Blackwell Workstation Display Resolution Capabilities

Application Note

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Document History

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02	November 24, 2025	JS, RK	Removed confidentiality markers.

Table of Contents

Overview 5

Display Features 6

- Display Connectors 6
- DisplayPort 6
  - DisplayPort Multi-Streaming 7
- HDMI 8

Maximum Supported Resolutions 10

- Display Pixel Clock and Bandwidth 10
- Display Color Depth 11
- High Dynamic Range 14
- Display Stream Compression 16

8K and Higher Resolution Support 18

List of Figures

Figure 1. Create Custom Resolution Calculator 11
Figure 2. Color Depth Setting 13
Figure 3. Color Term Examples 14

List of Tables

Table 1. NVIDIA Blackwell Workstation Products 5
Table 2. NVIDIA GPU Generation and DisplayPort Standards 7
Table 3 Commonly Supported DisplayPort 2.1b Resolutions 7
Table 4. Commonly Supported HDMI 2.1 Resolutions 9
Table 5. Operating System Maximum Pixel Supported 10
Table 6. DisplayPort Resolution and Maximum Bits per Pixel 12
Table 7. 8K and Higher Resolutions 18

Overview

This application note lists the display resolution capabilities of the NVIDIA® Blackwell architecture workstation products.

Table 1 lists the workstation products and their display connectors for NVIDIA Blackwell products.

Table 1. NVIDIA Blackwell Workstation Products

NVIDIA RTX Boards	Display Configuration
NVIDIA RTX PRO 6000 Blackwell	4 x VESA DP 2.1b
NVIDIA RTX PRO 6000 Max-Q Blackwell	4 x VESA DP 2.1b
NVIDIA RTX PRO 5000 Blackwell	4 x VESA DP 2.1b
NVIDIA RTX PRO 4500 Blackwell	4 x VESA DP 2.1b
NVIDIA RTX PRO 4000 Blackwell	4 x VESA DP 2.1b
NVIDIA RTX PRO 4000 Blackwell SFF	4 x VESA mDP 2.1b
NVIDIA RTX PRO 2000 Blackwell	4 x VESA mDP 2.1b

For information on earlier generation GPUs, refer to the *Display Resolution Capabilities for Workstation Products* (NVOnline ID: 1008217).

Display Features

Display Connectors

The NVIDIA Blackwell workstation products have four DisplayPort or four Mini DisplayPort connectors.

The NVIDIA Blackwell workstation products do not have native HDMI connectors, so an adapter must be used when connecting HDMI devices. When using HDMI connections, full display performance requires the use of high-quality active DisplayPort-to-HDMI protocol converters. Refer to the *Display Adapter RVL (Recommended Vendor List)* (NVOnline ID: 1001022) for a list of recommended adapters.

DisplayPort

The NVIDIA Blackwell architecture fully supports DisplayPort 2.1b. This is a significant upgrade from the previous generations, which was limited to DisplayPort 1.4a.

NVIDIA Blackwell introduces support for the following Ultra High Bit Rate (UHBR) transmission modes:

- UHBR10
- UHBR13.5
- UHBR20

These new modes provide a massive increase in bandwidth over the DisplayPort 1.4a standard.

DisplayPort 2.1b also utilizes a far more efficient 128b/132b encoding scheme as compared to DisplayPort 1.4's earlier 8b/10b encoding. This improves coding efficiency from approximately 80% to 97%. As a result, the highest transmission mode UHBR20 provides up to an effective bandwidth of 76.96 Gbps across all four DisplayPort lanes.

The NVIDIA Blackwell offers almost three times as much effective bandwidth as the previous generation. This allows Blackwell GPUs to support extremely high-resolution and high-refresh-rate displays, such as 8K resolution at 165Hz. Table 2 shows the DisplayPort features of the Blackwell generation versus NVIDIA Ampere and NVIDIA Ada generation.

Table 2. NVIDIA GPU Generation and DisplayPort Standards

	Ampere	Ada	Blackwell
DisplayPort Standard	DisplayPort 1.4	DisplayPort 1.4	DisplayPort 2.1b
Encoding Scheme	8b/10b	8b/10b	128b/132b
Maximum Bandwidth	32.4 Gbps	32.4 Gbps	80 Gbps
Max Effective Bandwidth	25.14 Gbps	25.14 Gbps	76.96 Gbps
Maximum resolution	8K @ 60Hz with DSC	8K @ 60Hz with DSC	8K @ 165Hz with DSC

Table 3 shows the commonly supported display resolutions for NVIDIA Blackwell architecture.

