

AMIRA

Color by Numbers

WHITE PAPER (DRAFT VERSION)

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1. Introduction

The ARRI AMIRA is a versatile documentary-style camera that combines exceptional image quality and affordable CFast 2.0 workflows with an ergonomic design that is optimized for single-operator use. Its flexible color processing chain offers the ease of editing video with the possibilities of capturing log data. This makes an AMIRA suitable for production scenarios ranging from daily broadcast production to high quality drama.

This document gives an insight to the color processing of an AMIRA and describes the creative options you can use when shooting with this camera.

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2. Shooting with the AMIRA

The ARRI AMIRA uses a new revision of the same Super 35 sensor, that can be found in the ARRI ALEXA and ALEXA XT cameras. This enables an AMIRA to capture 16:9 HD or 2K QuickTime ProRes clips at up to 200 frames per second. As with the ALEXA, an AMIRA allows you to store your footage, encoded as **Log C** data or **Rec 709** video. These terms refer to two types of image encoding that are commonly used in today's broadcast and feature productions.

2.1. Rec 709 Video

Rec 709 video is the default video encoding in an HDTV production. Without the time, the budget or the tools to allow color grading, shooting Rec 709 video for recording will produce images that are ready to use for edit or TV broadcast without further conversion. The term **video** refers to images that are encoded for display on a computer, video monitor, or digital projector.

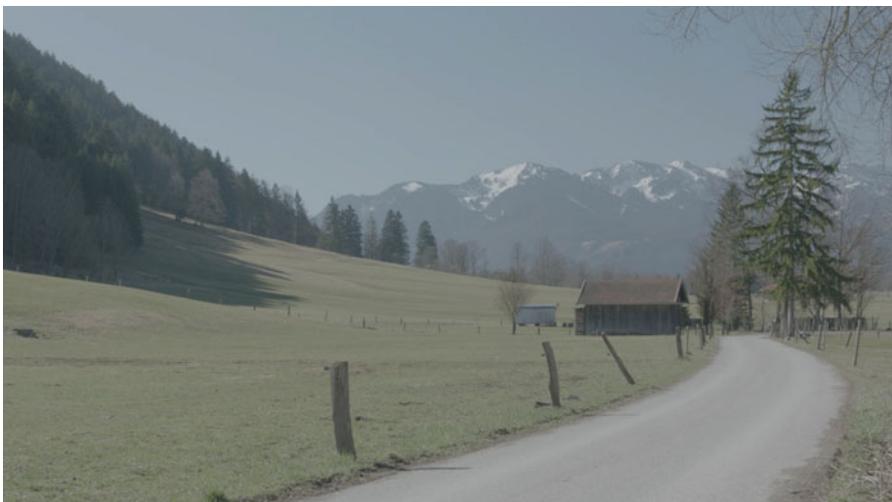
Rec 709, short for ITU Rec. BT.709, defines the primary colors and white point of HDTV displays. In addition to this, the contrast characteristic curve for flat panel displays is defined in ITU Rec. BT.1886.



2.2. Log C

If you have access to current editing tools, you can unlock the camera's true potential by recording Log C. The digital numbers in a Log C encoded image are proportional to the exposure measured in stops. This creates a flat "data curve" which provides optimum control over the image information in the top range of the camera's 14-stop latitude. Log C encoding, which is the same basis for all ALEXA and AMIRA camera formats, stores color information in the native camera color space.

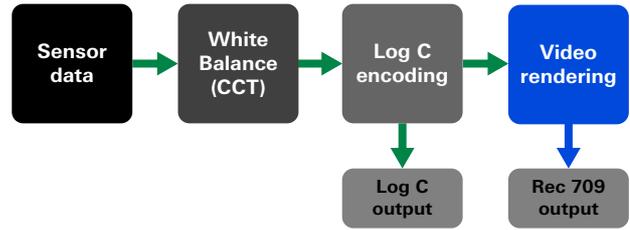
To properly view the footage on a monitor, it has to be converted to the color space of the viewing device (e.g. Rec 709 video for an HDTV).



2.3. Processing Chain

After an exposed image is read from the sensor, the camera first applies a white balance and then encodes the sensor-linear image to a Log C image, which can be recorded.

The default video output option, or default look of the AMIRA is Rec 709 video. If you set the camera to deliver Rec 709, the camera renders the video output based on the Log C encoded image.



