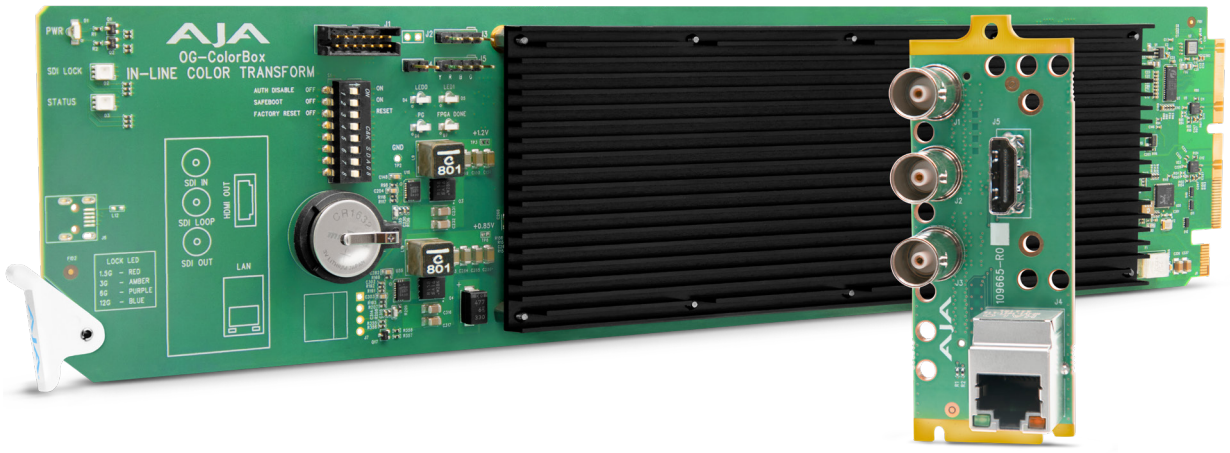
OG-ColorBox

openGear Card



Installation and Operation Guide

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AJA VIDEO SYSTEMS

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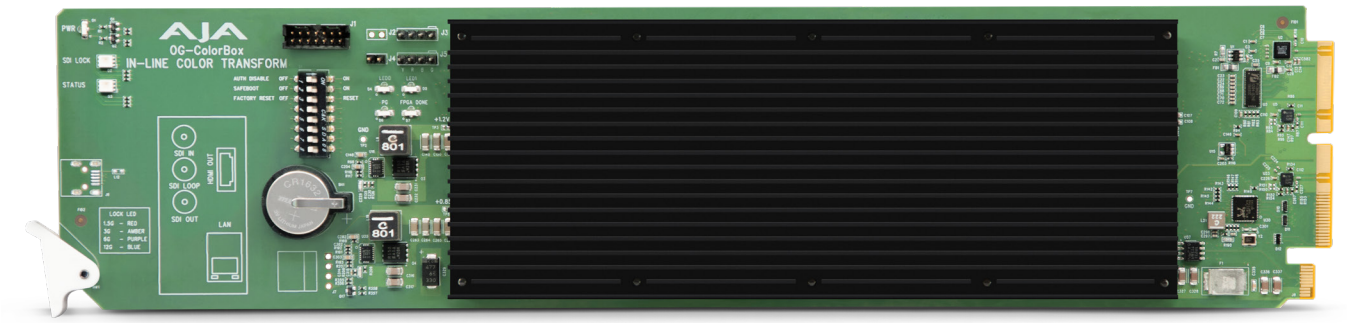


Card Overview

OG-ColorBox from AJA is a high performance color management openGear card specifically designed to meet the color conversion and color correction needs of broadcast, live events, and on-set applications. Supporting HDR, SDR, and Wide Color Gamut (WCG) signals, it utilizes 12G-SDI for single wire 4K/UltraHD up to 4:2:2 10-bit 60p or 4:4:4 12-bit 30p, with a unique color processing pipeline, and down-conversion. The OG-ColorBox's ultra-low latency, less than ½ of a video line, makes it ideal for color managed workflows for live productions.

Built around a 33-point 3D LUT processor with tetrahedral interpolation, the AJA Color Pipeline provides additional 4x 1D LUTs and 2x 3x3 matrices that are each individually configurable or can be converted to Proc Amps or RGB Color Correctors. All of the color processing options can be easily managed via the web user interface, which can be accessed directly from a wired Ethernet connection.

OG-ColorBox also includes processing pipelines from NBCU and ACES. Additionally, OG-ColorBox offers licensable upgrade options for advanced color managed workflows, including the Colorfront Engine, BBC HLG LUTs, and ORION-CONVERT. ORION-CONVERT's unique real time floating point math approach to color transformations produces higher precision results to get "access to the colors between the colors." This enables pixel perfect color transforms and round-tripping where maintaining color fidelity is paramount.

The ACES Pipeline includes support for ACES Metadata File (AMF). Internal AMF processing is built on the OpenColorIO (OCIO) from the Academy Software Foundation and supports configurable input and output transforms.

OG-ColorBox can overlay information onto the image, including helpful user definable text fields, user loaded images such as graphic elements and frame lines, and more.

OG-ColorBox also offers a sophisticated 4K test pattern generator and frame store, bringing useful tools to your workflow, including capturing up to a 4K image as a 16-bit .tiff file for the highest quality reference stills. These captures can be saved locally on OG-ColorBox or onto third party connected computers which can simultaneously be running applications like Pomfort's Livegrade Pro/Studio, Assimilate Live Looks, and QTAKE Video Assist software.

Features

- openGear compatible card
- 12-bit 4:4:4 12G-SDI I/O for up to 4K/UltraHD HDR/WCG 30p
- 10-bit 4:2:2 12G-SDI I/O for up to 4K/UltraHD HDR/WCG 60p
- 12-bit 4:4:4 HDMI 2.0 output for up to 4K/UltraHD HDR/WCG 30p
- 10-bit 4:2:2 HDMI 2.0 output for up to 4K/UltraHD HDR/WCG 60p
- Ultra-low latency, less than ½ of a video line
- Extensive AJA Color Pipeline built around the 33-point 3D LUT processor with tetrahedral interpolation
  - 7x nodes plus Overlay
    - 1x 3D LUT processor, user configurable as 3D LUT or Dynamic
    - 4x 1D LUT processors, user configurable as 1D LUT, Dynamic, or Color Corrector
    - 2x 3x3 Matrix processors, user configurable as 3x3 Matrix, Dynamic, or ProcAmp
  - Supports industry standard file types, no conversion to proprietary format required
  - Configurable Color Space, Range, and Transfer Characteristic
  - Full frame LUT processing
- Six Color Processing Pipelines
  - AJA Color
  - Colorfront (Licensable option)
  - ORION-CONVERT (Licensable option)
  - BBC HLG LUT (Licensable option)
  - NBCU LUTs
  - ACES
- Down-convert 4K to 2K or UltraHD to HD via SDI and/or HDMI outputs
- 4K/2K Crop for HDMI output
- Video Preview in web user interface for confidence monitoring
- Built-in Frame Store
  - Up to 4K/UltraHD frame capture and recall
  - Capture pre or post processed images
- Test Pattern up to 4K/UltraHD, 14 test patterns built-in
- Overlay information on output
  - User Text
  - User Overlay
  - Input and Output signal information
  - Pipeline Configuration
  - Overlay can be captured with image for future reference
- Onboard library for file management
  - 16x 1D LUTs
  - 16x 3D LUTs, CLFs, and CTFs
  - 16x 3x3 Matrices
  - 16x Images
  - 16x Overlays
  - 16x AMFs
- Preset Management, 10 per Pipeline plus Startup Preset
- HDR signaling metadata management
- ANC metadata pass-through
- Embedded audio pass-through, SDI 16-Ch and HDMI 8-Ch

- Support for ARRI Alexa 35's Wireless Video Optimized LogC4 (WVO)
- Extensive API for third party control integrations
- Embedded web server for remote control
- IP configuration and monitoring through Ross DashBoard software
- Power: 19 watts
- Hot-swappable
- Rear I/O card included
- Two slots required for each card
- Compatible with OG-X-FR and OG-3-FR openGear frames
- Redundant power supply option available with openGear frames
- Five year warranty

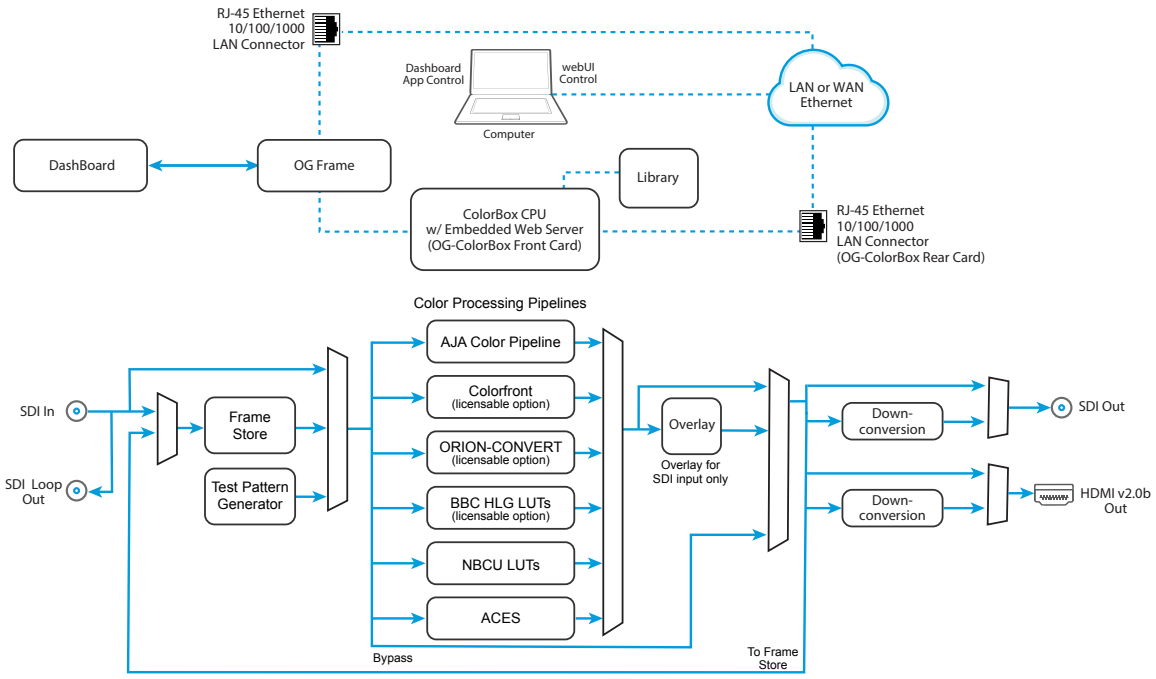
DashBoard for openGear

DashBoard by Ross Video is used with openGear cards and frames. Use DashBoard as part of the configuration process of OG-ColorBox during setup of the system integration.

NOTE: See "DashBoard Control System" on page 20.

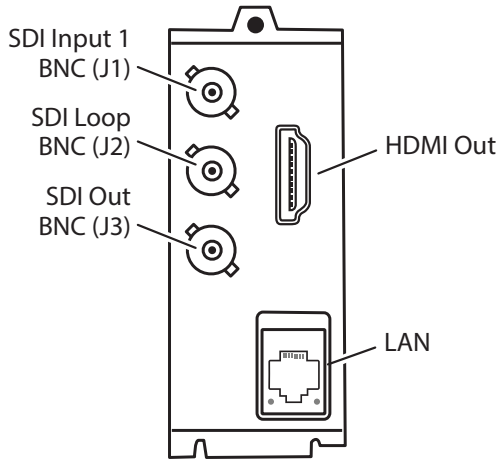
OG-ColorBox Simplified Block Diagram

Figure 2. OG-ColorBox Simplified Block Diagram



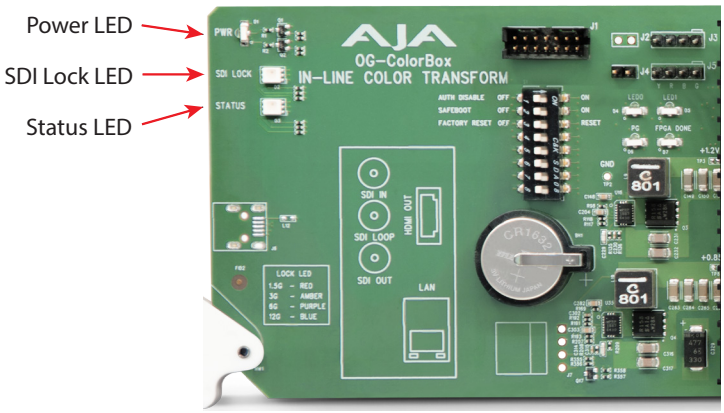
I/O Connections

Figure 3. OG-ColorBox Rear Card I/O Connections



LED Indicators

Figure 4. Indicator LEDs on OG-ColorBox Front Card



Power LED

- Green = App running, No Alarms
- Blinking Green = Bootloader running or Identify
- Blinking Amber = Card Identify
- Yellow = Warning Alarm, board specific
- Red = Error Alarm, multiple conditions (including Overtemp)

SDI Lock LED

- Red = 1.5G
- Amber = 3G
- Purple = 6G
- Blue = 12G
- Off = no signal (OG-ColorBox is not locked to valid or supported input format)

Status LED

- Red = Factory Reset
- Amber = Safeboot
- Green = Pipeline Processing
- Purple = Pipeline Bypassed

Indicators in the DashBoard Control System

OG-ColorBoxCard and Connection Status are found using the DashBoard Control System, on a connected host computer.

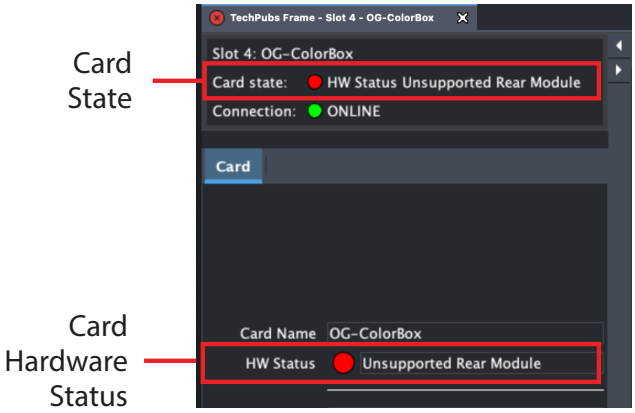
NOTE: See "DashBoard Control System" on page 20.

Card Alarm State – Red

When the card is connected to an incompatible rear card, or when the card is not inserted fully, it will result in a red alarm indicator:

- HW Status Unsupported Rear Module

Figure 5. Card Alarm State Red



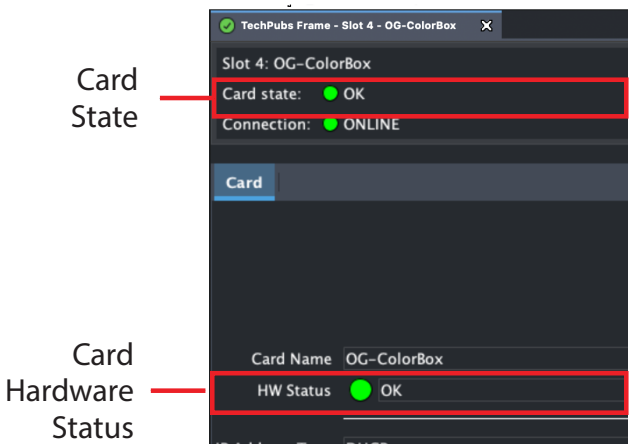
IMPORTANT: A common reason for this error message to occur is that the front card has not been fully inserted. When inserting the front card, there will be an initial click and it may seem like the card is fully inserted. However, you need to push the card into the frame a little bit harder until you hear or feel a second click.

NOTE: See "OG-ColorBox Front Card Installation" on page 17.

Card Alarm State – Green

When there is no card issue detected, the DashBoard Control System shows a green Card State.

Figure 6. Card Alarm State Green: No Issues



User Controls

The essential user controls for the OG-ColorBox consist of four components—an openGear 2RU frame, the DashBoard Control System, the OG-ColorBox WebUI, and the OG-ColorBox DIP switches.

openGear and AJA

openGear is an open-architecture, modular frame system designed by Ross Video and supported by a diverse range of terminal equipment manufacturers, including AJA. Ross Video manufactures the frames, power supplies and network cards for openGear. AJA is a reseller of the openGear frames.

AJA Video is a leading manufacturer of video interface technologies, converters, and digital video recording solutions, bringing high quality, cost-effective products to the professional, broadcast and post-production markets. AJA products, including openGear cards, are designed and manufactured at our facilities in Grass Valley, California.

DashBoard Control System

The DashBoard Control System, created by Ross Video, provides a control interface between Windows, macOS and Linux computers and the cards installed in an openGear frame. DashBoard operates through TCP/IP communication and requires an Ethernet connection between the controlling computer and an openGear frame.

In the case of the OG-ColorBox, a limited set of DashBoard features are utilized, because the OG-ColorBox has its own WebUI interface.

NOTE: See "DashBoard Control System" on page 20.

The DashBoard application is used for initial OG-ColorBox IP Configuration as well as for monitoring the status of the openGear frame and the OG-ColorBox Card.

OG-ColorBox WebUI

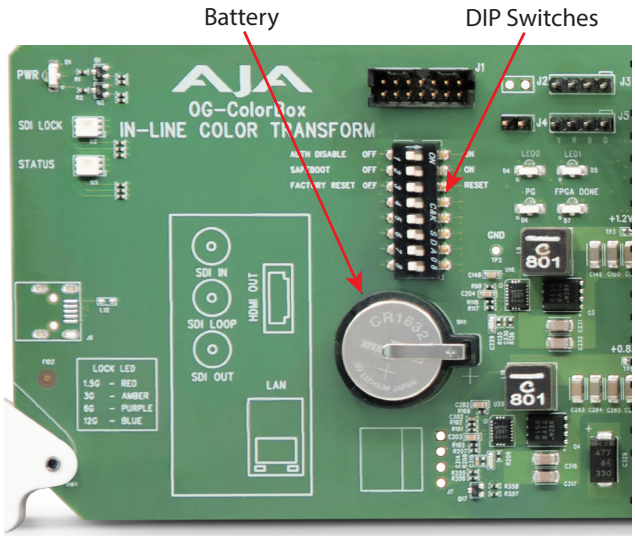
All features and functions of the OG-ColorBox (except initial network setup and basic card status) are controlled by its WebUI. These features include color processing pipeline configuration and system management tools.

NOTE: See "OG-ColorBox Operation" on page 28.

DIP Switches

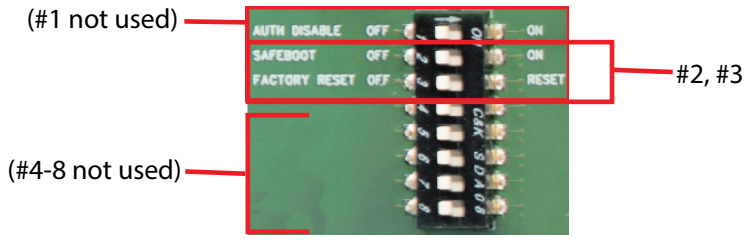
The OG-ColorBox has a DIP Switches module mounted just above the battery on the card. The DIP Switches are used to configure the card for various boot modes.

Figure 7. Location of DIP Switches on OG-ColorBox Card



Only switches #2 and #3 are used. Switches #1 and #4-8 are not used.

Figure 8. DIP switches #2 and #3 (closeup)



DIP Switch Configuration

Table 1. General Configuration DIP Switches

SWITCH	FUNCTION	DIP Set LEFT (default)	DIP Set RIGHT
1	N/A		
2	SAFEBOOT	OFF	ON
3	FACTORY RESET	OFF	RESET
4 - 8	N/A		

The default DIP switches positions are all in the left position.

DIP Switch Access Requires Front Card Removal/Re-Insertion

In each of the following several DIP procedures, before removing the front card, you must first open the frame door, and then securely close it when done.

1. Open the openGear frame door as follows:
   A. Gently pull the side door tabs towards the center of the door, releasing the door from the frame.

B. Using both hands, pull the door towards you. The door extender arms prevent the door from falling.

2. Configure the OG-ColorBox card:

A. Remove the OG-ColorBox card for DIP switches access.

B. When re-inserting the front card, be sure that it is fully seated and that the white card tab is locked inward.

3. Close the openGear frame door.

NOTE: See "OG-ColorBox Front Card Installation" on page 17.

A. Pull and release the door tabs to ensure the frame door is securely locked to the frame.

Using the DIP Switches

Putting OG-ColorBox into Safeboot

1. Open Frame Door.
2. Remove card to safely access the DIPs.
3. Set DIP SWITCH #2 to RIGHT/ON.
4. Re-Install card, making sure it is fully seated.

NOTE: The front card Status LED will stay amber when in Safeboot.

5. Close Frame Door.
6. Boot into Safeboot.

Getting OG-ColorBox out of Safeboot

1. Open Frame Door.
2. Remove card to safely access the DIPs.
3. Set DIP SWITCH #2 to LEFT/OFF.
4. Re-Install card, making sure it is fully seated.
5. Close Frame Door.
6. Boot normally.

Perform Factory Reset (Restore Factory Settings)

1. Open Frame Door.
2. Remove card to safely access the DIPs.
3. Set DIP SWITCH #3 to RIGHT/ON.
4. Re-Install card, making sure it is fully seated.

NOTE: The front card status LED will turn red when in Factory Reset.

5. Close Frame Door.
6. Boot normally except with Factory (default) Settings.

WARNING: ***Restore Factory Settings clears all configuration data from the OG-ColorBox, including the entire Library, all Images and Presets, and network settings (DHCP is enabled after reset). Any installed licenses, however, are retained after a Factory reset.***

WARNING: ***If you wish to retain user configuration data, images, Library and Presets for later use, first store them in one or more Presets and Export them to files on the host computer. Do this before you do a Factory Reset.***

Exit Factory Reset State

1. Open Frame Door.
2. Remove card to safely access the DIPs.
3. Set DIP SWITCH #3 to LEFT/OFF.
4. Re-Install card, making sure it is fully seated.
5. Close Frame Door.
6. Boot normally, without resetting to Factory Settings.

WARNING: ***Be sure to Exit Factory Reset State before rebooting, if you have made any configuration or other changes after the Factory Reset. If you do not, then upon reboot the Factory Settings will again over-write any user configurations that you have made since the prior Factory Reset boot.***

Installation

Summary

NOTE: Use with openGear OG-3-FR and OG-X-FR 2RU frames. DFR-8321 frame is not supported.

Installing an OG-ColorBox into an OG-X-FR openGear frame consists of the following hardware procedures which are detailed in this chapter:

- Unpack OG-ColorBox components.
- Install the rear card onto the back of the openGear frame corresponding to the slot pair you will be using for the OG-ColorBox front card.
- Insert the OG-ColorBox front card into the frame in the right (even numbered) slot of the pair.
- Connect BNC, HDMI and LAN cables to the OG-ColorBox Rear I/O card connectors.

NOTE: OG-ColorBox requires an Ethernet network connection and is shipped from the factory with DHCP enabled. If your network has a DHCP server, by simply connecting OG-ColorBox to your network with an Ethernet cable, the DHCP server will assign OG-ColorBox a compatible IP address. However, you will need to know that IP address before you will be able to access OG-ColorBox's internal web server for WebUI user configuration, as detailed in the below procedures.

ESD Susceptibility - Static discharge can cause serious damage to sensitive semiconductor devices. Avoid handling circuit boards in high static environments such as carpeted areas, and when wearing synthetic fiber clothing. Always exercise proper grounding precautions when working on circuit boards and related equipment.

Unpacking

Unpack each openGear product you received from the shipping container and ensure that all items are included. If any items are missing or damaged, contact your sales representative or AJA directly.

Parts List

Quantity	Description
1	OG-ColorBox Front Card in ESD bag
1	3 BNC, 1 HDMI, 1 LAN Rear Card in ESD bag
1	HDMI Cable Bracket

OG-ColorBox Rear Card Installation (without HDMI Bracket)

If you are connecting a cable to the HDMI output on the OG-ColorBox rear card, continue with the procedure *"OG-ColorBox Rear Card Installation (with HDMI Bracket)" on page 15*. Otherwise when not using HDMI, continue as illustrated below to install the rear card without the optional HDMI cable bracket.

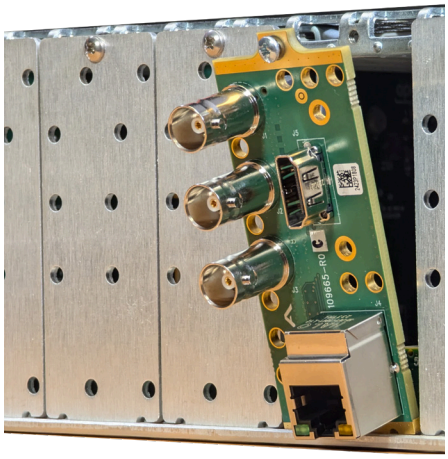
Ensure that the openGear frame is properly installed.

1. Locate the slot on the rear of the openGear frame into which you wish to install the openGear card.

NOTE: An OG-ColorBox card occupies two slots in the frame.

2. Using a Phillips screwdriver, unscrew the top screw from the desired slot's blank plate.
3. Remove the blank plate.
4. Seat the bottom of the rear card in the seating slot at the base of the frame backplane.

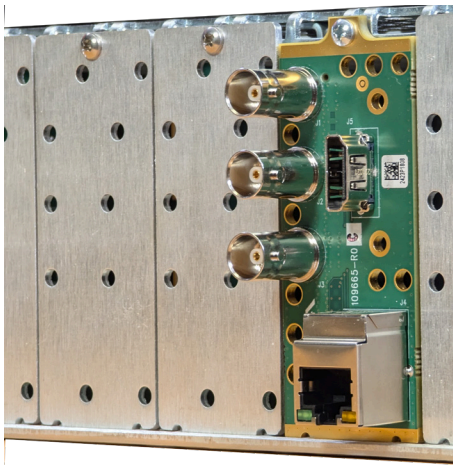
Figure 9. Rear Card Inserting into Frame Seating Slot



5. Align the top screw of the rear card with the screw hole on the top edge of the frame backplane.
6. Ensure the rear card aligns with the desired card slot before tightening the screw.
7. Using a Phillips screwdriver, fasten the rear card to the frame backplane.

