9904-UDX-4K

12G/6G/3G/HD/SD-SDI Up-Down-Cross Converter / Frame Sync / Embed/De-Embed Audio Processor

Product Manual

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9904-UDX-OM (V1.0J)

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Trademark Information

Congratulations on choosing the Cobalt® 9904-UDX-4K 12G/6G/3G/HD/SD-SDI Up-Down-Cross Converter / Frame Sync / Embed/De-Embed Audio Processor. The 9904-UDX-4K is part of a full line of modular processing and conversion gear for broadcast TV environments. The Cobalt Digital Inc. line includes video decoders and encoders, audio embedders and de-embedders, distribution amplifiers, format converters, remote control systems and much more. Should you have questions pertaining to the installation or operation of your 9904-UDX, please contact us at the contact information on the front cover.

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Description of product/manual changes:	- Update manual for expanded descriptions and operating setup info regarding Real-Time Loudness Leveling DSP function. - Update manual to show corrected GPIO/COMM pinouts for RM20-9904-B-HDBNC rear module. - Update manual for added rear I/O modules and expanded AES I/O functionality. - Update manual for minor consistency edits and appearance of UI elements per most recent firmware releases.

Table of Contents

Chapter 1

Introduction

Overview

This manual provides installation and operating instructions for the 9904-UDX-4K 12G/6G/3G/HD/SD-SDI Up-Down-Cross Converter/Frame Sync/Embed/De-Embed Audio Processor card (also referred to herein as the 9904-UDX-4K).

This manual consists of the following chapters:

- **Chapter 1, "Introduction"** – Provides information about this manual and what is covered. Also provides general information regarding the 9904-UDX-4K.
- **Chapter 2, "Installation and Setup"** – Provides instructions for installing the 9904-UDX-4K in a frame, and optionally installing a 9904-UDX-4K Rear I/O Module.
- **Chapter 3, "Operating Instructions"** – Provides overviews of operating controls and instructions for using the 9904-UDX-4K.

This chapter contains the following information:

9904-UDX-4K Card Software Versions and this Manual

When applicable, Cobalt Digital Inc. provides for continual product enhancements through software updates. As such, functions described in this manual may pertain specifically to cards loaded with a particular software build.

The Software Version of your card can be checked by viewing the **Card Info** menu in DashBoard™. See Checking 9904-UDX-4K Card Information (p. 3-7) in Chapter 3, “Operating Instructions” for more information. You can then check our website for the latest software version currently released for the card as described below.

Note: Not all functionality described in this manual may appear on cards with initial software versions.

Check our website and proceed as follows if your card’s software does not match the latest version:

Card Software **earlier** than latest version	Card is not loaded with the latest software. Not all functions and/or specified performance described in this manual may be available. You can update your card with new Update software by going to the **Support>Firmware Downloads** link at www.cobaltdigital.com. Download “Firmware Update Guide”, which provides simple instructions for downloading the latest firmware for your card onto your computer, and then uploading it to your card through DashBoard™. **Software updates are field-installed without any need to remove the card from its frame.**
Card Software **newer** than version in manual	A new manual is expediently released whenever a card’s software is updated **and specifications and/or functionality have changed** as compared to an earlier version (a new manual is not necessarily released if specifications and/or functionality have not changed). A manual earlier than a card’s software version may not completely or accurately describe all functions available for your card. If your card shows features not described in this manual, you can check for the latest manual (if applicable) and download it by going to the card’s web page on www.cobaltdigital.com.

Cobalt Reference Guides

From the Cobalt® web home page, go to **Support>Reference Documents** for easy to use guides covering network remote control, card firmware updates, example card processing UI setups and other topics.

Manual Conventions

In this manual, display messages and connectors are shown using the exact name shown on the 9904-UDX-4K itself. Examples are provided below.

- Connector names are shown like this: **SDI IN A**

In this manual, the terms below are applicable as follows:

- **9904-UDX-4K** refers to the 9904-UDX-4K 12G/6G/3G/HD/SD-SDI Up-Down-Cross Converter/Frame Sync/Embed/De-Embed Audio Processor card.
- **Frame** refers to the HPF-9000, oGx, OG3-FR, 8321, or similar 20-slot frame that houses Cobalt® or other cards.
- **Device** and/or **Card** refers to a Cobalt® or other card.
- **System** and/or **Video System** refers to the mix of interconnected production and terminal equipment in which the 9904-UDX-4K and other cards operate.
- Functions and/or features that are available only as an option are denoted in this manual like this:

  

  Most options are covered in this manual. However, if your card has DashBoard tabs that are not described in this manual it indicates that the optional function/feature is covered in a separate Manual Supplement.

  If your have not received a Manual Supplement for options on your card, you can download a pdf for the option by going to the card's web page and clicking on **Product Downloads**, where you can select from any available option Manual Supplements for the card.

Note: Some options listed here and in promotional materials may not be available in conjunction with initial or preliminary device firmware release versions. Some option descriptions are for information only.

Warnings, Cautions, and Notes

Certain items in this manual are highlighted by special messages. The definitions are provided below.

Warnings

Warning messages indicate a possible hazard which, if not avoided, could result in personal injury or death.

Cautions

Caution messages indicate a problem or incorrect practice which, if not avoided, could result in improper operation or damage to the product.

Notes

Notes provide supplemental information to the accompanying text. Notes typically precede the text to which they apply.

Labeling Symbol Definitions

	Important note regarding product usage. Failure to observe may result in unexpected or incorrect operation.
	Electronic device or assembly is susceptible to damage from an ESD event. Handle only using appropriate ESD prevention practices. If ESD wrist strap is not available, handle card only by edges and avoid contact with any connectors or components.
	Symbol (WEEE 2002/96/EC) For product disposal, ensure the following: • Do not dispose of this product as unsorted municipal waste. • Collect this product separately. • Use collection and return systems available to you.

Safety and Regulatory Summary

Warnings

! WARNING ! **To reduce risk of electric shock do not remove line voltage service barrier cover on frame equipment containing an AC power supply. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.**

! WARNING ! **Following sustained card operation, heatsink surfaces can have high contact temperatures. Avoid touching heatsink(s) after the card has been operating.**

Cautions

CAUTION **This device is intended for environmentally controlled use only in appropriate video terminal equipment operating environments.**

CAUTION **This product is intended to be a component product of an openGear® frame. Refer to the openGear® frame Owner's Manual for important safety instructions regarding the proper installation and safe operation of the frame as well as its component products.**

CAUTION **Heat and power distribution requirements within a frame may dictate specific slot placement of cards. Cards with many heat-producing components should be arranged to avoid areas of excess heat build-up, particularly in frames using only convection cooling. The 9904-UDX-4K can have a high power dissipation (>58 W). As such, avoiding placing the card adjacent to other cards with similar dissipation values if possible.**

CAUTION **If required, make certain Rear I/O Module(s) is installed before installing the 9904-UDX-4K into the frame slot. Damage to card and/or Rear I/O Module can occur if module installation is attempted with card already installed in slot.**

CAUTION **If card resists fully engaging in rear I/O module mating connector, check for alignment and proper insertion in slot tracks. Damage to card and/or rear I/O module may occur if improper card insertion is attempted.**

CAUTION **The 9904-UDX-4K FPGA is designed for a normal-range operating temperature around 95° C core temperature. Operation in severe conditions exceeding this limit for non-sustained usage are within device operating safe parameters, and can be allowed by setting this control to Disable. However, the disable (override) setting should be avoided under normal conditions to ensure maximum card protection.**

EMC Compliance Per Market

Market	Regulatory Standard or Code
United States of America	FCC "Code of Federal Regulations" Title 47 Part15, Subpart B, Class A
Canada	ICES-003
International	CISPR 24:2010 IEC 61000-4-2:2008 IEC 61000-4-3:2006 with A1:2007 and A2:2010 IEC 61000-4-4:2004 IEC 61000-4-6:2008 IEC 61000-6-3:2006 with A1:2010 CISPR 22:2008

9904-UDX-4K Functional Description

Figure 1-1 shows a functional block diagram of the 9904-UDX-4K. The 9904-UDX-4K up/down/cross converter also includes AES audio support. The 9904-UDX-4K upconverts 12G/6G/3G/HD/SD to either UHD1 3840x2160 Square Division Multiplex (SDM) or Two-Sample Interleave (2SI) quad 3G-SDI based formats, or can output ST 2082 12G-SDI and 4069x2160 (4k DCI) for single-wire 4K transport. With both 12G-SDI and quad 3G-SDI inputs, the 9904-UDX-4K can downconvert 12G and quad UHD. The 9904-UDX-4K provides an HDMI 2.0 output for economical 4K video monitoring.

Note: **This manual and the 9904-UDX-4K product/device and firmware release are preliminary.** Not all functions described here may be available on your 9904-UDX-4K product.

Note: The **9904-UDX-4K-DSP** DSP base adds support for various DSP audio options. Specific individual DSP user assets (such as loudness processing, upmixing, and Dolby encoders) are activated for use only when corresponding option licenses also reside on the card.

9904-UDX-4K Input/Output Formats

The 9904-UDX-4K provides the following inputs and outputs:

- **Inputs:**
  - **12G/6G/3G/HD-SDI IN 1** thru **SDI IN 6** – six 12G/6G/3G/HD-SDI inputs. The inputs can be DashBoard user-configured as ST 2082 12G-SDI single-wire or SDM/2SI quad 3G-SDI based formats.
  - **AES IN –** Coaxial (AES-3id, 75Ω) input ports (up to eight ports; number of ports dependent on rear I/O module used and user input or output assignment).
- **Outputs:**
  - **12G/6G/3G/HD-SDI OUT 1A/B** thru **4A/B** – four, 1X2 DA 12G/6G/3G/HD-SDI video outputs. For UHD, the outputs can be DashBoard user-configured as ST 2082 12G-SDI single-wire or SDM/2SI quad 3G-SDI based formats. Where down-converted to 3G, HD, or SD, up to eight single-wire ports are available.
  - **AES OUT –** Coaxial (AES-3id, 75Ω) input ports (up to eight ports; number of ports dependent on rear I/O module used and user input or output assignment).
  - **HDMI/DVI OUT** – HDMI/DVI out (suitable for direct connection to monitor panels)

Note: The card offers up to eight (8) AES-3id 75Ω coaxial ports, with port direction assignable as inputs or outputs in groups of 4 ports (hardware versions earlier than -E have four (4) ports max.

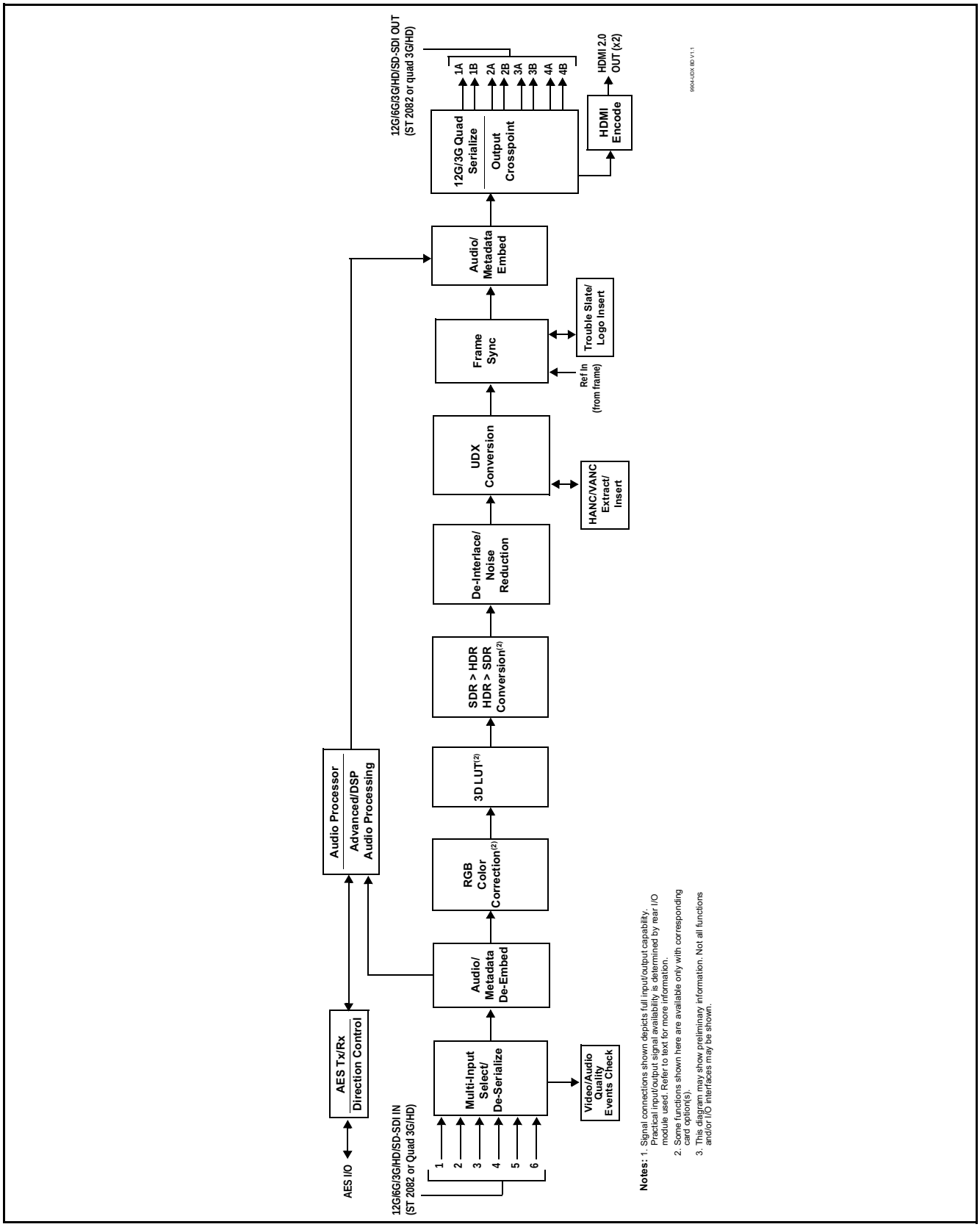

Figure 1-1 9904-UDX-4K Functional Block Diagram

Video Processor Description

The 9904-UDX-4K features a up/down/cross-convert scaler, frame sync, and (where applicable) conversion between ST 2082 single-wire and quad SDI SDM and 2SI UHD formats. The 9904UDX-4K also offers several options, such as 4K color correction and SDR>HDR conversion. The 9904-UDX-4K video subsystem also provides the functions described below.

Input Video Select/Quality Check Functions

A GUI-based control allows program video selection from six inputs as follows:

- **SDI IN 1 (QL 1)** thru **SDI IN 4 (QL 4)** – Quad 3G-SDI inputs reserved for quad SDI SDM or 2SI UHD signal formats
- **SDI IN 5** and **SDI IN 6** – Single-wire inputs reserved for ST 2082 12G and 6G signal formats

While the input selector is based primarily on the groupings above, any individual input can be routed as the sole card SDI input.

Option **(Option +QC)**. Quality Check allows criteria such as black/frozen frame events to propagate an event alert. This alert can be used by the card Presets function to invoke video routing changes, GPO, and other actions.

Color Corrector Option

Options **+COLOR-4K** (and non-4k option **+COLOR**) convert the YCbCr SDI input video to the 4:4:4 RGB color space (where the color correction is applied), and then back to YCbCr SDI on the output. Controls are available to adjust each RGB level independently for both white levels (gain) and black levels (offset). Gamma can also be independently adjusted for each RGB channels. Various controls can be ganged to provide adjustment for all three color channels simultaneously.

3D LUT Processor Option

Options **+3D-LUT-PRO-4K** (and non-4k option **+3D-LUT-PRO**) provide 33-cube LUT for mapping from 10-bit RGB to the color space appropriate for color grading. This option may also be used for static HDR>SDR or SDR>HDR conversions. This option can be controlled via WonderLookPro (from TV-Logic) or LiveGradePro (from Pomfort).

The positioning of the 3D LUT function before the UDX scaler and SDR-HDR conversion allows LUT and HDR conversion such that scaler artifacts are not “amplified” by these processes.

SDR <> HDR Conversion Option

Options **+HDR-ITM-4K** (and non-4k option **+HDR-ITM**) provide conversion from Standard Dynamic Range (SDR) to High Dynamic Range (HDR) using Technicolor® Intelligent Tone Management™ (ITM)[1]. ITM, when enabled, is applied in real-time and optimizes the processed output for use HDR displays. The SDR-to-HDR process, when used with compatible SDR sources, typically results in enhanced luminance range, grain, and detail while preserving the original colors/color balance in the content. De-noising and de-banding functions provide “clean-up” of artifacts that can appear in upconversions. Output modes include Hybrid Log Gamma (HLG) functions, S-Gamma (SLOG3), and Perceptual Quantizer (PQ) functions.

Basically, user interface to this function is based around three modes:

Preset Mode (Basic) – This mode provides a one-button enable where HDR conversion parameters a re optimized for typical cases, as determined by trials observed and analyzed by experts to arrive at a best-case data set. This mode provides simplified controls that allow “tweaking” various aspects (such as brightness, contrast, and saturation) to obtain tailored optimized results. The Preset Mode mode offers to the user a possibility to quickly switch between predefined tunings, basically balancing between brightness and contrast.

Bright Spot Auto processing automatically reduces or monitors large image areas of potential glare while not impacting small details (highlights or “sparkles”). All underlying functions are applied on an image basis and flexibly and automatically adapt on every image.

Manual HMS Mode – This mode exposes all available parametric controls used in the ITM SDR-to-HDR process. The initial settings are based on data set conclusions and provide a baseline for very detailed adjustments with a high degree of granularity and control. This is the most flexible mode, enabling the manual adjustment/tuning of the SDR-HDR conversion taking into full account the picture or scene characteristics.

Auto Mode – This mode is designed to provide SDR-HDR conversion of the video with minimal user interaction. This mode is based on machine learning using a database of thousands of video images, wherein each were graded and tweaked by experts arriving at base settings derived from this research and trials. Where useful, various controls are exposed allowing further fine-tuning of aspects temporal filtering. The Auto mode also exposes some controls found in the Manual HMS Mode.

The SL-HDR functionality provides a single layer encoding which allows an SDR stream for distribution, with HDR metadata that, when decoded by compatible downstream monitors/devices, provides conversion to HDR.

1. Intelligent Tone Management™ is a trademark of Technicolor. ITM is used in this product under license from Technicolor.

SL-HDR Encoder Option

Options **+SL-HDR-4K** (and non-4k option **+SL-HDR**) provide tone mapping and encoding, as well as metadata embedding to perform OETF handling. This provides for accommodating SDR display devices while providing the necessary OETF encoding to enable HDR attributes (“reconstruction”) when the signal is fed to compatible HDR display devices.

The functions has settings that accommodate the input characteristics, as well as output settings mapped to SL-HDR1 and SL-HDR2, as well as OETF ITU-R PQ, HLG, and SLog3 standards. A Tuning Parameters control set allows custom tailoring of parameters such as lift, Y-gain, and saturation.

Frame Sync Function

This function provides for frame sync control using either one of two external **FRAME REF IN (1,2)** reference signals distributed with the card frame, or the input video as a frame sync reference.

This function also allows horizontal and/or vertical offset to be added between the output video and the frame sync reference.

Frame sync can select from either of two card frame reference sources, or free-run input video sync. Selectable failover allows alternate reference selection should the initial reference source become unavailable or invalid. In the event of input video loss of signal, the output can be set to disable video, go to black, go to an internal test signal generator pattern, or freeze to the last intact frame (last frame having valid SAV and EAV codes).

An internal test signal generator provides a selection of various standard patterns such as color bars, sweep patterns, and other technical patterns. The test patterns can be applied to the output video upon loss of input or manually inserted at any time.

Wings Insertion

Wings insertion allows a symmetrical L-R wings insertion to be integrated into the card program video output. Wings video is accommodated using a separate wings SDI input. The wings user interface displays wings timing relative to the card output video, allowing wings timing offset to be adjusted such that wings can be properly framed. (This function does not provide timing offset control of the wings video; offset must be provided by a external frame sync card or device controlling the wings video feed.)

Output Video Format (Scaler) Function

The scaler function provides up/down/cross-conversion ranging from conversions to SD, cross-conversions between 3G/HD formats, 3G level A output formats, and conversions from and to 4K UHD formats. Table 1-1 lists the available input and output formats supported by the 9904-UDX-4K card.

For 4K UHD outputs, the output video format selections offer the following packaging choices:

- Standard SMPTE 424M, 292M, SMPTE 259M-C single-wire 3G/HD/SD-SDI (e.g., **1280x720p 59.94**)
- Quad-link 2SI SDI (e.g., **3840x2160p 59.94 QL 2SI**)
- Quad-link SDM SDI (e.g., **3840x2160p 59.94 QL SDM**)
- ST 2082 12G and 6G single-wire SDI signal formats (e.g., **4096x2160p 59.94 12G**)

When any scaler setting offering any of the packaging above is selected, the output routing is automatically set to support the selected formatting.

Example: When a quad-link SDM package is selected, **SDI Output 1** thru **SDI Output 4** automatically are configured to provide the four ordered link signals comprising the quad-link UHD package.

Table 1-1 9904-UDX-4K Input/Output Formats

525i 59.94	1920x1080p 29.97	3840x2160p 50 QL 2SI	4096x2160p 50 QL 2SI
625i 50	1920x1080p 30	3840x2160p 59.94 QL 2SI	4096x2160p 59.94 QL 2SI
		3840x2160p 60 QL 2SI	4096x2160p 60 QL 2SI
1280x720p 23.98	1920x1080psf 23.98		4096x2160p 50 QL SDM
1280x720p 24	1920x1080psf 24	3840x2160p 23.98 QL SDM	4096x2160p 59.94 QL SDM
1280x720p 25	1920x1080psf 25	3840x2160p 24 QL SDM	4096x2160p 60 QL SDM
1280x720p 29.97	1920x1080psf 29.97	3840x2160p 25 QL SDM	
1280x720p 30	1920x1080psf 30	3840x2160p 29.97 QL SDM	4096x2160p 50 12G
1280x720p 50		3840x2160p 30 QL SDM	4096x2160p 59.94 12G
1280x720p 59.94	1920x1080p 50 A	3840x2160p 50 QL SDM	4096x2160p 60 12G
1280x720p 60	1920x1080p 59.94 A	3840x2160p 59.94 QL SDM	
	1920x1080p 60 A	3840x2160p 60 QL SDM	
1920x1080i 50			
1920x1080i 59.94	2048x1080p 23.98	3840x2160p 50 12G	
1920x1080i 60	2048x1080p 24	3840x2160p 59.94 12G	
	2048x1080p 25	3840x2160p 60 12G	
1920x1080p 23.98	2048x1080p 50 A		
1920x1080p 24	2048x1080p 59.94 A		
1920x1080p 25	2048x1080p 60 A		

Audio Processor Description

The audio processor operates as an internal audio router. This function chooses from the following inputs:

- 16 channels of embedded audio from the SDI video input (default 1-to-1 routing to SDI output)
- 8 pairs max (16 channels) of discrete AES audio

The audio processing subsection is built around a card internal 16-channel audio bus. This 16-channel bus receives inputs from an input routing crosspoint that routes de-embedded audio inputs over the 16-channel card bus. Correspondingly, at the output end of the 16-channel bus is an output routing crosspoint that in turn distributes the 16-channel bus signals to embedded outputs.

Audio Down Mix Function

(See Figure 1-2.) The Audio Down Mixer function provides for the selection of any five embedded channels serving as Left (**L**), Right (**R**), Center (**C**), Left Surround (**Ls**), and Right Surround (**Rs**) individual signals to be multiplexed into stereo pair Down Mix Left (**DM-L**) and Down Mix Right (**DM-R**). The resulting stereo pair **DM-L** and **DM-R** can in turn be routed to any embedded audio pair as desired (or de-embedded to an AES audio output).

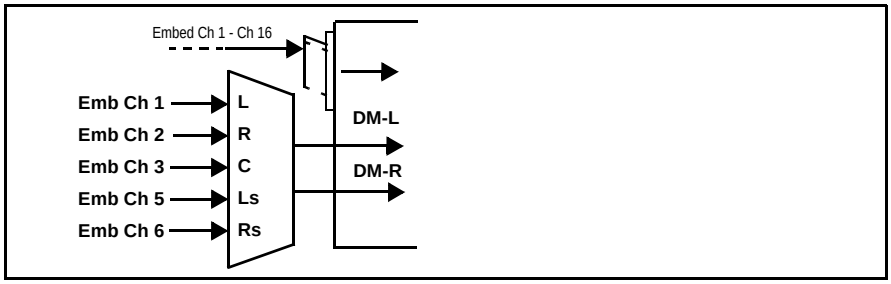

Figure 1-2 Audio Down Mix Functional Block Diagram with Example Sources

Flex Buses. Flex buses provide flexible-structure mixers in which any of 16 summing nodes (**Flex Mix Bus A** thru **Flex Mix Bus P**) can receive any card audio input, thereby allowing several customizable mixing schemes.

Option **+DSP Options (model 9904-UDX-4K-DSP only).** Option licenses provide the user-exposed DSP functions. Available DSP options are as follows. Multiple licenses for the same or different options can be installed and used simultaneously.

- **+DSP-RTLL-5.1** Dolby® Real-Time Loudness Leveling™ 5.1-Channel Loudness Processor Option
- **+DSP-RTLL-2.0** Dolby® Real-Time Loudness Leveling™ 2.0-Channel Loudness Processor Option

  Both **DSP-RTLL-5.1** and **DSP-RTLL-2.0** provide for specially suited Target Level (which sets the target loudness level) as desired. A Peak Limit function can be set to provide absolute peak limiting. This function is also configurable for aggressiveness. An intelligent Speech Percentage detection algorithm can help distinguish between program speech and other sounds. This can help in “fine tuning” various parameters to best suit the program material.

- **+DSP-ENCD-5.1** Dolby® Digital/Digital Plus 5.1 Encoder
- **+DSP-ENCD-2.0** Dolby® Digital/Digital Plus 2.0 Encoder
- **+DSP-DEC** Dolby® Decoder
- **+DSP-UPMIX-LA** Linear Acoustic® UPMAX™ 2.0-to-5.1 Upmixer

Note: The **-DSP** version of the card (9904-UDX-4K-DSP) has the necessary hardware to support **+DSP** options via additional licensing. The individual +DSP options listed above are not standard with model 9904-UDX-4K-DSP.

User Control Interface

Figure 1-3 shows the user control interface options for the 9904-UDX-4K. These options are individually described below.

Note: All user control interfaces described here are cross-compatible and can operate together as desired. Where applicable, any control setting change made using a particular user interface is reflected on any other connected interface.

- **DashBoard™ User Interface** – Using DashBoard™, the 9904-UDX-4K and other cards installed in openGear®[1] frames can be controlled from a computer and monitor.

  DashBoard™ allows users to view all frames on a network with control and monitoring for all populated slots inside a frame. This simplifies the setup and use of numerous modules in a large installation and offers the ability to centralize monitoring. Cards define their controllable parameters to DashBoard™, so the control interface is always up to date.

  The DashBoard™ software can be downloaded from the Cobalt Digital Inc. website: www.cobaltdigital.com (enter "DashBoard" in the search window). The DashBoard™ user interface is described in Chapter 3,"Operating Instructions".

- **Cobalt® OGCP-9000 and OGCP-9000/CC Remote Control Panels** – The OGCP-9000 and OGCP-9000/CC Remote Control Panels conveniently and intuitively provide parameter monitor and control of the 9904-UDX-4K and other video and audio processing terminal equipment meeting the open-architecture Cobalt® cards for openGear™ standard.

  In addition to circumventing the need for a computer to monitor and control signal processing cards, the Control Panels allow quick and intuitive access to hundreds of cards in a facility, and can monitor and allow adjustment of multiple parameters at one time.

  The Remote Control Panels are totally compatible with the openGear™ control software DashBoard™; any changes made with either system are reflected on the other. The Remote Control Panel user interface is described in Chapter 3,"Operating Instructions".

1. openGear® is a registered trademark of Ross Video Limited. DashBoard™ is a trademark of Ross Video Limited.

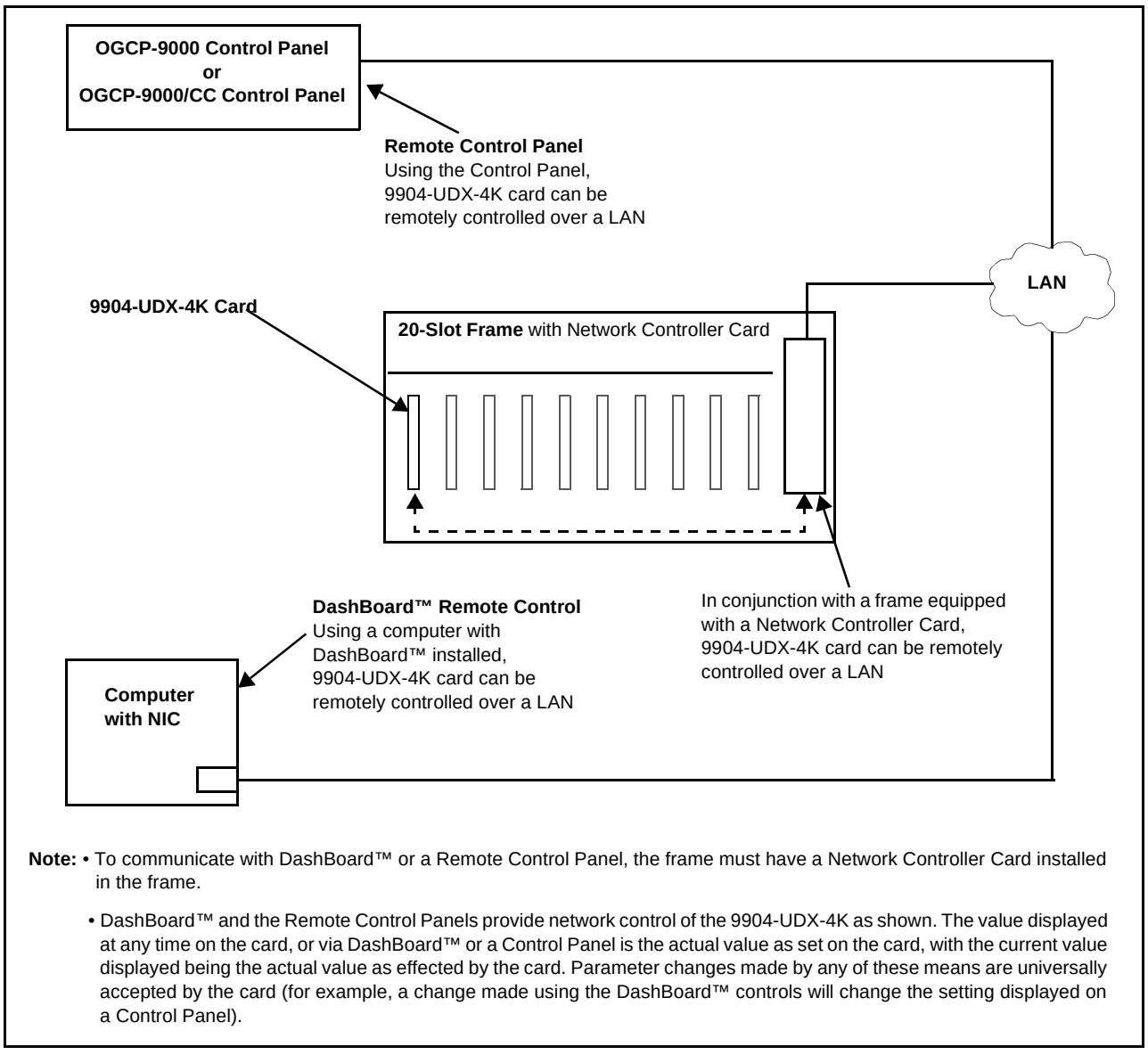

Figure 1-3 9904-UDX-4K User Control Interface

Note: If network remote control is to be used for the frame and the frame has not yet been set up for remote control, Cobalt® reference guide **Remote Control User Guide (PN 9000RCS-RM)** provides thorough information and step-by-step instructions for setting up network remote control of Cobalt® cards using DashBoard™. (Cobalt® OGCP-9000 and OGCP-9000/CC Remote Control Panel product manuals have complete instructions for setting up remote control using a Remote Control Panel.)

