Display Resolution Capabilities for Workstation Products

Application Note

Document History

DA-07089-001_v10

Version	Date	Authors	Description of Change
01	November 1, 2013	AP, SM	Initial release.
02	October 28, 2014	AP, SM	> Updated with the following products: Quadro K5200, Quadro K4200, Quadro K2200, Quadro K620, and Quadro K420. > Added “HDMI 2.0” section. > Added “VGA Via DisplayPort to VGA Adaptor” section. > Added “Display Color Depth” section.
03	June 13, 2016	JK, AP, PV, SM	> Added Quadro K1200, Quadro M2000, Quadro. M4000, Quadro M5000, Quadro M6000 and NVS 810. > Updated the display resolution tables. > Added NVIDIA Maxwell generation support.
04	September 23, 2016	JK, SM	> Added Quadro P5000 and Quadro P6000. > Added “DP 1.4” section. > Updated the display resolution tables.
05	September 29, 2016	JK, SM	Updated display connectors table (Table 4).
06	April 28, 2017	JK, SM	Added Pascal generation support for Quadro.
07	March 13, 2019	EL, SM	> Added NVIDIA Turing generation support for Quadro. > Added Quadro RTX boards in “Display Connectors” table (Table 5.) > Added a note in Table 7 that says, “NVIDIA Turing supports Display Stream Compression (DSC) to drive an 8K DSC panel over a single connector.” > Updated the “DisplayPort” section. > Updated “UltraHD (3840 x 2160) and Cinema 4K (4096 x 2160) Option Support” table (Table 8).
08	May 15, 2019	EL, SM	Added “High Dynamic Range” section.
09	July 23, 2021	AS, SM	> Changed application note title to Display Resolution Capabilities for Workstation Products. > Updated Table 2 with additional NVIDIA Turing products (T1000, T600 and T400). > Added NVIDIA Ampere generation support for NVIDIA RTX. > Added NVIDIA Ampere RTX boards in Table 6. > Updated the “DisplayPort” section to address Ampere and NVIDIA Turing products.
10	August 28, 2024	AS, DV	> Added Table 1 with Ada generation cards > Updated Table 2 with remaining Ampere generation cards.

Version	Date	Authors	Description of Change
			> Updated Table 7 with Ada generation cards and remaining Ampere generation cards > Added PCIe Ada generation GPU resolution information > Added DSC description.

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Overview

This application note lists the display resolution capabilities of the NVIDIA® Kepler™ and later generations of NVIDIA RTX™, NVIDIA® Quadro®, and NVIDIA® NVS™ workstation products. The following product naming conventions help identify which generation of graphics processing units (GPUs) is represented for NVIDIA RTX and Quadro boards.

- The “Ada” represents the NVIDIA Ada Lovelace Architecture generation (example: NVIDIA RTX 6000 Ada)
- The “A” represents the NVIDIA Ampere Architecture generation (example: NVIDIA RTX A6000)
- The “RTX” represents the NVIDIA Turing™ generation (example: Quadro RTX™ 6000)
- The “P” represents the Pascal generation (example: Quadro P6000)
- The “M” represents the NVIDIA Maxwell™ generation (example: Quadro M6000)
- The “K” represents the Kepler generation (example: Quadro K6000) except for K2200, K1200, and K620 as noted in Table 4.

The NVS boards do not have a family identifier in their name. The NVS 510 and NVS 315 boards are part of the Kepler family, and the NVS 810 board is part of the NVIDIA Maxwell family.

Table 1 through Table 6 list the Quadro products for each of the generation of GPUs.

Table 1. NVIDIA Ada Generation GPUs

NVIDIA RTX Boards
NVIDIA RTX 6000 Ada
NVIDIA RTX 5880 Ada
NVIDIA RTX 5000 Ada
NVIDIA RTX 4500 Ada
NVIDIA RTX 4000 Ada
NVIDIA RTX 4000 SFF Ada
NVIDIA RTX 2000 Ada
NVIDIA RTX 2000E Ada

Table 2. NVIDIA Ampere Generation GPUs

NVIDIA RTX Boards
NVIDIA RTX A6000
NVIDIA RTX A5500
NVIDIA RTX A5000
NVIDIA RTX A4500
NVIDIA RTX A4000
NVIDIA RTX A4000H
NVIDIA RTX A2000 12GB
NVIDIA RTX A2000 6GB
NVIDIA RTX A1000
NVIDIA RTX A400

Table 3. NVIDIA Turing Generation GPUs

Quadro Boards
Quadro RTX 8000
Quadro RTX 6000
Quadro RTX 5000
Quadro RTX 4000
NVIDIA T1000
NVIDIA T1000-8GB
NVIDIA T600
NVIDIA T400E
NVIDIA T400
NVIDIA T400-4GB

Table 4. NVIDIA Pascal Generation GPUs

Quadro Boards	Quadro Mobile or MXM Boards[1]
Quadro GP100	Quadro P5000
Quadro P6000	Quadro P4000
Quadro P5000	Quadro P3000
Quadro P4000	Quadro M2200
Quadro P2000	Quadro M1200
Quadro P1000	Quadro M620
Quadro P600	Quadro M520
Quadro P400	

Note:

[1]Since the Mobile and MXM boards do not ship from NVIDIA with display connectors attached, you will need to verify display connector specifics with the system vendor.

