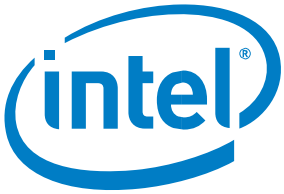

# High Dynamic Range (HDR) on Intel Graphics

## Technical White Paper

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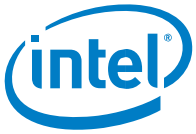
***Supporting 7th Generation Intel® Core™ Processor and Newer Core™ Platforms***

***November 2017***

***Revision 1.1***

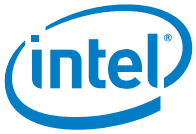
# Contents



# Revision History

| Revision Number | Description | Revision Date |
|---|---|---|
| 1.0 | • Initial release | Nov 2017 |
| 1.1 | • Updated document details | June 2021 |

# 1 Abstract & Background



This document explains High Dynamic Range (HDR) technologies and provides details on HDR support on Intel graphics platforms running Windows 10. Intended audience include PC users and consumers that are looking to get a full HDR viewing experience on these platforms.

## 1.1 What is HDR

Ever since the first days of black and white broadcast television, video has been produced with a limited range of brightness. For example, a white piece of paper and a lightning bolt would both be displayed at the same intensity. This existing brightness range has been come to be known as Standard Dynamic Range (SDR).

In the past few years, advances in display technologies have made it practical for TVs and monitors to support a larger range of brightness known as HDR. HDR creates much more lifelike experiences by allowing bright objects such as lights and highlights glinting off shiny objects to be displayed much more brightly than other objects in the scene. HDR also allows for more detail in dark scenes.

In practice, HDR brings with it a wider range of colors. The combination of wider range of brightness and colors create a much more vivid viewing experience.

To experience HDR, you need HDR content, a source device capable of HDR playback, and an HDR monitor or TV.

# 2 HDR on Intel Graphics

The 7th Generation Intel Core processor platform (formerly codenamed Kaby Lake) was the first Intel integrated graphics platform to support HDR. Laptops, desktops and 2-in-1s manufactured by Original Equipment Manufacturers (OEMs) using this processor were available in the market, after which PCs with 8th Generation Intel Core processors and newer Core processors were introduced. At that time, because HDR was a relatively new technology, and there were several ingredients that needed to be on a PC for it to be capable of supporting HDR. This whitepaper was created to describe all the ingredients in detail, with the goal to aid the user in determining whether a system is HDR capable.

Intel first launched support for HDR in the form of Ultra HD Blu-ray* playback in 2016 on Kaby Lake platforms on Windows 10. Since that time, Intel and Microsoft* have worked together to support OS-native HDR on Intel graphics with the Windows 10 Fall Creator's Update (RS3).

## 2.1 HDR Flavors

There are several different HDR standards in the industry, such as HDR10, HDR10+, DolbyVision, and Hybrid-Log Gamma (HLG). At present, HDR support on Intel graphics is limited to HDR10 and DolbyVision, and Intel is investigating expanding support to other standards in the future. For the moment, however, all HDR movies and shows today are available in the above supported formats, so a consumer can experience the full catalog of available HDR entertainment on Intel graphics. Every HDR monitor and TV support HDR10 as well.

## 2.2 HDR Sources

Part of achieving an HDR experience requires HDR source content. Some of the key HDR content sources today are.

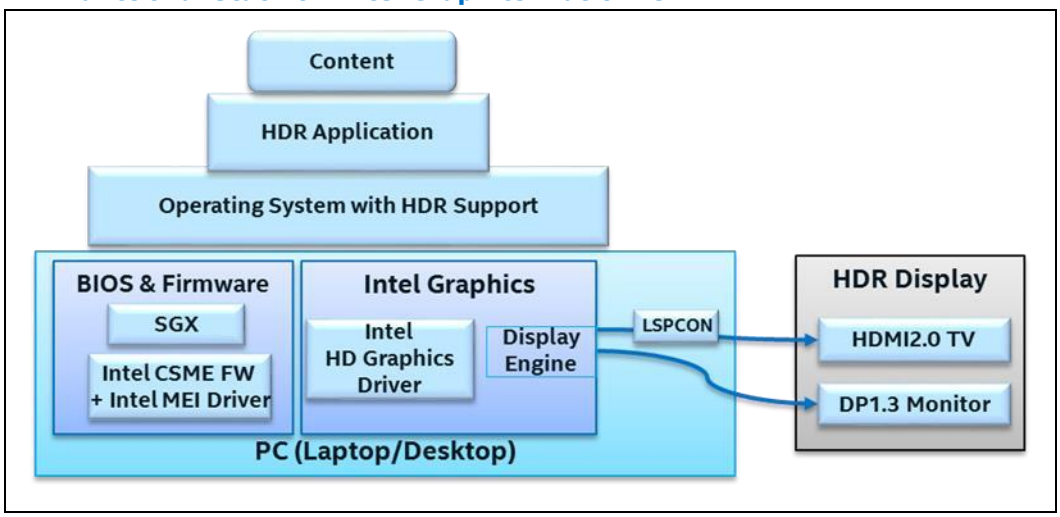
- Streaming HDR (e.g. YouTube*)
- Streaming premium HDR (e.g. Netflix*)
- Local HDR Video Files
- Ultra HD Blu-ray*
- HDR games
- HDR content creation apps