Download a copy of this guide by clicking on the **Support>Reference Documents** link at www.cobaltdigital.com and then select DashBoard Remote Control Setup Guide as a download, or contact Cobalt® as listed in Contact Cobalt Digital Inc. (p. 1-19).

9904-UDX-4K Rear I/O Modules

The 9904-UDX-4K physically interfaces to system video connections at the rear of its frame using a Rear I/O Module.

All inputs and outputs shown in the 9904-UDX-4K Functional Block Diagram (Figure 1-1) enter and exit the card via the card edge backplane connector. The Rear I/O Module breaks out the 9904-UDX-4K card edge connections to coaxial and other connectors that interface with other components and systems in the signal chain.

The full assortment of 9904-UDX-4K Rear I/O Modules is shown and described in 9904-UDX-4K Rear I/O Modules (p. 2-4) in Chapter 2, “Installation and Setup”.

Technical Specifications

Table 1-2 lists the technical specifications for the 9904-UDX-4K 12G/6G/3G/HD/SD-SDI Up-Down-Cross Converter/Frame Sync/Embed/De-Embed Audio Processor card.

Table 1-2 Technical Specifications

Item	Characteristic
Part number, nomenclature	9904-UDX-4K 12G/6G/3G/HD/SD-SDI Up-Down-Cross Converter/ Frame Sync/Embed/De-Embed Audio Processor
Installation/usage environment	Intended for installation and usage in frame meeting openGear™ modular system definition
Power consumption	Up to 60 Watts (45 W typ.)
Installation Density	Up to 10 cards per 20-slot frame
Environmental: Operating temperature: Relative humidity (operating or storage):	 32° – 104° F (0° – 40° C) < 95%, non-condensing
Frame communication	10/100/1000 Mbps Ethernet with Auto-MDIX
Serial Digital Video Input	Number of Inputs: (6) 75Ω inputs (max) SDI Formats Supported: SMPTE ST2082-1,10, 424M, 292M, SMPTE 259M-C. Inputs IN 1 thru IN 4: Suitable for SDM/2SI quad 3G compliant Inputs IN 5 and IN 6: Suitable for single-wire SMPTE ST2082-1,10 6G/12G Input Cable Rx Length (max): 45m Belden 1694A cable at 11.88 Gbps 120m Belden 1694A cable at 2.97 Gbps 240m Belden 1694A cable at 1.485 Gbps 400m Belden 1694A cable at 270 Mbps

Table 1-2 Technical Specifications — continued

Item	Characteristic
Post-Processor Serial Digital Video Outputs	Number of Outputs: (8) 75Ω outputs (max) in form of four, 2x1 DA outputs Return Loss: > 15 dB up to 1.485 GHz > 10 dB up to 3 GHz > 7 dB up to 6 GHz > 5 dB up to 12 GHz Output Signal Level: 800 mV ±10% DC Offset: 0 V ± 50 mV Rise and Fall Time @ 11.88 Gbps: < 45 ps Alignment Jitter (12G/3G/HD/SD): < 0.3/0.3/0.2/0.2 UI
HDMI Out	HDMI 2.0; Type A connector
IP ST 2022-6 Interface (model 9904-4K-UDX-IP only)	(2) 10GigE multi-mode optical Tx/Rx interface; female LC duplex connectors
Frame Sync Audio/VIdeo Delay	Max offset: 20 frames Latency (min): 1 frame User Audio Delay Offset from Video: Bulk delay control: -33 msec to +3000 msec. Per-channel delay controls: -800 msec to +800 msec
Embedded Audio Output	16-ch embedded. User crosspoint allows routing of any embedded channel to any embedded channel output. Multi-frequency tone generator for each audio output.
AES Audio Inputs/Outputs	Standard: SMPTE 276M Number of Inputs/Outputs: Up to 8 pairs; unbalanced; AES-3id (can be set as a combined group as either all inputs or all outputs) Impedance: 75 Ω **Note:** The card offers up to eight (8) AES-3id coaxial ports, with port direction assignable as inputs or outputs in groups of 4 ports (earlier versions have four (4) ports max).
Frame Reference Input	Number of Inputs: Two, REF 1 and REF 2 from frame with selectable failover Standards Supported: SMPTE 170M/318M (“black burst”) SMPTE 274M/296M (“tri-level”) Return Loss: > 35 dB up to 5.75 MHz

Warranty and Service Information

Cobalt Digital Inc. Limited Warranty

This product is warranted to be free from defects in material and workmanship for a period of five (5) years from the date of shipment to the original purchaser, except that 4000, 5000, 6000, 8000 series power supplies, and Dolby® modules (where applicable) are warranted to be free from defects in material and workmanship for a period of one (1) year.

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This limited warranty applies only to the original end-purchaser of the product, and is not assignable or transferrable therefrom. This warranty is limited to defects in material and workmanship, and shall not apply to acts of God, accidents, or negligence on behalf of the purchaser, and shall be voided upon the misuse, abuse, alteration, or modification of the product. Only Cobalt authorized factory representatives are authorized to make repairs to the product, and any unauthorized attempt to repair this product shall immediately void the warranty. Please contact Cobalt Technical Support for more information.

To facilitate the resolution of warranty related issues, Cobalt recommends registering the product by completing and returning a product registration form. In the event of a warrantable defect, the purchaser shall notify Cobalt with a description of the problem, and Cobalt shall provide the purchaser with a Return Material Authorization ("RMA"). For return, defective products should be double boxed, and sufficiently protected, in the original packaging, or equivalent, and shipped to the Cobalt Factory Service Center, postage prepaid and insured for the purchase price. The purchaser should include the RMA number, description of the problem encountered, date purchased, name of dealer purchased from, and serial number with the shipment.

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Chapter 2

Installation and Setup

Overview

This chapter contains the following information:

Installing the 9904-UDX-4K Into a Frame Slot

CAUTION

Heat and power distribution requirements within a frame may dictate specific slot placement of cards. Cards with many heat-producing components should be arranged to avoid areas of excess heat build-up, particularly in frames using only convection cooling. The 9904-UDX-4K can have a high power dissipation (>58 W). As such, avoiding placing the card adjacent to other cards with similar dissipation values if possible.

CAUTION

This device contains semiconductor devices which are susceptible to serious damage from Electrostatic Discharge (ESD). ESD damage may not be immediately apparent and can affect the long-term reliability of the device.

Avoid handling circuit boards in high static environments such as carpeted areas, and when wearing synthetic fiber clothing. Always use proper ESD handling precautions and equipment when working on circuit boards and related equipment.

Note: **If installing the 9904-UDX-4K in a slot with no rear I/O module, a Rear I/O Module is required** before cabling can be connected. Refer to Installing a Rear I/O Module (p. 2-3) for rear I/O module installation procedure.

CAUTION

If required, make certain Rear I/O Module(s) is installed before installing the 9904-UDX-4K into the frame slot. Damage to card and/or Rear I/O Module can occur if module installation is attempted with card already installed in slot.

Note: Check the packaging in which the 9904-UDX-4K was shipped for any extra items such as a Rear I/O Module connection label. In some cases, this label is shipped with the card and to be installed on the Rear I/O connector bank corresponding to the slot location of the card.

Install the 9904-UDX-4K into a frame slot as follows:

1. Determine the slot in which the 9904-UDX-4K is to be installed.
2. Open the frame front access panel.
3. While holding the card by the card edges, align the card such that the plastic ejector tab is on the bottom.
4. Align the card with the top and bottom guides of the slot in which the card is being installed.
5. Gradually slide the card into the slot. When resistance is noticed, gently continue pushing the card until its rear printed circuit edge terminals engage fully into the rear I/O module mating connector.

CAUTION

If card resists fully engaging in rear I/O module mating connector, check for alignment and proper insertion in slot tracks. Damage to card and/or rear I/O module may occur if improper card insertion is attempted.

6. Verify that the card is fully engaged in rear I/O module mating connector.
7. Close the frame front access panel.
8. Connect the input and output cables as shown in 9904-UDX-4K Rear I/O Modules (p. 2-4).
9. Repeat steps 1 through 8 for other 9904-UDX-4K cards.

Note:
- The 9904-UDX-4K coaxial inputs are internally 75-ohm terminated. It is not necessary to terminate unused coaxial inputs or outputs.
- External frame sync reference signals are received by the card over a reference bus on the card frame, and not on any card rear I/O module connectors. The frame has BNC connectors labeled **REF 1** and **REF 2** which receive the reference signal from an external source such as a house distribution.
- To remove a card, press down on the ejector tab to unseat the card from the rear I/O module mating connector. Evenly draw the card from its slot.

10. If network remote control is to be used for the frame and the frame has not yet been set up for remote control, perform setup in accordance with Setting Up 9904-UDX-4K Network Remote Control (p. 2-8).

Note: If installing a card in a frame already equipped for, and connected to DashBoard™, no network setup is required for the card. The card will be discovered by DashBoard™ and be ready for use.

Installing a Rear I/O Module

Note: This procedure is applicable **only if a Rear I/O Module is not currently installed** in the slot where the 9904-UDX-4K is to be installed.

If installing the 9904-UDX-4K in a slot already equipped with a suitable I/O module, omit this procedure.

Install a Rear I/O Module as follows:

1. On the frame, determine the slot in which the 9904-UDX-4K is to be installed.
2. In the mounting area corresponding to the slot location, install Rear I/O Module as shown in Figure 2-1.

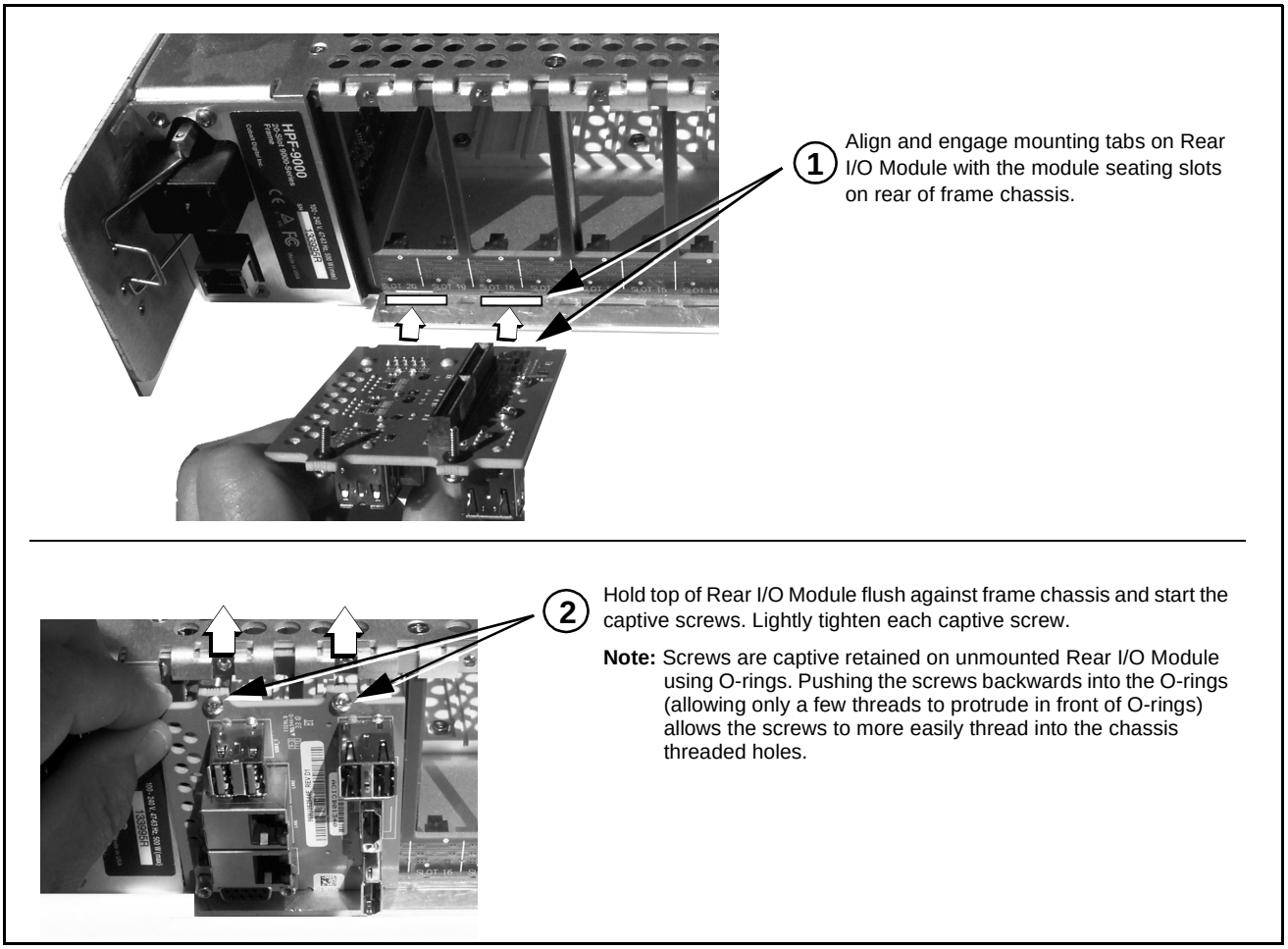


Figure 2-1 Rear I/O Module Installation

9904-UDX-4K Rear I/O Modules

Table 2-1 shows and describes the full assortment of Rear I/O Modules specifically for use with the 9904-UDX-4K.

Table 2-1 9904-UDX-4K Rear I/O Modules

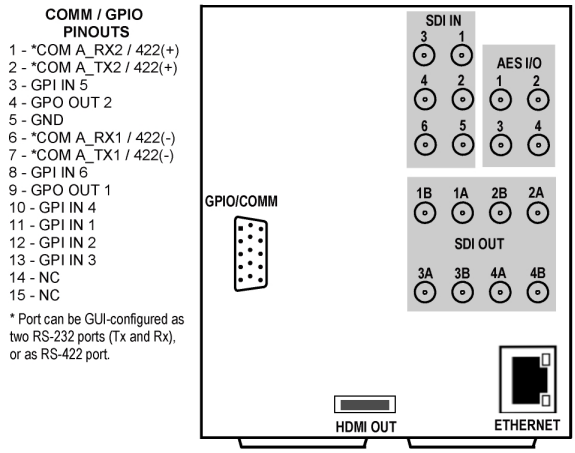
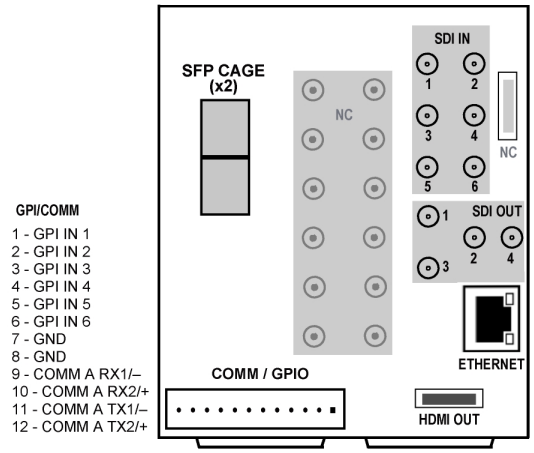
9904-UDX-4K Rear I/O Module	Description
Note: On rear modules below showing **SFP CAGE**, the cage receptacles are functional only on model **9904-UDX-4K-IP** or on models factory ordered and equipped with hardware option **-UDX-SFP**. In all other cases, the SFP cage is NC and non-functional.	
RM20-9904-B-HDBNC 	Provides the following connections: • Four 3G/HD/SD-SDI coaxial quad-link inputs (**SDI IN 1** thru **SDI IN 4**) • Two 12G/6G/3G/HD/SD-SDI coaxial single-wire inputs (**SDI IN 5** and **SDI IN 6**) (suitable for ST 2082 12G-SDI) • Four AES coaxial input/outputs (**AES I/O 1** thru **AES I/O 4**) • Eight 4x2 SDI processed coaxial outputs (**SDI OUT 1A/1B** thru **SDI OUT 4A/4B**) • **HDMI OUT** connector (HDMI 2.0; Type A connector) • **GPIO/COMM** multi-conductor connector • **ETHERNET** 10/100/1000 RJ-45 connector (reserved) **Note:** All coaxial connectors are HD-BNC.
RM20-9904-C-HDBNC 	Provides the following connections: • Four 3G/HD/SD-SDI coaxial quad-link inputs (**SDI IN 1** thru **SDI IN 4**) • Two 12G/6G/3G/HD/SD-SDI coaxial single-wire inputs (**SDI IN 5** and **SDI IN 6**) (suitable for ST 2082 12G-SDI) • Four SDI processed coaxial outputs (**SDI OUT 1** thru **SDI OUT 4**) • **HDMI OUT** connector (HDMI 2.0; Type A connector) • **SFP CAGE (x2):** Two user-accessible SFP cages that can be user-fitted with various SFP types. See SFP Types (Rear Modules Equipped with SFP Cages) (p. 2-7) for available SFP types and other details. • **GPIO/COMM** multi-conductor connector • **ETHERNET** 10/100/1000 RJ-45 connector (reserved) **Note:** • All coaxial connectors are HD-BNC. • SFP interfaces applicable for model 9904-4K-UDX-IP or models with **-UDX-SFP** option only.

Table 2-1 9904-UDX-4K Rear I/O Modules — continued

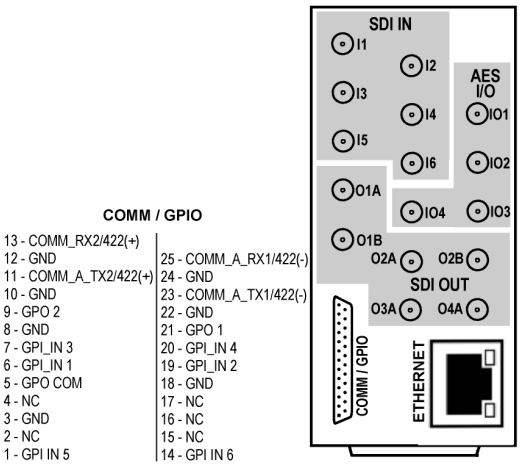
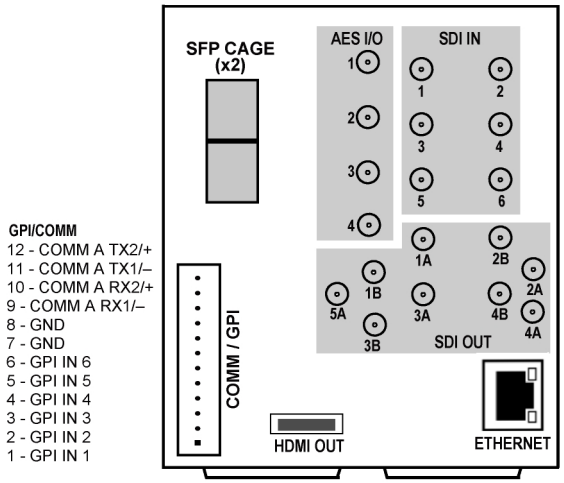
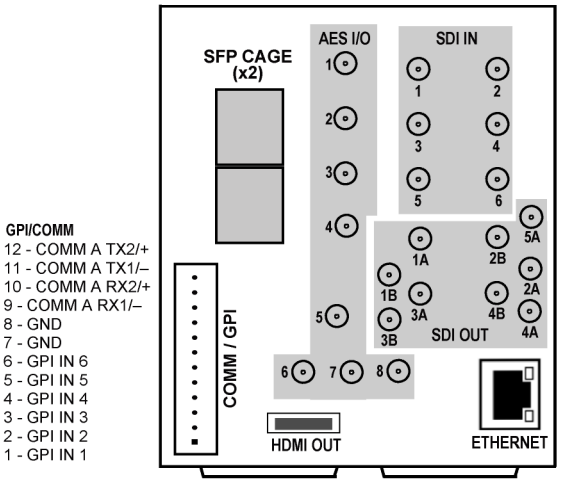
9904-UDX-4K Rear I/O Module	Description
RM20-9904-D-HDBNC 	Provides the following connections: • Four 3G/HD/SD-SDI coaxial quad-link inputs (**SDI IN 1** thru **SDI IN 4**) • Two 12G/6G/3G/HD/SD-SDI coaxial single-wire inputs (**SDI IN 5** and **SDI IN 6**) (suitable for ST 2082 12G-SDI) • Six SDI processed coaxial outputs (**SDI OUT 1A** thru **SDI OUT 4A**) • Four AES coaxial input/outputs (**AES I/O 1** thru **AES I/O 4**) • **GPIO/COMM** multi-conductor connector (Micro D25) • **ETHERNET** 10/100/1000 RJ-45 connector (reserved) **Note:** All coaxial connectors are HD-BNC.
RM20-9904-E-HDBNC 	Provides the following connections: • Four 3G/HD/SD-SDI coaxial quad-link inputs (**SDI IN 1** thru **SDI IN 4**) • Two 12G/6G/3G/HD/SD-SDI coaxial single-wire inputs (**SDI IN 5** and **SDI IN 6**) (suitable for ST 2082 12G-SDI) • Nine SDI processed coaxial outputs (**SDI OUT 1A** thru **SDI OUT 5A**) • Four AES coaxial input/outputs (**AES I/O 1** thru **AES I/O 4**) • **HDMI OUT** connector (HDMI 2.0; Type A connector) • **SFP CAGE (x2):** Two user-accessible SFP cages that can be user-fitted with various SFP types. See SFP Types (Rear Modules Equipped with SFP Cages) (p. 2-7) for available SFP types and other details. • **GPIO/COMM** multi-conductor connector • **ETHERNET** 10/100/1000 RJ-45 connector (reserved) **Note:** • All coaxial connectors are HD-BNC. • SFP interfaces applicable for model 9904-4K-UDX-IP or models with **-UDX-SFP** option only.

Table 2-1 9904-UDX-4K Rear I/O Modules — continued

9904-UDX-4K Rear I/O Module	Description
RM20-9904-F-HDBNC 	Provides the following connections: • Four 3G/HD/SD-SDI coaxial quad-link inputs (**SDI IN 1** thru **SDI IN 4**) • Two 12G/6G/3G/HD/SD-SDI coaxial single-wire inputs (**SDI IN 5** and **SDI IN 6**) (suitable for ST 2082 12G-SDI) • Nine SDI processed coaxial outputs (**SDI OUT 1A** thru **SDI OUT 5A**) • Eight AES coaxial input/outputs (**AES I/O 1** thru **AES I/O 8**) • **HDMI OUT** connector (HDMI 2.0; Type A connector) • **SFP CAGE (x2):** Two user-accessible SFP cages that can be user-fitted with various SFP types. See SFP Types (Rear Modules Equipped with SFP Cages) (p. 2-7) for available SFP types and other details. • **GPIO/COMM** multi-conductor connector • **ETHERNET** 10/100/1000 RJ-45 connector (reserved) **Note:** • All coaxial connectors are HD-BNC. • SFP interfaces applicable for model 9904-4K-UDX-IP or models with **-UDX-SFP** option only. • Up to eight (8) AES-3id coaxial ports are available on latest rev cards. Hardware versions earlier than -E support only AES ports 1 thru 4.

SFP Types (Rear Modules Equipped with SFP Cages)

(See Table 2-2.) For the rear modules shown above on cards factory-ordered that are compatible with SFP support, the following user-accessible SFP types/functions are available. SFPs install in rear module rear-accessible SFP cage.

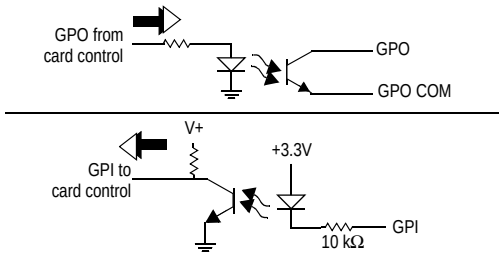
Note: SFP interfaces applicable for model 9904-4K-UDX-IP or models with **-UDX-SFP** factory-installed hardware option only.

Table 2-2 SFP Types Available

Cobalt Part Number	Description/Details
-SFP-EOOE-MSA-12G	12G/6G/3G/HD/SD-SDI UHD Transceiver (LC female connectors)
-SFP-EO-MSA-12G	12G/6G/3G/HD/SD-SDI UHD Transmitter (LC female connector).
-SFP-OE-MSA-12G	12G/6G/3G/HD/SD-SDI UHD Receiver (LC female connector)
-SFP-EOOE-MSA	Single-Channel Video Optical Transceiver (LC female connectors)
-SFP-EO-MSA	Single-Channel Video Optical Transmitter (LC female connector)
-SFP-OE-MSA	Single-Channel Video Optical Receiver (LC female connector)
-SFP-IP-SWD-MSA	Software-Defined EmSFP 2011/2022-6 Encap/De-Encap Host. 10GigE Multi-Mode Optical Interface with Female LC Duplex Connectors. The following I/O purposing software options are available for cards using SFP type -SPF-IP-SWD-MSA (Up to 3 software licenses can be added to the -SFP-IP-SWD-MSA, but only 1 license can be active at a time): **+ADD-SFP-2SDI-TO-IP-2022-6** SFP Software License; Dual-Channel Encapsulator 2SDI-to-IP-2022-6 **+ADD-SFP-2SDI-TO-IP-2110** SFP Software License; Dual-Channel Encapsulator 2SDI-to-IP-2110 **+ADD-SFP-IP-TO-2SDI-2022-6** SFP Software License; Dual-Channel De-Encapsulator IP-2022-6-to-2SDI **+ADD-SFP-IP-TO-2SDI-2110** SFP Software License; Dual-Channel De-Encapsulator IP-2110-to-2SDI **+ADD-SFP-IP-TO-SDI-2022-6** SFP Software License; Single-Channel De-Encapsulator IP-2022-6-to-SDI **+ADD-SFP-IP-TO-SDI-2110** SFP Software License; Single-Channel De-Encapsulator IP-2110-to-SDI **+ADD-SFP-SDI-TO-IP-2022-6** SFP Software License; Single-Channel Encapsulator SDI-to-IP-2022-6 **+ADD-SFP-SDI-TO-IP-2110** SFP Software License; Single-Channel Encapsulator SDI-to-IP-2110

GPIO Electrical Details

Figure 2-2 shows the equivalent circuits used for GPIO, and specifies external parametric limitations when using GPIO.



GPIO uses equivalent opto-isolated circuits shown below.

GPO Specifications:
Max I: 120 mA
Max V: 30 V
Max P: 120 mW
Pullup R >500Ω resistor is recommended when using 5V control.

GPI Specifications:
GPI LO @ Vin < 1.5 V
GPI HI @ Vin > 2.3 V
Max Vin: 9 V

Figure 2-2 GPIO Electrical Details

Setting Up 9904-UDX-4K Network Remote Control

Perform remote control setup in accordance with Cobalt® reference guide "Remote Control User Guide" (PN 9000RCS-RM).

Note: • If network remote control is to be used for the frame and the frame has not yet been set up for remote control, Cobalt® reference guide **Remote Control User Guide (PN 9000RCS-RM)** provides thorough information and step-by-step instructions for setting up network remote control of Cobalt® cards using DashBoard™. (Cobalt® OGCP-9000 and OGCP-9000/CC Remote Control Panel product manuals have complete instructions for setting up remote control using a Remote Control Panel.)

Download a copy of this guide by clicking on the **Support>Reference Documents** link at www.cobaltdigital.com and then select DashBoard Remote Control Setup Guide as a download, or contact Cobalt® as listed in Contact Cobalt Digital Inc. (p. 1-19).

• If installing a card in a frame already equipped for, and connected to DashBoard™, no network setup is required for the card. The card will be discovered by DashBoard™ and be ready for use.

Chapter 3

Operating Instructions

Overview

If you are already familiar with using DashBoard or a Cobalt Remote Control Panel to control Cobalt cards, please skip to 9904-UDX-4K Function Menu List and Descriptions (p. 3-8).

This chapter contains the following information:

Control and Display Descriptions

This section describes the user interface controls, indicators, and displays for using the 9904-UDX-4K card. The 9904-UDX-4K functions can be accessed and controlled using any of the user interfaces described here.

The format in which the 9904-UDX-4K functional controls, indicators, and displays appear and are used varies depending on the user interface being used. Regardless of the user interface being used, access to the 9904-UDX-4K functions (and the controls, indicators, and displays related to a particular function) follows a general arrangement of Function Menus under which related controls can be accessed (as described in Function Menu/Parameter Overview below).

Note: When a setting is changed, settings displayed on DashBoard™ (or a Remote Control Panel) are the settings as effected by the card itself and reported back to the remote control; the value displayed at any time is the actual value as set on the card.

Function Menu/Parameter Overview

The functions and related parameters available on the 9904-UDX-4K card are organized into function **menus**, which consist of parameter groups as shown below.

Figure 3-1 shows how the 9904-UDX-4K card and its menus are organized, and also provides an overview of how navigation is performed between cards, function menus, and parameters.

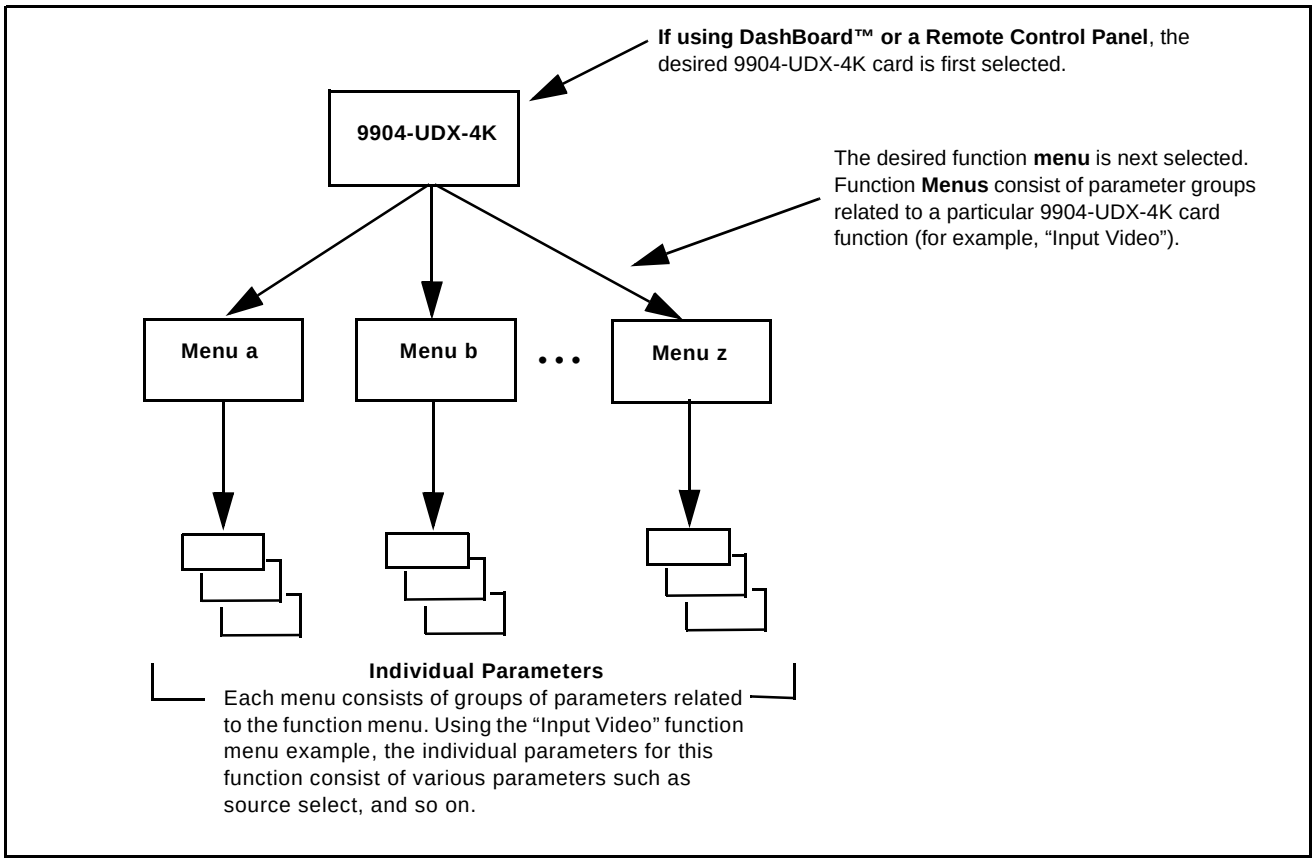


Figure 3-1 Function Menu/Parameter Overview

DashBoard™ User Interface

(See Figure 3-2.) The card function menus are organized in DashBoard™ using tabs. When a tab is selected, each parametric control or selection list item associated with the function is displayed. Scalar (numeric) parametric values can then be adjusted as desired using the GUI slider controls. Items in a list can then be selected using GUI drop-down lists.

