Victor Steinberg,
Roderick Snell

Video Standards

Signals, Formats and Interfaces

Part 11

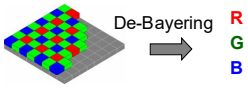
HDR-LOG Format – The Best of Two Worlds

www.videoq.com

Camera LOG Formats Family

Logarithmic 'Camera LOG' formats are often confused with 'Camera RAW' formats.

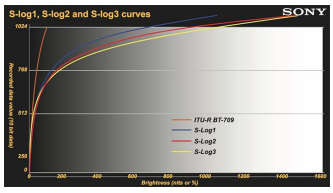
Camera RAW is a common name for camera sensor data taken **before any processing**:
- Prior to black balance, white balance and gain (sensitivity) adjustments
- 12 to 16 bit depth, for **single-chip imagers** – color-multiplexed 'Bayer Matrix' data stream
- Direct view on a color monitor could be a problem – e.g. 'De-Bayering' conversion to RGB video required



Camera LOG (aka LOG-RAW) is the "half-cooked" camera output format suitable for post-production and conversion to **DC / HDR / SDR** video:
- De-Bayering, black balance and white balance corrections applied, but **further corrections / adjustments** are often required
- Typically recorded in a high bitrate **YUV** data format, 10, 12 or more bits per component, but the **RGB** format is also in use
- **Processing information** & **metadata** are included, e.g. **E**xposure **I**ndex (**EI** aka **ISO** settings, affecting the **captured light gradations sub-range**)

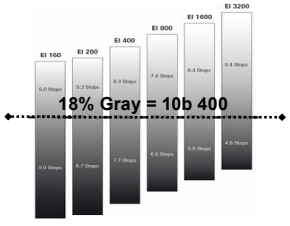
Using the embedded metadata and reference to **18% Gray** LOG video data 'maps' to **relative L**ight **L**evels (%) *and* **absolute L**ight **L**evels (nit)
Camera LOG formats are **specific to camera manufacturers** with some discrepancies in the metadata formatting and in the LOG curve shapes
The captured **Dynamic Range** limits depend upon the selected EI value – *in fact following the human eye '**static dynamic range**' limits.*

S-Log OETF variants



LOG Format	0% Black 10 bit value	18% Gray 10 bit value	90% White 10 bit value
Sony S-Log	90	394	636
Sony S-Log2	90	347	582
Sony S-Log3	95	420	598
Arri Log C	96	400	580
Canon C-Log	128	351	614
Panasonic V-Log	128	433	602

Log C dynamic range for various EI values



Light Levels ⇔ Signal Levels

The main **Reference Level** in LOG format is **not 100% White** (used for SDR and HDR-HLG), but **18% Gray** value.

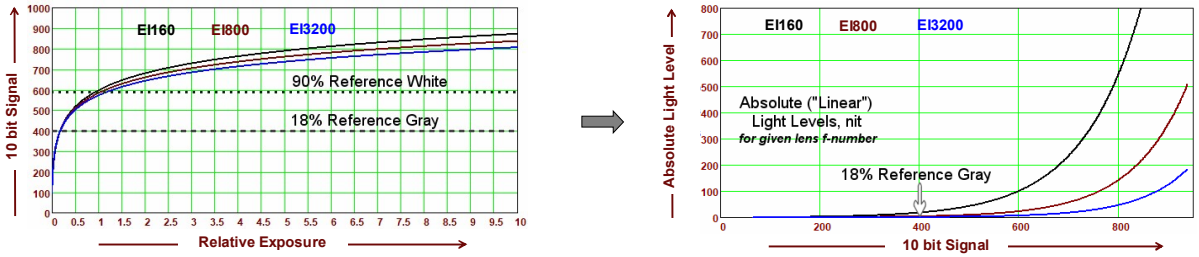
A **Gray Card** is a reference object, traditionally used for consistent image exposure and/or color handling in photography and cinematography.

