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NVIDIA

QUADRO SYNC II

DU-08348-001_v01 | December 2016

User Guide

DOCUMENT CHANGE HISTORY

DU-08348-001_v01

Version	Date	Authors	Description of Change
01	December 14, 2016	JK, DT, TS	Initial Release

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GETTING STARTED

The NVIDIA Quadro® Sync II card is designed as a daughter card for Quadro Pascal series GPUs; “4000” class and later. (For Quadro Kepler and Maxwell series graphics cards refer to the Quadro Sync User Guide). NVIDIA Quadro Sync II card fits into a free PCI Express slot within the system. The card does not use any electrical or data connection through the PCIe bus.

SYSTEM REQUIREMENTS

- NVIDIA® Quadro® Pascal series graphics boards and later.
  - The Quadro Sync II card supports up to four matching Quadro graphics processing units (GPUs). Each GPU is connected to the Quadro Sync II card via an internal flexible cable.
  - Two Quadro Sync II cards are supported in a single workstation syncing up to eight Quadro GPUs. Two Quadro Sync II cards require an internal flexible cable connection between the boards.
  - For an up to date list of the Quadro GPU boards compatible with Sync, refer to www.nvidia.com/sync.
- Operating Systems
  - Windows 10 RS1: 64-bit recommended, 32-bit supported.
  - Windows 7: 64-bit recommended, 32-bit supported.
  - Linux: 64-bit recommended, 32-bit supported
- Driver
  - R375 branch and newer display drivers support single Quadro Sync II with MOSAIC topologies
  - R378 branch and newer display drivers will support dual Quadro Sync II
  - R381 branch and newer display drivers will support dual Quadro Sync II with MOSAIC topologies

Enhanced Quadro Sync II feature support anticipated Q1 2017.

- Chassis Requirements
  - Single free PCIe slot
  - 6-pin PCI or SATA power connector

NEW FEATURES

The Quadro Sync II card provides the following new functionality over the Quadro Sync card:

- Compatibility with Quadro Pascal series graphics boards and later (The board is not compatible with older GPU generation series graphics boards).
- Five on-board connections. The 5th connection is to be used as the connector to a 2nd Quadro Sync II card in a common chassis.
- Synchronization of up to 8 GPUs in a common chassis when used with a 2nd Quadro Sync II card.
- TTL Sync Generation output via the BNC connector.
- Support for up to four sync "chains" in a single system when 2 Quadro Sync II cards are used in a single system.

QUADRO SYNC II CARD OVERVIEW

The Quadro Sync II card is an accessory to the Quadro Professional GPU. On the top edge of the card are five connectors that connect up to four GPUs and a second Quadro Sync II card (see Figure 1). The flexible cables to make these connections are included in the box; four 12-inch cables and two 24-inch cables.

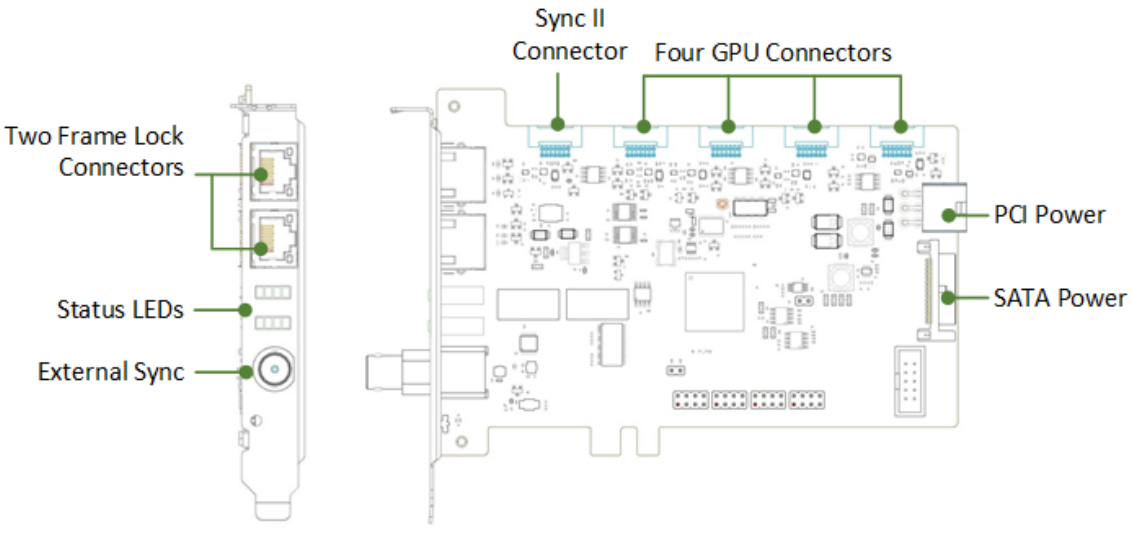


Figure 1. Quadro Sync II Overview

For high vibration environments, self-latching/locking cable connectors are utilized, which hold all cables securely in place on both the Quadro Sync II card and Quadro GPU. Since the SATA power connector has no physical retention the board has a hole that can be used to secure the cable with a cable tie.

IN THE BOX

Quadro Sync II Card
12-Inch Short Sync Cables (Four)
24-Inch Long Sync Cables (Two)
Quick Start Guide

INSTALLATION

Prior to installing the Quadro Sync II card, make sure to power down the machine and unplug the power connecter.

QUADRO SYNC II CARD INSTALL

Use the following steps and Figure 2 to install the Quadro Sync II Card

1. Place the Quadro Sync II card in a free PCI Express slot on the motherboard (1). Note the PCIe edge fingers may not bottom out in the PCIe slot.

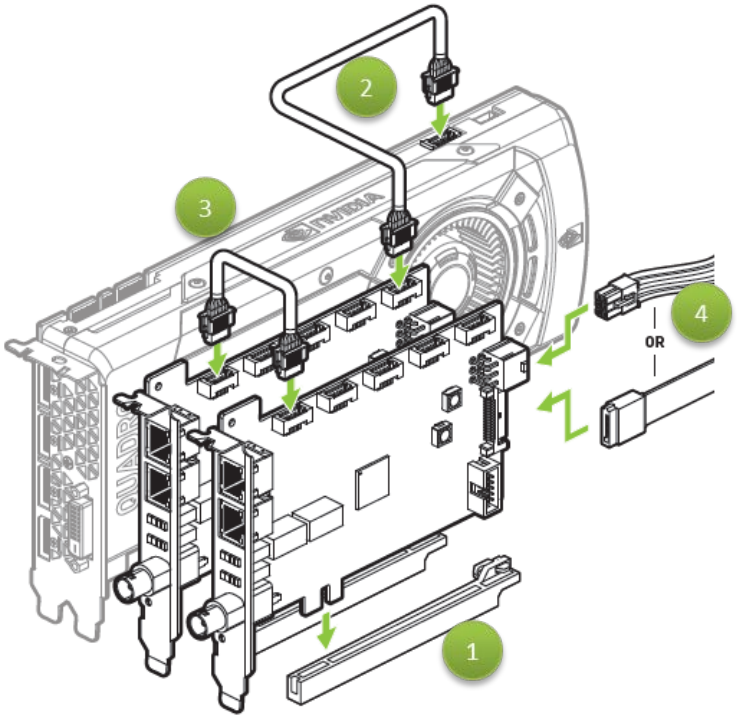


Figure 2. Installing and Connecting the Quadro Sync II Card

2. Connect up to four Quadro cards to the Quadro Sync II card GPU connectors (2 in Figure 2) using the included cables.

   There is no order when connecting the Quadro cards to the Quadro Sync II card GPU connectors.

3. Connect power to the Quadro Sync II card using either a 6-pin PCIe or SATA power cable (4 in Figure 2).

Adding a second Quadro Sync II card for a Dual Quadro Sync II configuration:

4. Install a second Quadro Sync II card into the adjacent PCIe slot.
5. Connect up to four Quadro cards to the Quadro Sync II card GPU connectors (2 in Figure 2) using the included cables.
6. Connect power to the second Quadro Sync II card using either a 6-pin PCIe or SATA power cable (4 in Figure 2).
7. Connect one Quadro Sync II card to the other Quadro Sync II card (3 in Figure 2) using the included cables between the Sync II connectors.
   This dual configuration enables up to eight GPUs in a single system.

   When using Quadro Sync II card in a system that supports NVIDIA SLI® an SLI bridge does not need to be connected unless you are planning to use SLI-specific features like SLI Frame Rendering or SLI Anti-Aliasing. These SLI modes are not compatible with most of the features of Sync.

   There may be restrictions when using Quadro Sync II with some SLI modes. Contact QuadroSVS@nvidia.com with questions if you are considering these types of configurations.

