# LivePremier:
# Understanding and configuring the HDR processing of your system

**Analog Way Worldwide**
**Europe & Africa**: +33 (0)1 81 89 08 60
**Middle East:** +971 4 25 33 818
**The Americas**: +1 212 269 1902
**Asia Pacific**: +852 6882 7140
**www.analogway.com**

# Introduction

The LivePremier series with firmware v2.0 is the first generation of presentation systems embedding dynamic range converters for all its inputs and outputs.

This document is intended to give a better understanding of how the dynamic Range Management of LivePremier series works and how to configure it.

## Contents



**Analog Way Worldwide**
**Europe & Africa**: +33 (0)1 81 89 08 60
**Middle East:** +971 4 25 33 818
**The Americas**: +1 212 269 1902
**Asia Pacific**: +852 6882 7140
www.analogway.com

## Figures

## Normative Reference List

- CTA-861-G (11/2016) A DTV Profile for Uncompressed High Speed Digital Interfaces
- ITU-R BT.601-7 (03/2011) Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios
- ITU-R BT.709-6 (6/2015) Parameter values for the HDTV standards for production and international programme exchange
- ITU-R BT.2020-2 (10/2015) Parameter values for ultra-high definition television systems for production and international programme exchange
- ITU-R BT.2100-0 (07/2016) Image parameter values for high dynamic range television for use in production and international programme exchange
- ITU-R BT.2390-9 (03/2021) High dynamic range television for production and international programme exchange
- ITU-R BT.2408-4 (03/2021) Guidance for operational practices in HDR television production
- SMPTE ST 425-1:2017 Source Image and Ancillary Data Mapping for the 3Gb/s Serial Interface
- SMPTE ST 2081-10:2018 2160-line and 1080-line Source Image and Ancillary Data Mapping for 6G-SDI
- SMPTE ST 2082-10:2018 2160-line and 1080-line Source Image and Ancillary Data Mapping for 12G-SDI
- SMPTE ST 2084:2014 High Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays
- SMPTE ST 2086:2018 Mastering Display Color Volume Metadata Supporting High Luminance and Wide Color Gamut Images
- SMPTE ST 2110-20-2017 Professional Media Over Managed IP Networks: Uncompressed Active Video

# 1. Basic knowledge

## 1.1. Wide Color Gamut

The gamut is the whole range of the colors managed by a device. Computer graphics and video systems handle a subset of the color spectrum the human eye can see. Models of this spectrum were created in 1931 by the International Commission on Illumination and are known as CIE 1931 color spaces (CIE is the abbreviation of French name “Commission internationale de l’éclairage”).

- The color space of SDTV system was specified in ITU-R BT.601 and covers 35% of the CIE 1931 color space.
- The color space of HDTV system was specified in ITU-R BT.709. It is very close to the color space of ITU-R BT.601 and covers 35.9% of the CIE 1931 color space.
- The color space of UHDTV system is specified in ITU-R BT.2020 and covers 75.8% of the CIE 1931 color space. It is called ***Wide Color Gamut***.