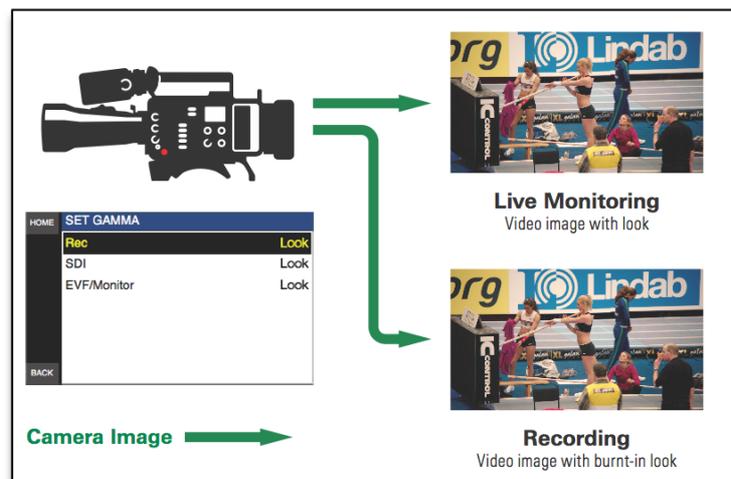
2.4. Capturing Images with Looks

Using the GAMMA menu in the camera, you can choose between Look and Log C output for **Recording**, **SDI**, and **EVF/Monitor** (the viewfinder and its external display). While you typically want the look to be visible in the viewfinder and over the SDI outputs, you may prefer to keep the recorded image in Log C, unless you have to deliver Rec 709 files straight out of the camera.

Rec: Look

Selecting **Look** for the recorded image means that it will be transformed with the look. The active look becomes inseparable from the image.

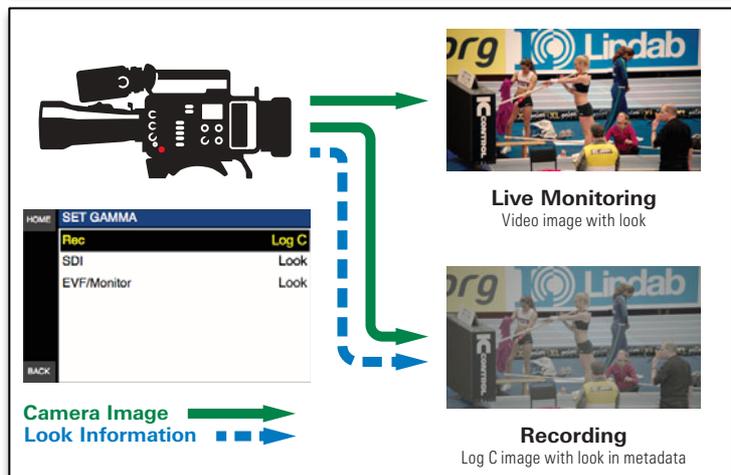
If the look, for example, produces a black and white image, you will not be able to take the look out to get the colors back.



Rec: Log C

Selecting **Log C** for the recorded image means that the look is registered only as metadata, embedded in the camera footage.

Since the look can be applied, or simply discarded, recording Log C with look metadata is a non-destructive operation.



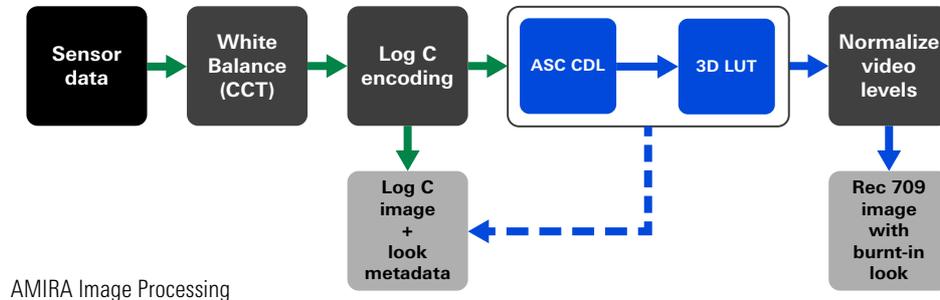
3. Look Controls

Next to the default Rec 709 video look, the AMIRA's LOOK menu offers a few look options, to deliver, for example, a softer transition into highlights (LCC), or more vivid images. Depending on the camera license – Eco, Advanced, or Premium – the look menu allows you to create your own look by modifying one of the presets, or to manage (add, duplicate, modify, export and delete) a look or to bring in a 3D LUT that was created with a color grading tool and use that as the look.

