THE IMPACT OF MULTICHANNEL TV SOUND ON THE CABLE SYSTEM HEADEND

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ABSTRACT

Although the Federal Communications Commission (FCC) did not rule on a Multichannel Television Sound (MTS) standard, they did protect the Electronic Industry Association's (EIA) recommended system. As such, the FCC has created a de facto standard for the transmission and reception of MTS.

This paper summarizes the effect of the MTS de facto standard on the cable system's headend equipment. Although other cable carriage schemes are in use today to supply satellite stereo services, this paper will only consider in-band carriage of the MTS signal. No judgements will be made concerning the audio performance of the MTS signal. Also discussed will be an overview of the modifications and equipment necessary for upgrading the headend to accommodate the MTS signal.

Since the FCC recently decided to indefinitely delay the decision to impose cable must-carry for MTS, no attempt will be made in this paper to anticipate any future FCC decision concerning this issue.

THE HISTORY OF MULTICHANNEL TELEVISION SOUND - A BRIEF CHRONOLOGY

In 1961, the Federal Communications Commission (FCC) decided on and approved a single stereo transmission system for FM radio. More than two decades later, in a time when Federal intervention was being downplayed, the FCC approved the use of sub-carriers for AM stereo, but did not choose a single AM stereo radio transmission system. Rather, they allowed the marketplace to decide. On March 29, 1984, the FCC approved the expanded use of the television aural baseband for stereo, second language service, and any other broadcast or non-broadcast purpose and also, like AM stereo radio, did not decide on a particular transmission system. To avoid a repeat of the present AM stereo radio controversy, however, the FCC protected the EIA's recommended MTS system and, in effect, created a de facto standard.

All problems solved, right? Not quite. During the decades which followed FM stereo radio, an entire cable television industry was developing. By 1984, more than 30 million subscribers were being served by over 7000 cable systems throughout the nation. These systems employ various generations of equipment and technology. Many are small 12 channel systems with limited bandwidth and outdated technology, while others have excess capacity and utilize state-of-the-art technology. Regardless of the available bandwidth or technology employed, these systems will have to deal with the issue of MTS. The driving forces behind cable system implementation of MTS could be any or all of the following:

1) A future must-carry mandate from the FCC.

2) Subscriber demand.

3) Revenue generation.

4) Franchise requirement.

Must-Carry Mandate

The decision regarding whether cable systems should be forced to carry the MTS signal, and in what format, was indefinitely delayed recently by the FCC. The cable industry had strongly argued against must-carry on the grounds of system incompatibility and resultant high cost to upgrade. The broadcast industry, on the other hand, had argued that copyright laws prohibit the modification of protected programs and, therefore, cable systems should be required to supply the MTS signal to the subscriber. The FCC compromised by directing its Mass Media Bureau (MMB) to annually monitor market penetration of MTS braodcasts and MTS

compatible receivers. The MMB was also directed to monitor the voluntary implementation of MTS by cable systems. In the meantime, the must-carry issue will remain open until such time the FCC solicits a new round of comments on the subject. Cable operators should, therefore, not overlook the possibility of a future must-carry mandate from the FCC.

Subscriber Demand

Most TV receiver manufacturers have recently announced the availability of multichannel sets. Some consumer electronics manufacturers have also announced availability of MTS adapters to convert monophonic sets to stereo. These announcements have undoubtedly created a consumer awareness of MTS. With this awareness comes unrealistic expectations from the cable subscriber that they will soon be receiving MTS via cable. Subscriber demand for MTS, whether founded or unfounded, will be a factor which cannot be overlooked by the industry.

Revenue Generation

MTS consumer awareness and resultant demand has created an opportunity for operators to generate additional revenue. Broadcasters are well aware that advertising revenues can be increased when native language programming is accompanied by native language commercials. Cable operators serving non-English speaking communities, in the same way could increase their advertising revenues by utilizing the second language program of the MTS standard. Major networks have already test-marketed bilingual broadcasts in non-English speaking markets and have had excellent results.

Those ignored stereo satellite services could also be offered in or out-of-band for additional revenue. For the consumer not sold on cable, these expanded audio services could help add subscribers and increase penetration.

Franchise Requirement

Although program material with bilinqual audio is limited in its availability at present, major city systems, in the future, may be required by franchising authorities to carry second language service for non-English speaking residents. The transmission of MTS will proliferate the availability of bilinqual programming as broadcasters seek to expand their market penetration and advertising revenues.