CAUTION: *Do not over-tighten.*

Figure 10. Rear Card Inserted and Secured Into Frame Seating Slot



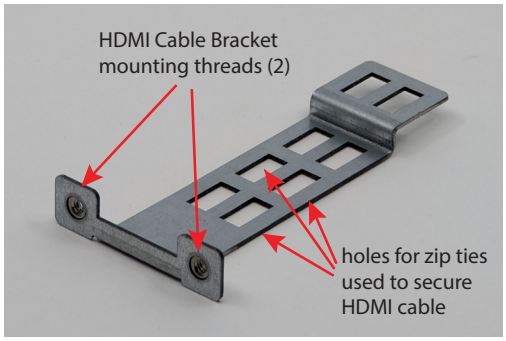
8. Ensure proper frame cooling and ventilation by having all rear frame slots covered with rear cards or blank plates if plates were not previously pre-installed.

IMPORTANT: Leaving one or more rear frame slots completely empty could result in overheating alarms or other error conditions.

OG-ColorBox Rear Card Installation (with HDMI Bracket)

The (optional) HDMI Cable Bracket is designed to provide HDMI cable retention to ensure it remains securely connected, for example even after transportation in a mobile production truck.

Figure 11. OG-ColorBox (optional) HDMI Cable Bracket

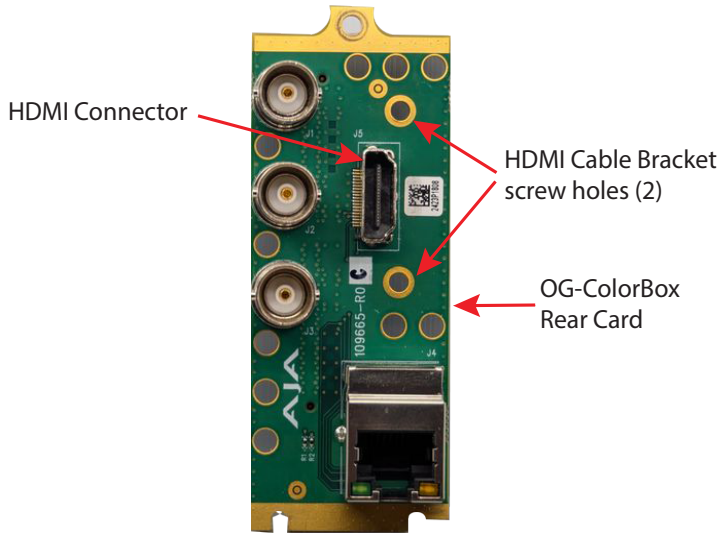


The HDMI Cable Bracket must be installed with the rear card removed from the openGear frame. This is because the HDMI Cable Bracket mounting screws are installed from the back (interior) side of the Rear Card.

Mount the HDMI Cable Mounting Bracket to Rear Card

1. Locate the OG-ColorBox Rear Card, HDMI Cable Bracket, and the two bracket mounting screws (supplied).
2. Align the two mounting threads on the HDMI Cable Bracket with the two screw holes on either side of the HDMI Connector.
3. Using a Phillips screw driver, screw both screws through the back (interior) side of the rear card and into the mounting threads in the HDMI Cable Bracket.

Figure 12. Rear Card Location of HDMI Cable Bracket screw holes



Install Rear Card into openGear Frame

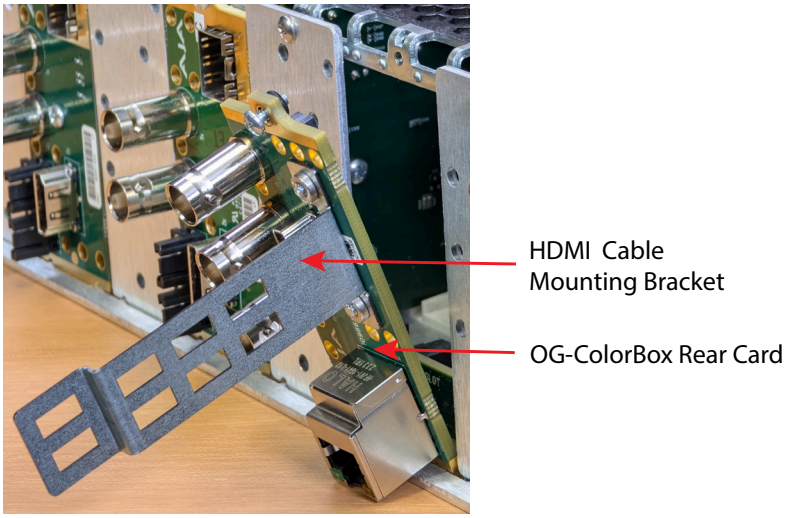
Ensure that the openGear frame is properly installed.

1. Locate the slot on the rear of the openGear frame into which you wish to install the openGear card.

NOTE: An OG-ColorBox card occupies two slots in the frame.

2. Using a Phillips screwdriver, unscrew the top screw from the desired slot's blank plate.
3. Remove the blank plate.
4. Seat the bottom of the rear card (with the HDMI bracket attached) in the seating slot at the base of the frame backplane.

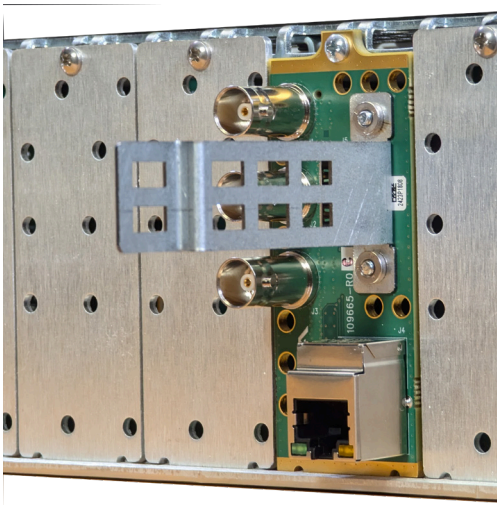
Figure 13. Rear Card with HDMI Bracket Inserting Into Frame Seating Slot



5. Align the top screw of the rear card with the screw hole on the top edge of the frame backplane.
6. Ensure the rear card aligns with the desired card slot before tightening the screw.
7. Using a Phillips screwdriver, fasten the rear card to the frame backplane.

CAUTION: *Do not over-tighten.*

Figure 14. Rear Card with HDMI Cable Bracket Installed into Frame



8. Ensure proper frame cooling and ventilation by having all rear frame slots covered with rear cards or blank plates if plates were not previously pre-installed.

IMPORTANT: Leaving one or more rear frame slots completely empty could result in overheating alarms or other error conditions.

9. Connect the HDMI cable.
10. Zip tie (not provided) the HDMI cable to the HDMI cable bracket.

OG-ColorBox Front Card Installation

1. Open the openGear frame door as follows:
   A. Gently pull the side door tabs towards the center of the door, releasing the door from the frame.
   B. Using both hands, pull the door towards you. The door extender arms prevent the door from falling.
2. Locate the rear card you installed as described above. The interior slot number is dependent on the slot combinations into which you installed the rear card. This allows adequate spacing to avoid damaging the card, the cards installed in the neighboring slots, or both.
3. Hold the card by the edges and carefully align the card edges with the rails inside the frame. The slots are numbered starting from the left-most slot when facing the frame front.

IMPORTANT: OG-ColorBox cards are installed into the right (even numbered) slot of the pair in order to connect with the rear card.

4. Fully insert the card into the frame until the card is properly seated in the rear card. There are two stages to inserting the card:
   A. After you feel the card's first click, its partially inserted position in the frame will resemble the below example:

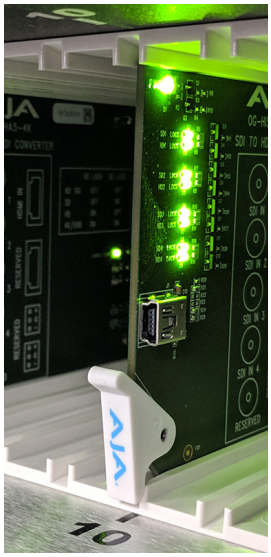
Figure 15. Partially Inserted Card with Unlocked Plastic Tab

B. Next, press against the white plastic tab until you feel the second click.

NOTE: Some cards require more pressure than others to be fully inserted. Make sure that the plastic tab at the bottom of the front edge of the card is completely upright. If it is tilting forward, the card is not yet fully inserted.

C. The card's fully inserted position in the frame will resemble the below example:

Figure 16. Fully Inserted Card with Locked Plastic Tab



5. Close the frame door as follows:
   A. Slide the door into the frame.
   B. Pull and release the door tabs to ensure the frame door is securely locked to the frame.

Cabling

Refer to *"I/O Connections" on page 8* to identify the input and output signal connectors. For example:

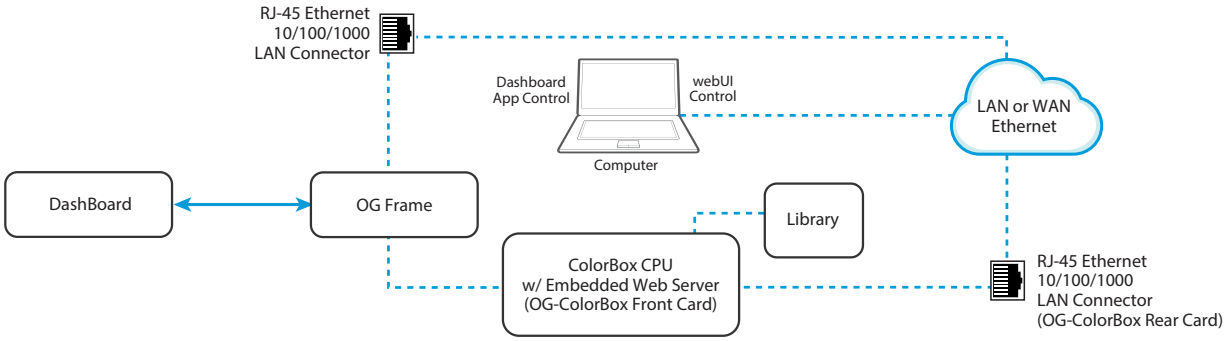
- Connect your video source to the SDI IN BNC connector.
- Connect the SDI OUT BNC to a router or directly to the target receiving devices input.
- Connect the SDI LOOP OUT BNC to the next device to receive the unprocessed source signal.
- Connect the HDMI OUT to an HDMI display for monitoring.

LAN Ports

- There is a dedicated LAN port located on all openGear frames, using a unique IP address for communication with the DashBoard Control System.
- The OG-ColorBox LAN Port located on its rear card, has its own IP configuration to communicate with the OG-ColorBox WebUI.

NOTE: The OG-ColorBox LAN port includes network communications status LEDs.

Figure 17. LAN Ports



Chapter 2 – Initial Configuration

OG-ColorBox Initial Configuration Overview

Before proceeding below, complete hardware installation of OG-ColorBox front and rear cards into an openGear frame. See *"Installation" on page 13.*

After hardware installation, OG-ColorBox initial configuration consists of the steps detailed on the following pages:

1. Download and Install the Ross DashBoard application on a host computer.
2. Connect OG-ColorBox's LAN port to a network that is accessible by your computer.
3. Power up the openGear frame that OG-ColorBox is installed in.
4. Launch the DashBoard application by Ross and double Click on the ColorBox card in the Basic Tree View to set the Initial IP configuration of the OG-ColorBox. See *"Network Setup Using DashBoard" on page 24.*
5. Once the IP addresses are compatible, enter the OG-ColorBox's IP address into a web browser on your connected computer. The OG-ColorBox's web page will be displayed, allowing complete control of the device.
6. If you will be using licensable options, acquire and install the options software license keys. See *"OG-ColorBox Option Licensing" on page 25.*
7. You will now be able to A/B compare your processed and unprocessed video on your color reference monitor and make color adjustments.

DashBoard Control System

The DashBoard Control System is available as a free download from the openGear DashBoard Software Download webpage:

https://www.rossvideo.com/support/software-downloads/dashboard/

Ross Video offers comprehensive documentation that covers the extensive capabilities of the DashBoard Control System:

https://www.rossvideo.com/support/product-documentation/dashboard/

DashBoard Requirements

The DashBoard Control System requires the following components:

- openGear frame with a Frame Controller card
- Ethernet connection between the controlling computer and the openGear frame

NOTE: The openGear frame ships from AJA with the MFC-8322-S Frame Controller card for controlling the new AJA DashBoard cards. The openGear frame also supports the MFC-0GX-N Advanced Networking Frame Controller card, which can be used to control compatible OG cards.

DashBoard automatically discovers openGear and DashBoard Connect devices, such as openGear frames and cards that are present and accessible on your network.

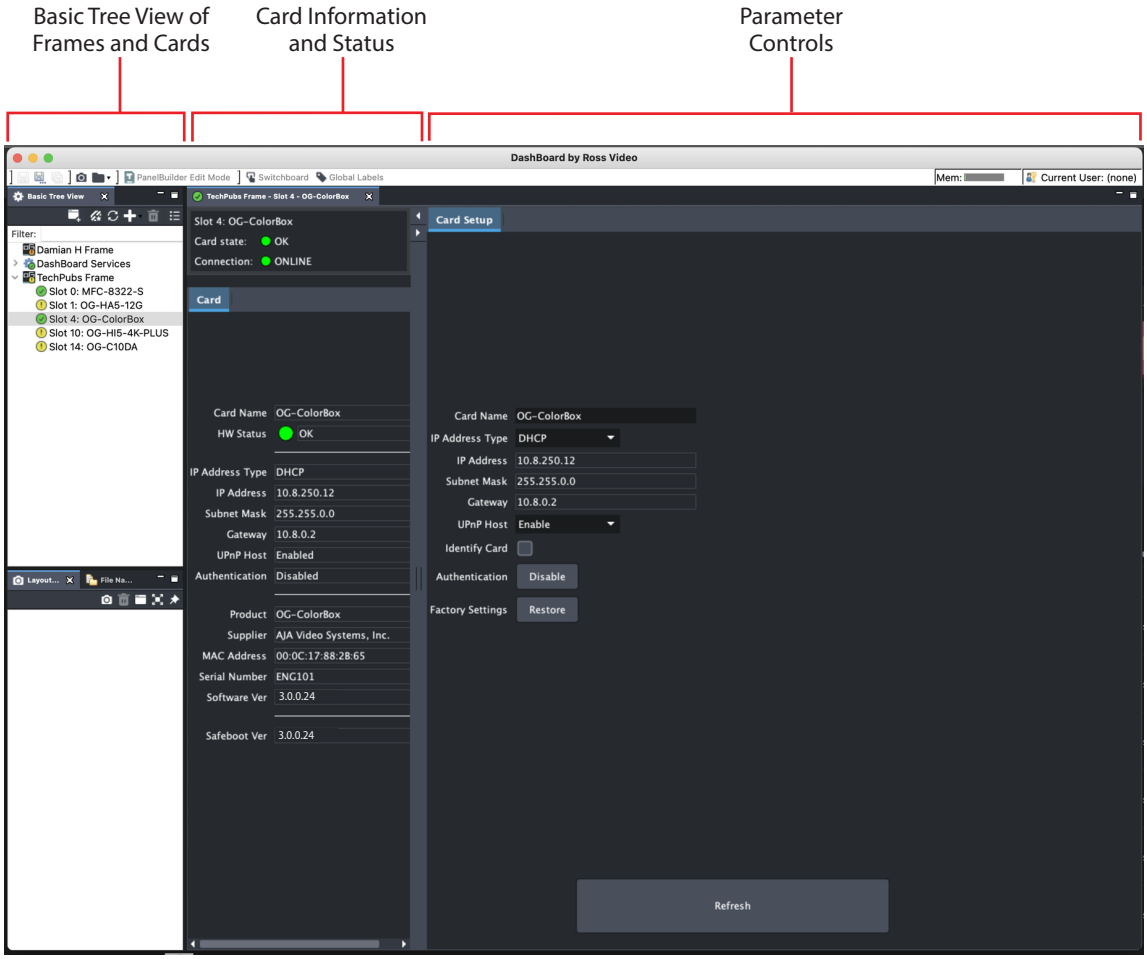
Configuration Settings Stored in OG Card

Configuration settings made through DashBoard are stored in the OG-ColorBox card through subsequent power cycles.

DashBoard Control Interface Basic Components

The basic components of the DashBoard Control System user interface consist of the Basic Tree View of frames and cards, the Card Information and Status panel, and the Parameter Controls panel. These elements are shown below.

Figure 18. Main Sections of the DashBoard User Interface



Basic Tree View of Frames and Cards

The Basic Tree View in the left column shows the frames and cards that are discoverable by DashBoard on your network.

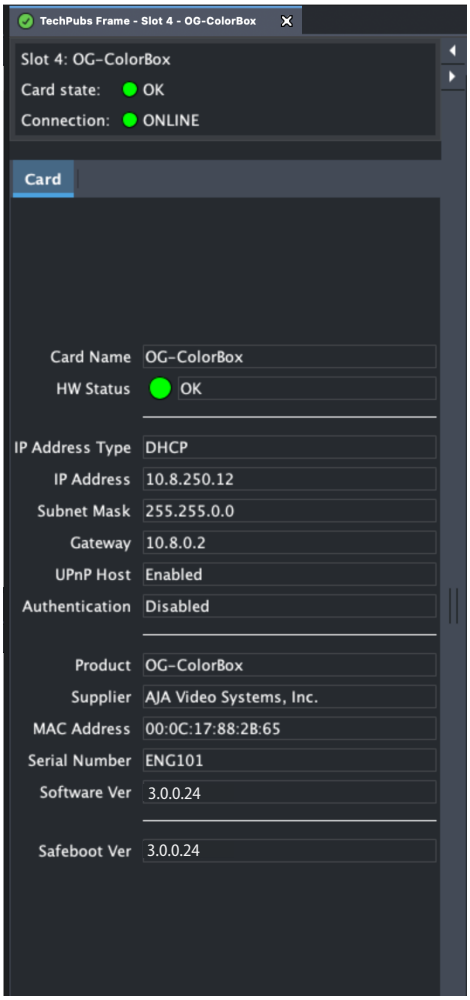
Parameter Controls

The Parameter Controls panel on the right side of DashBoard shows the tabs and parameters that are configurable for the selected card. These fields can be written to or modified.

Card Information and Status

The Card Information and Status panel, shown in the middle panel, display the basic status of the card currently selected in DashBoard The fields in this panel indicate that they are read-only.

Figure 19. OG-ColorBox Card Information Screen in DashBoard



The Card information screen indicates the basic information about the card itself such as the card name, hardware status, serial number, software version and other items.

NOTE: See "Indicators in the DashBoard Control System" on page 9.

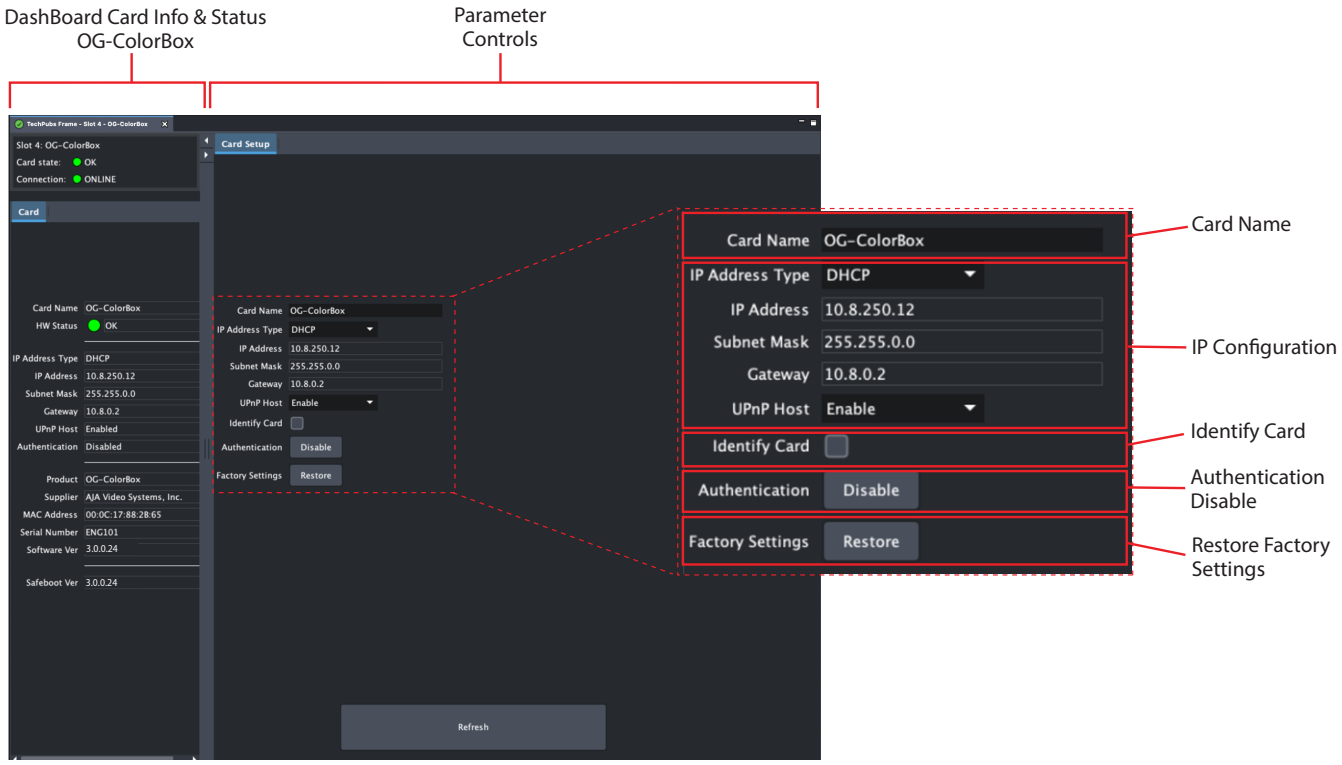
Card Setup Screen

The OG-ColorBox Card Setup tab selected in the DashBoard Card Infor and Status tab (fig. 20) in the left-side (Slot) Tab, showing the Card Setup (default Tab) on the right-side.

The Card Information and Status panel displays the basic hardware status of the OG-ColorBox card currently selected in DashBoard.

The Parameter Controls panel shows the parameters that the selected OG-ColorBox card has available for user configuration and control.

Figure 20. OG-ColorBox Card Setup View in DashBoard



Card Name - By default, this field is pre-populated with the card name = "ColorBox" + (last 4 digits of serial number). You can change the card name by editing the text in the Card Name field.

NOTE: Changing the Card Name in the Setup tab also changes the name of the card in the DashBoard tree view.

IP Configuration - See *"Network Setup Using DashBoard" on page 24.*

Identify Card - Select the checkbox to turn on the Identify Card function. When this function is turned on, an LED light on the front of the OG-ColorBox card inside the openGear frame will blink to help you quickly identify the card. Open the front of the openGear frame in order to see the light blinking.

Authentication Disable - The next reboot of the OG-ColorBox card will bypass the need for entering a password.

Restore Factory Settings -

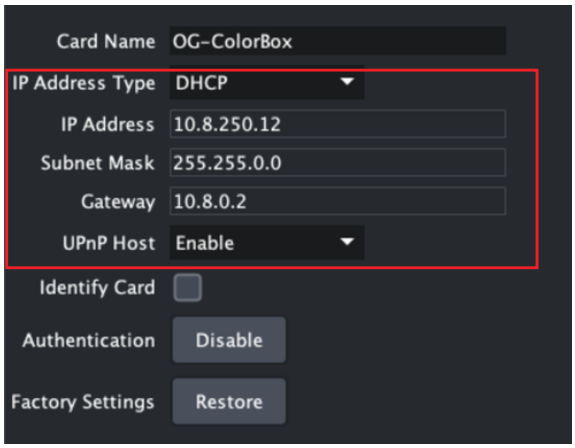
- Restore Factory Settings clears all configuration data from the OG-ColorBox, including the entire Library, all Images and Presets, and network settings (DHCP is enabled after reset).
- Any installed licenses, however, are retained after a Factory reset.

WARNING: ***If you wish to retain user configuration data, Library, Images and Presets for later use, first store them in one or more Presets and Export them to files on the host computer. Do this before you do a Restore Factory Settings.***

NOTE: You may alternatively Restore Factory Settings by using the OG-ColorBox DIP Switches. See "Perform Factory Reset (Restore Factory Settings)" on page 12.

Refresh - Reads and then displays the currently active OG-ColorBox card parameters on the Card Setup screen.

Figure 21. Card Setup Tab in DashBoard for OG-ColorBox



OG-ColorBox Network Controls

An IP configuration compatible with that of the host computer running the OG-ColorBox WebUI is required.

IP Address Type - IP Address Type determines the type of TCP/IP network configuration to be used. DHCP enables connecting to the network DHCP server, which assigns the IP Address, Netmask, and Gateway automatically. Static lets you set these parameters manually.

- DHCP (default) - Selects automatic IP address assignment from the LAN DHCP server. If a DHCP server cannot be found, OG-ColorBox will fall back to the previously entered Static IP address. If no Static IP address had been entered, the system fails over to a link local static IP address (169.254.x.x).
- Static - Assigns a static IP address manually.

IP Address - IP Address determines a static IP address to be used for TCP/IP networking. Consult your network administrator about how to set this value.

- If IP Address Type is set to DHCP, the IP address is set automatically by the network DHCP server.
- If IP Address Type is set to Static, enter an IP address compatible with your LAN. This must be configured using Dashboard.
- If IP Address Type is set to DHCP and there is a DHCP failure, the IP address is set to a link local static IP address.

Subnet Mask - Subnet Mask determines the subnet mask to be used for TCP/IP networking.

- Use a subnet mask compatible with your LAN. This is only needed for Static IP configurations. The factory default Subnet Mask is 255.255.255.0.
- If IP Address Type is set to DHCP, the Subnet Mask is set by the DHCP server and cannot be changed by the user.