Each of these content types requires a slightly different set of ingredients for HDR playback to be supported. We will describe these ingredients at a high level and then provide more detailed guidance on which versions are needed for which usage models.

# 3 System Ingredients

The ingredients required for a fully functional stack on Intel graphics platform are shown in the figure below, along with a brief note on each of the ingredients.

**Figure 1. HDR Functional Stack on Intel Graphics Platforms**




- **Intel Graphics Controller**: This is the graphics engine hardware integrated in 7th Generation Intel Core Processors and newer, used to decode and render HDR content. Its display engine transmits HDR signals over HDMI and DisplayPort cables to an HDR display.
- **Intel Graphics Driver**: In addition to the appropriate HW above, a particular driver version is required. It is always recommended to get the latest graphics driver released on intel.com, PC OEM website, or via Windows Update.
- **Operating System**: An appropriate version of the Windows 10 operating system. Windows 10 Fall Creators Update (RS3) is the minimum OS version – any newer release is good.
- **LSPCON**: To achieve HDR signaling over HDMI on 7th Generation Intel Core Processors, an additional hardware component known as the LSPCON (Level Shifter and Protocol Converter) must be on the motherboard. This is an ingredient that must be installed by the PC manufacturer and cannot be added by end-users. Note that the LSPCON is required only for HDMI, and not for DisplayPort. Please check with your PC manufacturer about HDMI2.0a support. In newer platforms that use 9th Generation Intel Core Processor or later, HDMI2.0 is supported natively, so there is no need for LSPCON support.
- **LSPCON FW**: The correct version of FW is required on the LSPCON.
- **System BIOS**: Specifically, for Ultra-HD Blu-ray playback, the system BIOS must be properly configured to support Intel® Software Guard Extensions (SGX). It is possible that the system provider turned off SGX by default, in which case the user would have to manually turn it on in the BIOS settings.
- **Intel CSME FW**: The Intel Management Engine (ME) Firmware version is required to achieve necessary HW-DRM support and HDCP2.2 link protection required for premium HDR video content. It is typically included in the System BIOS owned by the system manufacturer.

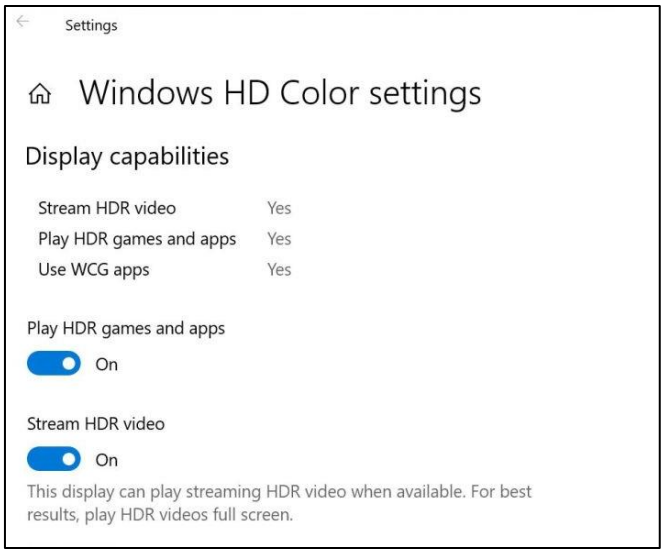
- **Intel MEI Driver**: This driver must be installed so that software can communicate with the ME FW.
- **Application**: Specific application and internet browsers (like Microsoft* Edge) are required to play HDR content.
- **Content**: HDR video files come for different sources. To receive HDR content from certain streaming providers such as Netflix, you must have an appropriate plan/account type.
- **HDR display**: True HDR playback is not yet available on the built-in displays of laptops and tablets, although a partial HDR experience known as Extended Dynamic Range (EDR) is available on the built-in displays of a small number of devices today. TVs are of course available across various makes and models. PC monitors (DisplayPort) supporting HDR are also available as listed below:
  - DisplayPort HDR-10 monitors with HDCP2.2 and with Local Dimming:
    - Dell* UP2718Q (with the right firmware update)
  - DisplayPort HDR-10 monitors with HDCP2.2:
    - Acer* H277HK – HDR10 (look for the HDR sticker on the box)
    - BenQ* SW320 – HDR10
    - LG* 32MU99-W – HDR10