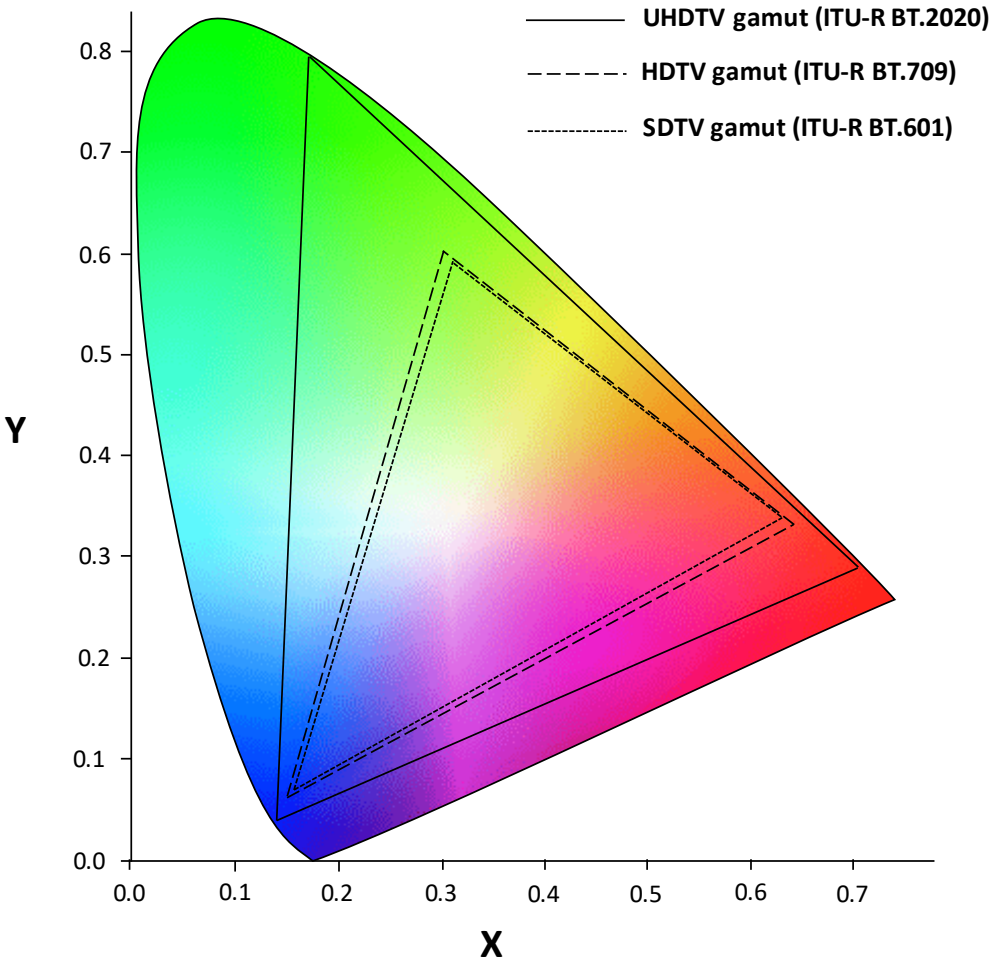


**Figure 1:CIE 1931 chromaticity diagram with SDTV, HDTV and UDTV gamuts**

## 1.2.High Dynamic Range

There are many HDR standards, but this chapter mainly focuses on the two standards specified in the ITU-R BT.2100 and supported by LivePremier series:

- ***PQ*** (Perceptual Quantizer)
- ***HLG*** (Hybrid Log-Gamma)

### 1.2.1. HDR10 Media Profile

Commonly called ***HDR10***, it was announced by the CTA (Consumer Technology Association, formerly CEA Consumer Electronics Association) in 2015.
HDR10 uses:

- the ***Wide Color Gamut*** specified in ***ITU-R BT.2020***
- a bit depth of ***10 bits*** (30 bits per pixel)
- the ***PQ*** transfer function specified in the ***SMPTE ST 2084***. It is a nonlinear electro-optical transfer function (EOTF) supporting a luminance range of 0-10000cd/m$^2$ (or Nits).
- static metadata to send information about the data content. These metadata are specified in ***SMPTE ST 2086*** and ***CTA-861-G***. Among the metadata information, two of them are important to know:
    - Maximum Frame-Average Light Level (***MaxFALL***): contains the highest frame-average light level in of whole content.
    - Maximum Content Light Level (***MaxCLL***): contains the light level of the brightest pixel in the whole content.

### 1.2.2. Hybrid Log-Gamma

The HLG profile was jointly developed the ***BBC*** (British Broadcasting Corporation) and the ***NHK*** (Nippon Hōsō Kyōkai, translated as Japan Broadcasting Corporation in English).
It is a backwards-compatible HDR standard as it is still compatible with existing transmissions standards regarding SDR.
HLG uses a nonlinear transfer function composed, as its name indicates, of:

- A ***gamma*** curve in its lower half of signal values
- A ***logarithmic*** curve in its upper part.

HLG does not require metadata except the one specifying HLG profile is used.

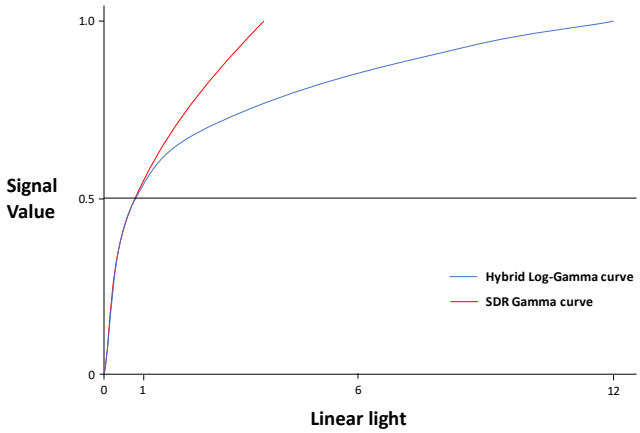


**Figure 2: HLG transfer function vs SDR transfer function**

## 1.3. HDR AND INTERFACES

### 1.3.1. DisplayPort

HDR10 support is specified in version 1.4 of DisplayPort. This version integrates a DPCD (DisplayPort Configuration Data) that enables to handle the HDR10 metadata.