Gateway - Gateway determines the gateway or router used on your LAN for TCP/IP networking. Without a properly configured default gateway (whether you have a router/gateway or not), your OG-ColorBox will be unable to see other OG-ColorBoxes on the network, although you may still be able to control this OG-ColorBox via a web browser. Also, without a proper gateway defined, the discovery feature on the Network web page will not list other units on the network.

- Use a default gateway or router address. This is only needed for Static IP configurations.

- If IP Address Type is set to DHCP, the Default Gateway is set by the DHCP server and cannot be changed by the user.

UPnP Host - When this parameter is enabled, you can view the OG-ColorBox on a Windows Network. Any OG-ColorBoxes on the network will be listed under Other Devices. If your system does not have network discovery enabled, you may need to enable it following the Windows help instructions to make network devices visible in the Windows Network window.

OG-ColorBox Network Configuration

1. Ensure the OG-ColorBox's LAN port is connected to a computer on a compatible network.
2. Power up the openGear frame.
3. Launch DashBoard on your computer.
4. Select the OG-ColorBox card under its factory default name which includes the serial number. The Card Setup Tab appears which shows the OG-ColorBox's current IP network settings.
   A. OG-ColorBox requires an Ethernet network connection and is shipped from the factory with DHCP enabled. If your network has a DHCP server, by simply connecting OG-ColorBox to your network with an Ethernet cable, the DHCP server will assign OG-ColorBox a compatible IP address. However, you will need to know that IP address before you will be able to access OG-ColorBox's internal web server for configuration.
   B. If your OG-ColorBox is not connected to a network, or your network does not use DHCP, you will need to configure it with a static IP address.
      - Edit the OG-ColorBox's Static IP address to be compatible with your computer's current network settings.
      - Alternatively, you can change your computer's IP settings to be compatible with the OG-ColorBox's Static IP address.
   C. When set to DHCP, OG-ColorBox selects automatic IP address assignment from the LAN DHCP server. If a DHCP server cannot be found, OG-ColorBox will fall back to the previously entered Static IP address. If no Static IP address had been entered, the system fails over to a link local static IP address (169.254.x.x)
5. Once the IP addresses are compatible, enter the OG-ColorBox's IP address into a web browser on your connected computer. The OG-ColorBox's internal web page (WebUI) will be displayed, allowing complete control of the device.

NOTE: Typically compatible Static IP settings will have identical values for the first three IP address numbers, different values for the last IP address number, and identical Subnet Masks.

OG-ColorBox Option Licensing

NOTE: Watermarks are added to the OG-ColorBox's video output when an unlicensed pipeline is being used. This lets you test the color science in advance of purchase.

OG-ColorBox options can be purchased from an AJA reseller. Option licensing involves a License Key that is associated with a particular OG-ColorBox that has a specific serial number. It is not a floating license. The License Key, once activated, is perpetual, non-volatile, and will not be affected by OG-ColorBox resets or power cycling.

Licenses are available to enhance the following pipelines:

- ORION-CONVERT - Offers the necessary tools for broadcasters to create and deliver the HDR and SDR content consumers expect from a single master HDR workflow by providing critical controls required to set up the right conversion for your production. SDR, HLG, and PQ conversion are available utilizing floating point math that eliminates interpolation errors.
- BBC HLG LUT - Offers field proven HLG LUT conversion options with 19 LUTs, used particularly by television broadcasters who are looking for specific conversion criteria.
- Colorfront - Offers a color processing pipeline with optimized transforms that maintain perceptual integrity designed for use wherever HDR productions are performed including TV, Live, and SDR to Dolby Vision Preview modes.

A single License Key can be used to enable multiple OG-ColorBox options on that device. Watermarks displayed when running un-licensed options will be automatically removed after the License Key is activated.

1. Purchase the license from an AJA reseller and download the License Key to a computer that can access your OG-ColorBox over a network.
2. In the OG-ColorBox WebUI, go to System Settings > System.
3. Click **Browse** and locate the License Key file. It will have a file name that includes the serial number of the OG-ColorBox to be licensed. The connected OG-ColorBox's serial number is shown above, under System Details.
4. Select that license file and click **Accept**. The license file will load into that OG-ColorBox. The gray dot next to the license name will turn blue indicating the option is now licensed and any watermarks associated with that option are automatically removed.
5. For the license to be fully enabled, power cycle the OG-ColorBox.

NOTE: Do not change the License Key filename. OG-ColorBox will reject the License Key if the filename is changed. The filename format is: AJA_COLORBOX-LIC-ACT_PERP_XXXXXXXXX where XXXXXXXXX is the serial number of the OG-ColorBox.

OG-ColorBox Firmware Update

Visit the AJA website to locate and download the latest firmware.

https://www.aja.com/products/og-colorbox#support

New firmware downloaded from the website can be installed using the OG-ColorBox's WebUI.

1. Download the OG-ColorBox firmware to a computer that can access your OG-ColorBox over a network.
2. In the OG-ColorBox WebUI, go to System Settings > Firmware.
3. Click **Browse**, locate the OG-ColorBox License firmware file and click **Upload**.
4. Click **Submit**. A message appears indicating the progress of the update.
5. A restart is required after the firmware is loaded, which can be accomplished by clicking that message's **Restart** button.
6. The OG-ColorBox's web connection will disconnect, and then reconnect with the updated firmware.

OG-ColorBox Safeboot

OG-ColorBox has a safety feature where an internal “safeboot” copy of minimal system software is retained in the event the update process fails or the loaded software becomes corrupted. The safeboot software is intended only to restore the unit to a known configuration (the last network configuration settings are retained) with which you can successfully connect to the device over the network and download and reinstall fully functional system software.

NOTE: OG-ColorBox Safeboot software does not provide any video processing. You will need to install new OG-ColorBox firmware to restore full operation.

OG-ColorBox Safeboot is initiated by DIP switch settings. See *"Putting OG-ColorBox into Safeboot" on page 12.*

With the safeboot software running, you will be able to update your OG-ColorBox to the latest firmware version using its WebUI.

Chapter 3 – OG-ColorBox Operation

Overview

An optimized web server in OG-ColorBox allows remote control and parameter setting adjustments via a web browser client running on a network connected computer. The network can be a closed local area network, a straight computer to OG-ColorBox cable, or even exposed through a firewall to a broadband WAN.

OG-ColorBox uses a standard RJ-45 LAN connector and will automatically configure to work with a standard “straight-through” CAT 5 Ethernet cable or a null-modem (cross-over) cable.

NOTE: Safari is the preferred web browser for control on the Mac, and additionally Chrome and Firefox on Windows. Other web browsers may work, but AJA cannot guarantee consistent operation for all web browsers or web browser versions.

To connect to OG-ColorBox, simply attach OG-ColorBox to your network and enter OG-ColorBox’s IP address into the web browser. If authentication has been configured, you may need to enter user name (default "admin") and the currently configured password.

About the OG-ColorBox Library

The OG-ColorBox Library is a local non-volatile repository of color processing files and images that can be quickly recalled for consistent use. Up to 16 1D LUTs, 3x3 Matrices, 3D LUTs, Images, and Overlays can be stored. Library files can be imported and exported via a network connection. Library files exported from one OG-ColorBox can be imported to other OG-ColorBoxes. This allows for easy sharing of pipeline configurations and their files, ensuring absolute color processing consistency.

When using the AJA Color Pipeline (ACP), stored Presets retain all files loaded into the nodes, either active or not. When loading an ACP Preset, all files that were stored in that Preset will populate the OG-ColorBox Library if not already present. A warning will be displayed if not enough library locations are available.

OG-ColorBox Image Files

Sixteen Frame Store image storage locations are available in the local Library. These images can be used in any pipeline mode, and images can be captured to the Library from any pipeline mode. Images can also be imported, exported, and deleted from the Library from any pipeline mode.

NOTE: When capturing images to the Frame Store, an Overlay can be captured on the output image. The Overlay can contain information such as User Text fields, Input and Output format information (including VPID), Timecode presence, Closed Captioning presence, Pipeline Configuration information, and user created keyable graphics that could be logos and/or framelines.

OG-ColorBox Overlay Files

Sixteen Overlay image storage locations are also available in the local Library, which can be used for customer uploaded keyable .PNG files. These files can be used to overlay custom frame lines, images, logos, etc. with the push of a button.

About Presets

Each Color Processing Pipeline mode has 10 Presets, each of which can store and recall the current configuration of that pipeline. Included in each Preset are the currently selected LUTs, any Color Corrector or Proc Amp settings, the on/off state of each of that pipeline's nodes, and other pipeline specific parameters.

When using the AJA Color Pipeline (ACP), stored Presets retain all files loaded into the nodes, either active or not. When loading an ACP Preset, all files that were stored in that Preset will populate the OG-ColorBox Library if not already present. A warning will be displayed if not enough library locations are available.

If Dynamic LUTs are being used in the AJA Color Pipeline, storing a Preset saves the latest Dynamic LUTs or 3x3 matrices values provided from the external color management system for that node. When recalling this preset, the Dynamic values are restored.

Each Preset saves only the current settings for the selected pipeline mode (i.e. AJA Color, Colorfront, BBC HLG LUTs, NBCU LUTs, and ACES). However, also included in each Preset is the current Bypass state, any Overlay text settings, the current Frame Store settings, and the recalled image whether or not it is enabled.

These settings apply to all OG-ColorBox's pipeline modes.

NOTE: While it is rare to change pipeline modes during production, be aware that recalling a Preset from one pipeline mode can change the current Bypass or Overlay settings of other modes. If, after going to another mode, you immediately recall a Preset for that mode, you can ensure all of the settings will be restored, including Bypass and Overlay.

Startup Preset

Each Color Processing Pipeline mode can also be assigned a Startup Preset, which will be automatically recalled when that OG-ColorBox starts up. This makes it possible for an expert to configure a Preset, select it for startup, and power down the OG-ColorBox. Another perhaps less experienced person could then carry that OG-ColorBox to its intended location, connect its inputs and outputs, and restore all the previous settings by simply powering up the unit.

NOTE: The Startup Preset number recalled on startup will be for the pipeline mode the OG-ColorBox had selected when it was powered down.

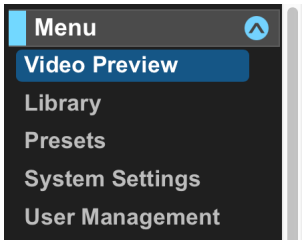
WebUI Description

Figure 22. OG-ColorBox WebUI Example

All OG-ColorBox web screens have certain areas and controls in common. Vertical and horizontal scroll bars appear when information extends past the border of a screen panel. The round blue Up/Down or Left/Right arrow button on each pane opens and closes that pane.

Menu Pane

Figure 23. OG-ColorBox Menu Pane, Video Preview Selected



The Menu Pane is used to select what will be displayed in the central area of the screen.

Video Preview

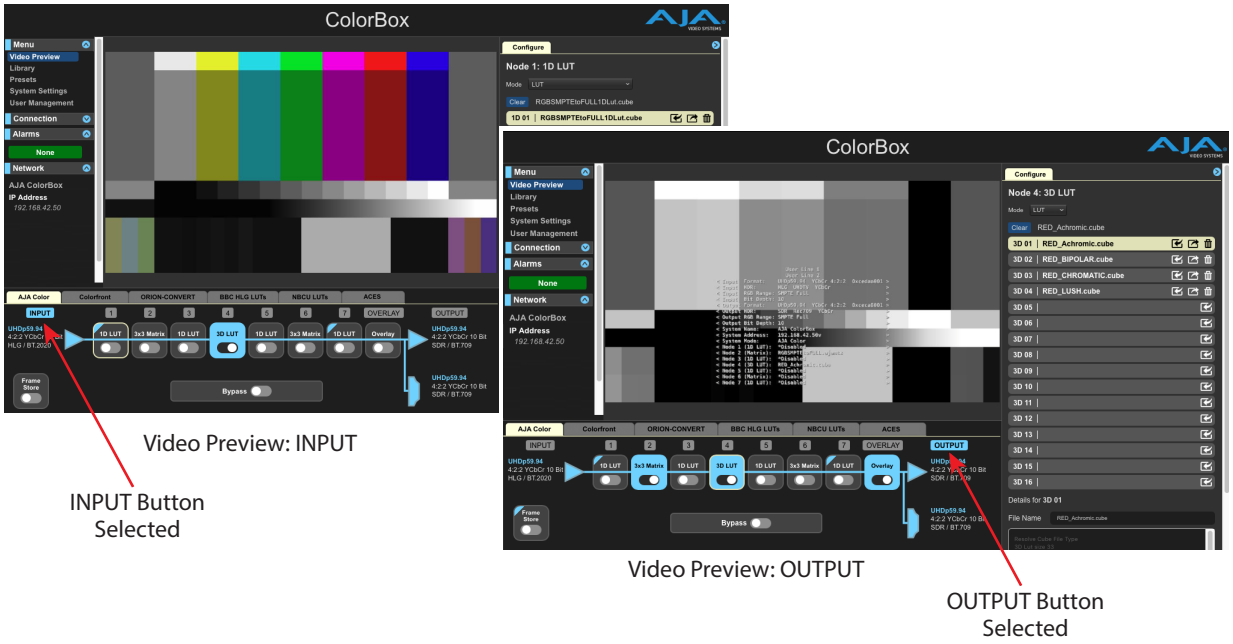
When Video Preview is selected from the menu, a low frame rate video preview of the input or output video is displayed for signal confidence monitoring.

NOTE: The colors shown by Video Preview confirm color processing is being performed, but may not be color accurate depending on several factors, including the display device.

Use the INPUT and OUTPUT buttons to select whether the input or output video is displayed. *"Video Preview Input vs Output" on page 31* shows a pipeline example with an achromatic LUT with Overlay Text ON.

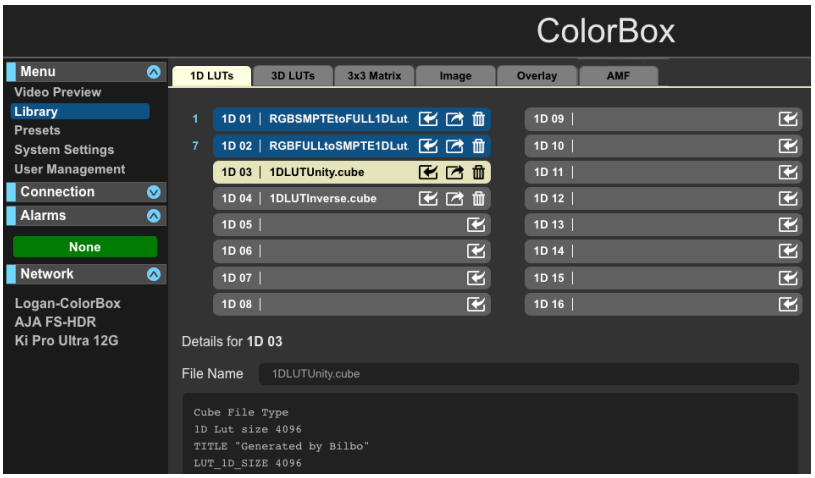
- When INPUT is selected, unprocessed video displays in Video Preview, without color change or overlay text.
- When OUTPUT is selected, processed video displays in Video Preview, with achromatic video and overlay text.

Figure 24. Video Preview Input vs Output



Library Pane

Figure 25. Library Pane, Image Example



The Library pane lets you manage all your files in one place. See *"About the OG-ColorBox Library" on page 28* for more information.

When selected, this pane displays the OG-ColorBox Library with tabs for 1D LUTs, 3D LUTs, 3x3 Matrix, Image files, Overlay, and AMF files. The LUTs and 3x3 Matrix files are available for use only in the AJA Color Pipeline Mode. AMF files are available for use only in the ACES Pipeline Mode. Image and Overlay files however, are available for use in all Pipeline modes.

The Library pane keeps you informed about what files are being used by displaying a blue node number next to a file if it is loaded into that node.

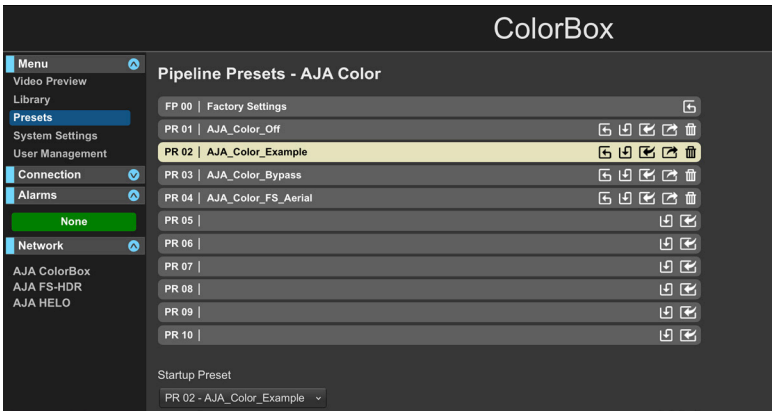
Files can be imported from and exported to a network location.

NOTE: LUTs from other providers can be loaded into AJA Color Pipeline nodes. For example, a free LUT downloaded from the Internet can be loaded into an AJA Color Pipeline node, and you can then A/B compare it to a different LUT, or see what their combination does to the output color.

NOTE: Information displayed in the Library pane can also be presented in the Configure pane. Deleting a file from either pane deletes the file from that OG-ColorBox (see "Configure Pane" on page 36).

Presets Pane

Figure 26. Pipeline Presets Pane, AJA Color Example



The Presets pane lists the 10 Presets available for importing, exporting, saving and recalling Pipeline configurations, which can include images, for quick and reliable reuse. See *"About Presets" on page 29* for more information.

A Startup Preset can be chosen from a drop down list at the bottom of this pane, which will be automatically recalled when that OG-ColorBox starts up.

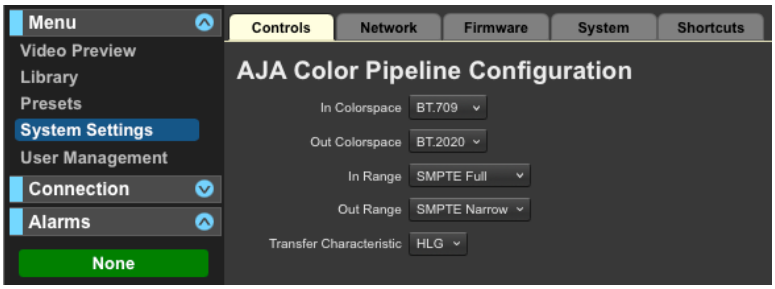
NOTE: The Startup Preset recalled on startup will be for the pipeline mode the OG-ColorBox was configured for when it was powered down.

System Settings Pane

The System Setting pane displays various OG-ColorBox parameters, depending on the tab selected at the top.

Controls Tab (AJA Color Pipeline and ACES Pipeline ONLY)

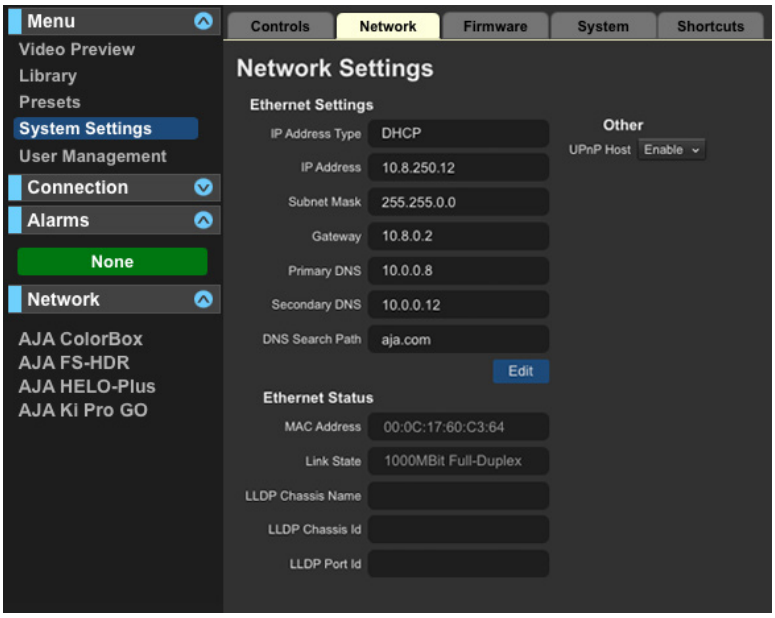
Figure 27. AJA Color Pipeline Configuration Settings



The Controls Tab settings only apply to the AJA Color and ACES Pipelines, and are not used in other pipeline modes. These controls will be grayed out (inactive) if not accessed from the AJA Color or ACES Pipelines. See *"Using the Controls Tab with the AJA Color Pipeline" on page 44* and *"Using the Controls Tab with the ACES Pipeline" on page 68* for detailed information.

Network Tab

Figure 28. Network Settings



The Network Tab gives information about the OG-ColorBox's network settings, and allows changing them to meet your network environment. For OG-ColorBox, various network settings are configured using the Dashboard application by Ross. See *"Network Setup Using DashBoard" on page 24.*

IP Address Type - IP Address Type determines the type of TCP/IP network configuration to be used. DHCP enables connecting to the network DHCP server, which assigns the IP Address, Netmask, and Gateway automatically. Static lets you set these parameters manually.

- DHCP (default) - Selects automatic IP address assignment from the LAN DHCP server. If a DHCP server cannot be found, OG-ColorBox will fall back to the previously entered Static IP address. If no Static IP address had been entered, the system fails over to a link local static IP address (169.254.x.x).
- Static - Assigns a static IP address manually.

IP Address - IP Address determines a static IP address to be used for TCP/IP networking. Consult your network administrator about how to set this value.

- If IP Address Type is set to DHCP, the IP address is set automatically by the network DHCP server.
- If IP Address Type is set to Static, enter an IP address compatible with your LAN. This must be configured using AJA eMini-Setup..
- If IP Address Type is set to DHCP and there is a DHCP failure, the IP address is set to a link local static IP address.

Subnet Mask - Subnet Mask determines the subnet mask to be used for TCP/IP networking.

- Use a subnet mask compatible with your LAN. This is only needed for Static IP configurations. The factory default Subnet Mask is 255.255.255.0.
- If IP Address Type is set to DHCP, the Subnet Mask is set by the DHCP server and cannot be changed by the user.

Gateway- Gateway determines the gateway or router used on your LAN for TCP/IP networking. Without a properly configured default gateway (whether you have a router/gateway or not), your OG-ColorBox will be unable to see other OG-ColorBoxes on the network, although you may still be able to control this OG-ColorBox via a web browser. Also, without a proper gateway defined, the discovery feature on the Network web page will not list other units on the network.

- Use a default gateway or router address. This is only needed for Static IP configurations.
- If IP Address Type is set to DHCP, the Default Gateway is set by the DHCP server and cannot be changed by the user.

Primary and Secondary DNS Servers - In DHCP mode, reports the current DNS Server IP addresses. In Static mode, allows entry of DNS Server IP addresses.

CAUTION: *If DNS servers are not present or have incorrectly entered IPs, then wherever OG-ColorBox specifies machines by name the names won't work, although numeric IP addresses will still work.*

CAUTION: *When using Static IP addressing for* OG-ColorBox*, be sure to also enter a valid DNS server address in the "Primary DNS Server" field. If the DNS Server address is not entered or is invalid, URLs in streaming destinations won't work and an Alarm will be displayed:*

DNS Search Path- Defines the Domain Name System search path for the OG-ColorBox.

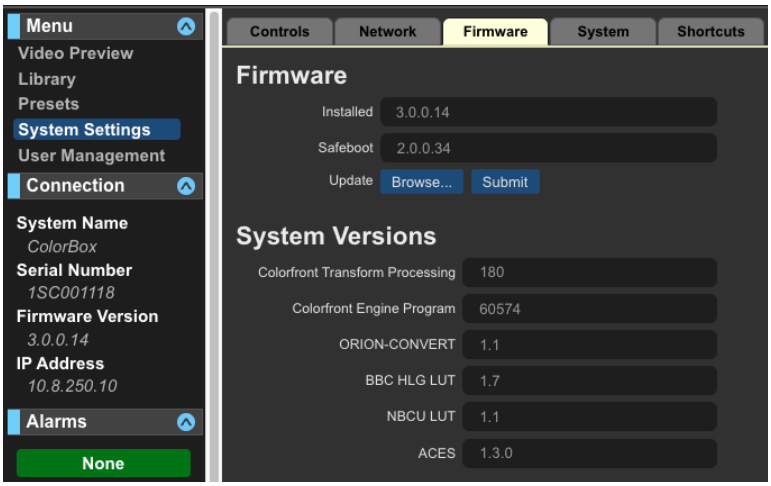
MAC Address - Reports the connected OG-ColorBox's Media Access Control Address.

Link State - Reports the link speed of the Ethernet connection.

UPnP Host - When this parameter is enabled, you can view the OG-ColorBox on a Windows Network. Any OG-ColorBoxes on the network will be listed under Other Devices. If your system does not have network discovery enabled, you may need to enable it following the Windows help instructions to make network devices visible in the Windows Network window.

Firmware Tab

Figure 29. Firmware Information

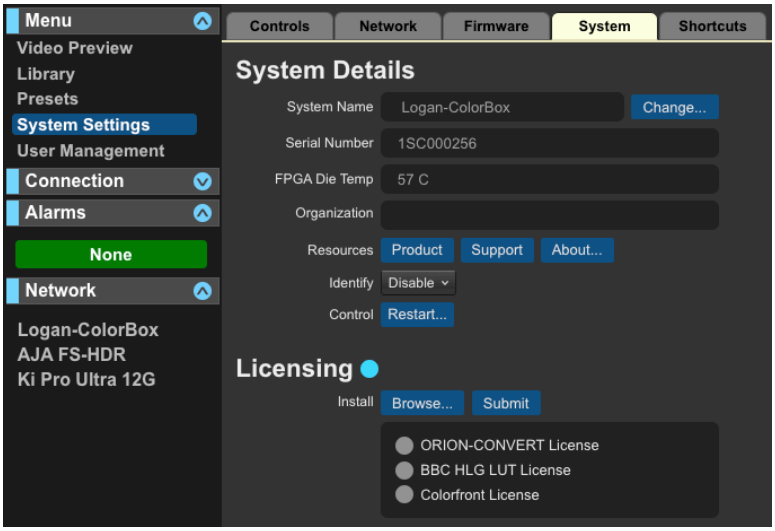


The Firmware Tab gives information about the OG-ColorBox's firmware, and is used to update its firmware. A restart is required after the firmware is loaded.