QUADRO DISPLAY DRIVER

Quadro Sync II card does not require a dedicated driver; all the files needed to operate it are included in the Quadro display driver. Drivers are available on the NVIDIA Web site at www.nvidia.com/drivers. When choosing the drivers for use with Quadro Sync II, make sure to select the following from the pull-down lists (see Figure 3):

- *Quadro Sync Series* from the **Product Series** pull down list
- *Quadro Sync II* from the **Product** pull down list
  - R375 branch and newer display drivers support single Quadro Sync II with MOSAIC topologies
  - R378 branch and newer display drivers will support dual Quadro Sync II
  - R381 branch and newer display drivers will support dual Quadro Sync II with MOSAIC topologies

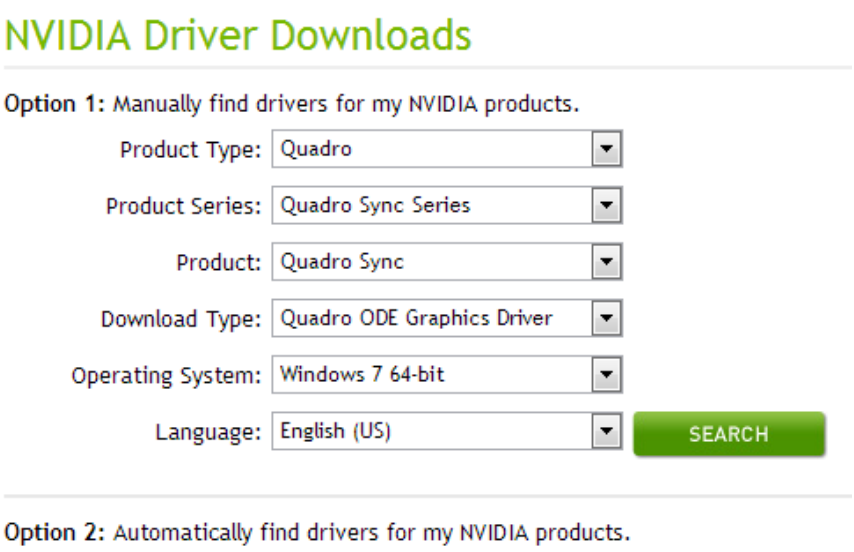


Figure 3. Quadro Drivers Compatible with Quadro Sync II

WORKING WITH QUADRO SYNC II

Whether working with a single node or visualization cluster the Quadro Sync II card provides multiple forms of display synchronization:

- **Multi-GPU Mosaic**
  Mosaic is a software technology that abstracts multiple physical displays into a larger virtual display. When the virtual display spans across multiple GPUs, the Quadro Sync II card synchronizes the GPUs to ensure all the displays stay aligned.
- **Frame Lock**
  Synchronize multiple displays, in one machine or spread across multiple machines in a cluster. For Frame Lock a single display is chosen as the timing master and all other displays in the cluster align to it. Frame Lock can be used with individual physical displays and single or multi-GPU Mosaic displays.
- **Sync to an External Timing Source**
  Aligns a selected display to an external timing generator. The selected display can be a Mosaic or physical and can be used as the Frame Lock master if desired.
- **Internal Timing Source Generator**
  Output an internal video signal as TTL.

The Quadro Sync II card supports mixing and matching the different synchronization options to build the correct configuration your installation needs. Installations with Quadro Sync II card can become complex and architecture decisions can impact performance and reliability, for questions on how to architect systems with Quadro Sync II card or Mosaic contact QuadroSVS@nvidia.com.

MULTI-GPU MOSAIC CONFIGURATION

MOSAIC OVERVIEW

Mosaic is a technology that combines multiple displays or projectors into a single virtual display. Mosaic creates a projector overlap region by subtracting the area behind screen bezels to create a single unified display surface. With dual Quadro Sync II cards and supported Quadro GPUs, up to 32 displays can display as one to the operating systems and any application that runs on them. The image in shown in Figure 4 is an example of a 3 × 3 display wall connected to three Quadro P6000 cards and one Quadro Sync II card.

Figure 4. 3 x 3 Mosaic with Quadro Sync II

When working with multi-GPU Mosaic, the Quadro Sync II card automatically keeps all the displays that are part of the Mosaic synchronized.

For more information on Mosaic refer to the NVIDIA Web site at www.nvidia.com/svs.

CONFIGURING MOSAIC

Mosaic is configured either through the control panel, with the `configureMosaic` utility or through one of the programmatic interfaces. The `configureMosaic` utility is not part of the standard driver download but is easily downloaded from www.nvidia.com/drivers as shown in Figure 5.

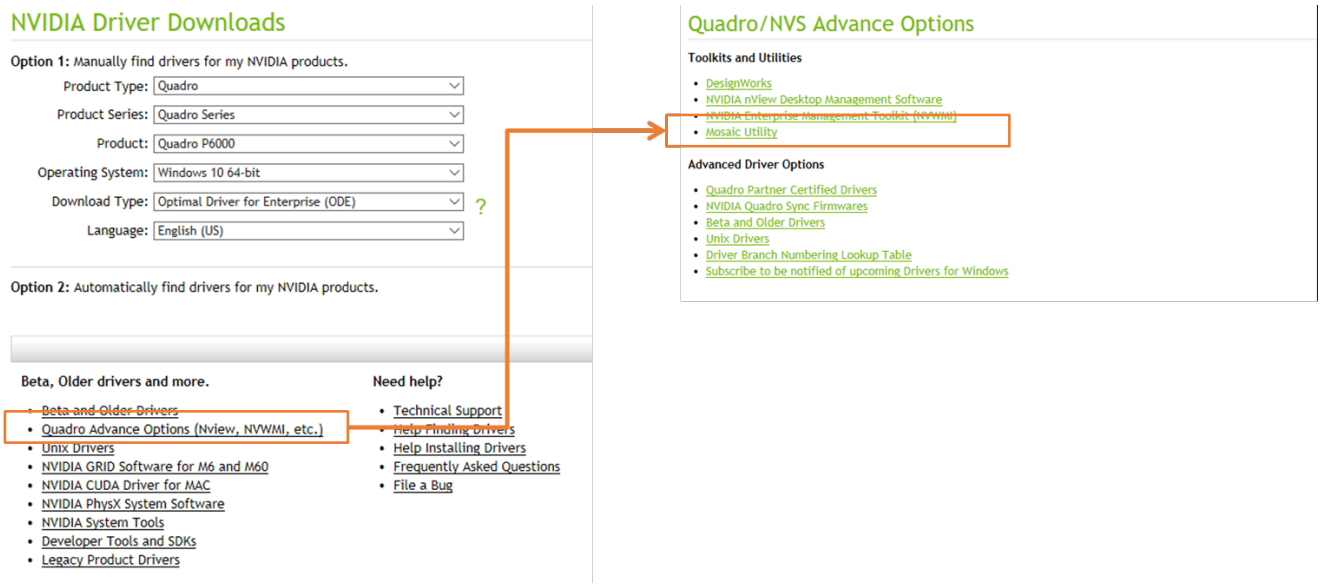


Figure 5. NVIDIA Driver Downloads, Mosaic Utility

Mosaic is compatible with the other synchronization methods covered in this document. **When combining Mosaic with other forms of synchronization make sure to enable Mosaic first then continue with synchronizing.**

FRAME LOCK CONFIGURATION

Frame Lock synchronizes all the selected displays in a system and across systems in a cluster. A single display is selected as the timing master and the Quadro Sync II cards adjust all the other displays to synchronize with it. This operation may take a few minutes.

CONNECTING NODES IN A VISUALIZATION CLUSTER

If using the multi-node synchronization features of Quadro Sync II cards, the nodes in the cluster need to be connected together. Connecting the nodes require CAT-5 Ethernet cables that are not included. It is recommended that you use high quality cables, using the shortest length possible for your installation. Do NOT use Ethernet hubs or switches to branch or extend the signal. Quadro Sync II cards are not compatible with TCP/IP protocols and the card will not operate if it is connected to networking equipment.

! CAUTION: Do not connect the Quadro Sync II card to TCP/IP networking equipment.

Choose one node as the timing master to control the timing on all the other nodes. For clusters using active stereo it is recommended that the timing master also drive the stereo sync output. From the timing master, connect a CAT 5 cable between the Frame Lock connectors on the timing master and a client machine, it does not matter which connector you use. It is recommended to create two signal chains off the timing master s shown in Figure 6.