- **Display connector:** The physical display interface (connector) on the PC that connects it to the HDR display could be HDMI, DisplayPort, mini-DisplayPort, or USB Type-C. For HDMI, version2.0a is required. It is important to look for HDCP2.2 support, which is needed for premium content to be transmitted to the display.
- **Cable/dongle:** For PCs with native HDMI or DP connector support, it is straightforward to use an appropriate cable to connect to the display. In case of PCs with USB Type-C port (with Thunderbolt 3 support or DP Alt mode), an adapter or dongle is required to convert USB Type-C to HDMI2.0 or DisplayPort, as well as to support HDCP2.2. Similar adapter is required for miniDP connector too. Such adapters are available from 3rd party vendors such as Club3D*, Belkin*, Uptab*, etc.

# 4 Activating Native HDR Mode on Windows

OS-native HDR support is an opt-in feature in Windows 10 OS. To enable HDR, go to 'Display Settings', click 'Windows HD Color Settings' and enable the HDR settings. The screenshot below was captured in Windows 10 May 2020 Update (2004).

**Figure 2. Screenshot Showing HDR Mode Turned on in Display Settings Page**




As soon as you activate this switch, everything on screen may immediately appear darker, and by comparison desaturated or washed out. This is because most applications and content are SDR while your system is now in HDR mode. For SDR and HDR content to appear at the same time, the SDR content must be shown darker than the HDR. You will also find that if the color gamut of the display is wider than sRGB, transition to HDR mode will make the desktop appear washed out, compared to SDR mode where the sRGB colors looked oversaturated due to color mapping (stretching sRGB to panel's wide color gamut). To adjust the relative brightness of SDR and HDR content, use the slider under 'HDR/SDR brightness balance' setting in Windows HD Color Settings.

This approach allows HDR content to be properly viewed, with highlights far brighter than the SDR content and with greater detail in darker scenes.

Also, if you need to stream HDR contents with applications like Netflix and YouTube, make sure "Stream HDR Video" setting is on in the 'Video playback' settings page.

# 5 Ingredient Details for Different Usage Models

## 5.1 Local HDR Video File Playback

HDR video files are either user generated content or downloaded sample videos. Playing back a local HDR file using the Movies & TV app would be a basic test to perform on any system.

Note that most of the HDR content available are compressed in HEVC codec format. Starting with Redstone 3 (RS3), the HEVC Video Extension is required to play content encoded using HEVC. This extension is provided by device manufacturers and is automatically installed on entitled systems. If it is present on your device, it will be listed in the OS Settings app under "Apps & features." If this extension is not present, your device is not capable of HEVC playback.

For displaying HDR on an external HDR TV (i.e. via HDMI cable), as discussed earlier, the PC may need LSPCON component, like on a PC with 7th Generation Intel Core processor. It is recommended to keep the firmware for LSPCON updated to the latest version made available by OEM. PCs with recent processors like 9th Generation Intel Core processors or newer do not need any converter for HDMI2.0. HDR over DP1.3 is natively supported without a need for any converter.

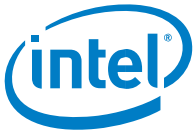
## 5.2 Streaming HDR

This usage is similar to the local video playback as the content is free and not considered premium. On top of that, the PC requires the additional capability in the network bandwidth/speed to download high bitrate content.

## 5.3 Streaming Premium HDR

Playback of premium DRM-protected content on a laptop or desktop computer involves secure handling of the content through the entire pipeline of media decoding, processing, and displaying the content. This requires additional SW/FW ingredients like, Intel ME FW and MEI driver to be present on the Intel graphics platform to ensure end-to-end protection. For displaying premium content over digital ports, HDCP2.2 support is required, which is available on supported Intel graphics platforms natively on DP and via LSPCON on HDMI.