Table 3 Commonly Supported DisplayPort 2.1b Resolutions

Display Standard	Example Display Resolutions
VESA® DisplayPort™ 2.1b	Maximum pixel clock[1]: Up to 9670 Mpixels per second Maximum effective bandwidth[2]: 76.96 Gbps **Preliminary examples** of DP2.1b resolutions with CVT-RB timings[3]: 7680 × 4320 × 24 bpp at 120 Hz[4, 8] 7680 × 4320 × 24 bpp at 60 Hz[5, 8] 7680 × 4320 × 36 bpp at 60Hz[5, 7] 5120 × 3200 × 24 bpp at 60 Hz[5] 5120 × 2880 × 24 bpp at 60 Hz[5] 3840 x 2160 x 24bpp at 120Hz[5, 6] 3840 x 2160 x 30bpp at 120Hz[5, 6] 3840 x 2160 x 24bpp YUV422 or DSC at 144Hz[5] 3840 x 2160 x 30bpp YUV422 or DSC at 144Hz[5]

Notes:
[1]Depending on GPU resources applied to the port.
[2]Maximum raw bandwidth represents the raw bandwidth of four lanes of UHBR20.
[3]Assume RGB/Y'CBCR 4:4:4 color, unless otherwise stated.
[4]Using DSC (Display Stream Compression).
[5]Uncompressed.
[6]Requires ≥ UHBR10.
[7]Requires UHBR20.
[8]Requires ≥ UHBR13.5.

DisplayPort Multi-Streaming

When using DisplayPort Multi-Streaming (MST), multiple display streams are combined into one output. Displays that are connected to MST must share the total bandwidth of that single DisplayPort cable.

DisplayPort 1.4 Multi-Streaming

DisplayPort 1.4 has a maximum effective bandwidth of 25.14 Gbps. Multiple display streams must be equal or less than the total bandwidth of the maximum effective bandwidth.

The following examples are calculated with uncompressed display streams with CVT-RB:

> 4 displays of 1920 x 1200, 24 bpp at 60Hz
  4 x 154 MHz x 24 bpp = 14.784 Gbps – which works
> 2 displays of 3840 x 2160, 30 bpp at 60Hz
  2 × 522 MHz Pixel Clock × 30 bpp = 31.3 Gbps – which does not work
> 3 displays of 2560 x 1600, 30 bpp at 60Hz
  3 x 268.5 MHz Pixel Clock x 30 bpp = 24.165 Gbps – which works

DisplayPort 2.1b Multi-Streaming

DisplayPort 2.1b has a maximum effective bandwidth of 76.96 Gbps. Multiple display streams must be equal or less than the total bandwidth of the maximum effective bandwidth.

The following examples are calculated with uncompressed display streams with CVT-RB:

> 2 displays of 3840 x 2160, 24 bpp at 144Hz
  2 x 1332.75 MHz x 24 bpp = 63.972 Gbps – which works
> 4 displays of 3840 x 2160, 30 bpp at 60Hz
  4 × 533.25 MHz Pixel Clock × 30 bpp = 64 Gbps – which works
> 2 displays of 7680 x 4320, 30 bpp at 60Hz
  2 x 2089.75 MHz Pixel Clock x 30 bpp = 125.385 Gbps – which does not work

There are a few other restrictions with multi-streaming, so if you are designing a system that pushes the boundaries of the pixel clock on the heads, contact your NVIDIA field engineering resources for assistance.

Caution: Since DisplayPort MST relies upon an external device to receive and re-broadcast the data, the MST hub used might reduce usable bandwidth.

HDMI

The NVIDIA Blackwell architecture maintains the same HDMI 2.1 standard as the standard of earlier Ampere and Ada generations. HDMI 2.1 supports a maximum bandwidth of 48Gbps with the Fixed Rate Link (FRL) signaling technology, which is significantly higher than the maximum bandwidth of 18Gbps with HDMI 2.0.