Table 5. NVIDIA Maxwell Generation GPUs

Quadro 1st Gen Boards	Quadro 2nd Gen Boards	Quadro 1st Gen Mobile or MXM Boards[1]	Quadro 2nd Gen Mobile or MXM Boards[1]	NVS Boards
Quadro K2200 Quadro K1200 Quadro K620	Quadro M6000 24GB Quadro M6000 Quadro M5000 Quadro M4000 Quadro M2000	Quadro M2000M Quadro M1000M Quadro M600M Quadro M500M	Quadro M5500 Quadro M5000M Quadro M4000M Quadro M3000M	NVS 810

Note:

[1]Since the Mobile and MXM boards do not ship from NVIDIA with display connectors attached, you will need to verify display connector specifics with the system vendor.

Table 6. NVIDIA Kepler Generation GPUs

Quadro Boards	Quadro Mobile or MXM Boards[1]	NVS Boards
Quadro K6000 Quadro K5000 Quadro K4000 Quadro K2000 Quadro K2000D Quadro K600 Quadro 410 Quadro K5200 Quadro K4200 Quadro K2200 Quadro K620 Quadro K420	Quadro K5100M Quadro K4100M Quadro K3100M Quadro K2100M Quadro K610M Quadro K510M Quadro K5000M Quadro K4000M Quadro K3000M Quadro K2000M Quadro K1000M Quadro K500M	NVS 510

Note:

[1]Since the Mobile and MXM boards do not ship from NVIDIA with display connectors attached, you will need to verify display connector specifics with the system vendor.

Display Connectors

The NVIDIA Ada, Ampere, NVIDIA Turing, Pascal, NVIDIA Maxwell, and Kepler of the Quadro and NVS boards have a combination of dual-link DVI (DL) and/or VESA®

DisplayPort™ 1.2 or 1.4 (output) connectors on the board. Most have the ability to drive a single VGA display through a DVI-VGA adaptor. Other display connections, like HDMI™, can be achieved using DisplayPort or DVI adaptor cables. The *Display Adapter RVL (Recommended Vendor List)* document DA-04797-001 summarizes the display adapters that have been tested by NVIDIA and its respective vendors.

Table 7. Display Connectors

Board	Connector Type	DisplayPort 1.4	USB-C	Dual/Single -Link DVI	VGA	HDMI
NVIDIA RTX 6000 Ada NVIDIA RTX 5880 Ada NVIDIA RTX 5000 Ada NVIDIA RTX 4500 Ada NVIDIA RTX 4000 Ada	1. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	4. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
NVIDIA RTX 2000 Ada NVIDIA RTX 2000E Ada NVIDIA RTX 4000 SFF Ada	1. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	4. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI

Board	Connector Type	DisplayPort 1.4	USB-C	Dual/Single -Link DVI	VGA	HDMI
NVIDIA RTX A6000 NVIDIA RTX A5500 NVIDIA RTX A5000 NVIDIA RTX A4500 NVIDIA RTX A4000 NVIDIA RTX A4000H	1. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	4. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
NVIDIA RTX A2000 12GB NVIDIA RTX A2000 6GB NVIDIA RTX A1000 NVIDIA RTX A400	1. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	4. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI

Board	Connector Type	DisplayPort 1.4	USB-C	Dual/Single -Link DVI	VGA	HDMI
Quadro RTX 8000 Quadro RTX 6000 Quadro RTX 5000	1. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI

Board	Connector Type	DisplayPort 1.4	USB-C	Dual/Single -Link DVI	VGA	HDMI
	4. USB-C	USB-C -> DP	✓	X	X	USB-C -> HDMI
	5. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
Quadro RTX 4000	1. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. DP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	4. USB-C	USB-C -> DP	✓	X	X	USB-C -> HDMI
NVIDIA T1000 NVIDIA T1000-8GB NVIDIA T600 NVIDIA T400E	1. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	4. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
NVIDIA T400 NVIDIA T400-4GB	1. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	2. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI
	3. mDP	✓	X	DP->DVI	DP->VGA	DP->HDMI

Board	Connector Type	DisplayPort 1.4	Single-Link DVI	Dual-Link DVI	VGA	HDMI
Quadro P6000 Quadro P5000 Quadro GP100	5. DVI-D	X	✓	✓	X	DVI->HDMI
	4. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
Quadro P4000 Quadro P2000	4. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
Quadro P1000 Quadro P600	4. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI

Quadro P400	3. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI

Board	Connector Type	DisplayPort 1.2	Single-Link DVI	Dual-Link DVI	VGA	HDMI
Quadro M6000 24GB Quadro M6000 Quadro M5000	5. DVI-I	X	✓	✓	DVI->VGA	DVI->HDMI
	4. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
Quadro M4000 Quadro M2000	4. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
Quadro K6000 Quadro K5000 Quadro K5200	4. DVI-D	X	✓	✓	X	DVI->HDMI
	3. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DVI-I	X	✓	✓	DVI->VGA	DVI->HDMI
Quadro K4000 Quadro K2000 Quadro K4200 Quadro K2200	3. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DVI-I	X	✓	✓	DVI->VGA	DVI->HDMI

Board	Connector Type	DisplayPort 1.2	Single-Link DVI	Dual-Link DVI	VGA	HDMI
Quadro K2000D	3. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. DVI-D	X	✓	✓	X	DVI->HDMI
	1. DVI-I	X	✓	✓	DVI->VGA	DVI->HDMI
Quadro K1200	4. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI

Quadro K600 Quadro 410 Quadro K620 Quadro K420	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DVI-I	X	✓	✓	DVI->VGA	DVI->HDMI

NVS 810	8. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	7. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	6. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	5. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	4. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI

NVS 510	4. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	3. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	2. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. mDP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI

NVS 315	DMS59	DMS->DP	DMS->DVI	X	DMS->VGA	X

NVS 310	2. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI
	1. DP	✓	DP->DVI-SL	DP->DVI-DL	DP->VGA	DP->HDMI

Common Supported Resolutions

Table 8 and Table 9 list the most commonly supported resolutions for the NVIDIA Ada, NVIDIA Ampere, NVIDIA Turing, Pascal, NVIDIA Maxwell, and NVIDIA Kepler generation boards.

Table 8. Common Supported Resolutions

Resolution at 60 Hz	Single-Link DVI	VGA[1]	Dual-Link DVI	DisplayPort
640 × 480	✓	✓	✓	✓
720 × 480	✓	✓	✓	✓
720 × 576	✓	✓	✓	✓
800 × 600	✓	✓	✓	✓
1024 × 768	✓	✓	✓	✓
1152 × 864	✓	✓	✓	✓
1280 × 720	✓	✓	✓	✓
1280 × 768	✓	✓	✓	✓
1280 × 800	✓	✓	✓	✓
1280 × 960	✓	✓	✓	✓
1280 × 1024	✓	✓	✓	✓
1360 × 768	✓	✓	✓	✓
1600 × 900	✓	✓	✓	✓
1600 × 1024	✓	✓	✓	✓
1600 × 1200	✓	✓	✓	✓
1680 × 1050	✓	✓	✓	✓
1920 × 1080	✓	✓	✓	✓
1920 × 1200	✓	✓	✓	✓
1920 × 1440		✓	✓	✓
2048 × 1152	✓	✓	✓	✓
2048 × 1536		✓	✓	✓
2560 × 1440			✓	✓
2560 × 1600			✓	✓

Note:

Resolution at 60 Hz	Single-Link DVI	VGA[1]	Dual-Link DVI	DisplayPort

[1]Native connection or through DVI-VGA adaptor.

Table 9. Common Supported Resolutions 4K and Over

Resolution at 60 Hz		DisplayPort 1.2	DisplayPort 1.4	HDMI 2.0	HDMI 2.1
3840 × 2160	Ultra HD	✓	✓	✓	✓
4096 × 2160	Cinema 4K	✓	✓	✓	✓
5120 × 2880	5K	2 connectors	✓		✓
7680 × 4320 (8K)	8K	4 connectors	2 connectors[1]		✓

Note:

[1]NVIDIA Turing, Ampere, and Ada support Display Stream Compression (DSC), which allows them to drive an 8K DSC panel over a single connector.

Note: For more information on 4K displays refer to the “Single Connector 4K” section of this application note.

Maximum Supported Resolutions

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

- **The maximum number of pixels per second that can be carried across the link:** It doesn't matter to the graphics processing unit (GPU) if those pixels are allocated onto a single large desktop refreshing slowly or a small desktop refreshing quickly. The maximum desktop size allowed by the GPU is 16 k × 16 k pixels – the different operating systems may have different limitations as addressed in Table 10.
- **The maximum bandwidth available on the link:** This is most important to DisplayPort connections.

Table 10. Operating System Maximum Pixel Supported

Operating System	Max Pixel
Linux	32K × 32K
Windows 10	16K × 16K

The rest of this application note covers the physical connector types (DVI and DisplayPort) and the common connections that can be reached with adaptors (VGA and HDMI).

Display Pixel Clock and Bandwidth

All the display connection technologies have a maximum bandwidth. In general, any resolution and refresh rate that fits within this bandwidth will work.