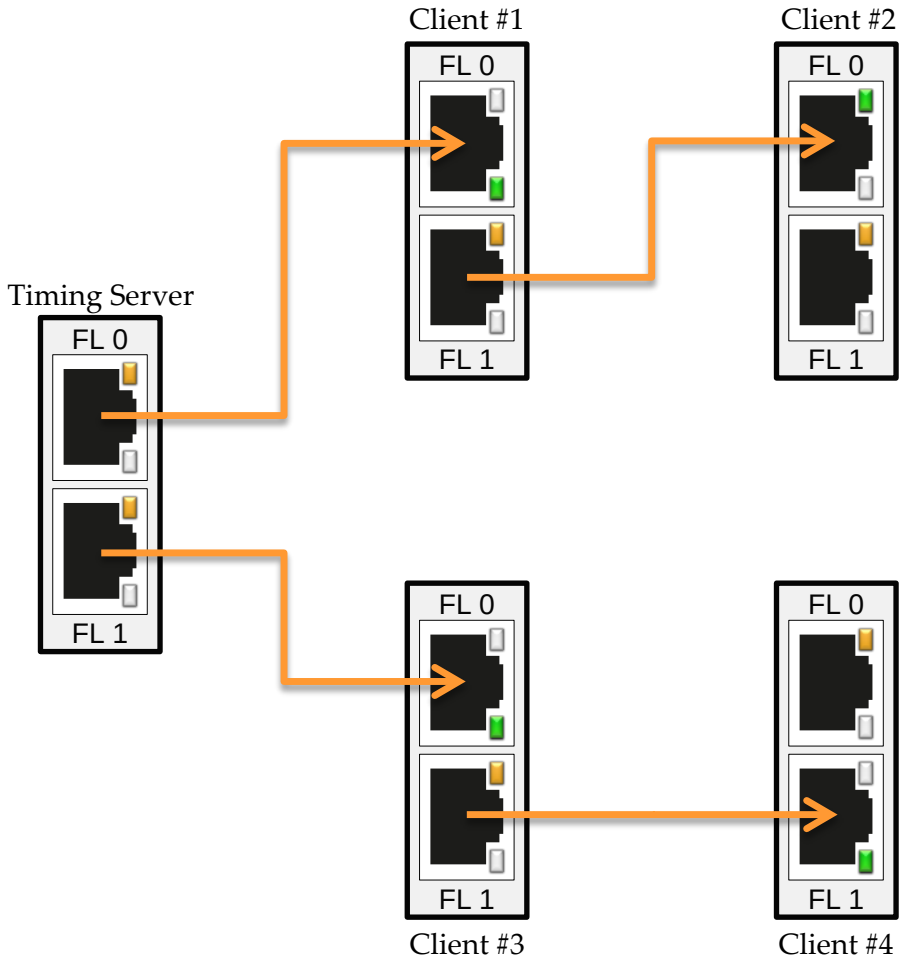


Figure 6. Frame Lock Connections on Timing Server

FRAME LOCK CONNECTOR LEDS

The Frame Lock connector LEDs indicate how the frame lock signal is flowing from one Quadro Sync II card to the next. The light indicates if the port is receiving a Frame Lock signal or sending a Frame Lock signal. The ports auto-configure so different nodes in the cluster may have different LED configurations. See Table 1 for the meaning of the LEDs.

Table 1. Frame Lock LED Status

Frame Lock LEDs	Status	Meaning
		Port is an output but no signal is present
		Port is an input but no signal detected
		Port is an output and sending a signal, the frequency of the blinking is the refresh rate of the signal
		Port is an input and receiving a signal, the frequency of the blinking is the refresh rate of the signal

When connecting the Frame Lock ports, the timing server sends two outputs and all the other nodes configure themselves to one output and one input.

VISUALIZATION CLUSTER SETUP ORDER

When configuring a visualization cluster the order of operations for configuration is important:

1. Start with the Timing Master
   a) Enable Sync to Vertical Blank
   b) Enable stereo with the correct stereo mode if using stereo
   c) Configure and enable the timing master
2. Configure each client machine
   a) Enable Sync to Vertical Blank
   b) Enable the same stereo type as the timing master if using stereo set
   c) Enable Frame Lock on each machine

RESTARTING A VISUALIZATION CLUSTER

Like configuration, a cluster should be re-started in the following order to minimize the synchronization time:

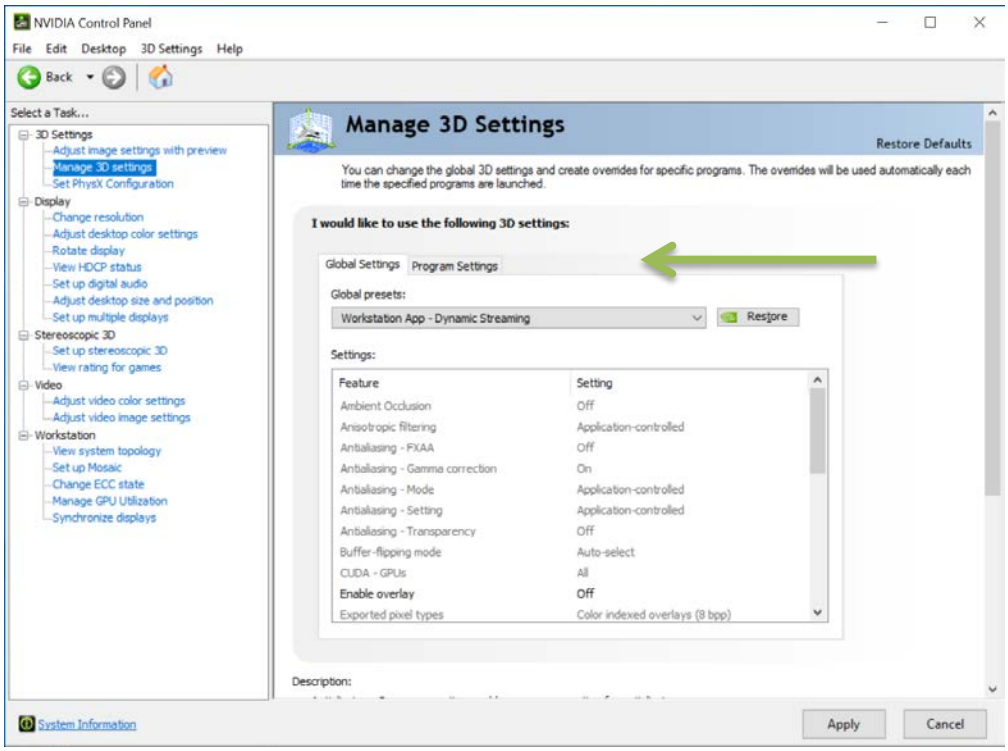
1. Start all the client machines.
2. Start the Timing Master once all client machines are stable.

Depending on the configuration, it can take many minutes for a cluster to fully synchronize.

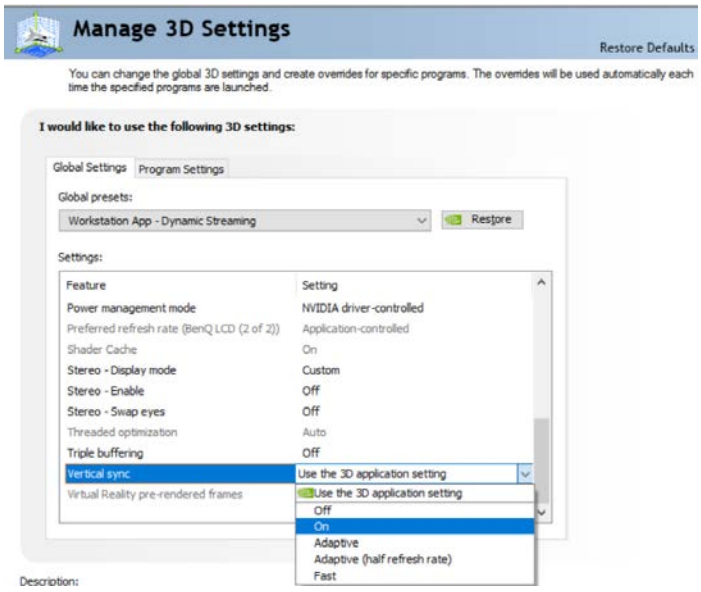
WINDOWS DRIVER CONFIGURATION

Before configuring any of the synchronization modes, verify in the **NVIDIA Control Panel** that the **Vertical Sync** setting is on and, if using stereo, that the correct Stereo display mode is selected and enabled. For best performance in a cluster it is recommended that you select the **Workstation App–Dynamic Streaming** driver preset as well.

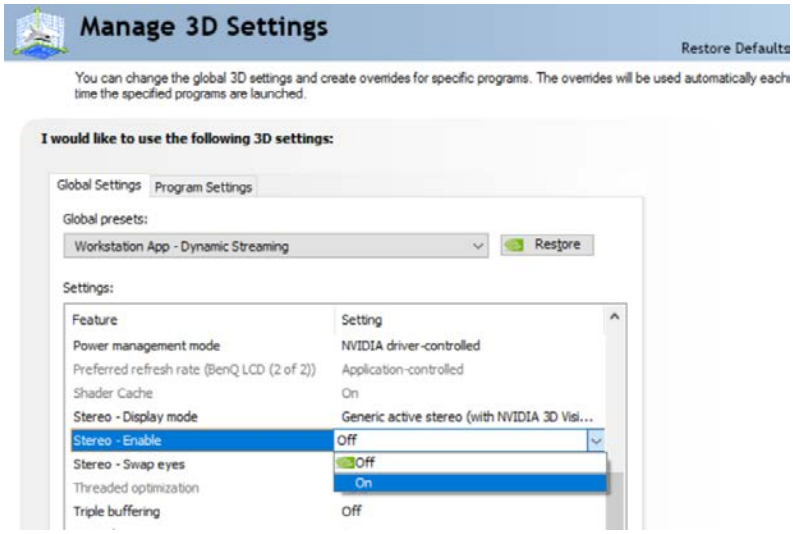
1. Open the NVIDIA Control Panel and select Manage 3D Settings.
2. Select Workstation App-Dynamic Streaming as the Global Preset.