This higher bandwidth allows the transmission of uncompressed video at resolutions and refresh rates such as UHD 4K with 36bpp at120Hz. HDMI 2.1 also adds the ability to transmit DSC compressed streams, which allows HDMI 2.1 to support even higher bandwidth resolutions such as 8K with 36bpp at 60Hz with DSC.

Table 4. Commonly Supported HDMI 2.1 Resolutions

Display Standard	Example Display Resolutions
HDMI™ 2.1b[8]	Example maximum resolution at CVT-RB timing: 7680 × 4320 × 24bpp YUV420 or DSC at 60Hz 7680 × 4320 × 30bpp YUV420 or DSC at 60Hz 7680 × 4320 × 36bpp YUV420 or DSC at 60Hz 3840 x 2160 x 24bpp uncompressed at 120Hz 3840 x 2160 x 30bpp uncompressed at 120Hz 3840 x 2160 x 36bpp uncompressed at 120Hz 4096 x 2160 x 24bpp uncompressed at 120Hz 4096 x 2160 x 30bpp uncompressed at 120Hz 4096 x 2160 x 36bpp uncompressed at 120Hz

Maximum Supported Resolutions

There is no single maximum resolution for a given connector type. The maximum resolution is defined by several constraints which are different for each connector type:

- **The maximum number of pixels per second that can be carried across the link:** It does not matter to the graphics processing unit (GPU) if the pixels are allocated on a large desktop that is refreshing slowly or a small desktop that is refreshing quickly.

  The maximum desktop size allowed by the GPU is 16 k × 16 k pixels. Different operating systems might have different limitations (refer to Table 5).
- **The maximum bandwidth available on the link**: This constraint is most important to DisplayPort connections.

Table 5. Operating System Maximum Pixel Supported

Operating System	Max Pixel
Linux	32K × 32K
Microsoft® Windows 10®	32K × 32K

The rest of this section covers the resolution information for DisplayPort and HDMI connectors.

Display Pixel Clock and Bandwidth

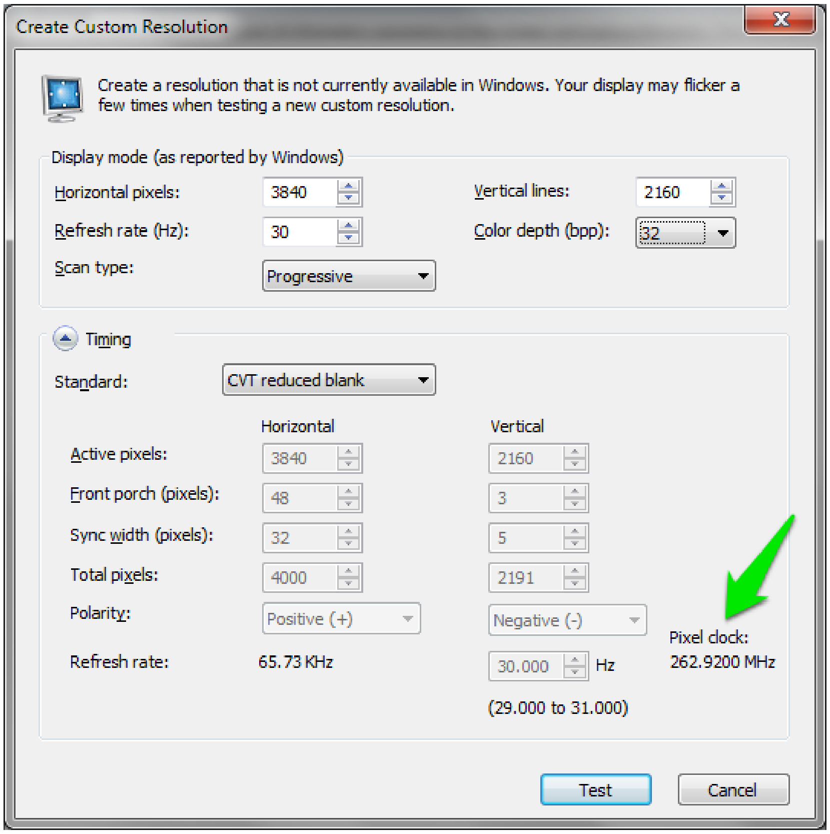
All display connection technologies have a maximum bandwidth. In general, any resolution and refresh rate that fits within this bandwidth will work. The display bandwidth is defined by the pixel clock and how many bits per pixel are requested. The easiest way to compute the pixel clock is with the NVIDIA Control Panel's custom resolution calculator.