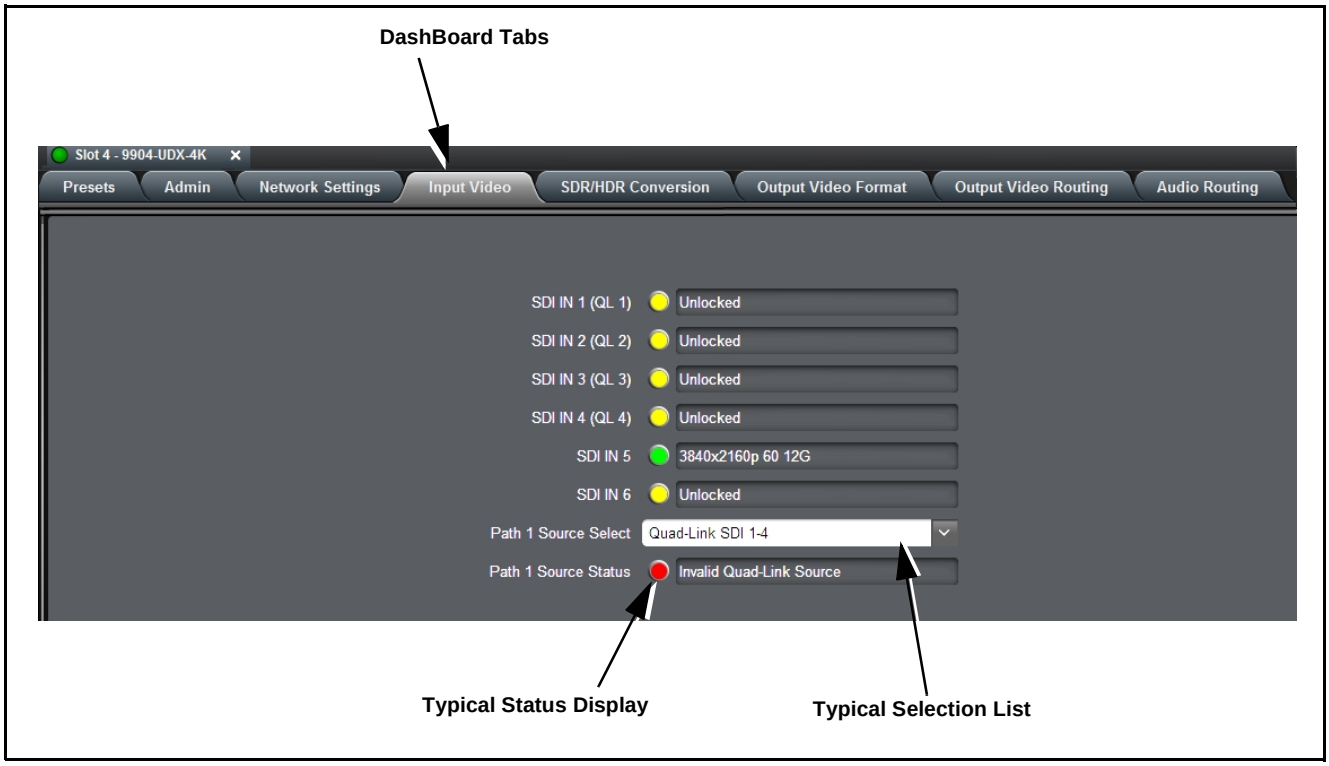


Figure 3-2 Typical DashBoard Tabs and Controls

Cobalt® Remote Control Panel User Interfaces

(See Figure 3-3.) Similar to the function menu tabs using DashBoard™, the Remote Control Panels have a Select Submenu key that is used to display a list of function submenus. From this list, a control knob on the Control Panel is used to select a function from the list of displayed function submenu items.

When the desired function submenu is selected, each parametric control or selection list item associated with the function is displayed. Scalar (numeric) parametric values can then be adjusted as desired using the control knobs, which act like a potentiometer. Items in a list can then be selected using the control knobs which correspondingly act like a rotary switch.

Figure 3-3 shows accessing a function submenu and its parameters (in this example, “Video Proc”) using the Control Panel as compared to using the card edge controls.

Note: Refer to “OGCP-9000 Remote Control Panel User Manual” (PN OGCP-9000-OM) or “OGCP-9000/CC Remote Control Panel User Manual” (PN OGCP-9000/CC-OM) for complete instructions on using the Control Panels.

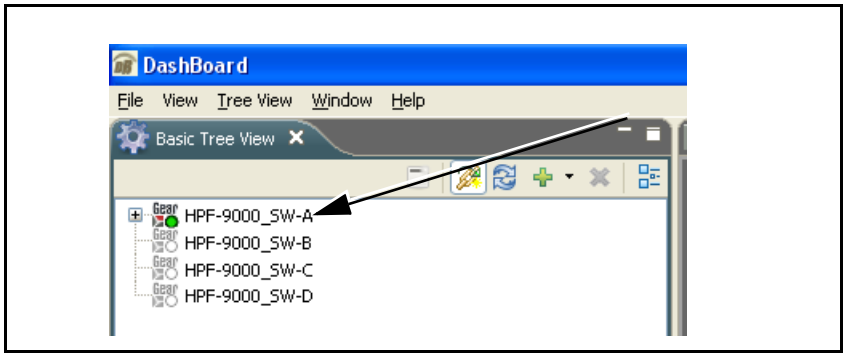
Figure 3-3 Remote Control Panel Setup of Example Video Proc Function Setup

Accessing the 9904-UDX-4K Card via Remote Control

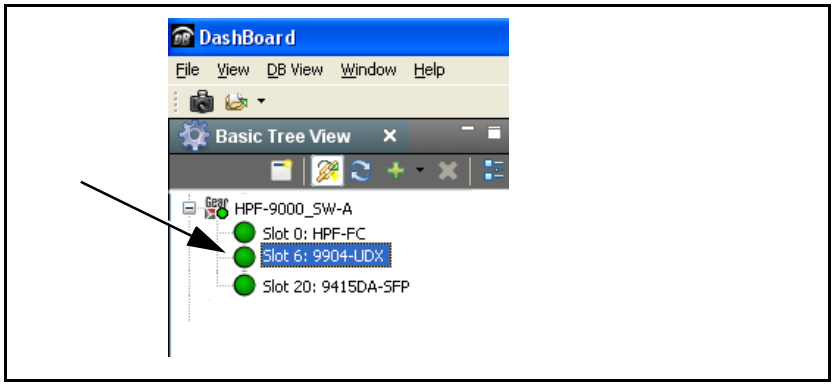
Access the 9904-UDX-4K card using DashBoard™ or Cobalt® Remote Control Panel as described below.

Accessing the 9904-UDX-4K Card Using DashBoard™

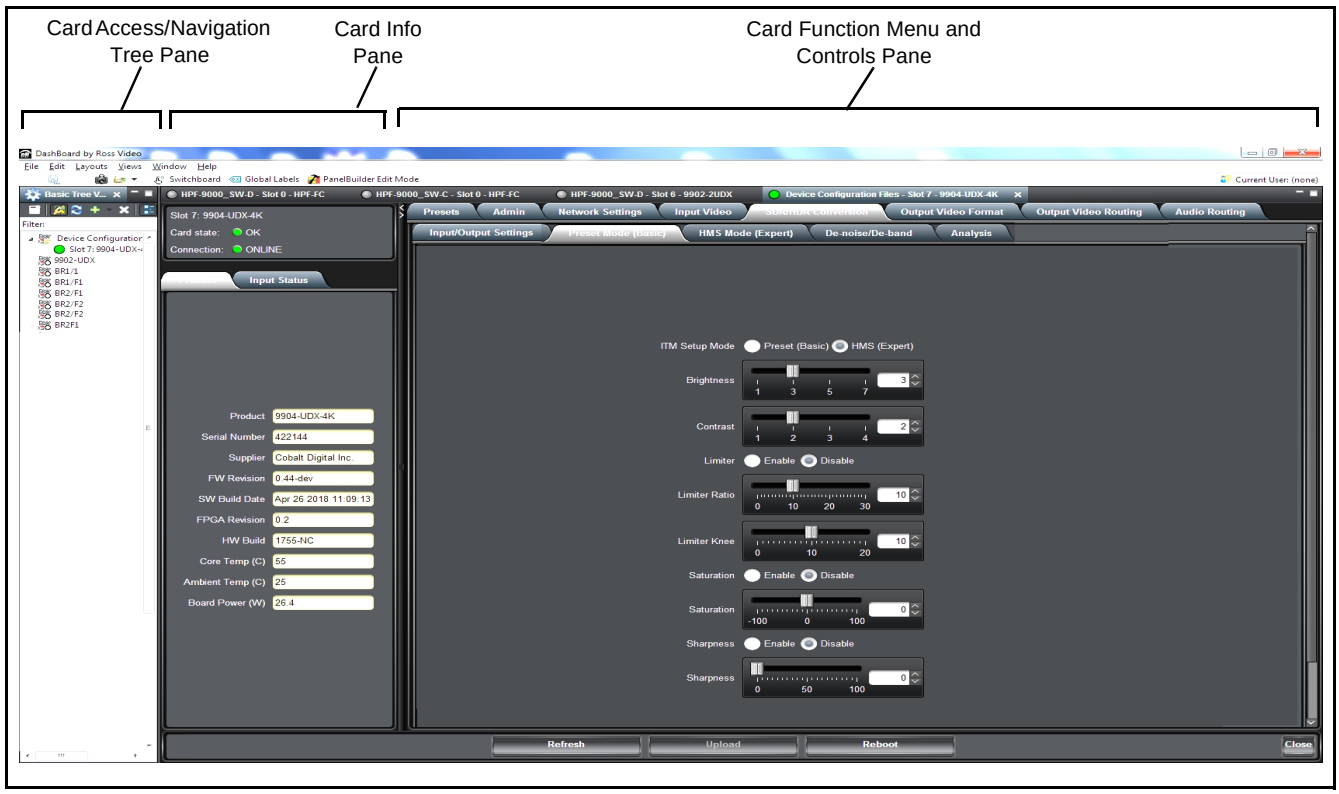
1. On the computer connected to the frame LAN, open DashBoard™.
2. As shown below, in the left side Basic View Tree locate the Network Controller Card associated with the frame containing the 9904-UDX-4K card to be accessed (in this example, “HPF-9000_SW-A”).



3. As shown below, expand the tree to access the cards within the frame. Click on the card to be accessed (in this example, “Slot 6: 9904-UDX”).

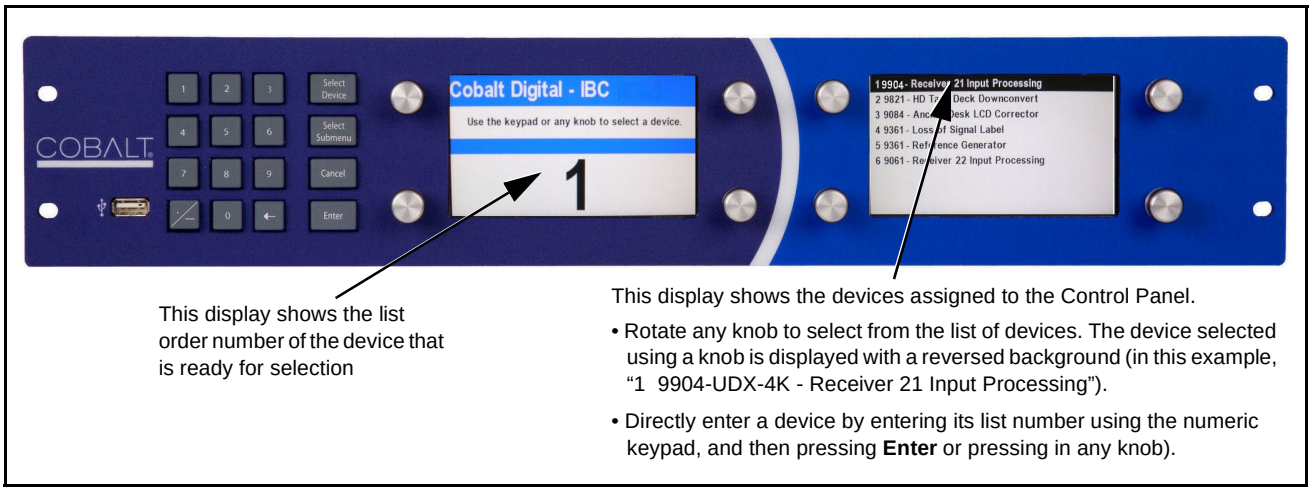


As shown on the next page, when the card is accessed in DashBoard™ its function menu screen showing tabs for each function is displayed. (The particular menu screen displayed is the previously displayed screen from the last time the card was accessed by DashBoard™).



Accessing the 9904-UDX-4K Card Using a Cobalt® Remote Control Panel

Press the **Select Device** key and select a card as shown in the example below.



This display shows the list order number of the device that is ready for selection

This display shows the devices assigned to the Control Panel.

- Rotate any knob to select from the list of devices. The device selected using a knob is displayed with a reversed background (in this example, “1 9904-UDX-4K - Receiver 21 Input Processing”).
- Directly enter a device by entering its list number using the numeric keypad, and then pressing **Enter** or pressing in any knob).

Checking 9904-UDX-4K Card Information

The operating status and software version the 9904-UDX-4K card can be checked using DashBoard™ or the card edge control user interface. Figure 3-4 shows and describes the 9904-UDX-4K card information screen using DashBoard™ and accessing card information using the card edge control user interface.

Note: Proper operating status in DashBoard™ is denoted by green icons for status indicators. Yellow or red icons respectively indicate an alert or failure condition. Refer to Troubleshooting (p. 3-62) for corrective action.

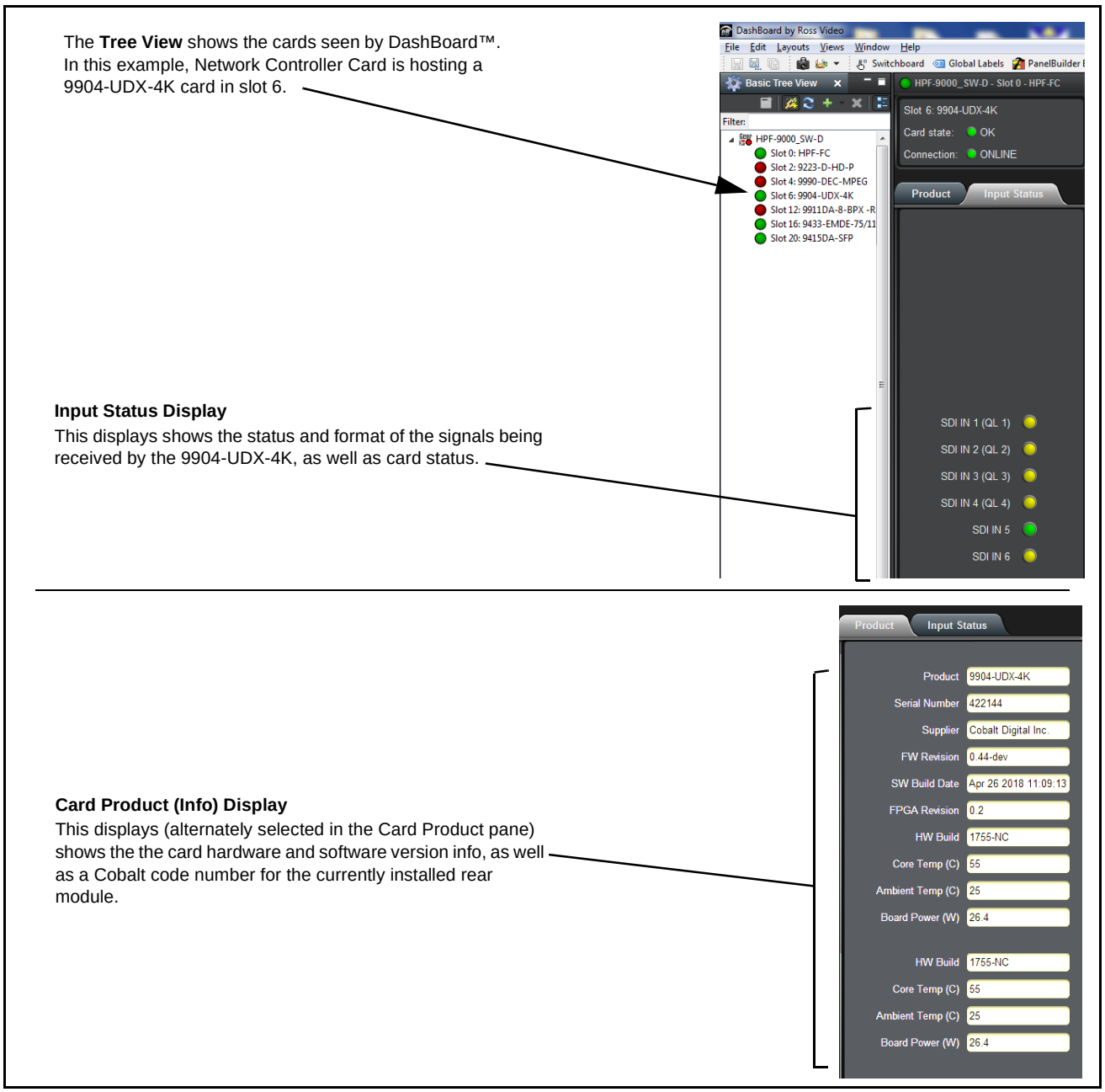


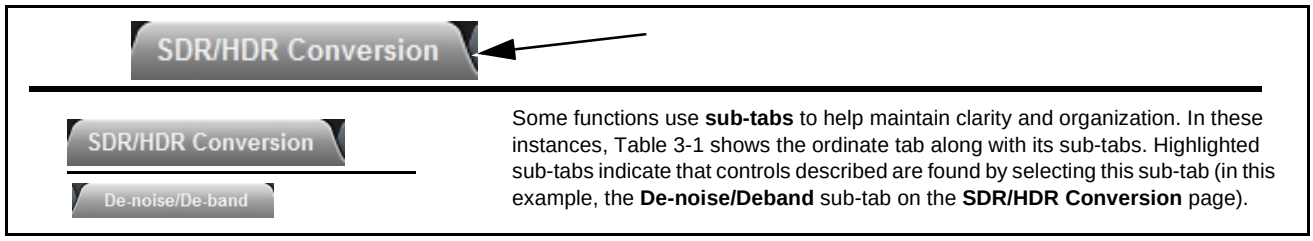
Figure 3-4 9904-UDX-4K Card Info/Status Utility

9904-UDX-4K Function Menu List and Descriptions

Table 3-1 individually lists and describes each 9904-UDX-4K function menu and its related list selections, controls, and parameters. Where helpful, examples showing usage of a function are also provided. Table 3-1 is primarily based upon using DashBoard™ to access each function and its corresponding menus and parameters.

Note: **Option** For any DashBoard tabs on card not appearing in this manual, this indicates the function is an option and covered in a separate Manual Supplement. Please refer to card web page Product Downloads for pdf Manual Supplements covering these options.

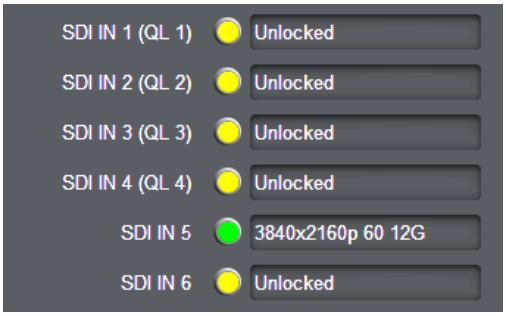
On DashBoard™ itself and in Table 3-1, the function menu items are organized using tabs as shown below.



Some functions use **sub-tabs** to help maintain clarity and organization. In these instances, Table 3-1 shows the ordinate tab along with its sub-tabs. Highlighted sub-tabs indicate that controls described are found by selecting this sub-tab (in this example, the **De-noise/Deband** sub-tab on the **SDR/HDR Conversion** page).

The table below provides a quick-reference to the page numbers where each function menu item can be found.

Table 3-1 9904-UDX-4K Function Menu List

<table>
<tr><td> 
</td><td>Displays input video status for the up to six SDI card inputs. Sets card for the format (single-wire ST 2082 or quad-link SDM) of input video being received.</td></tr>
<tr><td>• Input Video Status</td><td>Displays input status of each video input, along with format where lock is detected.</td></tr>
<tr><td colspan="2"> 

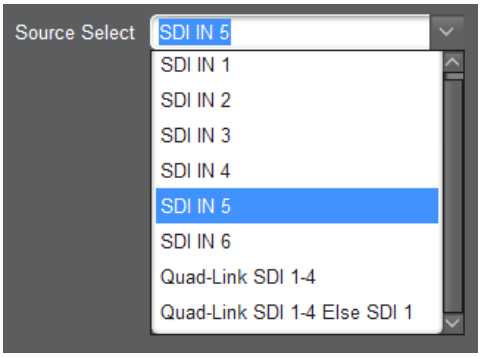
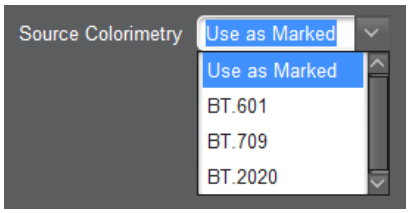
In this example, SDI IN 5 shows raster/format for detected input, with all other inputs being Unlocked. If signal is not present or is invalid, Unlocked is displayed. (These status indications are also propagated to the Card Info pane.)
Note: Only SDI inputs SDI IN 5 and SDI IN 6 are compatible with single-wire ST 2082 sources.</td></tr>
<tr><td>• Input Video Source Select
 
</td><td>Source Select drop-down selects either Quad-Link SDI 1-4 SDM or any of inputs SDI IN 1 thru SDI IN 6 (SDI IN 5 and IN 6 compatible with single-wire ST 2082 sources) as the input video source to be applied to the card's program video input.
Source Status shows the status/viability of the selected input.
Note: "Path 1" banner for control can be ignored. Currently, the card supports only one program video path.</td></tr>
<tr><td>• Input Video Source Status
 
</td><td>Source Status shows the status/validity of the selected input.</td></tr>
<tr><td>• Input Video Source Colorimetry Select
 
</td><td>Source Colorimetry sets the card processing to conform with colorimetry present on selected input (from choices shown).</td></tr>
</table>

Table 3-1 9904-UDX-4K Function Menu List — continued

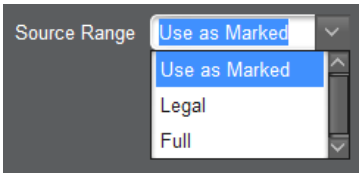
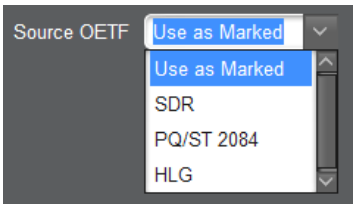
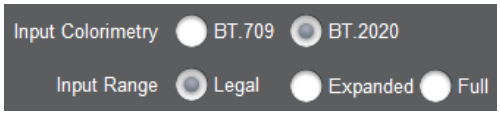
	**(continued)**
• **Input Video Source Range Select** 	**Source Range** sets the card to accommodate Full or Legal color parametric ranges corresponding to range on the selected input video.
• **Input Video Source OETF Select** 	**Source Range** sets the card to accommodate output characteristics/ transfer functions marking/format present on the selected input video.
 **Option**	(Option **+HDR-ITM**; **+HDR-ITM-4K**) Provides controls for applying Intelligent Tone Management to content. Also provides controls for applying template “presets” conversion and custom modes which expose multiple detailed expert parametric controls, allowing highly specific aspects to be adjusted as desired.
	**Input/Output Settings** – Provides controls for setting the card to conform with received input color space and range. Similarly sets card output Hybrid Log Gamma (HLG) and S-Gamma (SLOG) processing of the output video.
• **Input Configure Controls** 	Sets the card to accommodate various input (upstream) characteristics of the received input video as follows: • **Input Color Space:** Sets the card to accommodate either BT.709 or BT.2020 color space corresponding to color space on the received input video. • **Input Range:** Sets the card to accommodate Full, Legal, or Extended color parametric ranges corresponding to range on the received input video. **- Legal** performs clipping of lo or hi values to make any input legal. **- Extended** performs clipping only on values exceeding lo value limit, with no clipping performed on hi value limits **- Full** performs no clipping regardless of what is present on input. **Note:** Input range of “Legal” can be changed to “Full” for output video if desired using controls described below (Full = 4 - 1019; Legal = 64 - 959).

Table 3-1 9904-UDX-4K Function Menu List — continued

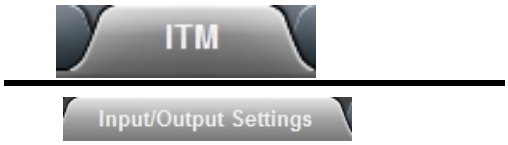
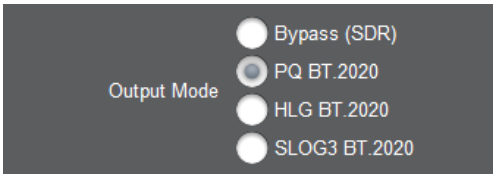
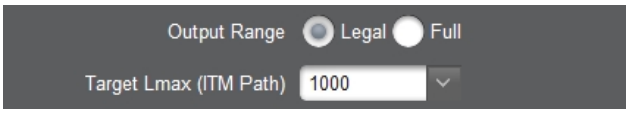
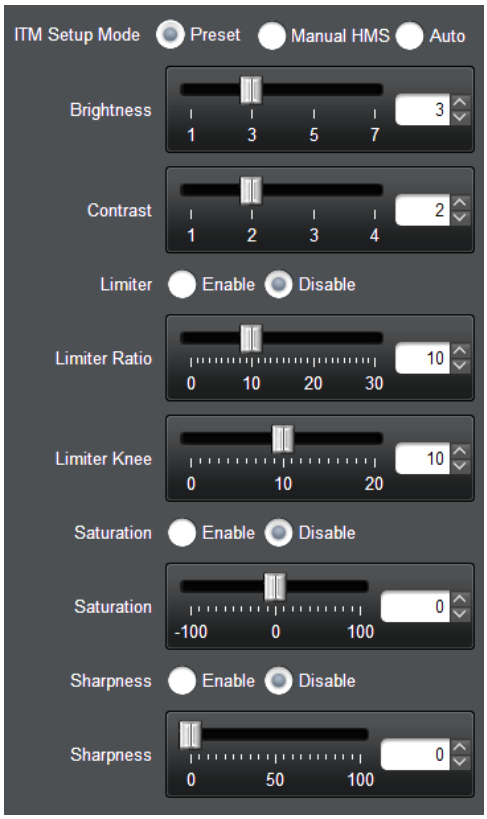
	**(continued)**
• **Output Mode Configure Controls**	Sets the card to provide various output characteristics/transfer functions (OETF) for the processed output video as follows:
	• **Bypass (SDR):** Sets the card to bypass **all** HDR conversion. Output is delivered as SDR. • **Output Mode:** Sets the card to provide a choice of the following HDR processing characteristics: **- PQ BT.2020** – Sets output to use Perceptual Quantization transfer function in accordance with (IAW) BT.2020. - **HLG BT.2020** – Sets Hybrid Log Gamma (HLG) as IAW BT.2020. - **SLOG3 BT.2020** – Sets OETF to S-Gamma (SLOG) SLOG3 BT.2020 function.
• **Output Range/Target Lmax Configure Controls**	Sets the card output color range (Full or Legal) as well as Target Lmax (luma) for the processed output video as follows:
	• **Output Range:** Sets the card to provide Full or Legal color parametric ranges. • **Target Lmax (ITM Path):** Provides independent Lmax (peak luminance) settings for ITM engaged operating mode.

Table 3-1 9904-UDX-4K Function Menu List — continued

Preset Mode Settings engages a consensus balanced setting of ITM expert controls, while exposing various basic controls.

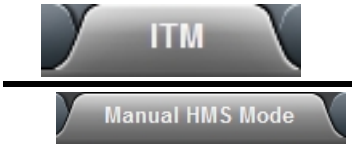
• Basic Preset Mode Controls



Sets the card to accommodate various input (upstream) characteristics of the received input signal as follows:

Note: In addition to setting unexposed expert settings automatically to consensus settings, the default exposed settings here are recommended "starting point" settings.

- **Brightness/Contrast:** Controls for providing a preset-limited range of "minor tweak" values.
- **Limiter:** When set to **Enabled**, provides controls for cases exhibiting clipping. The Limiter controls can be used to soften the expansion curve whenever a lower maximum output level is targeted. This will reduce the level of large bright areas, while keeping a maximum level for small highlights or sparkles.
  - **Limiter Ratio** applies a ratio or scaling factor to maximum peak luma. (For example, if Ratio is set to 20 with a peak luma occurring of 1000, resulting peak luminance will be approximately 800 Nits.) (Default value = 10)
  - **Limiter Knee** defines a relative starting position of the slope used to reach the target defined by the **Limiter Ratio** slider. The higher the setting, the less impact the Limiter knee has on the picture in general while impacting maximum effect on the highest levels of luminance. (Default value = 10)
- **Saturation** enhances or reduces the global saturation of color throughout the image. Saturation values range from -100 (monochrome), or complete desaturation, to +100 (complete saturation). (Default value = 0; null)
  Note: Values above 5 are typically not recommended.
- **Sharpness** controls the amount of sharpness and contrast added globally to the image's edges, details and grain. This applies to all details within the image.
  Note: Higher slider values may cause excessive sharpening of film grain and noise. Adding some amount of Sharpness improves the rendering of speculars and typically makes images more attractive. 25 to 30 is recommended as a starting point for HD formats, while 40 to 50 is recommended as a starting point for UHD.



Manual HMS (Hightlights - Midtones - Shadows) Mode Settings exposes the full set of ITM HMS parametric controls, allowing highly specific image tailoring specifically suited for specific content.

Manual mode controls, if not properly used, can result in objectionable and possibly unexpected video quality impacts.

Note: The controls described here have interaction. The Tips provided for various controls describe how to best deal with the interaction and help get the best results from each control.

• ITM Setup Mode - Expert Enable

Allows selection of Manual HMS mode (using controls described below), or revert back to Preset (Basic) or Auto modes.

