Alternative HLG appearance with Grass Valley LDX cameras

Matthias Wilkens

UHD/HDR-Supervisor

matthias.wilkens@bet.de

www.bet.de

Preface

For most broadcasters, HLG (Hybrid Log Gamma) is the production format of choice to produce and distribute HDR (High Dynamic Range) content.

However, the native appearance of HLG is criticised by some, especially due to its characteristic look of having more visible image content in darker image areas. Some content producers might prefer an alternative, non-standard look where the camera characteristics in the blacks are intentionally changed, to creatively design a specific look.

In an ideal scenario, where only HDR sources are used, this won't be an issue. However, in a common production environment with mixed SDR (Standard Dynamic Range) and HDR equipment, this creative approach has an immediate effect on the SDR-to-HDR signal mapping.

For some time now, SONY, with its own eco-system of HDC cameras in combination with the HDRC-4000 production converter unit, has offered the possibility to create a certain look in the blacks with their "Black Compress" function. Until recently, it was not possible to create a similar look with Grass Valley cameras.

This article gives a quick overview of how this look is now implemented in Grass Valley cameras and how this, in combination with certain BBC[1] LUTs, offers complete mapping workflows.

SDR appearance with "Gamma"

The ITU-R BT.601/709/2020 SDR "Gamma" is based on two combined characteristics, the most important being an initial gain, which limits the gradient of the lower end of the signal curve and leads to compressed blacks. The result is an image that is perceived to have more contrast without changing the technical contrast[2]. This so called "Strict gamma" follows exactly the defined mathematical calculation.

Within GV's LDX cameras, an alternative, called "SQRT[3] gamma", is available. Activating SQRT gamma implements a straight-forward power function with an exponent of 0.5 and no initial gain.
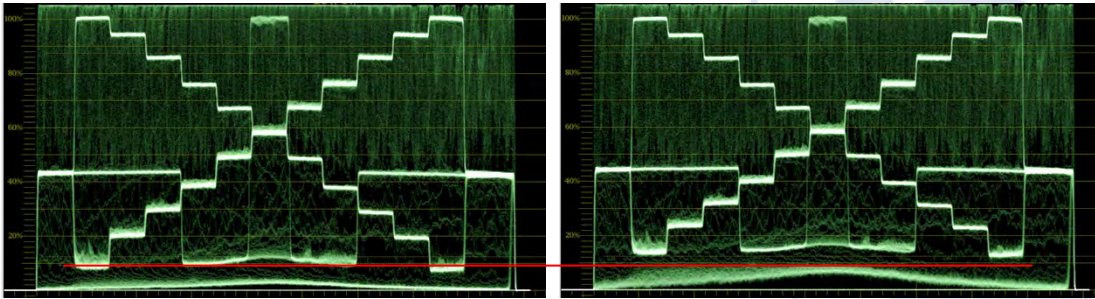
---

[1] BBC = British Broadcasting Corporation
[2] Contrast between 0% and 100% of video level
[3] SQRT = Square Root

BASE OF EXPERT TRAINING

These two Waveform screenshots clarify the difference between "Strict gamma" and "SQRT gamma":

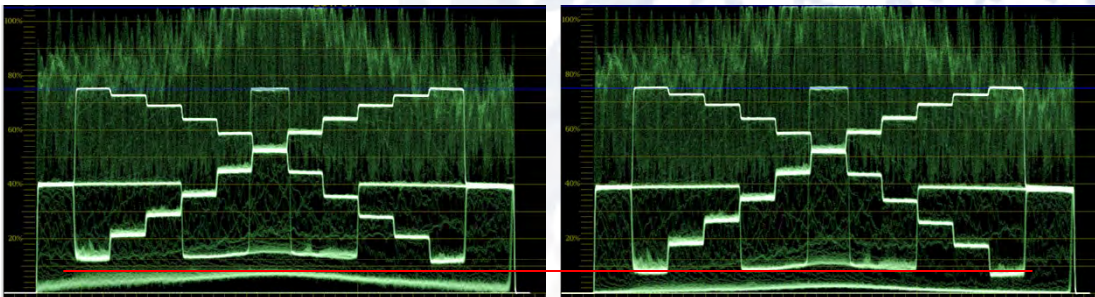Left: "Strict gamma" provides what most people perceive as darker or richer blacks.
Right: "SQRT gamma" provides more visible content in darker parts of the image.

HLG appearance

Hybrid Log Gamma, following ITU-R BT.2100, is a hybrid signal, based on a standard SDR gamma, enhanced with logarithmic quantization. In HLG, the gamma part of the transfer function does not follow the Strict gamma approach but uses SQRT gamma instead. The result is more visible content in the darker parts of the image. This was deliberately chosen and is technically understandable, however it leads to an unfamiliar look compared to typical SDR content.

As a recent addition GV LDX cameras now offer an alternative HDR look by using a new function: "Black Contrast". This brings back the initial gain function as used in SDR and leads to a HLG signal with Strict gamma in the gamma part of the HLG transfer function.

The following two waveforms illustrate the differences in the dark picture areas achieved by these two approaches:

Left: "SQRT gamma" delivers more visible content in darker areas in HLG.
Right: "Strict gamma" delivers a more familiar image with what most people perceive as darker or richer blacks.

When "Black Contrast" gets activated, and therefore HLG no longer follows its initial mathematical definition, a correct mapping to SDR is mandatory. A "transparent" mapping can only be achieved when the camera and mapper characteristics are precisely matched.

BASE OF EXPERT TRAINING

Standard Mapping

To use a mix of SDR and HDR camera signal sources in today's HDR production, the SDR signals need to be mapped to HLG. The BBC defined two variants of the BBC LUT #4[4] for scene light mapping from SDR to HLG.

