

High Dynamic Range (HDR) on Intel Graphics

Technical White Paper

Supporting 7th Gen Intel® Core™ Processor and Newer Platforms

November 2017

Revision 1.0



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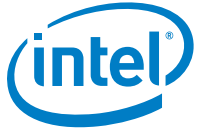
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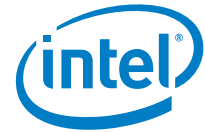
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Revision History

Revision Number	Description	Revision Date
1.0	• Initial release	Nov 2017



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.

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 High Dynamic Range (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*

7th Gen Intel Core processor platforms (formerly codenamed Kaby Lake) is the first Intel integrated graphics platform to support HDR. Laptops, desktops and 2-in-1s manufactured by OEMs using this product are available in the market today. Further PCs with 8th Gen Intel Core processor are getting introduced as well. However, because HDR is a relatively new technology, there are several ingredients that need to be on a PC before it is capable of supporting HDR. This whitepaper will describe these ingredients in detail in order to aid the user in determining whether the user's 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 Intel is investigating expanding support to other standards in the future. For the moment, however, all HDR movie and shows today are available in the HDR10 format, 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.

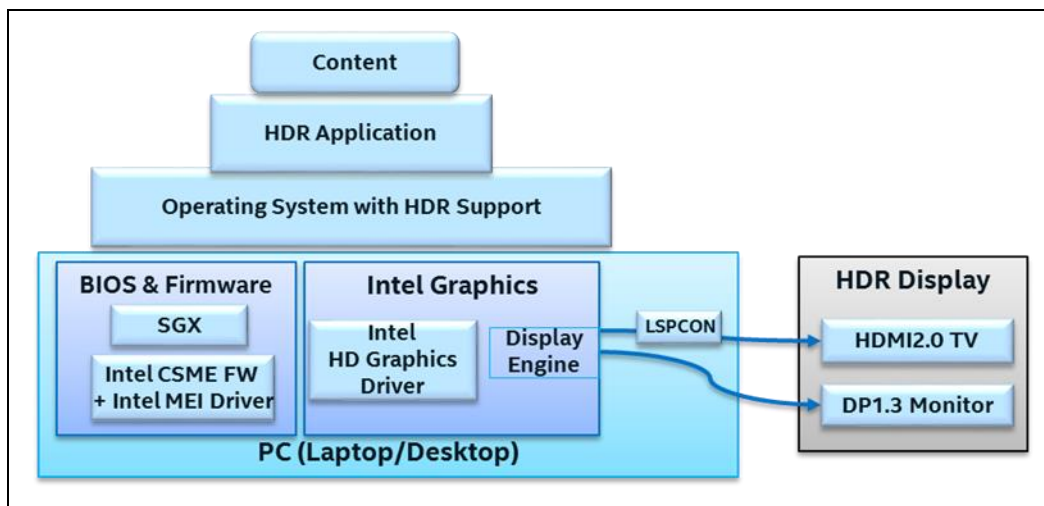
- Streaming HDR (eg. YouTube*)
- Streaming premium HDR (eg. Netflix*)
- Local HDR Video Files
- ULTRA HD Blu-ray*
- HDR games//
- HDR content creation apps

Each of these content types requires a slightly different set of ingredients in order 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 HD/UHD Graphics:** This is the graphics engine hardware integrated in the 7th Gen Intel Core Processor, used to decode and render HDR content. Its display engine transmits HDR signals over HDMI and DisplayPort cables to an HDR display.
- **Intel HD/UHD 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, or PC OEM website or via Windows Update path.
- **Operating System:** An appropriate version of the Windows 10 operating system. Windows 10 Fall Creators Update (or newer) is required.
- **LSPCON:** In order to achieve HDR signaling over HDMI on 7th Gen Intel Core Processor, 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. Future revisions of Intel graphics HW will not require LSPCON. Note that the LSPCON is required only for HDMI, and not for DisplayPort. Please check with your PC manufacturer about HDMI2.0a 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 in order to achieve necessary HW-DRM support and HDCP2.2 link



