

White Paper

Master Control Operations with
Multichannel Audio

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Introduction

Probably every television facility contains at least one master control switcher. Its purpose is to switch and crossfade between many inputs to create the final audio and video program output that will be sent to transmission for delivery to consumers. In a digital television facility, the master control switcher must also be able to handle programs with different audio configurations. Network programs may be 5.1 channels, however it is very likely that commercials and local programs will have only two channels. This creates somewhat of a problem, a bit like asking the master control switcher to fade between a 16:9 high definition signal and a 4:3 standard definition signal. Obviously, either the 16:9 HD program must be downconverted to 4:3 SD, or the SD must be upconverted, than normal master control operations can take place. This paper discusses a solution for the audio half of the problem.

Master Control

How do you perform a standard crossfade between a two channel and a multichannel program? Good question. Unfortunately, the simple answer is that there is no simple answer.

The wrench in the gears is none other than Audio Metadata. To operate as designed, the metadata must change at the boundary of the two programs. When the video and audio switches, so must the metadata. Unfortunately, if the video and audio dissolve from one source to the next, the metadata would have to do the same and it cannot. Let's investigate a typical consumer Dolby Digital (AC-3) decoder to see exactly what is happening.

Figure 1 shows the basic signal flow inside a 5.1 channel Dolby Digital (AC-3) decoder. Note that as is shown in this drawing, all 5.1 channel decoders also have a Pro Logic decoder present. This decoder is present to allow matrix decoding of any two channel material sent via the Dolby Digital (AC-3) stream.

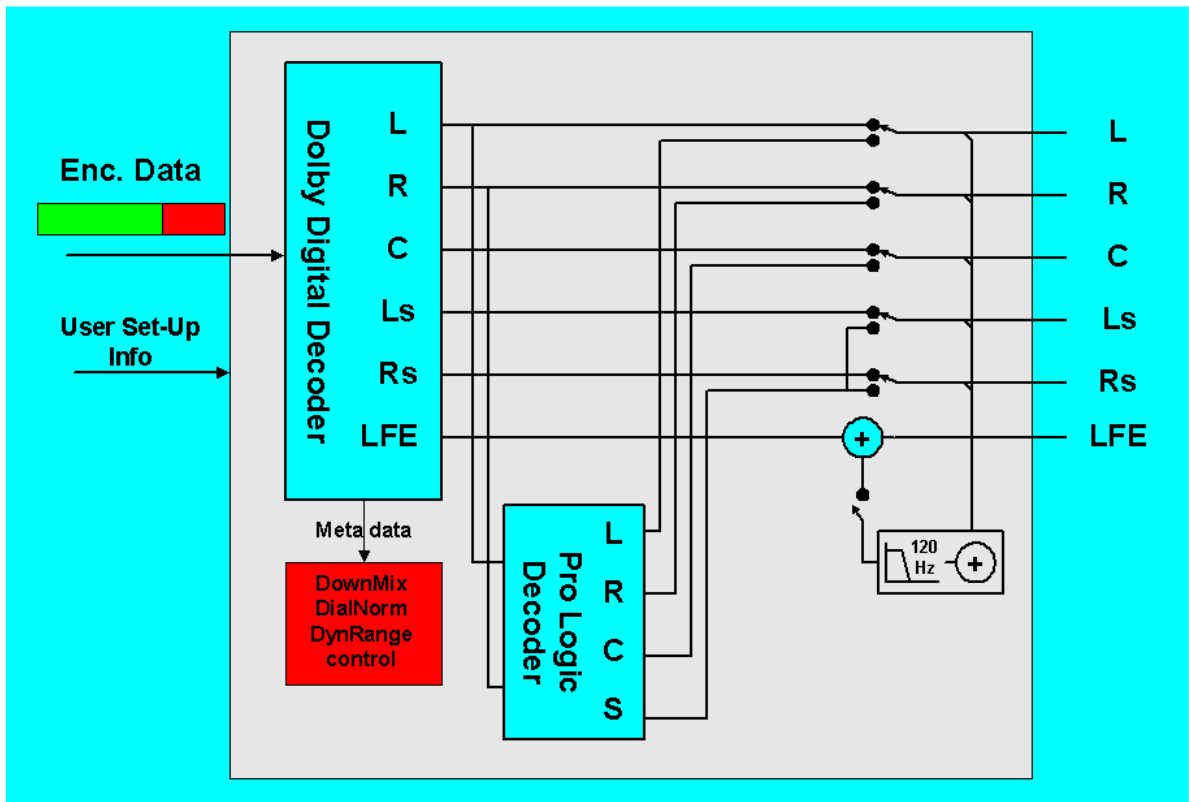


Figure 1 – Typical 5.1 channel Dolby Digital (AC-3) Decoder with Pro Logic Decoding.