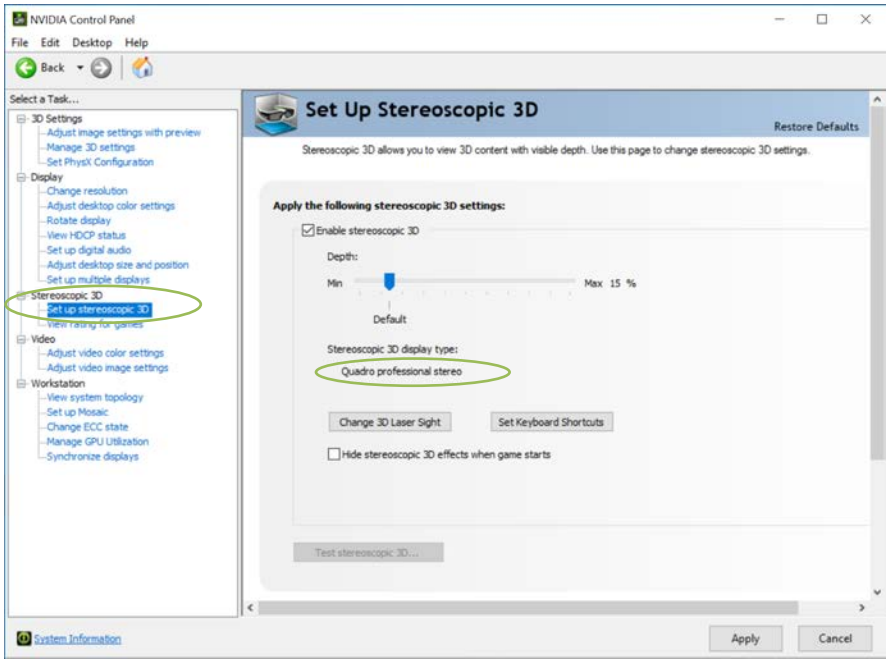
3. Select **On** to enable **Vertical sync**.



4. Select **On** to enable Stereo under **Stereo Enable**.



5. **Windows 10 Only**: Enable stereo in the **Set up stereoscopic 3D** menu. The display type should be **Quadro professional stereo** for most displays.



Enabling Frame Lock

When enabling Frame Lock across a cluster, you must define a display as the timing server that all the clients connect to. Following the guidelines given in *Connecting Nodes in a Visualization Cluster* on page 10, it is recommended this node be in the middle of the cluster.

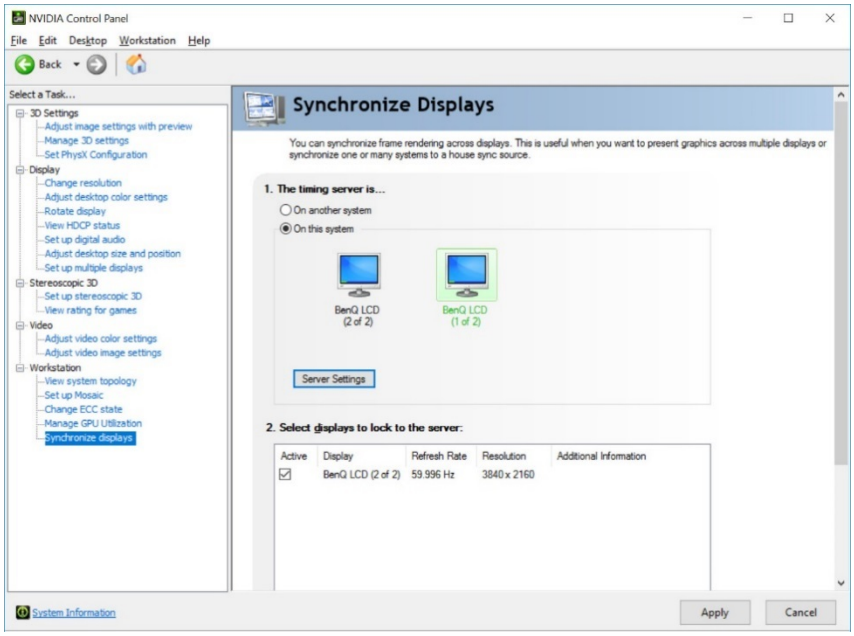
For best results synchronizing the cluster, configure the Timing Master first, and then the client machines so you can verify each client synchronizes correctly as you add it. After the cluster is configured it is recommended to reboot the cluster in the opposite order: clients then Frame Lock master.

When rebooting the cluster after a configuration, boot the client nodes first, then once the clients are stable boot the timing master.

Configure Frame Lock Master

To enable Frame Lock on the master, open the **Synchronize Displays** tab in the **NVIDIA Control Panel**.

1. Open the **NVIDIA Control Panel** and select **Synchronize Displays** from the left menu.
2. Select **On this system** radio button under **The timing server is ...** in the right menu.



When the system has multiple displays, the driver automatically selects the primary display to be the timing server and all other displays are the clients. To change the configuration, select the icon of the display that you want to be the timing server

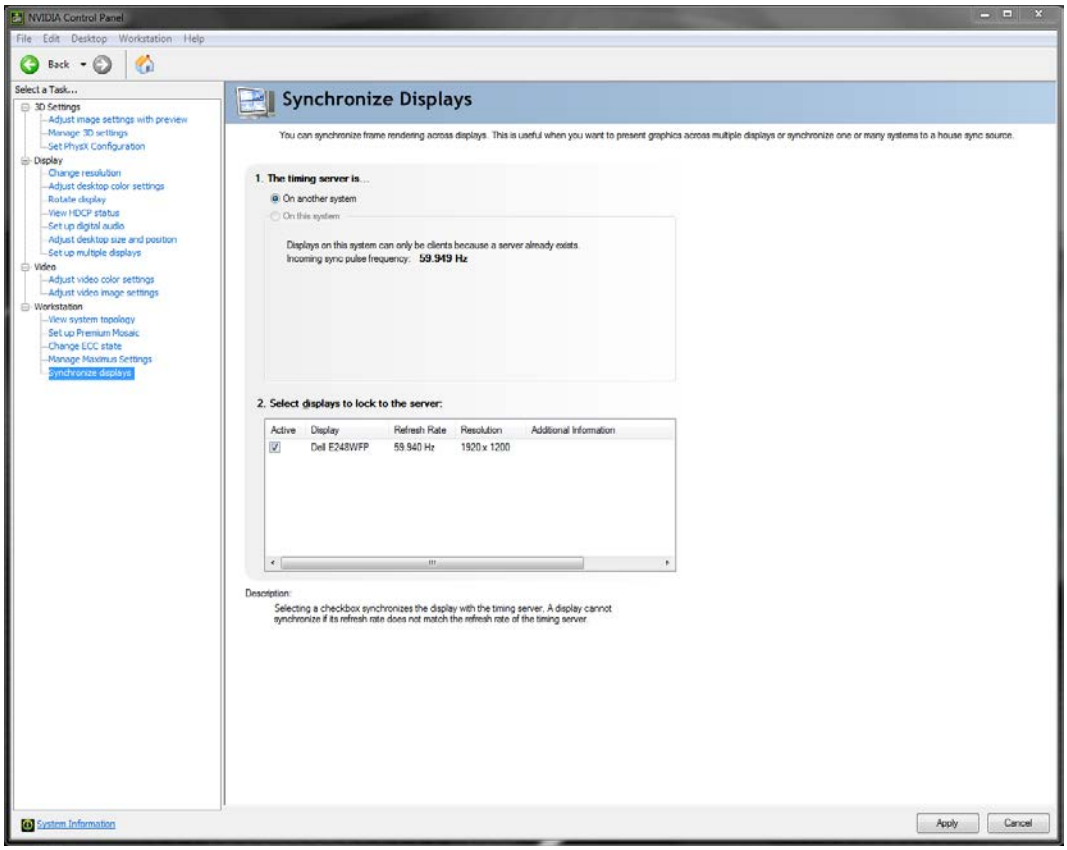
The *Master* node refers to the node used as the Timing Server. There can only be one Timing Server in a cluster. All others nodes are commonly referred to as *clients* or *slaves*.

3. Click **Apply**.

Configure Frame Lock Clients

The client machines are also configured through the **Synchronize Displays** menu on the **NVIDIA Control Panel**. Since there is already a timing master on the chain when you open the control panel, it only offers the option to synchronize to the master.

1. Open the **NVIDIA Control Panel** and select **Synchronize Displays** from the left menu.
2. Select the displays to synchronize from those listed under **2. Select displays to lock to the server**.



During the synchronization, the displays may blink as they adjust their timing. The Status LEDs on the Quadro Sync II card and the System Topology Viewer in the control panel report when the cluster is synchronized.

> The Quadro Sync II card requires the timings of all displays be within ±20 ppm to properly synchronize. See the *Sync Timing Limits* on page 30 for more information.