An AMIRA Look File can be put together from two sets of control parameters. The first part are ASC CDL parameters, that will be applied to the Log C encoded image. Second, a rendering 3D LUT, which controls the transformation of Log C data to the output color space.

This 3D LUT can be:

- a) the default ARRI AMIRA 3D LUT, providing a Rec 709 video output.
- b) a customized version of the 3D LUT with a tone map curve and/or color transformations that have been modified with the Video Look Parameters (see below).
- c) an imported User 3D LUT, that was generated in a color grading tool. VLP controls are not available when an imported 3D LUT is used.



With the basic feature set, the AMIRA offers only the Video Look Parameters for look adjustments. The Advanced license adds ASC CDL controls and support for external look files. The Premium version enables all look options, including the use of custom 3D LUTs in the look files.

3.1. Why use Looks?

Establishing looks in early in the production process helps everyone, who is involved in the production. Being able to monitor images with their intended look during the shoot and during editing helps getting used to the visual language of the production. As a result, we hope to see less time spent in the color grading sessions, because everybody will have the same idea of what the images are supposed to look like.

To establish one or more looks, you can:

- Shoot some **reference images** representing the key visuals.
- **Establish the main looks** in a grading session with the colorist.
- **Use looks in camera** to monitor the image with look while on set.
- See images with look **during the edit**.
- Finalize color **grading based on looks**.

3.2. ASC CDL Transforms

The American Society of Cinematographers has specified a set of transforms that have become a standard in the post industry. The transforms are controlled by the parameters slope, offset, power and saturation (applied in that order), which are based on simple color manipulations of multiplying with a factor, adding an offset, or raising to an exponent. Noted as "Color Decision List" (ASC CDL), they serve as an exchange format for basic look transformations between color correction systems and editing tools by different manufacturers.

The AMIRA image processing applies the ASC CDL transforms to the Log C encoded image. This enables manipulations like exposure correction or bringing down highlights, before the picture is converted to the display color space with its steeper contrast curve.

The ASC CDL adjustments are available for AMIRA Advanced and Premium.

Slope

The linear section of the Log C curve is equivalent to the gamma of a negative film stock. The Log C curve has a default gamma of approximately 0.51, which can be adjusted with the slope parameter.

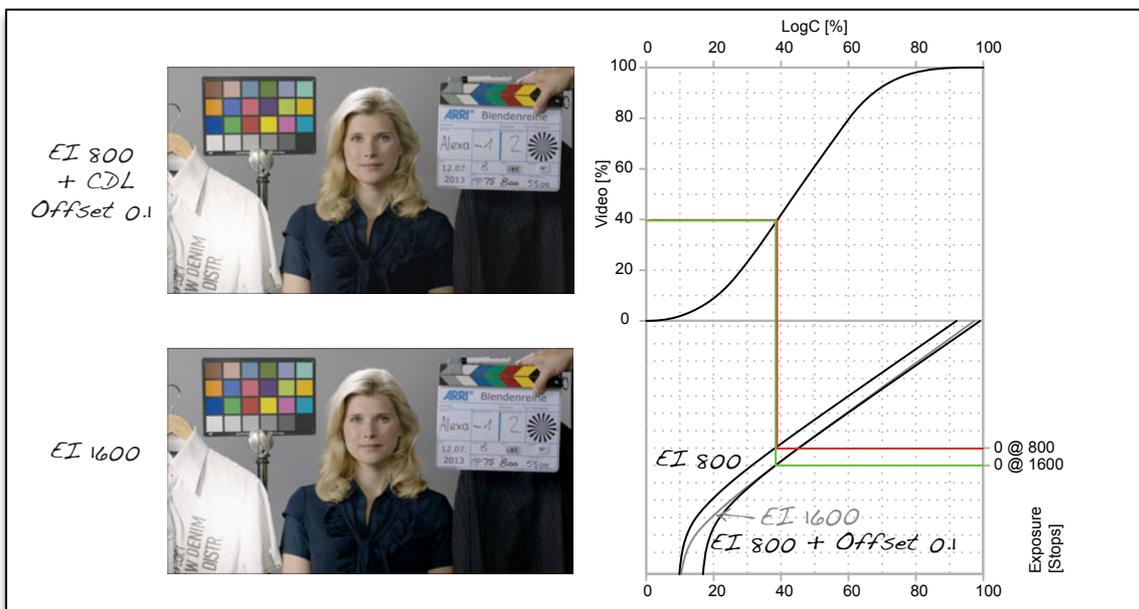
A slope value of 1.2 will have a similar effect as using negative stock with a gamma of 0.6 ($= 1.2 * 0.5$). A parameter below 1.0 will lower the gamma accordingly.



