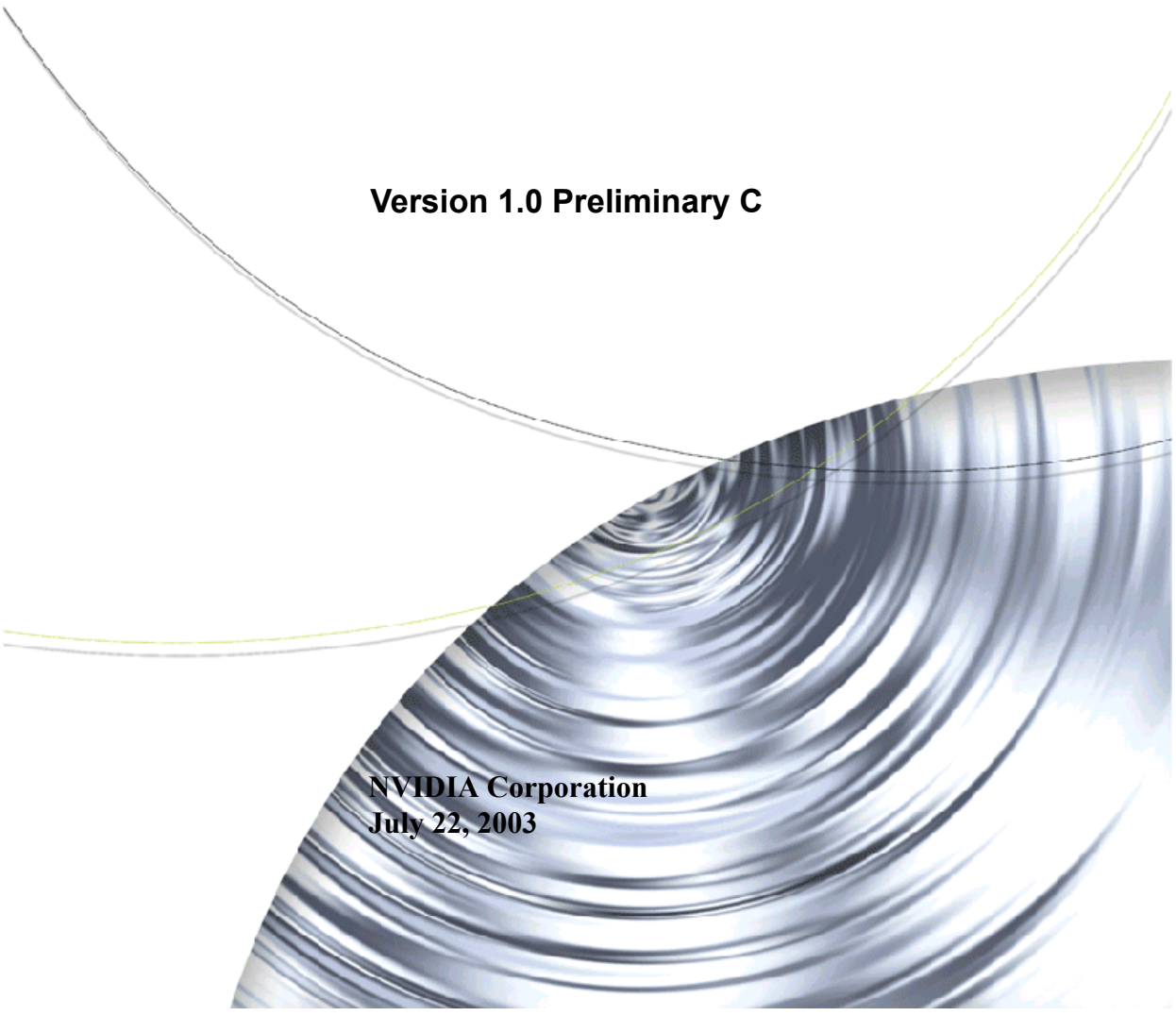
Drivers for Windows

NVIDIA Frame Lock User's Guide

Version 1.0 Preliminary C



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CHAPTER 1

ABOUT NVIDIA FRAME LOCK

When presenting applications across multiple displays or projection systems, it is important that the displays operate in unison to create the appearance of a single display. Seamless presentation requires the following processes:

- Synchronizing the rendering of frames across all displays
- Synchronizing the swapping of front and back buffers

About This Document

NVIDIA Frame Lock hardware and software enable you to create one large virtual canvas using multiple displays, as explained in the following sections:

- "NVIDIA Frame Synchronization" on page 2

  explains how to set up the hardware and software on multiple systems for frame synchronization.