Table 3-1 9904-UDX-4K Function Menu List — continued

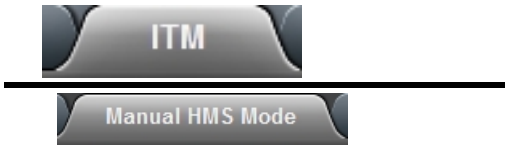
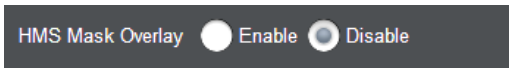
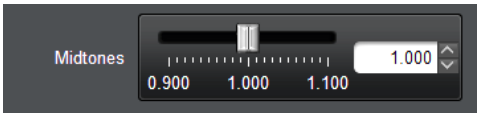
	**(continued)**
• **HMS (Highlights-Midtones-Shadows) Mask Overlay Enable** 	Allows enabling the suite of HMS Mask controls described below. The HMS Mask Overlay is a tool that is used only during setup. When enabled the picture becomes a three color image: - **Black** represents the portions in the shadow region - **Gray** represents the portions for midtones - **White** represents the portions for highlights. You can use this overlay to configure and view how the ITM process defines and acts on the regions of the picture. You can disable Mask Overlay while performing other assessments. The Mask Overlay should then be disabled when done using the tool.
• **Highlights Luminance Control** 	• **Highlights** slider controls the luminance of the **brightest** areas within the images of the incoming video content as determined by the Highlights Cut slider. Setting the Highlights slider to 1.0 ensures that any color initially registered as full white will output as full white, provided that the Midtones slider is set to 1.0. (Default value = 1.0) - **Raising** the value enhances brighter regions and may potentially oversaturate details in white. - **Lowering** the value reduces the expansion of those regions. **Tip 1:** Values in the [0..1] range will decrease the luminance of the highlights, while values in the [1..3] range will increase it. **Tip 2:** Because of Tip 1, the Highlight Cut slider has no effect when the Highlights slider is set to 1.0. **Tip 3:** When the Highlights slider is set to its minimum (0.01), the expansion of the highlights part of the image (as determined by the Highlights Cut slider) is similar to a constant gamma whose value is set by the Midtones slider.
• **Midtones Luminance Control** 	• **Midtones** slider controls the luminance of **all** tones within the image. Changing the midtones through this control has a similar effect as globally changing the gamma of an image. Higher values make the ITM expansion more extreme and lead to overall expansions in brightness and contrast. **Tip 1:** The Midtones slider is the one to start with when you want to adjust the overall brightness of an image. **Tip 2:** When both cut sliders are set to 0.0, or both Highlights and Shadows sliders are set to 1.0, the Midtones slider is the only slider used for controlling the ITM curve. In this case, and when Midtones is above 1.0, use the Brightspot slider to avoid clipping. **Tip 3:** To avoid clipping when this slider is above 1.0, and depending on the image content, reduce the value of the Highlights slider under 1.0 or increase the value of the Brightspot slider. **Tip 4:** When reducing the value of this slider, increase the value of the Shadows slider to keep details in the dark areas, and increase the value of the Highlights slider to reach the maximum peak luminance. **Tip 5:** When increasing the value of this slider, decrease the value of the Shadows slider to avoid milky dark areas, and decrease the value of the Highlights slider to avoid clipping.

Table 3-1 9904-UDX-4K Function Menu List — continued

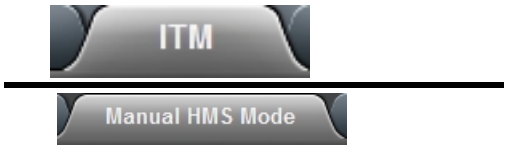
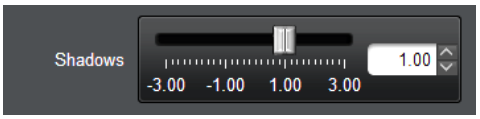
	**(continued)**
• **Shadows Luminance Control** 	• **Shadows** slider controls the luminance of the darkest portions of the images of the incoming video content as determined by the Shadows Cut slider. Lower values of this slider make shadowed areas darker and increase contrast but may lose detail in the darkened areas. Higher values bring out detail in dark areas but may make the image look flat and/or enhance noise and artifacts in dark areas. Absolute black (i.e. 0) is always mapped to black regardless of the Shadows slider value. **Tip 1:** Values in the [-3..1] range will decrease the luminance of the shadows, while values in the [1..3] range will increase it. **Tip 2:** Because of Tip 1, the Shadows Cut slider has no effect when the Shadows slider is set to 1.0. **Tip 3:** When the Shadows slider is set to 0.0, the expansion of the Shadows part of the image (as determined by the Shadows Cut slider) is similar to a constant gamma whose value is set by the Midtones slider.
• **Highlights Cut Control** 	• **Hightlights Cut** slider controls the range of values considered to be highlights. When set to 1.0, the darkest value of the highlights will overlap with the lightest value of the shadows, provided that the Shadow Cut slider is also set to 1.0. Smaller values reduce the range of the highlights affected to only the brighter ones. Consequently, when the Highlights Cut slider is set to 0.0, the Highlights slider doesn't have any effect. **Tip 1:** The Highlights slider has no effect when the Highlights Cut slider is set to 0.0. **Tip 2:** When both Highlights Cut and Shadows Cut sliders are set to 1.0, the image is divided in only two parts: the highlights and the shadows. **Tip 3:** When the Highlights slider is set to a given value in the [0..1] range, reducing the value of the Highlights Cut slider (and then reducing the number of pixels belonging to the highlights part of the image) will increase the luminance of the highlights part of the image. **Tip 4:** When the Highlights slider is set to a given value in the [1..3] range, reducing the value of the Highlights Cut slider will decrease the luminance of the highlights part of the image. **Tip 5:** When moving the Highlights Cut slider, the Highlights slider must be moved accordingly to keep the highest values at the same level (excepted if Highlights = 1.0).

Table 3-1 9904-UDX-4K Function Menu List — continued

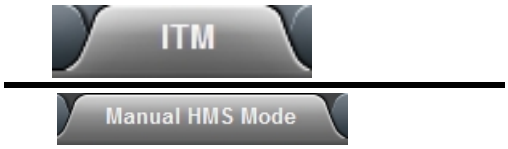
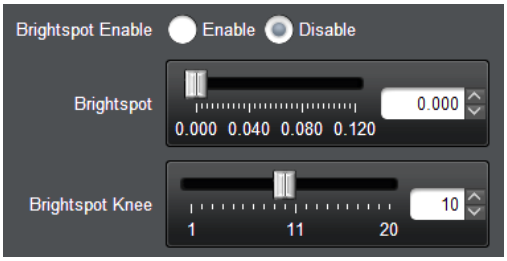
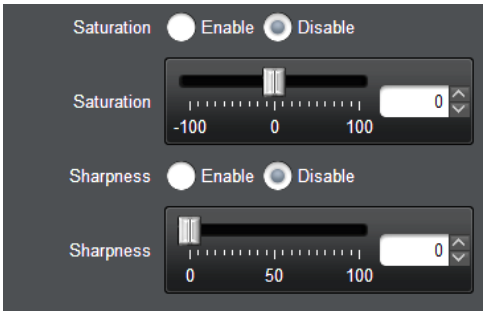
	**(continued)**
• **Shadows Cut Control** 	• **Shadows Cut** slider controls the range of values considered to be shadows. When set to 1.0, the lightest value of the shadows will overlap with the darkest value of the highlights shadows, provided that the Highlights Cut slider is also set to 1.0. Smaller values reduce the range of the shadows affected to only the darker ones. Consequently, when the Shadows Cut slider is set to 0.0, the Shadows slider doesn't have any effect. **Tip 1:** The Shadows slider has no effect when the Shadows Cut slider is set to 0.0. **Tip 2:** When both Highlights Cut and Shadows Cut sliders are set to 1.0, the image is divided in only two parts: the highlights and the shadows. Check it with the Show Cut Masks checkbox. **Tip 3:** When the Shadows slider is set to a given value in the [-3..1] range, reducing the value of the Shadows Cut slider (and then reducing the number of pixels belonging to the Shadows part of the image) will increase the luminance of the Shadows part of the image. **Tip 4:** When the Shadows slider is set to a given value in the [1..3] range, reducing the value of the Shadows Cut slider will decrease the luminance of the Shadows part of the image. **Tip 5:** When moving the Shadows Cut slider, the Shadows slider must be moved accordingly to keep the lowest values at the same level (excepted if Shadows = 1).
• **Brightspot Controls** 	• **Brightspot Enable** provides controls for Preserving brightspots form being clipped from appearing as the result of other control settings. - **Brightspot** adjusts how much compression will be used (while avoiding hard clipping). - **Brightspot Knee** defines a relative starting position of the slope used.
• **Saturation/Sharpness Controls** 	• **Saturation** enhances or reduces the global saturation of color throughout the image. Saturation values range from -100 (monochrome), or complete desaturation, to +100 (complete saturation). (Default value = 0; null) **Note:** Values above 5 are typically not recommended. • **Sharpness** controls the amount of sharpness and contrast added globally to the image's edges, details and grain. This applies to all details within the image. **Note:** Higher slider values may cause excessive sharpening of film grain and noise. Adding some amount of Sharpness improves the rendering of speculars and typically makes images more attractive. 25 to 30 is recommended as a starting point for HD formats, while 40 to 50 is recommended as a starting point for UHD.

Table 3-1 9904-UDX-4K Function Menu List — continued

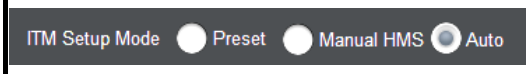
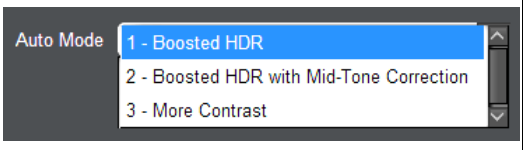
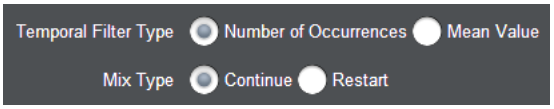
<table>
<tr><td> 
</td><td>Auto Mode Settings exposes SDR-HDR conversion controls selected for minimal user interaction. This mode is based on machine learning using a database of thousands of video images.</td></tr>
<tr><td colspan="2">Auto mode controls, if not properly used, can result in objectionable and possibly unexpected video quality impacts.</td></tr>
<tr><td colspan="2">Note: • The controls described here have interaction. The Tips provided for various controls describe how to best deal with the interaction and help get the best results from each control.
• The default settings provide the consensus-arrived settings. Slider controls can be tweaked for best results, but button selections should typically be left at default settings unless directed to be changed according to instructions herein.</td></tr>
<tr><td>• ITM Setup Mode - Expert Enable
 
</td><td>Allows selection of Auto mode (using controls described below), or revert back to Preset (Basic) or Manual modes.</td></tr>
<tr><td colspan="2">• Tips for Using Auto Mode Controls
Tip 1: Select the desired Auto Mode model using the Auto Mode drop-down.
Tip 2: Enable the Auto Bright Spot button to avoid unwanted clipping in the brightest parts of images.
Tip 3: Enable Temporal Filter (and set parameters as described in its section) to avoid inappropriate parameter matching when the contrast of the video changes while no cut detection has occurred.
Tip 4: Global contrast can be increased (typically providing a subjective improvement in image “eye-catching” appeal) by enabling Contrast/Light and setting the Contrast and Light controls (described below) as subjectively desired.
Tip 5: Typically, it is recommended to enable Contrast Color Correction if Contrast/Light is also enabled.
Tip 6: It is recommended to enable Temporal Filter to use this functionality whenever content sequences include cross-fades or long shots.</td></tr>
<tr><td>• Auto Mode Select
 
</td><td>Sets the auto mode using the following base characteristics:
• 1 - Boosted HDR – Provides a boosted HDR effect (note that this mode can clip highlights).
• 2 - Boosted HDR with Mid-Tone Correction – Uses same characteristics as 1 - Boosted HDR, but applies a correction to mid-tones thereby limiting the clipping effect that could occur with boosted HDR.
• 3 - More Contrast – Provides characteristics in between 1 and 2 above, but with more contrast.</td></tr>
</table>

Table 3-1 9904-UDX-4K Function Menu List — continued

(continued)

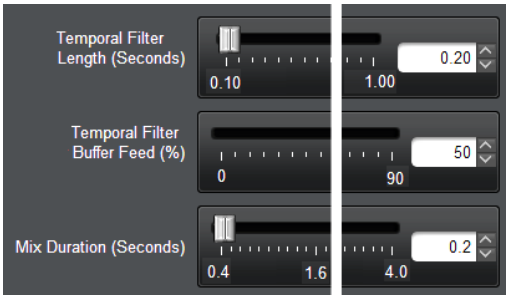
• Temporal Filter - MIx Select

Provides temporal filter type selection and mix type as described below.



- **Temporal Filter Type** selects from the following modes:
  - **Number of Occurrences** starts a process where the decision to start a mix (or a transition) to a new class is done when the number of contiguous of this new class is greater than a given threshold, as set using the **Temporal Filter Length** control (see below).
  - **Mean Value** starts a process where the decision to start a mix (or a transition) is made when, over a given period, the number of occurrences of this class is greater than a given threshold “Mean Threshold”.
- **Mix Type** selects from the following modes:
  - **Continue** terminates the current mix before starting a new one.
  - **Restart** starts a new mix immediately from the current state of the current mix (if the required conditions as set using Number of Occurrences control are met). This means that the current state of the current mix is viewed as a class, even if this class doesn’t exist in the model.
    Tip: Restart mode is recommended in most cases.

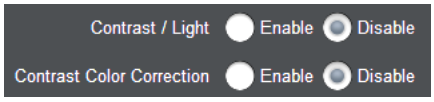
• Temporal Parametric Controls



- **Temporal Filter Length** sets the decision where to start a mix (or a transition) to a new class.
  Tip: 0.2s is a good starting point for 25p frame rates; 0.24s for 30p; 0.4s for 50p, and 0.48s for 59.94/60p.
- **Temporal Filter Buffer Feed (%)** sets the decision where to start a mix (or a transition) when, over a given period, the number of occurrences of this class is greater than a given threshold “Mean Threshold”.
  Tip: “50” is a good starting point, since it provides results that are easy to compare with the Number of Occurrences mode.
- **Mix Duration** sets the duration of the mix between two models.
  Tip: 2s is a good starting point regardless of frame rate.

• Contrast - Contrast Color Correction - Temporal Filter Select Controls

Provides enable (default) or disable for various auto mode processing functions.



- **Contrast/Light** enables the **Contrast** and **Light** sliders described below.
- **Contrast [specific] Color Correction** enables color correction specifically targeting contrast enhancement.

Table 3-1 9904-UDX-4K Function Menu List — continued

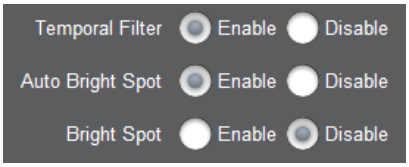
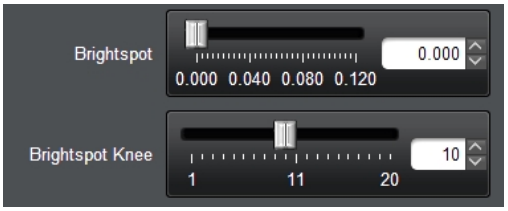
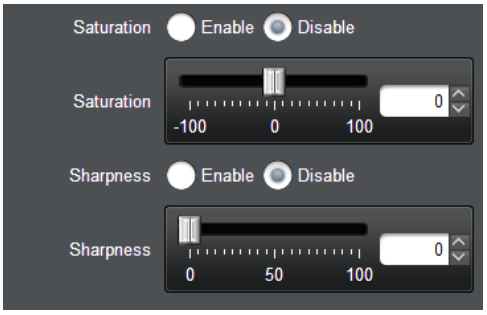
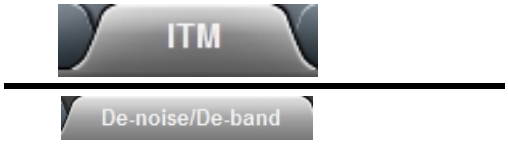
	**(continued)**
• **Contrast/Light Controls** 	• **Contrast** automatically increases or decreases contrast while maintaining the global (or average) amount of light in the image. The contrast modification is done on an image basis, but is designed to circumvent any “pumping” effect. • **Light** is dependent on Contrast setting: moving this slider while Contrast slider is at default (0.00) will have no effect. Moving Light slider to a positive value will increase the global amount of light, while moving it to a negative value will decrease it. The optimum value of the Light slider setting will depend on the value of the Contrast slider setting.
• **Temporal/Bright Spot Select Controls** 	• **Temporal Filter** when enabled provides temporal filtering using the settings as described above. • **Auto Bright Spot** when enabled uses a histogram/algorithm that helps maintain speculars without acting on or clipping other content elements. • **Brightspot Enable** provides controls for preserving brightspots from being clipped as the result of other control settings.
• **Brightspot Controls** 	• **Brightspot** adjusts how much compression will be used (while avoiding hard clipping). • **Brightspot Knee** defines a relative starting position of the slope used.
• **Saturation/Sharpness Controls** 	• **Saturation** enhances or reduces the global saturation of color throughout the image. Saturation values range from -100 (monochrome), or complete desaturation, to +100 (complete saturation). (Default value = 0; null) **Note:** Values above 5 are typically not recommended. • **Sharpness** controls the amount of sharpness and contrast added globally to the image’s edges, details and grain. This applies to all details within the image. **Note:** Higher slider values may cause excessive sharpening of film grain and noise. Adding some amount of Sharpness improves the rendering of speculars and typically makes images more attractive. 25 to 30 is recommended as a starting point for HD formats, while 40 to 50 is recommended as a starting point for UHD.

Table 3-1 9904-UDX-4K Function Menu List — continued



De-noise/De-band controls can help remove or mitigate noise artifacts in HD content that, if not compensated for, could be made more visible following UHD up-conversion and/or SDR-to-HDR conversion.

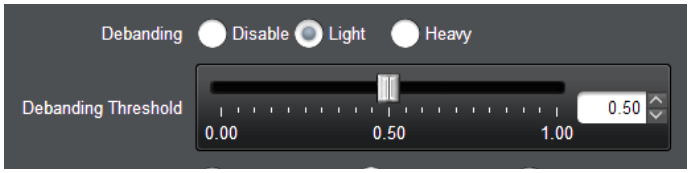
Note: • The denoising process is functionally placed before the ITM function. Even if setting the denoising settings are done while looking to the ITM result, it must be noted that the denoising changes the **incoming** image. Setting the denoising controls **must** be done independently from the ITM.

• Denoising runs efficiently if the noise is the same size as the pixel. Consequently:
- If the input image must be up-sampled, the ITM operation, and then the denoising, must be done before the up-sampling operation.
- Included film grain (whose size is generally bigger than the pixel size) is not removed, even if slightly attenuated, by the denoising. Because the ITM is an expansion, film grain is then amplified by the ITM. Consequently, if film grain must be added in the workflow, this operation must be done **after** the ITM.

• De-banding Configure Controls

Enables and selects de-banding profile used to suppress banding effects from lower-res input content.

Banding describes a noise artifact with large areas with constant level and perceptible boundaries that instead should be a smooth blend. This kind of artifact can generally be identified in high luminance pixels areas (for example: a bright sky).



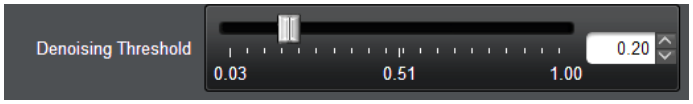
• **Debanding** selects between disabled, or light or heavy debanding.

• **Debanding Threshold** sets the luminance value (normalized in the [0..1] range) above which the Debanding process is applied. Banding generally occurs in high level luminance pixels, with this control typically set at the high-end of its range.

• De-noising Configure Controls

Enables and selects de-noising profile used to suppress noise artifacts from lower-res input content.

• **Denoising** selects between Disable, Enable or Enable by Zone. (More on Denoising by Zone below.)



• **Denoising Threshold** must be set at an optimum value to catch the maximum amount of noise without altering the overall content of the image. The higher the value of the threshold, the largest the amount of noise which is removed.

Tip: It is recommended to set the Denoising Strength (see below) at its maximum, and then moving the Denoising Threshold up to the point where the noise is fully removed (making the image completely blurred). Then the Denoising Strength can be reduced to a convenient value. The Denoising Threshold can then at that point be finely adjusted.

Table 3-1 9904-UDX-4K Function Menu List — continued

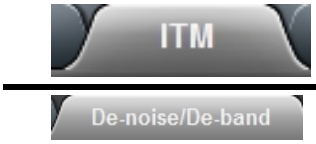
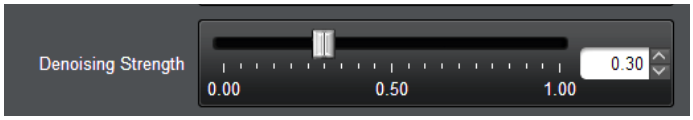
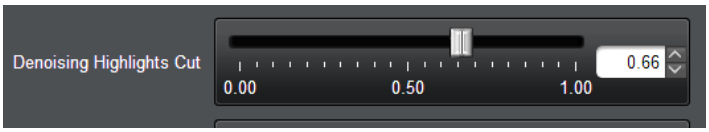
	**(continued)**
	• **Denoising Strength** slider filters out noise and grain within otherwise smooth areas of the image while still preserving edges and actual detail. The Intelligent Tone Management technology has a proprietary algorithm that assists it in deciphering the difference between detail and noise, even though both may be accentuated by use of the Sharpness slider. The higher the denoising value, the progressively smoother the image will become; however, higher values may also filter out edges in the denoising process.
	• **Denoising Shadow Cut** – When the Use Denoising by Zone checkbox is checked, this slider controls the range of values impacted by the Shadows Strength slider. **Note:** This slider is not related to ITM Shadows Cut.
	• **Denoising Hightlights Cut** – When the Use Denoising by Zone checkbox is checked, this slider controls the range of values impacted by the “Highlights Strength” slider. **Note:** This slider is not related to ITM Highlights Cut.
	• **Denoising Hightlights Strength** – When the Use Denoising by Zone checkbox is checked, this slider is related to the denoising strength dedicated to the Highlights parts in the image. See Denoising Strength slider for more information.
	• **Denoising Midtones Strength** – When the Use Denoising by Zone checkbox is checked, checkbox is checked, this slider is related to the denoising strength dedicated to the parts in the image located between the two Highlights cut and Shadows cut values. See Denoising Strength slider for more information.
	• **Denoising Shadows Strength** – When the “Use Denoising by Zone” checkbox is checked, this slider is related to the denoising strength dedicated to the Shadows parts in the image. See Denoising Strength slider for more information.

Table 3-1 9904-UDX-4K Function Menu List — continued

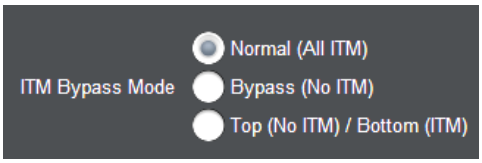
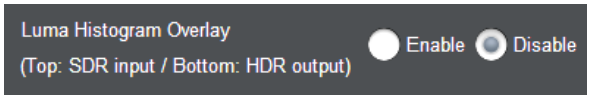
	**ITM Bypass** allows ITM preview and enable master control.
• **ITM Setup Mode - Expert Enable** 	• **Normal** provides a full-screen preview and output showing normal ITM processing. • **Bypass** provides full bypass of ITM in the preview and the card output. • **Top / Bottom** provides a preview showing bypass (no ITM) in the top portion of the screen, and ITM processed output in the bottom portion of the screen. ⚠ Top / Bottom is intended for preview evaluation only. Top/bottom preview will be outputted from the card if left in this mode.
	**Analysis** subtab allows enable of a histogram overlay that provides two bar graphs that respectively show input vs. output luma histogram.
• **Luma Histogram Overlay** 	Sets the card output color range and target Lmax for the processed output video as follows: • **Enable** superimposes histogram on output video for analysis. • **Disable** turns off histogram when done with tool.

Table 3-1 9904-UDX-4K Function Menu List — continued

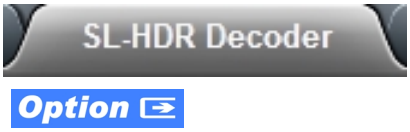
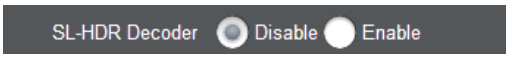
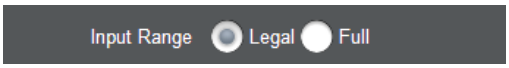
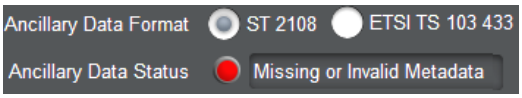
	(Option **+SL-HDR**; **+SL-HDR-4K**) Provides controls and processing to handle SDR content and exploit metadata (where available) to “re-inflate” SDR content to desired HDR content, as driven by the received metadata.
• **Decoder Enable/Disable** 	Enables or disables decoder function.Selects the type of SL-HDR processing that is performed on the signal as follows: • **Bypass** outputs source HDR, fully bypassing the SL-HDR block. (All SL-HDR are suppressed from the SL-HDR UI page in this mode.) • **SL-HDR1** provides a standardized SL-HDR output, providing an SDR compatibility output along with metadata to recover HDR on compatible HDR devices. When SL-HDR is selected, **SL-HDR Mode** select appears, allowing selection of SL-HDR1 or SL-HDR-2 standard for the output • **PQ** sets output to use Perceptual Quantization transfer function in accordance with (IAW) BT.2020. • **HLG** sets Hybrid Log Gamma (HLG) as IAW BT.2020. • **SLOG3 BT.2020** sets OETF to S-Gamma (SLOG) SLOG3 BT.2020 function.
• **Input Range Select** 	**Input Range:** Sets the card to accommodate Full or Legal, color parametric ranges corresponding to range on the received input video. • **Legal** performs clipping of lo or hi values to make any input legal. • **Full** performs no clipping regardless of what is present on input.
• **Display OETF Select** 	Sets the card to provide various output characteristics/transfer functions (OETF) to match that of the targeted (intended) display device as follows: • **PQ** sets output to use Perceptual Quantization transfer function in accordance with (IAW) BT.2020. • **SLOG3 BT.2020** sets OETF to S-Gamma (SLOG) SLOG3 BT.2020 function.
• **Ancillary Data Format Select** 	Sets the card to accept the expected ANC format on then received content as ST 2108 or ETSI TS 103 433. Also shows receive status of selected ANC type.

Table 3-1 9904-UDX-4K Function Menu List — continued

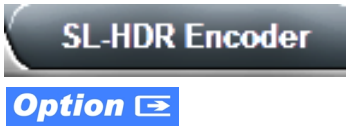
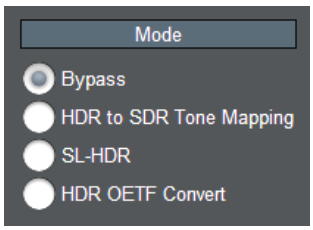
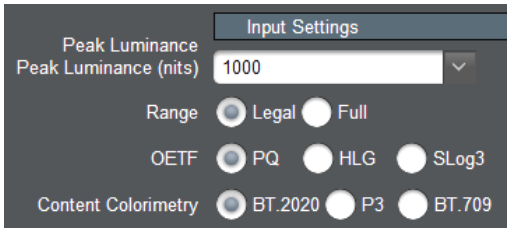
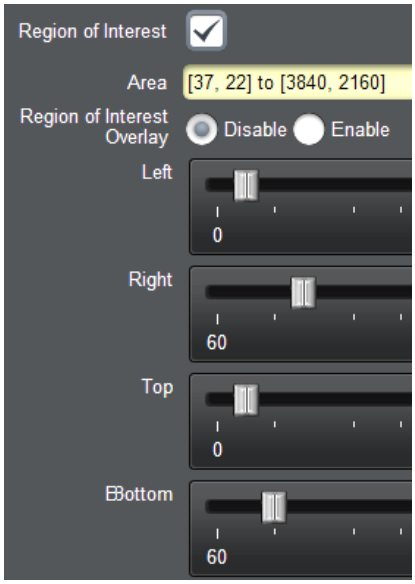
	(Option **+SL-HDR**; **+SL-HDR-4K**) Provides controls and processing to encode HDR content and output content as SDR, and also provide (where desired) metadata to allow to content for re-inflation to HDR on compatible downstream devices.
• **Output Mode Select** 	Selects the type of SL-HDR processing that is performed on the signal as follows: • **Bypass** outputs source HDR to pass. • **HDR to SDR Tone Mapping** provides direct conversion to SDR, with no accompanying metadata. The output becomes a dedicated SDR output. • **SL-HDR** provides conversion to SDR, but also provides metadata that directs HDR re-inflation on downstream systems that are compatible with the metadata. • **HDR OETF Convert** provides an HDR-only output.
Note: Depending on Mode selected, controls shown and described below are dynamic and appear only when applicable to the selected mode. (For example, if **Bypass** is selected, none of the controls described here appear in the UI. Also for example, output OETF standard selections (PQ, HLG, SLog3) only appear if HDR OETF Convert is selected.).	
• **Input Configure Controls** 	Sets the card to accommodate various input (upstream) characteristics of the received input video as follows: • **Peak Luminance:** Sets the card to accommodate the peak (max) luminance expected to occur on the received input video. • **Input Range:** Sets the card to accommodate Full or Legal, color parametric ranges corresponding to range on the received input video. **- Legal** performs clipping of lo or hi values to make any input legal. **- Full** performs no clipping regardless of what is present on input. • **Content (Input) Colorspace:** Sets the card to accommodate either BT.709, P3, or BT.2020 color space corresponding to colorspace on the received input video.
• **Region of Interest Select** 	When checked, sets 2-dimensional **Region of Interest** area for processes described in this page. The **Area** dialog shows the user-configured area set using the Left, Right, Top, and Bottom controls. The Overlay can be enabled to graphically show the configured interest area.

Table 3-1 9904-UDX-4K Function Menu List — continued

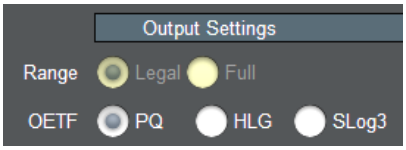
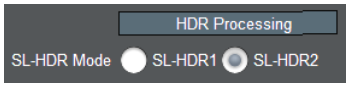
	**(continued)**
• **Output Configure Controls** 	Allows setting the output color range (Full or Legal) as well as OETF to suite the downstream device.
• **Output Configure Controls** 	**SL-HDR Mode** provides a standardized SL-HDR output, providing an SDR compatibility output along with metadata to recover HDR on compatible HDR devices. When SL-HDR is selected, **SL-HDR Mode** select appears, allowing selection of SL-HDR1 or SL-HDR-2 standard for the output.