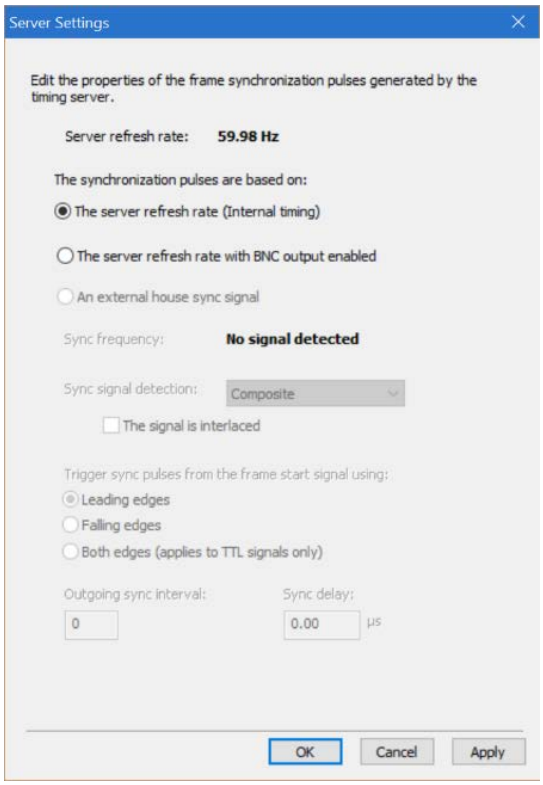
3. Click **Apply**
4. Disable Frame Lock by reversing the process.

TTL Sync (House Sync) Generator Output

The Quadro Sync II card supports the generation of TTL Sync output using the onboard BNC connector. The output is locked to the frame lock signal generated by the Quadro Sync II card. The output can be used to synchronize compatible third party equipment using a TTL sync signal.

Synchronize to an Internal TTL Sync Source for Windows

1. Open the NVIDIA Control Panel.
2. Select Synchronize Displays.
3. Click The timing server is On this system radio button.
4. Click the **Server Settings** button.
5. Select The server refresh rate with BNC output enabled.
6. Adjust the other options as needed.
7. Select **OK.**



CAUTION: If the BNC port is configured as a Sync output, DO NOT connect to a Sync Generator. This may cause damage to the Quadro Sync II card and the Sync Generator.

LINUX DRIVER CONFIGURATION

The NVIDIA Control Panel on Linux allows one node to manage all nodes in the cluster. To work properly, the security settings need to be set properly or client nodes may not display.

Set Driver Security to Allow Remote Management

Any X Server can be added to the frame lock group as long as the system supporting the X Server is configured to support frame lock and is connected via RJ45 cable to the other systems in the frame lock group.

The system driving NVIDIA-settings can communicate with the X server that is to be included for frame lock. This means that either:

- The server must be listening over TCP and the system's firewall is permissive enough to allow remote X11 display connections.

Or

- An alternative mechanism is configured, such as ssh(1), forwarding between the machines.

For listening over TCP, verify that the `-nolisten tcp` command line option was not used when starting the X server. You can find the X server command line with a command such as

```
% ps ax | grep X
```

If `-nolisten tcp` is on the X server command line, consult your Linux distribution documentation for details on how to properly remove this option.

For example, distributions configured to use the GDM login manager may need to set "`DisallowTCP=false`" in the GDM configuration file (e.g., `/etc/gdm/custom.conf`, `/etc/X11/gdm/gdm.conf`, or `/etc/gdb/gdb.conf`; the exact configuration file name and path varies by the distribution). Or, distributions configured to use the KDM login manager may have the line

```
ServerArgsLocal=-nolisten tcp
```

in their `kdm` file (e.g., `/etc/kde3/kdm/kdmrc`). This line can be commented out by prepending with "#".

The system driving NVIDIA-settings can locate and has display privileges on the X server that is to be included for frame lock.

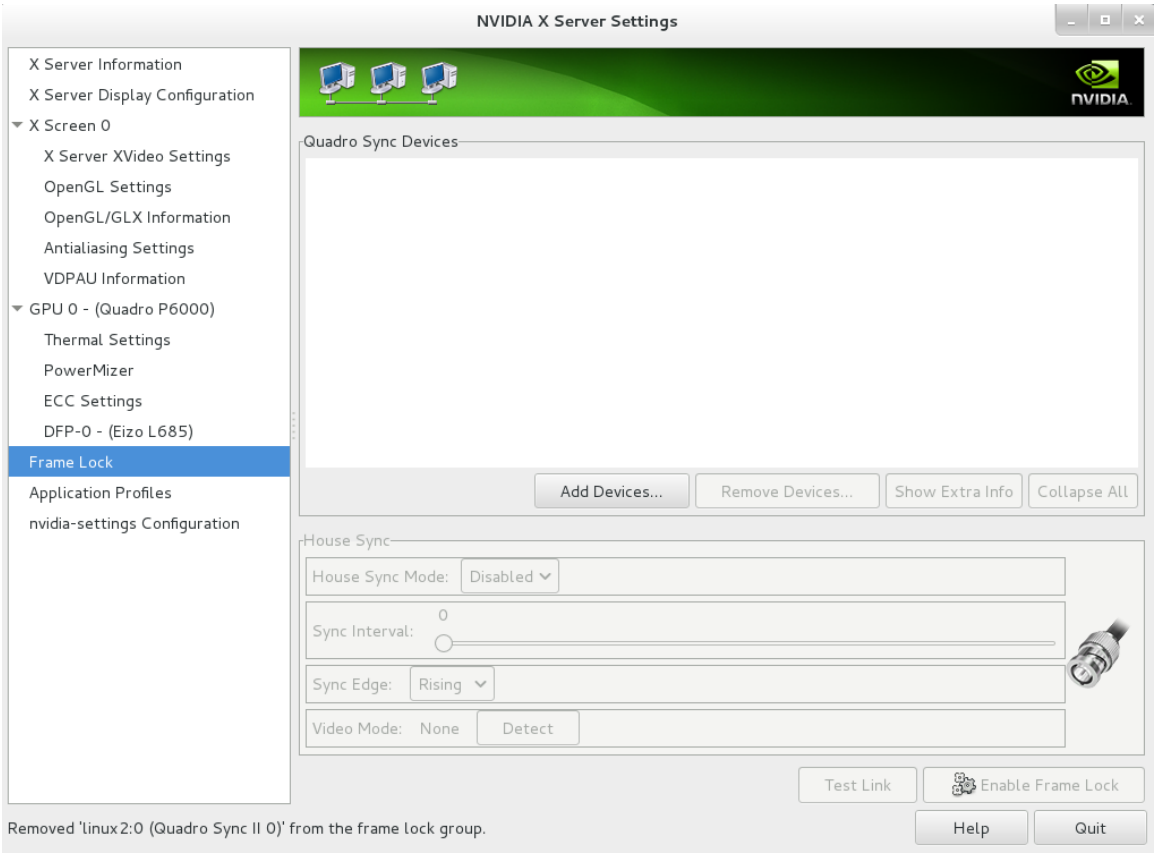
A system can gain display privileges on a remote system by executing

```
% xhost +
```

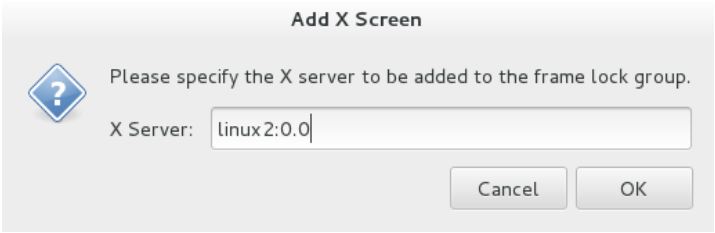
on the remote system. See the `xhost(1)` man page for details.

Configure Frame Lock

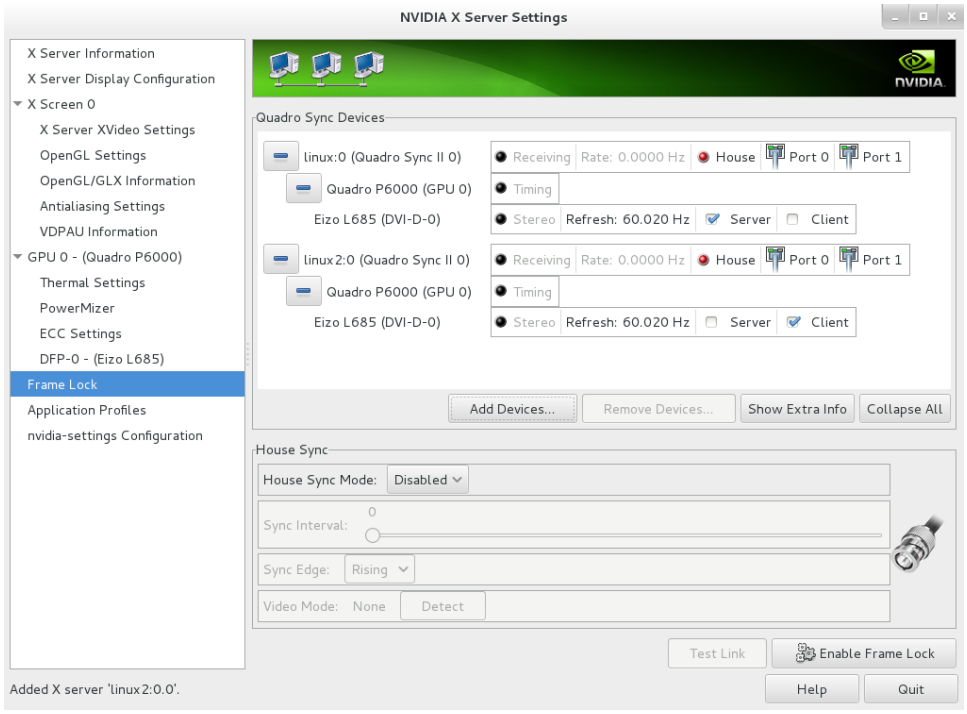
1. Open the **NVIDA X Server Settings** on the master machine.
2. Select **Frame Lock** from the left menu.
3. Select **Add Devices...** from the right menu.



