Audio and Timecode Embedder/Deembedder for Cheetah Audio/Video Router

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PESA Switching Systems, Inc.

Introduction

The broadcast video market has undergone a complete revolution over the past few years. The transition to digital has brought about a new set of challenges as well as a new set of opportunities. While traditional analog routing systems required separate video and audio distribution systems, today's digital video signals have the ability to carry multiple audio channels and other information in addition to the video content. While this capability exists, the market has not yet fully adopted embedded audio throughout the full production environment and most facilities continue to process and distribute discrete audio and video signals using separate systems. There are a few areas where embedded audio has been adopted and this causes a problem for the facility that employs discrete audio and video distribution systems. In this case it becomes necessary to provide a way to transition between embedded and discrete audio signals. To address this problem PESA has developed the Cheetah DRS Audio Embedder card (part # CH-OUTPUT-MUX-BNC) and Cheetah DRS Audio Deembedder card (part # CH-INPUT-DEMUX-BNC). The embedder is sometimes referred to as a MUX card (short for multiplexer) and the deembedder is sometimes referred to as a DEMUX card (short for demultiplexer).

Timecode is used to convey a unique timestamp for each frame of video. There are primarily two different methods of conveying timecode in a broadcast video plant today. The traditional method employs a Longitudinal Timecode (LTC) track that is carried on a separate audio channel and is distributed using audio routing equipment. The second method employs a timecode packet that is inserted directly into the video signal, thereby eliminating the need for a separate timecode track. Both of these methods are in use and there are times when it becomes necessary to convert from one method to the other. The Audio Embedder and Deembedder cards may be used to perform this conversion.

Product Description

The Deembedder card will occupy an input slot in the Cheetah video frame and is designed to be used in place of the standard Cheetah Multirate Video Input card (see “Figure 1 - Cheetah Video/Audio Routing System with Deembedders and Embedders Block Diagram”). Each input card carries 16 video signals and each video signal may carry up to 16 embedded audio channels. The Deembedder card connects to a standard DRS system and provides 128 audio inputs to the DRS. The Deembedder also has the ability to detect SMPTE 12M Ancillary Timecode packets and to generate LTC data streams into the DRS router. The PERC2000 GUI provides setup screens that allow the user to map the deembedded audio and timecode from the video signals to DRS inputs.

The Embedder card will occupy an output slot in the Cheetah video frame and is designed to be used in place of the standard Cheetah Multirate Video Output card. Each output card provides 16 video signals and each video signal may carry up to 16 embedded audio channels. The Embedder card accepts 128 audio outputs from a DRS router. The PERC2000 GUI provides setup screens that allow the user to map these DRS output signals into the video signals. The Embedder also has the ability to accept LTC data streams from the DRS and to embed SMPTE 12M Ancillary Timecode packets into the video signals.

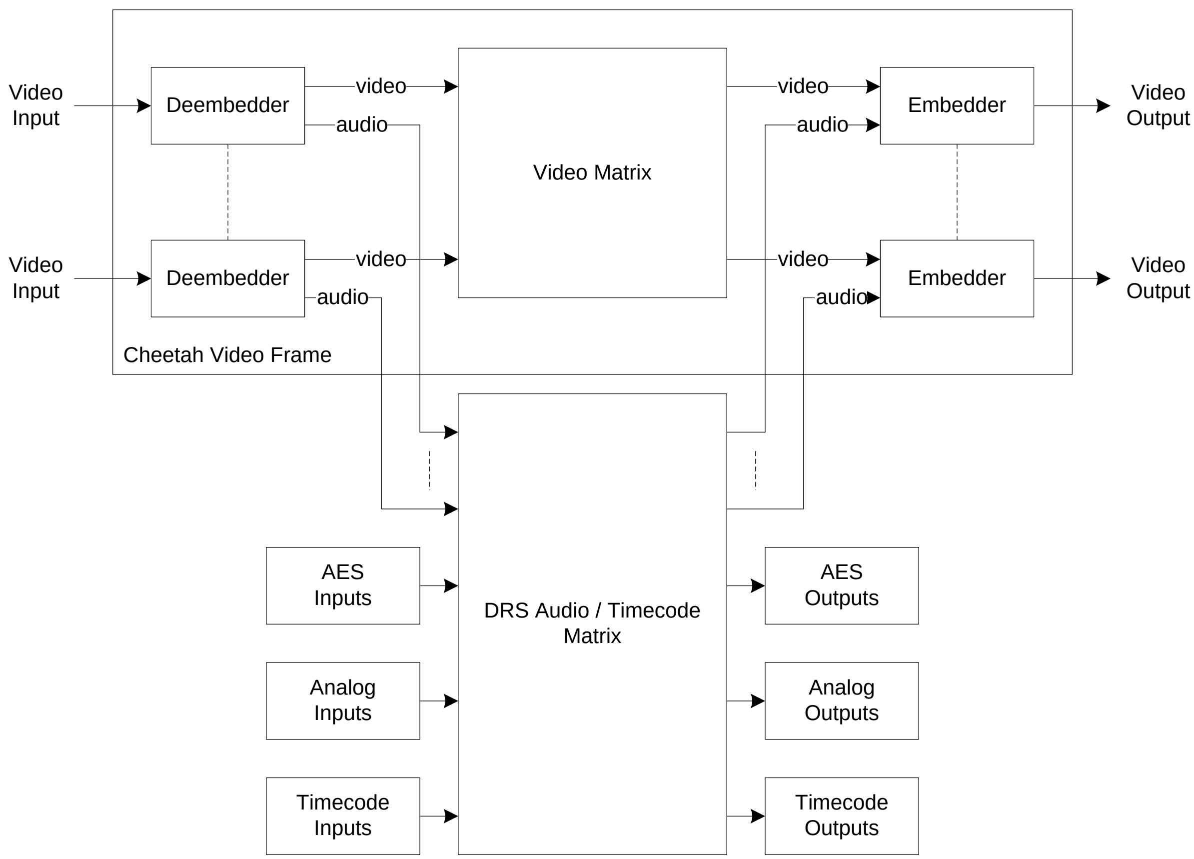


Figure 1 - Cheetah Video/Audio Routing System with Deembedders and Embedders Block Diagram