Offset

Offset is the most intuitive of the CDL parameters. It has a similar effect as increasing the exposure index on the camera. If you are familiar with the motion picture print film process, it's the same as printer lights.

The images below show a scene that was exposed for 1600 ASA. In one case, the camera was set to EI 800, resulting in an underexposure of one stop. This was corrected with a CDL offset value of 0.07.

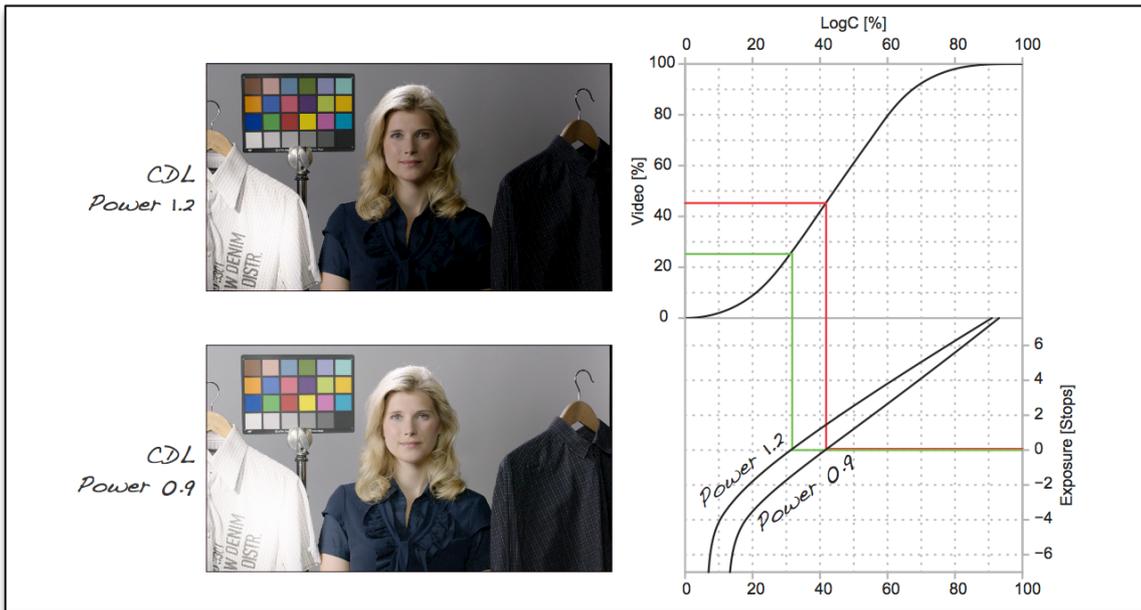


Power

Power can be used to adjust the mid tones, similar to the Gamma parameter in video color grading.

A power value below 1.0 will increase the brightness of the mid tones.

A value greater than 1.0 will decrease their brightness.