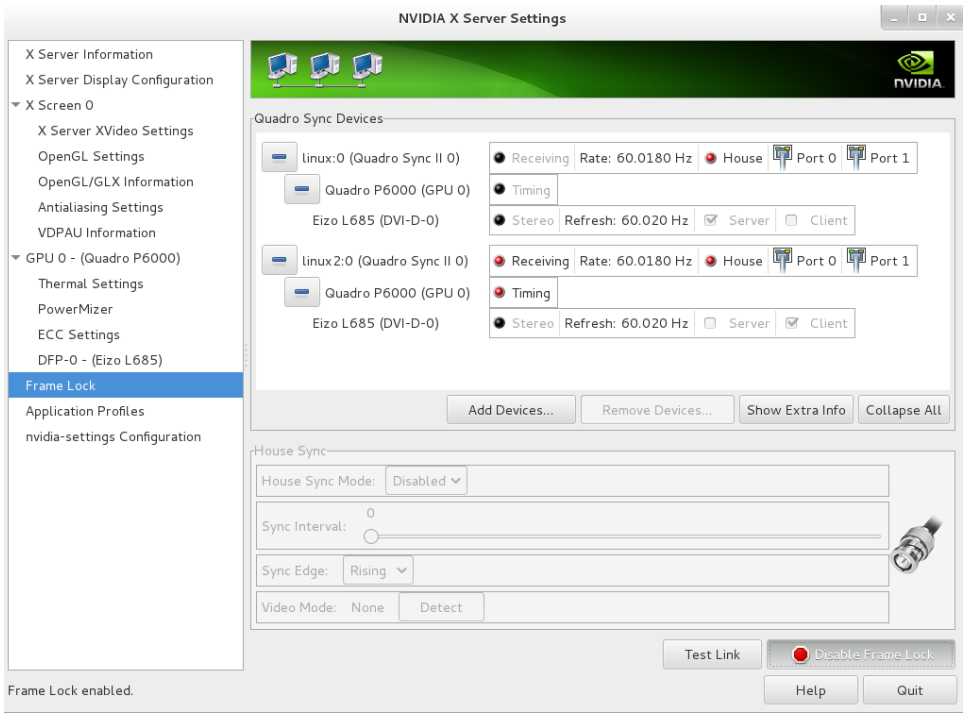
4. Enter the name of the `hostname/ip address` and `XServer ID` of the XServer you want to add. For example: `localhost:0.0` or in this case our machine named `viz0:0.0`.



5. Select the display that is the Server and those that are clients. There can only be one server per Frame Lock group.



6. Add the other nodes in the same way as step 2 and set the Client displays as desired.



SYNC TO AN EXTERNAL TIMING SOURCE

EXTERNAL TIMING SOURCES

The Quadro Sync II card supports three types of external timing sources through the BNC connector on the bracket.

- TTL: 3.3 V, 50% duty cycle, high impedance
- Bi-Level Composite (NTSC/PAL): 75 Ω impedance
- Tri-Level Composite (HDTV): 75 Ω impedance
  - SMPTE Standard 240 compliant

CAUTION: Using timing signal Voltages above specification, +3.3 V for TTL, ±300 mV for Composite will damage the Quadro Sync II card.

When using TTL Sync it is important to use a high-quality signal generator as variances in the external sync frequency will cause the displays to blink as they adjust their timings to follow the wandering input signal.

CAUTION: If the BNC port is configured as a Sync output, DO NOT connect to an External Timing Source. This may cause damage to the Quadro Sync II card and the External Timing Source.

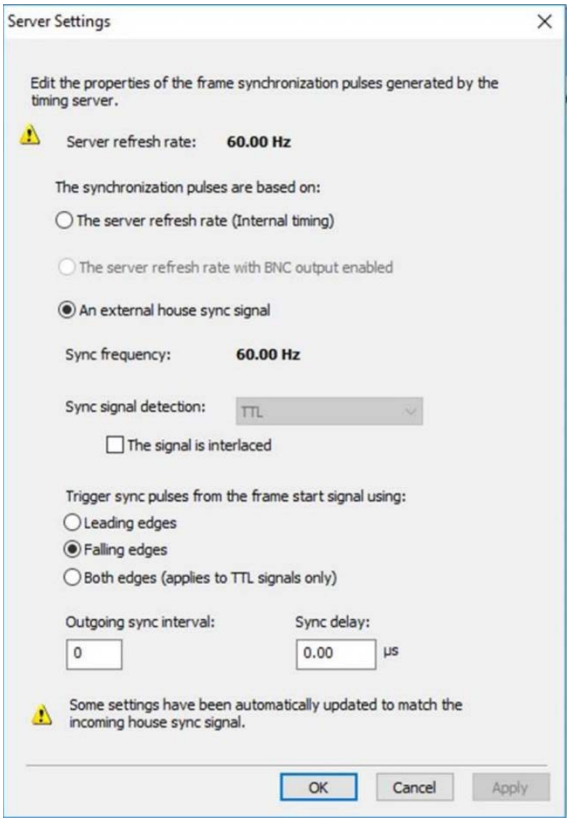
When a valid signal is connected to the BNC connector, the LED below it lights solid green. Once the Quadro Sync II card is using the external signal the same LED flashes green at the rate of the incoming sync signal.

When using an external sync, both Windows and Linux identifies the incoming sync type and configure the card to use it at the same refresh rate. There are extra settings available to adjust how the card converts the external sync to the internal sync:

- Select which edge of external sync pulse triggers the internal pule, leading, trailing, or on TTL both
- Identify that the incoming signal is interlaced
- Set a **Sync Interval** defining how many incoming external sync pulses need to be received before the Quadro Sync II card sends an internal pulse
  - The default value is 0, meaning every external packet is sent internally
  - Setting 1 will cause the Quadro Sync II card to send every other received pulse causing the internal sync pulses to run at half the speed of the external
- Define a start **Sync Delay** in µSeconds between the external signal and internal sync pulses

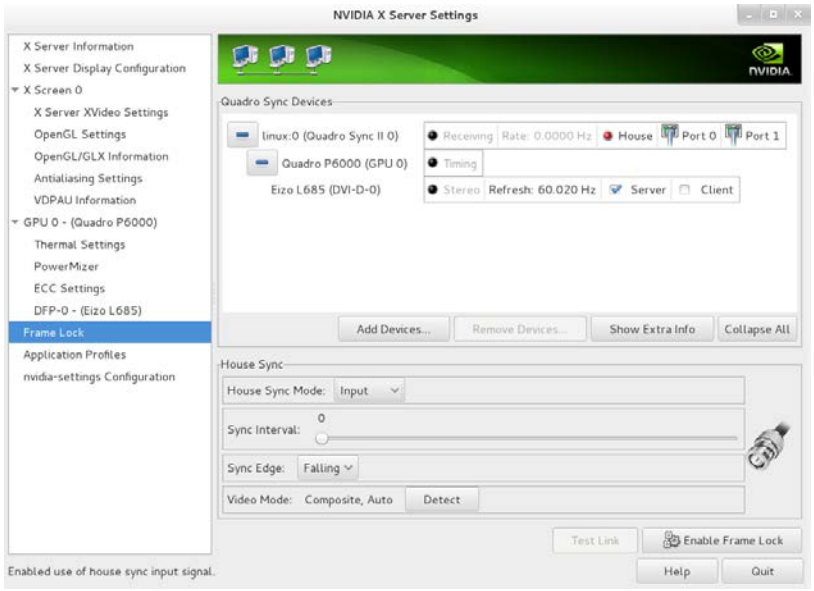
Synchronize to an External Sync Source for Windows

1. Open the NVIDIA Control Panel.
2. Select Synchronize Displays.
3. Click The timing server is On this system radio button.
4. Click the **Server Settings** button.
5. Click An external house sync signal.
6. Adjust the other options as needed.
7. Press **OK.**

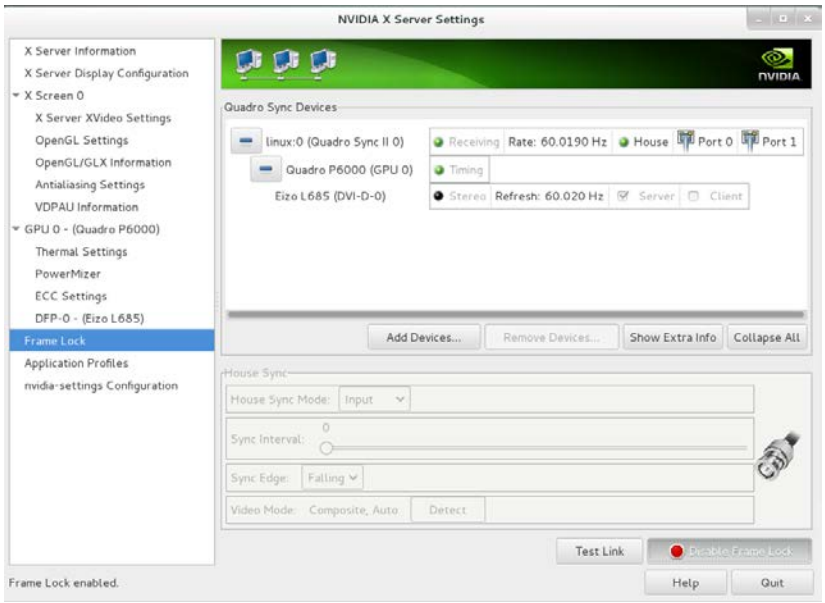


Synchronize to an External Sync Source for Linux

1. Open the NVIDIA X Server Settings.
2. Select **Frame Lock** from the left menu.
3. Select **Add Device** if needed and configure a display to be the timing server.
4. Select **Input** within **House Sync Mode** drop down box and define and other options needed.