Deembedder Operation

Each video channel on the Deembedder card has an equalizer to compensate for input cable loss (refer to “Figure 2 - Deembedder Card Single Channel Block Diagram”). The video signal then passes through a high-speed video FPGA for processing and then through driver circuitry and out to the video matrix cards. Inside the video FPGA the audio and timecode packets are extracted and sent to an audio FPGA. The audio FPGA maps the deembedded audio and timecode signals into a DRS data stream and sends it through a Gigabit Ethernet interface as inputs to the DRS routing system.

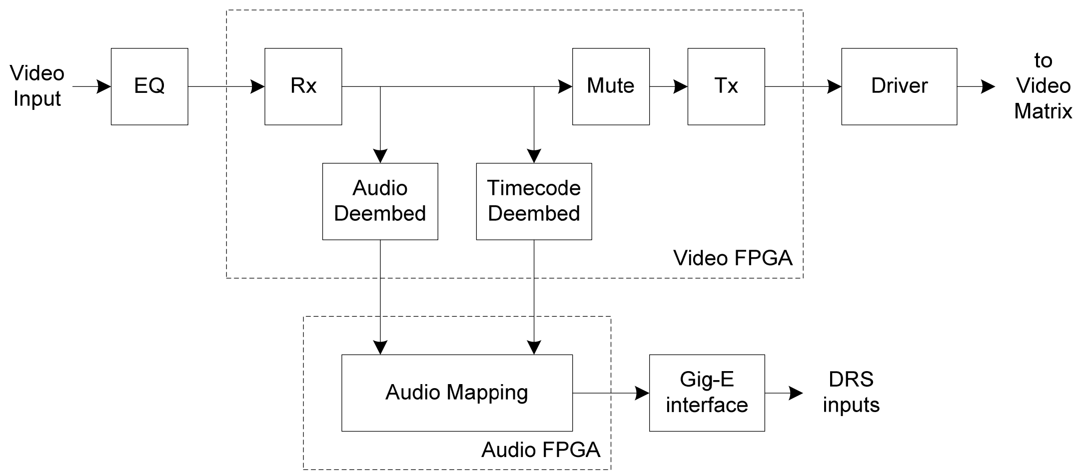


Figure 2 - Deembedder Card Single Channel Block Diagram

Configuring the Deembedder

Setup screens in the PERC2000 GUI are used to configure the Deembedder card. Clicking the Setup button opens the “Input Demux Parameters” screen (see “Figure 3 - Input Demux Parameters Setup Screen”). From this screen the user may adjust the gain, invert the phase and apply stereo remedies to each audio input signal. Clicking the “Audio Delay” button opens the “Demux Input Delay” screen where the user may configure up to 10 frames of delay per input. Clicking the “Demux Setup” button opens the “Input Demux” screen where the user may configure the Deembedder Card. This screen has separate tabs to configure Audio and Timecode settings. The Audio tab (see “Figure 4 - Input Demux - Audio Setup Screen”) provides a place to label each video input channel, a mute control and a DRS Group Assignment drop-down control for each audio group within each video channel. The video input label may be used to assign a useful name for each video channel and this name will be shown on each of the setup screens. The Timecode tab (see “Figure 5 - Input Demux - Timecode Setup Screen”) provides an Enable control and a DRS Timecode Channel Assignment drop-down control for each video channel.