To access the calculator, click **Display** > **Change Resolution** > **Customize** > **Create Custom Resolution**.

1. Enter the desired horizontal and vertical pixels and refresh rate.
2. Select the timing standard.
3. On the bottom right, verify that you can see the configured pixel clock.

If the requested pixel clock is within the capabilities of the connection, the timing is valid.

Figure 1. Create Custom Resolution Calculator



Display Bandwidth mainly applies to the DisplayPort connection. For this application note, the pixel clock is multiplied by the number of color bits per pixel. For example:

200 MHz pixel clock × 30 bits per pixel = 6,000 M bits per second (or 6 G bits per second Gbps)

Display Color Depth

In addition to the frame rate, resolution displays, connector type, the number of color bits per pixel (bpp) can also affect the maximum supported resolution. Standards such as DVI define that each pixel must be made of a red, green, and blue component with 8 bits each or 24 bits per pixel (bpp). HDMI and DisplayPort also offer 8, 10, or 12 bits per component (bpc). The display device defines the bit depth that it wants to receive, and the GPU will try to honor this value.

The maximum supported bpp can be calculated by the transmission mode’s maximum effective bandwidth divided by the pixel clock that is required at that resolution.

The NVIDIA Ampere and Ada generation GPUs support up to DisplayPort 1.4a. Starting with NVIDIA Blackwell, the GPU supports DisplayPort 2.1b. Examples of the supported bpp for each display resolution format is provided in Table 6.

Table 6. DisplayPort Resolution and Maximum Bits per Pixel

		DisplayPort 1.4	DisplayPort 2.1b			
		HBR3	UHBR10	UHBR13.5	UHBR20	
Format	BW* / PCLK	25.14G	38.48G	51.95G	76.96G	
4k@60cvt rb1	533.25	47.1	72.2	97.4	144.3	Supported w/o DSC[1]
4k@60cta	594	42.3	64.8	87.5	129.6	
4k@120cvt rb1	1097.75	22.9	35.1	47.3	70.1	
4k@120cta	1188	21.2	32.4	43.7	64.8	
8k@60cvt rb1	2089.75	12.0	18.4	24.9	36.8	
4k@240cvt rb1	2331.75	10.8	16.5	22.3	33.0	
8k@60cta	2376	10.6	16.2	21.9	32.4	
4k@360cvt rb1	3728	6.7	10.3	13.9	20.6	Supported with DSC[2]
8k@120cvt rb1	4302.25	5.8	8.9	12.1	17.9	
8k@120cta	4752	5.3	8.1[3]	10.9	16.2	
		Can not be supported				

Note:

* The maximum bpp is calculated by taking maximum effective bandwidth divided by the Pclk.