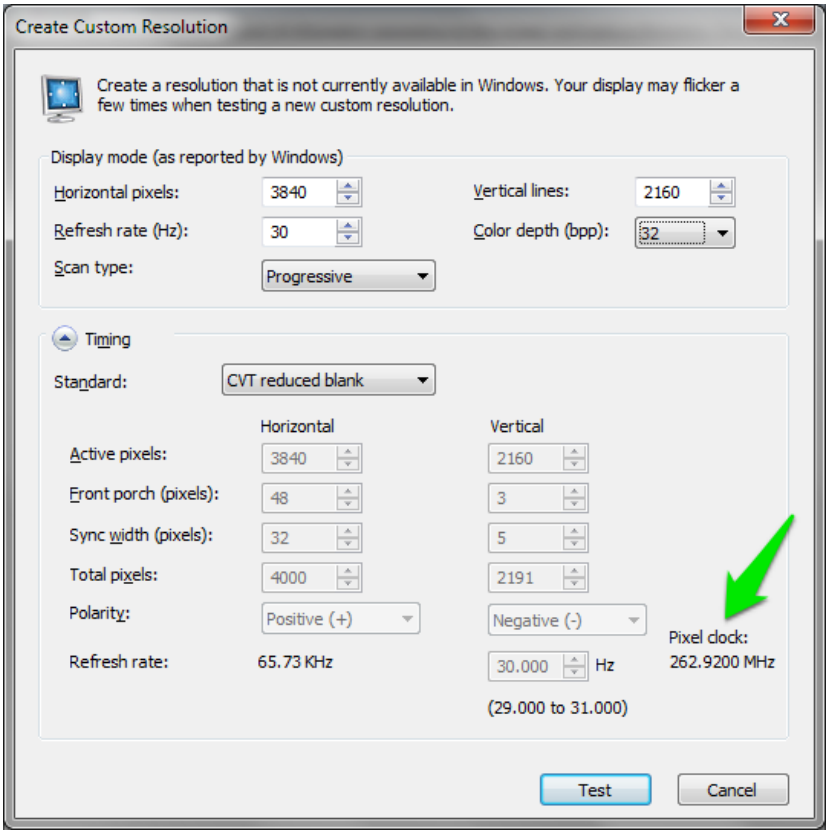
The display bandwidth is defined by the pixel clock and how many bits per pixel are requested. The easiest way to compute the pixel clock is with the NVIDIA Control Panel's custom resolution calculator.

You can access the calculator at:

Display / Change Resolution / Customize / Create Custom Resolution

Enter the desired horizontal and vertical pixels and refresh rate. Then select the timing standard. On the bottom right, you will see the pixel clock needed. As long as 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 the purpose of this application note it is the pixel clock multiplied by the number of color bits per pixel. As an example:

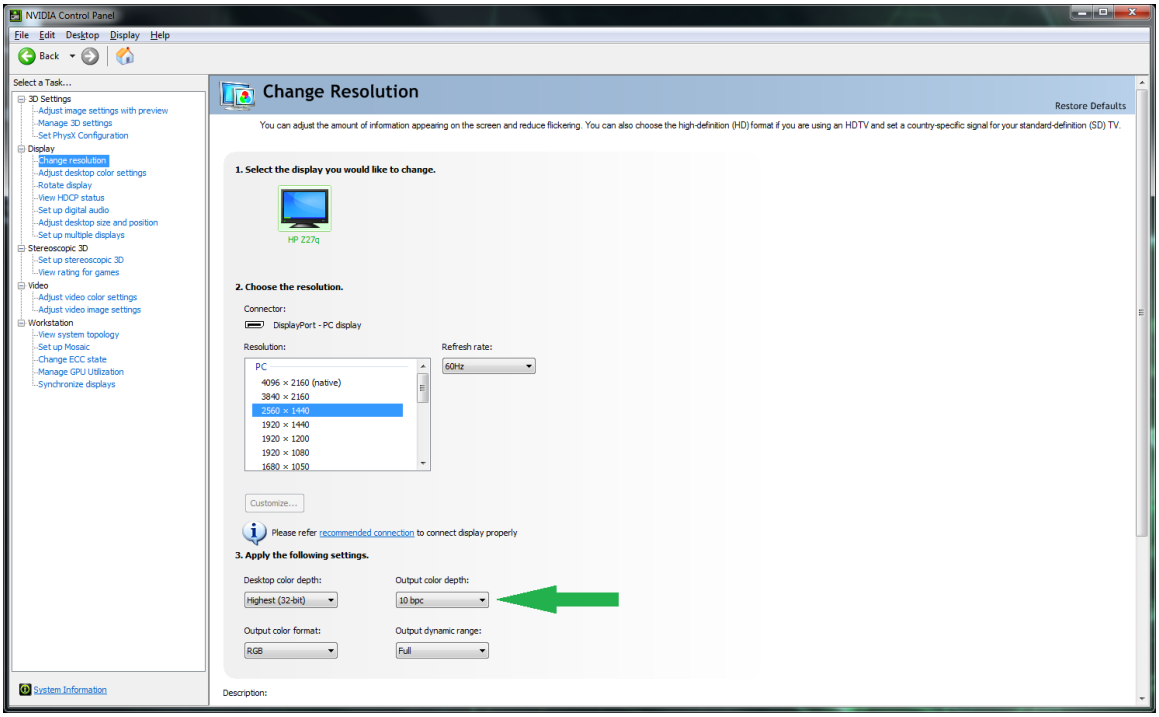
200 MHz pixel clock × 30 bits per pixel = 6,000 M bits per second (or 6 G bits per second Gbps)