THE MULTICHANNEL TELEVISION SOUND SYSTEM

The objective of the EIA's Broadcast Television Systems Committee (BTSC) was to arrive at a single multichannel television sound transmission standard which would incorporate a compatible main channel, a full quality stereo sub-channel, a lesser quality seperate audio program (SAP) sub-channel and the potential for a professional sub-channel for telemetry purposes. Following initial testing, it was determined that some form of noise reduction would be necessary to compensate for the lower signal-to-noise ratio associated with the wider audio bandwidth of the MTS signal.

Of the three proposed transmission systems considered by the EIA, a single system was recommended which met the above objectives. As illustrated in Figure 1, the recommended BTSC MTS system consists of a main channel containing both left and right audio signals. The main channel pre-emphasis, bandwidth and audio deviation are identical to the current monophonic standard, i.e. 75 usec, 15 KHz and ±25 KHz respectively, and is therefore fully compatible with non-stereo TV receivers.

To separate the left and right audio signals, the stereo sub-channel contains the difference of left and right and has an effective bandwidth of 15 KHz with a sound carrier deviation of ±50 KHz. The combined audio deviation of the main and stereo sub-channel is ±50 KHz, since by definition, both signals cannot be maximum at the same time. The stereo sub-carrier uses double sideband suppressed carrier amplitude modulation with the sub-carrier locked to twice the horizontal scanning frequency. Dbx companding or noise reduction is added to this channel to improve the signal-to-noise ratio. The companding process also provides an improvement to the usual pre-emphasis technique for the stereo sub-channel. A pilot signal at the horizontal scanning frequency, causing a deviation of ±5 KHz, provides the necessary reference signal to control the stereo decoder in the TV receiver.

The SAP sub-carrier is locked at 5 times the horizontal scanning frequency and is frequency modulated with a bandwidth of 10 KHz and audio deviation of ±15 KHz. To boost the signal to noise ratio of this carrier, dbx companding is also incorporated and provides an improvement to the usual pre-emphasis technique. Finally, the professional sub-channel has its sub-carrier located at 6.5 times the horizontal scanning

THE BROADCAST TELEVISION SYSTEMS COMMITTEE (BTSC)
MULTICHANNEL TELEVISION SOUND SYSTEM

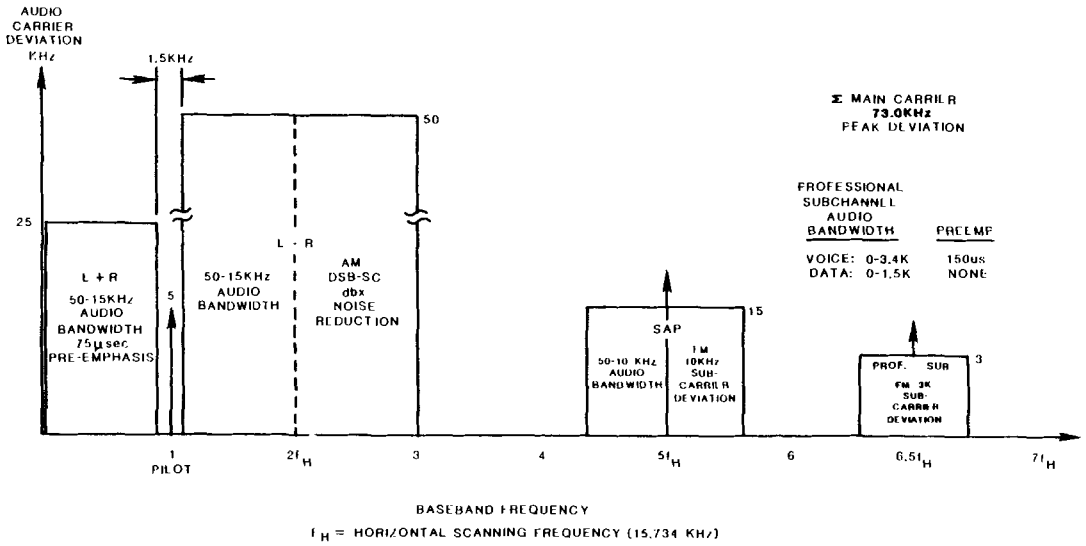

FIGURE 1

frequency and has a bandwidth of 1.5 KHz to 3.4 KHz (depending on the type of modulating signal) and audio deviation of ±3 KHz.