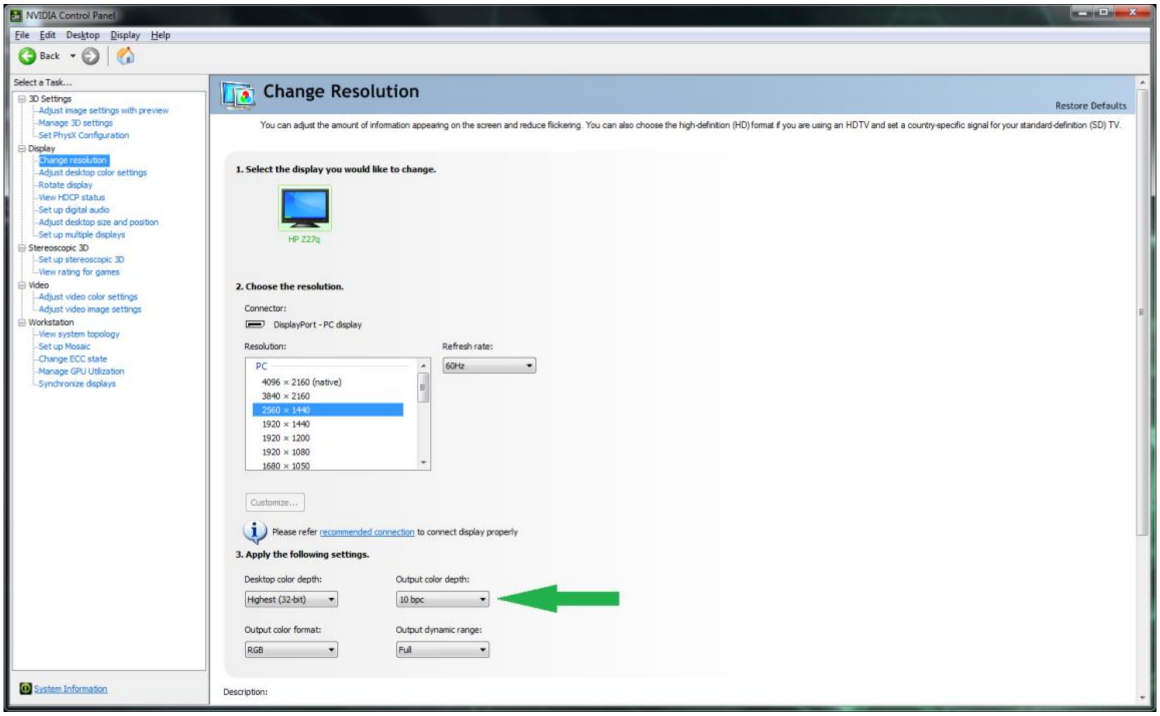
[1] When the maximum bpp is greater or equal to 24bpp indicates that the display format can support uncompressed stream without DSC.

[2] A maximum bpp value greater than 8 indicates that the display format **can be** supported with DSC. A maximum bpp less than 8 indicates that the resolution **cannot be** supported with or without DSC.

[3] UHBR10 BW is not enough for 8k@120 CTA because of additional EOC symbols, so you need to use CVT RB1 timing or DSC with YUV native422 format

On supported displays, the Change Resolution section of the control panel offers a choice to select the Output Color Depth. Reducing the color depth on connections like DisplayPort might enable higher resolutions or frame rates.

Figure 2. Color Depth Setting



In this application, the following terms are used for color:

> BPC**:** Bits Per Component.

  How many bits represent each component in the pixel: 8, 10, or 12.

> BPP: Bits Per Pixel.

  The number of bits for color in each pixel: 24, 30, 36.

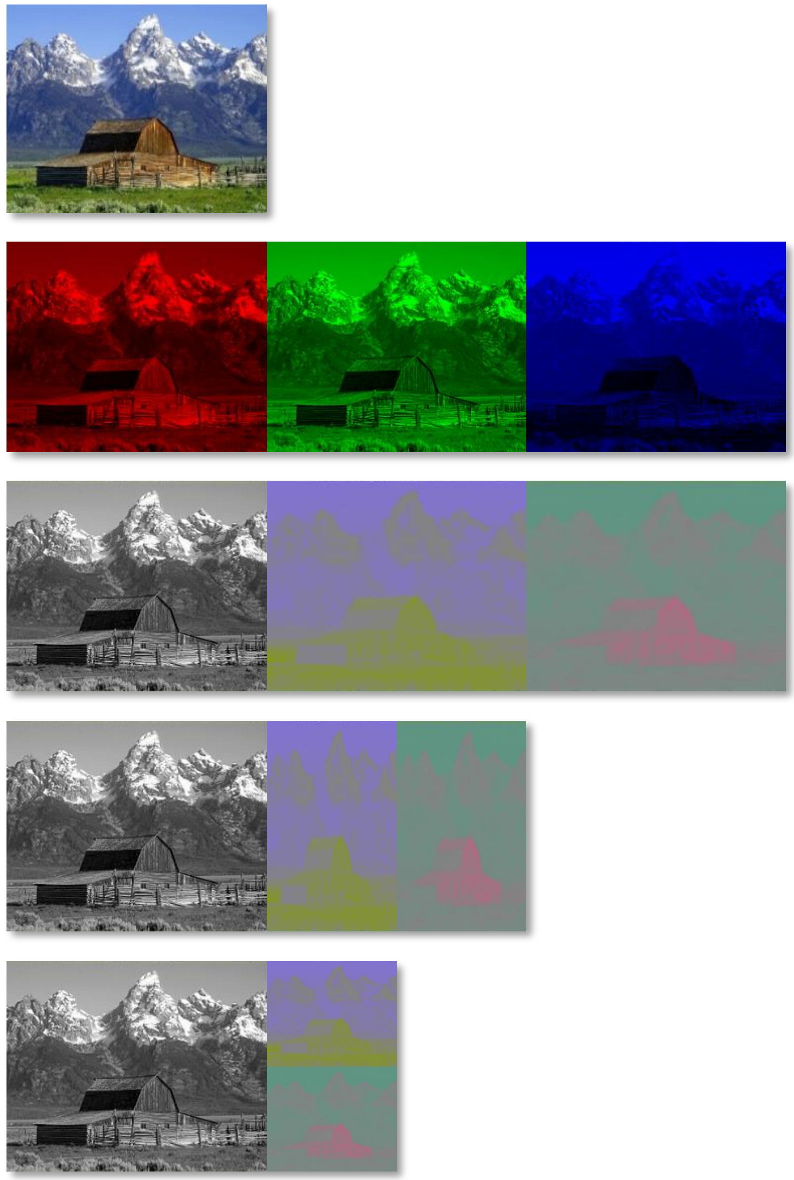
> RGB: The colors in a pixel are made up of red, green, and blue components.

