PHABRIX®

Visualization & analysis of HDR / WCG content

Application Note

Visualization & analysis of HDR / WCG content

Introduction

The adoption of High Dynamic Range (HDR) and Wide Colour Gamut (WCG) content is accelerating for both 4K/UHD and HD applications. HDR provides a greater range of luminance, with more detailed light and dark picture elements, whereas WCG allows a much wider range of colours to be displayed on a television screen. The combined result is more accurate, more immersive broadcast content.

Hand-in-hand with exciting possibilities for viewers, HDR and WCG also bring additional challenges with respect to the management of video brightness and colour space for broadcasters and technology manufacturers. To address these issues, an advanced set of visualization, analysis and monitoring tools is required for HDR and WCG enabled facilities, and to test video devices for compliance.

HDR: managing a wider range of luminance

Multiple HDR standards are now used worldwide. Hybrid Log-Gamma (HLG), developed by the BBC and NHK, provides some backwards compatibility with existing Standard Dynamic Range (SDR) infrastructure. It offers ease of luminance mapping in the SDR zone, and extended luminance in its HDR zone of 12 times that of peak SDR.

The Dolby® PQ (Perceptual Quantizer) HDR standard supports the widest range of brightness (perceived luminance) of any HDR system – with luminosity from 0.0001 nits up to 10,000 nits. Dolby research found that the human eye is more sensitive to variations in darkness, so the PQ model provides the most nuanced display of these dark scene details, in addition to light scene details. Other key HDR standards include S-LOG3, HDR10, HDR10+ and SL-HDR1.

The challenges of multiple HDR standards, and the greater range of luminance in HDR signals, need to be managed carefully in view of the limitations of current HDR and legacy television displays. SDR display luminance is limited at around 100 nits. Current HDR display technology supports up to 4,000 nits, although most consumer LCD and OLED monitors do not go much past 1000 nits.

It is therefore crucial to accurately measure luminance levels during HDR production to avoid displaying washed out, desaturated images on consumers' television displays. It's also vital in many production environments to be able to manage both HDR and SDR content in the same facility using similar workflows.

WCG: managing a broader colour space

In environments with WCG and regular colour space video, it's essential to be able to swiftly identify WCG content to ensure its correct processing. Incorrect treatment of colour space can lead to out of specification mapping of video signals, and poor colour reproduction. Monitoring the results of a colour space conversion can prevent a lot of problems down the line.

The testing of devices to ensure compliance with WCG, ITU- Rec BT.2020 colour space specifications is also of fundamental importance. With rapidly evolving products and standards, ensuring consistent settings across all equipment is key.

Original HDR content

Example of 'washed out' display of HDR content

HDR visualization using *HDR Heat-map* tool

Measuring HDR brightness is important

With HDR production, it's important to accurately measure luminance levels to successfully handle any chosen clipping of light areas or suppression of dark areas in a picture, without losing key detail, or ending up with 'washed out', desaturated images on the intended displays.

Important questions when analysing video signal brightness include:

- What are the peak luminance levels in my HDR signal?
- Where are my image bright spots?
- Which elements of my picture are in the HDR zone?
- What colour grading is required to adjust my signal brightness levels for the target displays?

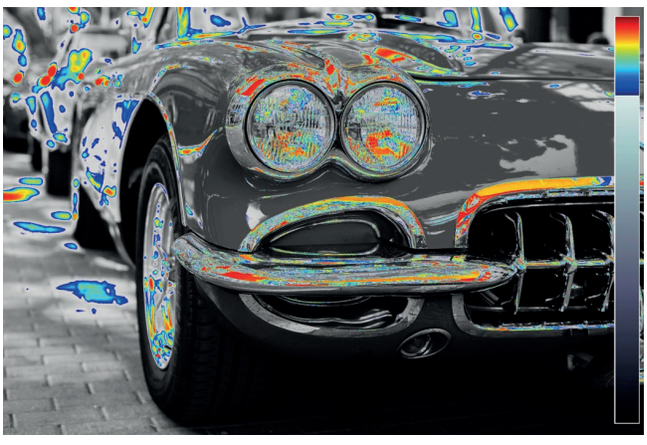
Easily measure brightness levels

It is really helpful to be able to visually identify HDR content 'at a glance'. It is often also important to know which elements of your image have HDR brightness levels, particularly when making colour grading decisions. A key tool for measuring luminance is a HDR heat-map, which overlays all pixels within a picture that are in the HDR luminance zone.

A configurable, colour-coded heat-map scale can allow the operator to isolate luminance in up to 7 adjustable zones of their choice – be it, HDR zones above 100 nits, SDR levels, very low levels between 0.0001 and 0.1 nits, or whatever is required. This can simplify the identification of shadows, mid-tones and specular highlights.

The ability to set these user defined luminance thresholds is helpful when identifying HDR ceilings for different devices and systems.

HDR content without Heat-map



HDR Heat-map applied, clearly highlighting HDR level heat spots

WCG colour space analysis using CIE chart tool

WCG colour space confirmation

To successfully manage video colour space, it's important to know the answers to questions like:

- What is my signal colour space?
- Is my signal chromaticity within the bounds of my expected colour space?
- Does my WCG signal chromaticity fit within the Rec. 709 colour space without the need for significant modification?
- Has my signal been successfully mapped to another colour space?

A quick colour space sanity check is essential, and such questions can be promptly answered with a CIE 1931 X Y chart tool.