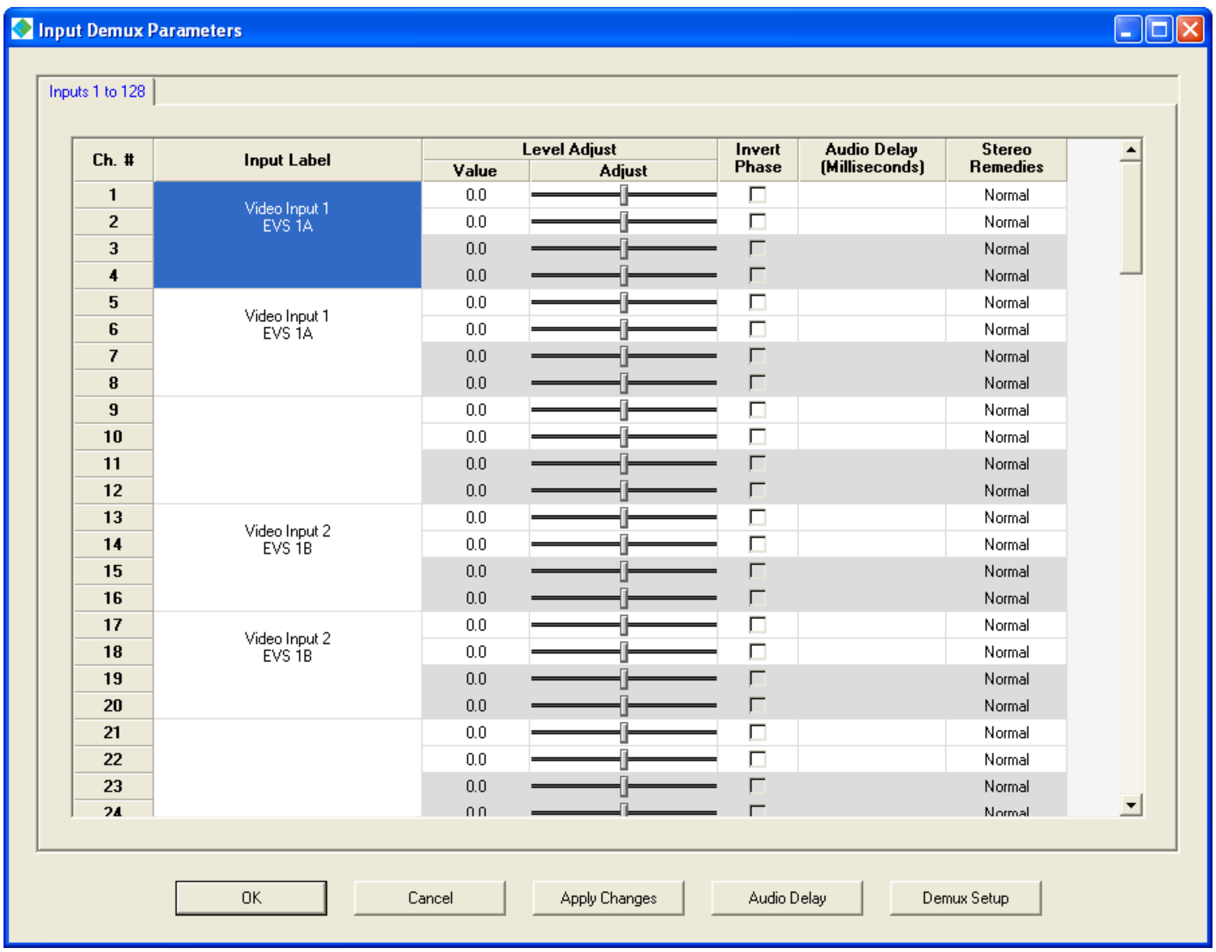


Figure 3 - Input Demux Parameters Setup Screen

Audio Deembedder

The SMPTE video specifications refer to “groups” of audio channels where each group consists of four audio signals. Each HD-SDI or 3G-SDI video signal may carry up to four audio groups for a total of 16 audio signals per video. SD-SDI video signals are limited to two audio groups for a total of 8 audio signals per video. The “group” concept is used to configure the audio portion of the Deembedder card. Mute and DRS Group Assignment controls are provided for each potential audio group within each video signal (see “Figure 4 - Input Demux - Audio Setup Screen”).