(Log) Saturation

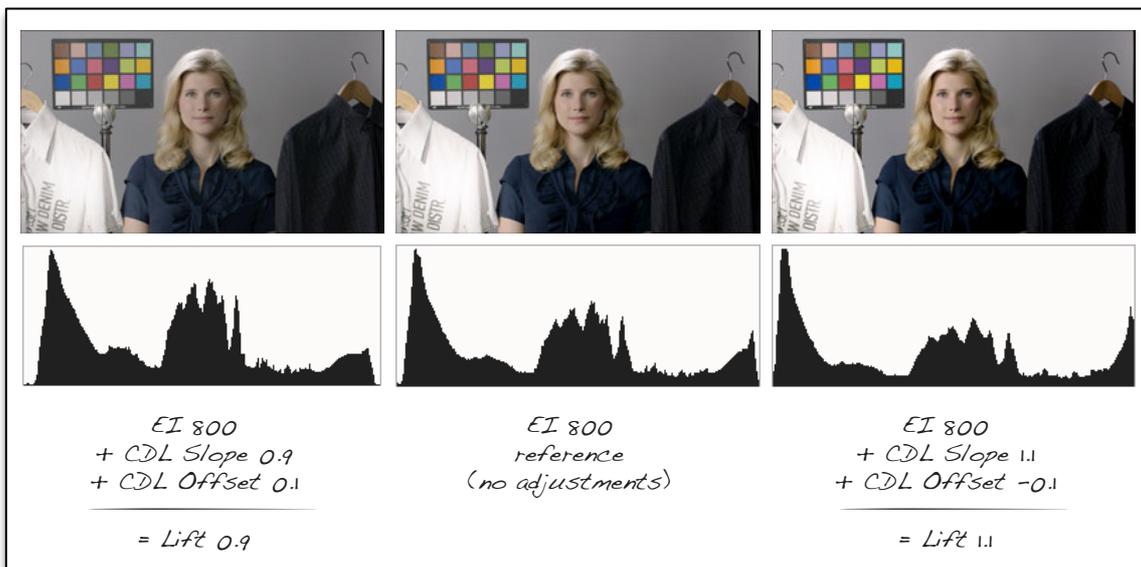
The saturation parameter affects all color components in the Log domain.



Slope + Offset = Lift

Very often, slope is combined with an offset to compensate the change in overall brightness. In other words, this operation tries to keep the white point at a fixed position and rotate the (Log C) curve around that point. In video color grading, this combination is called lift.

As an example, a slope of 1.15 with an offset of -0.15 will keep the highlights at a constant level.



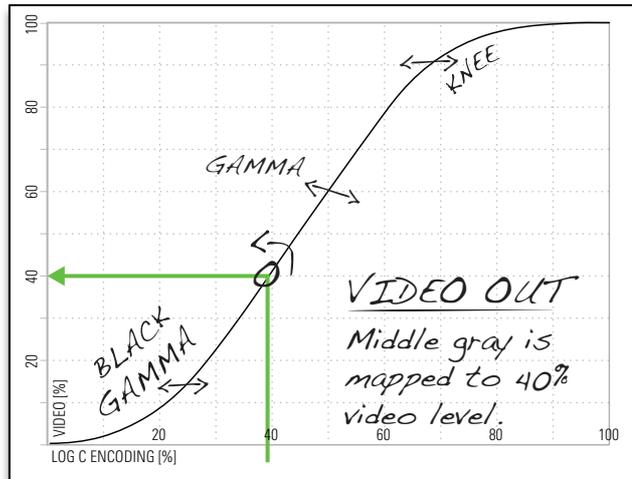
3.3. 3D LUT and Video Look Parameters

The AMIRA uses a 3D LUT to generate a Rec 709 video image from Log C data. Next to the ASC CDL parameters, which apply to the Log C image, the camera also offers a set of Video Look Parameters (VLP), that influence the tone mapping and color transformation of the rendering 3D LUT.

The VLP control knee, black gamma and the gamma of the tone map curve, which affect the contrast characteristic of the output image. The VLP also include values for saturation and the saturation by hue for the six color vectors of green, yellow, red, magenta, blue, and cyan.

Regardless of the adjustments, the underlying 3D LUT always performs a Log C to Rec 709 color space conversion.

Video Look Parameters are available in all three AMIRA license bundles.



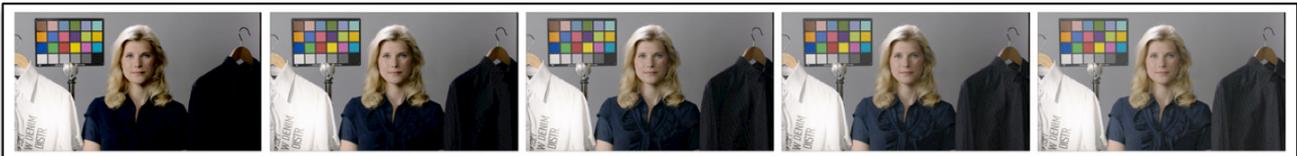
Knee

The knee parameter controls the transition of mid-tones into highlights. Values below 0.5 (default) produce harder highlights, higher values soften them. Knee is applied to all channels equally (master control). It has no effect on the mid gray level.