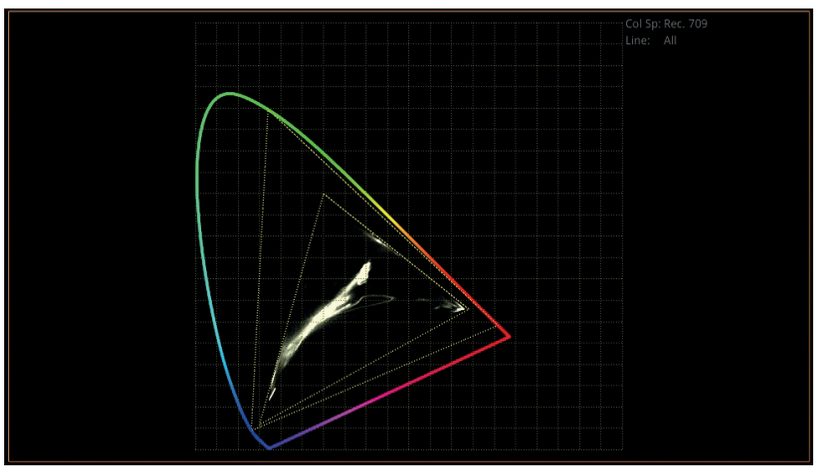
How the colour space of a video signal can be identified

The colour space observable to the human eye is defined in the CIE 1931 x y chart. The colour space of a video signal lies within this range, and a CIE Chart analysis tool provides information on the chromatic make-up of a video signal.

Wide Colour Gamut is defined by the Rec. 2020 colour space. This is an expansion beyond the colour gamut earlier defined by the Rec. 709 colour space.

A CIE chart tool with Rec. 2020 (WCG) and Rec. 709 overlays can be used to observe and confirm a video signal's colour space 'at a glance'. The inclusion of a DCI-P3 overlay is advantageous for Digital Cinema colour space compliance, and consumer Ultra HD Premium label designation testing.

A further application of the CIE Chart tool is in identifying HDR content with signal chromaticity entirely within Rec. 709 bounds. It can also be used to confirm the colour space of a video signal before and after a colour space conversion.



CIE 1931 x y chart tool showing signal chromaticity within Rec. 709 and Rec. 2020 overlays

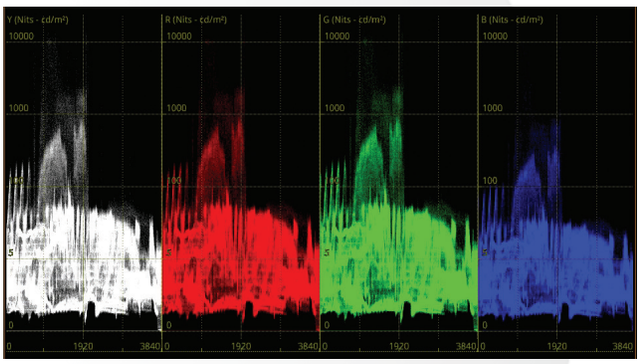
Other key HDR and WCG tools

Waveform analysis of HDR/WCG

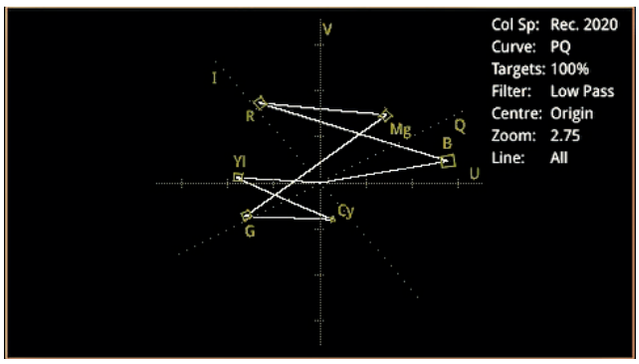
When dealing with HDR and WCG content, it's important for the test tools to display HDR range luminance and WCG traces. For example, they need to allow users to ensure that HDR levels for skin tone and grass areas are correct. To achieve this, a waveform instrument with Wide Colour Gamut support for Rec. 2020, and Dolby® PQ scale up to 10,000 nits is needed. YCbCr/YRGB traces at full 12-bit resolution are required to support the highest required HDR bit depth present in Dolby® PQ.

Vectorscope analysis

Another key instrument for analysing HDR and WCG signals is a vectorscope with support for the Rec. 2020 colour space, with coefficients adjusted for the analysis of HDR, and full 12 bit processing to handle Dolby® PQ HDR.



Waveform tool displaying YRGB trace of HDR signal with luminance up to 10,000 nits



Vectorscope tool with Rec. 2020 colour space signal display capability

HDR test pattern generator

Another valuable HDR analysis tool is a signal generator which delivers Rec. 709 and Rec. 2020 colour space patterns.

A HDR generator should offer test patterns to debug HDR/WCG down-conversion, and patterns with minimum and maximum PQ values.

Ideally, the HDR signal generator should support SDR patterns in HDR containers, and also deliver a pathological overlay in a full range of HD to UHD standards.

HDR test pattern generator

Conclusion

HDR and WCG video, at 4K/UHD or HD resolution, presents additional challenges to broadcast engineers with respect to managing the greater video brightness and expanded colour space. Unless it's carefully controlled, HDR/WCG content can cause multiple problems, such as clipped, 'washed out', desaturated images, and poor colour grading and conversion outcomes. Fortunately, new signal generation, analysis and monitoring tools are now available to enable engineers to confidently manage HDR luminance levels and Wide Colour Gamut content.

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HDR/WCG test & measurement contact:

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