See *"OG-ColorBox Network Configuration" on page 25* for instructions.

System Tab

Figure 30. System Details



System Name - Click the Change button to enter a custom name for this OG-ColorBox, which can be useful if more than one OG-ColorBox is being used in a production. This name appears in the Network tab of AJA devices connected on that network.

Product - Opens OG-ColorBox page on the AJA website for an overview of the product.

Support - Opens OG-ColorBox page on the AJA website and presents Contact Support information.

About - Opens About OG-ColorBox information panel.

Identify - Selecting Enable will make the front panel STATUS LED of the connected OG-ColorBox turn blue and blink. This can be useful to identify a particular OG-ColorBox when several are in use at the same time.

Restart - Opens a window allowing you to restart your OG-ColorBox.

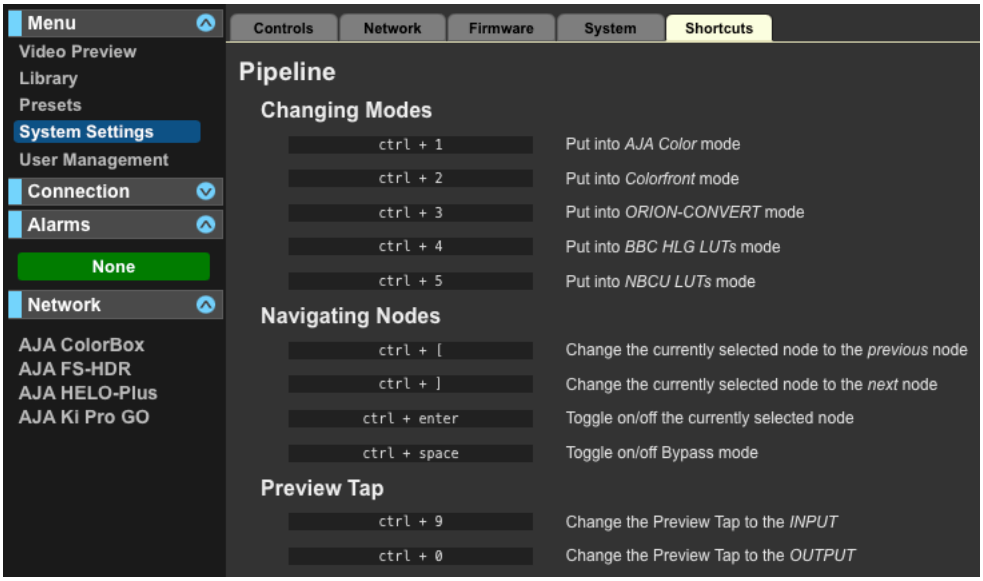
Licensing - Used to install license keys for optional features. See *"OG-ColorBox Option Licensing" on page 25.*

for instructions.

Shortcuts Tab

The System Settings Shortcuts pane displays keystroke shortcuts available for faster system operation.

Figure 31. System Settings Pane, Shortcuts

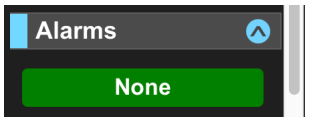


Connection Pane

The Connection pane displays information for the connected OG-ColorBox. (See *"OG-ColorBox WebUI Example" on page 30*).

Alarms Pane

Figure 32. OG-ColorBox Alarms Pane



Alarms are displayed in a pane on the left side of the screen. For example, if the OG-ColorBox overheats an Overtemp Alarm will be displayed. Clicking on the arrow opens or closes this pane to show or hide the alarms.

Network Pane

At-a-glance you can see the AJA devices that are present on the same local LAN using the Network pane (*"OG-ColorBox WebUI Example" on page 30*). This feature is only available when the AJA devices have IP addresses configured under a common network and subnet and are connected to the network.

Click on the device's name to switch the browser to that particular AJA device.

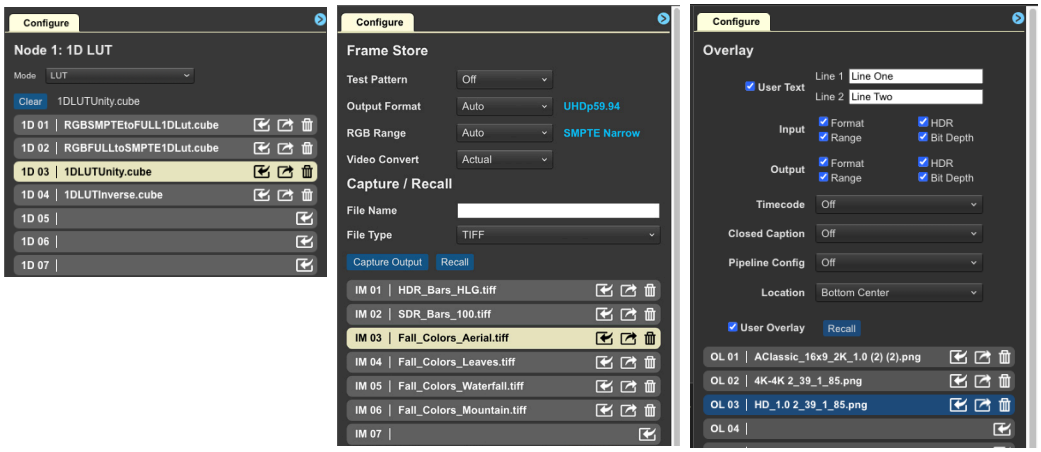
The OG-ColorBox name appearing on this list can be changed. (See*"System Tab" on page 35*).

Configure Pane

On the right side of the screen the Configure pane displays parameters and controls for the selected item in the currently active pipeline. The selected pipeline item will be outlined in light yellow. (See *"OG-ColorBox WebUI Example" on page 30*.)

Different configuration options will be available, depending on the pipeline mode you are using and the pipeline item selected. Controls available in the Configure pane can include selecting and loading LUTs for use in a particular node, importing, exporting and deleting LUT and Image files, and adjusting Color Corrector and Proc Amp settings.

Figure 33. Configure Pane, 1D LUT, Frame Store, and Overlay Examples



When a node is selected that has a Library associated with it, the Configure pane on the right offers similar controls, but also allows you to select a file to load into the selected node. This cannot be accomplished in the Library pane.

NOTE: Information displayed in the Configure pane can also be presented in the Library pane. Deleting a file from either pane deletes the file from that OG-ColorBox (see "Library Pane" on page 31).

LUT Selection

With the desired pipeline and node selected, simply click on the name of the desired LUT listed in the Configure pane to load it into that pipeline's node. The LUT will be applied when that node is turned on.

Frame Store Image Selection

With the desired pipeline selected, select the Frame Store node, click on the name of the desired file listed in the Configure pane, and then click **Recall** to load that file for use with that pipeline.

To route that image file to the OG-ColorBox's output, simply turn on the Frame Store node.

Overlay File Selection

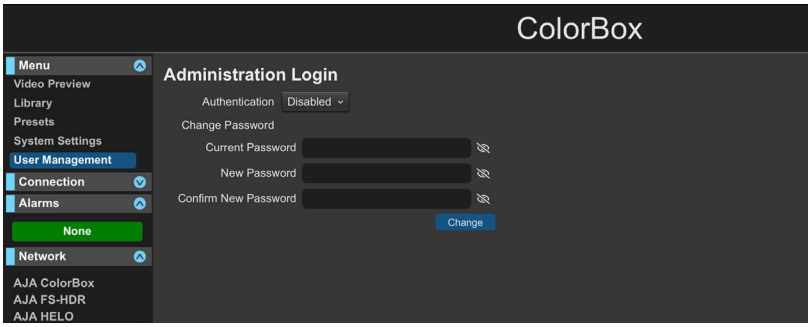
With the desired pipeline selected, select the Overlay node, click on the name of the desired Overlay file listed in the Configure pane, click **Recall** to load that file for use with that pipeline, and then click on the **User Overlay** box to activate the overlay image.

To route that image file to the OG-ColorBox's output simply turn on the Overlay node.

NOTE: To include an Overlay with a Frame Store capture, the Overlay Configure pane User Overlay box must be checked before you turn on the Frame Store node.

User Management Pane

Figure 34. User Management Pane Example



Access to the OG-ColorBox over the network can be managed by configuring an Administration Login for that device. The default User Name and Password are both "admin".

When Authentication is Enabled, you will need to perform a login each time you access the OG-ColorBox via its WebUI. The browser presents the login screen first, requiring you to log in before you can access any other browser screens.

NOTE: If authentication is used, it provides only a minimum security safeguard against unauthorized use of the OG-ColorBox. The authentication mechanism is simple and does not provide robust security.

OG-ColorBox Pipelines

The lower area of the screen has a signal flow diagram of the currently selected Color Processing Pipeline. OG-ColorBox comes with a range of pipelines to choose from.

- AJA Color Pipeline (ACP)
- Colorfront Pipeline
- ORION-CONVERT Pipeline
- BBC HLG LUTs Pipeline
- NBCU LUTs Pipeline
- ACES Pipeline

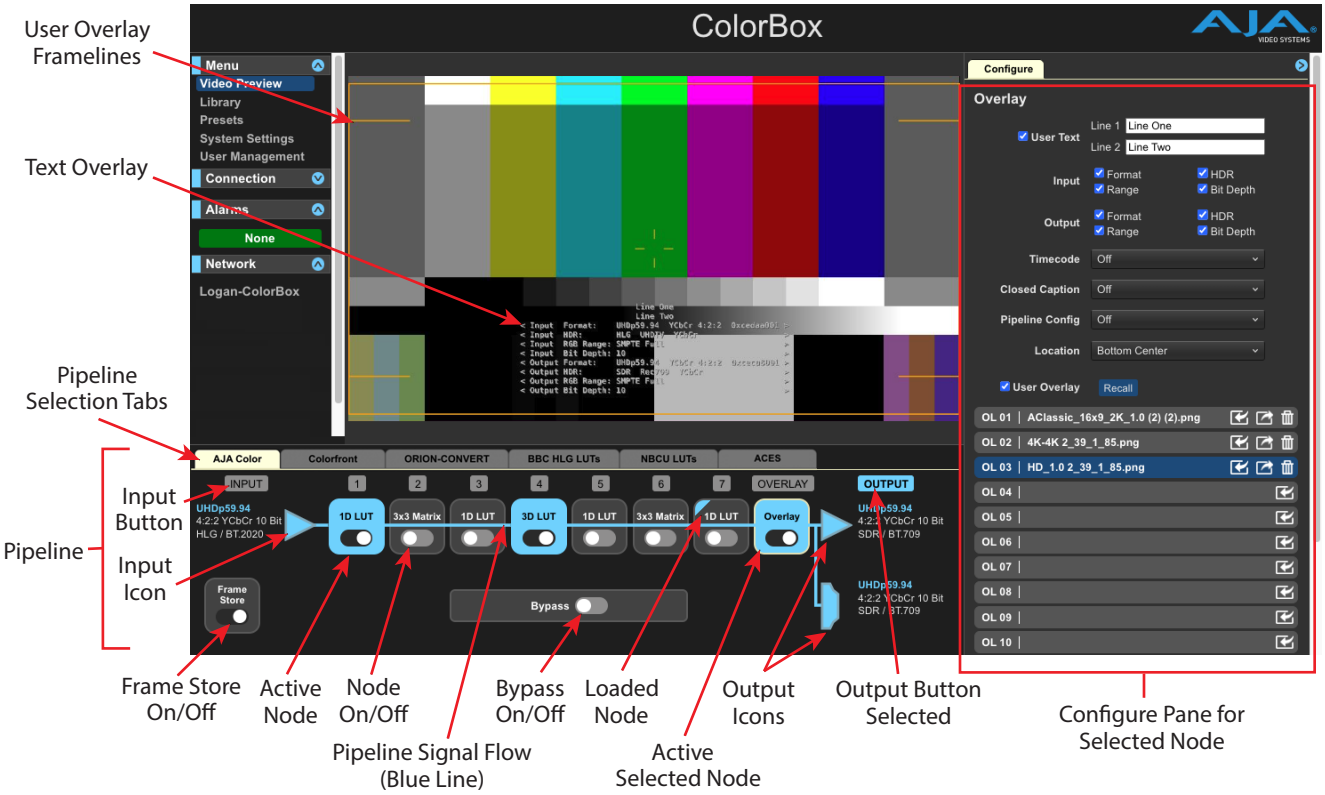
Some pipelines are designed specifically for live broadcast or live event needs. Others, like the AJA Color Pipeline (ACP), offer great flexibility for more control over each step of a transform for any application.

OG-ColorBox pipelines such as Colorfront, BBC HLG LUTs, and ORION-CONVERT will display a watermark over the image until a license is applied offering you the ability to evaluate the color science prior to purchasing the optional license. Only one processing pipeline can be displayed and made active at a time. Tabs at the top allow selection of one of the available pipeline modes.

NOTE: It is assumed only one pipeline mode will be used at a time. Switching between OG-ColorBox pipeline modes during actual production is discouraged.

Pipeline General Description

Figure 35. AJA Color Pipeline Example, with Overlay



Pipeline Selection Tabs

Clicking on a pipeline tab selects that pipeline and makes it active. Any color or other processing configured in that pipeline will immediately be applied to the OG-ColorBox's outputs, and any color processing configured in other pipeline modes will be disabled. Different pipelines will have different signal flow diagrams.

NOTE: Switching from one pipeline mode to another requires OG-ColorBox to reconfigure its internal pipeline, which requires a few seconds.

Pipeline Video Format Information

The current input and output video format information is displayed on the left and right sides of the pipeline display. The input video format information will only change if the actual video input format changes. Pipeline parameter changes, however, can change some of the output video format information.

Pipeline Nodes

Each selected pipeline has processing node boxes. Clicking on a node box selects that node for configuration, that box will be outlined in light yellow, and parameters available for that node will be displayed in the Configure pane on the right side of the screen. Each node has an on/off toggle switch used to activate or disable that node.

INPUT and OUTPUT Buttons (All Pipelines)

Labeled buttons above the video format information are used to select whether the Input (unprocessed) or Output (processed) video signal is displayed on the Video Preview display. In addition, these buttons select which signal is routed to the Frame Store input for capture. These buttons are highlighted when chosen, and do not have a yellow border, indicating they do not change the information shown on the Configure pane. INPUT and OUTPUT button selections apply to all OG-ColorBox pipelines.

INPUT

When selected, displays the unprocessed video input signal on the Video Preview pane and routes that signal to the Frame Store input. The Capture button on the Frame Store Configure pane will then be labeled "Capture Input".

OUTPUT

When selected, displays the processed video output signal on the Video Preview pane, including Overlay if enabled, and routes that signal to the Frame Store input. The Capture button on the Frame Store Configure pane will then be labeled "Capture Output".

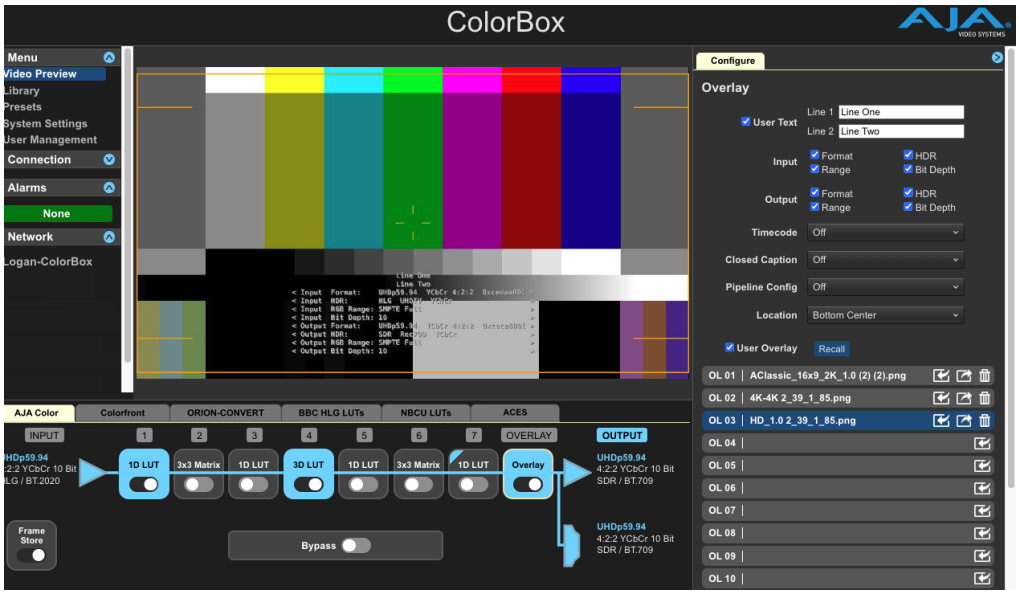
Input and Output Icons (All Pipelines)

Clicking on the pipeline Input triangle on the left displays input signal information in the Configure pane, and clicking on the Output triangle or HDMI icon on the right displays output signal information and optional Output configurations (see *"SDI/HDMI Output Configurations" on page 71*). These buttons do not change the Video Preview image, if shown, which always displays the signal selected with the INPUT and OUTPUT buttons, described above.

Input and Output Icon selections apply to all OG-ColorBox pipelines.

Overlay (All Pipelines)

Figure 36. Configure Pane Overlay Settings



When Overlay has been selected in a pipeline, the Configure pane presents overlay text parameters, along with a list of user imported graphic files that can be keyed over the processed video output.

The Overlay settings are shared with all OG-ColorBox pipeline modes. Any Overlay adjustment made in one mode will affect the Overlay behavior in every other OG-ColorBox pipeline mode.

NOTE: Whenever the Frame Store is active the Overlay becomes unavailable and is removed from the OG-ColorBox pipeline signal flow diagram.

Overlay Text

When the Overlay node has been selected in a pipeline, the Configure pane displays controls allowing the addition of various types of text information to the processed video output.

The following information can be displayed:

- User Text lines (2)
- Input and Output VPID for Format, Range, HDR, and Bit Depth
- Timecode presence
- Closed Caption presence
- Pipeline Configuration
- Location (of overlay text on screen)

The customizable user text lines are great for overlaying, for example, information such as camera or lens information if the camera can't provide it.

User Overlay Images

The User Overlay feature provides the ability to import, export, and overlay custom images onto the OG-ColorBox's video output.

The User Overlay feature supports:

- .PNG format files
- Up to 4096 x 2160 resolution
- Standard raster sizes
- Automatically scales to fit source raster
- Available in all pipelines

Those images could be frame lines or any other image (such as logos, etc.) imported as .png files to the Overlay library. The ability to see frame lines on-set gives the production the best chance at capturing the shot composition correctly.

An Overlay image file can be displayed with or without the overlay text information, and can include shaded surrounds with transparency modified for masking/dimming camera OSD information.

Recall - Click this button to load the selected Overlay file into Overlay node.

User Overlay - Click on this check box to toggle the Overlay image on and off in the Overlay node. The overlay image, and any selected overlay text, will then be routed to the OG-ColorBox's output when the Overlay node is turned on.

Frame Store (All Pipelines)

Figure 37. AJA Color Pipeline Example, with Frame Store Selected

When the Frame Store has been selected in a pipeline, the Configure pane displays Frame Store parameters, from which you can import, export, capture and recall video images up to 4K (4096x2160) resolution, as well adjust the Test Pattern generator and other controls.

The Frame Store is shared with all OG-ColorBox pipeline modes. Any Frame Store adjustment made in one mode will affect Frame Store behavior in every other OG-ColorBox pipeline mode.

Test Patterns

The following test patterns are available:

Black	Slant Ramp	BT.2111 HLG Narrow
Color Bars 100%	Zone Plate	BT.2111 PQ Narrow
Color Bars 75%	Quad Border	BT.2111 PQ Wide
Color Bars SMPTE	Circle	NBCU HLG Fancy BT.2111 Color Bars
Linear Ramp	EBU HDR HLG Color Bars	

Switching the Frame Store toggle On routes the output of the Frame Store to the input of the Color Processing Pipeline, as shown by the pipeline signal flow diagram (*Figure 22 on page 43*).

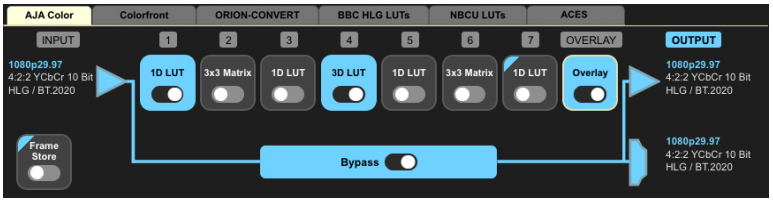
Figure 38. AJA Color Pipeline Example, with Frame Store On

NOTE: Whenever the Frame Store is On, Overlay becomes unavailable and is removed from the OG-ColorBox pipeline signal flow diagram.

Bypass (All Pipelines)

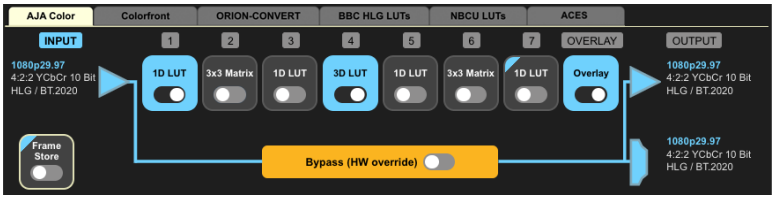
Clicking on the Bypass on/off toggle switches OG-ColorBox into a hardware bypass mode, where all color processing is bypassed. The Pipeline signal flow line will show Bypass is active.

Figure 39. Pipeline Bypass On



This signal routing is identical to pressing the front panel SELECT button, in which case a yellow Bypass (HW override) message is displayed.

Figure 40. Pipeline Hardware Bypass On



AJA Color Pipeline

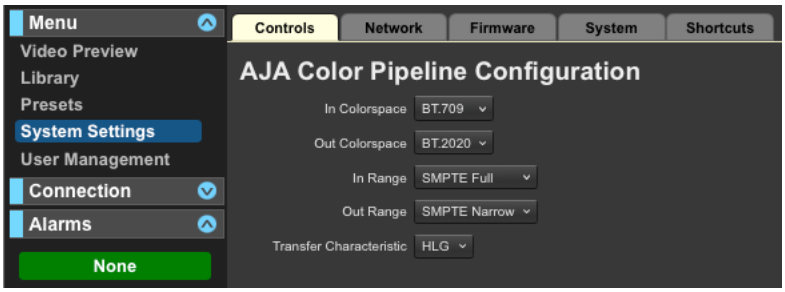
NOTE: The Frame Store, Bypass, and Overlay controls are available in all OG-ColorBox pipeline modes, and their settings are applied to all the other pipeline modes. These settings are also saved to Presets.

The AJA Color Pipeline has seven color processing nodes, along with the Overlay, Frame Store and Bypass features. This pipeline has four 1D LUT nodes, two 3x3 Matrix nodes, and one 3D LUT node. Each of these seven nodes can be configured with different types of processing, depending on the type of node.

NOTE: LUTS from other providers can be loaded into AJA Color Pipeline nodes. For example, a free LUT downloaded from the Internet can be loaded into an AJA Color Pipeline node, and you can then A/B compare it to a different LUT, or see what their combination does to the output color.

Using the Controls Tab with the AJA Color Pipeline

Figure 41. AJA Color Pipeline Configuration Settings



The settings on this screen allows you to configure the input and output range (SMPTE/Full), Colorspace (BT.709/BT.2020), and the HDR output Transfer Characteristic (SDR/PQ/HLG) that will be used with the AJA Color Pipeline.

NOTE: The settings on this tab must match how the LUT was designed. This setting is persistent when switching between AJA Color and ACES pipelines.

In Colorspace - Select either BT.709 or BT.2020 as the input color space.

Out Colorspace - Select either BT.709 or BT.2020 as the output color space.

In Range - Select either SMPTE Full or SMPTE Narrow.

- SMPTE Full selects a full input scaling/range, which includes sub-blacks and super-whites. Input video values of 0-1023 (10 bit) or 0-4095 (12 bit) are scaled to 0-1 before being sent to the LUT processor.
- SMPTE Narrow selects a narrow input scaling/range, such that an input video value of 0 represents black, and an input video value of 1 represents white. Input video values of 64-940 (10 bit) or 256-3760 (12 bit) are scaled to 0-1 before being sent to the LUT processor.

Out Range - Select either SMPTE Full or SMPTE Narrow.

- SMPTE Full selects a full output scaling/range, which includes sub-blacks and super-whites. Output values from 0-1 are scaled to 0-1023 (10 bit) or 0-4095 (12 bit).
- SMPTE Narrow selects a narrow output scaling/range. Output values from 0-1 will be scaled to 64-940 (10 bit) or 256-3760 (12 bit).

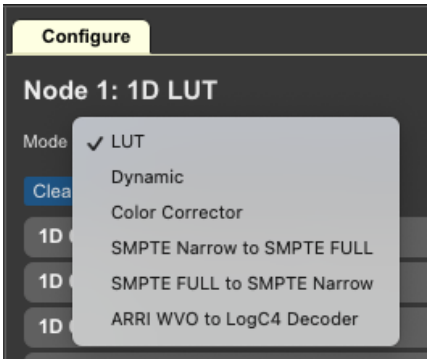
Transfer Characteristic - Select either SDR, HLG or PQ.

- This setting indicates the transfer characteristic that will be signaled in the SDI Output VPID, as well as the EOTF that will be signaled in the HDMI Output HDR Infoframe. This setting has no effect on the pixel values.

1D LUT Nodes

With four 1D LUTs it is easy to manage your Color Processing Pipeline to get the best possible image. 1D LUTs are commonly used as “shaper LUTs” wrapping around the 3D LUT. The front shaper 1D LUT allows you map perceptually significant values, typically the darker part of the colorspace, to use more of the 3D LUT transform data set resulting in a more effective use of the 3D LUT to produce a better image. The backside shaper 1D LUT is usually the inverse of the front, mapping pixel values into the original dynamic range. 1D LUTs can also be effectively used as log-to-linear and linear-to-log transforms.