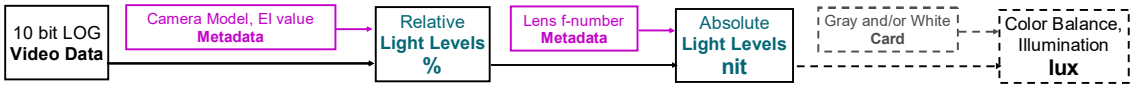
Mid-range reference level is more reliable and less affected by non-linear distortions which may occur on both ends of the dynamic range.
Also 18% Gray is closer to the human face tones than 100% White.

For best results, 18% reflectance Gray Card is often combined with **90% reflectance White Card** *aka "Diffuse White".*

A **Black Card** with nearly **0% reflectance** ("Black hole") is quite difficult to make and utilize, so its usage is limited to top-tier studios and R&D labs.

Examples of Arri ALEXA v3 **Log C** camera **Light ⇔ Signal** conversion curves for 3 different **E**xposure **I**ndex values





LOG Format in Post-production & Distribution

DPX (Digital Pictures Exchange) file format is fully described in the **SMPTE 268** standard.

It is based on, but largely supersedes, Kodak's **Cineon** format that has a more film specific header.

LOG format is used in video and digital cinema post-production to handle logarithmic high dynamic range values at a variety of bit depths using **RGB** or **YUV** formats.

For example, **LOG1 ⇒ LOG2** conversion from **S-Log** or **Log C** to full scale **DPX LOG** is the very first stage of a typical **HDR / SDR post-production workflow**.

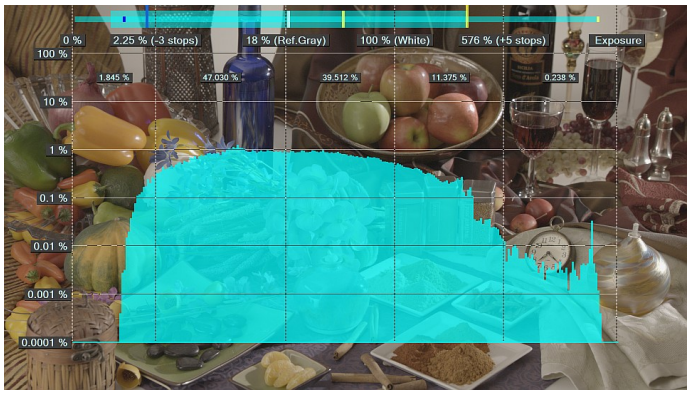
For a 10 bit logarithmic image the black and white points are often set at **95** for **Black** and **685** for **White**, but **full [0,1023] range** mode is also in use.

DPX LOG image with VideoQ **Light Levels Histogram** & **L-Bar** Overlays

Majority of pixels are in the light levels **middle range** – below and above the 18 % Gray:
47.0 % + 39.5 % = **86.5 %**.

On the dark side (low light levels) the frequency of occurrence drops down sharply below -3 stops (light level = 18/ 8 = 2.25 %).

Total share of pixels **below -3 stops** is rather small: **1.8 %**.



On the bright side (high light levels) the frequency of light levels occurrence drops down gradually.

11.4 % of image pixels have brightness **above 100 % White** and **below +5 stops** level.

Above the +5 stops boundary (light level = 18 x 32 = 576 %) total share of pixels is small, but not negligible: **0.24 %**.

Image – courtesy of Sony

Logarithmic Video & Look Up Tables (LUTs)

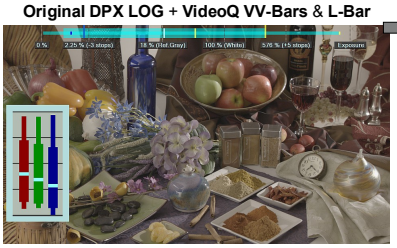
LUTs can be employed to adjust LOG material colors for **live streaming**, viewing on a **monitor**, to create a **preview** of the **intended look**, or to **convert DR format**.