IMPACT OF THE BTSC MULTICHANNEL TELEVISION SOUND SYSTEM ON THE CABLE SYSTEM HEADEND

The cable system headend has experienced many technological changes over the last 25 years. From the earliest strip amplifier processing, utilizing vacuum tubes, to today's surface acoustical wave (SAW) filter processing utilizing integrated circuitry, the headend has evolved to meet the increased performance and bandwidth requirements of today's sophisticated systems. Because of the various technologies of headend systems in operation today, the BTSC MTS system will impact each in different ways. Three types of off-air headend processing are in varying use today: strip amplifier processors, demodulator-modulator baseband processing and heterodyne processors. Figure 2 summarizes the impact of the MTS signal on each type of headend processing method.

Strip Amplifier Processors

Strip amplifier processors are typically associated with small channel systems and over the years have gradually been replaced with heterodyne processors. The expanded bandwidth of the BTSC MTS system may not pass the sound trap of the strip amplifier processor without distortion, and thus, only the main channel (L + R) signal would be unaffected. Depending on the particular design of the strip amplifier processor, modification to the sound trap circuit may be possible so that both the main channel and the stereo sub-channel would have acceptable distortion. Most likely it would not be possible to pass the SAP sub-channel. However, caution should be given to the effects that widening the sound trap will have on the video passband. Widening the sound trap will decrease the video passband. It is recommended that the strip amplifier processor manufacturer be consulted to determine if the design will support a modification for MTS and to what extent the modification will support MTS, i.e: main channel, stereo sub-channel and SAP or just the main channel and stereo sub-channel.

Demodulator-Modulator Baseband Processing

This type of processing utilizes a demodulator to convert the received off-air signal to an intermediate frequency (IF) and then to baseband. The baseband signal is then fed to a modulator which remodulates the signal to the desired cable channel frequency. The demodulator incorporates an IF sound trap network which is designed to remove any residual IF sound from the IF video signal. This trap may not handle the wider bandwidth MTS signal and, therefore, may

MTS HEADEND IMPACT

HEADEND PROCESSING METHOD	SOUND TRAP BANDWIDTH MODIFICATION	SOUND IF BANDWIDTH MODIFICATION	AUDIO MODULATION BANDWIDTH MODIFICATION	AUDIO DISCRIMINATOR BANDWIDTH MODIFICATION	PRE-EMPHASIS DISABLE	DE-EMPHASIS DISABLE
STRIP AMPLIFIER	X	N/A	N/A	N/A	N/A	N/A
BASEBAND DEMODULATOR-MODULATOR	X (Demod. Only)	X	X (Mod. Only)	X (Demod. Only)	X (Mod. Only)	X (Demod. Only)
HETERODYNE PROCESSOR	X	X	N/A	N/A	N/A	N/A

Figure 2

distort the video. De-emphasis must also be disabled to eliminate incompatibility with the stereo sub-channel and SAP. The audio detector and baseband circuits must also be checked for sufficient bandwidth for compatibility with the MTS signal.

Concerning the modulator, the increased bandwidth of the MTS signal will require a modification to the audio modulation circuitry. The Jerrold Commander IV modulator, model C4MS, for example, has been modified to increase the baseband audio bandwidth to accommodate the MTS signal. The pre-emphasis was also made operator selectable so it could be disabled when modulating with an MTS signal. Both the audio bandwidth and pre-emphasis modifications on the Jerrold C4MS modulator were made to the audio modulator module (CAM). This module is a plug-in type and can be quickly and easily replaced in the field with a MTS compatible version (CAMS) for Commander III and IV modulators.

Heterodyne Processors

The heterodyne processor is the workhorse of headend off-air signal processing. Since demodulated baseband video and audio signals are not typically utilized in the headend, the heterodyne processor can process and channel convert an off-air signal more cost effectively than a demodulator-modulator system. The heterodyne processor heterodynes or mixes the off-air signal with a signal from the local crystal controlled oscillator to produce a stable IF. The IF is then amplified and heterodyned back to a particular cable channel frequency. As in the case of the demodulator, the bandpass of the sound trap must be increased to accommodate the wider bandwidth MTS signal. The sound trap bandpass on the Jerrold Commander IV processor, model C4P, for example, was increased to accommodate the MTS signal. It is important to note that subjective testing has shown that with accurate alignment all generations of Jerrold Commander series processors (CI through CIV) can be used to process the MTS main channel and stereo sub-channel signals with minimal impact on performance.

When the sound trap is widened to accommodate the MTS signal, the video IF passband is slightly decreased. In the case of the Jerrold Commander IV processor, the overall video IF bandwidth was reduced from approximately 4.2 MHz to 4.0 MHz relative to the picture carrier. This has been found to have no effect on subjective resolution, even on "full bandwidth" type receivers. For full compatibility with the MTS signal, Jerrold Commander III and IV processors can be field upgraded by replacing the IF amplifier module (CIA) with an MTS compatible module (CIAS). This module is located in the center slide-out drawer of the processor and replacement can be easily accomplished without removing the unit from the cabinet or rack.