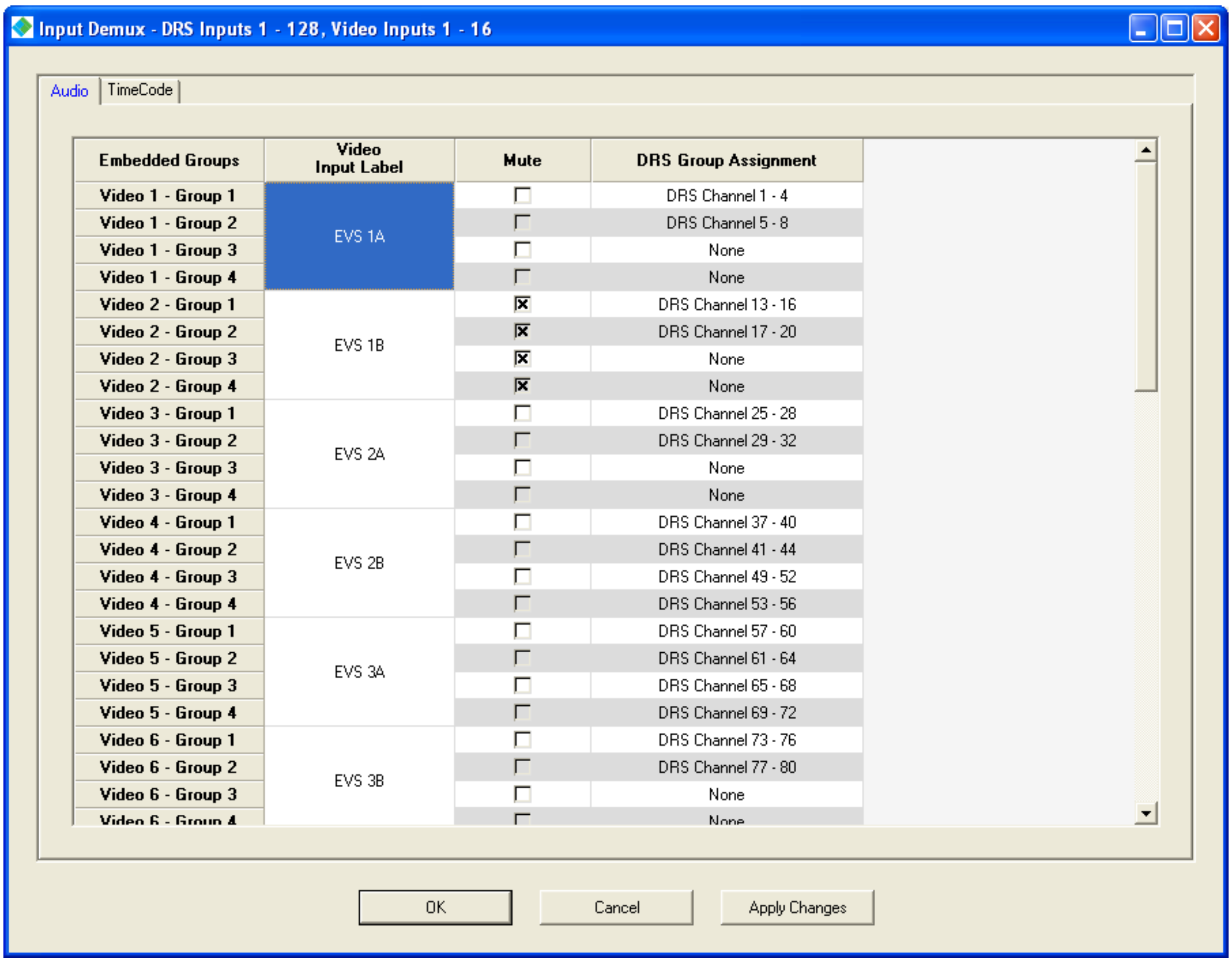


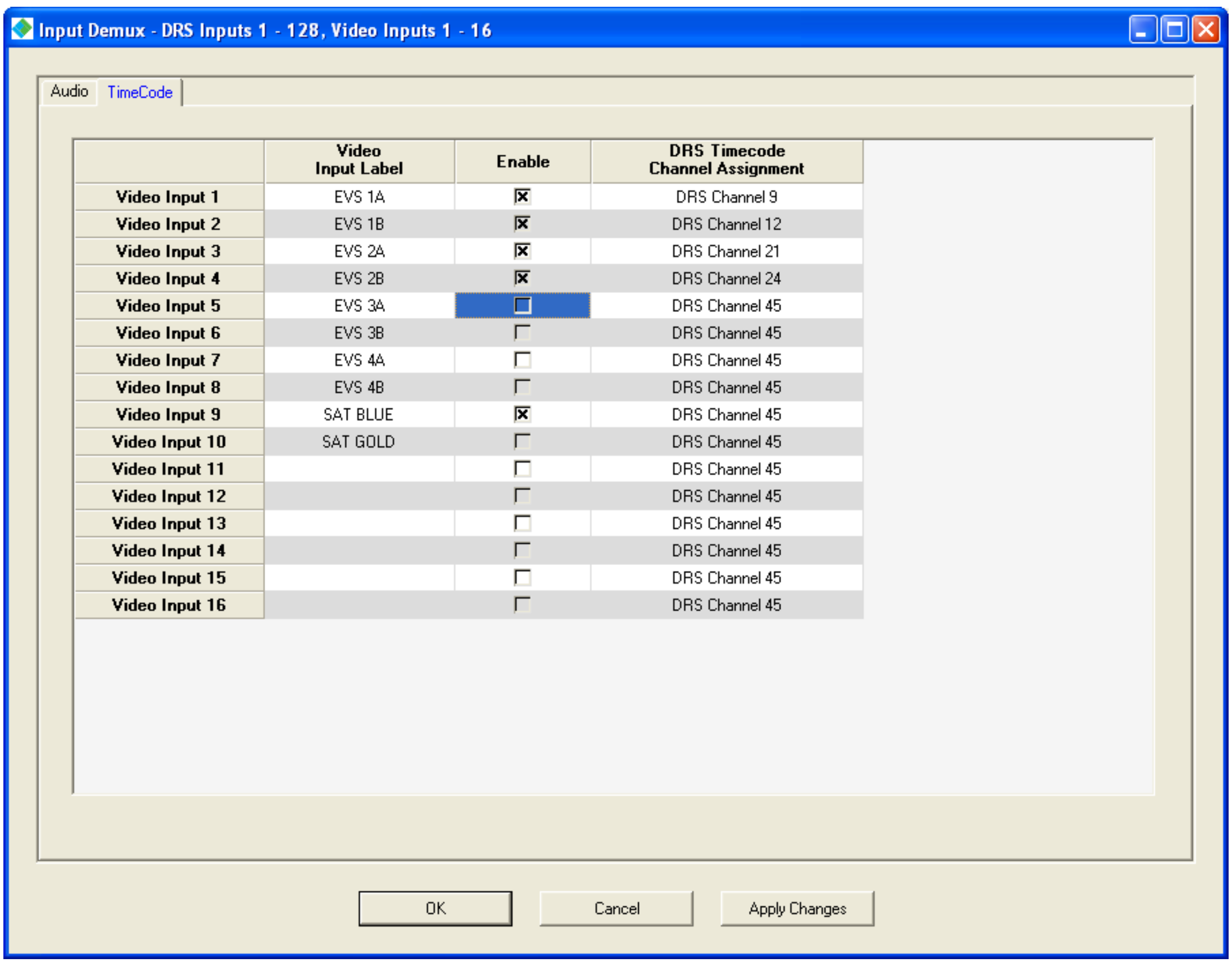
Figure 4 - Input Demux - Audio Setup Screen

Selecting the Mute control on the Audio tab causes the deembedder card to remove any audio within the selected group from the video before passing the video into the video matrix. If the Mute control is not selected then any audio present on the video input is passed as-is into the video matrix. (**Note: the Mute function only affects the embedded audio on the video signal entering the video matrix and has no effect on the audio entering the DRS router.** The user may choose to mute a group even when that group is not mapped to DRS inputs. Refer to “Figure 2 - Deembedder Card Single Channel Block Diagram” to see where the Mute function occurs in the video signal flow.)

The DRS Group Assignment control on the audio tab is used to map the deembedded audio signal into DRS inputs. As the name implies this mapping is done on a group basis, meaning that each DRS Group Assignment control will map four audio channels at a time. The first entry in the drop-down box is "None" and will disable the deembedder for that audio group. The remaining entries allow the user to select a group of DRS inputs into which the deembedded audio signals will be mapped. Since each DRS input channel may only carry a single audio signal, once a group of DRS inputs have been assigned to a particular video signal they may not be re-used on another video signal. The GUI will not allow the user to use a DRS group more than once. Recall that HD-SDI and 3G-SDI video signals may carry up to 16 audio signals and the Deembedder card carries 16 video signals for a potential total of 256 embedded audio signals per card. Once all 128 DRS inputs have been assigned any remaining embedded audio signals will be unavailable. In practice it is rare to see more that 6-8 embedded audio signals in use so this will not pose a problem. For the occasional video signal with more than 6-8 audio channels, the deembedder controls are flexible enough to allow all 16 audios from any given video to be deembedded, but doing so will reduce the number of DRS inputs available to the other video signals.