> YCbCr: The colors in the pixels are made up of a Luminance (Y) and two color/chroma channels (Cb and Cr)

> YCbCr 4:2:0: In a YCbCr image, you can sample the chroma or color information at different rates from the Luminance information.

  - 4:2:0 means all the Luminance information is sent but only a quarter of the color information.
  - This compression means each frame of a 4:2:0 compressed stream uses half the data of an uncompressed (or 4:4:4) frame.

Figure 3. Color Term Examples



Source

RGB

YCbCr 4:4:4

YCbCr 4:2:2

YCbCr 4:2:0

High Dynamic Range

High Dynamic Range (HDR) displays allow manufacturers to produce brighter, greater contrast displays that can reproduce more realistic images. A nit is the most common measure of brightness and is defined as one candela per square meter. The observable world has such a large range of luminance, yet up until the last few years, few displays produced more than 200-300 nits of brightness.

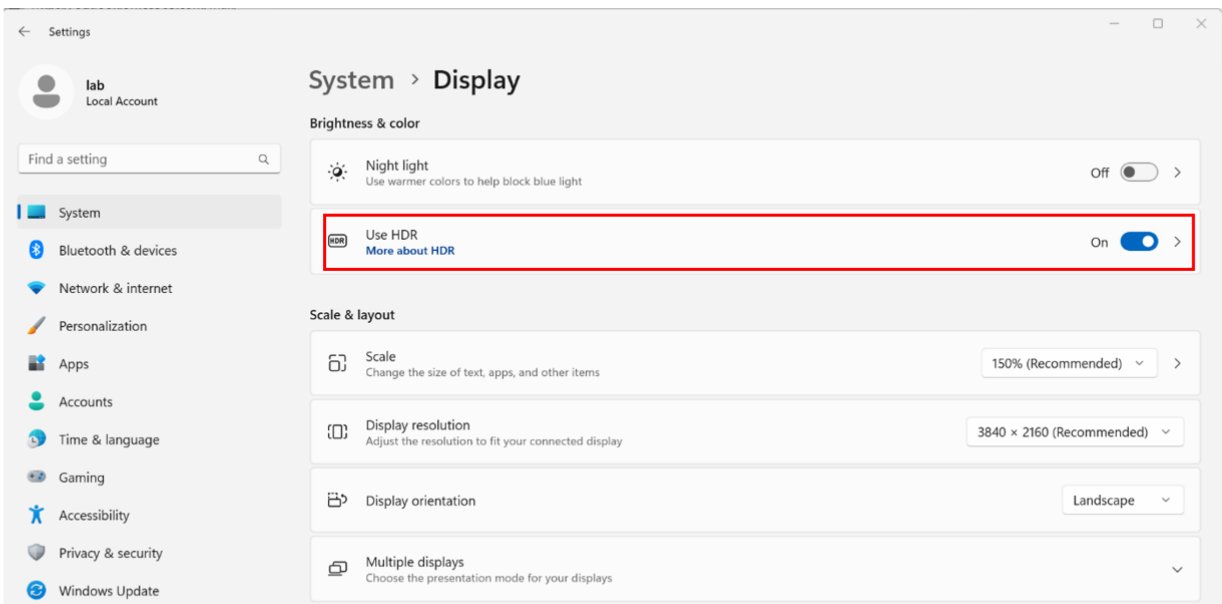
In August 2015, the Consumer Technology Association (CTA) announced an industry definition for HDR Compatible Displays that included the definition of the HDR10 Media Profile. While other HDR formats exist, HDR10 has been the most widely adopted in the display industry. Starting with the NVIDIA Pascal generation, NVIDIA GPUs have supported HDR10 by sending an Infoframe, which indicates support for SMPTE ST 2084. The electro-optical transfer function that is defined for luminance values up to 10,000 nits, which is also known as Perceptual Quantizer (PQ) when connected to an HDR10 capable sink device.