Although the surround signal is mono it is sent to the left and right surround speakers, and if selected, the low frequency information below 120 Hz is filtered from the left, center, and right channels and sent to the subwoofer. So, while the audio is not truly 5.1 channels, appropriate signals are reproduced from all 5.1 speakers.

This scheme allows smooth integration of legacy mono and stereo material with more recent 5.1 channel programs. It importantly provides for dialogue to be reproduced from the center speaker regardless of how many channels are encoded thereby keeping a consistent sound field for all audio programs. Even non-surround encoded stereo programs can benefit from this decoder, but the consumer can always bypass it if they so choose.

This means that a 5.1 channel program will be reproduced as such by a 5.1 channel decoder, however a 2 channel program will first be Pro Logic decoded, then output as a 4.0 or 4.1 (via bass management) channel program. This switch occurs when the audio coding mode (acmod) element of metadata changes from 3/2L to 2/0. As can be seen from the drawing in Figure 1, there is no way for this transition to ever be anything other than a switch.

Looking further back up the line, dialnorm also presents quite a challenge. Remember that dialnorm is the metadata value that represents the average dialogue loudness of a program. This value is applied to an attenuator in the Dolby Digital (AC-3) decoder that is adjustable in 1-dB steps over a 31 dB range. With this being the case, at which point should dialnorm be switched during a crossfade?

Let's suppose we are crossfading from a 5.1 channel program to a two channel program. If we switch metadata at the beginning, the acmod will change from 3/2L to 2/0 while there is still 5.1 channel audio present. This means that the Center, Left Surround, and Right surround channels disappear for the duration of the crossfade- not good as the dialogue will be missing. If we instead switch metadata at the end of the crossfade, everything will be fine until the acmod again switches from 3/2L to 2/0. The multichannel consumer decoder will suddenly invoke Pro Logic decoding at the end of the transition and dialogue will snap from the Left and Right speakers to the Center speaker. Switching at the center of the transition is the worst of both worlds and makes a real mess.

As if this weren't difficult enough, we cannot forget the dialnorm issue. If the values of the two programs are different, there will be a level shift if the value changes before the audio does. This means that in the above scenarios the dialnorm value of one of the programs will be applied to both for the duration of the transition. If they are very different values, there can be disturbing consequences. One example is a program that is very loud (say, dialnorm = -15) getting the next very quiet program's dialnorm value (dialnorm = -31). The result would be that the loud program, which would normally be attenuated by 16 dB would, for a split second, not be attenuated and would be 16 dB too loud. Ranges like these are very possible, especially when dealing with loud commercials and quiet movies. This would definitely cause some complaints.

So what are the options? The easiest is to not allow crossfades. If this is not an option, it is possible to make the system work by tricking metadata. It is rather complex, but in simple terms you work the system backwards: fix the metadata values and make the audio fit. As Audio Metadata is data that describes the audio, it can work in either direction. You can describe the audio that exists by changing metadata values, or you can change the audio to match preset metadata values. By fixing dialnorm at -31 and making sure that all sources match this level, you can now crossfade between sources with no level shift. By fixing acmod at 3/2L and making sure all sources fit this channel configuration, you can now crossfade between sources with no loss of channels. Sounds simple, but it requires some tools and products that do not yet exist commercially.