A one-dimensional (**1D**) **LUT** is applied to **3 parallel channels** of **RGB contrast / brightness** adjustment with varying **intensity** across the contrast range.
Apart from making the image gradations scale linear and then adjusting the gamma for display this LUT establishes the black and white levels mapping.
A three-dimensional (**3D**) **LUT** works like a **single multi-channel** converter. In addition to 1D LUT functions, it supports **color re-mapping** & **saturation adjustments**.

A 1D or 3D LUT can be applied:
- at the camera **live / preview** output
- in a **specialized video monitor** accepting LOG inputs
- in a software or hardware **adapte**r prior to feeding a video monitor
- in an adaptive or non-adaptive **HDR ⇒ HDR** or **HDR ⇒ SDR converter**

*The **preview** LUTs should be selected on a shot-by-shot basis, depending on the EI and other settings; with **so many variants** available finding the right one is rather **art** than **science**.*

Original DPX LOG + VideoQ VV-Bars & L-Bar



RGB range is reduced – low contrast "bleak" image

Converted to **HDR-HLG** via **VideoQ 1D LUT**

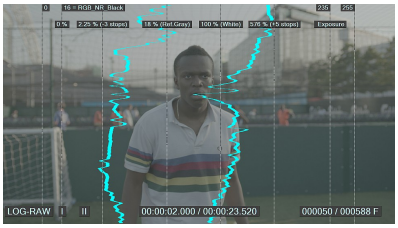
Nearly full RGB range, significant share of pixels is above HLG Ref. White (RSL 75%), but no clipping

Converted to **SDR** via **VideoQ 1D LUT**

SDR format can not accommodate highlights, so there is a noticeable peak clipping in all 3 RGB channels

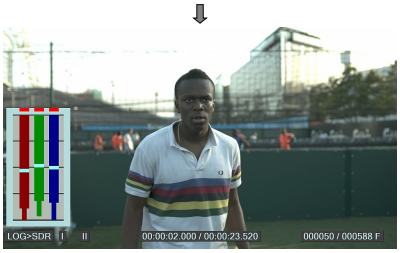
Image – courtesy of Sony

Dynamic Range Conversion – Issues & Options

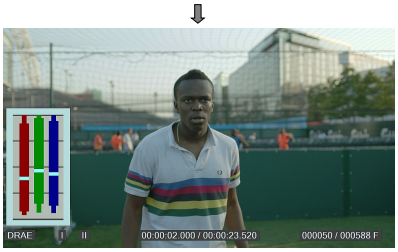


Log C video, T-shirt: ≈100% White, frame upper part: ≈500%.
*Conversion to HDR-HLG & SDR **may be difficult**.*

Non-adaptive conversion to HDR-HLG, video looks OK.
But the frame area brighter than HLG White is far too large



Non-adaptive conversion to SDR, such video is not acceptable.
*Massive clipping in the upper half – note **overload indicators**.*



Adaptive conversion to SDR (VQV **DRAE** Mode), video looks good.
After auto remapping the T-shirt is darker, but grass is brighter.

Video images – courtesy of KSI This Is Drama

About This Presentation

Produced by	**Josef Marc**
Written by	**Victor Steinberg, PhD**
Narrated by	**Josef Marc**
Conceived by	**Roderick Snell**
Technical consulting by	**Maxim Levkov**

Based on the book
"Video Standards: Signals, Formats and Interfaces" by Victor Steinberg
Published by Snell & Wilcox

For further reading we recommend wikipedia.org

About VideoQ

Company History

- Founded in 2005
- Formed by an Engineering Awards winning team sharing between them decades of global video technology.
- VideoQ is a renowned player in calibration and benchmarking of video processors, transcoders and displays, providing tools and technologies instantly revealing artifacts, problems and deficiencies, thus raising the bar in productivity and video quality experience.
- VideoQ products and services cover all aspects of video processing and quality assurance - from visual picture quality estimation and quality control to fully automated processing, utilizing advanced VideoQ algorithms and robotic video quality analyzers, including latest UHD and HDR developments.

Operations

- Headquarters in Sunnyvale, CA, USA
- Software developers in Silicon Valley and worldwide
- Distributors and partners in several countries
- Sales & support offices in USA, UK

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