Reproducing more of the colors the human eye can see is also important to making high-quality HDR displays. For the last couple of decades, the most common color space for the PC industry has been sRGB. It uses the same three-color primaries as the Rec. 709 color space that was defined for HDTVs. This format was defined in the era of CRT displays and was extremely useful for representing the most achievable range of colors.

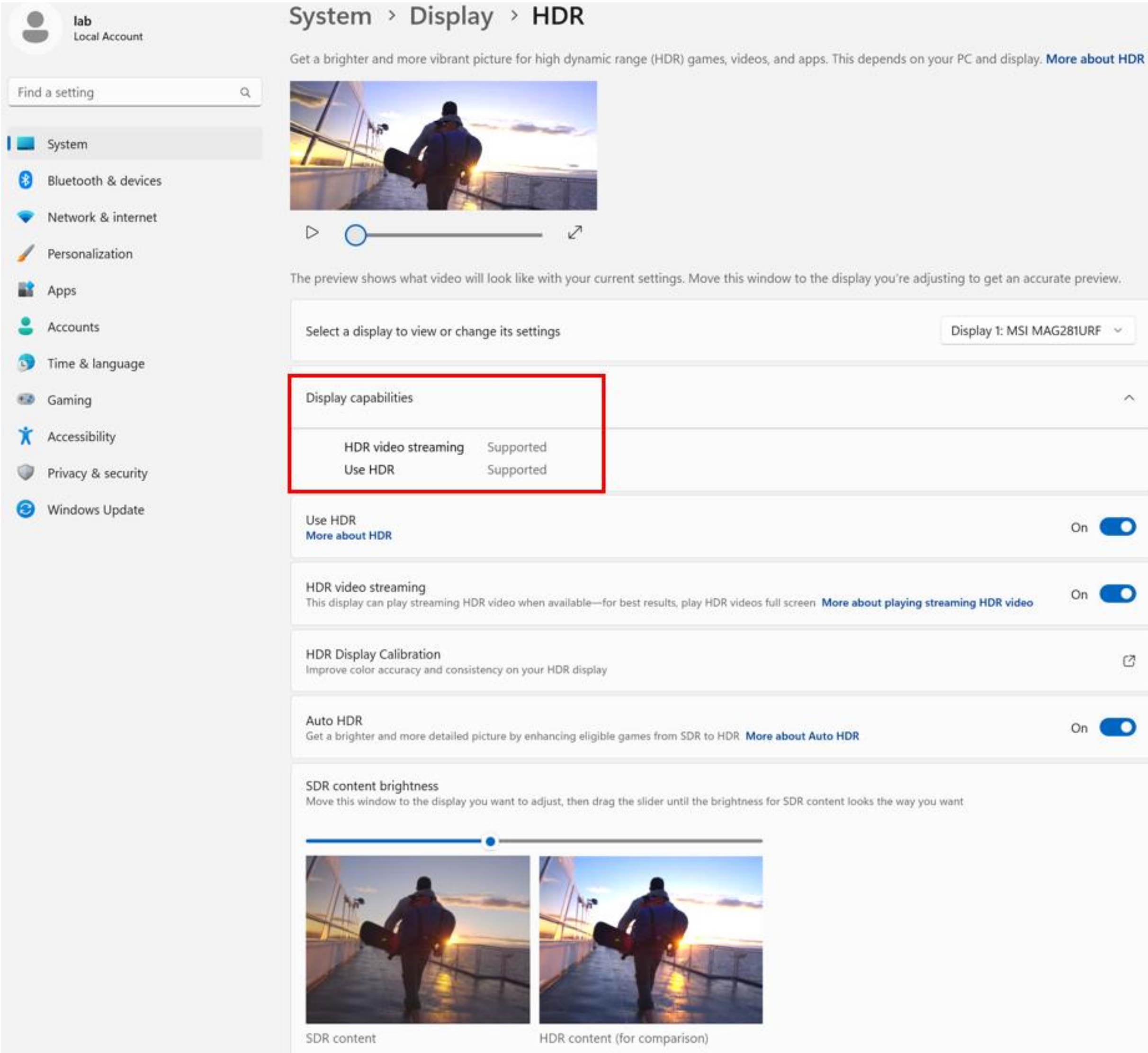
BT. 2020 is now the target color gamut for HDR displays. HDR10 also supports a much wider range of colors that are much closer to the limits of human color vision. NVIDIA Blackwell generation GPUs can support the BT. 2020 colorimetry by sending a video stream configuration data packet over the DisplayPort to displays that can support this color gamut.