Display Color Depth

Along with the frame rate and resolution displays and connectors can also vary the bit depth of the color information for each pixel. Standards like DVI define that each pixel must be made of a red, green, and blue component 8 bits each or 24 bits per pixel. HDMI and DisplayPort offer 8, 10, or 12-bit per component as well. The display device defines the bit depth that it wants to receive, and the GPU will honor it if it can.

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 may enable higher resolutions or frame rates.

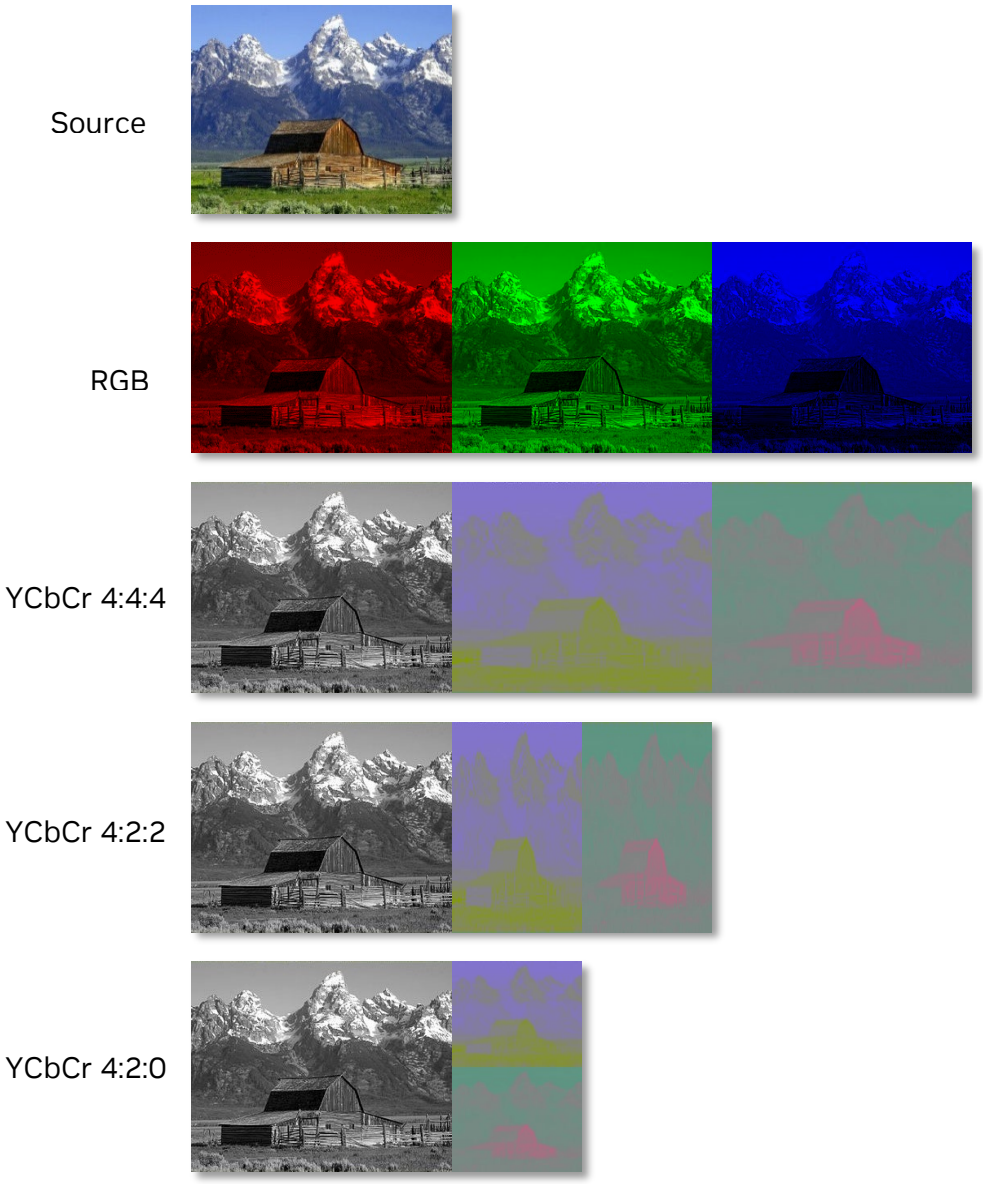
Figure 2. Color Depth Setting



In this application note the following terms are used about 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, it is possible to 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 1/4 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