Black gamma

The black gamma controls the shadow detail in the image. Values below 0.5 (default) bring down the blacks, higher values brightens them. Black gamma is applied as master control. It only affects the mid gray level for very high values.



Gamma

The gamma setting can be used to brighten or darken the mid tones, while leaving the black and white level unchanged. Values below 1.0 (default) will darken the image, higher values will brighten the image.



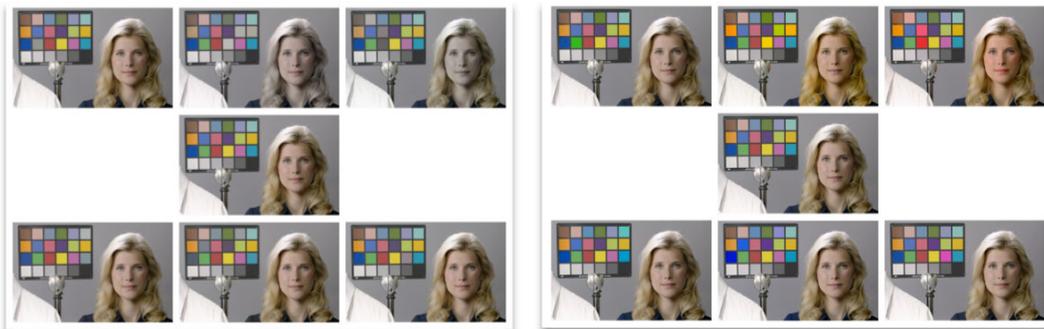
(Video) Saturation

The VLP set also includes a saturation control, which has a similar effect as the ASC saturation control. A value of 1.0 represents the default saturation.



Saturation by Hue

The AMIRA allows you to control the saturation for the six color vectors red, yellow, green, cyan, blue, and magenta. In the images below, the center shows the scene, photographed with default values. Starting at the top left, going clockwise, you can see the effect of turning the hue values for green, yellow, red, magenta, blue, and cyan to zero (left group) or maximum (right group).

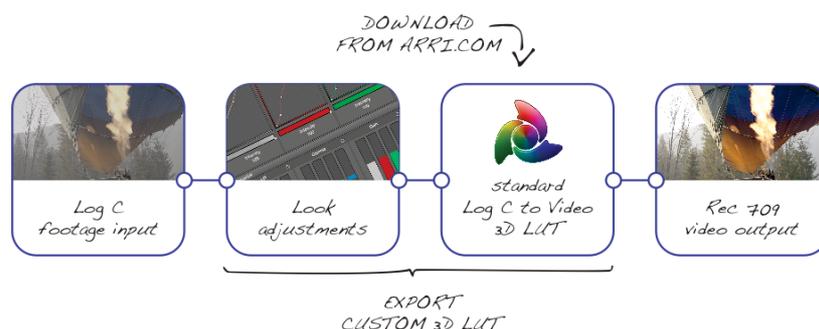


3.4. Custom 3D LUT

The AMIRA Premium can also use a look file that includes a custom 3D LUT, created and exported from a color grading tool. This LUT then needs to be stored in the AMIRA Look File format with the free AMIRA Color Tool (or directly in the color correction tool if it supports the export of AMIRA Look Files).

Using a custom 3D LUT disables the video look parameter controls. The resulting look, however, can still be tuned with the ASC CDL parameters.

A grading system usually offers better and finer color adjustment options for all parameters described above. It also offers additional manipulations, that are not available with the set of CDL and VLP values, such as the ability to pick any key color, not just one of the six main color vectors, and change its chromaticity rather than just its saturation.



To generate a 3D LUT for use in the AMIRA, you can follow these steps:

- 1) Load Log C footage.
- 2) Apply creative color grading.
- 3) Apply Log C to Rec 709 video rendering (or any other output color space).
- 4) Show resulting look on a reference monitor.
- 5) Export the look for the AMIRA as a concatenated 3D LUT, using the transforms from steps 2 and 3.

A good line of action is to include a default ARRI Log C to Rec 709 video 3D LUTs as an output LUT (step 3) in the grade. This ensures that your color grade starts from a color-correct output image.

Remember, the default rendering 3D LUT performs a tone mapping and a color space conversion! A default 3D LUT can be generated with our online ARRI LUT Generator at www.arri.com/alexa/tools.