Microsoft Windows 11® provides a control panel switch to enable HDR10 output:

1. In the Windows 11 control panel, to enable HDR output, click **Start** > **Settings** > **System** > **Display**.



2. Select **Use HDR** and click the arrow next to it to expand it.
3. Under **Display capabilities**, verify that it says **Supported** next to **HDR video streaming** and **Use HDR**.
4. Enable **Use HDR** and **HDR video streaming** by toggling the selector to **On**.



Display Stream Compression

Display Stream Compression (DSC) is a visually lossless compression technology standardized by VESA and is designed to reduce the data required for high-resolution and high-refresh-rate video streams. DSC typically achieves a compression ratio of up to 3:1, which means it can compress video data to one-third of its original size without a perceptible loss in quality. This allows the transmission of video content at resolutions like 4K and 8K, or with high color depth, over standard interfaces like HDMI, DisplayPort, and USB-C without exceeding their bandwidth limits.

In dual monitor setups, DSC compresses video streams that enables a source to drive multiple high-resolution displays smoothly without additional cables or complex hardware. This technology is particularly beneficial in gaming, professional workstations, and scenarios where high-visual fidelity is required without sacrificing performance or connectivity simplicity.

DSC minimizes the impact on advanced display features like HDR, G-Sync, and Deep Learning Super Sampling (DLSS).

> For HDR, DSC maintains enhanced contrast and color accuracy by compressing video without significantly affecting visual quality.
> For G-Sync, DSC does not interfere with the synchronization between the GPU and the monitor, ensuring smooth gameplay without screen tearing.
> For DLSS, DSC compresses the final output stream and preserves the upscaling and performance enhancements provided by this AI-based technology.

DSC ensures that the benefits of these advanced features are preserved even as it reduces the video data's size.

8K and Higher Resolution Support

The NVIDIA Blackwell architecture now supports DisplayPort 2.1b, which enables up to 16K resolution at 60Hz. The NVIDIA Blackwell architecture also carries over support for high-bandwidth HDMI 2.1 FRL, which enables resolutions higher than 8K with DSC.

Table 7 lists some 8K and higher resolution examples based on NVIDIA Blackwell's capabilities, although these capabilities have not been tested with real displays.

Table 7. 8K and Higher Resolutions

Possible Display Resolutions	HDMI 2.1	DisplayPort 2.1b
CTA timing examples:		
10240 x 4320 x 24bpp with DSC or YUV420 at 120Hz	✓	✓
CVT-RB timing examples:		
8192 x 4320 x 24bpp uncompressed at 60Hz	✓[1]	✓
10240 x 4320 x 24bpp uncompressed at120Hz	✓[1]	✓
15360 x 8640 x 24bpp with DSC or YUV420 at 60Hz		✓

Note:

[1]Possible for HDMI 2.1 FRL with the DSC stream.

Notice

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HDMI

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