder is purchased with an audio modulator, then adjusting the system should be relatively simple because the modulation level will have been preset at the factory. It is only necessary to apply the proper left and right input levels to the encoder (these levels are not that critical). It might be pointed out that the level adjustments on the encoder audio inputs serve essentially the same function that the modulation control performed on the monaural system.

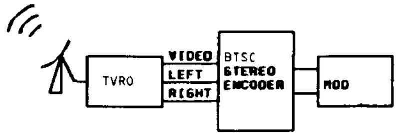


FIGURE 3

If the encoder which is purchased does not contain an audio modulator then it will be necessary to have an aural modulator which is compatible with the BTSC stereo signal. Once this is obtained it will be necessary to set the modulation level of the modulator. This presents a problem similar to that of setting the modulation level in the demodulator/modulator combination. One solution to the problem of adjusting the modulation level is for the BTSC encoder to provide a test tone to the modulator which produces a specified deviation. (In the case of the Scientific-Atlanta 6380 BTSC encoder, the tone should produce 25KHz deviation of the main carrier.) When the test tone is switched on, the aural modulator modulation level is adjusted until the overdeviation indicator on the aural modulator is just flickering on. It has been found that with a properly designed overdeviation light, this method gives excellent results in setting deviation levels. This method also allows the encoder to be aligned with the modulator with no test equipment.

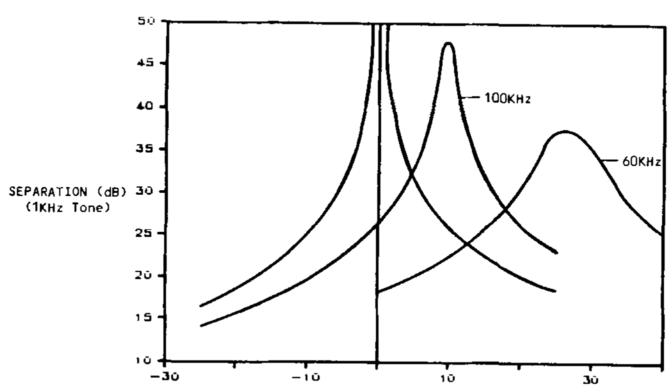
DEMODULATORS

This leaves only the demodulator to be considered. If it is desired to demodulate a BTSC signal to left and right audio (perhaps for simulcast into the FM band), it is important to choose a BTSC decoder which can demodulate the 4.5MHz output of the demodulator instead of decoding the broadband audio output of the demodulator. This will eliminate the problem of having to adjust the baseband level into the decoder. There are several consumer decoders which are designed to use baseband inputs. Although these could theoretically be used on the output of the demodulator, there is no way to properly set the signal level going into the decoder. This would present a problem similar to the problem of adjusting the modulation level of the modulator. (An error in the baseband level going into the decoder would have the same effect as an error in the modulator modulation level). For this reason it is recommended to use a decoder that will accept a 4.5MHz input.

As can be seen from the information presented here, the accurate adjustment of modulation at the headend is important in order to achieve the maximum amount of separation. This might suggest to some that the best way to adjust the modulation of a BTSC signal is to maximize the separation by driving one audio input to the BTSC encoder and adjusting the modulation level for a null in the undriven channel when the signal is monitored with a stereo television. Although this can be done to produce the maximum amount of separation, it is not a recommended method to adjust the modulation level. It was found (as shown in figure 4), that it is possible to correct for imperfections in the television or in the aural modulator (such as inadequate bandwidth of the television receiver) by allowing errors in the modulation level. This indicates that it is possible to maximize the stereo separation of the system by overmodulating the system! This is undesirable, and indicates that stereo separation is not the criteria which should be used to adjust modulation levels in a headend.

CONCLUSION

This article has pointed out some of the major headend operating problems that operators will face if they decide to carry BTSC stereo in their cable system. The most important point made is that the modulation level of a BTSC signal cannot be adjusted accurately with a program audio signal. For each combination of headend equipment there is an accurate method for adjusting the modulation level. All of these require the use of a test tone or external source. Although these procedures may seem overly complicated, they are required to obtain optimum performance from the headend when processing a BTSC stereo signal.



Separation of system with different baseband bandwidths.

Figure 4