IMPORTANT:

- It is possible to implement a DisplayPort 1.2 interface with a DPCD version 1.4 and therefore to support HDR10 with static metadata. But it cannot be called DP1.4 as its bandwidth is limited to 21,6Gbits/s and does not support other features such as DSC (Display Stream Compression).

Consequently, LivePremier series have DP1.2 interfaces and **do support HDR10** up to 4K 60Hz 10bit 4:4:4.

### 1.3.2. HDMI

HDMI 2.0 supports the color space of ***ITU-R BT.2020***. But support of HDR with static metadata only comes in version 2.0a. This version included the support of HDR10. Later, HLG was added in specification of **HDMI 2.0b**.

LivePremier series integrates HDMI 2.0b.

IMPORTANT:
Due to HDMI2.0's 18Gbits/s bandwidth, supporting both 4K/UHDTV and a 10-bit data format needed for HDR implies to either sub-sample the chroma data or reduce the frame rate:

- 3840 x 2160 @ 50/60Hz 10bit 4:2:2 or 4:2:0
- 3840 x 2160 @ 25/30Hz 10bit 4:4:4

### 1.3.3. SDI

After several evolutions of the standards, HDR is supported by 3G-SDI, 6G-SDI and 12G-SDI. The HDR profile is available in the payload identifier's byte 2 specifying the transfer characteristics.

LivePremier series supports HDR for 3G-SDI, 6G-SDI and 12G-SDI.

### 1.3.4. ST2110

ST 2110 interfaces support HDR. According to SMPTE 2110-20:2017, it is possible to specify in the Media Type Parameters:

- the color space in the Colorimetry parameter
- the dynamic range in the Transfer Characteristic System parameter

### 1.3.5. NDI

HDR is supported by NDI version 4.0 (2019-11).

### 1.3.6. SDVoE

SDVoE Tx/Rx are implemented with HDMI interfaces. It means that they send and receive HDMI data and metadata over an IP network. Therefore, SDVoE natively supports HDR.

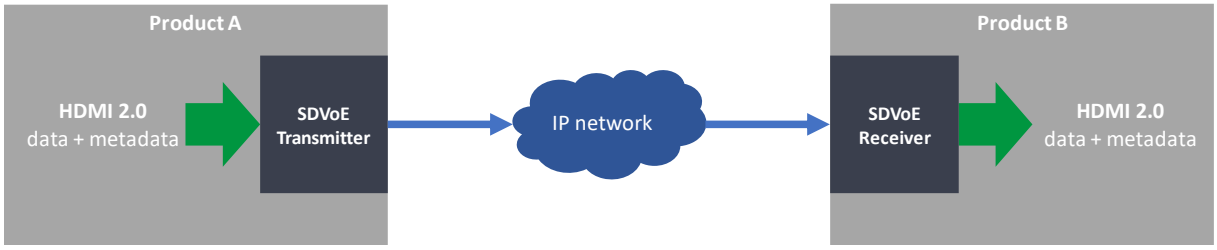


**Figure 3: SDVoE with HDMI interfaces**

# 2. LivePremier Series: the 1st presentation system with native HDR conversions

## 2.1. Why is HDR conversion needed?

Most of presentation systems claiming to support HDR processing implement a passthrough management. This implies that the whole workflow is homogeneous, and the same dynamic range standard is used from the sources to the display systems.

As soon as one of the contents or displays is using a different standard, some problems appear:

- sources with different dynamic range standards cannot be mixed properly together,
- the output cannot simply be displayed on a non-HDR compliant display.

**Figure 4: SDR image in an HDR10 workflow with conversion (left) and without conversion(right) leading to over-saturated and burned colors**

**Figure 5: HDR10 content displayed in an HLG workflow with conversion (left) and without conversion(right) leading to washed out colors**

Therefore, external converters must be used with the subsequent possible drawbacks:

- **additional cost,**
- **additional latency,**
- **additional risk of failure.**