Figure 42. AJA Color 1D LUT Modes



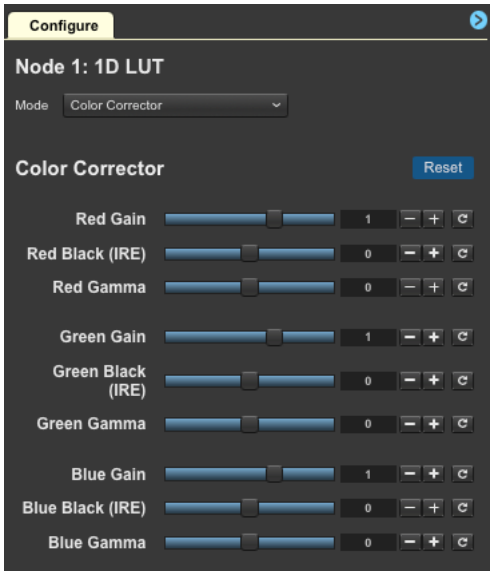
Options, selected in that node's Configuration pane, include:

- LUT
- Dynamic
- Color Corrector
- SMPTE Narrow to SMPTE FULL
- SMPTE FULL to SMPTE Narrow
- ARRI WVO to LogC4 Decoder (see *"ARRI WVO to LogC4 Decoder in the AJA Color Pipeline" on page 73*).

RGB Color Corrector

In the AJA Color Pipeline (ACP), 1D LUT nodes can be set up as RGB Color Correctors for color correcting a source before or after 3D LUT processing. This is a common workflow in live production applications.

Figure 43. Color Corrector Controls



NOTE: RGB Color Correctors are also available with the BBC HLG LUTs and NBCU LUTs pipelines.

3x3 Matrix Nodes

OG-ColorBox's two 3x3 Matrices provide the operator a means to perform different color processing tasks outside of a LUT using their own 3x3 matrix files. 3x3 Matrices are commonly used for colorspace conversion, for example between RGB and XYZ or YUV, BT. 709 and BT. 2020, or other color spaces with different primaries. A 3x3 Matrix can be used to color balance a signal if the white balance is off. They can also be used for look creation such as film emulation.

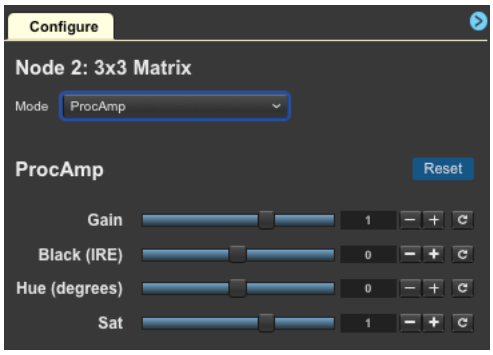
Available options are:

- Matrix
- Dynamic
- Proc Amp
- SMPTE Narrow to SMPTE FULL
- SMPTE FULL to SMPTE Narrow

Proc Amp

In the AJA Color Pipeline, 3x3 Matrices can be set up as Proc Amps for adjusting a signal's Gain, Black level, Hue, and Saturation before 3D LUT processing. This is a common workflow in live production applications.

Figure 44. Proc Amp Controls



NOTE: Proc Amps are also available with the BBC HLG LUTs and NBCU LUTs pipelines.

3D LUT Node

This primary 33-point 3D LUT uses tetrahedral interpolation for the highest accuracy conversion. 3D LUTs provide full volumetric non-linear color adjustment and a 33-point 3D LUT is a requirement for color managed and monitor calibration workflows. Similarly, high end movie and television productions depend on 3D LUT processing for look generation, distribution, and management.

When set to Dynamic, the 3D LUT is fully controllable through 3rd party software like Pomfort's Livegrade and Assimilate Live Looks.

Available options are:

- LUT
- Dynamic

Dynamic LUTs

A node can be configured for Dynamic LUT operation and be controlled by a third-party Look Management system, providing real-time modification of LUT information. Dynamic LUT operation allows a third party application to transfer LUTs to the OG-ColorBox over Ethernet without user intervention. As changes are made to the LUT in the third party application, the new LUT is instantly loaded into the OG-ColorBox's node. Dynamic LUT operational procedures will vary, depending on the third party application being used.

Colorfront Pipeline

NOTE: The Frame Store, Bypass, and Overlay controls are available on all OG-ColorBox pipeline modes, and their settings are applied to all the other pipeline modes. These settings are also saved to Presets.

Colorfront Overview

The OG-ColorBox HDR/WCG capabilities leverage video and color space processing algorithms within the Colorfront Engine, developed by Colorfront's CTO Bill Feightner and Lead Engineer Tamas Perlaki. Colorfront offers a color processing pipeline with optimized transforms that maintain perceptual integrity designed for use wherever HDR productions are performed.

Colorfront's TV Mode and Live Mode are now available in both FS-HDR and as a licensable option in OG-ColorBox. TV Mode is an intuitive color processing engine aimed at broadcast workflows that contain SDR, HLG, PQ, and Sony S-Log3 transforms.

The same license also enables Colorfront Live Mode, which includes several camera Log formats beyond TV Mode, like the new ARRI LogC4, as well as the new SDR to Dolby Vision Preview Mode with simplified controls for highlights and contrast. This is a licensable upgrade and includes:

- TV Mode, Live Mode, and SDR to Dolby Vision Preview Mode
- Highlight and roll-off management
- Color correction controls
- Optimized transforms designed for broadcast television workflows
- Maintains perceptual integrity
- Full bypass node for 12G-SDI and HDMI v2.0
- Support for ITU BT.2408, Operational Practices in HDR Television Production

NOTE: Watermarks are added to the OG-ColorBox's video output when an unlicensed pipeline is being used. This lets you test the color science in advance of purchase.

Figure 45. Watermarked Content in Unlicensed Mode

Colorfront TV Mode

OG-ColorBox's Colorfront TV Mode provides operators access to new Brightness, Highlight, Super Highlight, and Colorfulness tools that enable greater control over critical elements in color conversions. With this expanded toolset, get controlled corrections within the guardrails of Colorfront's perceptual processing algorithm, which will maintain perceived color, hue, and saturation without hard clipping artifacts. TV Mode also includes Sony S-Log3 conversions, which have proven advantageous in modern live production applications.

When Colorfront TV Mode is selected, the following profiles are available:

DynRange&Gamut IN

SDR BT.709 (default)	Standard Dynamic Range input with BT.709 color space.
HLG BT.2020	HDR input with HLG curve and BT.2020 color space.
PQ BT.2020	HDR input with PQ curve and BT.2020 color space.
Sony SLog3 BT.2020	A Sony proprietary format with wide dynamic range and a BT.2020 color space.

DynRange&Gamut OUT

SDR BT.709 (default)	Standard Dynamic Range input with BT.709 color space.
HLG BT.2020	HDR input with HLG curve and BT.2020 color space.
PQ BT.2020	HDR input with PQ curve and BT.2020 color space.
PQ BT.2020 ConstrainP3	HDR input with PQ curve and BT. 2020 color space, constrained to P3.
Sony SLog3 BT.2020	A Sony proprietary format with wide dynamic range and a BT.2020 color space.

Colorfront Engine

The Colorfront Engine parameter Enables and Disables Colorfront Engine user adjustments.

Default	Colorfront Engine settings are set to default, but adjustment settings are retained, allowing easy A/B visual comparison.
Adjust	Currently configured Colorfront adjustments are reapplied to the system output. In this mode further adjustments can be made.

When Default is selected all Colorfront settings are temporarily reset. When Adjust is selected, the previously set Colorfront adjustments are restored, and additional Colorfront parameters become available for further adjustment:

Reset Button

Click on the **Reset** button reset the Colorfront settings in Adjust menu to unity. This reset cannot be undone.

Brightness

Adjusts the overall brightness or darkness of an image. It is "display-referred" brightness or gain. Even when set to maximum it does not clip, and performs a perceptual roll off maintaining proper color and hue. Brightness adjustments are perceptually constant, that is, the perceived color, hue, and saturation remain constant.

- Range -1.00 to +1.00 (default 0)

Highlight

Adjusts the highlight brightness of the picture from midtones to highlights. This control is usually used in tandem with Brightness, to alter the remap grayscale. Highlight adjustments are perceptually constant, that is, the perceived color, hue, and saturation remain constant.

- Range -1.00 to +1.00 (default 0)

Super Highlight

Adjusts the extreme highlights or bright areas of an image, and does not affect the bottom end of the signal. These adjustments are perceptually constant, that is, the perceived color, hue, and saturation remain constant.

- Range -1.00 to +1.00 (default 0)

Colorfulness

Adjusts perceptual colorfulness as opposed to mathematical saturation, overriding the colorfulness compensation in the perceptual model. As an image gets brighter, its apparent colorfulness increases, and, conversely, as it gets dimmer, it appears less colorful (Hunt effect). The default setting conforms to the ideal perceptual mapping.

- Range -1.00 to +1.00 (default 0)

Color Corrector

Colorfront Engine TV Mode incorporates its own color corrector, separate from the OG-ColorBox's Color Corrector available in other modes. The parameters available when this Color Corrector is on include:

Master Lift	Red Lift	Green Lift	Blue Lift
Master Gamma	Red Gamma	Green Gamma	Blue Gamma
Master Gain	Red Gain	Green Gain	Blue Gain
Saturation			

Camera Correction

Enables or disables Exposure, Color Temp, and Tint adjustments.

Off (default)	Camera correction settings are not applied, hiding the following parameters.
On	Camera correction settings are applied, and can be adjusted using the following parameters.

Exposure

Scene referred linear light adjustment to compensate for scene lighting intensity. The Exposure control is the equivalent of adjusting the number of photons landing on the camera sensor.

- Range +4.00/-4.00 (default 0.00)

Color Temp

Scene referred linear light adjustment to compensate for color temperature. The Color Temp control affects the image the same as changing the lighting color temperature in front of the camera.

- Range + 10.00/-10.00 (default 0.00)

Tint

The Tint Control compensates for the coloration that most neutral-density (ND) filters add to the image. Adjusts an equivalent of an image's color tint.

- Range +16.00/-16.00 (default 0.00)

Roundtrip

For SDR to HDR and back to SDR conversions, turning this control On maintains a roundtrip technical vectorscope match, at the expense of a slight reduction in an ideal perceptual match. This only affects color, not the grayscale. For the best picture result, leave this setting at the default Off setting. Roundtrip should only be used for special cases.

- Select On or Off (default).

Clamp to Legal

Brightness settings can reach up to 108%. Turning this control On ensures the brightness maximum stays at 100%. This setting does not clip the signal, but instead performs a perceptual clamp maintaining the original perceived color, hue, and saturation.

- Select On or Off (default).

Colorfront Live Mode

OG-ColorBox's Colorfront Live mode is designed primarily for broadcast style workflows, supporting a variety of color space formats, including camera log.

When Live Mode is selected, the following parameters are available:

DynRange&Gamut IN

This parameter is used to identify the Dynamic Range, OETF, and Color Gamut of the incoming video. This information is used by the Video Processor to choose the appropriate internal processing to be used with that input signal. The following profiles are available:

SDR BT.709 100 Nits (default)	Standard Dynamic Range input with BT.709 color space.
SDR Extended BT.709	Standard Dynamic Range input with BT.709 color space with values between SMPTE and Full Range Max preserved.
PQ BT.2020 1000 Nits	HDR input with PQ curve and BT.2020 color space.
PQ P3D65 1000 Nits	HDR input with PQ curve and P3 (cinema) color space.
Hybrid Log Gamma BT.2100	HDR input with HLG curve and BT.2100 color space.
HLG Extended BT.709	BT.709 color space, values between SMPTE and Full Range Max are preserved for more headroom, and support for HLG superwhites.
HLG Extended BT.2100	BT.2020 color space, values between SMPTE and Full Range Max are preserved for more headroom, and support for HLG superwhites.
Sony SLog3 S-Gamut3	A Sony proprietary format with wide dynamic range and an almost native camera color space.
Sony SLog3 S-Gamut3 Cine	A Sony proprietary format with wide dynamic range and a slightly wider than DCI-P3 color space.
Sony SLog3 BT.2020	A Sony proprietary format with wide dynamic range and a BT.2020 color space.
ARRI Log C Wide Gamut	ARRI Log C proprietary camera format.
ARRI LogC4 Wide Gamut 4	ARRI LogC4 proprietary camera format.
ARRI LogC4 Wide Gamut 4 WVO	ARRI LogC4 proprietary camera format with WVO decoder.
Panasonic V-Log	A Panasonic proprietary camera format.
RED Log3G10 Wide Gamut	A RED proprietary camera format.
Canon Log 2	Canon Log 2 proprietary camera format.
Canon Log 3	Canon Log 3 proprietary camera format.

DynRange&Gamut OUT

This parameter can be used to specify the Dynamic Range, OETF, and Color Gamut of the outgoing video, and determines the color conversion (if any) to be applied. The following profiles are available:

SDR BT.709 100 Nits (default)	Standard Dynamic Range output with BT.709 color space.
SDR Extended BT.709	Standard Dynamic Range input with BT.709 color space with values between SMPTE and Full Range Max preserved.
PQ BT.2020 1000 Nits	HDR output with PQ curve and BT.2020 color space.
PQ P3D65 1000 Nits	HDR output with PQ curve and P3D65 color space.
Hybrid Log Gamma BT.2100	HDR output with HLG curve and BT.2100 color space.
HLG Extended BT.709	BT.709 color space, values between SMPTE and Full Range Max are preserved for more headroom, and support for HLG superwhites.
HLG Extended BT.2100	BT.2020 color space, values between SMPTE and Full Range Max are preserved for more headroom, and support for HLG superwhites.
Sony SLog3 S-Gamut3	A Sony proprietary format with wide dynamic range and an almost native camera color space.
Sony SLog3 BT.2020	A Sony proprietary format, with wide dynamic range and a BT.2020 color space.
ARRI Log C Wide Gamut	ARRI Log C proprietary camera format.
ARRI LogC4 Wide Gamut 4	ARRI LogC4 proprietary camera format.

SDR Preview

Allows users to quickly preview what an HDR signal may look like on an SDR monitor, without having to switch between HDR and SDR modes on that monitor (which may go black during the change-over). The default setting is Off, and this generally should be used during production. When set to On, the HDR signal is cleanly transformed to SDR, allowing quick A/B comparison on an HDR display in HDR mode.

NOTE: The SDR Preview parameter only applies when the OG-ColorBox's Dyn Range&Gamut OUT parameter is set to HDR (PQ or HLG).

Off (default) On	Off (no preview processing). Output is transformed to 100 Nits SDR.

Colorfront Engine

The Colorfront Engine parameter Enables and Disables Colorfront Engine user adjustments.

Default	Colorfront Engine settings are set to default, but adjustment settings are retained, allowing easy A/B visual comparison.
Adjust	Currently configured Colorfront adjustments are reapplied to the system output. In this mode further adjustments can be made.

When Default is selected all Colorfront settings are temporarily reset. When Adjust is selected, the previously set Colorfront adjustments are restored, and additional Colorfront parameters become available for further adjustment:

Reset Button

Click on the **Reset** button reset the Colorfront Settings in Adjust menu to unity. This reset cannot be undone.

HDR Amount

This adjustment guides the Colorfront Engine's color volume expansion algorithm. The setting applies to all conversions whether SDR to HDR, HDR to HDR, HDR to SDR, and SDR to SDR.

- Range +/-1.00, Default 0.00

Amb Light Comp

Ambient Light Compensation adjusts the signal based on the intended ambient light settings of the of the mastering or viewing environment. Of course a variety of ambient light environments exist, but this knob may be useful, for example, at an outdoor sports stadium when driving an LED scoreboard and video display at either mid-day or at night.

- Range +/-1.00, Default 0.00

HDR Log Look

If the Input Dynamic Range and Gamut is set to a Log format (e.g. Sony S-Log3 or Canon Log3), this control adjusts the look between dramatic (cinema) and broadcast (television), with dramatic being 0.0 and broadcast 1.0.

- Range +1.00/0.00, Default 0.500

NOTE: This parameter only applies if the OG-ColorBox's input is a camera log format.

SDR Softness

If the Input Dynamic Range and Gamut is set to SDR BT.709 100 Nits, this control adjusts how the SDR brights/highlights are mapped into brights and speculars of the 1000 nit HDR output range. This control can be used to accommodate SDR source material that was produced at different "knee" points and slopes.

- Range +1.00/0.00, Default 0.00

NOTE: This parameter only applies if the OG-ColorBox's input is SDR.

Master Lift

Simultaneously adjusts the bottom side of the Reds, Greens, and Blues.

- Range +/-1.00, Default 0.00

Red Lift

Adjusts the bottom side of the Reds.

- Range +/-1.00, Default 0.00

Green Lift

Adjusts the bottom side of the Greens.

- Range +/-1.00, Default 0.00

Blue Lift

Adjusts the bottom side of the Blues.

- Range +/-1.00, Default 0.00

Master Gamma

Simultaneously adjusts the midlevel (between shadows and highlights) of the Reds, Greens, and Blues.

- Range +2.00/0.00, Default 1.00

Red Gamma

Adjusts the midlevel (between shadows and highlights) of the Reds.

- Range +2.00/0.00, Default 1.00

Green Gamma

Adjusts the midlevel (between shadows and highlights) of the Greens.

- Range +2.00/0.00, Default 1.00

Blue Gamma

Adjusts the midlevel (between shadows and highlights) of the Blues.

- Range +2.00/0.00, Default 1.00

Master Gain

Simultaneously adjusts the top side of Reds, Greens, and Blues.

- Range +5.00/0.00, Default 1.00

Red Gain

Adjusts the top side of the Reds.

- Range +5.00/0.00, Default 1.00

Green Gain

Adjusts the top side of the Greens.

- Range +5.00/0.00, Default 1.00

Blue Gain

Adjusts the top side of the Blues.

- Range +5.00/0.00, Default 1.00

Saturation

Adjusts the chrominance saturation of the signal. At 0.0 a monochrome image is created.

- Range +2.00/0.00, Default 1.00

Exposure

Scene referred linear light adjustment to compensate for scene lighting intensity. The Exposure control is the equivalent of adjusting the photons landing on the camera sensor.

- Range +4.00/-4.00, Default 0.00

Color Temp

Scene referred linear light adjustment to compensate for color temperature. The Color Temp control affects the image the same as changing the lighting color temperature in front of the camera.

- Range +10.00/-10.00, Default 0.00

Tint

The Tint Control compensates for the coloration that most neutral-density (ND) filters add to the image.

- Range +16.00/-16.00, Default 0.00

PQ Output Nit Level

This parameter sets the maximum output Nit level for a PQ signal. Currently almost all PQ production is mastered to 1000 Nits maximum, so a processing step is required to fit any video data above 1000 nits down to 1000 nits or less. The Colorfront Engine transform remaps PQ output video data above the set level.

- Variable adjustments from 48-4000 Nits, default 1000 Nits.

NOTE: This parameter only applies if the OG-ColorBox's Dyn Range&Gamut OUT setting is PQ BT.2020 1000 Nits.

P3 Colorspace Clamp

This parameter limits the PQ output video data to be within the P3 gamut. If the Clamp is on and the output signal contains colors that extend past P3 into BT.2020, the Colorfront Engine transform will remap PQ output video data to be within P3.

- Select On or Off (default).

NOTE: This parameter only applies if the OG-ColorBox's Dyn Range&Gamut OUT setting is PQ BT.2020 1000 Nits.

BT.2408 Mode

This function provides a transform that meets the targets defined in the ITU publication ITU-R BT.2408 Operational Practices in HDR Television Production for converting SDR to HDR or HDR to SDR. Specifically, 100% reference white is mapped to 203 nits in 1000 nit HDR, which is a 75% signal level in HLG and 58% signal level in PQ, and vice versa.

- Range 0.00/+1.00, Default 0.0
- When set to 0, this function is off (no BT.2408 mapping)
- When set to 1, the function is on (full BT.2408 mapping)
- Values between 0 and 1 will apply an intermediate BT.2408 mapping.

NOTE: This parameter only applies to SDR > HDR (PQ or HLG), or HDR (PQ or HLG) > SDR conversions.

Colorfront SDR to Dolby Vision Preview Mode

OG-ColorBox's Colorfront SDR to Dolby Vision Preview mode, together with Colorfront Transkoder, enables productions to deliver HDR/Dolby Vision content more rapidly while keeping costs low. With the same simple set of controls for highlight and contrast in both products, colorists can grade in SDR and preview in real-time what the Dolby Vision HDR will look like using OG-ColorBox prior to Transkoder encoding it with the proper Dolby Vision metadata. This enables fast creation of Dolby Vision HDR graded content that guarantees a precise roundtrip match between the original and derived SDR content. While the tool is primarily used for preview, it can also be applied as an SDR to HDR conversion in live production to produce a perceptually matching HDR output.

NOTE: OG-ColorBox does not produce Dolby Vision metadata.

When SDR to Dolby Vision Preview Mode is selected, the following parameters are available:

Highlights

Influences the brightness of pixels and determines the HDR level by specifying the intensity of bright pixels.

Low Mid (default) High	300 Nits 600 Nits 1000 Nits

Contrast

Specifies contrasts between blacks and whites.

Low Mid (default) High	Diminishes the darkness of blacks and reduces the brightness of whites. Balanced darkness of blacks and brightness of whites. Intensifies the darkness of blacks and enhances the brightness of whites.

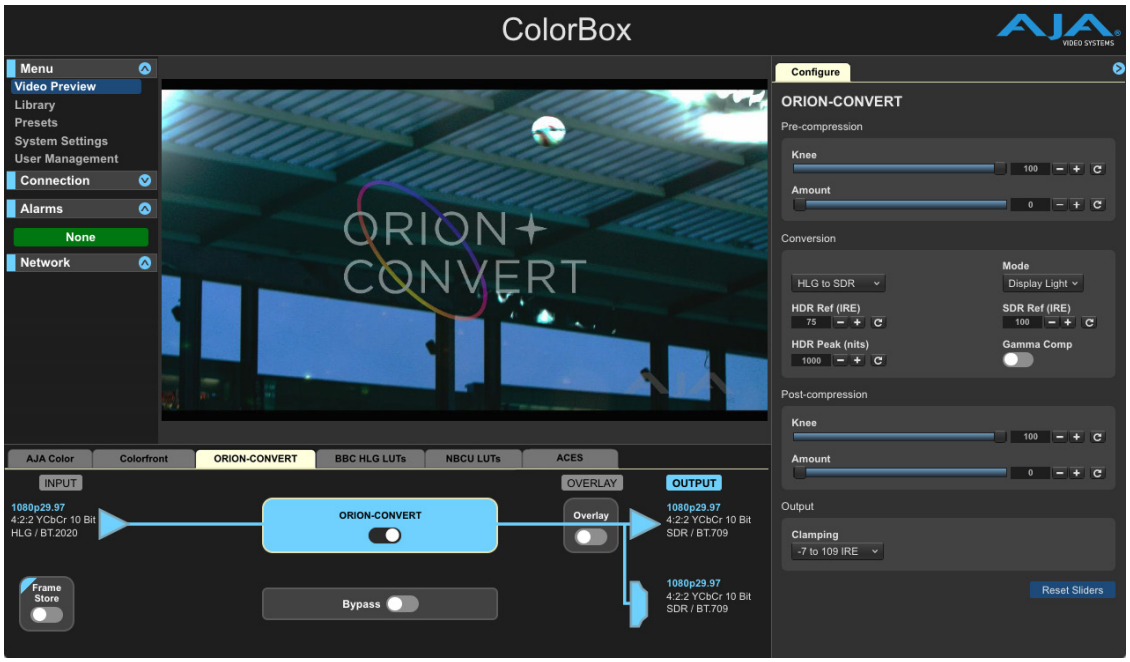
Bypass

Similar function to turning the Colorfront node to off or enabling the Bypass node in the pipeline UI. Options are Off (default), On.

Reset

Resets Colorfront SDR to Dolby Vision Preview parameters to default states.

ORION-CONVERT Pipeline



NOTE: The Frame Store, Bypass, and Overlay controls are available on all OG-ColorBox pipeline modes, and their settings are applied to all the other pipeline modes. These settings are also saved to Presets.

Overview

ORION-CONVERT brings the power of Cromorama color science to real time hardware based conversion. ORION-CONVERT offers the necessary tools for broadcasters to create and deliver the HDR and SDR content consumers expect from a single master HDR workflow by providing critical controls required to set up the right conversion for your production. By being able to set the HDR and SDR reference anchor points in an HDR to SDR conversion, you can target a SDR program output that suits your markets' SDR display needs. You can target 200 nits SDR resulting in a much more representative image for the camera shader and a more vibrant HDR image for the viewer at home or target a perceptual match at 100 nits SDR. Also, in an HDR to SDR conversion, the unique 2 stage knee offers a pre-conversion compression in HDR only and a post-conversion compression in SDR only providing very effective roll off management control.

NOTE: Watermarks are added to the OG-ColorBox's video output when an unlicensed pipeline is being used. This lets you test the color science in advance of purchase.

This is a licensable upgrade and includes:

- Conversions utilizing floating point math for higher precision results
- SDR, HLG and PQ transforms
- Scene-light and Display-light modes
- 2 stage Knee adjustment for pre and post conversion compression or expansion
- Compression amount control in HDR to SDR conversions
- Expansion amount control in SDR to HDR conversions
- Configurable SDR and HDR reference anchor points
- HDR Peak Nit sets the system gamma for display light conversions
- Gamma Compensation setting to compensate for the subjective change in appearance between SDR and HDR
- Easy to configure pixel perfect round tripping
- Clamping options
- Full bypass node for 12G-SDI and HDMI v2.0
- Support for ITU BT.2408, Operational Practices in HDR Television Production

ORION-CONVERT Configure Pane Description

When the ORION-CONVERT node is selected in that pipeline, the Configure pane shows an array of dynamic controls, which can vary depending on the direction of conversion selected. Parameter controls not appropriate for a selected conversion type will be grayed out. All conversions have an Output/Clamping control.