High Dynamic Range

A new generation of High Dynamic Range (HDR) displays is allowing manufacturers to produce brighter, greater-contrast displays that can reproduce more realistic images. A nit is the most commonly used 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 of 2015, the Consumer Technology Association (CTA) announced an industry definition for HDR Compatible Displays which included the definition of the HDR10

Media Profile. While other HDR formats exist, HDR10 has been the most widely adopted in the display industry. Pascal, NVIDIA Turing, NVIDIA Ampere, and NVIDIA Ada generation GPUs support HDR10 by sending an Infoframe indicating support for SMPTE ST 2084, the electro-optical transfer function defined for luminance values up to 10,000 nits – also known as Perceptual Quantizer (PQ) - when connected to an HDR10 capable sink device.

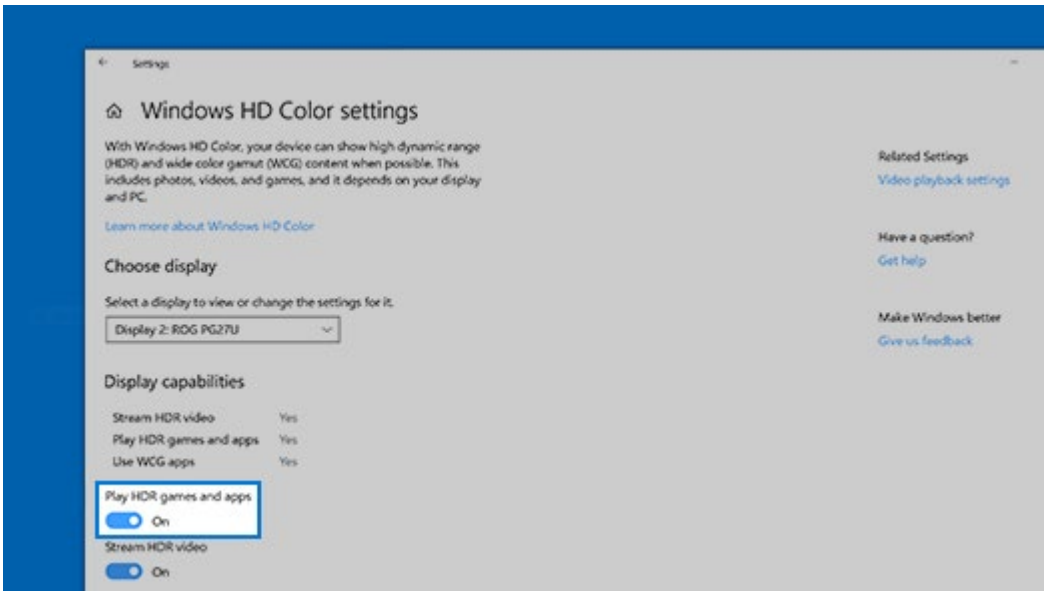
Reproducing more of the colors the human eye can see is also important to making high-quality HDR displays. For the last couple of decades, the most commonly used color space for the PC industry has been sRGB. It uses the same three-color primaries as the Rec. 709 color space defined for HDTVs. This 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, much closer to the limits of human color vision. Several HDR formats use it as a container for content as it is assumed to be future-proof—including HDR10 with support for 10-bit encoded BT. 2020. Pascal, NVIDIA Turing, NVIDIA Ampere, and NVIDIA Ada generation GPUs can support the BT. 2020 colorimetry by sending a video stream configuration data packet over DisplayPort to displays that are capable of supporting this color gamut.

Windows 10 (starting with Build 1809) provides a control panel switch to enable HDR10 output:

1. Select the **Start** button, then select **Settings** > **System** > **Display**.
2. Select **Windows HD Color settings**.
3. Under **Display capabilities**, check to make sure it says **Yes** next to **Play HDR games and apps.**
4. Turn on **Play HDR games and apps**.

Figure 4. Windows HD Color Settings



Display Stream Compression (DSC)

Display Stream Compression (DSC) is a visually lossless compression technology standardized by VESA, designed to reduce the data required for high-resolution, high-refresh-rate video streams. It typically achieves a compression ratio of up to 3:1, meaning it can compress video data to one-third of its original size without 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, enabling a single source to drive multiple high-resolution displays smoothly without additional cables or complex hardware. This technology is particularly beneficial in gaming, professional workstations, and any scenario where high visual fidelity is required without sacrificing performance or connectivity simplicity.

DSC is designed to minimize the impact on advanced display features like HDR (High Dynamic Range), G-Sync, and DLSS (Deep Learning Super Sampling). For HDR, DSC maintains enhanced contrast and color accuracy by compressing video without significantly affecting visual quality. In the case of G-Sync, DSC does not interfere with the synchronization between the GPU and the monitor, ensuring smooth gameplay without screen tearing. With DLSS, DSC compresses the final output stream while preserving the upscaling and performance enhancements provided by this AI-based technology. Thus, DSC ensures that the benefits of these advanced features are preserved even as it reduces the video data's size.