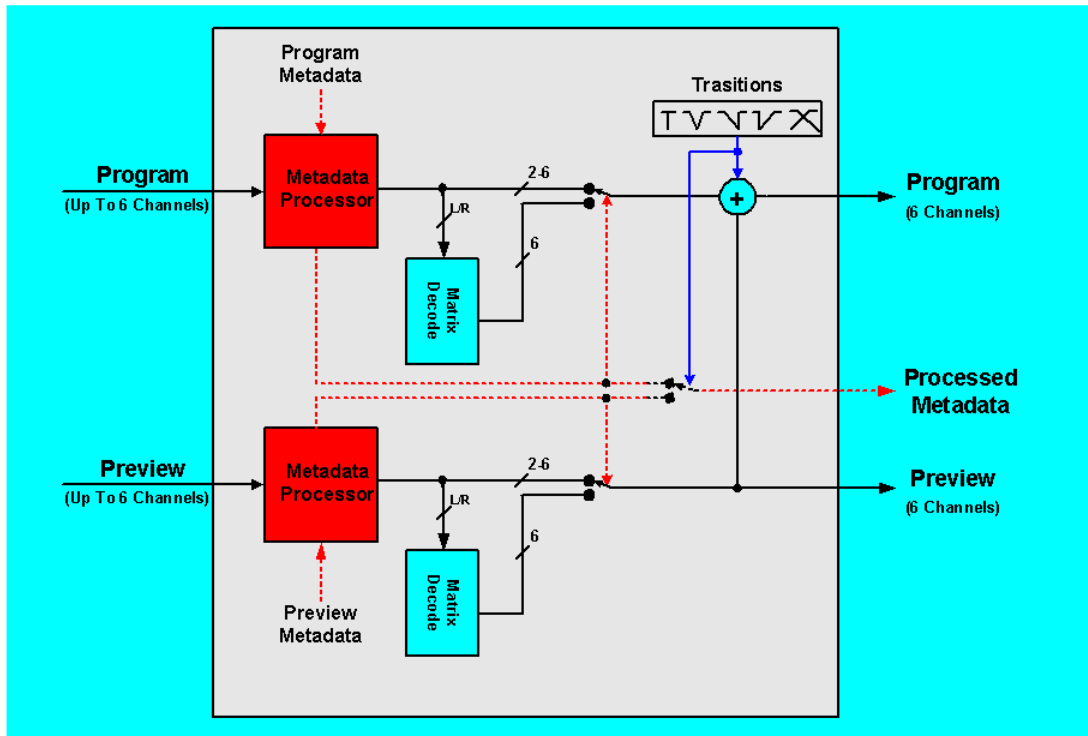


Figure 2 - Conceptual drawing of a Master Control switcher that is capable of performing all current transitions on any number of audio channels and audio metadata. Note that the matrix decoders have special requirements such as being downmix compatible. (Drawing courtesy of Linear Acoustic Inc., (C)2002).

In addition to downmix compatible matrix decoders, Figure 2 assumes a few other pieces are in place. First, metadata must be re-authored after it has passed through the switcher. As all audio sources can fill 5.1 channels, the audio coding mode parameter (acmod) must be overwritten to be a fixed value of 3/2L (three front/two back, plus an LFE). This is true even if the nightly news broadcast is mono voice with a stereo intro because after matrix decoding, the voice will come out of the center channel and the music will be spread throughout all of the channels. The drawing also assumes that dialnorm will be applied to the audio sources for the purposes of allowing crossfades, voiceovers, and other mix-type operations to take place. Therefore, the dialnorm parameter can be selectively over-written as it only needs to be set to a fixed value while a transition is taking place.

One last point is that for perfect downmix compatibility, the 90-degree surround channel phase shift should always be enabled in the Dolby Digital (AC-3) encoder. The filters only process the surround channels and are inaudible under most all listening conditions,

however without them consumers with two channel receivers and a Pro Logic decoder will not get the best audio possible.

So, how do you do all of this metadata work? Luckily, the Dolby DP570 Multichannel Audio Tool can handle it. In fact, with the scenario outlined in Figure 2, it can even act as the metadata switch when given GPI commands from the master control switcher. After over-writing the necessary metadata parameters, it can also provide the advanced monitoring functionality required for the master control environment.

There are solutions to the master control problem. They simply require thinking outside the standard box and keeping in mind the fact that metadata can be worked both ways: it can vary to describe a given program or the program can be varied to match the metadata.

If you have any questions, please contact us.