The following groups of parameters are available for each conversion type:

Table 2. Conversion Direction Parameter Groups

Conversion Direction	Pre-compression	Post-compression	Pre-expansion	Post-expansion
HLG to SDR	X	X		
SDR to HLG			X	X
HLG Compress	X			
PQ to SDR	X	X		
SDR to PQ			X	X
PQ Compress	X			
HLG to PQ			X	X

Conversion Direction	Pre-compression	Post-compression	Pre-expansion	Post-expansion
PQ to HLG	X	X		

ORION-CONVERT Parameters

Pre-compression/Pre-expansion

Knee - This controls the breakpoint where compression or expansion begins on the selected "input" signal for the conversion. Example: In an up-conversion (SDR to HDR), the breakpoint will be applied at this level to boost the SDR into the HDR domain, but may be moved by the subsequent Post-conversion process.

Amount - This controls the amount of compression in down-conversion and expansion in up-conversion. When compressing, a value of zero applies no compression (at which point the value of Knee is irrelevant) and a value of 1 will compress completely, flattening everything above the value of Knee to that value.

Conversion

Direction

Here you choose the direction of the colorimetric conversion needed. Select from:

- HLG to SDR
- SDR to HLG
- HLG Compress
- PQ to SDR
- SDR to PQ
- PQ Compress
- HLG to PQ
- PQ to HLG

NOTE: After finding the settings desired for the conversion (pre-compression and post-compression), if the direction of the conversion is then reversed, the values of pre and post compression are swapped to generate an absolute mathematical inverse. This way, a visually lossless round trip is possible.

Mode

Display light - Display-Light mapping is used when the goal is to preserve the colors and relative tones seen on an SDR BT.709 or BT.2020 display, when the content is shown on a BT.2100 HDR display (or on an SDR display depending on the direction of the conversion). An example of which is the inclusion of SDR graded content within an HDR program. This type of conversion, for example, would be used for graphics insertion. These elements are mostly designed (creative intent) in an sRGB environment, so to preserve this creative intent, we want to represent these elements exactly as they were seen at the time of their creation.

Scene light - Scene-Light mapping is used where the source is a direct SDR camera output or an HDR camera output, and the goal is to match the colors and tones of that camera to another camera source after conversion. We would use these conversions when the appearance of the content, as seen by a camera, is the intended process. For example, when using the SDR output

of a Camera (as camera splits/isos, etc.) that can simultaneously produce SDR and HDR, we want the HDR program (after conversion to SDR) to match in the best way possible. It depends very much on the camera manufacturer as some have creative tools independent for HDR and SDR outputs. Matching configuration settings to the HDR converted signal "look" for the SDR output must be found and locked.

HDR and SDR Reference Points

This controls the HDR and SDR "anchor points". At the default settings of 75 and 100, for example for an HLG to SDR conversion, if no compression or expansion is applied, 75% HLG will be mapped to exactly 100% SDR (direct mapping). If any compression is applied on the pre-compression, then the absolute colorimetric conversion to SDR is performed, scaled based on the selected HLG Ref and SDR Ref. However, if these values are above the pre-compression and/or post-compression points, the correspondence will be shifted.

HDR Peak

The peak luminance (referred to as LW in ITU-R BT.2100) in Nits of the 'virtual HLG display` used in conversion calculations. This is normally left at the default value of 1000, but could, for example, be reduced to 392 which is the value for an HLG display which produces 100 nits at 75% IRE.

This does not affect the relative scaling of HDR and SDR, as that is controlled by the HDR Ref and SDR Ref above. But it does control the gamma of the HLG OOTF as defined in ITU-R BT.2100.

NOTE: This value is not used in scene-light conversions.

Gamma Comp

Gamma Compensation sets a parameter that makes SDR transforms compatible with different transforms philosophies. This is a luminance only gamma modification described in Rep. ITU-R BT.2408-5 and is indicated as "optional". Testing has shown that when SDR gamma is increased as specified, the shadow region is lifted excessively, producing milky shadows, so subsequent shadow compression is needed to revert the shadow region to its original state, and so the gamma adjustment is applied only to the mid-tones.

Post-compression/Post-expansion

Knee - This slider controls the threshold at which compression (for down-conversion) or expansion (for up-conversion) begins. Example: A value of 50 places this at 50% SDR IRE in a down-conversion. The start of the compression will be seen at this value on a waveform monitor because this compression is the last step of the process.

Amount - This controls the amount of compression in down-conversion and expansion in up-conversion. When compressing, a value of zero applies no compression (at which point the value of Knee is irrelevant) and a value of 1 will compress completely, flattening everything above the value of Knee to that value.

Output

Clamping

Internally the result of the conversion is unclamped float, meaning that even HDR values that cannot be represented on an SDR display after conversion, will be converted to SDR values outside the displayable range. When outputting over SDI, it is necessary to limit the range of the output. This control applies a clamp to the output R'G'B' values.

Select from:

- Unclamped (clamping will still occur in the hardware output)
- Clip sub-blacks
- -7 to 109 IRE (SDI permissible range)
- -5 to 105 IRE (EBU R 103 preferred range)
- 0 to 100 IRE

Reset Sliders

Click to reset slider controls to default values.

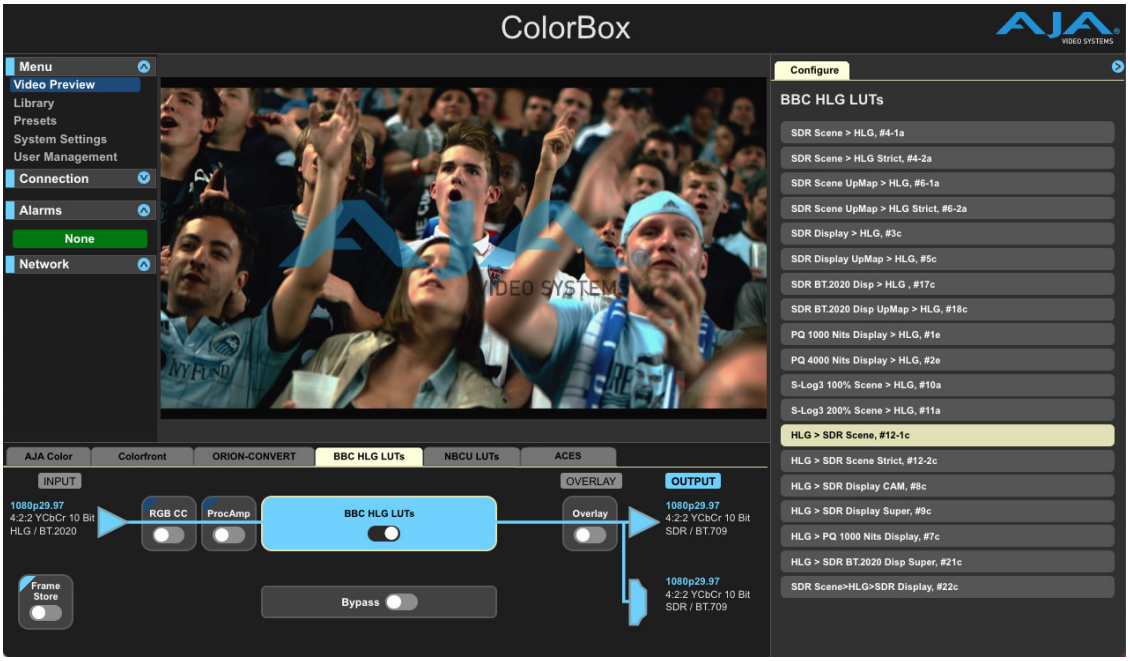
ORION-CONVERT Workflow Example

Round Trip Conversion

Thanks to the core design of the ORION-CONVERT algorithm, it is very easy and fast to create a conversion round trip (up-map and down-map). In the Conversion section of the Configure pane, select the direction of conversion method from the drop down menu. Set all other parameters relevant to your conversion (HDR Peak, etc.).

1. Choose one of the conversions needed (we recommend starting with an HDR to SDR for example) and feed content into the device.
2. Choose on the drop-down menu the direction of the conversion and select the method you would like to use and all other parameters relevant to your conversion (HDR Peak, etc.)
3. Now you are all set to start creating your highlight compression/expansion using the powerful pre and post sliders.
4. Once you've found the desired result, simply invert the direction of the conversion on the drop-down menu and you will get an absolute mathematical invert to ensure a clean round trip.

BBC HLG LUTs Pipeline



NOTE: The Frame Store, Bypass, and Overlay controls are available on all OG-ColorBox pipeline modes, and their settings are applied to all the other pipeline modes. These settings are also saved to Presets.

The BBC HLG LUTs Pipeline offers licensed 3D LUTs that add field proven HDR conversion options, particularly for television broadcasters who are looking for specific conversion criteria. This mode provides a RGB Color Corrector (see *"RGB Color Corrector" on page 46*) and Proc Amp (see *"Proc Amp" on page 46*) to color correct the signal prior to conversion.

NOTE: Watermarks are added to the OG-ColorBox's video output when an unlicensed pipeline is being used. This lets you test the color science in advance of purchase.

This is a licensable option and includes:

- SDR, PQ, and S-Log3 to HLG
- HLG to SDR and PQ
- Scene-light and Display-light conversions
- Utilizes 33-point Tetrahedral 3D LUT Interpolation
- Proc Amp and Color Corrector
- Full bypass node for 12G-SDI and HDMI v2.0
- Support for mathematical HLG HDR dynamic range mapping per ITU BT.2408

BBC HLG LUT Conversions

Description abbreviations:

SDR = Standard Dynamic Range

PQ = High Dynamic Range using Perceptual Quantization curve

HLG = High Dynamic Range using Hybrid Log Gamma curve

Scene = Scene Referred

Display = Display Referred

P3 = RGB color space for digital movie projection

Table 3. Convert to HLG, BBC HLG LUT Detailed Information

BBC HLG LUT Number and Name	Description
#4-1a, v1.7 SDR Scene > HLG	For use with most compact SDR cameras that approximate the BT.709 OETF with a square root. BT.709 signals are directly-mapped into BT.2100 HLG at the BT.2408 signal levels using a scene-light conversion. The "look" of the original BT.709 content is changed to match the subjective look of "native" BT.2100 HLG cameras. 100% SDR signal is directly-mapped to 75% HLG ("HDR Reference White"). This LUT is intended to be used with compact SDR cameras with a limited dynamic-range, so no highlight "boost" is applied.
#4-2a, v1.7 SDR Scene > HLG Strict	For use with compact SDR cameras that implement a strict BT.709 OETF. BT.709 signals are directly-mapped into BT.2100 HLG at the BT.2408 signal levels, using a scene-light conversion. The "look" of the original BT.709 content is changed to match the subjective look of "native" BT.2100 HLG cameras. 100% SDR signal is mapped to 75% HLG ("HDR Reference White"). This LUT is intended to be used with compact SDR cameras with a limited dynamic-range, so no highlight "boost" is applied. NOTE: Unlike BT.2100 HLG, SDR cameras that implement a strict BT.709 OETF tend to crush detail in the shadows of a scene. Such detail will become more evident after applying this conversion. It is often better to adjust the SDR camera's native OETF to approximate a square root (which provides a better match to HLG) and then use LUT 4-1 rather than this LUT.
#6-1a, v1.7 SDR Scene UpMap > HLG	For use with SDR cameras that approximate the BT.709 OETF with a square root. BT.709 signals are up-mapped (inverse tone-mapped) to BT.2100 HLG, using a scene-light conversion. The "look" of the original BT.709 content is changed to match the "look" of native BT.2100 HLG cameras. While the ITU-R BT.2408 signal levels are taken into account, a small boost is applied to the SDR highlights so that there is a close match to natively produced HDR content. 100% SDR signal is up-mapped to 79% HLG. 105% SDR signals (EBU R.103 "preferred range" signals) are up-mapped to 83% HLG.
#6-2a, v1.7 SDR Scene UpMap > HLG Strict	For use with SDR cameras that implement a strict BT.709 OETF BT.709 signals are up-mapped (inverse tone-mapped) to BT.2100 HLG using a scene-light conversion. The "look" of the original BT.709 content is changed, so that the native look of BT.2100 HLG cameras is achieved. While the ITU-R BT.2408 signal levels are taken into account, a small boost is applied to the SDR highlights so that there is a closer match to natively produced HDR content. A 100% SDR signal is up-mapped to 79% HLG. 105% SDR signals (EBU R.103 "preferred range" signals) are up-mapped to 83% HLG. NOTE: Unlike BT.2100 HLG, SDR cameras that implement a strict BT.709 OETF tend to crush detail in the shadows of a scene. Such detail will become more visible after applying this conversion. It is often better to adjust the SDR camera's native OETF to approximate a square root (which provides a better match to HLG) and then use LUT 6-1.
#3c, v1.7 SDR Display > HLG	For use with SDR Graphics. BT.709 signals are directly-mapped into BT.2100 HLG at the BT.2408 signal levels using a display-light conversion. The "look" of the original BT.709 content is therefore preserved on conversion. A 100% SDR signal is mapped to 75% HLG ("HDR Reference White").
#5c, v1.7 SDR Display UpMap > HLG	For use with SDR Graded Content. BT.709 signals are up-mapped (inverse tone-mapped) to BT.2100 HLG using a display-light conversion. This LUT is designed to complement LUTs 8 and 9 (BT.2100 HLG to BT.709 down-mapping) so that losses associated with 'round-tripping' (i.e. SDR-to-HDR-to-SDR conversion) are minimized. While the ITU-R BT.2408 signal levels are taken into account, a modest boost is applied to the SDR highlights so that there is a closer match to natively-produced HDR content. The LUT does, however, attempt to preserve the artistic intent of the original BT.709 content. 100% SDR signal is up-mapped to 82% HLG.
#17c, v1.7 SDR BT.2020 Disp > HLG	For use with SDR Graded Content. BT.2020 signals are directly-mapped into BT.2100 HLG at the BT.2408 signal levels using a display-light conversion. The "look" of the original BT.2020 content is therefore preserved on conversion. A 100% SDR signal is mapped to 75% HLG ("HDR Reference White").

BBC HLG LUT Number and Name	Description
#18c, v1.7 SDR BT.2020 Disp UpMap > HLG	For use with SDR BT.2020 Graded Content. BT.2020 signals are up-mapped (inverse tone-mapped) to BT.2100 HLG using a display-light conversion. While the ITU-R BT.2408 signal levels are taken into account, a modest boost is applied to the SDR highlights so that there is a closer match to natively produced HDR content. The LUT does, however, attempt to preserve the artistic intent of the original BT.2020 content. 100% SDR signal is up-mapped to 82% HLG.
#1e, v1.7 PQ 1000 Nits Display > HLG	For use with Graded Content. BT.2100 PQ signals are converted to BT.2100 HLG in the 1000 cd/m2 "bridge" condition, so that 1000 cd/m2 PQ maps to 100% HLG. Please refer to ITU-R report BT.2390 Section 7.2 ("Conversion concepts using a reference condition at 1000 cd/ m2"). With the Type III LUTs, PQ signals above 1000 cd/m2 are mapped into the HLG "superwhite" signal range up to 109% signal, equivalent to 1811 cd/m2 (PQ).
#2e, v1.7 PQ 4000 Nits Display > HLG	For use with Graded Content. 4000 cd/m2 BT.2100 PQ signals are converted to BT.2100 HLG by first tone-mapping to the 1000 cd/m2 "bridge" condition, and then converting to HLG. The tone-mapping is applied to the luminance component so that hue distortions are avoided NOTE: that 4000 cd/m2 PQ maps to 100% HLG. For more information, please refer to ITU-R report BT.2390 Section 7.4 ("Handling PQ signals with greater than 1000 cd/m2 peak-luminance"). With Type III LUTs, PQ signals above 4000 cd/m2 are mapped into the HLG "super-white" signal range.
#10a, v1.7 S-Log3 100% Scene > HLG	For use with Sony S-Log3 cameras in non-live workflows. S-Log3 (BT.2020 color) signals produced using the Sony's "100%" workflow (i.e. 100% IRE input equals 90% reflectance) are converted to BT.2100 HLG with ITU-R BT.2408 signal levels. A 100% IRE input signal (90% reflectance) thus maps to 73% HLG. A scene-light conversion is used, so that the converted S-Log3 signal is a close subjective-match to the "look" of BT.2100 HLG cameras.
#11a, v1.7 S-Log3 200% Scene > HLG	For use with Sony S-Log3 cameras in "SR Live" workflows. S-Log3 (BT.2020 color) signals produced using Sony's "SR Live" "200%" workflow (i.e. 200% IRE input equals 90% reflectance) are converted to BT.2100 HLG with ITU-R BT.2408 signal levels. A 200% IRE input signal (90% reflectance) thus maps to 73% HLG. 200% workflows are commonly encountered whenever the S-Log3 curve has been used in live productions. A scene-light conversion is used, so that the converted S-Log3 signal matches the "look" of BT.2100 HLG cameras.

Table 4. Convert from HLG, BBC HLG LUT Detailed Information

BBC HLG LUT Number and Name	Description
#12-1c, v1.7 HLG > SDR Scene	For matching downstream SDR cameras that approximate the BT.709 OETF with a square root function. BT.2100 HLG signals are down-mapped (tone-mapped) to BT.709, using scene-light conversion. The "look" of the original BT.2100 HLG content is changed to match "native" BT.709 cameras with a square-root approximation of the BT.709 OETF. This LUT is the exact inverse of LUT 6-1 (BT.709 to BT.2100 up-mapping, scene-light), so that the losses associated with 'roundtripping' (i.e. SDR-to-HDR-to-SDR conversion) are minimized. "HDR Reference White" (75% HLG) is tone-mapped to 95% BT.709, allowing for some soft-clipping of highlights. A 79% HLG signal is tone-mapped to 100% BT.709. With Type III LUTs that process sub-blacks and super-whites, the LUT outputs are clipped to EBU R.103 signal levels. The 3D-LUT interpolation errors are greatest for the HDR to SDR down-mapping LUTs, as the output signals reach the extremities of the RGB signal range. For that reason, in addition to the "ideal" output values for the EBU Tech 3373 HLG Color Bars, we also provide the expected output values from a trilinear interpolator. Errors should be smaller with tetrahedral interpolation, the 65-cubed LUTs and also with real pictures.

BBC HLG LUT Number and Name	Description
#12-2c, v1.7 HLG > SDR Scene Strict	For use with SDR cameras that implement a strict BT.709 OETF. BT.2100 HLG signals are down-mapped (tone-mapped) to BT.709, using a scene-light conversion. The "look" of the original BT.2100 HLG content is changed to match "native" BT.709 cameras, with a strict implementation of the BT.709 OETF. This LUT is the exact inverse of LUT6-2 (BT.709 to BT.2100 HLG inverse tone-mapping, scene-light), so that the losses associated with 'round-tripping' (i.e. SDR-to-HDR-to-SDR conversion) are minimized. "HDR Reference White" (75% HLG) is tone-mapped to 95% BT.709, allowing for some soft-clipping of highlights. 79% HLG signal is tone-mapped to 100% BT.709. With Type III LUTs that process sub-blacks and super-whites, the LUT outputs are clipped to EBU R.103 signal levels. NOTE: Unlike BT.2100 HLG, SDR cameras that implement a strict BT.709 OETF tend to crush detail in the shadows of a scene. Shadow-detail visible in the HDR image will, as a result, become less evident after applying this conversion. The 3D-LUT interpolation errors are greatest for the HDR to SDR down-mapping LUTs, as the output signals reach the extremities of the RGB signal range. For that reason, in addition to the "ideal" output values for the EBU Tech 3373 HLG Color Bars, we also provide the expected output values from a trilinear interpolator. Errors should be smaller with tetrahedral interpolation, the 65-cubed LUTs and also with real pictures.
#8c, v1.7 HLG > SDR Display CAM	BT.2100 HLG signals are down-mapped (tone-mapped) to BT.709 using a model of the human visual system (CAM). The LUT attempts to preserve the artistic intent of the original HDR content. As the LUT is based on a CAM, the appearance of colors, mid-tones and lowlights after conversion are significantly improved. This disadvantage if this approach is that it does not cascade as well as LUT9c does, with the SDR to HLG direct-mapping and up-mapping LUTs (3 & 5). LUT8 is, therefore, not currently recommended for live production, where it is usually important to minimize 'roundtripping' losses (i.e. SDR-to-HDR-to-SDR conversion). "HDR Reference White" (75% HLG) is tone-mapped to 88% BT.709, facilitating signal headroom for compressed highlights. 100% HLG signal is tone-mapped to 100% BT.709. With Type III LUTs that process sub-blacks and super-whites, the HLG super-white signals are tone-mapped to SDR super-white signals. The LUT outputs are clipped to EBU R.103 signal levels. The 3D-LUT interpolation errors are greatest for the HDR to SDR down-mapping LUTs, as the output signals reach the extremities of the R'G'B' signal range. For that reason, in addition to the "ideal" output values for the EBU Tech 3373 HLG Color Bars, we also provide the expected output values from a tetrahedral interpolator. Errors should be smaller with tetrahedral interpolation, the 65-cubed LUTs and also with real pictures. NOTE: Neither the EBU Tech 3373 HLG color bars nor the ITU-R BT.2111 HLG color bars will look like standard BT.709 color bars after conversion, as the BT.2100 color-primaries are quite different to those of BT.709. Furthermore, the converted color bars will not look like BT.2111 color bars displayed on a current reference display as their color-primaries tend to be closer to DCI-P3 than BT.2100. Most noticeable might be the BT.2100 green, which is much more cyan in color than the DCI-P3 and BT.709 greens.

BBC HLG LUT Number and Name	Description
#9c, v1.7 HLG > SDR Display Super	BT.2100 HLG signals are down-mapped (tone-mapped) to BT.709 using a display-light conversion. Colors and the appearance of mid-tones and lowlights are maintained after conversion. The LUT, therefore, attempts to preserve the artistic intent of the original HLG content. "HDR Reference White" (75% HLG) is mapped to 95% BT.709 and HDR highlights extend into the SDR super-white region; for that reason, only "Full-Range Mode" Type III LUTs are made available. 100% HLG signal is mapped to the EBU R103 preferred maximum of 105% BT.709. HLG signals above 100% are clipped. This LUT is recommended for use in scenarios where minimizing SDR>HDR>SDR "round-trip" losses is of the utmost importance. Minimal round-trip losses are achieved when used with the display-light up-mapping LUT5. Where the program delivery and distribution chain preserves the SDR super-white signal range, this LUT9 usually gives better results than LUT8 as its output color volume is larger. Where there is a risk of the SDR super-white signal range being clipped, LUT8 should be used instead. The 3D-LUT interpolation errors are greatest for the HDR to SDR down-mapping LUTs, as the output signals reach the extremities of the RGB signal range. For that reason, in addition to the "ideal" output values for the EBU Tech 3373 HLG Color Bars, we also provide the expected output values from a trilinear interpolator. Errors should be smaller with tetrahedral interpolation, the 65-cubed LUTs and also with real pictures. NOTE: Neither the EBU Tech 3373 HLG color bars nor the ITU-R BT.2111 HLG color bars will look like standard BT.709 color bars after conversion, as the BT.2100 color primaries are quite different from those of BT.709. Furthermore, the converted color bars will not look like BT.2111 color bars displayed on a current reference display, as their color primaries tend to be closer to DCI-P3 than BT.2100. Of these, the most noticeable might be the BT.2100 green. This contains more cyan content than the DCI-P3 and BT.709 greens.
#7c, v1.7 HLG > PQ 1000 Nits Display	BT.2100 HLG signals are converted to BT.2100 PQ at the 1000 cd/m2 "bridge" condition, so that 100% HLG maps to 1000 cd/m2 PQ. See ITU-R report BT.2390 Section 7.2 ("Conversion concepts using a reference condition at 1000 cd/m2"). For Type III LUTs, HLG signals above 100% are mapped to PQ signals greater than 1000 cd/m2, up to a maximum of 1810 cd/m2 (corresponding to 109% HLG 'super-white', i.e. 10-bit code value 1019).
#21c, v1.7, HLG > SDR BT.2020 Disp Super	BT.2100 HLG signals are down-mapped (tone-mapped) to BT.2020 using a display-light conversion. Colors and the appearance of mid-tones and lowlights are maintained after conversion. The LUT, therefore, attempts to preserve the artistic intent of the original HLG content. "HDR Reference White" (75% HLG) is mapped to 95% BT.709 and HDR highlights extend into the SDR super-white region; for that reason, only "Full-Range Mode" Type III LUTs are made available. 100% HLG signal is mapped to the EBU R103 preferred maximum of 105%. HLG signals above 100% are clipped. This LUT is recommended for specialist applications such as on-set monitoring, where a high brightness wide color gamut SDR display may be preferred over an HDR display. The 3D-LUT interpolation errors are greatest for the HDR to SDR down-mapping LUTs, as the output signals reach the extremities of the R'G'B' signal range. For that reason, in addition to the "ideal" output values for the EBU Tech 3373 HLG Color Bars, we also provide the expected output values from a tetrahedral interpolator. Errors should be smaller with tetrahedral interpolation, the 65-cubed LUTs and also with real pictures.

Table 5. Convert SDR to HLG to SDR, BBC HLG LUT Detailed Information

BBC HLG LUT Number and Name	Description
#22c, v1.7, SDR Scene>HLG>SDR Display	Combination LUT for shading SDR BT.709 cameras in live "single stream" HDR production. Combines LUT4-1 (scene-light BT.709 to HLG) and LUT9 (display-light HLG to BT.709) into single conversion, thereby allowing camera shaders to directly view the SDR signal seen by audiences.

NBCU LUTs Pipeline

NOTE: The Frame Store, Bypass, and Overlay controls are available on all OG-ColorBox pipeline modes, and their settings are applied to all the other pipeline modes. These settings are also saved to Presets.

NBCU LUTs, developed by NBCUniversal Media, LLC in collaboration with Cromorama, enable a workflow for single-master live production of simultaneous HDR and SDR content. Designed for television broadcasters, NBCU LUTs include SDR, HLG and PQ LUTs that maximize the dynamic range and color volume in HDR, without compromising core SDR broadcasts.