Table 3-1 9904-UDX-4K Function Menu List — continued

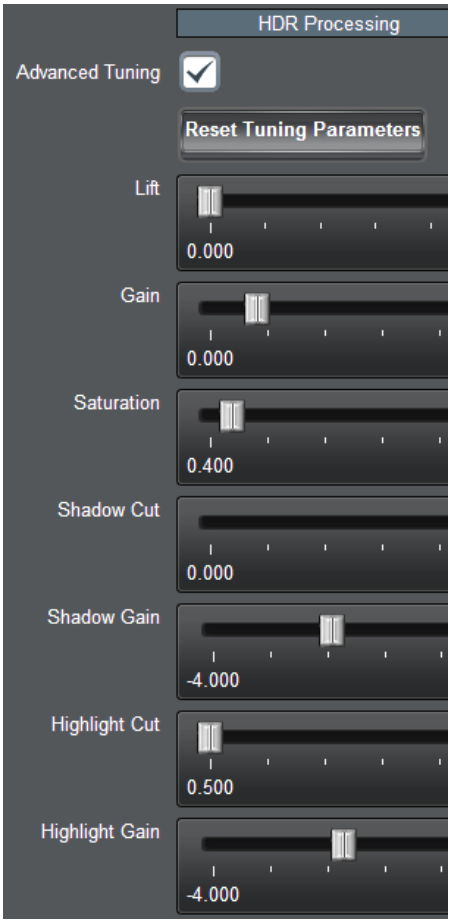
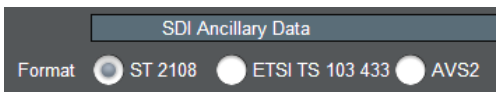
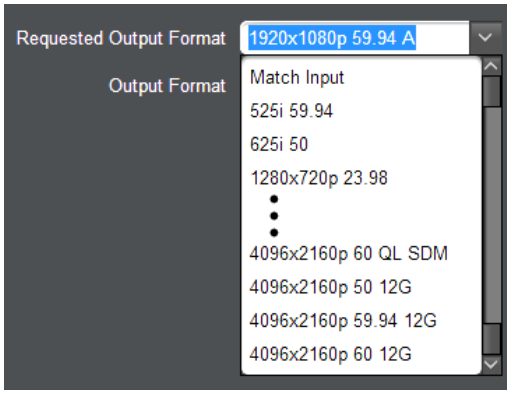
SL-HDR Encoder	**(continued)**
• **Advanced Tuning Controls** 	When checked, opens video proc and HDR processing controls as follows: • **Lift, Gain, Saturation** slider controls allow basic video proc of luminance lift and gain, and color saturation. • **Shadows Cut** slider controls the range of values considered to be shadows. When set to 1.0, the lightest value of the shadows will overlap with the darkest value of the highlights shadows, provided that the Highlights Cut slider is also set to 1.0. Smaller values reduce the range of the shadows affected to only the darker ones. Consequently, when the Shadows Cut slider is set to 0.0, the Shadows slider doesn't have any effect. **Tip 1:** The Shadows slider has no effect when the Shadows Cut slider is set to 0.0. **Tip 2:** When both Highlights Cut and Shadows Cut sliders are set to 1.0, the image is divided in only two parts: the highlights and the shadows. Check it with the Show Cut Masks checkbox. **Tip 3:** When the Shadows slider is set to a given value in the [-3..1] range, reducing the value of the Shadows Cut slider (and then reducing the number of pixels belonging to the Shadows part of the image) will increase the luminance of the Shadows part of the image. **Tip 4:** When the Shadows slider is set to a given value in the [1..3] range, reducing the value of the Shadows Cut slider will decrease the luminance of the Shadows part of the image. **Tip 5:** When moving the Shadows Cut slider, the Shadows slider must be moved accordingly to keep the lowest values at the same level (excepted if Shadows = 1). • **Shadow Cut** slider controls the range of values considered to be shadows. When set to 1.0, the lightest value of the shadows will overlap with the darkest value of the highlights shadows, provided that the Highlights Cut slider is also set to 1.0. Smaller values reduce the range of the shadows affected to only the darker ones. • **Shadow Gain** slider controls the luminance of the darkest portions of the images of the incoming video content as determined by the Shadows Cut slider. Lower values of this slider make shadowed areas darker and increase contrast but may lose detail in the darkened areas. Higher values bring out detail in dark areas but may make the image look flat and/or enhance noise and artifacts in dark areas. Absolute black (i.e. 0) is always mapped to black regardless of the Shadows slider value. • **Highlight Cut** and **Highlight Gain** sliders control the luminance of the lightest portions of the images of the incoming video content as determined by the HIghlight Cut slider.
• **SDI ANC Format Select** 	Where applicable, allows selecting the SDI ANC format for HDR metadata to be embedded in the output SDI.

Table 3-1 9904-UDX-4K Function Menu List — continued

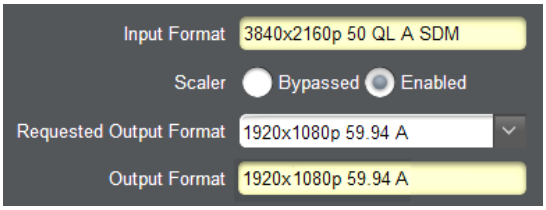
Allows selection of output format. Also displays current SDI input and output formats.

• Output Video Format Select



Provides Scaler master **Bypass/Enable** select button and conversions to formats (from SD up to 4096x2160p 50/59.94/60 12G.

Note: Although drop-down and card will allow output video raster/rate choices unrelated to the input rates (for example, PAL 50Hz rate for NTSC 59.94Hz input rates), cross-rate conversion choices should not be used for critical applications (frames will be dropped and/or duped when performing such conversions).



In this example, 1920x1080p 59.94 is a valid selected down-convert to 3G format. Input/output status displays show as-processed current input and output formats.

Scaler enable/bypass select is also provided.

Input/Output Formats Supported

525i 59.94	1920x1080p 29.97	3840x2160p 50 QL 2SI	4096x2160p 50 QL 2SI
625i 50	1920x1080p 30	3840x2160p 59.94 QL 2SI	4096x2160p 59.94 QL 2SI
		3840x2160p 60 QL 2SI	4096x2160p 60 QL 2SI
1280x720p 23.98	1920x1080psf 23.98		4096x2160p 50 QL SDM
1280x720p 24	1920x1080psf 24	3840x2160p 23.98 QL SDM	4096x2160p 59.94 QL SDM
1280x720p 25	1920x1080psf 25	3840x2160p 24 QL SDM	4096x2160p 60 QL SDM
1280x720p 29.97	1920x1080psf 29.97	3840x2160p 25 QL SDM	
1280x720p 30	1920x1080psf 30	3840x2160p 29.97 QL SDM	4096x2160p 50 12G
1280x720p 50		3840x2160p 30 QL SDM	4096x2160p 59.94 12G
1280x720p 59.94	1920x1080p 50 A	3840x2160p 50 QL SDM	4096x2160p 60 12G
1280x720p 60	1920x1080p 59.94 A	3840x2160p 59.94 QL SDM	
	1920x1080p 60 A	3840x2160p 60 QL SDM	
1920x1080i 50			
1920x1080i 59.94	2048x1080p 23.98	3840x2160p 50 12G	
1920x1080i 60	2048x1080p 24	3840x2160p 59.94 12G	
	2048x1080p 25	3840x2160p 60 12G	
1920x1080p 23.98	2048x1080p 50 A		
1920x1080p 24	2048x1080p 59.94 A		
1920x1080p 25	2048x1080p 60 A		

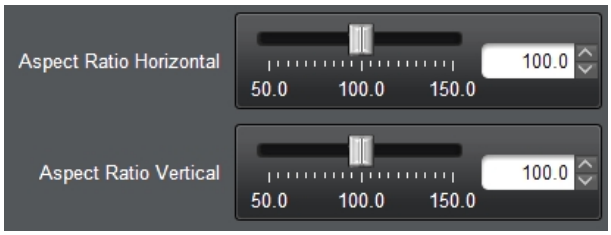
Table 3-1 9904-UDX-4K Function Menu List — continued

(continued)

- **User-defined Aspect Ratio Controls**

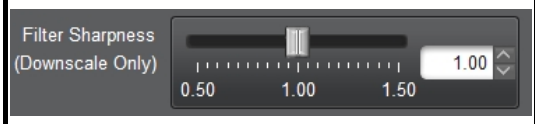
Aspect Ratio Horizontal and **Aspect Ratio Vertical** controls adjust horizontal and vertical zoom percentage. Settings less than (<) 100% provide zoom-out; settings greater than (>) 100% provide zoom-in.

(50% to 150% range in 0.1% steps; null = 100.0)



For any settings or output format, using the **Horizontal** or **Vertical** controls allow manual user custom settings deviating from null (100%) ARC.

- **Filter Sharpness Control**

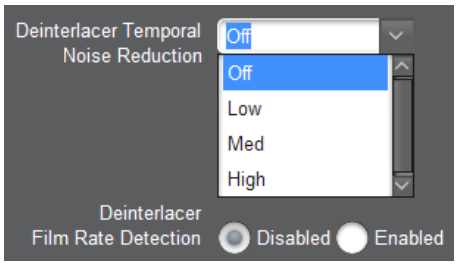


Adjusts the aggressiveness of sharpening or filtering applied to output video. Optimum setting results in overall perception of increased sharpness, while avoiding pattern noise artifacts.

(Range is 0.50 thru 1.50 in 0.01 steps; null = 1.00)

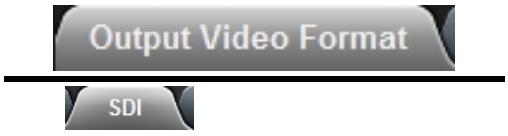
Note: Filter Sharpness control only affects downscaled output with scaler enabled.

- **Deinterlacer NR / Rate Detection Controls**



- **Deinterlacer Temporal Noise Reduction** provides relative selections of Off, Low, to High. (These settings are subjective and should be evaluated for suitability to specific cases.)

- **Deinterlacer Film Rate Detection** provides detection of incoming rates and other aspects to detect the original film rate (and then converted to interlaced via 3-2 pulldown) to optimize processing based on this knowledge.



SDI subtab shows SDI output format status.

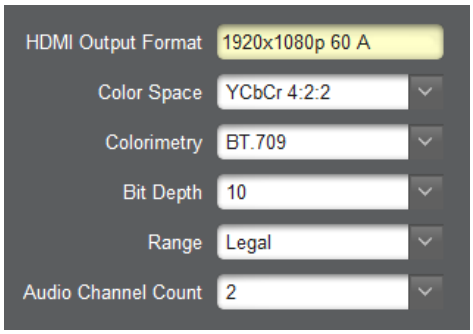
- **SDI Output Format Display**

Shows currently selected and outputted SDI format.

Table 3-1 9904-UDX-4K Function Menu List — continued

HDMI subtab exposes format controls specifically and independently for the card HDMI output.

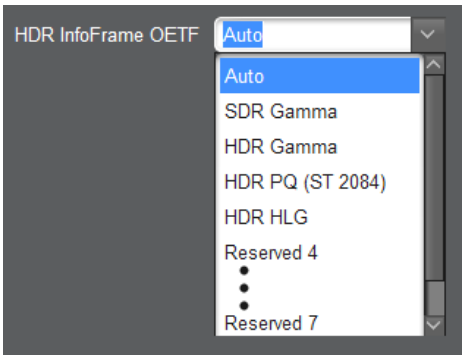
- **HDMI Standards Controls**



- **HDMI Output Format** shows the current HDMI output format (as selected using the **Format > Requested Output Format** control).
- **Color Space** sets the color space of the HDMI output
- **Colorimetry** sets the BT HDR colorimetry of the HDMI output
- **Bit Depth** sets the HDMI output of either 10-bit or 8-bit bit depth.
- **Range** selects from full or legal boundaries for the HDMI output color space.
- **Audio Channel Count** selects from 2-channel or 8-channel audio complement.

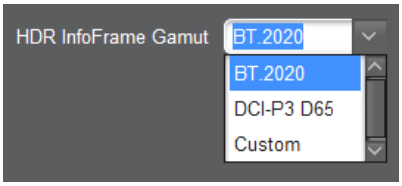
- **HDR InfoFrame Insertion** provides insertion on InfoFrame (Auto-populate, enabled with manual user settings (as performed below), or disabled (remove InfoFrame)).

- **HDR InfoFrame OETF Select**



Provides insertion of ANC metadata informing the display device what to "expect" in terms of OETF for the HDMI signal being provided.

- **HDR InfoFrame Gamut Select**



Provides insertion of ANC metadata informing the display device what to "expect" in terms of Gamut for the HDMI signal being provided.

Table 3-1 9904-UDX-4K Function Menu List — continued

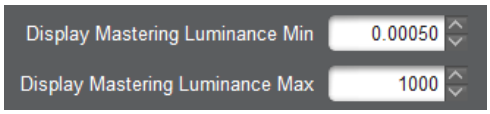
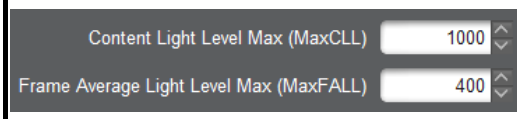
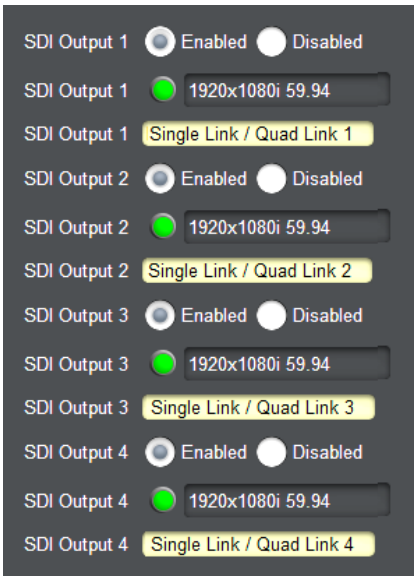
	**(continued)**
• RGB White Point Adjust/Set 	Provides insertion of ANC metadata informing the display device what to "expect" in terms of RGB white points for the HDMI signal being provided.
• Display Mastering Luminance Controls 	Provides insertion of ANC metadata informing the display device what to "expect" in terms of mastering luminance min/max for the HDMI signal being provided.
• Content/Frame Light Level Controls 	Provides insertion of ANC metadata informing the display device what to "expect" in terms of content light level max and frame average light level max for the HDMI signal being provided.
	Provides status displays and enable/disable for the four card SDI outputs.
• Output Video Enable / Status/Identification Display 	Provides enable/disable for each SDI output, and shows video format and other descriptive information for each of the card's four SDI outputs. In this example, the card is set to provide a quad-link SDM output, with each link consisting of 1920x1080p Level-A 3G SDI signals. When quad-link is being outputted, the status display shows the link number for each of the four signals, thereby helping with correlation to downstream systems.

Table 3-1 9904-UDX-4K Function Menu List — continued

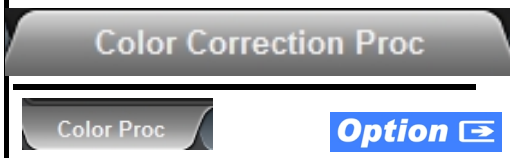
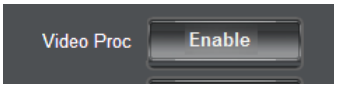
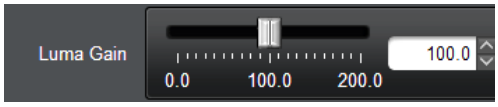
	(Option **+COLOR**; **+COLOR-4K**) Provides the following Video Proc and Color Correction parametric controls.
• **Video Proc Enable/Disable** 	**Video Proc (Enable/Disable)** provides master on/off control of all Video Proc functions. • When set to **Disable**, Video Proc is bypassed. • When set to **Enable**, currently displayed parameter settings take effect.
• **Reset to Unity** 	**Reset to Unity** provides unity reset control of all Video Proc functions. When Confirm is clicked, a **Confirm?** pop-up appears, requesting confirmation. • Click **Yes** to proceed with the unity reset. • Click **No** to reject unity reset.
• **Luma Gain** 	Adjusts gain percentage applied to Luma (Y channel). (0% to 200% range in 0.1% steps; unity = 100%)
• **Luma Lift** 	Adjusts lift applied to Luma (Y-channel). (-100% to 100% range in 0.1% steps; null = 0.0%)
• **Color Gain** 	Adjusts gain percentage (saturation) applied to Chroma (C-channel). (0% to 200% range in 0.1% steps; unity = 100%)
• **Color Phase** 	Adjusts phase angle applied to Chroma. (-360° to 360° range in 0.1° steps; null = 0°)
• **Gang Luma/Color Gain** 	When set to **On**, changing either the **Luma Gain** or **Color Gain** controls increases or decreases both the Luma and Color gain levels by equal amounts.

Table 3-1 9904-UDX-4K Function Menu List — continued

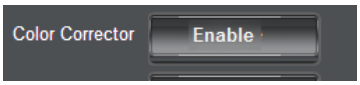
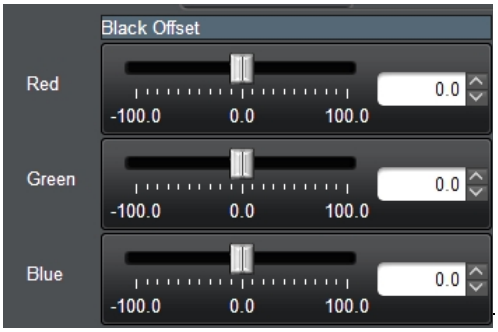
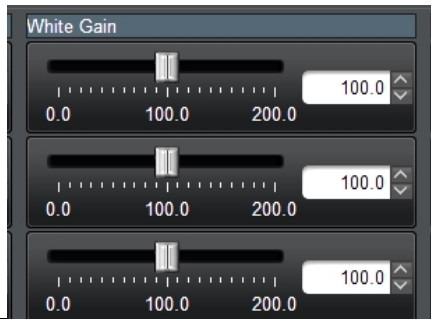
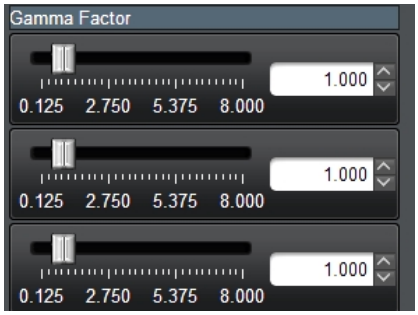
	Provides color correction for the individual RGB channels for the card program video path (option **+COLOR-4K**).
• **Color Corrector** 	**Color Corrector (On/Off)** provides master on/off control of all Color Corrector functions. • When set to **Disable**, all processing is bypassed. • When set to **Enable**, currently displayed settings take effect.
• **Reset to Unity** 	**Reset to Unity** provides unity reset control of all Color Corrector functions. When Confirm is clicked, a **Confirm?** pop-up appears, requesting confirmation. • Click **Yes** to proceed with the unity reset. • Click **No** to reject unity reset.
• **Black Offset R-G-B controls**  • **White Gain R-G-B controls**  • **Gamma Factor R-G-B controls** 	Separate red, green, and blue channels controls for Black Offset, White Gain, and Gamma Factor curve adjustment. Gain controls provide gain adjustment from 0.0 to 200.0% range in 0.1% steps (unity = 100.0) Gamma controls apply gamma curve adjustment in 0.125 to 8.000 range in thousandths steps (unity = 1.000) Each of the three control groups (Black Offset, White Gail, and Gamma have a **Gang Column** button which allows settings to be proportionally changed across a control group by changing any of the group's controls.

Table 3-1 9904-UDX-4K Function Menu List — continued

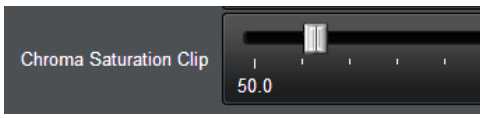
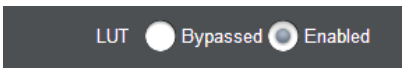
	**(continued)**
• **Black Hard Clip** 	Applies black hard clip (limiting) at specified percentage. (-6.8% to 50.0%; null = -6.8%)
• **White Hard Clip** 	Applies white hard clip (limiting) at specified percentage. (50.0% to 109.1%; null = 109.1%)
• **White Soft Clip** 	Applies white soft clip (limiting) at specified percentage. (50.0% to 109.1%; null = 109.1%)
• **Chroma Saturation Clip** 	Applies chroma saturation clip (limiting) chroma saturation at specified percentage. (50.0% to 160.0%; null = 160.0%)
	(Option **+3D-LUT-PRO-4K**; **+3D-LUT-PRO**) Provides 3D Look-Up Table to convert from 10-bit SDR RGB values to values appropriate for HDR downstream devices and displays.
• **LUT Enable/Color Range Setup Controls** 	• **LUT Bypass/Enable** – Enables or bypasses 3D LUT conversion.

Table 3-1 9904-UDX-4K Function Menu List — continued

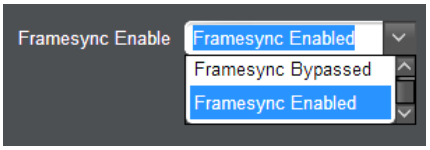
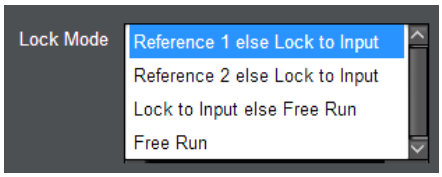
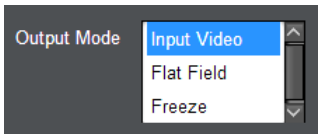
	Provides video frame sync/delay offset control and output control/loss of program video failover selection controls.
• **Framesync Enable/Disable Control** 	Provides master enable/disable of all card framesync functions/controls.
• **Lock Mode Select** 	Selects Frame Sync functions from the choices shown to the left and described below. • **Lock to Reference:** Output video is locked to selected external reference received on the frame reference bus. (External reference signal Ref 1 / Ref 2 are distributed to the card and other cards via the Ref 1 / Ref 2 buses on the frame.) **Note:** If valid reference is not received, the Card state: Reference Invalid indication appears in the Card Info status portion of DashBoard™, indicating invalid frame sync reference error. • **Lock to Input:** Uses the program video input video signal as the reference standard. **Note:** If **Lock to Input** is used for framesync, any timing instability on the input video will result in corresponding instability on the output video. • **Free Run:** Output video is locked to the card's internal clock. Output video is **not** locked to external reference.
• **Program Video Output Mode Select** 	Provides a convenient location to select between card program video output and other technical outputs from the choices shown to the left and described below. • **Input Video** – card outputs input program video (or loss of signal choices described below). • **Flat Field** – card outputs flat field. • **Freeze** – card outputs last frame having valid SAV and EAV codes.
• **Loss of Input Signal Selection** 	In the event of program input video Loss of Signal (LOS), determines action to be taken as follows: • **Disable Outputs:** Disable program video SDI outputs. • **Flat Field** – go to flat field on program video output. • **Freeze** – go to last frame having valid SAV and EAV codes on program video output.

Table 3-1 9904-UDX-4K Function Menu List — continued

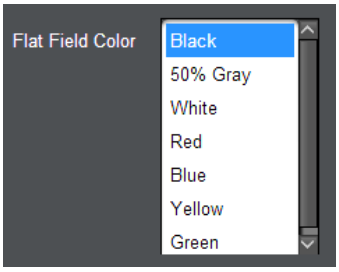
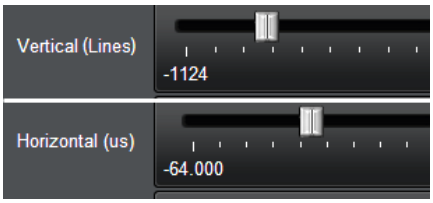
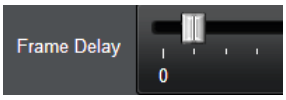
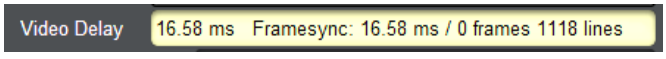
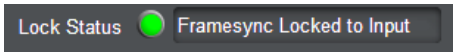
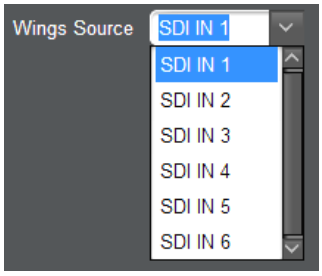
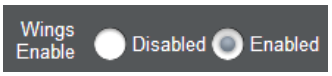
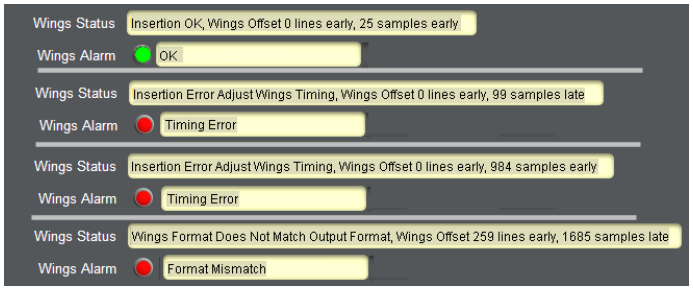
	**(continued)**
• **Flat Field Color Select** 	Provides a choice of flat field colors when **Flat Field** is invoked (either by LOS failover or directly by selecting Flat Field on the Program Video Output Mode Select control).
• **Output Video Reference Offset Controls** 	With framesync enabled, provides the following controls for offsetting the output video from the reference: • **Vertical (Lines)** – sets vertical delay (in number of lines of **output video** between the output video and the frame sync reference. (Positive values provide delay; negative values provide advance) (Range is -1124 thru 1124 lines; null = 0 lines.) • **Horizontal (µs)** – sets horizontal delay (in µs of **output video**) between the output video and the frame sync reference. (Positive values provide delay; negative values provide advance) (Range is -64 thru 64 µsec; null = 0.000 µsec.) **Note:** Offset **advance** is accomplished by hold-off of the reference-directed release of the frame, thereby effectively advancing the program video relative to the reference.
• **Frame Delay Control** 	When Framesync is enabled, specifies the smallest amount of latency delay (frames held in buffer) allowed by the frame sync. The frame sync will not output a frame unless the specified number of frames are captured in the buffer. **The operational latency of the frame sync is always between the specified minimum latency and minimum latency plus one frame (not one field).** **Note:** Due to card memory limits, the maximum available Minimum Latency Frames is related to the output video format selected. When using this control, be sure to check the **Report Delay** display to make certain desired amount of frames are delayed.
• **Video Delay Display** 	Displays the current input-to-output video delay (in msec units) as well as in terms of Frames/fractional frame (in number of lines). Status display shows total input-to-output video delay, along with any framesync delay.
• **Framesync Lock Status Display** 	Displays the current framesync status and reference source.

Table 3-1 9904-UDX-4K Function Menu List — continued

	Provides wings insertion/width controls and displays insertion status.
• **Wings Source Select Control** 	Selects the card SDI input video port to serve as the card's wings source. **Note:** SDI inputs selected must be used with Rear I/O Module correspondingly equipped with intended input ports.
• **Wings Insertion Enable Control** 	Enables or disables wings insertion into the output video. **Note:** For conditions where wings is not intended to be inserted, make certain this control is set to Disabled.
• **Wings Width Control** 	Allows symmetrical L/R wings insertion width, from none to widths extending into active image area if desired. (0 to 300 pixel range; null = 0)
• **Wings Status Displays**	Displays wings timing and insertion status as described below. **Note:** • Wings timing is a function of the wings frame sync card/ device. Ideal wings timing is **within 0 to 200 samples early** of output video timing. Wings timing cannot be controlled on host card wings inserter. • Error in wings timing will result in loss of wings (however, program video image will not be corrupted).



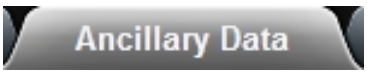
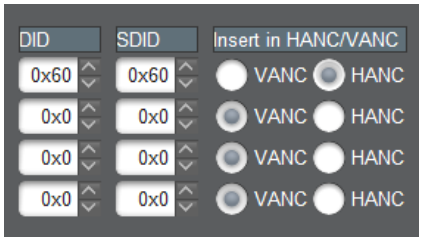
Wings insertion OK; within target 0-200 samples early

Wings insertion late

Wings insertion too early

Wings video wrong/mismatched format

Table 3-1 9904-UDX-4K Function Menu List — continued

	Provides controls for extracting packetized ANC data for re-insertion following scaling. This allows selected ANC data to be preserved for re-insertion following scaling.
	In this example, one of four independent ANC extractor/ inserters is set to extract packets at DID 60_h / SDID 60_h (packetized ATC_VITC timecode in this example). These packets are preserved and re-inserted in the output video SDI VANC or HANC ancillary space as selected (in this example, HANC).
 (Model **9904-UDX-4K-DSP** only)	Provides controls for enabling licensed DSP functions, routing inputs and outputs to and from the DSP functions, and setting individual parametric settings for each DSP function.

Read and understand the overview shown below before proceeding to specific DSP detailed control settings. The overview shows basic setup (with examples) to select and enable various DSP functional blocks, and shows how to route inputs and outputs to and from individual DSP blocks.

Input Mixer and Output Mixer DSP Positioning

Each pair of the eight DSP pipelines (**DSP A/B** thru **DSP G/H**) can be independently positioned either at the card **input** mixer (**Input Audio Routing/Controls**) location or at the card **output** mixer (**Output Audio Routing/Controls**) location.

Path positioning is set for each DSP pipeline pair in the upper pane of the **Audio DSP** page by selecting **Input Mixer** or **Output Mixer** button for each DSP pair (**DSP A / DSP B** thru **DSP G / DSP H**).

In this example, **DSP A/B** pair is set to work with the **input** mixer, and **DSP E/F** pair is set to work with the **output** mixer. Any DSP process can be set to use the input or output path as desired.

In each DSP function row, the **licenses available** displays shows whether or not the DSP function is licensed for the card, and if so the number of licenses available. As DSP functions are enabled for use, the available licenses is correspondingly decremented.

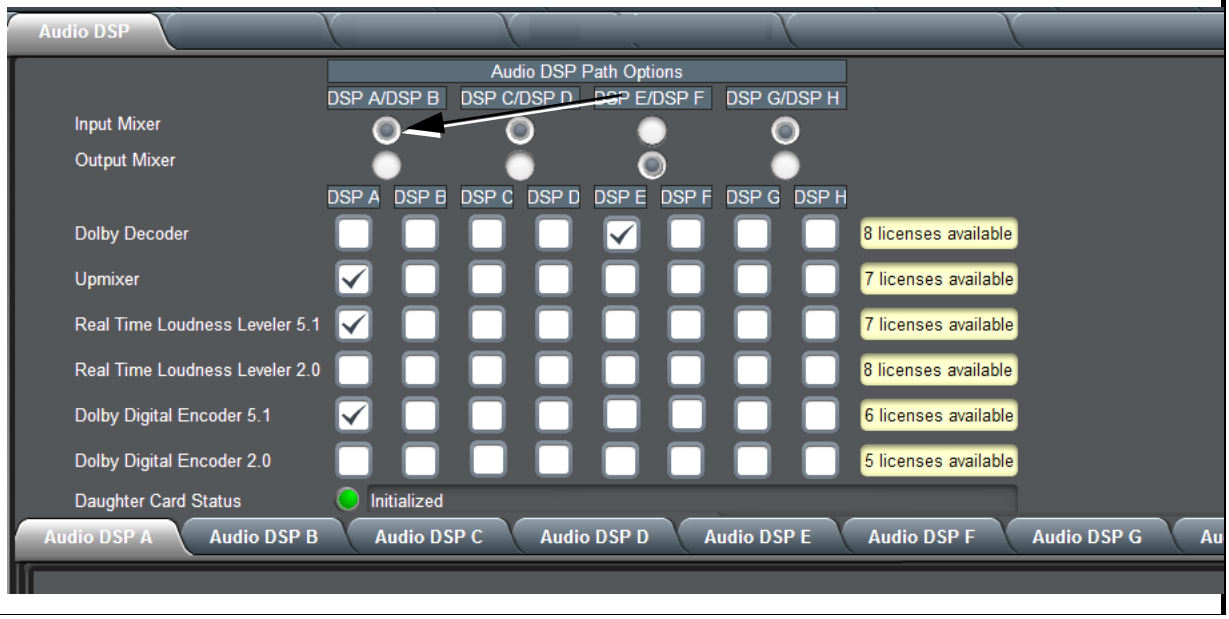
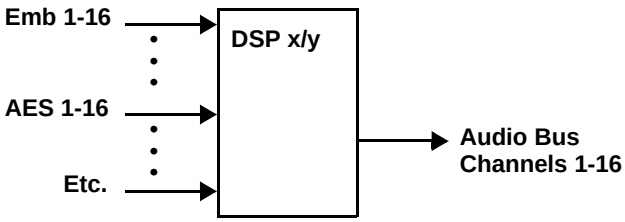
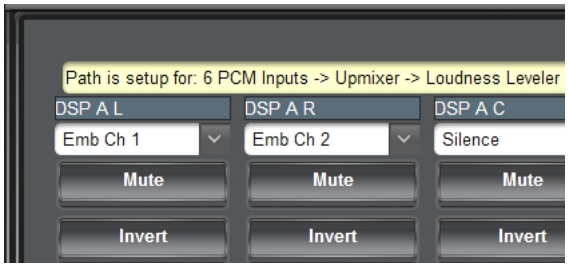


Table 3-1 9904-UDX-4K Function Menu List — continued

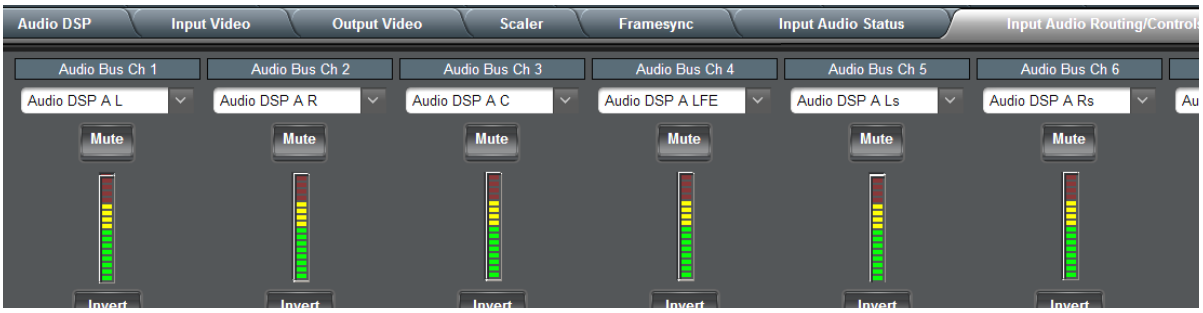
Audio DSP	(continued)

Input Mixer path positioning locates the DSP pipeline to receive basic external inputs coming into the card (in this example, Emb Ch 1 and Ch 2 feeding DSP A L and DSP A R), and then allows DSP processed output channels to be directed to the card internal Audio Bus channels by selecting Audio DSP channels as sources for destination Audio Bus channels via the Input Audio Routing/Controls.