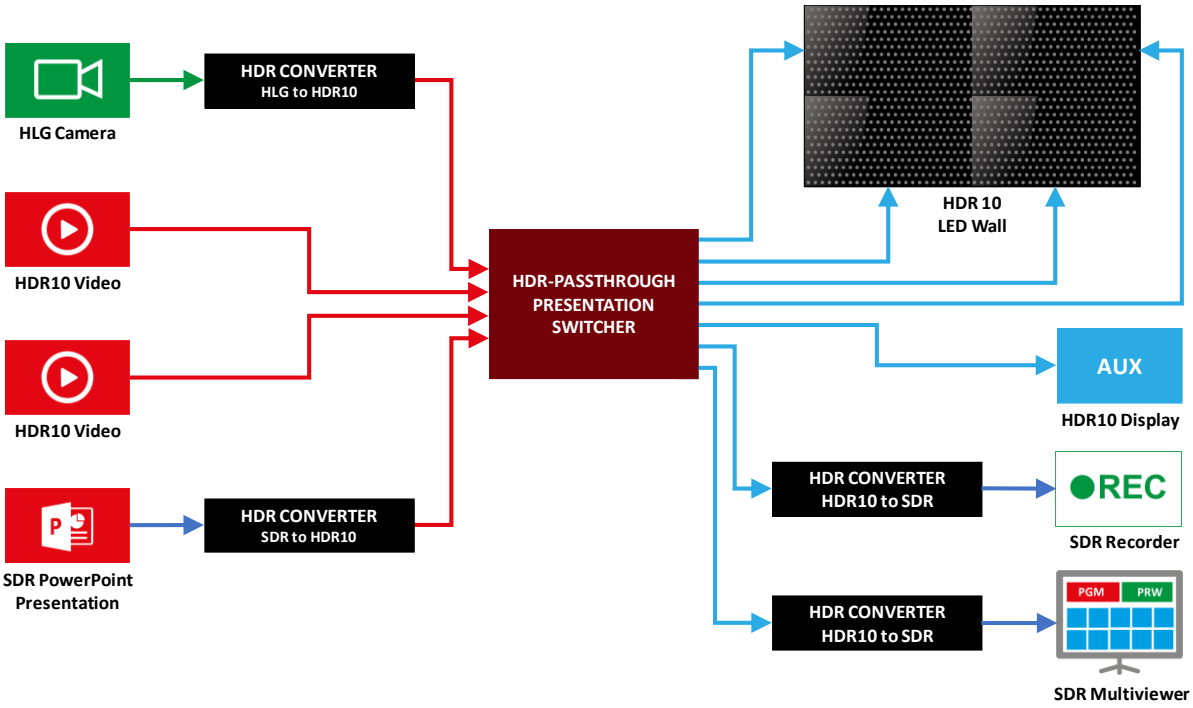


**Figure 6: Example of HDR setup with basic switcher requiring external converters**

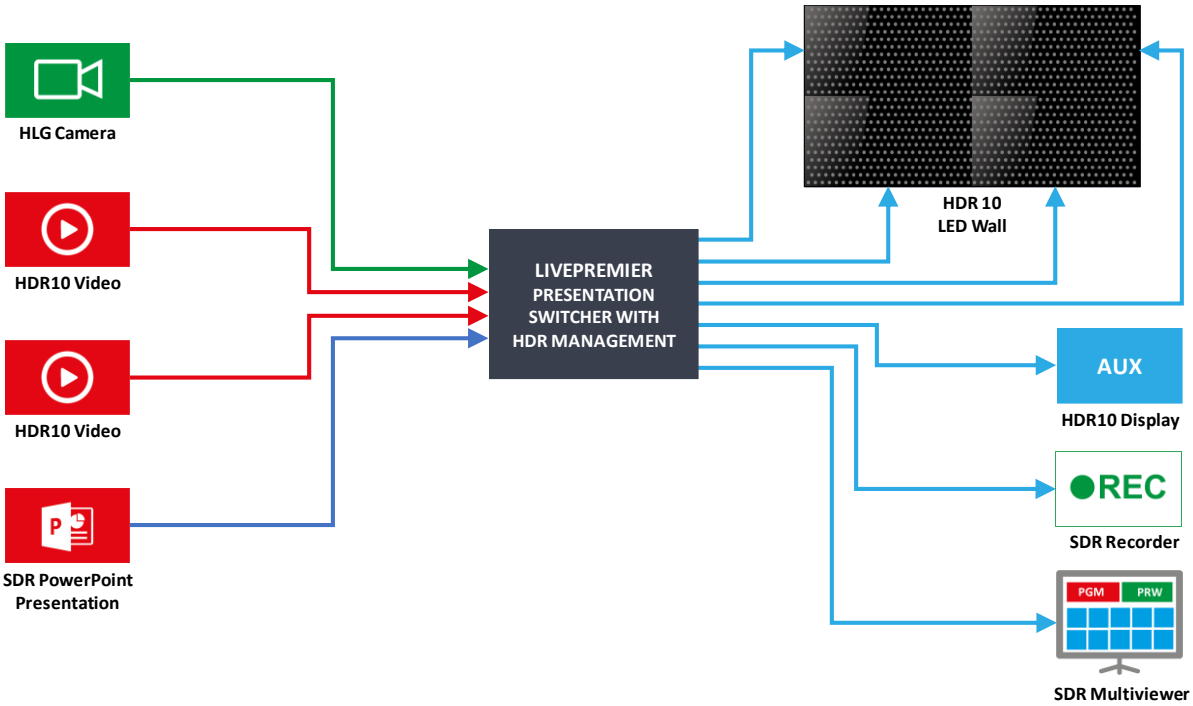


**Figure 7: Example of heterogeneous HDR setup with LivePremier**

## 2.2.LivePremier Series: HDR Architecture

Updated with firmware v2.0, the LivePremier series is the first generation of presentation systems embedding SDR-HDR converters for **all its inputs and outputs**.