DVI

This sub-section lists the resolutions for the different types of DVI connectors.

Dual-Link DVI (DVI-DL)

- **Maximum Pixel Clock:** 330 MHz
- **Maximum Bandwidth:** N/A - DVI is always 24 bits per pixel
- **Common Supported Maximum Resolutions (at CVT-RB timing):**
  - 1920 × 1200 at 120 Hz
  - 1920 × 2160 at 60 Hz
  - 2560 × 1600 at 60 Hz
  - 2048 × 2160 at 60 Hz
  - 4096 × 2160 at 30 Hz

Note: There are two types of DisplayPort to dual-link DVI adaptors. For the full 330 MHz of dual-link DVI make sure to select the stereo capable adaptors.

Single-Link DVI (DVI-SL)

- **Maximum Pixel Clock:** 167 MHz
- **Maximum Bandwidth:** N/A - DVI is always 24 bits per pixel
- **Common Supported Maximum Resolutions (at CVT-RB timing):**
  - 1920 × 1200 at 60 Hz
  - 1280 × 720 at 120 Hz

VGA

This sub-section lists the resolutions for the different types of VGA connections.

VGA via DVI-I to VGA Adaptor

- **Maximum Bandwidth:** 400 MHz DAC
- **Common Supported Maximum Resolutions (at CVT-RB timing):**
  - 2048 × 1536 at 85 Hz

VGA via DisplayPort to VGA Adaptor

- **Maximum Bandwidth:** Adaptor specific
- **Common Supported Maximum Resolutions (at CVT-RB timing):**
  - 1920 × 1200 at 60 Hz

HDMI

This sub-section lists the resolutions for the different types of HDMI connectors.

NVIDIA RTX and Quadro boards do not have native HDMI connectors, so an adaptor must be used. For full performance, high-quality DVI-to-HDMI cables or active DisplayPort-to-HDMI protocol converters are required.

Note: An active protocol converter is required to drive HDMI 2.1 sink devices. Based on this configuration the resolution limitation matches the DisplayPort resolution.

HDMI 1.4

- **Maximum Pixel Clock:** 340 MHz (for 24 bpp content)
- **Maximum Bandwidth:** N/A
- **Common Supported Maximum Resolutions (from CEA timing specifications):**

- 3840 × 2160 at 30 Hz 24 bpp
- 1920 × 1080 at 60 Hz 36 bpp
- 4096 × 2160 at 24 Hz 24 bpp
- 1920 × 1080 at 120 Hz 24 bpp – HDMI stereo

Note: Quadro boards do not have native HDMI connectors, so an adaptor must be used. High-quality DVI-to-HDMI cables or Type II DisplayPort-to-HDMI adaptors are required for full performance.

HDMI 2.0

HDMI 2.0 is supported on Windows 7 and newer with the R340 and newer display driver.

Kepler and NVIDIA Maxwell 1st Gen GPUs

- **Maximum Pixel Clock:** 340 MHz
- **Maximum Bandwidth:** N/A
- **Common Supported Maximum Resolutions (from CEA timing specifications):**
  - 3840 × 2160 at 60 Hz in 4:2:0 YCbCr 8 bpc

NVIDIA Ada, NVIDIA Ampere, NVIDIA Maxwell 2nd Gen, Pascal, and NVIDIA Turing GPUs

- **Maximum Pixel Clock:** 594 MHz
- **Maximum Bandwidth:** N/A
- **Common Supported Maximum Resolutions (from CEA timing specifications):**
  - 3840 × 2160 at 60 Hz in YCbCr 4:2:0 8 bpc (actually only requires HDMI 1.4 PHY)
  - 3840 × 2160 at 60 Hz in RGB 8 bpc
  - 3840 × 2160 at 60 Hz in YCbCr 4:2:2 and YCbCr 4:2:0 12 bpc

DisplayPort

This sub-section lists the resolutions for the different DisplayPort configurations.

DisplayPort 1.2

- **Maximum Pixel Clock:**
  - NVIDIA Ada, Ampere, NVIDIA Turing, Pascal, and NVIDIA Maxwell GPUs
    - 1080 MHz

- Kepler GPUs
  - 540 MHz

> **Maximum Boards Bandwidth:** 17.2 Gbps usable

> **Common Supported Maximum Resolutions (at CVT Reduced Blank Timings):**

- NVIDIA Ada, Ampere, NVIDIA Turing, Pascal, and NVIDIA Maxwell GPUs
  - 4096 × 2160 at 60 Hz 30 bpp
  - 2560 × 1600 at 120 Hz 30 bpp
- Kepler GPUs
  - 2560 × 1600 at 120 Hz 30 bpp
- All displays
  - 4096 × 2160 at 48 Hz 36 bpp
  - 2560 × 1440 at 120 Hz 30 bpp
  - 3840 × 2160 at 60 Hz 30 bpp