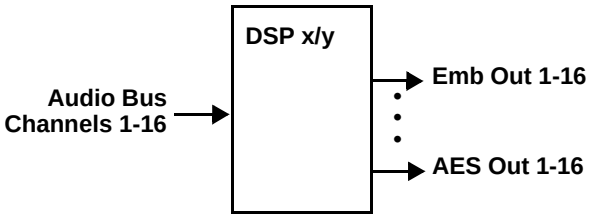


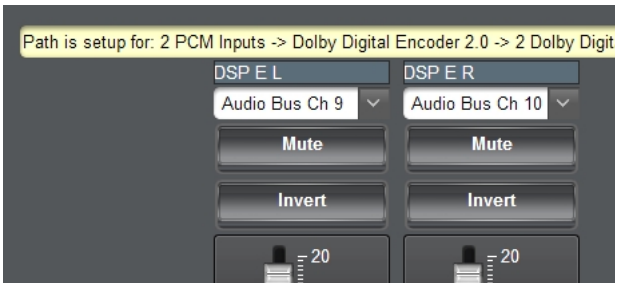


The DSP outputs are then routed to card Audio Bus Channels as desired (in this example, Audio DSP A L thru Audio DSP A Rs serving as sources for card audio bus channels Audio Bus Ch 1 thru Ch 6).



Output Mixer path positioning locates the DSP pipeline to receive card Audio Bus channels (in this example, DSP E L and DSP E R receiving card Audio Bus Channels 9 and 10) and then place the DSP processed output channels directly at the card audio outputs as sources for destination Embedded Output or AES Output channels via the Output Audio Routing/Controls.





The DSP outputs are then routed to card external outputs as desired (in this example, Audio DSP E Dolby L and Dolby R serving as sources for card outputs AES Out Ch 1 and Ch 2).

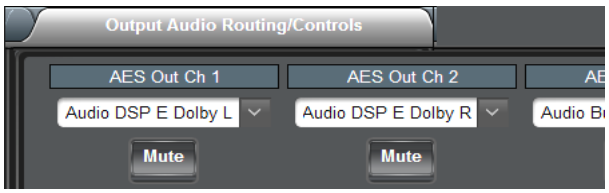


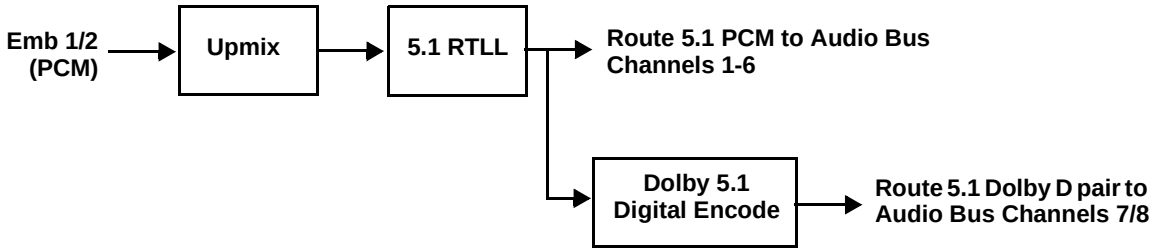
Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	**(continued)**

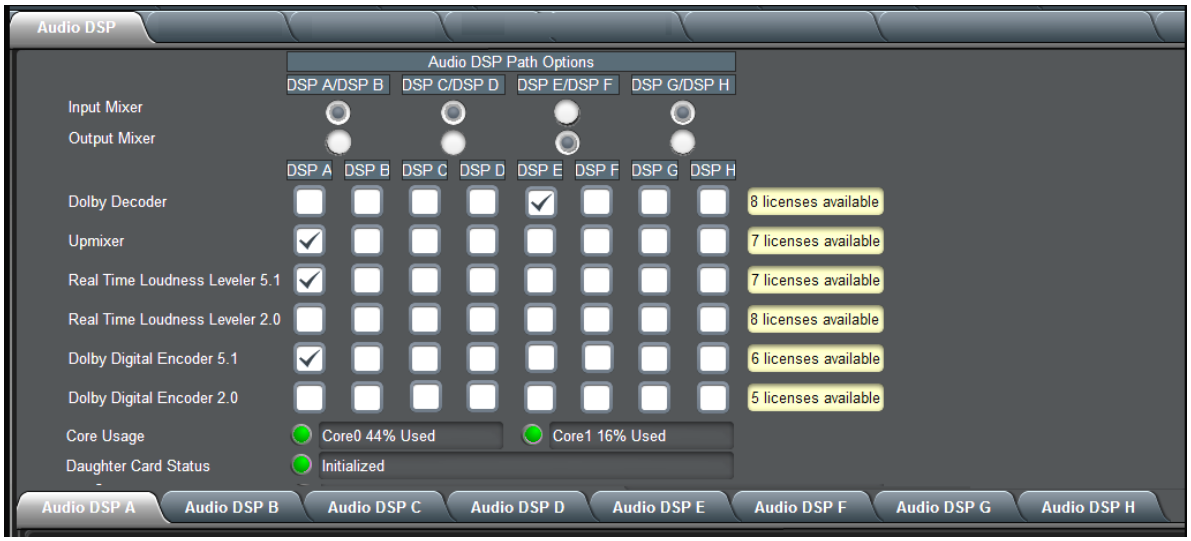
Example Multiple DSP Process Audio Routing and DSP Setup

In this example, single DSP pipeline **DSP A** is setup to:

- Receive an embedded PCM pair from the basic card input audio (input mixer positioning).
- Upmix the PCM stereo pair to 5.1 audio.
- Perform Real-Time Loudness Leveler (RTLL) loudness processing.
- Output the processed 5.1 complement as PCM and as a separate Dolby Digital 5.1 Encoded pair.
- Provide a separate additional Dolby 2.0 Encoder (on DSP E) for a SAP stereo PCM pair.



The upper pane on the Audio DSP tab allows enabling DSP processes for each of the eight DSP pipelines. In this example, DSP A is set to provide Upmixer, 5.1 RTLL, and Dolby Digital 5.1 Encode by checking the corresponding boxes. In this example, all processing is positioned at the **Input** mixer.



The **Core Usage** indicators provide an OK/Overload status indication and core capacity utilization percentage.

Make certain when set up that Core Usage indicators show green. Red indicates core capacity has been exceeded. It is good practice also to make certain neither core is exceeding 80% or so. If core exceed is being approached, spread some functions to another core (e.g., move some processing functions from DSP A-D to DSP E-H).

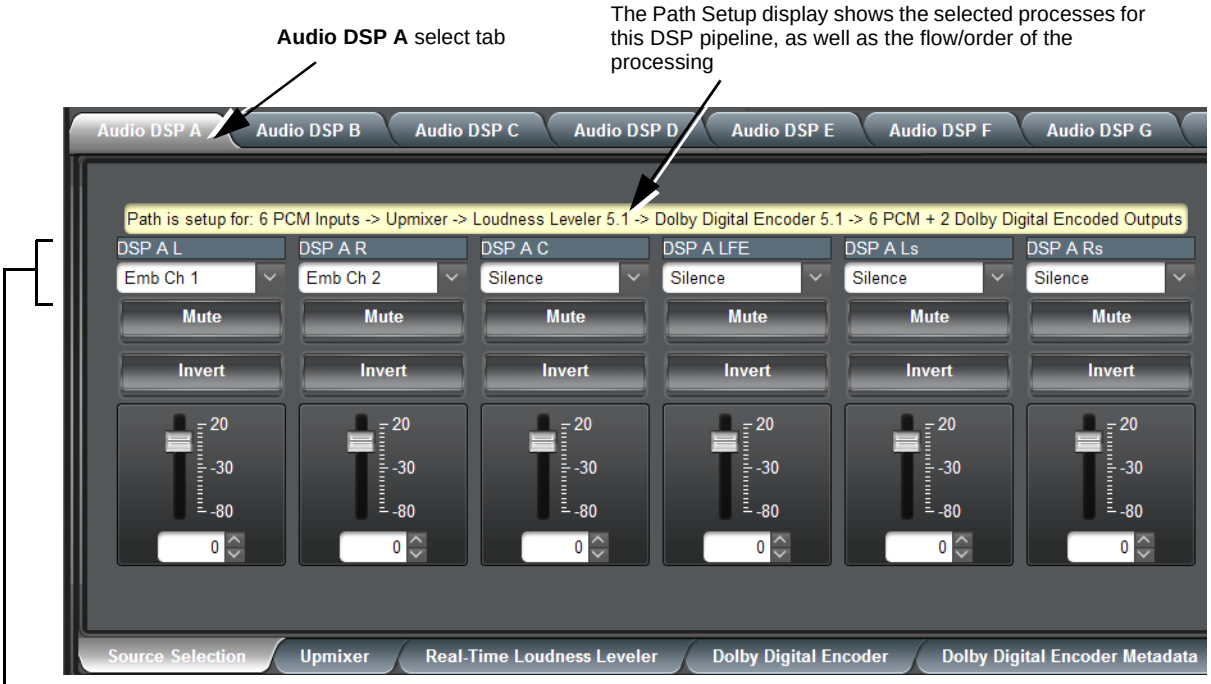
Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	**(continued)**

When a DSP pipeline is enabled for any function by checking any checkbox like that shown above, the sub-tabs for the related DSP in the lower pane expose all the setup functions required for the selected processes. In this example, we'll start with the **Source Selection** function since this is the first step in setting up a DSP.

After checkboxes enabling the desired processes are checked in the Audio DSP page upper pane, selecting the respective DSP tab (**Audio DSP A** thru **Audio DSP H**) shows the pertinent setup tabs for the functions that are selected.

In this example, we've selected DSP processes using DSP pipeline Audio DSP A. Clicking the **Audio DSP A** tab exposes the setup functions sub-tabs for the pipeline. Here, we will start with telling the DSP what inputs it will receive using the **Source Selection** sub-tab.

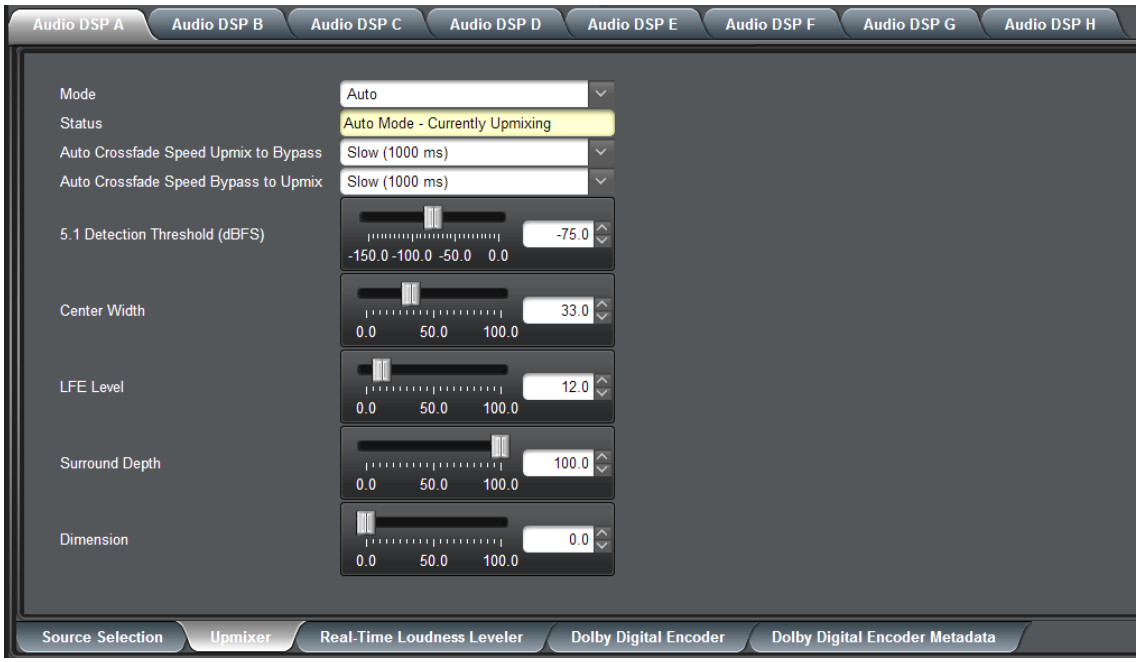


With the **Source Selection** sub-tab opened, we now assign the card basic input channels that the processing chain will use (in this example, sourcing from card basic inputs Emb Ch 1/2). Since all of the processes selected here reside in DSP A, each process will forward its processed signal to the next enabled process in the DSP pipeline.

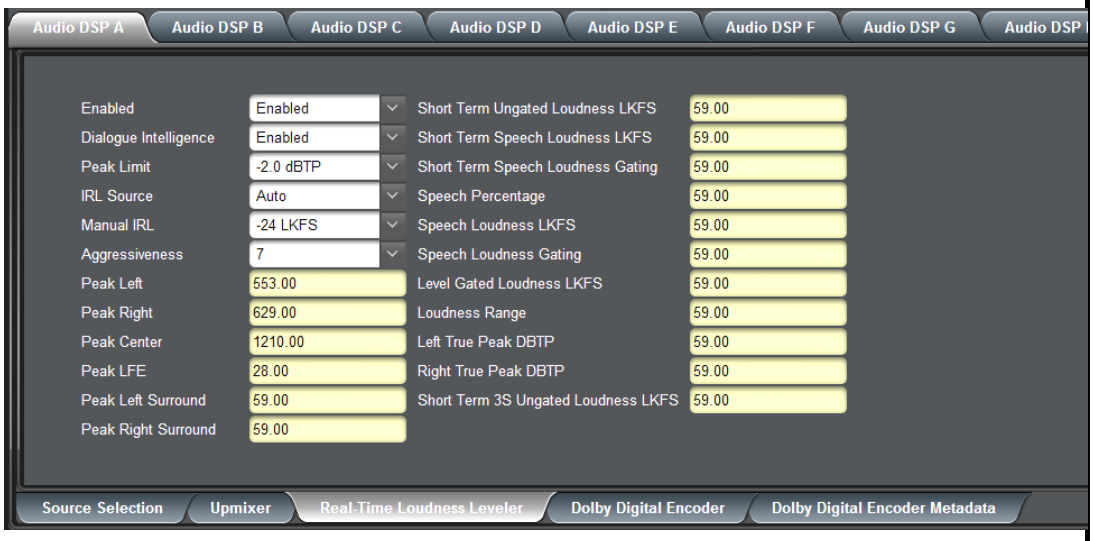
Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	(continued)

With source selection having been set, now we proceed to setting up the Upmixer. In our example we are sourcing from a stereo PCM pair, so Crossfade does not need to be considered (Mode can be set to Auto or Always Upmix). For cases where 5.1-channel PCM is used as an input, and may already carry 5.1 content, the Threshold and Auto Crossfade controls can make for smoother transitions between existing and Upmixer-developed 5.1 content. Default settings are recommended in most cases.



Now that the Upmixer is set up, the 5.1 Upmix content in our example is fed to the **Real Time Loudness Leveler 5.1** function (since we also have that checkbox checked for the **DSP A** pipeline).

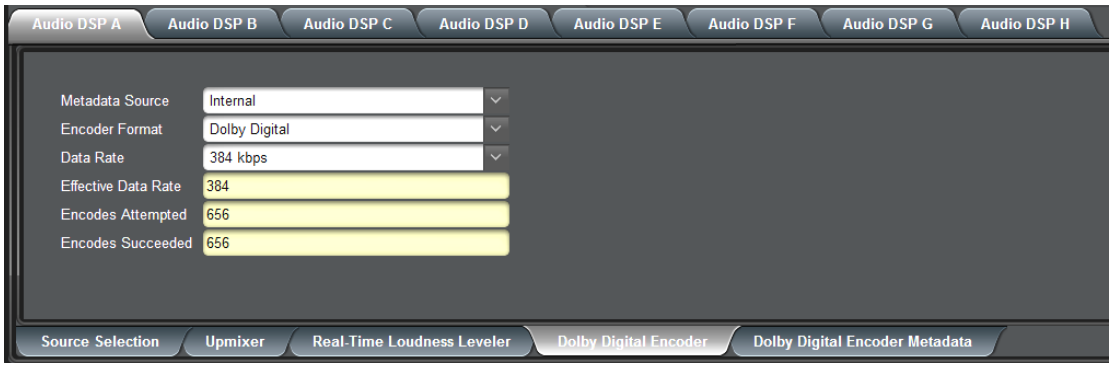


The RTLL blocks offer parametric controls for loudness leveling. Basic setup is setting RTLL to Enabled, and choosing a Manual IRL level (typically same as the desired loudness level). Other settings can typically be left at the default settings provided.

Table 3-1 9904-UDX-4K Function Menu List — continued

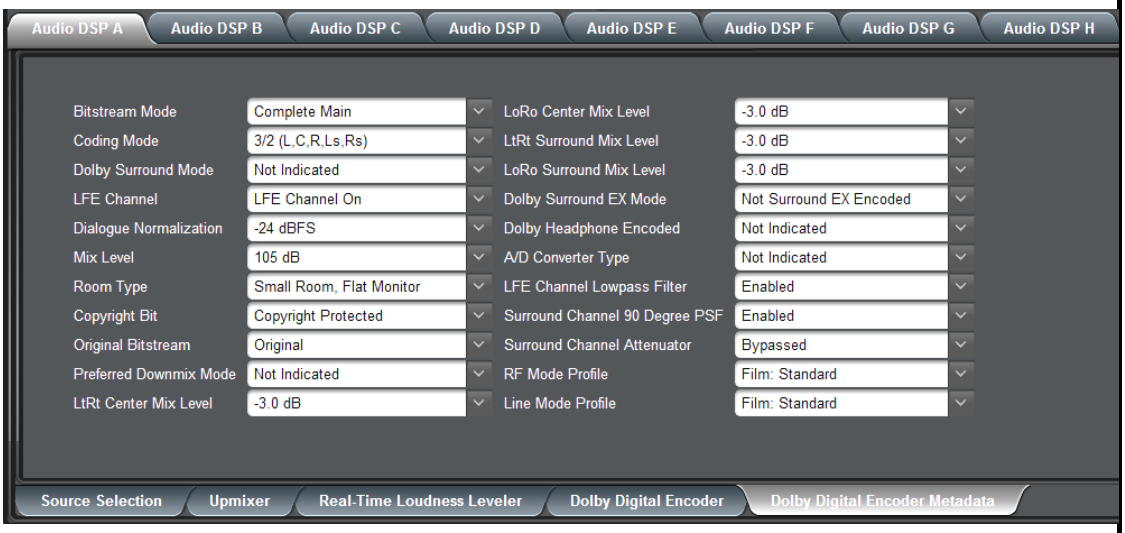
Audio DSP	(continued)

Our final processing step in this example is setting DSP A to also provide a Dolby 5.1 encoded pair. When a Dolby encoder is checked (enabled), the **Dolby Digital Encoder** and **Dolby Digital Encoder Metadata** sub-tabs appear, which allow setup of the Dolby encoded pair.



The first step in setting up an encoder is selecting the Encoder Format (which selects between Dolby Digital and Dolby Digital Plus formats). In this example, Dolby Digital is used, with the default data rate being used. The status displays below the setup drop-downs show data rate actually being used, as well as encode success.

Note: Although the Metadata Source drop-down allows choices other than encoder internal metadata, only internal metadata is currently supported.



With the encoder format and data rate basics set up above, now the bitstream mode, metadata, and other particulars related to the selected mode can be set. In this example, standard 5.1 is selected (3/2L) with a dialnorm of -24 (conforming to ATSC A/85). The encoded stream is now ready to be placed on an audio bus channel pair for eventual output from the card.

Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	(continued)

Routing the DSP Audio Outputs On the Card

Again, depending on whether the DSP is positioned at the card **input** or **output** mixer, Audio DSP processed outputs are available as follows:

- DSP positioned at the **Input Mixer** makes its outputs available to the card **Audio Bus Channels** (as choices on each card Audio Bus Ch 1 thru Audio Bus Ch 16 drop-down using the **Input Audio Routing** tab).
- DSP positioned at the **Output Mixer** makes its outputs available to the card **Embedded**, **AES**, and **Analog Audio** channels (as choices on each card output drop-downs using the **Output Audio Routing** tab).

Note: Dolby encoded audio can only be outputted on digital audio channels such as embedded or AES. However, DSP audio processed to provide PCM outputs can also be outputted on analog audio output channels. These outputs will be processed just like any other PCM handled by the card, and converted to analog by the card on-board audio DAC.

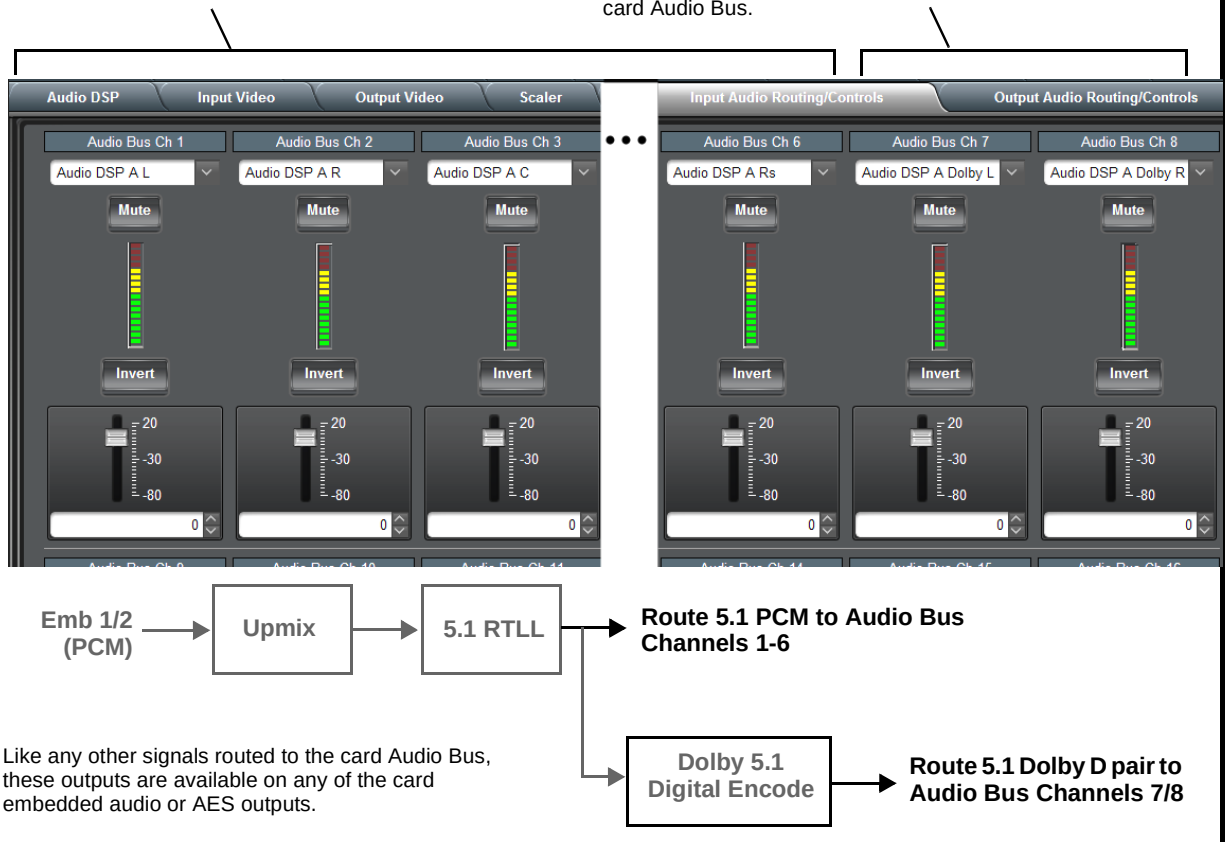
In the example here, since DSP A was set up to be positioned at the input mixer, its DSP outputs are routed to the card Audio Bus channels as shown below.

DSP A Upmix > RTLL 5.1 > 6 PCM **Audio DSP A L** thru **Audio DSP A Rs** routed to card input Audio Bus Channels Ch1 thru Ch 6, respectively.

The DSP outputs can be used for other internal card routing or processes, or be available as PCM outputs from the card via the card Audio Bus.

DSP A Upmix > RTLL 5.1 > 6 PCM + 2 Dolby Digital Encoded Outputs **Audio DSP A Dolby L** and **Audio DSP A Dolby R** routed to card input Audio Bus Channels Ch 7 and Ch 8, respectively.

The DSP outputs can be used for other internal card routing or processes, or be available as outputs from the card via the card Audio Bus.

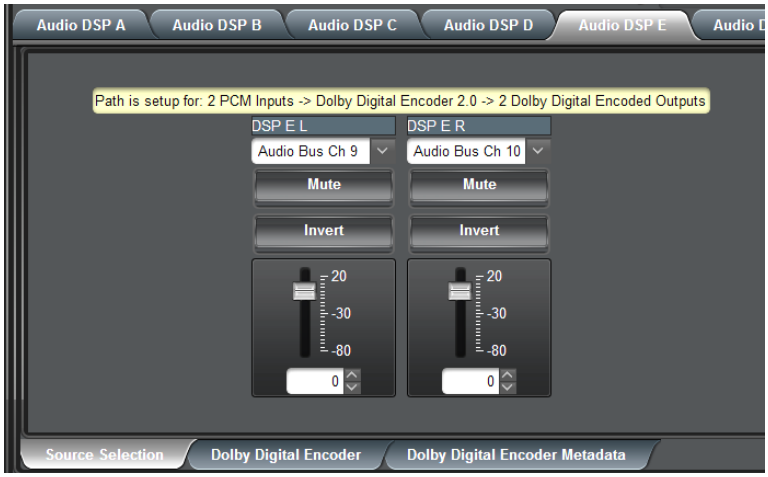


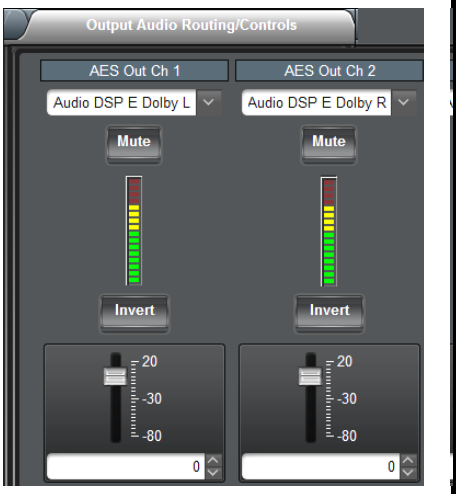
Like any other signals routed to the card Audio Bus, these outputs are available on any of the card embedded audio or AES outputs.

Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	**(continued)**

As mentioned earlier, a separate DSP pipeline (DSP E) has been set up in this example to provide a SAP Dolby 2.0 pair, with this DSP being positioned at the **output** mixer in this example. Shown below is the routing that provides this.





Emb 9/10 > Audio Bus 9/10

Route Audio Bus Ch 9/10 to DSP E L/R

DSP E Dolby 2.0 Digital Encode → **Route 2.0 Dolby D pair to AES Out Ch 1/2**

General Tips for Using Audio DSP

- Make certain Core Usage indicators show green following set up.
- Determine what positioning (input or output mixer) is best for the task being set up. Placement at the input mixer provides the most flexibility (especially if the processed output may be needed for other processes).
- When performing significant changes like unchecking or checking (enabling) new DSP functions, always press the DashBoard **Refresh** button to make sure the change is taken in on DashBoard and sub-tabs correspondingly displayed are refreshed with the drop-downs that correlate with the DSP setup. If DashBoard changes (such as channel routing) are done before refresh, the intended routing settings may not actually take place and engage.
- Where possible where a compound setup (like that shown in this example for DSP A) is being set up, it's a good idea to confine the processes to a single DSP pipeline. In this manner, the intermediate processed signals will always be routed to the next function selected, without requiring any manual routing setup in DashBoard.
- Audio lag (delay) will occur when RTLL is used. Using the card **Video Delay** controls (or **Frame Sync** controls and **Input Audio Routing > Audio Delay** controls where equipped), it is recommended to provide a 200 msec video delay (or 200 msec audio advance) to restore lip sync. As with all Dolby Encoders, restoring lip sync for a Dolby encode/decode chain must also be considered. Refer to applicable manual(s) for more information.

Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	(continued)

Note: This subsection of the Audio DSP presentation covers the specific controls and settings of the DSP enable setup pane, signal routing to and from DSP blocks, and the specific DSP blocks themselves. Reading and understanding the overview on the preceding pages is **strongly** recommended before proceeding to the descriptions below.

• **Audio DSP Basic Setup Pane (Upper Pane)**	When the Audio DSP tab is opened, the upper pane allows basic, primary setup of the card DSP functions (blocks) such as selecting (enabling) available DSP functions for each DSP pipeline. **These settings must be performed first**, as these settings will enable desired DSP functions and position the DSP assets at either the input mixer or output mixer as desired. DSP-specific controls appear **only** when the corresponding DSP function is enabled here.

Clicking the Audio DSP tab opens the upper and lower panes of the Audio DSP page. In the upper pane, select desired pairs **A/B** thru **G/H** of DSP pipelines as desired to facilitate DSP functions as needed.

- In each DSP function row (Dolby Decoder thru Dolby Digital Encoder 2.0), enable DSP function and apply it to a DSP pipeline pair as desired by clicking the corresponding checkbox.
- When DSP functions are enabled In a DSP pipeline column, now position the DSP pipeline to be at the input or output mixer as desired by checking the **Input Mixer** or **Output Mixer** button.

In this example, **DSP A** is set to enable **Upmixer**, **Real Time Loudness Leveler 5.1**, and **Dolby Digital Encoder 5.1**, with all set to be positioned at the **Input Mixer**.

In this example **DSP E** is set to enable **Dolby Decoder**, with this set to be positioned at the **Output Mixer**.