Just like for the frame rate and the internal rate, the sources must be converted to the same dynamic range called **Internal Profile** so they can be mixed properly.
Then all the outputs can be converted independently to another dynamic range.

All these conversions are using 3D Look-Up Tables (**LUTs**). Each color

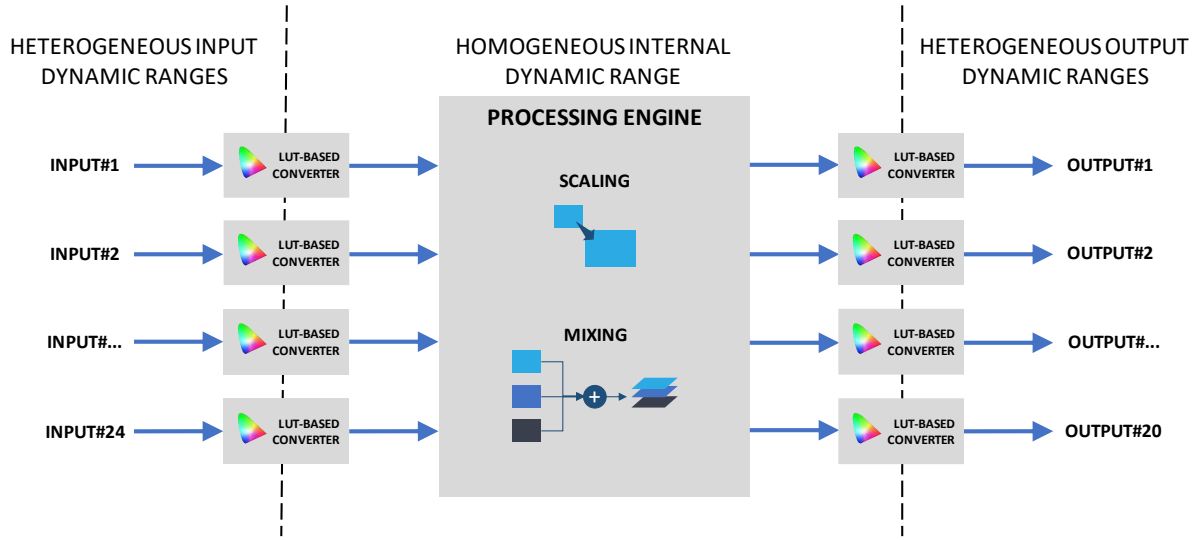


**Figure 8: HDR conversions in LivePremier Series**

LivePremier series integrate the LUTs developed by the BBC (British Broadcast Corporation) to ensure a high level of accuracy during conversions.

# 3. Configuring LivePremier's HDR management

A LivePremier system can be easily configured following these successive steps:

- Configure the EDID of the inputs
- Configure the internal processing
- Configure the inputs
- Configure the outputs

## 3.1. Configuring input EDIDs

For HDMI and DisplayPort inputs, configuring the EDID is crucial so that the source delivers its contents with the correct dynamic range.
To indicate the sink supports HDR, its EDID must contain a CTA-861 extension including an HDR Static Metadata Data Block.

In LivePremier series, there are two predefined EDIDs indicating the supported types of EOTF (Electro-Optical Transfer Function):

- Perceptual Quantizer (HDR10)
- Hybrid Log-Gamma based

These EDIDs are in the *SETUP>EDID* page of the Web RCS. One is for HDMI inputs and the other one is for DisplayPort inputs.