Timecode Deembedder

Each video channel has a timecode deembedder (see “Figure 2 - Deembedder Card Single Channel Block Diagram”) that decodes any SMPTE 12M Ancillary Timecode packets found in the video signal and converts them to Longitudinal Timecode (LTC) signals suitable for passing through the DRS audio matrix. The Timecode tab in the GUI provides an Enable control and a DRS Timecode Channel Assignment drop-down control for each video channel on the board (see “Figure 5 - Input Demux - Timecode Setup Screen”). When the Enable control is selected the deembedded LTC stream will be mapped to one of the DRS input channels. The DRS Timecode Channel Assignment drop-down control is used to select the DRS input into which the LTC datastream will be mapped. Unlike the audio deembedders each timecode deembedder uses a single DRS input channel. Once a DRS input is used for timecode it is no longer available for audio or another timecode deembedder. Also recall that the audio deembedder maps four DRS inputs at a time. When one DRS input is used to carry timecode the remaining three inputs in that group are no longer available to the audio deembedder but may be used to carry other timecode signals.



	Video Input Label	Enable	DRS Timecode Channel Assignment
Video Input 1	EVS 1A	☒	DRS Channel 9
Video Input 2	EVS 1B	☒	DRS Channel 12
Video Input 3	EVS 2A	☒	DRS Channel 21
Video Input 4	EVS 2B	☒	DRS Channel 24
Video Input 5	EVS 3A	☐	DRS Channel 45
Video Input 6	EVS 3B	☐	DRS Channel 45
Video Input 7	EVS 4A	☐	DRS Channel 45
Video Input 8	EVS 4B	☐	DRS Channel 45
Video Input 9	SAT BLUE	☒	DRS Channel 45
Video Input 10	SAT GOLD	☐	DRS Channel 45
Video Input 11		☐	DRS Channel 45
Video Input 12		☐	DRS Channel 45
Video Input 13		☐	DRS Channel 45
Video Input 14		☐	DRS Channel 45
Video Input 15		☐	DRS Channel 45
Video Input 16		☐	DRS Channel 45

Figure 5 - Input Demux - Timecode Setup Screen

Embedder Operation

Each video channel on the Embedder card has an 8x1 switch to select one of the internal matrix cards providing video signals (refer to "Figure 6 - Embedder Card Single Channel Block Diagram"). The video signal then passes through a high-speed video FPGA for processing and then through a re-clocker and out of the frame. An audio FPGA accepts 128 audio outputs from a DRS Audio Router through a Gigabit Ethernet connection. The audio FPGA maps the incoming audio signals to the audio and timecode embedders and passes these signals into the video FPGA where they are embedded into a video signal.

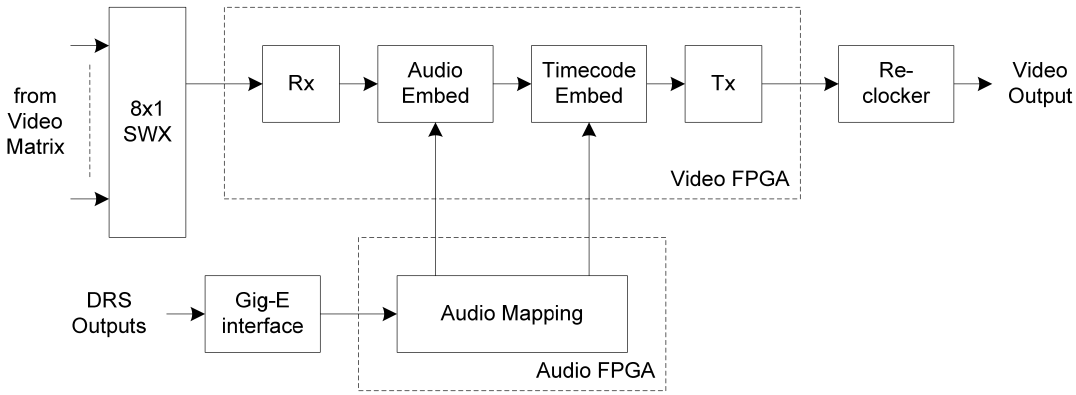


Figure 6 - Embedder Card Single Channel Block Diagram

Configuring the Embedder

Setup screens in the PERC2000 GUI are used to configure the Embedder card. Clicking the Setup button opens the “Output Mux Parameters” screen (see “Figure 7 - Output Mux Parameters Setup Screen”). From this screen the user may adjust the gain, invert the phase and apply stereo remedies to each audio output signal. Clicking the “Audio Delay” button opens the “Mux Output Delay” screen where the user may configure up to 10 frames of delay per output. Clicking the “Mux Setup” button opens the “Output Mux” screen where the user may configure the Embedder card. This screen has separate tabs to configure Audio and Timecode settings. The Audio tab (see “Figure 8 - Output Mux - Audio Setup Screen”) provides a place to label each video output channel, a mute control, a pass-through control and a DRS Group Assignment drop-down control for each audio group within each video channel. The video output label may be used to assign a useful name for each video channel and this name will be shown on each of the setup screens. The Timecode tab (see “Figure 9 - Output Mux - Timecode Setup Screen”) provides an Enable control and a DRS Timecode Channel Assignment drop-down control for each video channel.