- Unused DSP asset rows/columns can be left as-is with mixer selection being ignored.
- **licenses available** displays shows whether or not the DSP function is licensed for the card, and if so the number of licenses available. As DSP functions are enabled, the available licenses is correspondingly decremented.

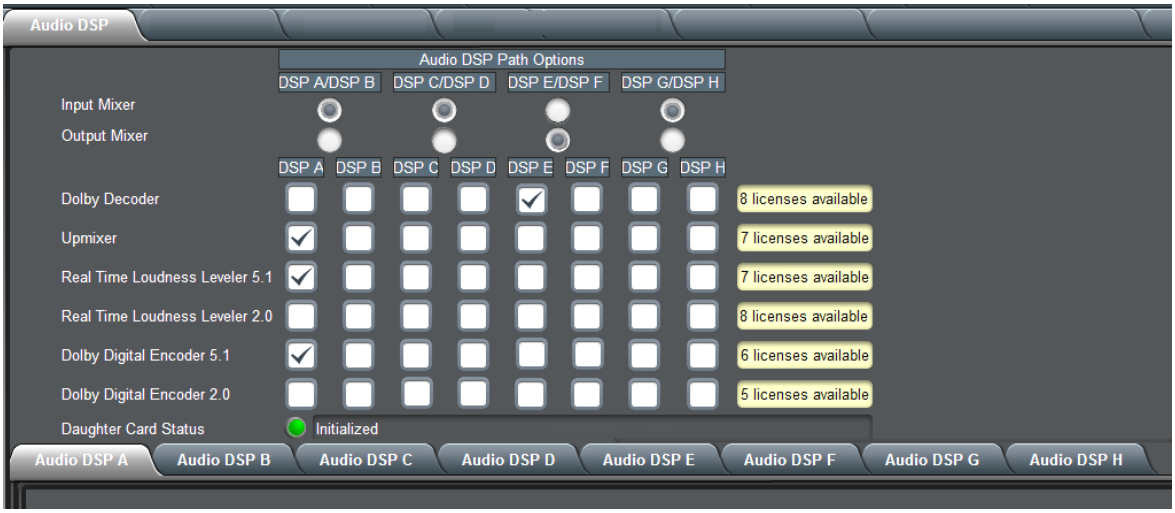
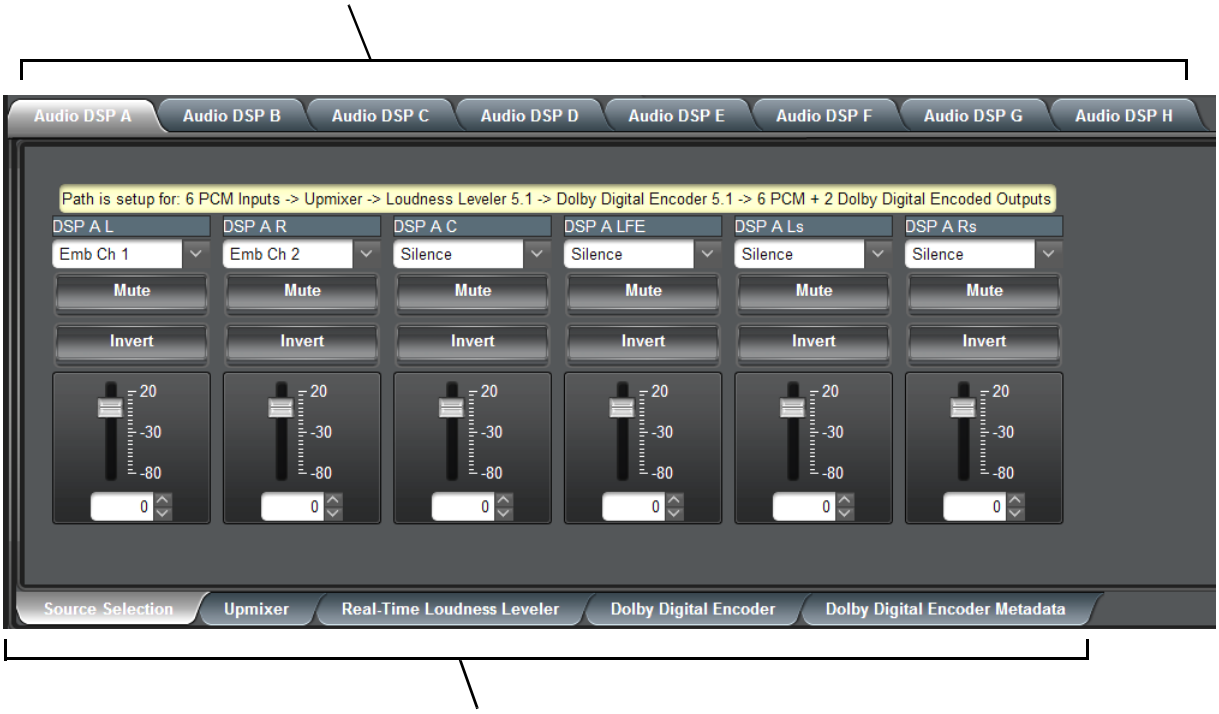


Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	**(continued)**
• **Audio DSP Pipeline Select/Setup Pane (Lower Pane)**	The lower pane that displays when the Audio DSP tab is opened allows "going into" each enabled DSP pipeline, and setting up attributes for the pipeline such as signal routing and function-specific settings for the DSP functions that are enabled.

Sub-tabs for each DSP pipeline allow selecting a specific pipeline to "go into" and access other settings specific to the enabled functions. In the running example here with **DSP A** having Upmixer, RTLL5.1, and Dolby Digital Encoder 5.1 enabled, when DSP A sub-tab is clicked, a series of applicable lower sub-tabs appear which allow specific setup of the enabled functions. The processing path to be applied is also shown in the Path Setup window.

If a DSP pipeline has no functions enabled, "Path is disabled" is displayed and no lower sub-tabs appear.



The lower sub-tabs that appear correspond to the setup required for the enabled functions (in the example here, Source Selection to route PCM inputs to the DSP functions, Upmixer setup, RTLL setup, and finally Dolby Encoder setup).

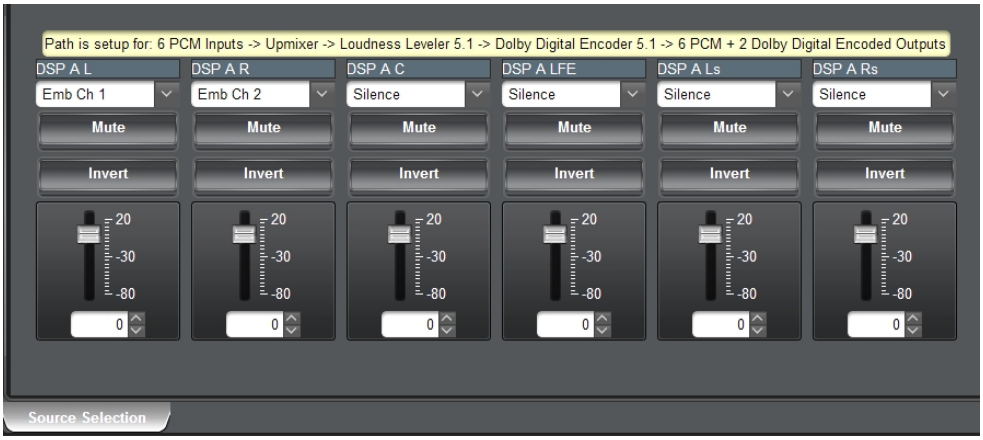
The tabs that appear are a dynamic function of enabled DSP functions (for example, if Upmixer was not enabled, the Upmixer sub-tab shown here would not appear).

Table 3-1 9904-UDX-4K Function Menu List — continued

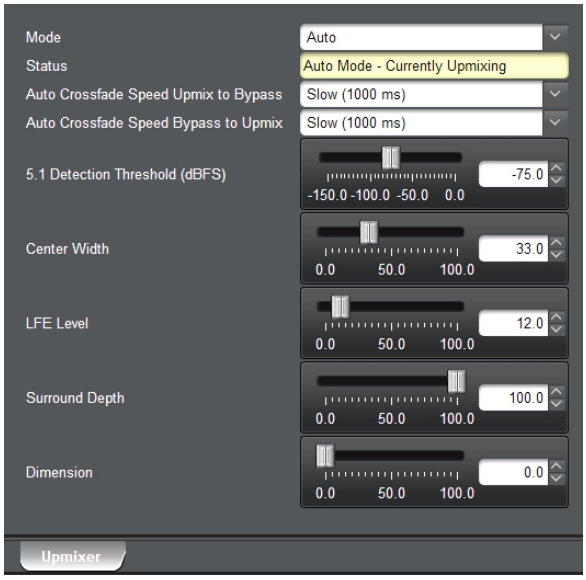
Audio DSP	(continued)

Note: As noted earlier, appearance of lower sub-tabs shown here depend on DSP function(s) selected. Sub-tabs only appear where required in setting up a selected DSP function(s).

• **Source Selection Sub-Tab**	Allows selecting audio channels to be inputted to any pipeline DSP function(s). Also provides Gain, Mute, and Invert controls for each input channel. **Note:** Drop-down source choices depend upon whether input mixer or output mixer positioning is selected. Input mixer choices are primarily basic card input audio sources; output mixer choices are primarily card audio bus channels.



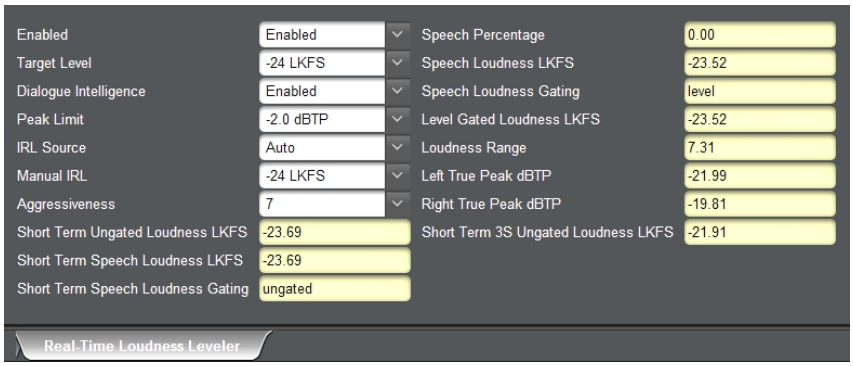
• **Upmixer Setup Sub-Tab** Option	(Option **+DSP-UPMIX-LA** only) Provides controls for setting up upmixing of any normal PCM stereo pair into 5.1 surround sound audio which in turn can be applied to six user-selectable channels or further DSP processing.



- **Mode** selects from Auto (detect content on surround, else force upmix), Bypass, or Always Upmix.
- **5.1 Detection Threshold** adjusts the threshold at which selected channels designated as C, LFE, Ls, and Rs are considered to have viable content, or at which signal levels can be considered insignificant when upmixer enable is set to **Auto**. Setting affects automatic enable/bypass of 5.1 upmix function.
- **Center Width** adjusts center channel content (in terms of percentage) applied to L and R channels.
  - Minimum setting keeps all L+R (mono) content confined to center (C) channel, with any center channel content removed from L and R channels.
  - Higher settings progressively blend respective L and R mono content back into L and R channels, with 100% setting resulting in center channel level going to zero and L/R channels becoming normal L/R channels containing some mono content.
- **LFE Level** allows gain to be added to derived LFE channel.
- **Surround Depth** adjusts surround channel content (in terms of percentage) applied to Ls and Rs channels.
  - Maximum setting results in greatest surround channel levels.
  - Lower settings progressively diminish surround channel levels, with 0% setting resulting in no Ls or Rs level, with Ls and Rs content progressively folded back into L and R, respectively.
- **Dimension** adjusts the perceptual spacial image in the surround channels to be accentuated or diminished.

Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	**(continued)**
• **Real-Time Loudness Leveler Setup Sub-Tab** Option	(Option **+DSP-RTLL** only) Provides controls for setting up Real Time Loudness Leveler loudness processing.



- **Enable** sets RTLL to enabled or bypassed.
- **Target Level** sets RTLL to specific LKFS output loudness target.
- **Dialogue Intelligence**, when enabled, allows loudness processing speech-gating that measures and adjusts loudness only during segments that contain dialog.
- **Peak Limit** applies a peak compressor/limiter if the selected threshold is exceeded.
- **IRL Source; Manual IRL** allows IRL from Auto, Target Level, or Manual.
- **Aggressiveness** adjusts how fast and deep loudness leveling is engaged.

Note: Default settings are recommended and conform to ATSC A/85.
Note: The level displays that appear are not user-facing units such as dBFS or percent.
Note: Parametric controls described here apply to -5.1 and -2.0 RTLL versions.

Tips for Using RTLL

- To monitor main program LKFS with an external downstream device, it is recommended to have device set to Level Gated Loudness LKFS (or equivalent). The **Level Gated Loudness LKFS** field on the RTLL tab shows running output LKFS.
- **Target Level** sets the desired target LKFS. For typical usage where no external metadata is present, it is recommended to select the desired LKFS target, and then set **IRL Source** to use **Target Level**. (Auto is recommended where suitable external metadata is present. If Auto **does not** provide expected LKFS level, use Target Level.)
- **Peak Limit** settings can influence overall peak trends in the output (especially if Aggressiveness is set to less aggressive settings (peak can occur and pass before peak limiter has “time” to react to the peak event)).
- **Speech Percentage** is derived from an algorithm that can detect speech (vs background sounds). However, it can be influenced by other aural factors.
- The short term reported measurements in the RTLL UI use a non-configurable window of 10 seconds.

Additional Parametric Descriptions

- **Short Term Ungated Loudness LKFS** – Indicates the output, short-term loudness (LKFS) as measured by ITU-R BS.1770-3 without a measurement gate. The measurement window is 10 seconds.
- **Short Term Speech Loudness LKFS** – Indicates the output, short-term speech loudness (LKFS) as measured by ITU-R BS.1770-3 with Dialogue Intelligence. The measurement window is 10 seconds.
- **Short Term Speech Loudness Gating** – Provides yes or no indicator of whether short-term speech loudness is active.
- **Speech Percentage** – Indicates the percentage of detected speech.
- **Speech Loudness LKFS** – Indicates the program speech loudness (LKFS) as measured by ITU-R BS.1770-3 with Dialogue Intelligence.
- **Speech Loudness Gating** – Indicates the type of gating used when calculating the short-term speech loudness.
- **Level Gated Loudness LKFS** – Indicates the program level-gated loudness (LKFS), as measured with the level gate defined by ITU-R BS.1770-3.
- **Loudness Range** – Indicates the program loudness range (LU) as measured per EBU R 128 and EBU Tech Doc 3342.
- **Left/Right True Peak dBTP** – Indicates the true peaks (dBTP) for the L and R channels, as measured by ITU-R BS.1770-3.
- **Short Term 3S Ungated Loudness LKFS** – Indicates the output, short-term loudness (LKFS) as measured by ITU-R BS.1770-3 without a measurement gate. The measurement window is three (3) seconds.

Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	**(continued)**

Tips for Using RTLL (cont.)

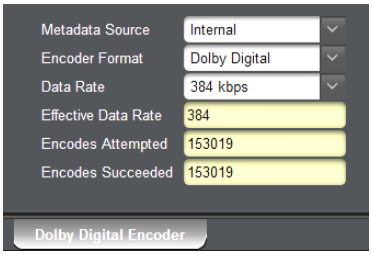
Loudness Leveler Control Settings Recommendations

- **Loudness Target:** -24 LKFS (ATSC), -23 LKFS (EBU)
- **Enabled (RTLL master enable control):** Enabled
- **Dialogue Intelligence:** Enabled (ATSC), Disabled (EBU)
- **Peak Limit:** -2.0 dBTP (ATSC), -3.0 (EBU)
- **IRL Source:** Set to **Target Level** if fixed target level is to be used (as set using **Target Level** value drop-down; else Auto is recommended.
- **Manual IRL:** -24 LKFS (ATSC), -23 (EBU) Note: This control is ignored when in Auto mode.
- **Aggressiveness:** 7

• Dolby® Digital Encoder Mode Setup Sub-Tab

Option

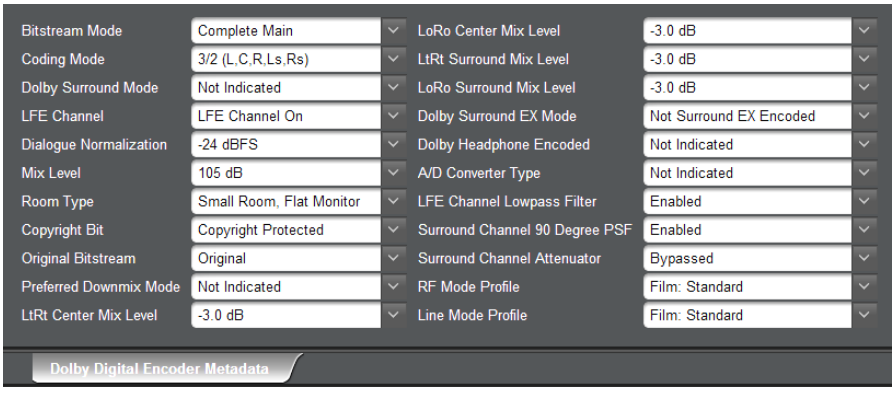
(Option **+DSP-ENCD** only) Provides controls for setting up Dolby Digital Encoder mode and bit rate.



- **Metadata Source** (currently, only Internal is supported).
- **Encoder Format** selects from Dolby Digital or Dolby Digital Plus modes.
- **Data Rate** selects max bit rate allowed.
- **Effective Data Rate** display shows bit rate being used.
- **Encodes Attempted** display shows number of encode frames attempted.
- **Encodes Succeeded** display shows running number of encode frames successfully generated.

Note: Parametric controls described here apply to -5.1 and -2.0 ENCD versions.

• Dolby Digital Encoder Metadata Setup Sub-Tab

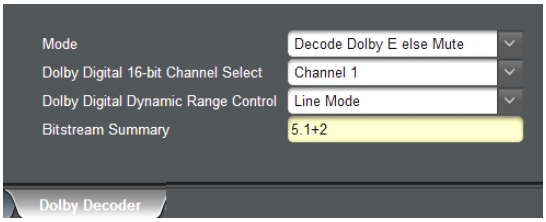


Contains conventional suite of Dolby Digital metadata setup controls and drop-downs.

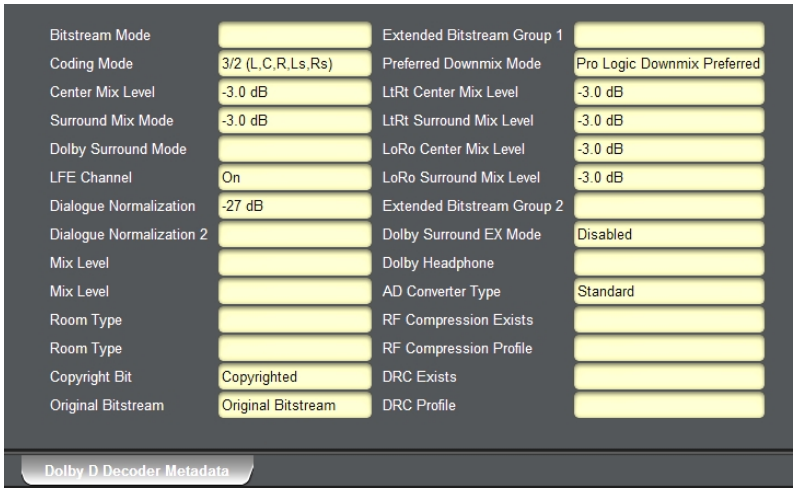
Note: Parametric controls described here apply to -5.1 and -2.0 ENCD versions.

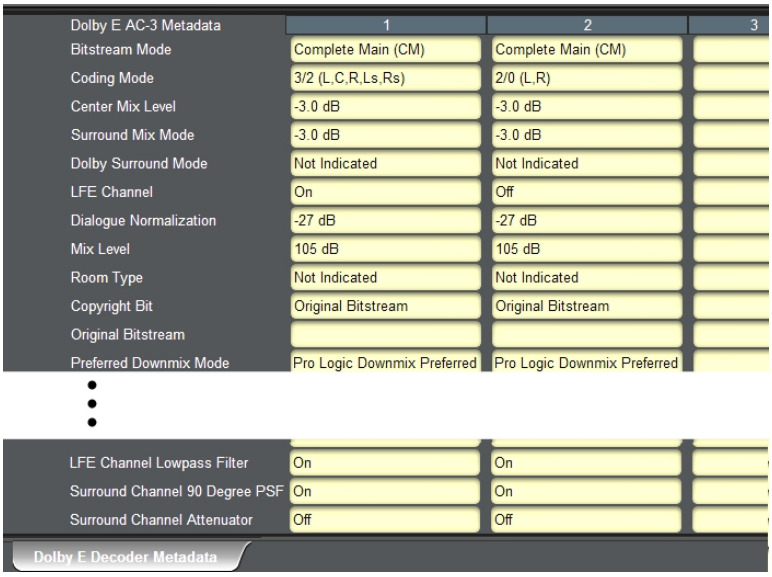
Table 3-1 9904-UDX-4K Function Menu List — continued

Audio DSP	**(continued)**
• **Dolby Decoder Setup Sub-Tab** Option	(Option **+DSP-DEC** only) Provides controls for setting up Dolby Decoder. **Note:** See Source Selection Sub-Tab (p. 3-46) for routing desired Dolby pair to decoder input.



- **Mode** sets decoder to disabled, decode Dolby D/D+ else mute, or decode Dolby E, else mute, or decode else pass PCM.
- **Dolby Digital 16-bit Channel Select** selects from Ch1 or Ch2 selections.
- **Dolby Digital Dynamic Range Control** selects from Dolby convention choices of Line mode, RF mode, Custom, or Bypass.
- **Bitstream Summary** display shows currently-received Dolby bitstream format.





- **Dolby D Decoder Metadata** and **Dolby E Decoder Metadata** sub-tabs show currently-received Dolby metadata for respective format (as applicable) using Dolby conventions.

Table 3-1 9904-UDX-4K Function Menu List — continued

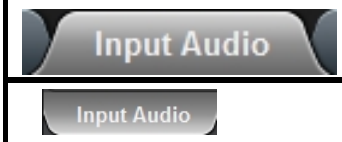
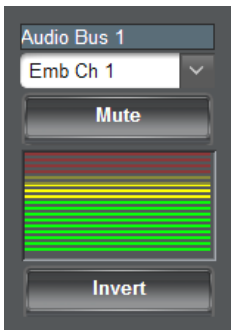
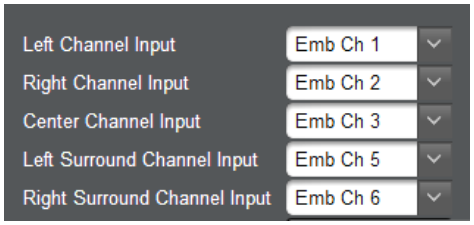
	Provides audio routing and per-channel/bulk audio delay controls, and audio meters. These controls route selected audio sources onto the card 16-channel internal bus (which is used for all audio processing). Also provides a Downmixer and Flex Mixer which can be applied to program audio.
Note: • **Embedded Ch 2** thru **Embedded Ch 16** have controls identical to the **Source** controls described here for **Embedded Ch 1**. Therefore, only the **Embedded Ch 1** controls are shown here. • For each channel, its source and destination should be considered and appropriately set. Unused destination channels should be set to the **Silence** selection. • AES channel count depends on card hardware rev. -Rev -E or later cards show **AES Ch 1** thru **AES Ch 16** where AES channels are shown and available on UI. -Cards of lower rev show **AES Ch 1** thru **AES Ch 8** where AES channels are shown and available on UI.	
• **Embedded Channel Source Select** 	Provides **Mute** and phase **Invert** channel controls, as well as peak level meter for each channel. Using the drop-down list, selects the audio input source to be embedded in the corresponding Audio Bus channel from the following choices: • **Embedded Ch 1** thru **Ch 16** • **AES Ch 1** thru **Ch *n*** • **Flex Bus A** thru **P** mixer sum node outputs • **Downmixer L** • **Downmixer R** • **Silence** • **Audio DSP** sources (route DSP output to card audio bus) **Note:** • Audio DSP source choices depend on Audio DSP asset(s) being enabled and position at input mixer (see Audio DSP Setup Controls (p. 3-36) for more information). • AES ports can be user-set as inputs or outputs using direction controls on **AES Routing** sub-tab. DIrection control(s) must be set as appropriate for AES ports to function as inputs or outputs as intended (see (p. 3-55)).
	Provides audio down-mix audio routing selections that multiplexes any five audio channel sources into a stereo pair.
• **Downmixer Source Controls** 	**Left Channel Input** thru **Right Surround Channel Input** select the five source channels to be used for the downmix. Downmix channels **Downmixer L** and **Downmixer R** are available as sources for embedded audio channels using the Channel Source controls described above.

Table 3-1 9904-UDX-4K Function Menu List — continued

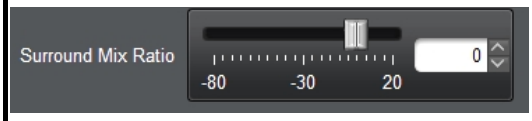
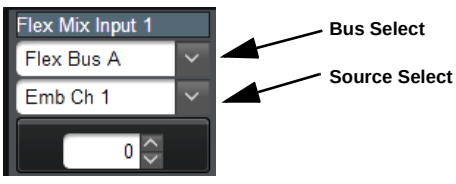
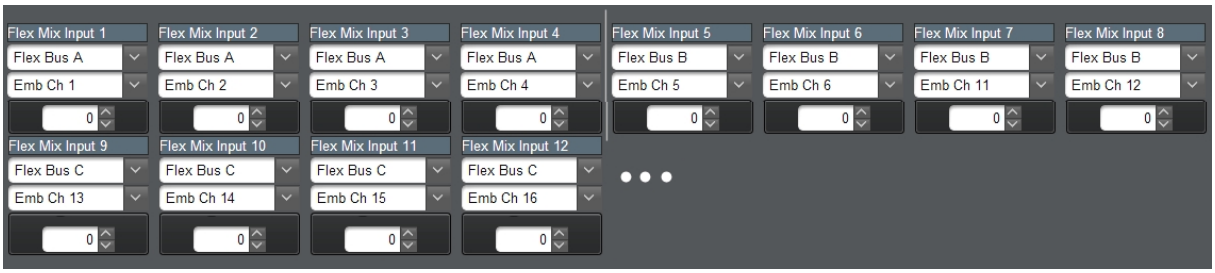
	**(continued)**
• **Center Mix Ratio Control** 	Adjusts the attenuation ratio of center-channel content from 5-channel source that is re-applied as Lt and Rt content to the DM-L and DM-R stereo mix. • 0 dB setting applies no ratiometric reduction. Center channel content is restored as in-phase center-channel content with no attenuation, making center-channel content more predominate in the overall mix. • Maximum attenuation setting (-80 dB) applies a -80 dB ratiometric reduction of center-channel content. Center-channel content is restored as in-phase center-channel content at a -80 dB ratio relative to overall level, making center-channel content less predominate in the overall mix. (20 dB to -80 dB range in 0 dB steps; default = 0 dB) **Note:** Default setting is recommended to maintain center-channel predominance in downmix representative to that of the original source 5-channel mix.
• **Surround Mix Ratio Control** 	Adjusts the attenuation ratio of surround-channel content from 5-channel source that is re-applied as Lo and Ro content to the DM-L and DM-R stereo mix. • 0 dB setting applies no ratiometric reduction. Surround-channel content is restored with no attenuation, making Lo and Ro content more predominate in the overall mix. • Maximum attenuation setting (-80 dB) applies a -80 dB ratiometric reduction of surround-channel content. Surround-channel content is restored at a -80 dB ratio relative to overall level, making surround-channel content less predominate in the overall mix. (20 dB to -80 dB range in 0 dB steps; default = 0 dB) **Note:** Default setting is recommended to maintain surround-channel predominance in downmix representative to that of the original source 5-channel mix.
	**Flex Mixer** – Provides a 16-channel mixer in which each of the inputs can be mixed onto up to 16 independent output summing nodes. The input sources are the flex mix input channels. Each input channel has independent gain and mute controls.
Note: For each Flex Mix input channel, its source should be considered and appropriately set. Unused input channels should be set to the **Silence** selection.	
• **Flex Bus Input Channel Source/Bus Assignment — Gain** 	**Bus Select** drop-down select the flex bus (**A** thru **P**) to which the source will be applied. **Source Select** drop-down selects a source channel to be applied to the selected bus from the choices listed below. • **Embedded Ch 1** thru **Ch 16** • **AES Ch 1** thru **Ch *n*** • **Silence** Also provides relative gain (in dB) control (-80 to +20 dB range in 0.1 dB steps; unity = 0.0 dB)

Table 3-1 9904-UDX-4K Function Menu List — continued

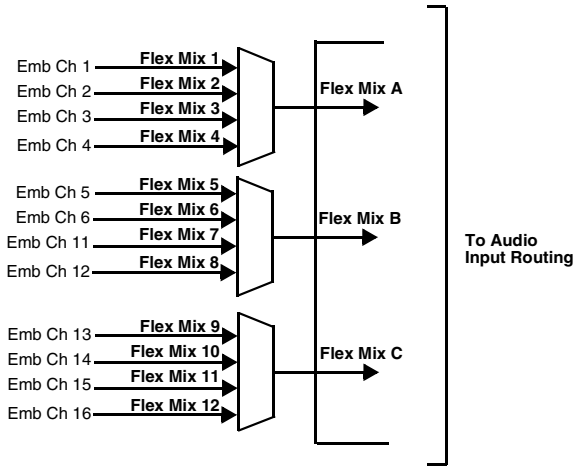
Input Audio

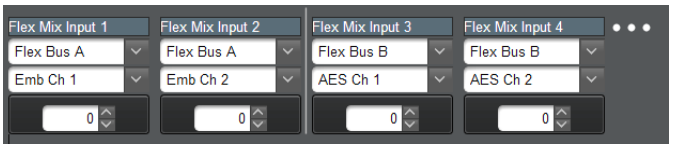
Flex Mixer

(continued)



In this example – three, 4-input mono mixers are provided by selecting **Flex Mixer Bus A** for the Flex Mix 1 thru Flex Mix 4 inputs, and **Flex Mixer Bus B** for the next four inputs, and so on as shown.





In this example – two, 2-input mono mixers are provided by selecting **Flex Mixer Bus A** for the Flex Mix 1 and Flex Mix 2 inputs, and **Flex Mixer Bus B** for the next two inputs as shown.

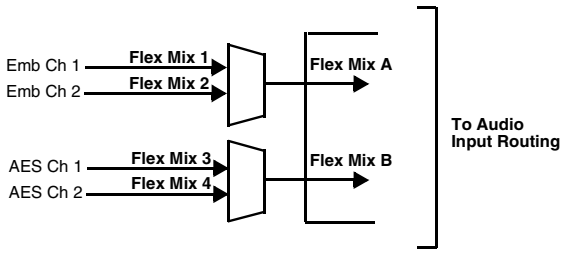
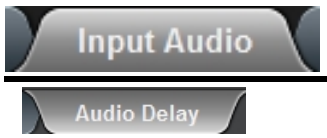


Table 3-1 9904-UDX-4K Function Menu List — continued



Audio Delay – Provides bulk (all four groups/master) and individual card audio bus channel delay offset controls and delay parametric displays.

• Bulk (Master) Audio/Video Delay Control

Bulk Delay control adds bulk (all four groups) audio delay from any video delay (net audio delay offset setting adds delay in addition to any delay included by other actions). This control is useful for correcting lip sync problems when video and audio paths in the chain experience differing overall delays. (-33 to +3000 msec range in 0.01-msec steps; null = 0 msec).