4. Creating Looks

There are several ways to create a look for the AMIRA. One option is to use a dedicated color grading tool using the steps described above, to create a look from a custom 3D LUT. This option, however, is only available for AMIRA cameras running the Premium license bundle.

Another option would be the AMIRA Color Tool, a free Mac software by ARRI, that can be used to create an AMIRA Look file with all CDL and VLP controls using a graphical interface.

Last, but not least, the camera also offers a Look Parameter screen that will allow you to create or modify a look with nothing but the camera and a monitor, attached to the camera's HD-SDI output.

4.1. In-Camera Grading

The Gamma/Look menu in the AMIRA can be used to import, export, duplicate, load, edit and save looks. The basic AMIRA (Eco) is limited to three look options and lacks the ability to load or export a look.

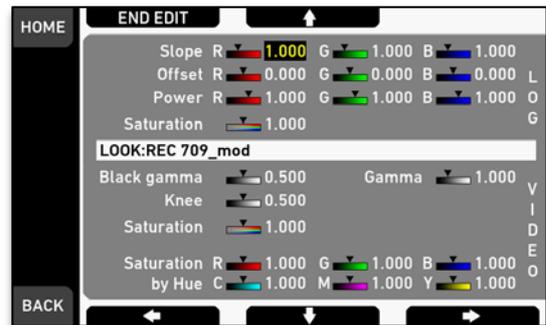
Creating a Look from Scratch

Start by duplicating the default Rec 709 look and saving it under the new look's name. You can also overwrite a look. Default looks can be restored from the menu.

Adjust the ASC CDL parameters and/or the Video Look Parameters and monitor the changes via the SDI output.

Tuning a Look

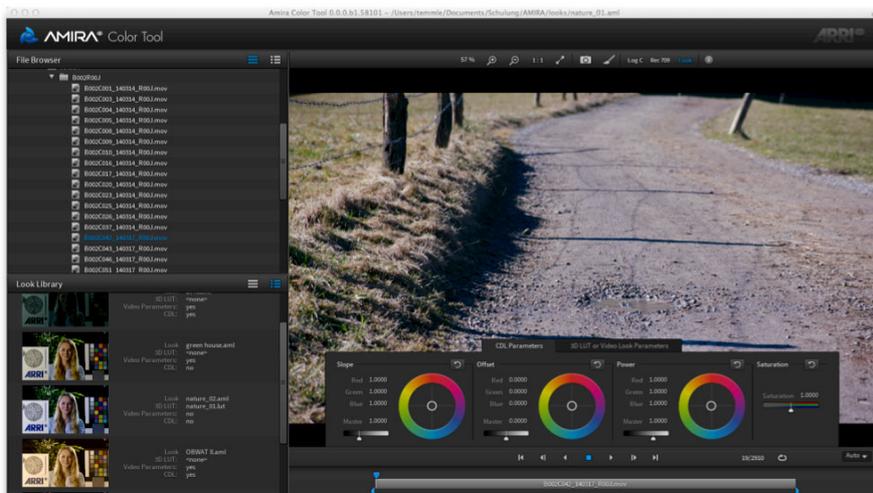
If adjustments like a change of the white balance cannot modify a look towards where you want it, you first should duplicate the original ARRIA Look File and save the copy under a new name. Next, use the ASC CDL controls to modify e.g. the color reproduction and/or the Video Look Parameters to adjust the tonal balance of the output. If the AMIRA Look File was created from a custom User 3D LUT, you can only make adjustments with the ASC CDL parameters.



4.2. AMIRA Color Tool

ARRI provides a free software that allows you to create, modify and store AMIRA Look Files outside the camera. The software can read files from camera footage or a library on the hard drive or import a custom 3D LUT that was created in a color grading tool and save looks in the AMIRA Look File format or export them as 3D LUT and separate CDL parameters (XML) or 3D LUT including CDL parameters for use in other applications.

Using the AMIRA Color Tool lets you work faster and more convenient than the camera menu. The software offers easy to use mouse or keyboard color controls (support for grading panels is planned).



4.3. Look Examples

The AMIRA ships with some ready-to-use technical or creative looks. Except for the X-2-ALEXA Look, all are created with Video Look Parameters and thus can be modified to your liking.