DisplayPort 1.2 Multi-Streaming

> **Maximum Pixel Clock for Each Display:**

- NVIDIA Ada, NVIDIA Ampere, NVIDIA Turing, Pascal, and NVIDIA Maxwell GPUs
  - 1080 MHz
- Kepler GPUs
  - 540 MHz
- All other boards display
  - 540 MHz

> **Total Bandwidth for All Displays:** 17.01 Gbps usable

When using DisplayPort multi-streaming, multiple displays are combined on the same DisplayPort link. Each display can have the full pixel clock available in the GPU, but all heads share the bandwidth of the link. For example:

> Four heads of 1920 × 1200, 24 bpp at 60 Hz

- 4 × 154.128 MHz Pixel Clock × 24 bpp = 14.8 Gbps – which works

> Four heads of 1920 × 1200, 30 bpp at 60 Hz

- 4 × 154.128 MHz Pixel Clock × 30 bpp = 18.5 Gbps – which does not work

> Three heads of 1920 × 1200, 30 bpp at 60 Hz

- 3 × 154.128 MHz Pixel Clock × 30 bpp = 13.4 Gbps – which works

ⓘ	**Caution:** Since DisplayPort 1.2 MST relies upon an external device to receive and re-broadcast the data the hub used may reduce usable bandwidth.

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.

- **Common Supported Maximum Resolutions (at CVT-RB timing):**
  - 4 × 1920 × 1200 at 60 Hz 24 bpp
  - 2 × 2560 × 1600 at 60 Hz 24 bpp

DisplayPort 1.4

- **Maximum Pixel Clock:**
  - NVIDIA Ada GPUs
    - 1350 MHz
  - NVIDIA Ampere GPUs
    - 1335 MHz
  - NVIDIA Turing GPUs
    - 1330 MHz
  - NVIDIA Pascal GPUs
    - 1325 MHz
- **Maximum Boards Bandwidth:** 25.9 Gbps usable
- **Common Supported Maximum Resolutions (at CVT Reduced Blank Timings):**
  - NVIDIA Pascal GPUs
    - 5120 × 2880 at 60 Hz 24 bpp
    - 4096 × 2160 at 60 Hz 36 bpp
    - 2560 × 1600 at 120 Hz 36 bpp

DisplayPort 1.4 Multi-Streaming

- **Maximum Pixel Clock for Each Display:**
  - NVIDIA Ada GPUs
    - 1350 MHz
  - NVIDIA Ampere GPUs
    - 1335 MHz
  - NVIDIA Turing GPUs
    - 1330 MHz
  - NVIDIA Pascal GPUs
    - 1325 MHz
- **Total Bandwidth for All Displays:** 25.5 Gbps usable

When using DisplayPort multi-streaming, multiple displays are combined on the same DisplayPort link. Each display can have the full pixel clock available in the GPU, but all heads share the bandwidth of the link. For example:

- Two heads of 3840 × 2160, 30 bpp at 60 Hz
  - 2 × 522.092 MHz Pixel Clock × 30 bpp = 31.3 Gbps – which does not work

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

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.

> **Common Supported Maximum Resolutions (at CVT-RB timing):**

- 4 × 1920 × 1200 at 60 Hz 24 bpp
- 3 × 2560 × 1600 at 60 Hz 30 bpp

Single Connector 4K

There are two main display definitions for 4K: UltraHD (3840 × 2160) and what is commonly called Cinema 4K (4096 × 2160). Depending on the frame rate, connectors, and bit depth, different GPUs support different options as covered in Table 11.

Table 11. UltraHD (3840 × 2160) and Cinema 4K (4096 × 2160) Option Support

Bit Depth		HDMI 1.4	HDMI 2.0	DisplayPort 1.2 MST	DisplayPort 1.2 Single	DisplayPort 1.4 MST	DisplayPort 1.4 Single
24 Hz	24 bpp	✓	✓	✓	✓	✓	✓
	30 bpp			✓	✓	✓	✓
	36 bpp	✓	✓	✓	✓	✓	✓
30 Hz	24 bpp	✓	✓	✓	✓	✓	✓
	30 bpp			✓	✓	✓	✓
	36bpp		✓	✓	✓	✓	✓
48 Hz	24 bpp		✓	✓	✓	✓	✓
	30 bpp			✓	✓	✓	✓
	36 bpp		✓4:2:0 YCbCr 4:2:2 YCbCr	✓	✓	✓	✓
60 Hz	24 bpp		✓	✓	✓	✓	✓
	30 bpp			✓	✓	✓	✓
	36 bpp		✓4:2:0 YCbCr 4:2:2 YCbCr			✓	✓

Notes:

For Pascal and later generations, the GPUs have DisplayPort 1.4 support.

For NVIDIA Maxwell 2nd generation and later, the GPUs have HDMI 2.0 support.

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