This table clarifies the relationship:

LUT	source	destination	characteristic
#4-2	SDR (Strict gamma)	HLG (SQRT gamma)	Changes the SDR appearance in HLG
#4-1	SDR (SQRT gamma)	HLG (SQRT gamma)	Keeps the SDR appearance in HLG

Both LUTs are needed, as both types of SDR are available in SDR cameras / sources.

Therefore, to choose the right mapping, it is essential to know which type of SDR gamma is used at the source. Then, by using the correct BBC LUT #4 variation, the right HLG appearance is achieved.

The following two waveform screenshots illustrate the difference in mapping results from SDR to HDR:
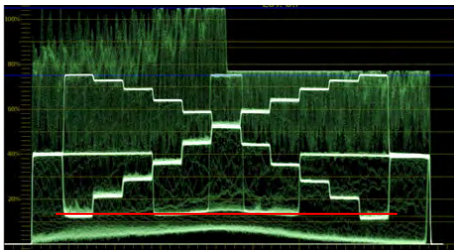
On the left, a native HLG camera source is shown and, on the right, an SDR camera with Strict gamma mapped to HLG is shown.

This mapping to HDR utilises the BBC LUT #4-2. The result is level transparent – and therefore correct.
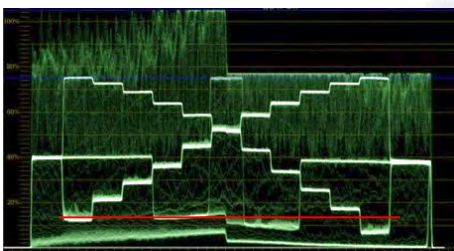
Again, on the left a native HLG camera source is shown and, on the right, an SDR camera with Strict gamma mapped to HLG is shown.
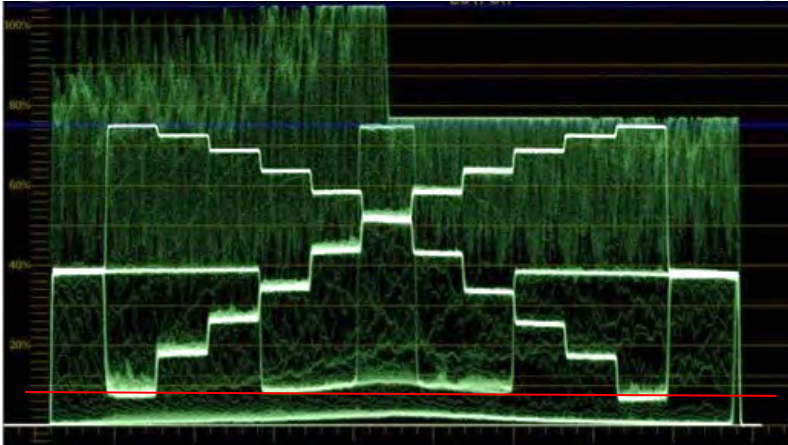
This mapping to HDR utilises the BBC LUT #4-1. The result is not level transparent – and therefore not correct.

---

[4] The BBC LUT #4 follows a direct mapping approach from diffuse white without highlight boost.

BASE OF EXPERT TRAINING

Black Contrast mapping

The right side of the previous waveform screenshot shows that, if using the "wrong" BBC LUT #4-1 there actually is a way to preserve the Strict gamma from SDR to HDR. Thus, this LUT is perfectly suitable for a HLG workflow that keeps the desired "Black Contrast" characteristics.

The following waveform screenshot illustrate the mapping result:

The left side shows a native HLG camera source with "Black Contrast" activated, while on the right there is an SDR camera with Strict gamma mapped to HLG.

This mapping to HDR utilises the BBC LUT #4-1. The result is level transparent – and therefore correct!

Summary

The Grass Valley LDX-Series cameras offer, with Strict gamma and SQRT gamma, two different appearances for SDR, and with the new "Black Contrast" function also two different appearances for HLG.

In combination with the BBC LUTs #4-2 as well as #4-1, the following workflows with mixed SDR and HLG cameras can be realised:

#	SDR-camera	LUT	HLG-mapping-result	HLG-camera
1	SDR (Strict gamma)	#4-2	HLG (SQRT gamma)	HLG (SQRT gamma)
2	SDR (SQRT gamma)	#4-1	HLG (SQRT gamma)	HLG (SQRT gamma)
3	SDR (Strict gamma)	#4-1	HLG (Strict gamma)	HLG (Strict gamma using "Black Contrast")

BASE OF EXPERT TRAINING

Workflow #1: Keeps the original mathematical definition in both domains, SDR with a Strict gamma and HLG with a SQRT gamma. Both pictures show different characteristics related to darker picture content. This is not a bug; this is what was intended.

Workflow #2: Here the SDR camera follows the HLG SQRT gamma approach by using SQRT gamma for SDR. Both pictures show a similar behavior in darker picture area with more information in the blacks. For SDR images, this is an unusual appearance.

Workflow #3: Here the HLG camera follows the SDR Strict gamma approach by using "Black Contrast" for HLG. The blacks in both images (SDR & HDR) now appear to be compressed. For SDR this is the familiar appearance and now is, as desired by some content creators, in HDR as well.

All three workflows / appearances can be achieved in a mixed environment by utilising the set of BBC LUTs[5] and can be done with any mapper that supports LUTs. There is no requirement to use a certain mapper from a specific manufacturer.

Note of thanks

Many thanks to the Grass Valley camera development team, who picked up and implemented my idea of adding an initial gain function for HLG to achieve, from an SDR perspective, a more familiar appearance in HLG.

Many thanks also to Michael Mücher, who tremendously supported my ideas and experiments.

---

[5] The LUT #2 of NBCU equally support the described workflow #3.

BASE OF EXPERT TRAINING