Large rapid changes in bulk delay (> 500 msec) can result in momentary full-scale noise burst on output processed audio. This burst can damage monitors or other equipment if not considered. Gain on output should be reduced if performing large adjustments to delay.

• Per-Channel Audio/Video Delay Offset Controls

Offset control adds or reduces (offsets) channel audio delay from the matching video delay (audio delay offset setting adds or removes delay in addition to any delay included by other actions). This control is useful for correcting lip sync problems when video and audio paths in the chain experience differing overall delays.

(-800.0 to +800.0 msec range in 0.02 msec steps; null = 0.0 msec)

Delay Status shows current delay from video for the corresponding audio channel.

Note: • Maximum advance/delay offset is dependent on video format.

• Where a Dolby pair is present, adjustment of either channel control results in a matching delay setting for the other channel in the pair.

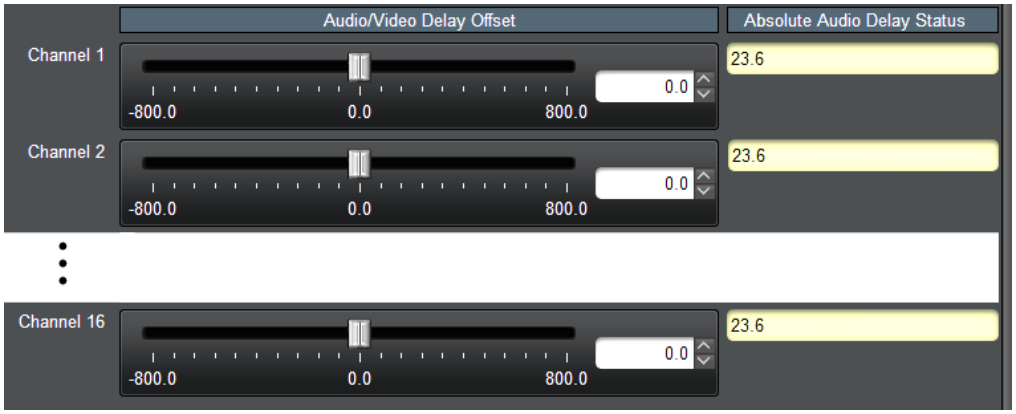
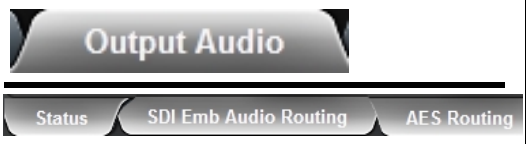
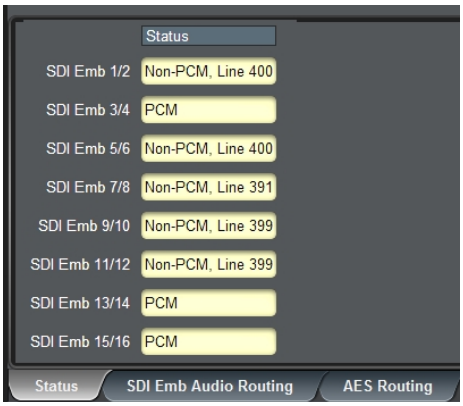


Table 3-1 9904-UDX-4K Function Menu List — continued



Provides an audio crosspoint allowing the audio source selection for each embedded audio output channel. Also provides an output node Downmixer and Flex Mixer which can be applied to output program audio.

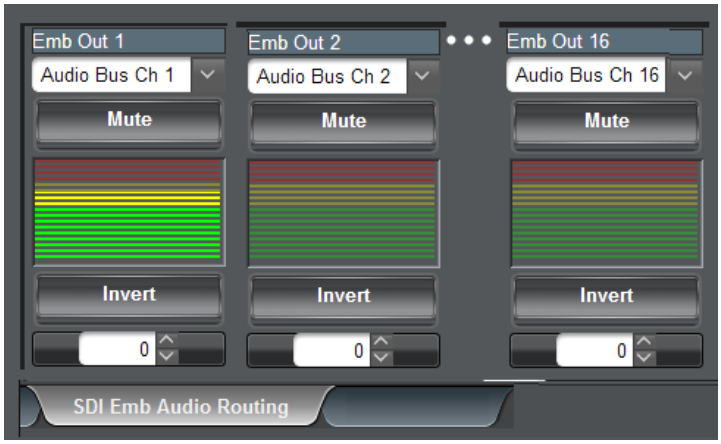
Note:
- **Embedded Ch 2** thru **Embedded Ch 16** have controls identical to those described here for **Embedded Ch 1**. Therefore, only the **Embedded Ch 1** controls are shown here.
- For each channel, its source and destination should be considered and appropriately set. Unused destination channels should be set to the **Silence** selection.
- AES channel count depends on card hardware rev.
  -Rev -E or later cards show **AES Ch 1** thru **AES Ch 16** where AES channels are shown and available on UI.
  -Cards of lower rev show **AES Ch 1** thru **AES Ch 8** where AES channels are shown and available on UI.



- **Status**

For each SDI embedded output pair, shows content presence and type

- **PCM** indicates recognized PCM present.
- **Dolby D** or **Dolby E** indicates Dolby non-PCM content is present, along with line number.
- **Non-PCM** indicates non-PCM content, along with line number.
- **Unlocked** indicates no lock/content detected (as in cases where upstream device has removed or not embedded any audio on the pair/group).



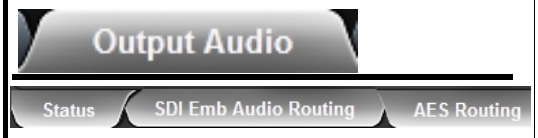
- **SDI Embedded Output Channel Source**

Provides Gain, Phase Invert, and Muting controls and peak level meters for each embedded output channel. Using the drop-down list, selects the card audio bus source to be embedded in the corresponding embedded output channel from the following choices:

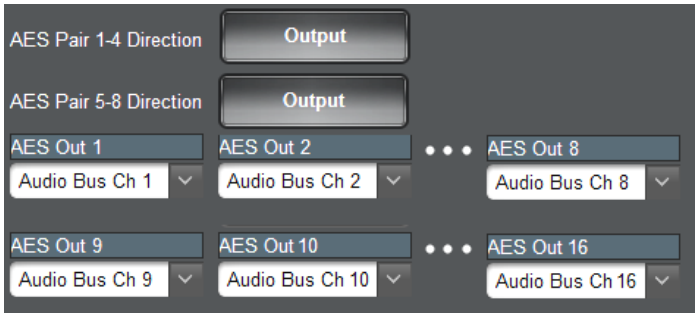
- Card **Audio Bus Ch 1** thru **Ch 16**
- **Audio DSP *n*** sources (route DSP output to card embedded output)
- **Flex Bus A** thru **P** mixer sum node outputs
- **Downmixer L**
- **Downmixer R**
- **Silence**

Note: Audio DSP source choices depend on Audio DSP asset(s) being enabled and position at output mixer (see Audio DSP Setup Controls (p. 3-36) for more information).

Table 3-1 9904-UDX-4K Function Menu List — continued



(continued)



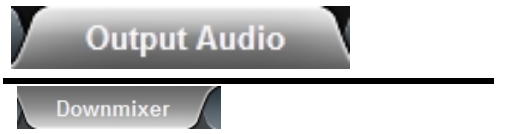
- **AES Channel Source/Direction Controls**

Using the drop-down list, selects the card audio bus source to be embedded in the corresponding AES output channel from the following choices:

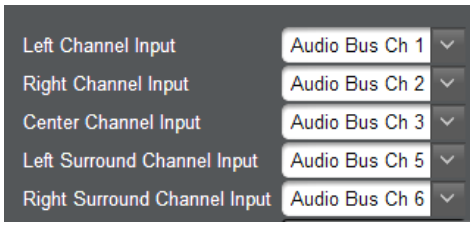
- Card **Audio Bus Ch 1** thru **Ch 16**
- **Audio DSP *n*** sources (route DSP output to card embedded output)
- **Silence**

Note: Audio DSP source choices depend on Audio DSP asset(s) being enabled and position at output mixer (see Audio DSP Setup Controls (p. 3-36) for more information).

Note: The **Input / Output** button (shown in **Output** mode here) sets **four groups of AES ports** (pairs of 8 channels) as **all outputs** (de-embed selected card Audio Bus Channels to desired AES outputs), or sets **four groups of AES ports** (8 channels) as **all inputs** (embed desired AES port(s) to selected card Audio Bus Channels). (Card hardware versions earlier than -E show controls only for pairs 1 thru 8.)



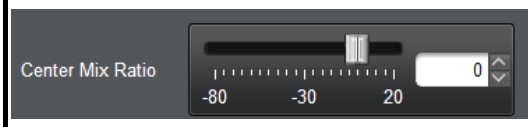
- **Downmixer Source Controls**



Left Channel Input thru **Right Surround Channel Input** select the five source channels to be used for the downmix.

Downmix channels **Downmixer L** and **Downmixer R** are available as sources for output audio channels using the Channel Source controls described above.

- **Center Mix Ratio Control**



Adjusts the attenuation ratio of center-channel content from 5-channel source that is re-applied as Lt and Rt content to the DM-L and DM-R stereo mix.

- 0 dB setting applies no ratiometric reduction. Center channel content is restored as in-phase center-channel content with no attenuation, making center-channel content more predominate in the overall mix.
- Maximum attenuation setting (-80 dB) applies a -80 dB ratiometric reduction of center-channel content. Center-channel content is restored as in-phase center-channel content at a -80 dB ratio relative to overall level, making center-channel content less predominate in the overall mix.

(20 dB to -80 dB range in 0 dB steps; default = 0 dB)

Note: Default setting is recommended to maintain center-channel predominance in downmix representative to that of the original source 5-channel mix.

Table 3-1 9904-UDX-4K Function Menu List — continued

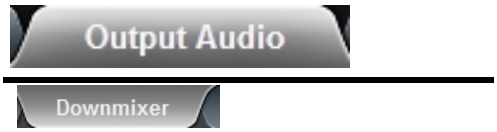
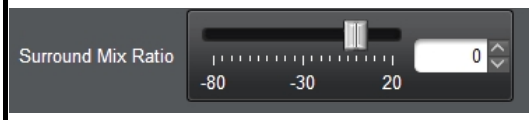
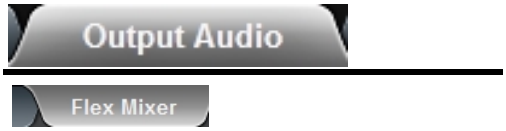
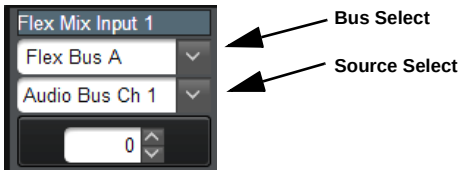
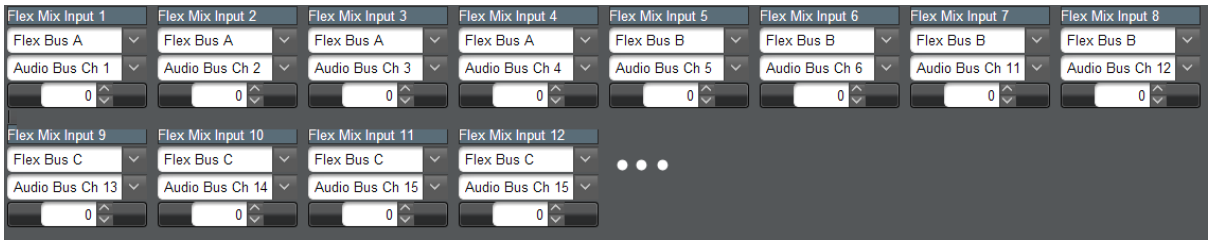
	**(continued)**
• **Surround Mix Ratio Control** 	Adjusts the attenuation ratio of surround-channel content from 5-channel source that is re-applied as Lo and Ro content to the DM-L and DM-R stereo mix. • 0 dB setting applies no ratiometric reduction. Surround-channel content is restored with no attenuation, making Lo and Ro content more predominate in the overall mix. • Maximum attenuation setting (-80 dB) applies a -80 dB ratiometric reduction of surround-channel content. Surround-channel content is restored at a -80 dB ratio relative to overall level, making surround-channel content less predominate in the overall mix. (20 dB to -80 dB range in 0 dB steps; default = 0 dB) **Note:** Default setting is recommended to maintain surround-channel predominance in downmix representative to that of the original source 5-channel mix.
	**Flex Mixer** – Provides a 16-channel mixer in which each of the inputs can be mixed onto up to 16 independent output summing nodes. The input sources are the flex mix input channels. Each input channel has independent gain and mute controls.
Note: For each Flex Mix input channel, its source should be considered and appropriately set. Unused input channels should be set to the **Silence** selection.	
• **Flex Bus Input Channel Source/Bus Assignment — Gain** 	**Bus Select** drop-down select the flex bus (**A** thru **P**) to which the source will be applied. **Source Select** drop-down selects a source channel to be applied to the selected bus from the choices listed below. • **Audio Bus Ch 1** thru **Ch 16** • **AES Ch 1** thru **Ch *n*** • **Silence** Also provides relative gain (in dB) control (-80 to +20 dB range in 0.1 dB steps; unity = 0.0 dB)

Table 3-1 9904-UDX-4K Function Menu List — continued

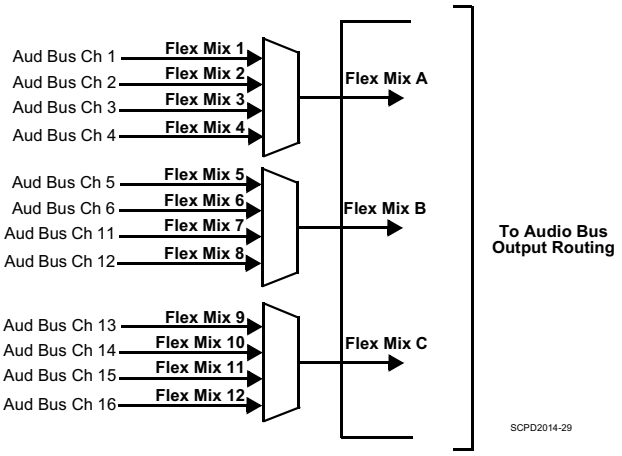
Output Audio

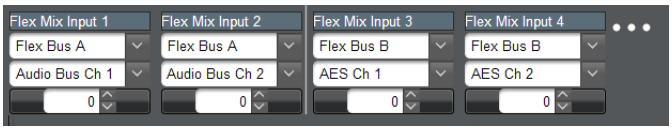
Flex Mixer

(continued)



In this example – three, 4-input mono mixers are provided by selecting **Flex Mixer Bus A** for the Flex Mix 1 thru Flex Mix 4 inputs, and **Flex Mixer Bus B** for the next four inputs, and so on as shown.





In this example – two, 2-input mono mixers are provided by selecting **Flex Mixer Bus A** for the Flex Mix 1 and Flex Mix 2 inputs, and **Flex Mixer Bus B** for the next two inputs as shown.

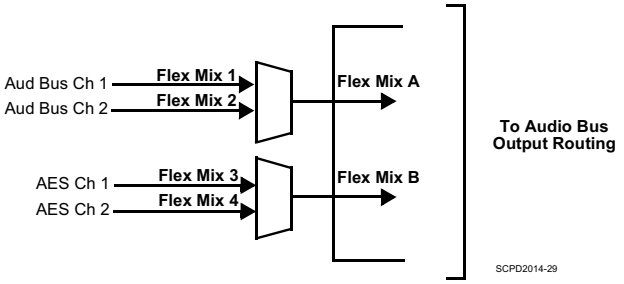


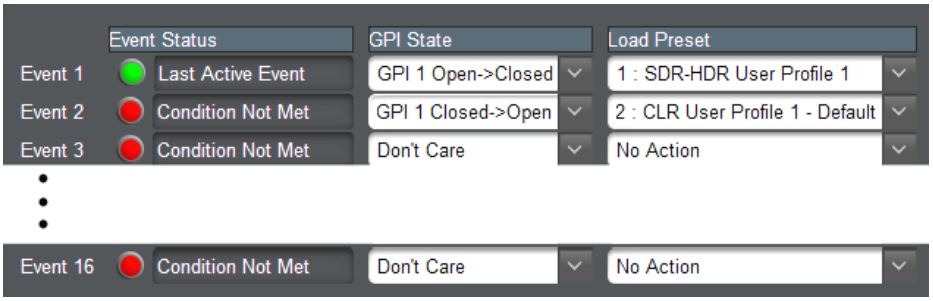
Table 3-1 9904-UDX-4K Function Menu List — continued

User Events	Provides GPI-triggered (Event) loading of user presets. Any combination of card settings can be nested within a preset. The preset can be automatically engaged when a defined GPI condition occurs.

- GPI-based preset loading is not passive and can result in very significant and unexpected card control and signal processing changes if not properly used. If user event presets are not to be used, make certain controls described here are not set to invoke a preset.
- Because preset loading can apply card control changes by invoking presets, loading conditions cannot be nested within a called preset (GPI-invoked loading settings performed here cannot be saved to presets, although the settings are persistent across power cycles).

A GPI Event trigger (GPI State) provides a trigger to invoke a card preset (Load Preset).

- Event 1 thru Event 16 are arranged with Event 1 having the highest priority, descending down to Event 16. Where multiple event screening is enabled, lower-priority events are serviced first, with the highest-priority event being the final event serviced and last action taken. This helps ensure that a lower-priority event does not mask detection of higher-priority event(s).
- The **Status** indicator and message shows the activation status of each Event. Green indicator means event is currently engaged.
- Up to four GPI inputs (GPI 1 thru GPI 4) can be used and monitored. Engage action for each independent GPI is edge triggering (open>closed or closed>open). Logic combinations using multiple GPIs for a given preset load (Event 1-Event 16) are not supported.



In the example above, a GPI 1 open>closed trigger will invoke selected user preset 1 (in this case, “1: SDR-HDR User Profile 1”). Also in this example, a GPI 1 closed>open trigger will be used to exit the previously invoked preset and go to a new preset (in this case, “2: CLR User Profile 1 - Default”).

Note:
- For an event to show Active Event (green indicator), a Load Preset must already be selected and present in the drop-down. Events, even if true, will not be acknowledged unless a go-to event (selection other than No Action) is selected for the corresponding row.
- Invoking of a preset via GPI is triggered upon start of event. Any event-based setup must be done in advance of the triggering event in order for event to be detected.
- Loss of true conditions does not disengage an event-based triggering. Another GPI trigger must be tied to another preset and then occur to transition from one triggered preset to another.
- Time required to engage a triggered preset depends upon complexity of the called preset. (For example, a preset that invokes a video change will take longer to engage than a preset involving only an audio routing change.)
- Make certain all definable event conditions that the card might be expected to “see” are defined in any of the Event 1 thru Event 16 rows. This makes certain that the card will always have a defined “go-to” action if a particular setup action is again needed.

Table 3-1 9904-UDX-4K Function Menu List — continued

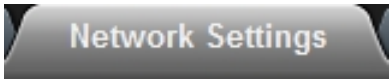
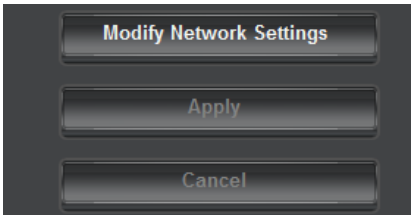
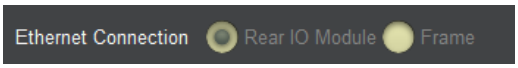
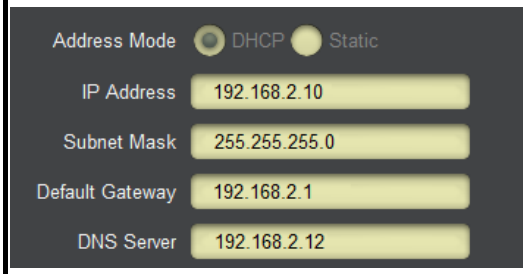
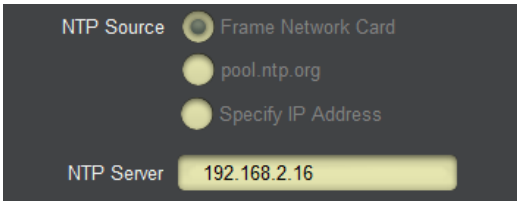
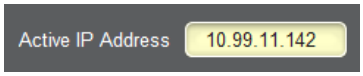
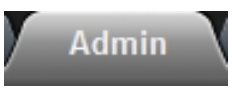
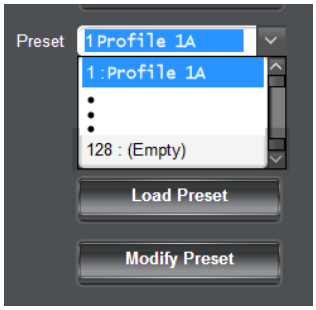
	The **Network Settings** tab provides a dedicated Ethernet connection to card control and monitoring via a rear module Ethernet port. (This IP interface is entirely independent and separate from the card's DashBoard frame-based remote control/monitoring interface.)
• **Opening Fields for Editing** 	• **Modify Network Settings** button opens dialog field for setting network parameters. • **Apply** button commits and applies the settings. • **Cancel** button exits dialog with no changes committed.
• **Card IP Physical Port Select Control** 	Allows card dedicated IP interface (as set below) to use frame communications or dedicated rear I/O module Ethernet RJ-45 port. **Note:** • Frame net connection allows cards with per-card Ethernet connection to connect with network via a shared frame Ethernet port instead of per-card dedicated Ethernet connectors on the card's rear module. Frame net connection is available only on certain frame models. • Card slot must be fitted with a rear I/O module equipped with an Ethernet connector in order to use **Rear I/O** selection.
• **Card IP Setup Controls** 	Provides controls for setting up card dedicated IP interface. • **Addressing Mode** selsects either DHCP or static. • Where **Static** is selected, standard IP fields allow entry of Address, Subnet Mask, and Default Gateway. • Where **DHCP** is selected, DNS Server address field is provided.
• **NTP Clock Setup** 	Allows device NTP clock IP source and localization. This is the clock/time device will use for logs and other recorded actions. • **NTP Source** buttons allow selecting the network source that will provide NTP time. • **NTP Server** sets the IP address where NTP is to be obtained when "Specify IP Address" is checked.
• **Card Active IP Address Display** 	Shows the connected (active) IP address the card is using (as set up using the controls described above).
	Shows card serial number.

Table 3-1 9904-UDX-4K Function Menu List — continued

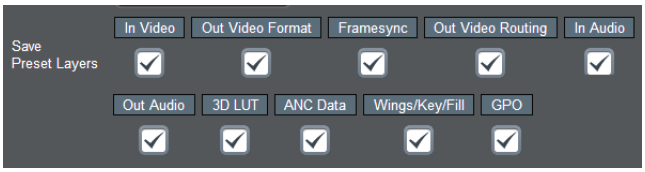
Presets	Allows user custom control settings to be saved in a Preset and then loaded (recalled) as desired, and provides a one-button restore of factory default settings.

• Preset Save / Select / Load Controls

- Pressing **Save Preset** opens field for entering user-defined **Preset Name** for the preset being saved (in this example, "Profile 1A"). Up to 128 individual presets can be saved.
- **Load Selected Preset** button allows loading (recalling) the selected preset. When this button is pressed, the changes called out in the preset are immediately applied.
- **Clear Preset** button deletes the currently selected preset.
- **Modify Preset** button allows currently-selected preset to take in current changed settings and nest the changes in the selected preset.
- **Restore Factory Defaults** button allows loading (recalling) the factory default preset. When this button is pressed, the changes called out in the preset are immediately applied.
- **Download** saves all individual presets to a .bin file to be downloaded to a connected computer.



- **Preset:** drop-down allows a preset saved above to be selected to be loaded, modified or cleared. (In this example, custom preset "1: Profile 1A" can be selected and then loaded, modified, or cleared by pressing the respective button.)



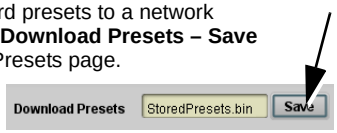
- **Preset Layer Select** allows selecting a functional layer (or "area of concern") that the preset is concerned with. Limiting presets to a layer or area of concern allows for highly specific presets, and masks changing card settings in areas outside of the layer or area of concern.

  Selecting a layer will set the preset to **only** "look at" and "touch" the selected layer(s) settings and save these settings under the preset. When the preset is invoked (loaded), **only** the layer(s) selected when the preset was saved are "touched".

Table 3-1 9904-UDX-4K Function Menu List — continued

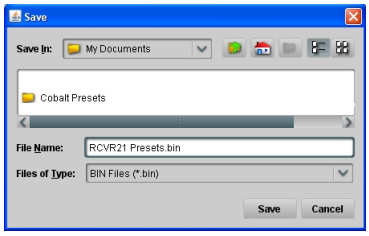
Presets	**(continued)**

Download (save) card presets to a network computer by clicking **Download Presets – Save** at the bottom of the Presets page.



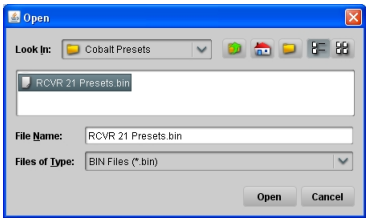
Browse to a desired save location (in this example, *My Documents\Cobalt Presets*).

The file can then be renamed if desired (*RCVR21 Presets* in this example) before committing the save.



Upload (open) card presets from a network computer by clicking **Upload** at the bottom of DashBoard.

Browse to the location where the file was saved on the computer or drive (in this example, *My Documents\Cobalt Presets*). Select the desired file and click **Open** to load the file to the card.



Note: • Preset transfer between card download and file upload is on a **group** basis (i.e., individual presets cannot be downloaded or uploaded separately).

• After uploading a presets file, engagement of a desired preset is only assured by selecting and loading a desired preset as described above.

Troubleshooting

This section provides general troubleshooting information and specific symptom/corrective action for the 9904-UDX-4K card and its remote control interface. The 9904-UDX-4K card requires no periodic maintenance in its normal operation; if any error indication (as described in this section) occurs, use this section to correct the condition.

Error and Failure Indicator Overview

The 9904-UDX-4K card itself and its remote control systems all (to varying degrees) provide error and failure indications. Depending on how the 9904-UDX-4K card is being used (i.e, standalone or network controlled through DashBoard™ or a Remote Control Panel), check all available indications in the event of an error or failure condition.

The various 9904-UDX-4K card and remote control error and failure indicators are individually described below.

Note: The descriptions below provide general information for the various status and error indicators. For specific failures, also use the appropriate subsection listed below.

- Basic Troubleshooting Checks (p. 3-63)
- Troubleshooting Network/Remote Control Errors (p. 3-65)
- In Case of Problems (p. 3-65)

DashBoard™ Status/Error Indicators and Displays

Figure 3-5 shows and describes the DashBoard™ status indicators and displays. These indicator icons and displays show status and error conditions relating to the 9904-UDX-4K card itself and remote (network) communications.

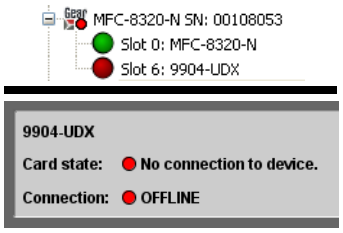
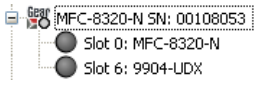
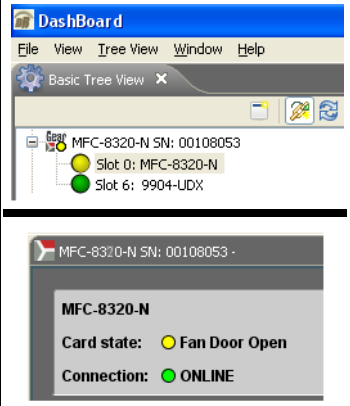
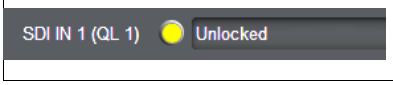
Indicator Icon or Display	Error Description
	Red indicator icon in Card Access/Navigation Tree pane shows card with Error condition (in this example, the Card Access/Navigation Tree pane shows a general error issued by the 9904-UDX-4K card in slot 6). Specific errors are displayed in the Card Info pane (in this example “No connection to device” indicating 9904-UDX-4K card is not connecting to frame/LAN).
	Gray indicator icon in Card Access/Navigation Tree pane shows card(s) are not being seen by DashBoard™ due to lack of connection to frame LAN (in this example, both a 9904-UDX-4K card in slot 6 and the MFC-8320-N Network Controller Card for its frame in slot 0 are not being seen).
	Yellow indicator icon in Card Access/Navigation Tree pane shows card with Alert condition (in this example, the Card Access/Navigation Tree pane shows a general alert issued by the MFC-8320-N Network Controller Card). Clicking the card slot position in the Card Access/Navigation Tree (in this example Network Controller Card “Slot 0: MFC-8320-N”) opens the Card Info pane for the selected card. In this example, a “Fan Door Open” specific error is displayed.
	Yellow indicator icon in 9904-UDX-4K Card Info pane shows error alert, along with cause for alert (in this example, the 9904-UDX-4K is not receiving an SDI input on SDI IN 1).

Figure 3-5 DashBoard™ Status Indicator Icons and Displays

Basic Troubleshooting Checks

Failures of a general nature (affecting many cards and/or functions simultaneously), or gross inoperability errors are best addressed first by performing basic checks before proceeding further. Table 3-2 provides basic system checks that typically locate the source of most general problems. If required and applicable, perform further troubleshooting in accordance with the other troubleshooting tables in this section.

Table 3-2 Basic Troubleshooting Checks

Item	Checks

Verify power presence and characteristics	• On both the frame Network Controller Card and the 9904-UDX-4K, in all cases when power is being properly supplied there is always at least one indicator illuminated. Any card showing no illuminated indicators should be cause for concern.
	• Check the Power Consumed indication for the 9904-UDX-4K card. This can be observed using the DashBoard™ Card Info pane.
	  • If display shows **no** power being consumed, either the frame power supply, connections, or the 9904-UDX-4K card itself is defective.
	  • If display shows **excessive** power being consumed (see Technical Specifications (p. 1-15) in Chapter 1, “Introduction”), the 9904-UDX-4K card may be defective.

Check Cable connection secureness and connecting points	Make certain all cable connections are fully secure (including coaxial cable attachment to cable ferrules on coaxial connectors). Also, make certain all connecting points are as intended. Make certain the selected connecting points correlate to the intended card inputs and/or outputs. Cabling mistakes are especially easy to make when working with large I/O modules.
Card seating within slots	Make certain all cards are properly seated within its frame slot. (It is best to assure proper seating by ejecting the card and reseating it again.)
Check status indicators and displays	On both DashBoard™ and the 9904-UDX-4K card edge indicators, red indications signify an error condition. If a status indicator signifies an error, proceed to the following tables in this section for further action.
Troubleshoot by substitution	All cards within the frame can be hot-swapped, replacing a suspect card or module with a known-good item.

Troubleshooting Network/Remote Control Errors

Refer to Cobalt® reference guide “Remote Control User Guide” (PN 9000RCS-RM) for network/remote control troubleshooting information.

In Case of Problems

Contact and Return Authorization

Should any problem arise with this product that was not solved by the information in this section, please contact the Cobalt Digital Inc. Technical Support Department.

If required, a Return Material Authorization number (RMA) will be issued to you, as well as specific shipping instructions. If required, a temporary replacement item will be made available at a nominal charge. Any shipping costs incurred are the customer’s responsibility. All products shipped to you from Cobalt Digital Inc. will be shipped collect.

The Cobalt Digital Inc. Technical Support Department will continue to provide advice on any product manufactured by Cobalt Digital Inc., beyond the warranty period without charge, for the life of the product.

See Contact Cobalt Digital Inc. (p. 1-19) in Chapter 1, “Introduction“ for contact information.

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