NBCU pipeline features include:

- Imperceptible round-tripping of SDR BT.709
- Conversions designed with a knee that is natural with latitude for live video shading
- Scene-light and Display-light conversions
- SDR, HLG, and PQ conversions
- Utilizes 33-point Tetrahedral 3D LUT Interpolation
- Proc Amp and Color Corrector
- Full bypass node for 12G-SDI and HDMI v2.0
- Support for ITU BT.2408, Operational Practices in HDR Television Production

NBCU LUTs LUT Conversions

Description abbreviations:

SDR = Standard Dynamic Range

PQ = High Dynamic Range using Perceptual Quantization curve

HLG = High Dynamic Range using Hybrid Log Gamma curve

SL = Scene Light

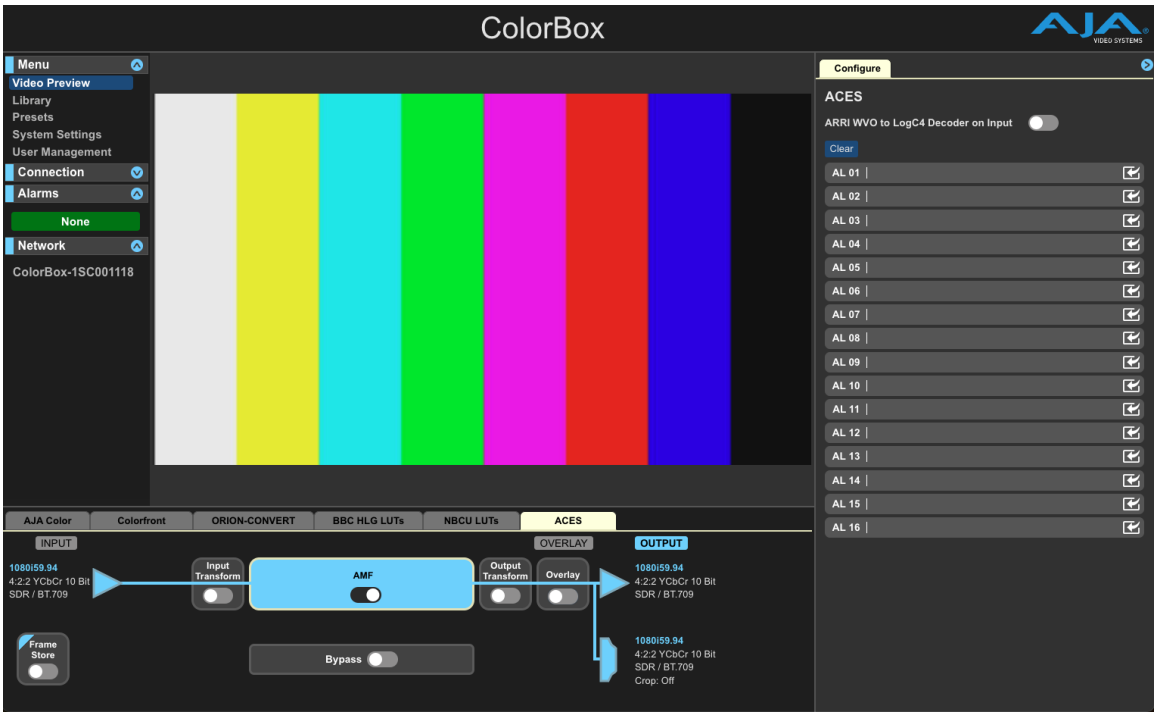
DL = Display Light

Table 6. NBCU LUT Conversions Detailed Information

SDR > HLG DL, #1	SDR UpMap to HLG using Display Light. For use with SDR playback sources. NBCU LUT 1 up-maps legacy SDR signals into a native HLG production using display-light conversion.
SDR > HLG SL, #2	SDR to HLG using Scene Light. For use with SDR camera sources. Tonemaps and matches SDR cameras with the HLG "Look" for a native HLG production using scene-light conversion.
HLG > SDR DL, #3	HLG to SDR using Display Light. For SDR camera shading and production output. Down-maps native HLG BT.2100 signals to SDR as a predictive LUT for legacy SDR-BT.709 transmission.
SDR > PQ DL, #4	UpMap to PQ using Display Light. For SDR to PQ conversion preserving the artistic intent or "SDR look." Up-Maps legacy SDR signals into a native PQ production or transmission.
PQ > SDR DL, #5	PQ to SDR using Display Light. For PQ to SDR conversion for transmission. Down-maps native PQ-BT.2100 signals to SDR-BT.709 as a predictive LUT or for legacy SDR transmission.
HLG 1000 > PQ, #7	HLG 1000 Nits to PQ. For HLG to PQ conversion. BT.2100 HLG signals are converted to BT.2100 PQ at the 1,000nits "bridge" condition so that 100% HLG maps to 1,000nits PQ. This is a transparent conversion.

NOTE: NBCU LUT numbering goes from #5 to #7. LUT #6 is skipped intentionally.

ACES Pipeline



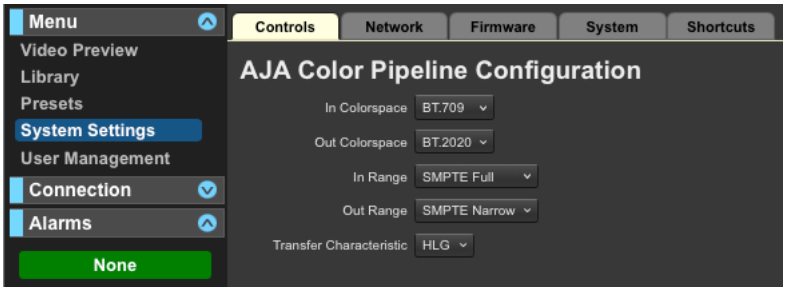
NOTE: The Frame Store, Bypass, and Overlay controls are available in all OG-ColorBox pipeline modes, and their settings are applied to all the other pipeline modes. These settings are also saved to Presets.

The ACES Pipeline enables look monitoring via ACES Metadata File (AMF) processing. AMF workflows support an exchange of information that allows for better interoperability of color throughout the filmmaking process. An AMF includes information needed for ACES based transforms such as input transform, look transform, and output transform into a single XML file that can be easily distributed to others working on the project from on-set to post to final grade.

NOTE: AJA's ACES Pipeline is built on OpenColorIO (OCIO) that has a new implementation of AMF. AMFs can be created by various tools and not all AMF's are supported by the ACES Pipeline. If an AMF file is imported that is not compatible, a warning will pop-up in the UI containing helpful information about the incompatibility. AJA will continue to improve the ACES Pipeline with AMF support over time.

Using the Controls Tab with the ACES Pipeline

Figure 46. ACES Pipeline Configuration Settings



The settings on this screen allows you to configure the input and output range (SMPTE/Full), Colorspace (BT.709/BT.2020), and the HDR output Transfer Characteristic (SDR/PQ/HLG) that will be used with the ACES Pipeline.

NOTE: The settings on this tab must match those specified in your AMF file. This setting is persistent when switching between AJA Color and ACES pipelines.

In Colorspace - Select either BT.709 or BT.2020 as the input color space.

Out Colorspace - Select either BT.709 or BT.2020 as the output color space.

In Range - Select either SMPTE Full or SMPTE Narrow.

- SMPTE Full selects a full input scaling/range, which includes sub-blacks and super-whites. Input video values of 0-1023 (10 bit) or 0-4095 (12 bit) are scaled to 0-1 before being sent to the LUT processor.
- SMPTE Narrow selects a narrow input scaling/range, such that an input video value of 0 represents black, and an input video value of 1 represents white. Input video values of 64-940 (10 bit) or 256-3760 (12 bit) are scaled to 0-1 before being sent to the LUT processor.

Out Range - Select either SMPTE Full or SMPTE Narrow.

- SMPTE Full selects a full output scaling/range, which includes sub-blacks and super-whites. Output values from 0-1 are scaled to 0-1023 (10 bit) or 0-4095 (12 bit).
- SMPTE Narrow selects a narrow output scaling/range. Output values from 0-1 will be scaled to 64-940 (10 bit) or 256-3760 (12 bit).

Transfer Characteristic - Select either SDR, HLG or PQ.

- This setting indicates the transfer characteristic that will be signaled in the SDI Output VPID, as well as the EOTF that will be signaled in the HDMI Output HDR Infoframe. This setting has no effect on the pixel values.

AMF Node

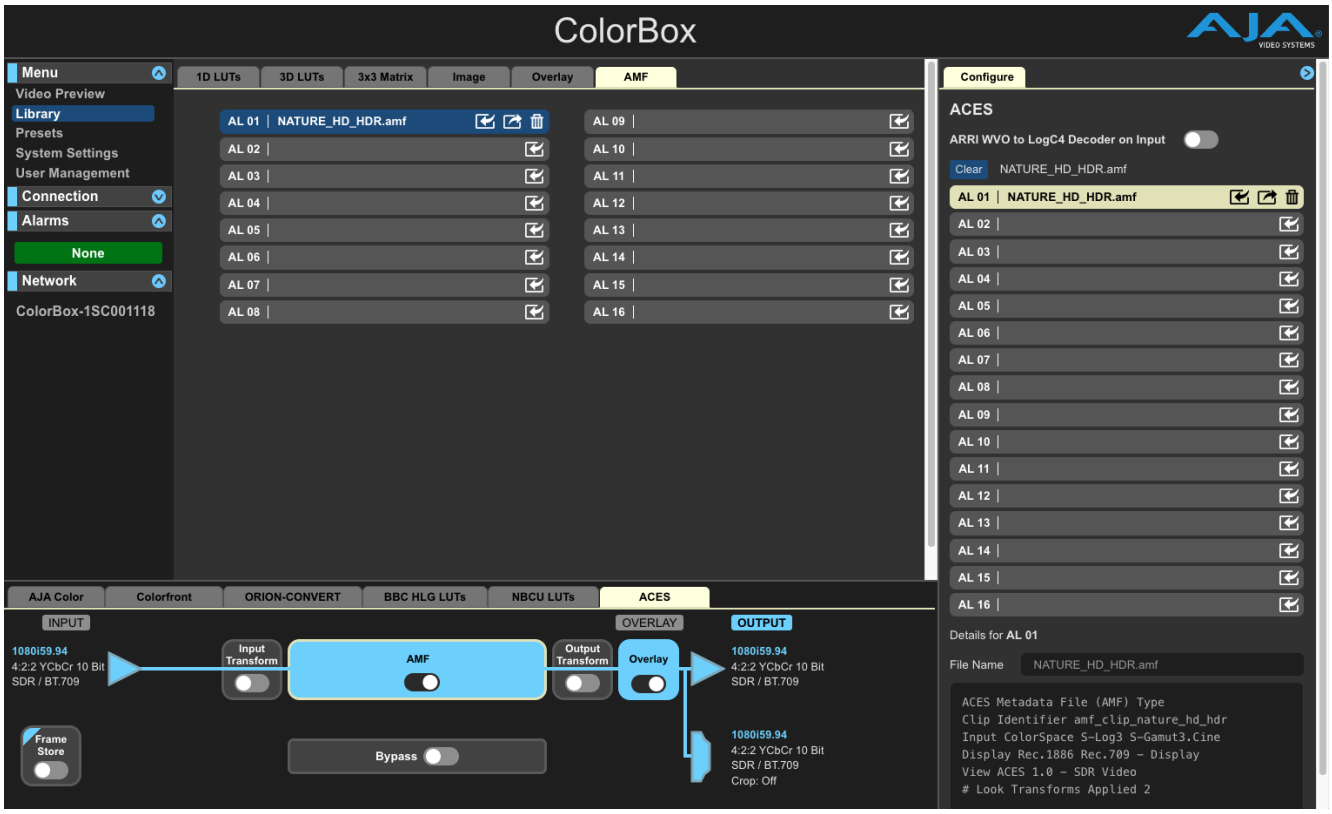
Import AMFs to the Library using the Library AMF tab or the Configure pane in the ACES pipeline.

Click the Import button and navigate to the location of your AMF files.

NOTE: You will not see any files in the location of your AMF files during this step. Click Upload to proceed to the file selection dialog.

Proceed through the dialogs to select the AMF file you want to upload. The file will appear in the AL Library and will be selectable in the ACES Pipeline Configure Pane.

Figure 47. ACES AMF Import



Options, selected in that node's Configuration pane, include:

ARRI WVO to LogC4 Decoder Control

To enable ARRI WVO to LogC4 decoding in the ACES Pipeline, enable the ARRI WVO to LogC4 Decoder on Input control in the Configure pane on the right (see *"ARRI WVO to LogC4 Decoder in the ACES Pipeline" on page 73*).

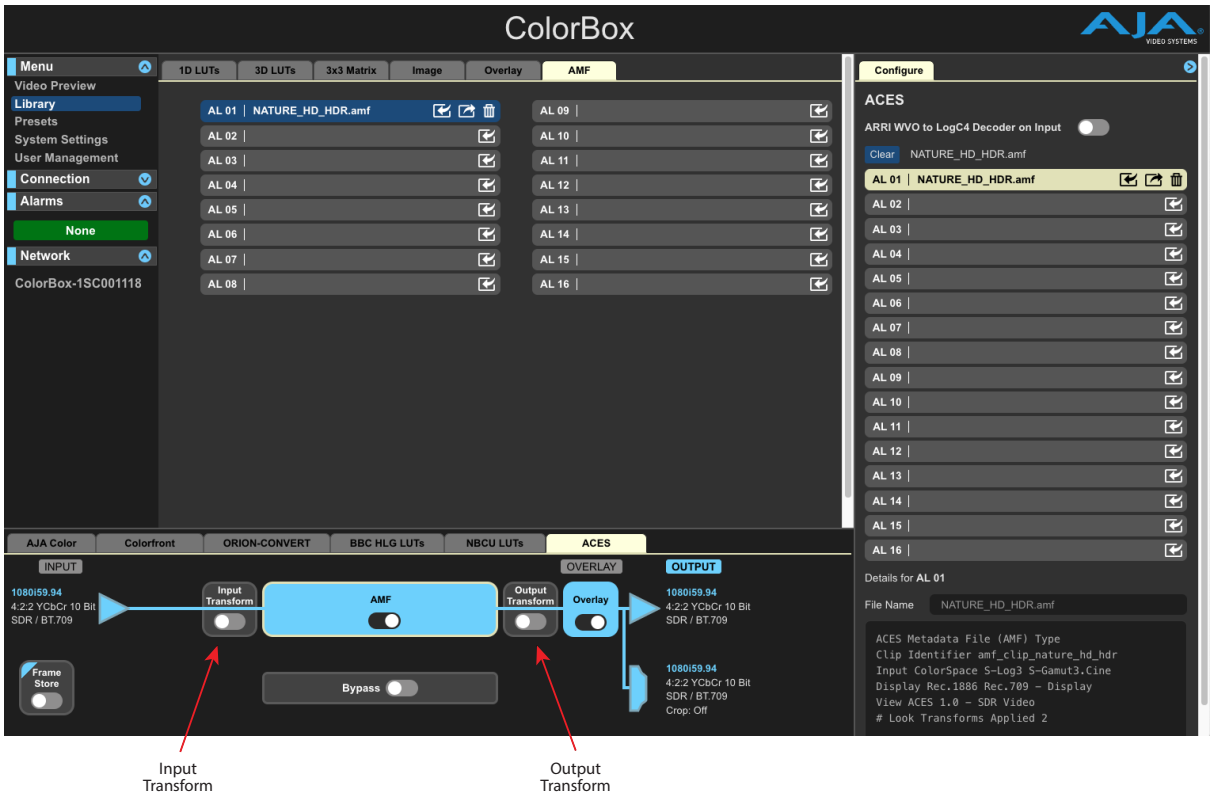
ACES Input and Output Transform Nodes

OG-ColorBox supports user overrides of input and/or output transforms for ACES AMF pipelines. See *"Input and Output Transforms" on page 70*. Typical use cases include:

- An AMF file is generated with a specific camera Log input but the onsite camera is of a different format. Enable Input Transform node and select the appropriate ACES input transform that matches the onsite camera to override the input transform value in the AMF file while still maintaining other AMF transforms indicated in the file. Output transforms may be modified in a similar fashion.
- No AMF file is in use, but compliant ACES input and output transforms are required. With AMF node disabled, specify input and output transforms.

NOTE: When AMF node is disabled, both input and output transforms must be selected and enabled.

Figure 48. Input and Output Transforms



The following transforms are supported:

Input Transforms

ARRI LogC3 (E1800)
ARRI LogC4
CanonLog2 CinemaGamut D55
CanonLog2 CinemaGamut D65
V-Log V-Gamut
Log3G10 REDWideGamutRGB
S-Log3 S-Gamut3
S-Log3 S-Gamut3.Cine
S-Log3 Venice S-Gamut3
S-Log3 Venice S-Gamut3.Cine

Output Transforms

Rec.1886 Rec.709 - Display/ACES 1.0 - SDR Video
Rec.2100-HLG - Display/ACES 1.1 - HDR Video (1000 nits & Rec.2020 lim)
Rec.2100-PQ - Display/ACES 1.1 - HDR Video (1000 nits & Rec.2020 lim)
Rec.2100-PQ - Display/ACES 1.1 - HDR Video (2000 nits & Rec.2020 lim)
Rec.2100-PQ - Display/ACES 1.1 - HDR Video (4000 nits & Rec.2020 lim)

SDI/HDMI Output Configurations

4K/UltraHD Down-Conversion of SDI/HDMI Outputs

OG-ColorBox supports independent down-conversion of SDI and HDMI outputs. This allows users to down convert 4K video to 2K video or UltraHD video to HD video.

Click on SDI and HDMI Outputs in any Pipeline. The SDI/HDMI Configure Pane will display with separate SDI and HDMI Outputs. The following parameters may be configured:

Video Format

Follow Input - Default setting. Passes input formats through without any down-conversion processing.

2K/1080p - When enabled, down converts 4K to 2K or UltraHD to 1080p.

NOTE: If source format is other than 4K or UltraHD, no conversion will be performed even if control is enabled.

4K/2K Crop of HDMI Output

OG-ColorBox supports cropping of 4K to UltraHD or 2K to HD for the HDMI output. This allows users to center crop the image and provide an unscaled image on the HDMI output that is compatible with a wider range of consumer UltraHD and HD displays

Click on SDI/HDMI Outputs in any Pipeline. The SDI/HDMI Configure Pane will display with separate SDI and HDMI Outputs. For HDMI outputs, the following parameters may be configured:

4K/2K Crop

Choose Auto, Off, or On. Provides the option of center cutting 4096x2160 signals to make 3840x2160, or center cutting 2048x1080 video signals to make 1920x1080.

Auto - (Default) Performs crop based on EDID and connected display's capabilities.

NOTE: When set to Auto, if the input is 2K, OG-ColorBox will automatically crop to HD (1920x1080). If the input is 4K, OG-ColorBox will use the EDID to determine if the display supports 4K if it doesn't, OG-ColorBox will crop to (3840x2160).

Off - No cropping is performed.

On - Cropping is performed.

NOTE: If source format is other than 4K or 2K, no cropping will be performed even if control is set to On or Auto.

Color Space and Bit Depth

Color Space

Output Color Space is configurable for supported video formats. Changing this setting sets the Color Space for both SDI and HDMI outputs.

NOTE: Setting the Color Space also sets the Bit Depth for the SDI output, YCbCr 4:2:2 sets it to 10-bits and RGB 4:4:4 sets it to 12-bits.

Auto - (Default) Automatically selects color space based on the input video parameters and payload ID.

4:2:2 YCbCr

4:4:4 RGB

Bit Depth

For HDMI Outputs, bit depth is configurable for supported video formats.

Auto - (Default) Automatically selects the bit depth based on the input video and the attached device's capabilities.

8-bit

10-bit

12-bit

ARRI WVO to LogC4 Decoder

OG-ColorBox supports decoding of ARRI Alexa 35's Wireless Video Optimized LogC4 (WVO) encoded camera outputs with the AJA Color, Colorfront, and ACES Pipelines. Wireless Video Optimized LogC4 (WVO LogC4) is an intermediate encoding for ALEXA 35 SDI outputs that is designed to improve monitoring image quality when transmitting LogC4 over wireless video transmitters. The WVO encoding is an option built into the ALEXA 35. A matching ARRI WVO decoding LUT must be used after signal reception to reconstitute regular LogC4.

The matching ARRI WVO decoding LUT is built into the 1D LUT options in the AJA Color Pipeline and is an option in the Colorfront Pipeline Live Mode, and ACES Pipeline.

ARRI WVO to LogC4 Decoder in the AJA Color Pipeline

The WVO to LogC4 Decoder is built into the 1D LUT options in the AJA Color Pipeline allowing the use of the remaining 6 nodes for additional processing.

In the AJA Color Pipeline, select the first 1D LUT node. In the Mode drop down, select ARRI WVO to LogC4 Decoder (see AJA Color Pipeline section under *"1D LUT Nodes" on page 45*).

ARRI WVO to LogC4 Decoder in the Colorfront Pipeline

In the Colorfront Pipeline Live Mode, select the Dyn Range&Gamut Input and select ARRI LogC4 Wide Gamut 4 WVO in the Configure pane on the right. See *"Colorfront Live Mode" on page 51*).

ARRI WVO to LogC4 Decoder in the ACES Pipeline

The WVO to LogC4 Decoder is built into the options in the ACES Pipeline.

In the ACES Pipeline, enable the ARRI WVO to LogC4 Decoder on Input control in the Configure pane on the right (see *"ARRI WVO to LogC4 Decoder Control" on page 69*).

Appendix A – Specifications

OG-ColorBox Tech Specs

HDR/WCG Real Time Processor

- HDR Conversions
  - HDR to HDR
  - HDR to SDR
  - SDR to HDR
- Colorimetry
  - BT.709 and BT.2020

Video Formats

- (4K) 4096x2160p
- (UltraHD) 3840x2160p
- (2K) 2048x1080p
- (HD) 1920x1080p
- (HD) 1920x1080i
- (HD) 1280x720p

Color Processing Pipeline

- Processes in 12-bit RGB
- 6x pipelines; AJA Color, Colorfront, ORION-CONVERT, BBC HLG LUTs, NBCU LUTs, ACES
- 7x processing nodes plus Overlay in AJA Color; 4x 1D LUTs, 2x 3x3 Matrices, 1x 3D LUT

AJA Color Pipeline (ACP)

- 7x nodes in order of processing:
  - 1D LUT, 3x3 Matrix, 1D LUT, 3D LUT, 1D LUT, 3x3 Matrix, 1D LUT, Overlay
- 3D LUT configurable as LUT or Dynamic
  - Supports custom 33-point .CUBE, .SPI3D, .3DL format 3D LUTs*, .CLF and .CTF
- 1D LUTs configurable as LUT, Dynamic, or Color Corrector
  - Supports custom 10 and 12-bit .CUBE and .SPI1D format 1D LUTs
- 3x3 Matrices configurable as Matrix, Dynamic, or Proc Amp
  - Supports custom .SPIMTX format matrices
- Tetrahedral 3D LUT interpolation
- Configurable Color Space, Range, and Transfer Characteristic
- ARRI Alexa 35's Wireless Video Optimized LogC4 (WVO) Decoder
- Nonvolatile storage of 16x 3D LUTs, 16x 1D LUTs, and 16x 3x3 Matrices
- Overlay

*Various 3D LUT sizes are supported but will be converted to 33-point for processing

Dynamic LUT Processing

- Supports third party apps for automatic loading and display of 3D LUTs
- Reflects dynamic changes in real time from source software
- Full frame LUT processing

- Supported by
  - Pomfort Livegrade Pro and Studio
  - Assimilate Live Looks and Live Assist
  - QTAKE Video Assist

Colorfront Pipeline

- Processing Based on Human Perception Model
- Perceptually optimized color volume remapping
- Preserves the original creative intent
- TV Mode for applications such as television broadcast
- Live Mode for applications such as broadcast, OTT, A/V
- SDR to Dolby Vision Preview Mode for applications such as broadcast and postproduction
- Input Video Dynamic Range/Color Gamut (varies by mode)
  - SDR BT.709 100 Nits
  - SDR Extended BT.709
  - PQ BT.2020 1000 Nits
  - PQ P3D65 1000 Nits
  - Hybrid Log Gamma BT.2100
  - HLG Extended BT.709
  - HLG Extended BT.2100
  - Sony S-Log3 S-Gamut3
  - Sony S-Log3 S-Gamut3 Cine
  - Sony S-Log3 BT.2020
  - ARRI Log C Wide Gamut
  - ARRI LogC4 Wide Gamut 4
  - ARRI LogC4 Wide Gamut 4 WVO
  - Panasonic V-log
  - RED Log3G10 Wide Gamut
  - Canon Log 2
  - Canon Log 3
- Output Video Dynamic Range/Color Gamut (varies by mode)
  - SDR BT.709 100 Nits
  - SDR Extended BT.709
  - PQ BT.2020 1000 Nits
  - PQ BT.2020 ConstrainP3
  - PQ P3D65 1000 Nits
  - Hybrid Log Gamma BT.2100
  - HLG Extended BT.709
  - HLG Extended BT.2100
  - Sony S-Log3 S-Gamut3
  - Sony S-Log3 BT.2020
  - ARRI Log C Wide Gamut
  - ARRI LogC4 Wide Gamut 4
- TV Mode controls
  - Highlight management: Brightness, Highlight, Super Highlight
  - Colorfulness control for managing the Hunt Effect
  - Color Correction: Lift, Gamma, Gain, Saturation
  - Camera Correction: Exposure, Color Temp, Tint
  - Roundtrip control ensures technical match
  - Clamp to Legal

- Live Mode controls
  - SDR Preview
  - HDR Amount
  - Ambient Light Compensation control
  - HDR Log Look
  - SDR Softness control
  - Color Correction: Lift, Gamma, Gain, Saturation
  - Camera Correction: Exposure, Color Temp, Tint
  - PQ Output Nit level: 48-4000 Nit
  - PQ Output P3 Colorspace Clamp
  - ITU-R BT.2408 Mode control
  - SDR to Dolby Vision Preview controls
    - Highlights: Low, Mid, High
    - Contrast: Low, Mid, High
- Overlay