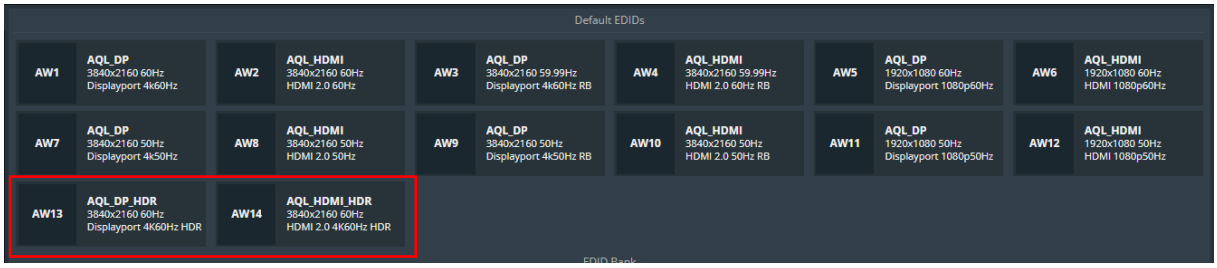


**Figure 9: Default EDIDs for HDR support**

When an HDMI or DisplayPort source reads such an EDID, it sends InfoFrames to the sink indicating that HDR is enabled, its type etc. Thanks to these InfoFrames, the LivePremier can update its input status. This status is visible in the page *SET>Inputs>Input_xx* of the Web RCS.

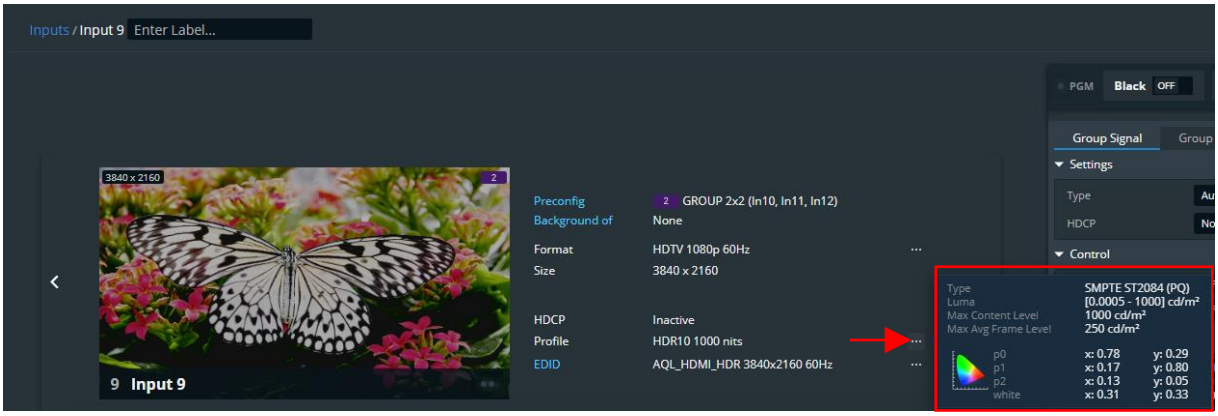


**Figure 10: Status of input 9 receiving an HDR10 1000nits content**

IMPORTANT:

- If for any reasons, the sink does not receive InfoFrames from the source, it is still possible to force the dynamic range type. For further details, please refer to the Input configuration chapter.

## 3.2.Configuring the internal color processing

### 3.2.1. Disabling HDR management

The color processing of LivePremier has been implemented so that if HDR management is not needed, the Web RCS will not display any unnecessary menu that may cause confusion and make things harder to understand. In this case, the HDR Processing must remain disabled (default value).
This setting is available in the page *SETUP>Preconfig>System* of the Web RCS.

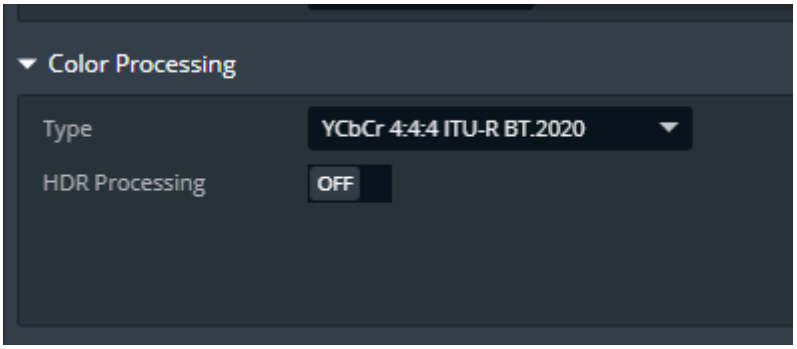


**Figure 11: HDR processing disabled**

### 3.2.1. Enabling HDR management

To work with HDR, first enable the HDR processing in the page *SETUP>Preconfig>System* of the Web RCS.

When HDR processing is enabled, all the settings appear in the different pages of the Web RCS:

- *SETUP>Preconfig>System*
- *SETUP>Inputs>Input_xx*: please refer to the Input configuration chapter for further details
- *SETUP>Outputs>Output_xx*: please refer to the Output configuration page for further details

Two new settings appear: Internal Profile and Luminance.
First select the type of the Color Space to use:

- **YCbCr 4:4:4 ITU-R BT.2020**: usually used for computer sources such as media servers.
- **YCbCr 4:4:4 ITU-R BT.2020 Limited**: usually used for video sources such as cameras and more usually in the broadcast world.