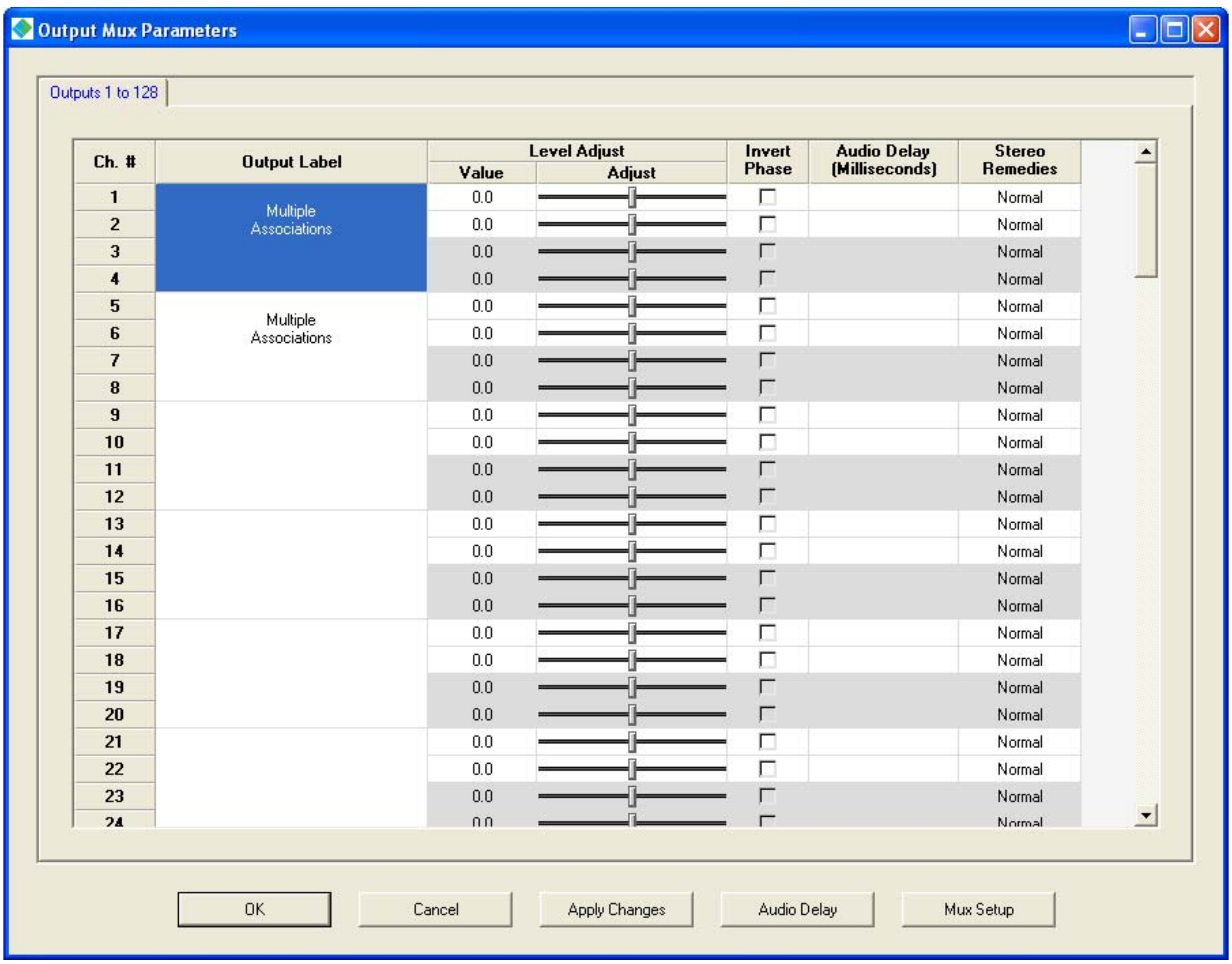
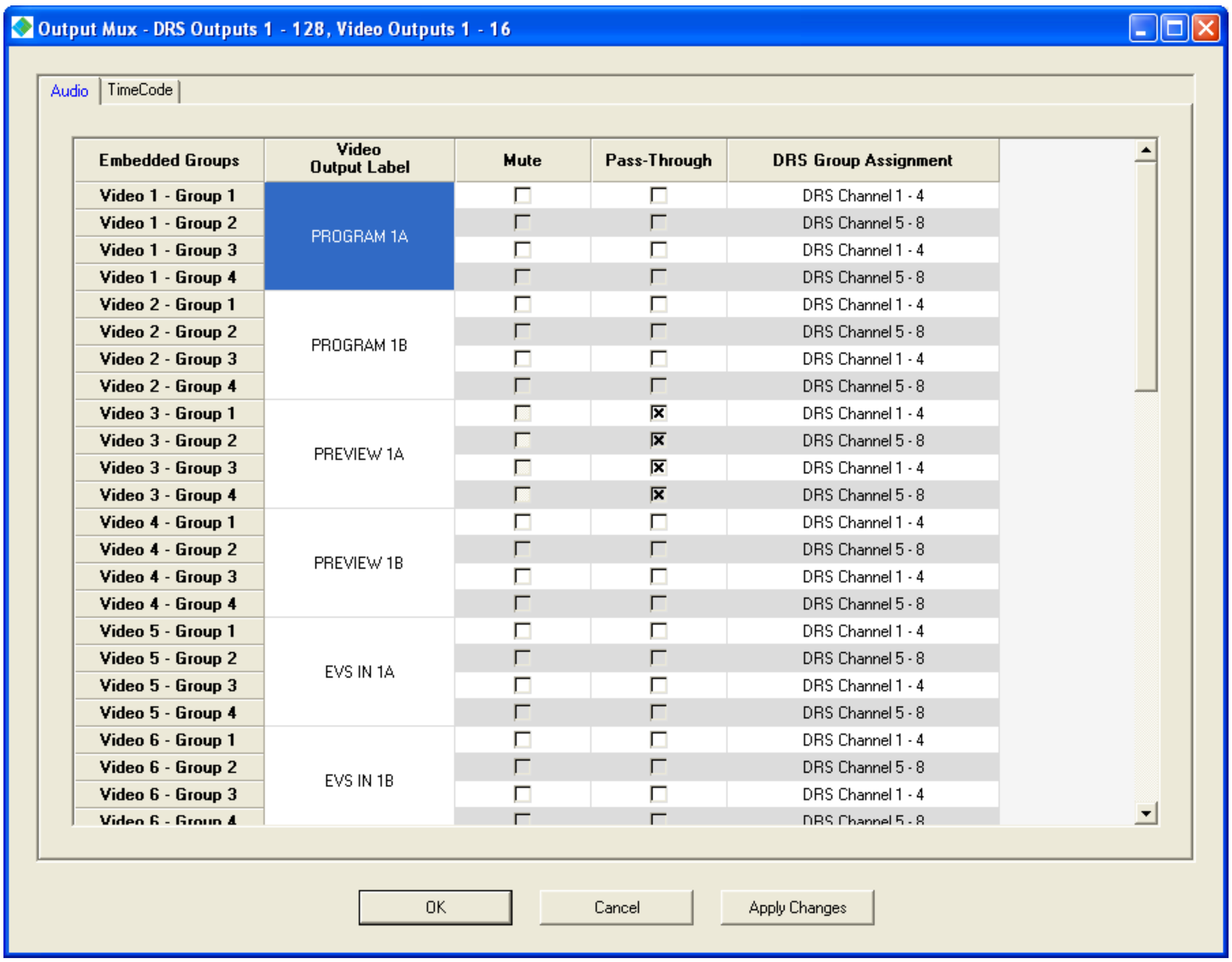