THE MTS COMPATIBLE HEADEND SYSTEM

Figure 3 illustrates a typical headend system designed to process the MTS signal in-band. Off-air MTS signals are processed by a modified heterodyne processor. Processing satellite signals in the MTS format will be more difficult than processing off-air MTS broadcasts. Since stereo satellite services utilize various stereo transmission formats and are not expected to be standardizing in the near future, a compatible stereo decoder/demodulator will be necessary to provide baseband audio inputs to a MTS

MULTICHANNEL TELEVISION SOUND (MTS) HEADEND SYSTEM

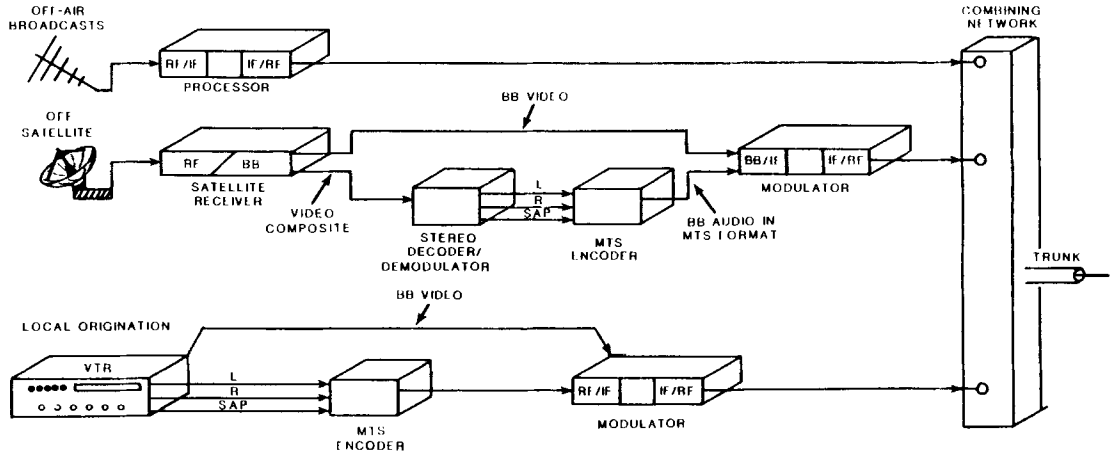

FIGURE 3

encoder. The MTS encoder generates the MTS baseband audio signal and would incorporate the necessary dbx companding and pre-emphasis. The MTS baseband audio signal is then fed to the audio input of the modified modulator and up-converted to the particular cable channel frequency. Local origination baseband audio inputs would be directly connected to the MTS encoder and then to the modified modulator. All signals would then be combined, as usual, before distribution.

CONCLUSIONS

Regardless of any future FCC decision concerning MTS must-carry for cable systems, market demand will be a driving force for determination of the cost versus technical feasibility and revenue potential of MTS implementation. With almost 1600 U.S. TV stations, including permittees, on record in 1984 and preliminary industry surveys indicating that more than 40% are planning to add MTS, means that more than 600 geographic areas will be soon served by MTS broadcasts. Taking a conservative average of 5 off-air channels carried per cable system, and cutting in half the industry surveys for broadcasters adding MTS, yields the fact that at least 1 must-carry off-air channel in every cable system will be broadcast soon in the MTS format. How soon is unknown. However, it cannot be overlooked that 1985 will begin with at least 15 TV stations regularly broadcasting MTS. These stations will ultimately affect at least 1 cable system in 20 or over 350 systems at the start of 1985.

As broadcasters add MTS capability and promote it accordingly, the cable subscriber will become very aware of MTS program availability and the availability of MTS TV receivers. It is expected that over 2 million MTS capable TV receivers will be sold in 1985. Some receiver manufacturers have even announced that MTS decoders may be standard in all receivers within 2 years. This will mean that the same questions that operators had to face when subscribers asked why their new "cable-ready" set could not give them premium services at basic rates or why their TV remote control was rendered useless when they added cable must again be faced when their subscriber asks why his $1,000.00 stereo TV set will not receive the stereo off-air broadcast the manufacturer promised. Even more serious will be the problem of retaining the subscriber when he reconnects his off-air antenna and enjoys the "free" stereo broadcast. It is time that cable operators look at ways to turn the MTS "problem" into an "opportunity" for additional revenue and/or increased subscriber penetration.