## 5.4 Ultra HD Blu-ray*



This usage requires an UltraHD BluRay optical drive and a supported UHD-BD player application. Another security feature required for UHD-Bluray is SGX.

There are a few PC designs that ship with Blu-ray UHD optical drives. External Blu-ray UHD are available to purchase are listed here.

PowerDVD* 17 from Cyberlink is a supported and certified UHD-BD player application. CyberLink's Ultra HD Blu-ray Advisor can check if your platform supports Ultra HD Blu-ray content playback. You can download the advisor tool here.

## 5.5 HDR Games and Content Creation Applications

To be updated in later revision.

## 5.6 Usages Summary and Dependencies

Summary of all the usages along with the individual dependencies for each usage are shown in the table below. Also shown is the latest/recommended version of drivers and FW at the time of publishing of the original article. Though an older version of a driver may still work fine, it is always recommended to obtain and install the latest version to get all the optimizations and continuous improvements made to the software stack.

| | | Local HDR Video Files | Streaming HDR content (non-premium) | HDR Content Creation apps & Games | Streaming HDR Premium Content | Ultra HD Blu-ray |
|---|---|---|---|---|---|---|
| **Intel Graphics** | | 7th Generation Intel Core Processor with Intel HD Graphics 620 or better[1,2] | | | | |
| **Operation System** | | Windows 10 Fall Creators Update (RS3 & later) | | | | Windows 10 |
| **OEM System BIOS** | **Intel® ME FW** | Latest System BIOS that includes the latest version of these ingredients:<br>- Intel® Manageability Engine Firmware: 11.7.4.3314 or newer<br>- Intel® Security Guard Extensions: 1.8.100.38781 or newer | | | | |
| | **Intel® SGX** | | | | | |
| **Intel® MEI Driver** | | N/A | N/A | N/A | Required 11.7.0.1032 or later | |
| **Intel® Graphics Driver** | | WDDM2.3 driver: 23.20.16.4849 (15.46.4849) or newer | | | | 15.46.4749 or newer |
| **Display** | | HDMI2.0a or DP1.3<br>(For HDMI2.0a support, make sure LSPCON[2] support is enabled) | | | | |
| **Display link protection** | | N/A | N/A | N/A | HDCP2.2 support<br>DisplayPort: Available natively<br>HDMI: Available with LSPCon[2] | |
| **Application** | | Movies and TV | YouTube* | NA | Netflix* Store App<br>Or via Edge browser | Cyberlink* PowerDVD17 |
| **Content** | | User generated HDR videos | 4K HDR clips | NA | HDR enabled titles | HDR-enabled Ultra HD Blu-ray titles |

[1] Non-Core products may not support HDR. For HDR support, please only use Core products
[2] LSPCON is only required on older platforms that did not support native HDMI2.0

**Table 1. Summary of HDR usages and dependencies**

# 6 Additional References

Here are some additional pointers to refer to, for purchasing, configuring, or building an HDR-capable PC with Intel graphics. Note that some of the links provided are for websites owned and maintained by a 3rd party vendor or publisher.

*System/HW:*

Mobile PCs – laptop/AIO devices from various PC OEMs that include the meet the requirements listed in the table shown in above section.

Desktop PCs – Desktop motherboards to connect to a HDMI 2.0a display can be found here. Desktop motherboards to connect to a DisplayPort display: Any 200 or 300 series Intel chipset based motherboard that provides DisplayPort, miniDP, or USB Type-C port

*Blu-ray UHD optical drives*: There are a few PC designs that ship with Blu-ray UHD optical drives. External Blu-ray UHD are available to purchase are listed here.

*Operating System*: Windows* 10 Fall Creators Update can be obtained here. The latest Windows* 10 updates can be found here.

*System BIOS*: To be obtained from respective PC or motherboard manufacturer websites.

*Graphics Driver*: This webpage provides generic graphics drivers that system integrators and motherboard users can apply. For many OEM PCs, the applicable graphics drivers are made available on the OEM websites, or via Windows Update*

*MEI driver*: This page. Provides MEI driver download that system integrators can use.

*Windows Settings:* This page provides more information on how to use Windows HD Color settings to enable HDR in Windows.

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