Figure 7 - Output Mux Parameters Setup Screen

Audio Embedder

The SMPTE video specifications refer to “groups” of audio channels where each group consists of four audio signals. Each HD-SDI or 3G-SDI video signal may carry up to four audio groups for a total of 16 audio signals per video. The “group” concept is used to configure the audio portion of the Embedder card. Pass-through, Mute, and DRS Group Assignment controls are provided for each potential audio group within each video signal. The Audio Embedder card will embed audio groups into HD-SDI or 3G-SDI signals and will pass SD-SDI signals with no modification.



Embedded Groups	Video Output Label	Mute	Pass-Through	DRS Group Assignment
Video 1 - Group 1	PROGRAM 1A	☐	☐	DRS Channel 1 - 4
Video 1 - Group 2		☐	☐	DRS Channel 5 - 8
Video 1 - Group 3		☐	☐	DRS Channel 1 - 4
Video 1 - Group 4		☐	☐	DRS Channel 5 - 8
Video 2 - Group 1	PROGRAM 1B	☐	☐	DRS Channel 1 - 4
Video 2 - Group 2		☐	☐	DRS Channel 5 - 8
Video 2 - Group 3		☐	☐	DRS Channel 1 - 4
Video 2 - Group 4		☐	☐	DRS Channel 5 - 8
Video 3 - Group 1	PREVIEW 1A	☐	☒	DRS Channel 1 - 4
Video 3 - Group 2		☐	☒	DRS Channel 5 - 8
Video 3 - Group 3		☐	☒	DRS Channel 1 - 4
Video 3 - Group 4		☐	☒	DRS Channel 5 - 8
Video 4 - Group 1	PREVIEW 1B	☐	☐	DRS Channel 1 - 4
Video 4 - Group 2		☐	☐	DRS Channel 5 - 8
Video 4 - Group 3		☐	☐	DRS Channel 1 - 4
Video 4 - Group 4		☐	☐	DRS Channel 5 - 8
Video 5 - Group 1	EVS IN 1A	☐	☐	DRS Channel 1 - 4
Video 5 - Group 2		☐	☐	DRS Channel 5 - 8
Video 5 - Group 3		☐	☐	DRS Channel 1 - 4
Video 5 - Group 4		☐	☐	DRS Channel 5 - 8
Video 6 - Group 1	EVS IN 1B	☐	☐	DRS Channel 1 - 4
Video 6 - Group 2		☐	☐	DRS Channel 5 - 8
Video 6 - Group 3		☐	☐	DRS Channel 1 - 4
Video 6 - Group 4		☐	☐	DRS Channel 5 - 8

Figure 8 - Output Mux - Audio Setup Screen

Selecting the Pass-through control on the Audio tab disables the audio embedder for that group and allows the existing audio (if any) embedded in the video signal to pass through with no change. The Pass-through control overrides the Mute and DRS Group Assignment controls.

The DRS Group Assignment control on the audio tab is used to select a group of DRS audio outputs to be embedded within a video signal. As the name implies this mapping is done on a group basis, meaning that each DRS Group Assignment control will map four audio channels at a time. The entries in the drop-down control allow the user to select a specific group of DRS outputs to be embedded in the selected audio group of the selected video signal.

Each group of DRS outputs may be embedded into multiple video signals as required. Recall that HD-SDI and 3G-SDI video signals may carry up to 16 audio signals and the Embedder card carries 16 video signals for a potential total of 256 embedded audio signals per card. The DRS provides 128 outputs and any DRS output group may be mapped into any embedded video group with no restrictions.

The Mute control on the Audio tab forces the audio embedder to insert silence (mute selected) or the selected DRS output group (mute deselected) in the selected audio group of the selected video signal.