5. Select **Enable Frame Lock.**
   Once enabled, the UI reflects the status in the Device list and the House Sync options are grayed out until Frame Lock is disabled.



MONITORING DISPLAY SYNCHRONIZATION

When working with synchronized displays it can often be difficult to verify that all the displays are correctly synchronized. Quadro Sync provides both card and driver-level indicators for the synchronization status.

BOARD-LEVEL STATUS INDICATOR

The bracket of the Quadro Sync II cards has multiple lights to provide configuration and status information

At system start-up, all LED's turn on and stay on until the graphics driver loads. Once the driver loads, the LEDs start to show the status of the card and GPUs.

If the LEDs do not turn on at startup, verify that external power is correctly connected and providing power.

See Figure 7 for the location of the LEDs.

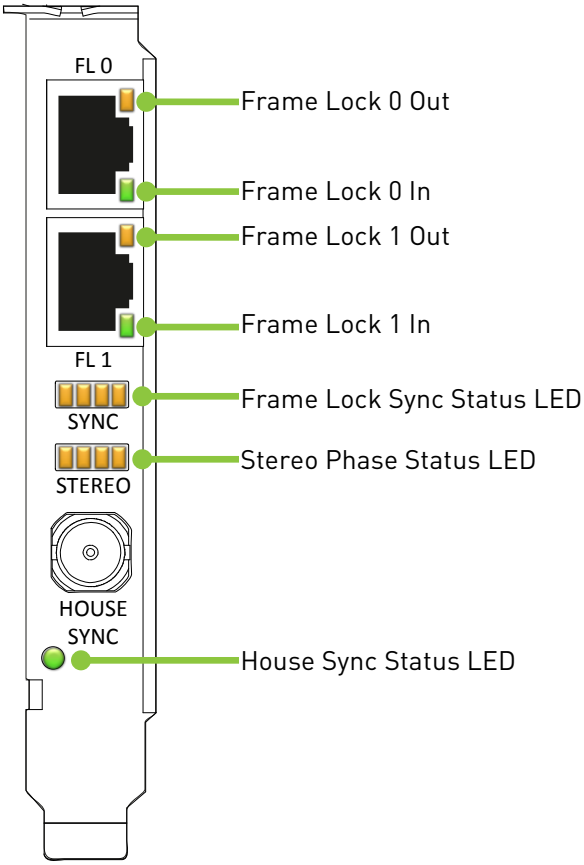


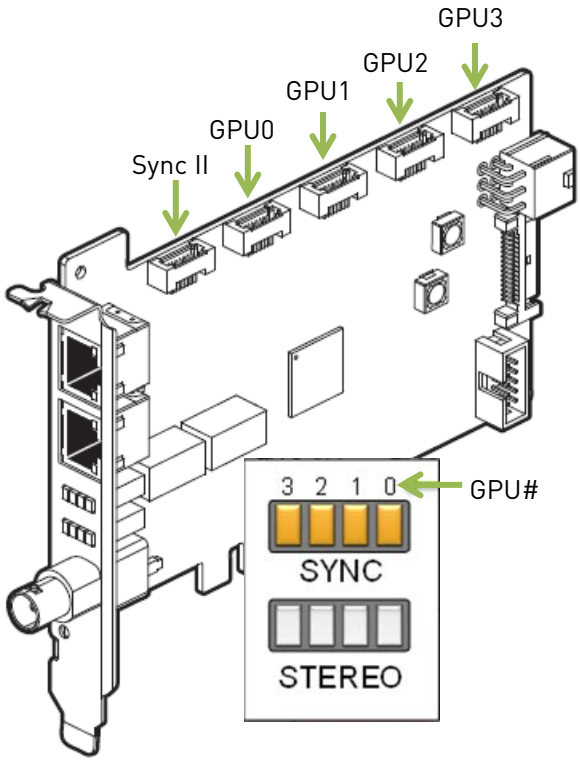
Figure 7. Board Level Status Indicators

If the LED's on the bracket do not turn on at system start-up, shutdown the system and verify the external power to the Quadro Sync II card is connected and operating correctly.

Frame Lock and Stereo Sync Status LEDs

The two rows of status LEDs provide information on the current state of synchronization of the card. There is one LED for each of the GPUs that can be connected.

The top row of LEDs, Sync, show the synchronization status of the connected GPU (see Figure 8 for Sync and Stereo LEDs).



SYNC LED Status	
	GPU Not connected
	GPU present but not synchronized
	GPU synchronized
	GPU is synchronized but within 5% of the threshold of losing sync
	GPU is synchronizing

STEREO LED Status	
	Stereo not active/no GPU
	Stereo locked
	Stereo in process of locking

Figure 8. Frame Lock and Stereo Sync Status LEDs

SYSTEM TOPOLOGY VIEWER FOR WINDOWS

The System Topology Viewer provides a single screen overview of the GPU displays and synchronization status (Figure 9).

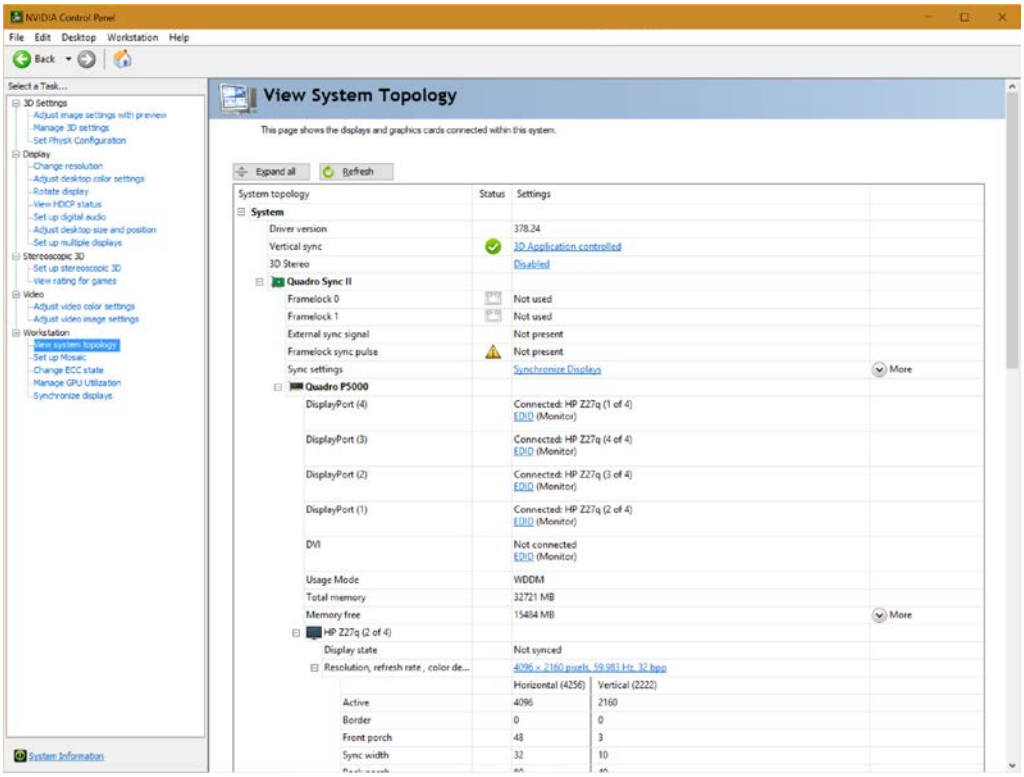
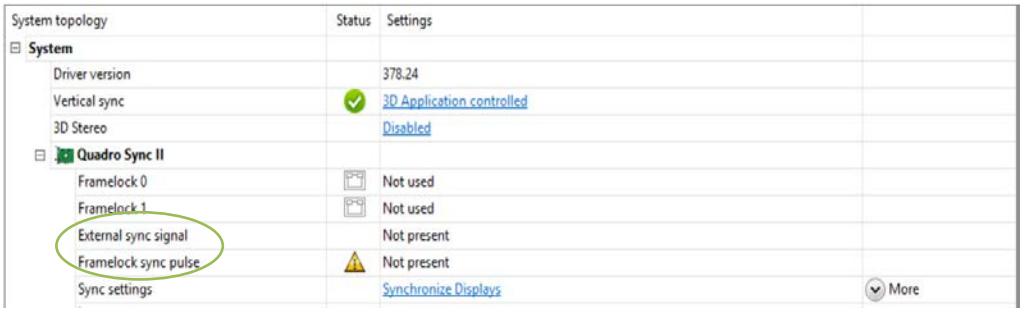