**Figure 12: HDR Processing enabled**

To configure the Internal Profile, you must identify the main HDR sources and select an internal profile that will generate as few conversions as possible for these sources.

IMPORTANT:

- If the HDR10 is selected, a large amount of luminance values is available: the luminance must be selected to the nit level just above the max level of the main sources.

**Tip:** you can use the input status to get the maximum level of an input (page *SETUP>Inputs>Input_xx* of the Web RCS)

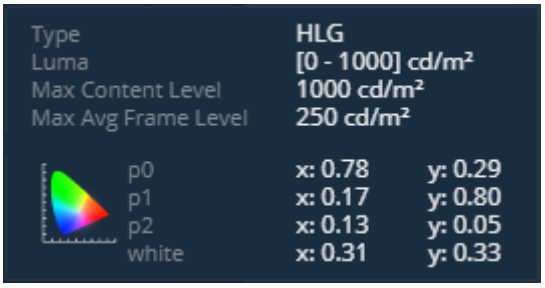


**Figure 13: Status of an HLG Source - max level at 1000 cd/m²**

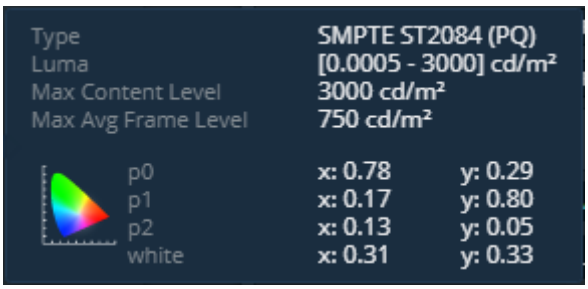


**Figure 14: Status of an HDR10 Source - max level at 3000 cd/m²**

## 3.3.Configuring the inputs

The HDR settings of the inputs are available in the *Group Signal* tab of the Web RCS page *SET>Inputs>input_xx*.

By default, all the settings are configured in AUTO mode. In this mode, all the input settings are automatically computed using the input HDR status and the internal profile.

However, it may happen that the InfoFrames are not received properly. Therefore, the input settings allow to override the status.

### 3.3.1. Configuring the inputs with an HLG BBC internal processing

| Input Profile | Settings |
|---|---|
| **SDR** | **BBC Mapping**: when converting SDR to HLG, pixels must be converted from the BT.601 / BT.709 color spaces to BT.2020 color space. This operation can be configured either as:<br>- **Inverse Tone Mapping**: conversion output is extended to -5%/+105%. This setting must only be used when the input color space and the internal color space have a limited range.<br>- **Direct Mapping**: each color of the input color space remains the same one.<br><br>**BBC Reference:** depending on the content type, two conversion types are available:<br>- **Scene referred**: Input is a camera or a graphic with camera image.<br>- **Display referred**: Input is a graded content or graphics.<br><br>**BBC OETF**: if the reference type is Scene referred, two types of Opto-Electric Transfer Function are available, and this setting must be chosen according to the camera specifications between the two values:<br>- **Square Root**<br>- **Strict (BT.709)** |
| **HDR10** | **Luminance**: to help the system to apply the most efficient LUT, the closest value above the input luminance level must be selected among:<br><br>- 100 nits - 700 nits - 1800 nits - 7000 nits<br>- 200 nits - 800 nits - 2000 nits - 8000 nits<br>- 300 nits - 1000 nits - 3000 nits - 9000 nits<br>- 400 nits - 1200 nits - 4000 nits - 10000 nits<br>- 500nits - 1400 nits - 5000 nits<br>- 600 nits - 1600 nits - 6000 nits |
| **HLG BBC** | No settings as no conversion. |

### 3.3.2. Configuring the inputs with an HDR10 internal processing

| Input Profile | Settings |
|---|---|
| **SDR** | **Luminance**: to help the system to apply the most efficient LUT so that the white level of the SDR content is not too bright leading to burned content, two values are available:<br>- 100 nits: standard luminance of SDR.<br>- 200nits: ITU-R BT.2408-3 recommends around **58%** of the PQ level, this corresponds to a 200nit luma level.<br><br>**IMPORTANT**: SDR→HDR10→SDR conversion may alter the colors |
| **HDR10** | No settings: as PQ scale uses an absolute scale. |
| **HLG BBC** | No settings: luminance is automatically forced to 1000 nits. |

