User Manual 1.1

INTRODUCTION

Conversion between HDR <-> SDR can be performed either on a "live" signal, using a hardware signal processor, or in post-production using editing or colour correction (grading) software. This conversion may be done mathematically, using an algorithm that takes the numerical values of each image pixel and calculates new values, based either on preset functions or functions with user controls to modify the conversion. Alternatively, a Look-Up Table (LUT) may be used which is a list of the output colours corresponding to particular input colours. LUTs are an efficient way of processing images but are imprecise because it is not practical to include every possible input colour in the list. A subset is used with in-between colours being created by interpolating (blending) between the nearby colours in the list.

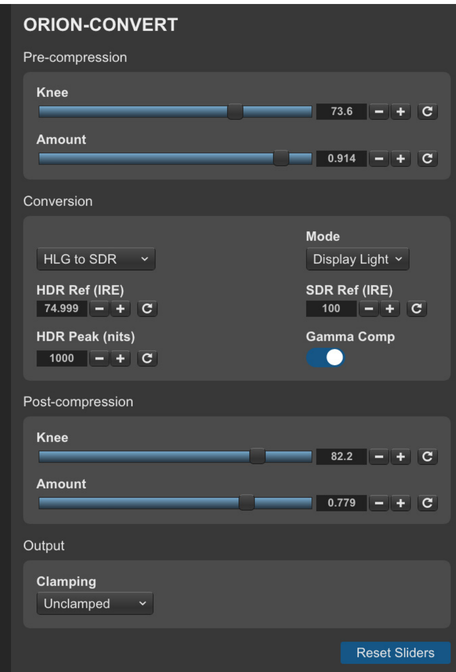
The ORION-CONVERT™ algorithm takes a novel three-step approach to HDR <-> SDR conversion, with a simple and intuitive set of user controls. The intent is not that these controls should be adjusted continuously during a broadcast transmission, but rather that settings suitable for a particular situation will be found and used as "presets".

Other HDR conversion systems based on LUTs offer a range of presets for different scenarios, but this means there are a large number of LUTs and understanding which one is appropriate in a given situation is not easy. There is also no option to "tweak" the conversion for specific needs.

Because the ORION-CONVERT™ conversion is mathematically defined, it is mathematically invertible. Applying identical parameter values in HDR to SDR (down-conversion) and then in SDR to HDR (up-conversion) will perform the same process in reverse. The compressed highlights of the SDR signal are expanded and converted to HDR. This can either be used to produce a simulated HDR signal from an SDR camera (such as a speciality slow-mo camera or mini-cam) or to recreate an original HDR signal from a prior down-conversion.

If this process is applied in high precision floating point, the round-trip of a down-conversion followed by an up-conversion can be lossless. A hardware signal processor will always have limited output precision (normally a 10-bit SDI or HDMI signal) so, in this case, feeding the resulting signal to a second device applying an inverse conversion will not produce a signal identical to the original. Nonetheless, testing has shown that the difference is indistinguishable to the viewer.

The ORION-CONVERT™ user interface makes it simple to set up two conversions as a matched pair of up and down conversions.



THE INTERFACE (CONFIG)

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.*

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 the Knee is irrelevant) and a value of 1 will compress completely, flattening everything above the value of the Knee to that value.*

Conversion direction

Here the user can choose the direction of the conversion needed (HLG to SDR, SDR to PQ, etc…).

When the direction of the conversion is reversed; the values of pre and post-compression are swapped to generate an absolute mathematical inverse. This way, a visually lossless roundtrip is possible due to the high-precision calculations used by ORION-CONVERT™.

Mode: Display light and Scene light

There's a lot of confusion about the use of these two different kinds of conversions described in BT.2390.

> Display-Light mapping is used when the goal is to preserve the colours 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 programme.

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, to represent these elements exactly as they were seen at the time of *their creation. Or when the look and feel of the HDR program is what the user wants to preserve.*

> 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 colours and tones of that camera to another camera source after conversion.

These conversions are used 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.

** It depends very much on the camera manufacturer as some have creative tools independent of 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 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 knee 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 Compensation

This check box will enable conversion using the optional gamma adjustment, described in ITU-R BT.2446-0 section 4.1.2, to compensate for 100 nit - 1000 nit (SDR-HDR) viewing environments.

It includes a custom shadow compression curve to compensate for the lifted blacks that the ITU-suggested formula for this method would produce.

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 the Knee is irrelevant) and a value of 1 will compress completely, flattening everything above the value of the Knee to that value.

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.

Options:

- 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

How to use ORION-CONVERT™ (Workflow examples)

There are lots of white papers where different types of conversions are mixed and others where only one prevails.

Here are some recommendations on the usage of these conversions:

Display referred Workflows:

These are often known as “single master” or “single layer workflows”, where all acquisition is HDR and only a final conversion to SDR is made for transmission. The roundtrip can be very close to 100%.

Note: HDR to SDR conversions can also be made available for preview purposes (shaders, gallery, etc…) where no HDR monitoring is available.

Scene referred Workflows:

Those where the mix and match of SDR and HDR cameras are unavoidable and/or where SDR camera outputs are provided as part of the deliverables of a program. Under this classification, we could include dual-layer workflows and some single-layer ones. The roundtrip can be very close to 100%.

Combined Scene/Display conversion workflows:

Lots of archive content, Graphics (where colour appearance must be preserved), etc… Roundtrip is sacrificed for some of the sources depending on the design of the workflow.

Conversion Setup

Thanks to the core design of the ORION-CONVERT™ algorithm, it is very easy and fast to create a conversion roundtrip (up-conversion and down-conversion) in just one go.

To do this, choose one of the conversions needed (we recommend starting with an HDR to SDR for example) and feed content into the device.

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…).

Now you are all set to start creating your highlight compression/expansion using the powerful pre and post-sliders.

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 roundtrip.

To understand how the various ORION-CONVERT™ controls operate, it can be useful to view the result on a waveform monitor of passing a linear ramp test pattern through the conversion while adjusting the controls. This will give the user a more intuitive feel for their effect.

Graphics are normally(*) converted without any highlight compression or expansion which is usually called "direct mapping".

* some creative approaches to graphic content creation can be used too

HDR Mastering Setup

When using ORION-CONVERT™ as an "HDR mastering" tool a no-conversion (HLG to HLG or PQ to PQ) could be also selected on the conversion direction drop-down menu. These are called HLG compress only and/or PQ compress only.

By using the pre-compression slider, the user can roll off any highlights beyond the range that a target consumer TV will be able to display; for example, super white areas (109% IRE) in HLG or different peak brightnesses when in PQ (2000nit to 1000nit, etc...) and adjust the signal to the delivery range desired.

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