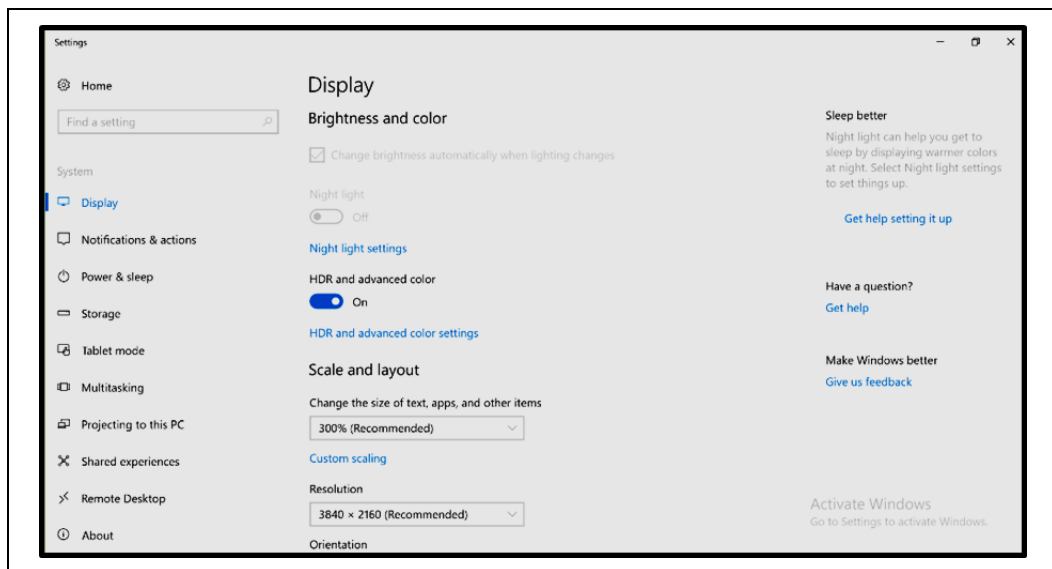
protection required for premium HDR video content. It is typically included in the System BIOS owned by the system manufacturer.

- **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. In order 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 on Windows 10 Fall Creator's Update (RS3). To enable HDR, go to 'Display Settings' and then slide on "HDR and advanced color" setting.