Figure 9. System Topology Viewer for Windows

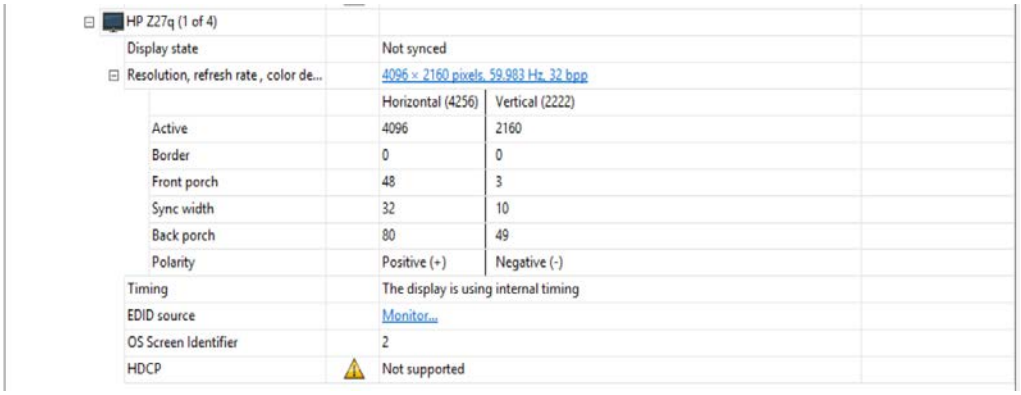
Use the following procedure to use the topology viewer:

1. Open the NVIDIA Control Panel
2. Select **View System Topology** from the left menu to display the Viewer.
   With multiple GPUs and displays, maximize the control panel.
3. Verify that the Framelock sync pulse and External sync signal are as expected.

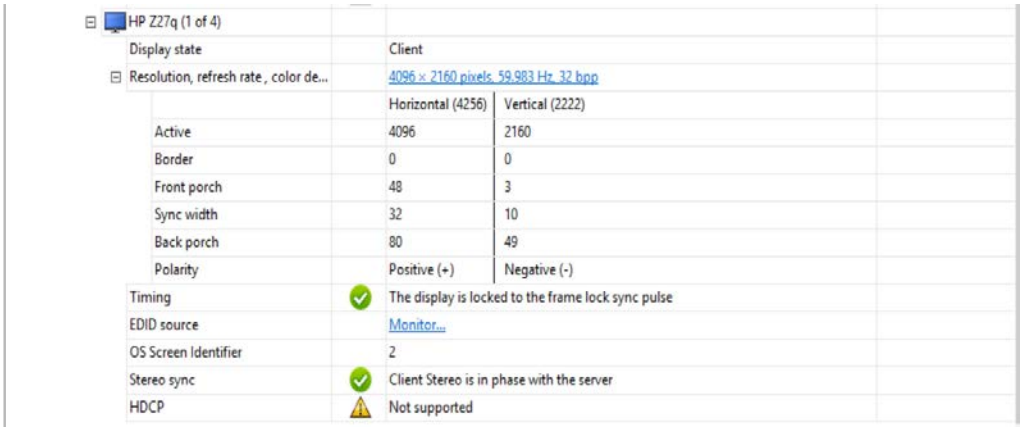


4. Scroll down to the individual displays within the GPUs.

5. Verify the **Timing** entry for the Server is locked to the internal or external timing.



6. Verify the other displays are **locked** to the sync pulse and that **Client Stereo is in phase** if using stereo



SYNC TIMING LIMITS

The Quadro Sync II card has the ability to align displays and sync sources up to ±20 ppm difference in the display timings. If the timings are outside this range the card is not able to synchronize them. The Frame Lock status LEDs on the card indicates that the card is approaching these limits.

Table 2. Sync Timing Limits

Display Refresh Rate (Hz)	Minimum (Hz)	Maximum (Hz)
200	199.996	200.004
120	119.9976	120.0024
100	99.998	100.002
60	59.9988	60.0012
50	49.999	50.001

FREQUENTLY ASKED QUESTIONS

Can the Quadro Sync II card be used with a Quadro M "Maxwell" or K "Kepler" series GPUs.

No.

Can Quadro Sync card be used to Sync with a Quadro Pascal GPUs.

No, the Quadro Sync card is not compatible with a Quadro P "Pascal" series cards.

Can you use the 5th port on the Quadro Sync II card to sync a 5th GPU?

No.

Can multi-GPUs be synchronized using the PCIe bus rather than using a ribbon cable.

No, for Sync functions to work, the Quadro Sync II card needs to be physically connected to the GPU.

Can you configure and monitor a Quadro Sync II card remotely on a Windows System.

Yes, you can use NVWMI to configure the Quadro Sync II card remotely. NVWMI also supports Sync Event monitoring.

Do you support different lengths of internal cables with the Quadro Sync II card?

Yes, the Quadro Sync II card ships with four 12" and two 24" sync cables.

What is the difference between Quadro Sync and Quadro Sync II cards?

The Quadro Sync II card provides the following new functionality over the Quadro Sync card:

- Compatibility with Quadro Pascal series graphics boards and later (The board is not compatible with older GPU generation series graphics boards).
- Five on-board connections. The 5th connection is to be used as the connector to a 2nd Quadro Sync II card in a common chassis.

- Synchronization of up to 8 GPUs in a common chassis when used with a 2nd Quadro Sync II card.
- TTL Sync Generation output via the BNC connector.
- Support for up to four sync “chains” in a single system when two Quadro Sync II cards are used in a single system.

Does the Quadro Sync II card require existing swap lock enabled applications to be modified?

Existing applications should not need any modifications, since we have not changed the core functionality if used in a similar configuration.

What order do I need to connect the GPUs to the Quadro Sync II card?

Connect the Quadro Sync II card and up to four Quadro boards with included cables. On the Quadro board make sure to connect to the connector labeled “SYNC”. There is no need to connect the Quadro boards to the connectors on the Quadro Sync II card in any particular order.

Does it matter which connector I use when connecting two Quadro Sync II cards together?

Connect the Quadro Sync II card to another Quadro Sync II card for a dual Quadro Sync II configuration with included cables enabling up to 8 GPUs in a single system. On the Quadro Sync II card, we recommend to connect to the closest connector to the bracket.

COMPLIANCE AND CERTIFICATIONS

The Quadro Sync II card is compliant with the following regulations:

- Australian Communications Authority and Radio Spectrum Management Group of New Zealand (C-Tick)
- Bureau of Standards, Metrology and Inspection (BSMI)
- China Compulsory Certification (CCC)
- Conformité Européenne (CE)
- Federal Communications Commission (FCC) – Class B
- Interference-Causing Equipment Standard (ICES)
- Imaging Science Foundation (ISF)
- Korean Communication Commissions (KCC)
- Underwriters Laboratories (UL, CUL)
- Voluntary Control Council for Interference (VCCI)

IMPORTANT SAFETY INFORMATION

NVIDIA products are designed to operate safely when installed and used according to the product instructions and general safety practices. The guidelines included in this document explain the potential risks associated with equipment operation and provide important safety practices designed to minimize these risks. By carefully following the information contained in this document, and the specific instructions provided with your product, you can protect yourself from hazards and create a safer environment.

The product is designed and tested to meet IEC-60950-1, the Standard for the Safety of Information Technology Equipment. This also covers the national implementation of IEC-60950-1 based safety standards around the world e.g. UL-60950-1. These standards reduce the risk of injury from the following hazards:

- **Electric shock**: Hazardous voltage levels contained in parts of the product
- **Fire:** Overload, temperature, material flammability
- **Mechanical:** Sharp edges, moving parts, instability
- **Energy:** Circuits with high energy levels (240 volt amperes) or potential as burn hazards
- **Heat:** Accessible parts of the product at high temperatures
- **Chemical:** Chemical fumes and vapors
- **Radiation:** Noise, ionizing, laser, ultrasonic waves

Retain and follow all product safety and operating instructions. Always refer to the documentation supplied with your equipment. Observe all warnings on the product and in the operating instructions.

> **!** **CAUTION: Failure to follow these safety instructions could result in fire, electric shock, or other injury or damage.**

To reduce the risk of bodily injury, electric shock, fire, and damage to the equipment observe the safety labels included on the equipment.

Table 3. Symbols on Equipment

Sign	Meaning
	This symbol in conjunction with any of the following symbols indicates the presence of a potential hazard. The potential for injury exists if warnings are not observed. Consult your documentation for specific details
	This symbol indicates the presence of hazardous energy circuits or electric shock hazards. Refer all servicing to qualified personnel. WARNING: To reduce the risk of injury from electric shock hazards, do not open this enclosure. Refer all maintenance, upgrades, and servicing to qualified personnel.
	This symbol indicates the presence of electric shock hazards. The area contains no user or field serviceable parts. Do not open for any reason. WARNING: To reduce risk of injury from electric shock hazards, do not open this enclosure.

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