### 3.3.3. Configuring the inputs with an SDR internal processing

| Input Profile | Settings |
|---|---|
| **SDR** | No settings as no conversion. |
| **HDR10** | **Luminance**: to help the system to apply the most efficient LUT, the closest value above the input luminance level must be selected among:<br><br>- 100 nits<br>- 200 nits<br>- 300 nits<br>- 400 nits<br>- 500nits<br>- 600 nits<br>- 700 nits<br>- 800 nits<br>- 1000 nits<br>- 1200 nits<br>- 1400 nits<br>- 1600 nits<br>- 1800 nits<br>- 2000 nits<br>- 3000 nits<br>- 4000 nits<br>- 5000 nits<br>- 6000 nits<br>- 7000 nits<br>- 8000 nits<br>- 9000 nits<br>- 10000 nits |
| **HLG BBC** | **BBC Reference:** depending on the content type, the conversion will also be different. Two types are available:<br>- **Scene referred**: Input is a camera or a graphic with camera image.<br>- **Display referred**: Input is a graded content or graphics.<br><br>**BBC OETF:** if the reference type is Scene referred, two types of OETF are available, and this setting must be chosen according to the camera specifications between the two values:<br>- **Square Root**.<br>- **Strict (BT.709)**. |

## 3.4.Configuring the outputs

The HDR settings of the outputs are available in the *Signal* tab of the Web RCS page *SET>Outputs>output_xx*.

By default, all the settings are configured in AUTO mode. In this mode, all the output settings are automatically computed using the EDID status of the output device and the internal profile.

However, it is possible to force the HDR configuration of an output using its settings.

### 3.4.1. Configuring the outputs with an HLG BBC internal processing

| Output Profile | Settings |
|---|---|
| **SDR** | **BBC Reference:** depending on the content type, the conversion will also be different. Two types are available:<br>- **Scene referred**: Input is a camera or a graphic with camera image.<br>- **Display referred**: Input is a graded content or graphics.<br><br>**BBC OETF**: if the reference type is Scene referred. Two types of OETF are available, and this setting must be chosen according to the camera specifications between the two values:<br>- **Square Root**<br>- **Strict (BT.709)** |
| **HDR10** | No settings: the Luminance InfoFrame is automatically forced to 1000 nits. |
| **HLG BBC** | No settings as no conversion. |

### 3.4.2. Configuring the outputs with an HDR10 internal processing

| Output Profile | Settings |
|---|---|
| **SDR** | No settings: the system automatically selects the best LUT according to the internal processing nit level. |
| **HDR10** | No settings: as PQ uses an absolute scale. The output send a Luminance InfoFrame based on the Internal Profile Luminance. |
| **HLG BBC** | No settings: the system automatically selects the best LUT according to the internal processing nit level. |

### 3.4.3. Configuring the outputs with an SDR internal processing

| Output Profile | Settings |
|---|---|
| **SDR** | No settings as no conversion. |
| **HDR10** | **Luminance**: to help the system to apply the most efficient LUT and send the proper InfoFrame, two values are available:<br>- 100 nits: standard luminance of SDR.<br>- 200nits: ITU-R BT.2408-3 recommends around **58%** of the PQ level, this corresponds to a 200nit luma level. |
| **HLG BBC** | **BBC Mapping**: when converting SDR to HLG, pixels must be converted from the BT.601 and BT.709 color spaces to BT.2020 color space. This operation can be configured either as:<br>- **Inverse Tone Mapping**: the output of the conversion is extended to -5%/+105%. This setting must only be used when the output color space and the internal color space have a limited range.<br>- **Direct Mapping**: each color of the output color space stays the same one.<br><br>**BBC Reference:** depending on the content type, the conversion will also be different. Two types are available:<br>- **Scene referred**: Input is a camera or a graphic with camera image.<br>- **Display referred**: Input is a graded content or graphics.<br><br>**BBC OETF**: this setting is only available if the reference type is Scene referred. Two types of OETF are available, and this setting must be chosen according to the camera specifications between two values:<br>- **Square Root**.<br>- **Strict (BT.709)** (recommended). |

## 3.5.Configuring an output connected to a DPH104

When a DPH104 is connected to an output of a LivePremier system, the DPH104 presents an EDID that is totally independent from the displays connected to its own outputs. This EDID supports 4K formats and HDR contents (HDR10 and HLG).
Therefore, if the internal profile of the LivePremier system is HDR10 or HLG, the output connected to the DPH104 will deliver HDR content when its HDR Output Profile is configured as “Auto”.
If non-HDR displays are connected to the DPH104 outputs and the LivePremier system internal profile is HDR10 or HLG, then the Output Profile of the output connected to the DPH104 must be forced to SDR.