LCC (Low Contrast Curve)

Black Gamma = 0.8, Knee = 0.85, Saturation = 0.7

If you cannot use Log C encoding, but need better highlight handling, you can use the LCC look. With this flattened Gamma curve, highlight definition and some black detail that would be lost by the typical Rec 709 tone mapping can still be accessed. For the final image, you can adjust the contrast to all critical image detail remains visible, but the overall softness is taken out again. Since the look already includes a Log C to Rec 709 color space conversion, no additional rendering step is required.

Commercial

Black Gamma = 0.3, Knee = 0.4, Gamma = 1.4

A creative, brighter look for nicer skin tones.

Landscape

Black Gamma = 0.3, Knee = 0.2, Gamma = 1.4, Saturation = 1.15

A creative look with a steeper contrast curve and lifted saturation.

Vibrant

Black Gamma = 0.4, Knee = 0.4, Saturation = 1.05, Saturation by Hue G/B/C/M = 1.15

This creative look boosts the color saturation except for red and yellow.

X-2-ALEXA

3D LUT (Premium Only)

This technical look produces a Rec 709 video output, closely matching that of an ALEXA camera.

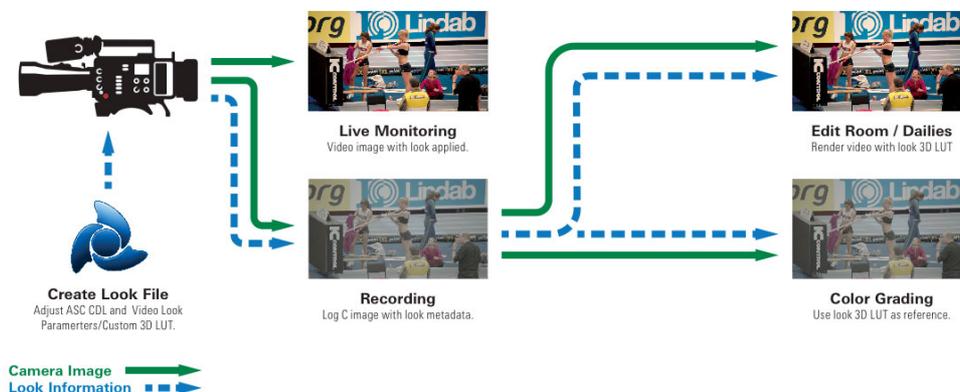
This look is based on a 3D LUT and requires a premium license. To tweak this look, you can only use the CDL parameters.

5. Looks in the Edit

Full AMIRA Look Support

At NAB 2014, Adobe, Avid, Colorfront and Pomfort were the first to embrace this look concept. They presented beta versions of their software that can read the look information from the QuickTime metadata in each AMIRA Log C clip and automatically perform the video rendering based on that look file.

As a result, the editor, DIT or data wrangler see the same image including the look that active in the camera, as the footage was shot. This step is fully automatic, adjustable and reversible. It represents a big improvement to Log C workflows as it combines the superior elasticity of Log C footage with the simplicity of video workflows.



Basic Log C Support

Many major editing tools already offer at least basic support for Log C material. In some cases (Final Cut Pro X, Media Composer 7 and later), the application will automatically detect Log C encoded material and apply a default Log C to Rec 709 video conversion.

Without Log C or Look Support

If the editing tool in use does not offer Log C support of any kind, you can use the AMIRA Color Tool to extract the look from the footage, export the look as a 3D LUT and render Rec 709 video dailies with a tool such as the free Blackmagic DaVinci Resolve Lite.

To learn how this can be done, please have a look at the ALEXA Dailies using Resolve 10 White Paper, available from www.arri.com/alexa/downloads.



Keeping looks available

One advantage of the new color/look concept in the AMIRA is, that it is based on 3D LUTs, which are supported by a great number of post production tools. When a look is used (with Log C recording), the AMIRA stores different flavors of this look as metadata in the QuickTime clips.

- Complete 3D LUT including all CDL and VLP settings, or CDL and custom 3D LUT.
- 3D LUT including only VLP settings, without CDL values.
- CDL values without VLF settings.

Even if it takes years until you get back, for example to re-master the original footage, you will be able to extract the original intended look and use it as a reference for your work.

6. Contact

If you have questions or recommendations about this paper, please contact the ARRI Digital Workflow Solutions group at digitalworkflow@arri.de.