ORION-CONVERT Pipeline

- Conversion algorithm that uses floating point math
- Pre and post transform Knee and Amount controls
- Display-Light and Scene-Light Modes
- Configurable HDR and SDR IRE Reference anchor points
- Configurable HDR Peak Nits sets system gamma for display light conversions
- Gamma Compensation
- Configurable Output Clamping
- Input Video Dynamic Range/Color Gamut
  - SDR BT.709
  - PQ BT.2020
  - HLG BT.2100
- Output Video Dynamic Range/Color Gamut
  - SDR BT.709
  - PQ BT.2020
  - HLG BT.2100
- Overlay

BBC HLG LUTs Pipeline

- Mathematical dynamic range mapping per ITU-R BT.2408
  - SDR/BT.709 Scene Referred to HLG/BT.2100 v1.7
  - SDR/BT.709 Scene Referred to HLG/BT.2100 Strict v1.7
  - SDR/BT.709 Scene Referred UpMap to HLG/BT.2100 v1.7
  - SDR/BT.709 Scene Referred UpMap to HLG/BT.2100 Strict v1.7
  - SDR/BT.709 Display Referred to HLG/BT.2100 v.1.7
  - SDR/BT.709 Display Referred UpMap to HLG/BT.2100 v1.7
  - SDR/BT.2020 Display Referred to HLG/BT.2100 v1.7
  - SDR/BT.2020 Display Referred UpMap to HLG/BT.2100 v1.7
  - PQ 1000 Nits Display Referred to HLG/BT.2100 v1.7
  - PQ 4000 Nits Display Referred to HLG/BT.2100 v1.7
  - S-Log3/BT.2020 100% Scene Referred to HLG/BT.2100 v1.7
  - S-Log3/BT.2020 200% Scene Referred(SR-Live) to HLG/BT.2100 v1.7
  - HLG/BT.2100 to SDR/BT.709 Scene Referred v1.7
  - HLG/BT.2100 to SDR/BT.709 Scene Referred Strict v1.7
  - HLG/BT.2100 to SDR/BT.709 Display Referred Color Appearance Model v1.7

- HLG/BT.2100 to SDR/BT.709 Display Referred Super White v1.7
- HLG/BT.2100 to PQ 1000 Nits Display Referred v1.7
- HLG/BT.2100 to SDR/BT.2020 Display Referred Super White v1.7
- SDR/BT.709 Scene Referred UpMap to HLG/BT.2100 to SDR/BT.709 Display Referred v1.7

- RGB Color Corrector and ProcAmp
- Overlay

NBCU LUTs Pipeline

- NBCU LUTs developed by NBCUniversal Media, LLC
  - 1-NBCU_SDR2HLG_DL_v1.1, SDR UpMap to HLG using Display Light v1.1
  - 2-NBCU_SDR2HLG_SL_v1, SDR to HLG using Scene Light v1.0
  - 3-NBCU_HLG2SDR_DL_v1.1, HLG to SDR using Display Light v1.1
  - 4-NBCU_SDR2PQ_DL_v1, SDR UpMap to PQ using Display Light v1.0
  - 5-NBCU_PQ2SDR_DL_v1, PQ to SDR using Display Light v1.0
  - 7-NBCU_HLG10002PQ_v1, HLG 1000 Nits to PQ v1.0
- RGB Color Corrector and ProcAmp
- Overlay

ACES Pipeline

- ACES Metadata File (AMF) processing
- Implementation using ACES v1.3
- Built using OpenColorIO (OCIO)
- ARRI Alexa 35's Wireless Video Optimized LogC4 (WVO) Decoder
- Nonvolatile storage of 16x AMFs
- Overlay

Video Input and Output SDI

- 1x 12G-SDI Input BNC, SMPTE-292/424/2081/2082
- 2x 12G-SDI Output BNCs, SMPTE-292/424/2081/2082
- YCbCr 4:2:2/4:4:4
- RGB 4:4:4, SMPTE or Full level
- 10 or 12-bit
- 1x 12G-SDI
  - (4K) 4096x2160p 23.98, 24, 25, 29.97, 30, 47.95, 48, 50, 59.94, 60
  - (UltraHD) 3840x2160p 23.98, 24, 25, 29.97, 30, 50, 59.94, 60
- 1x 6G-SDI
  - (4K) 4096x2160p 23.98, 24, 25, 29.97, 30
  - (UltraHD) 3840x2160p 23.98, 24, 25, 29.97, 30
- 1x 3G-SDI (Level A or B-Dual Link)
  - (2K) 2048x1080p 23.98, 24, 25, 47.95, 48, 50
  - (2K) 2048x1080PsF 23.98, 24, 25
  - (HD) 1920x1080p 23.98, 24, 25, 29.97, 30, 50, 59.94, 60
  - (HD) 1920x1080PsF 23.98, 24, 25, 29.97, 30
  - (HD) 1920x1080i 50, 59.94, 60
  - (HD) 1280x720p 50, 59.94, 60

- 1x 1.5G-SDI
  - (2K) 2048x1080p 23.98, 24, 25, 29.97, 30
  - (2K) 2048x1080PsF 23.98, 24, 25
  - (HD) 1920x1080p 23.98, 24, 25, 29.97, 30
  - (HD) 1920x1080PsF 23.98, 24, 25, 29.97, 30
  - (HD) 1920x1080i 50, 59.94, 60
  - (HD) 1280x720p 50, 59.94, 60

Note: Raster and Frame Rate Dependent, please see OG-ColorBox Video Formats in Documents

Video Output HDMI

- 1x HDMI Type A connector*, HDMI v2.0b
- HDR infoframe generation with pass-through for Colorimetry and Transfer Characteristic
- YCbCr 4:2:2
- RGB 4:4:4, SMPTE or Full level
- 8, 10, or 12-bit (HFR 4K/UltraHD 4:4:4 limited to 8-bit)
- 4K/UltraHD/2K/HD
- 4K/2K Crop to UltraHD or HD

*If a connected monitor doesn't support HDMI protocol, the unit automatically switches to DVI protocol (which does not pass audio)

Note: Raster and Frame Rate Dependent, please see OG-ColorBox Video Formats in Documents

Video Processing

- Nominal video delay is less than 0.5 of a video line and less than 4.5 video lines when down-converting
- Motion adaptive deinterlacer
- Proc Amp controls
- Color corrector
- Legalizer

Down-Conversion

- Hardware 10-bit
- Independent down-conversion for SDI and HDMI outputs
  - 4K to 2K or UltraHD to HD (1920x1080)

Frame Store

- Capture and Recall up to 4K/UltraHD 16-bit .TIFF
- Capture and Recall .TIFF, .PNG, .JPEG
- Capture input or output
- Nonvolatile storage of 16 images

Test Pattern Generator

- 10 or 12-bit
- 14x patterns built-in
- SDR and HDR test patterns

Ancillary Data

- All embedded ANC packets pass-through, including camera ancillary data

Overlay

- User Text
- Input and Output ancillary information, including VPID
- Timecode presence
- Closed captioning presence
- Pipeline Configuration
- User Overlay, Recall .PNG overlay images up to 4096x2160
- Nonvolatile storage of 16 overlays

Audio Input Digital

- SDI embedded audio, 24-bit, 16-channel

Audio Output Digital

- SDI embedded audio, 24-bit, 16-channel
- HDMI embedded audio, 24-bit, 8-channel

Network Interface

- 1x RJ-45, 10/100/1000 Ethernet
- Embedded web server for remote control
- REST Interface

User Interfaces

- openGear DashBoard network control software via Windows, macOS, or Linux.
- Web User Interface
- DIP Switches

Presets

- 10 Pipeline Presets per mode (AJA Color, Colorfront, ORION-CONVERT, BBC HLG LUTs, NBCU LUTs, ACES))
- Startup Preset

Size (w x d x h)

- openGear standard form factor, front slot, and rear card
- Two slots required for each card

Weight

- 0.7 lb (0.3 kg)

Power

- openGear frame compatible, 19 watts max per card

Environment

- Safe Operating Temperature: 0 to 40 C (32 to 104 F)
- Safe Storage Temperature (Power OFF): -40 to 60 C (-40 to 140 F)
- Operating Relative Humidity: 10-90% noncondensing
- Operating Altitude: <3,000 meters (<10,000 feet)

Appendix B – Safety and Compliance

Federal Communications Commission (FCC) Compliance Notices

Class A Interference Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15, Subpart B of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Canadian ICES Statement

Canadian Department of Communications Radio Interference Regulations

This digital apparatus does not exceed the Class A limits for radio-noise emissions from a digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications. This Class A digital apparatus complies with Canadian ICES-003.

Règlement sur le brouillage radioélectrique du ministère des Communications

Cet appareil numérique respecte les limites de bruits radioélectriques visant les appareils numériques de classe A prescrites dans le Règlement sur le brouillage radioélectrique du ministère des Communications du Canada. Cet appareil numérique de la Classe A est conforme à la norme NMB-003 du Canada.

European Union, European Free Trade Association (EFTA) and United Kingdom Regulatory Compliance

This equipment may be operated in the countries that comprise the member countries of the European Union, European Free Trade Association and the United Kingdom. These countries, listed in the following paragraph, are referred to as The European Community throughout this document:

AUSTRIA, BELGIUM, BULGARIA, CROATIA, CZECH REPUBLIC, DENMARK, ESTONIA, FINLAND, FRANCE, GERMANY, GREECE, HUNGARY, ICELAND, IRELAND, ITALY, LATVIA, LIECHTENSTEIN, LITHUANIA, LUXEMBOURG, MALTA, NETHERLANDS, NORWAY, POLAND, PORTUGAL, REPUBLIC OF CYPRUS, ROMANIA, SLOVAK REPUBLIC, SLOVENIA, SPAIN, SWEDEN, SWITZERLAND, UNITED KINGDOM

Declaration of Conformity

Marking by these symbols indicates compliance with the Essential Requirements of the EMC Directive of the European Union 2014/30/EU.

This equipment meets the following conformance standards:

Safety

EN 62368-1: 2014 + A11 (T-Mark License),

IEC 62368-1: 2014 (CB Scheme Report/Certificates

Additional licenses issued for specific countries available on request.

Emissions

EN 55032: 2017 + A11: 2020, CISPR 32: 2015 + AMD 1: 2020,

EN 61000-3-2: 2019 + A1: 2021 + A2: 2024, EN 61000-3-3: 2013 + A1: 2019 + A2: 2021

Immunity

EN55035: 2017 + A11: 2020, EN 61000-4-2:2009, EN 61000-4-3: 2020,

EN 61000-4-4: 2012, EN 61000-4-5: 2014 +A1: 2017, EN 61000-4-6: 2023,

EN 61000-4-8: 2010, EN 61000-4-11: 2020

The product is also licensed for additional country specific standards as required for the International Marketplace.

Warning! This is a Class A product. In a domestic environment, this product may cause radio interference, in which case, the user may be required to take appropriate measures.

Achtung! Dieses ist ein Gerät der Funkstörgrenzwertklasse A. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen auftreten, in welchen Fällen der Benutzer für entsprechende Gegenmaßnahmen verantwortlich ist.

Attention! Ceci est un produit de Classe A. Dans un environnement domestique, ce produit risque de créer des interférences radioélectriques, il appartiendra alors à l'utilisateur de prendre les mesures spécifiques appropriées.

Recycling Notice

This symbol on the product or its packaging indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste for recycling, please contact your local authority, or where you purchased your product.

Korea KCC Compliance Statement

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정 용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

Taiwan Compliance Statement

警告使用者：
這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

This is a Class A product based on the standard of the Bureau of Standards, Metrology and Inspection (BSMI) CNS 15936: 2016, Class A. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Japan Compliance Statement

この装置は、クラスA情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。 VCCI－A

This is a Class A product based on the standard of the VCCI Council (VCCI 32: 2016). If this equipment is used in a domestic environment, radio interference may occur, in which case, the user may be required to take corrective actions.

Translated Warning and Caution Messages

The following caution statements, warning conventions, and warning messages apply to this product and manual.

 Warning Symbol  Caution Symbol

Before Operation Please Read These Instructions

Warning! Read and follow all warning notices and instructions marked on the product or included in the documentation.

Avertissement! Lisez et conformez-vous à tous les avis et instructions d'avertissement indiqués sur le produit ou dans la documentation.

Warnung! Lesen und befolgen Sie die Warnhinweise und Anweisungen, die auf dem Produkt angebracht oder in der Dokumentation enthalten sind.

¡Advertencia! Lea y siga todas las instrucciones y advertencias marcadas en el producto o incluidas en la documentación.

Aviso! Leia e siga todos os avisos e instruções assinalados no produto ou incluídos na documentação.

Avviso! Leggere e seguire tutti gli avvisi e le istruzioni presenti sul prodotto o inclusi nella documentazione.

Warning! Do not use this device near water and clean only with a dry cloth.

Avertissement! N'utilisez pas cet appareil près de l'eau et nettoyez-le seulement avec un tissu sec.

Warnung! Das Gerät nicht in der Nähe von Wasser verwenden und nur mit einem trockenen Tuch säubern.

¡Advertencia! No utilice este dispositivo cerca del agua y límpielo solamente con un paño seco.

Aviso! Não utilize este dispositivo perto da água e limpe-o somente com um pano seco.

Avviso! Non utilizzare questo dispositivo vicino all'acqua e pulirlo soltanto con un panno asciutto.

Warning! Do not block any ventilation openings. Install in accordance with the manufacturer's instructions.

Avertissement! Ne bloquez aucune ouverture de ventilation. Suivez les instructions du fabricant lors de l'installation.

Warnung! Die Lüftungsöffnungen dürfen nicht blockiert werden. Nur gemäß den Anweisungen des Herstellers installieren.

¡Advertencia! No bloquee ninguna de las aberturas de la ventilación. Instale de acuerdo con las instrucciones del fabricante.

Aviso! Não obstrua nenhuma das aberturas de ventilação. Instale de acordo com as instruções do fabricante.

Avviso! Non ostruire le aperture di ventilazione. Installare in conformità con le istruzioni del fornitore.

Warning! Do not install near any heat sources such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat.

Avertissement! N'installez pas l'appareil près d'une source de chaleur telle que des radiateurs, des bouches d'air de chauffage, des fourneaux ou d'autres appareils (amplificateurs compris) qui produisent de la chaleur.

Warnung! Nicht in der Nähe von Wärmequellen wie Heizkörpern, Heizregistern, Öfen oder anderen Wärme erzeugenden Geräten (einschließlich Verstärkern) aufstellen.

¡Advertencia! No instale cerca de fuentes de calor tales como radiadores, registros de calor, estufas u otros aparatos (incluidos amplificadores) que generan calor.

Aviso! Não instale perto de nenhuma fonte de calor tal como radiadores, saídas de calor, fogões ou outros aparelhos (incluindo amplificadores) que produzam calor.

Avviso! Non installare vicino a fonti di calore come termosifoni, diffusori di aria calda, stufe o altri apparecchi (amplificatori compresi) che emettono calore.

Warning! Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding type plug has two blades and a third grounding prong. The wide blade or the third prong are provided for your safety. If the provided plug does not fit into your outlet, consult an electrician for replacement of the obsolete outlet.

Avertissement! La sécurité de la prise polarisée ou de la prise de type mise à la terre ne doit en aucun cas être empêchée de fonctionner. Une prise polarisée a deux broches, l'une étant plus large que l'autre. Une prise de type mise à la terre a deux broches et une troisième broche pour la mise à la terre. La broche large ou la troisième broche sont fournies pour votre sécurité. Si la prise fournie ne s'insère pas dans votre prise femelle, consultez un électricien pour le remplacement de la prise femelle obsolète.

Warnung! Der Sicherheitszweck des gepolten bzw. Schukosteckers ist zu berücksichtigen. Ein gepolter Stecker verfügt über zwei Pole, von denen einer breiter als der andere ist. Ein Schukostecker verfügt neben den zwei Polen noch über einen dritten Pol zur Erdung. Der breite Pol bzw. der Erdungspol dienen der Sicherheit. Wenn der zur Verfügung gestellte Stecker nicht in Ihren Anschluss passt, konsultieren Sie einen Elektriker, um den veralteten Anschluss zu ersetzen.

¡Advertencia! No eche por tierra la finalidad del tipo de enchufe polarizado con conexión a tierra. Un enchufe polarizado tiene dos espigas, una más ancha que la otra. Un enchufe con conexión a tierra tiene dos espigas iguales y una tercera espiga que sirve para la conexión a tierra. La expiga ancha, o la tercera espiga, sirven para su seguridad. Si el enchufe suministrado no encaja en el tomacorriente, consulte con un electricista para reemplazar el tomacorriente obsoleto.

Aviso! Não anule a finalidade da segurança da ficha polarizada ou do tipo ligação terra. Uma ficha polarizada tem duas lâminas sendo uma mais larga do que a outra. Uma ficha do tipo de ligação à terra tem duas lâminas e um terceiro terminal de ligação à terra. A lâmina larga ou o terceiro terminal são fornecidos para sua segurança. Se a ficha fornecida não couber na sua tomada, consulte um electricista para a substituição da tomada obsoleta.

Avviso! Non compromettere la sicurezza della spina polarizzata o con messa a terra. Una spina polarizzata ha due spinotti, di cui uno più largo. Una spina con messa a terra ha due spinotti e un terzo polo per la messa a terra. Lo spinotto largo o il terzo polo sono forniti per motivi di sicurezza. Se la spina fornita non si inserisce nella presa di corrente, contattare un elettricista per la sostituzione della presa obsoleta.

Warning! Since the Mains plug is used as the disconnection for the device, it must remain readily accessible and operable.

Avertissement! Puisque la prise principale est utilisée pour débrancher l'appareil, elle doit rester aisément accessible et fonctionnelle.

Warnung! Da der Netzstecker als Trennvorrichtung dient, muss er stets zugänglich und funktionsfähig sein.

¡Advertencia! Puesto que el enchufe de la red eléctrica se utiliza como dispositivo de desconexión, debe seguir siendo fácilmente accesible y operable.

Aviso! Dado que a ficha principal é utilizada como a desconexão para o dispositivo, esta deve manter-se prontamente acessível e funcional.

Avviso! Poiché il cavo di alimentazione viene usato come dispositivo di sconnessione, deve rimane prontamente accessibile e operabile.

Warning! Protect the power cord from being walked on or pinched particularly at plugs, convenience receptacles, and the point where they exit from the device.

Avertissement! Protégez le cordon d'alimentation pour que l'on ne marche pas dessus ou qu'on le pince, en particulier au niveau des prises mâles, des réceptacles de convenance, et à l'endroit où il sort de l'appareil.

Warnung! Vermeiden Sie, dass auf das Netzkabel getreten oder das Kabel geknickt wird, insbesondere an den Steckern, den Steckdosen und am Kabelausgang am Gerät.

¡Advertencia! Proteja el cable de corriente para que no se le pise ni apriete, en especial cerca del enchufe, los receptáculos de conveniencia y el punto del que salen del equipo.

Aviso! Proteja o cabo de alimentação de ser pisado ou de ser comprimido particularmente nas fichas, em tomadas de parede de conveniência e no ponto de onde sai do dispositivo.

Avviso! Proteggere il cavo di alimentazione in modo che nessuno ci cammini sopra e che non venga schiacciato soprattutto in corrispondenza delle spine e del punto in cui esce dal dispositivo.

Warning! Unplug this device during lightning storms or when unused for long periods of time.

Avertissement! Débranchez cet appareil pendant les orages avec éclairsou s'il est inutilisé pendant de longues périodes.

Warnung! Das Gerät ist bei Gewitterstürmen oder wenn es über lange Zeiträume ungenutzt bleibt vom Netz zu trennen.

¡Advertencia! Desenchufe este dispositivo durante tormentas eléctricas o cuando no se lo utilice por largos periodos del tiempo.

Aviso! Desconecte este dispositivo da tomada durante trovoadas ou quando não é utilizado durante longos períodos de tempo.

Avviso! Utilizzare soltanto i collegamenti e gli accessori specificati e/o venduti dal produttore, quali il treppiedi e l'esoscheletro.

Warning! Refer all servicing to qualified service personnel. Servicing is required when the device has been damaged in any way, such as power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the device, the device has been exposed to rain or moisture, does not operate normally, or has been dropped.

Avertissement! Référez-vous au personnel de service qualifié pour tout entretien. L'entretien est exigé quand l'appareil a été endommagé de quelque manière que ce soit, par exemple lorsque le cordon d'alimentation ou la prise sont endommagés, que du liquide a été versé ou des objets sont tombés dans l'appareil, que l'appareil a été exposé à la pluie ou à l'humidité, ne fonctionne pas normalement ou est tombé.

Warnung! Das Gerät sollte nur von qualifizierten Fachkräften gewartet werden. Eine Wartung ist fällig, wenn das Gerät in irgendeiner Weise beschädigt wurde, wie bei beschädigtem Netzkabel oder Netzstecker, falls Flüssigkeiten oder Objekte in das Gerät gelangen, das Gerät Regen oder Feuchtigkeit ausgesetzt wurde, nicht ordnungsgemäß funktioniert oder fallen gelassen wurde.

¡Advertencia! Consulte al personal calificado por cuestiones de reparación. El servicio de reparación se requiere cuando el dispositivo ha recibido cualquier tipo de daño, por ejemplo cable o espigas dañadas, se ha derramado líquido o se han caído objetos dentro del dispositivo, el dispositivo ha sido expuesto a la lluvia o humedad, o no funciona de modo normal, o se ha caído.

Aviso! Remeta todos os serviços de manutenção para o pessoal de assistência qualificado. A prestação de serviços de manutenção é exigida quando o dispositivo foi danificado mediante qualquer forma, como um cabo de alimentação ou ficha que se encontra danificado/a, quando foi derramado líquido ou caíram objectos sobre o dispositivo, quando o dispositivo foi exposto à chuva ou à humidade, quando não funciona normalmente ou quando foi deixado cair.

Avviso! Fare riferimento al personale qualificato per tutti gli interventi di assistenza. L'assistenza è necessaria quando il dispositivo è stato danneggiato in qualche modo, ad esempio se il cavo di alimentazione o la spina sono danneggiati, è stato rovesciato del liquido è stato rovesciato o qualche oggetto è caduto nel dispositivo, il dispositivo è stato esposto a pioggia o umidità, non funziona correttamente o è caduto.

Warning! Do not open the chassis. There are no user-serviceable parts inside. Opening the chassis will void the warranty unless performed by an AJA service center or licensed facility.

Avertissement! Ne pas ouvrir le châssis. Aucun élément à l'intérieur du châssis ne peut être réparé par l'utilisateur. La garantie sera annulée si le châssis est ouvert par toute autre personne qu'un technicien d'un centre de service ou d'un établissement agréé AJA.

Warnung! Öffnen Sie das Gehäuse nicht. Keine der Geräteteile können vom Benutzer gewartet werden. Durch das Öffnen des Gehäuses wird die Garantie hinfällig, es sei denn, solche Wartungsarbeiten werden in einem AJA-Service-Center oder einem lizenzierten Betrieb vorgenommen.

¡Advertencia! No abra el chasis. El interior no contiene piezas reparables por el usuario. El abrir el chasis anulará la garantía a menos que se lo haga en un centro de servicio AJA o en un local autorizado.

Advertência! Não abra o chassi. Não há internamente nenhuma peça que permita manutenção pelo usuário. Abrir o chassi anula a garantia, a menos que a abertura seja realizada por uma central de serviços da AJA ou por um local autorizado.

Avvertenza! Non aprire lo chassis. All'interno non ci sono parti riparabili dall'utente. L'apertura dello chassis invaliderà la garanzia se non viene effettuata da un centro ufficiale o autorizzato AJA.

Warning! Disconnect the external AC power supply line cord(s) from the mains power before moving the unit.

Avertissement! Retirez le ou les cordons d'alimentation en CA de la source d'alimentation principale lorsque vous déplacez l'appareil.

Warnung! Trennen Sie die Wechselstrom-Versorgungskabel vom Netzstrom, bevor Sie das Gerät verschieben.

¡Advertencia! Cuando mueva la unidad desenchufe de la red eléctrica el/los cable(s) de la fuente de alimentación CA tipo brick.

Advertência! Remova os cabos CA de alimentação brick da rede elétrica ao mover a unidade.

Avvertenza! Scollegare il cavo dell'alimentatore quando si sposta l'unità.

Warning! Only use attachments and accessories specified and/or sold by the manufacturer.

Avertissement! Utilisez seulement les attaches et accessoires spécifiés et/ou vendus par le fabricant.

Warnung! Verwenden Sie nur Zusatzgeräte und Zubehör angegeben und / oder verkauft wurde durch den Hersteller.

¡Advertencia! Utilice solamente los accesorios y conexiones especificados y/o vendidos por el fabricante.

Aviso! Utilize apenas equipamentos/acessórios especificados e/ou vendidos pelo fabricante.

Avviso! Utilizzare soltanto i collegamenti e gli accessori specificati e/o venduti dal produttore.

5 Year Warranty and Liability Information

Limited Warranty on Hardware

AJA Video Systems, Inc. (AJA Video) warrants that the hardware product, not including software components, will be free from defects in materials and workmanship for a period of five years from the date of purchase. AJA Video provides a separate software warranty as part of the license agreement applicable to software components.

If the Customer brings a valid claim under this limited warranty for a hardware product (hereafter, a "product") during the applicable warranty period, AJA Video will, at its sole option and as the Customer's sole remedy for breach of the above warranty, provide one of the following remedies:

- Repair or facilitate the repair the product within a reasonable period of time, free of charge for parts and labor.
- Replace the product with a direct replacement or with a product that performs substantially the same function as the original product.
- Issue a refund of the original purchase price less depreciation to be determined based on the age of the product at the time remedy is sought under this limited warranty.

To obtain service under this warranty, the Customer must notify AJA Video of the defect before expiration of the warranty period and make suitable arrangements for the performance of service by contacting AJA Video support through the channels set forth on the support contacts web page at https://www.aja.com/support. Except as stated, the Customer shall bear all shipping, packing, insurance and other costs, excluding parts and labor, to effectuate repair. Customer shall pack and ship the defective product to a service center designated by AJA Video, with shipping charges prepaid. AJA Video shall pay to return the product to Customer, but only if to a location within the country in which the AJA Video service center is located. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES OR LIMITATIONS ON APPLICABLE STATUTORY RIGHTS OF A CONSUMER, SO SOME OR ALL OF THE TERMS OF THIS PARAGRAPH MAY NOT APPLY TO YOU.

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