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



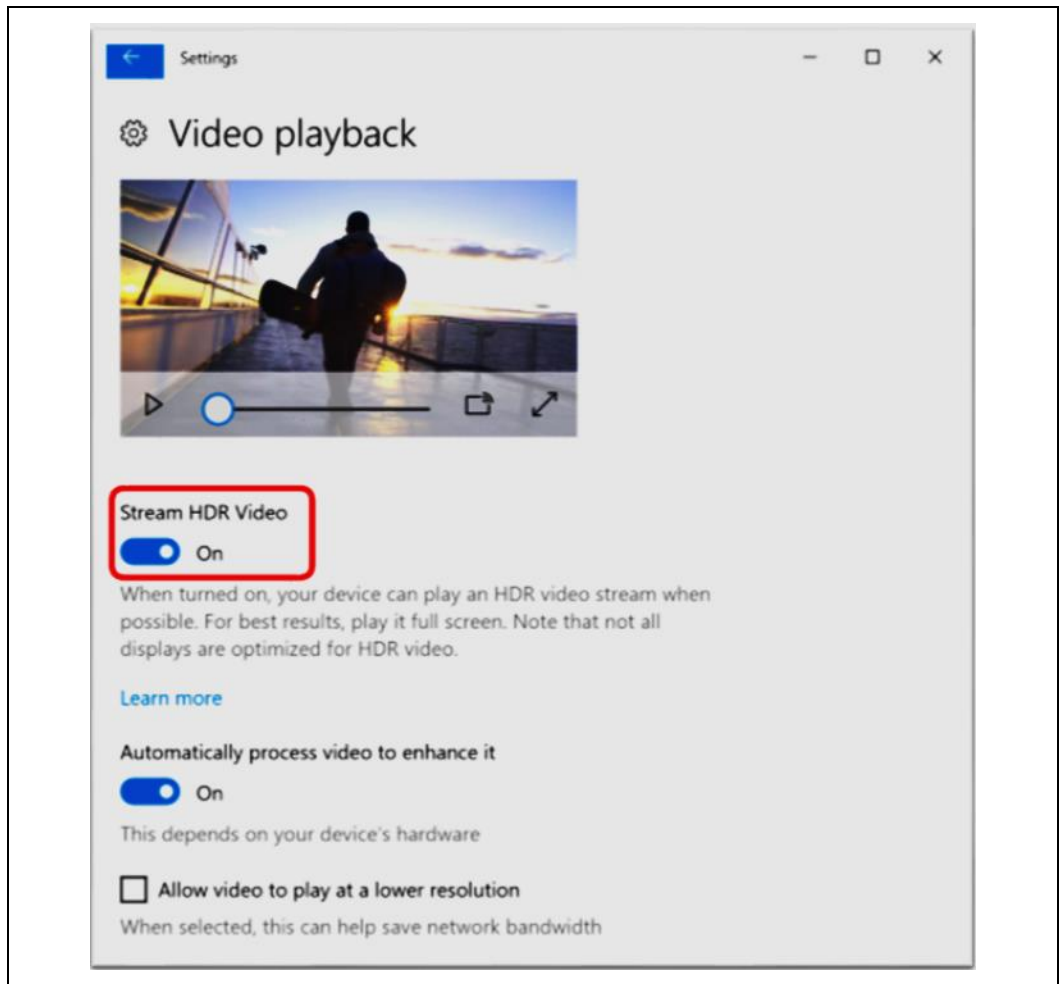
As soon as you activate this switch, everything on screen will immediately appear darker, and by comparison desaturated or washed out. This is because the vast majority of applications and content are SDR while your system is now in HDR mode. In order for SDR and HDR content to appear at the same time, 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).

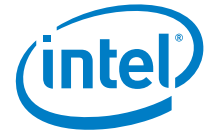
This approach allows HDR content to be properly viewed, with highlights far brighter than the SDR content and also with greater detail in darker scenes.

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.



Figure 3. Screenshot Showing 'Stream HDR Video' turned on





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 the basic test to perform on any system.

Note that most of the HDR content available are compressed in HEVC codec format. Starting with 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 (ie via HDMI cable), as discussed earlier, the PC would need LSPCon component. It is recommended to keep the firmware for LSPCON updated to the latest version made available by OEM. 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](#).



Currently, the only supported and certified UHD-BD player application is Cyberlink PowerDVD* 17. 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](#).

More supported software application for this usage is expected soon.

5.5 HDR Games and Content Creation Applications

Not yet validated.

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 this article. Though an older version of a driver may still work fine, it is always recommended to obtain and install the latest version in order 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	8 th Gen Intel Core Processor with Intel UHD Graphics 620 or better 7 th Gen Intel Core Processor with Intel HD Graphics 620 or better				
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: - Intel® Manageability Engine Firmware: 11.7.4.3314 or newer - 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 build like 4832, 4849
Display	HDMI2.0a or DP1.3 For HDMI2.0a support, make sure LSPCon support is enabled				
Display link protection	N/A	N/A	N/A	HDCP2.2 support DisplayPort: Available natively HDMI: Available with LSPCon	
Application	Movies and TV	YouTube*	NA	Netflix* Store App 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

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](#).

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*

LSPCon Firmware: If the system has the LSPCON part to support HDMI2.0a (and HDCP2.2 over HDMI2.0), the associated firmware for the LSPCON is included by the OEM/system provider. There may not be any specific tools available to check the version of this firmware. The system provider or OEM needs to be contacted if any issue detected with HDMI2.0 and HDCP2.2 functionality. For reference, the versions validated and recommended for these LSPCon parts from different IHV (Independent Hardware Vendor) are as follows:

Parade* PS175: v0x23 MegaChips* MCA2800: V1.66

MEI driver: See [here](#). Although this link is designated for NUC users, it also applies to all manufacturers and supports 7th Generation Intel Core and newer platforms.

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