Timecode Embedder

Each video channel has a timecode embedder (see “Figure 6 - Embedder Card Single Channel Block Diagram”) that encodes LTC data streams from a DRS output into SMPTE 12M Ancillary Timecode packets and inserts these into a video signal. The Timecode tab in the GUI provides an Enable control and a DRS Timecode Channel Assignment drop-down control for each video channel on the board (see “Figure 9 - Output Mux - Timecode Setup Screen”). When the Enable control is selected the LTC data stream from a DRS output will be inserted into the selected video signal. The DRS Timecode Channel Assignment drop-down control specifies which DRS output will carry the LTC data stream to be inserted. Unlike the audio embedder each timecode embedder uses a single DRS output channel. Once a DRS output has been used for timecode it is no longer available for audio but may be used by another timecode embedder. Also recall that the audio embedder maps four DRS outputs at a time. When one DRS output is used to carry timecode the remaining three outputs in that group are no longer available to the audio embedder but may be used to carry other timecode signals.

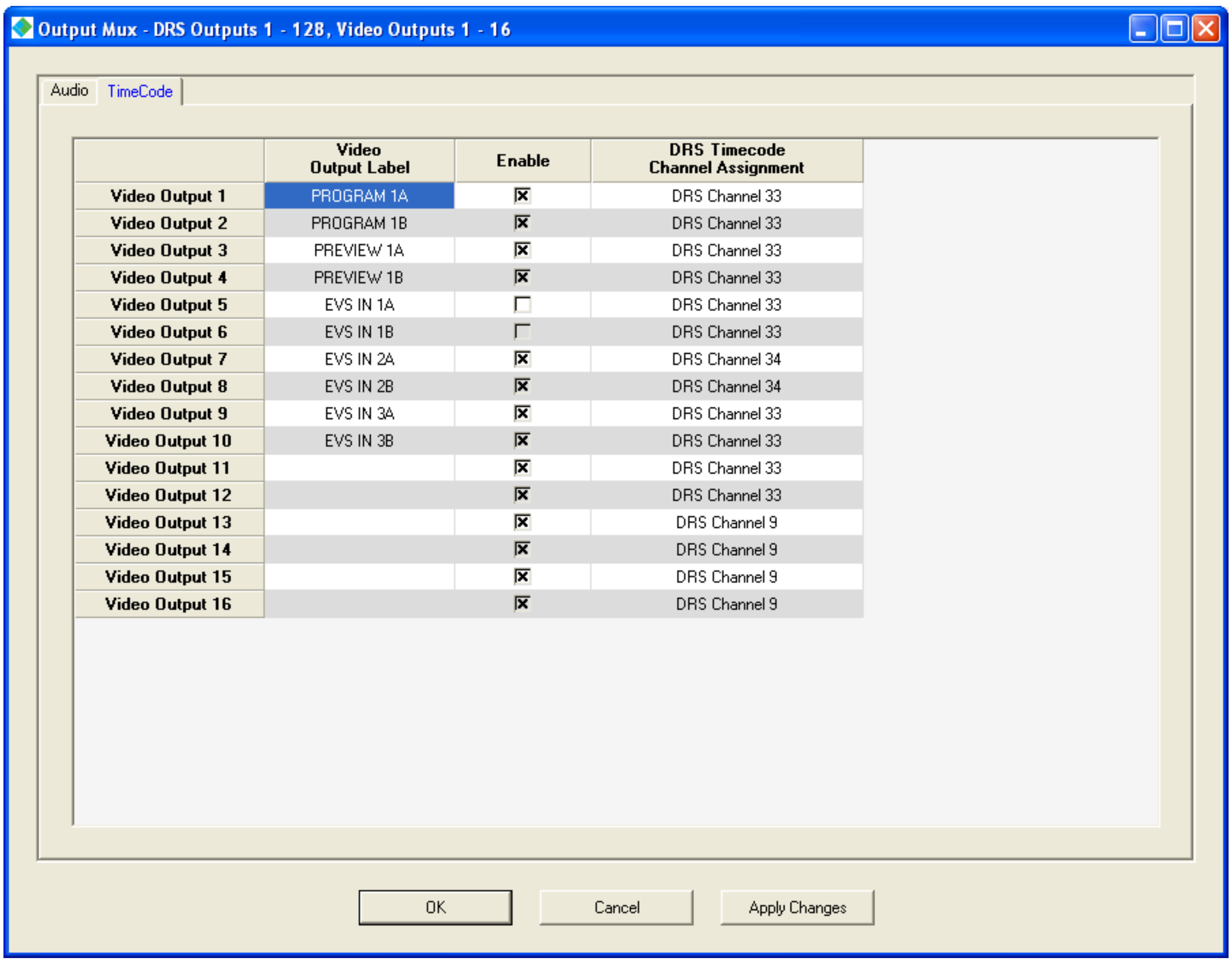


Figure 9 - Output Mux - Timecode Setup Screen

Timecode Embedder Dynamic Bypass

In addition to the Timecode Embedder configuration controls shown in “Figure 9 - Output Mux - Timecode Setup Screen” a method is provided to dynamically override an embedder without having to change the configuration screen. For example, assume that the timecode embedder for a given video signal is enabled and that a valid DRS output signal has been selected for the embedder. In normal operation the user will route a timecode source to that DRS output and the embedder will insert timecode packets into the video signal. A situation may arise when the user wishes to override this operation and allow existing timecode packets in the video to pass through with no change. The embedder card provides a way to dynamically disable or bypass the timecode embedder by routing DRS virtual input 4128 to the DRS output channel used by the embedder. Virtual input 4128 carries with it special coding that is recognized by the embedder, and when detected will dynamically disable the timecode embedder. This allows the user to specify on a source by source basis whether to embed timecode or to allow existing timecode packets to pass through. If a source definition contains a valid DRS input that is fed by a timecode signal then selecting that source will cause the timecode signal to be embedded in the video. If a source definition contains DRS input 4128 for the timecode input then selecting that source will cause the timecode embedder to be disabled and any timecode already in the video will pass with no change.