- "Using the OpenGL Extensions" on page 11

  explains how to use the OpenGL extensions supported by NVIDIA for synchronizing the display of frames among multiple displays as well as synchronizing buffer swaps among multiple application windows.

System Requirements

- Windows® 2000 and Windows® XP.
- Quadro FX 3000G Graphics Card
- NVIDIA Detonator FX Driver version 5x.xx

CHAPTER

2

NVIDIA FRAME SYNCHRONIZATION

Visual computing applications that involve multiple displays, or even multiple windows within a display, can require special signal processing and application controls in order to function properly. For example, display graphics must be synchronized with a video camera to produce quality recordings, and applications presented on multiple displays must be synchronized to complete the illusion of a larger, virtual canvas.

This chapter explains how the NVIDIA Frame Lock graphics cards and Frame Synchronization software lets you synchronize windows and displays for various visual computing applications.

Frame Synchronization Principles

NVIDIA Frame Synchronizing actually involves two main processes:

- **Frame Sync—**Synchronizing the displays to a common sync source
- **Frame Lock and Swap Sync—**Synchronizing applications across multiple displays or windows

Frame Sync

Frame Sync is the process of synchronizing the pixel scanning of displays to an external synchronization source. When several systems are connected together, a sync signal is fed from a master system to the other systems in the network and the displays are synchronized with each other.

Frame Lock and Swap Sync

Proper synchronization of an application running on multiple displays involves the following two processes:

- **Frame Lock**

  Frame lock involves the use of hardware to synchronize the frames on each display.

  When an application is displayed across multiple monitiors, frame locked systems help maintain image continuity to create a virtual canvas. Frame lock is especially critical for stereo viewing, where the left and right fields must be in sync across all displays.

  As with frame sync, frame locking of several systems requires the systems be connected together, with the sync signal fed from the master to the other systems in the group. A network of frame locked systems can be synchronized by connecting the master system to an external synchronization source.

- **Swap Sync**

  Swap sync refers to the synchronization of buffer swaps of multiple application windows. By means of swap sync, applications running on multiple systems can synchronize the application buffer swaps between all the systems. Swap sync requires that the systems are frame locked.

How To Synchronize Displays

Quick Start Guide

The following are the basic steps to frame locking several systems. Detailed instructions are provided in the section "Detailed Setup Instructions" on page 4.

1 Set Up the Hardware

- Connect all the systems together using standard CAT5 patch cabling.

  WARNING! The voltage and signal on the frame lock ports are different from Ethernet signals. ***Do not connect a Frame lock port to an Ethernet card or network hub.*** Doing so can cause damage to the hardware.

- If using an external sync source, connect it to the BNC connector on the graphics card designated as the server.

2 Set Up the Server

Use the Frame Synchronization property page to establish the system as the server, to choose the sync source, and configure the sync pulse.

3 Set Up the Clients

Use the Frame Synchronization property page for each client to enable frame lock on that system, and to add an optional delay to the sync pulse before transmitting to other clients.

Detailed Setup Instructions

Set Up the Hardware

1 Daisy chain the graphics cards together using a standard CAT5 patch cable plugged into the external RJ45 connector.

- You can connect to any of the two RJ45 connectors located on the graphics card bracket.
- Each connector automatically configures itself as an input or output after all the connections are made. A flashing green LED indicates an input and a flashing yellow LED indicates an output.

Figure 2.1 Frame Lock Connectors

WARNING! The voltage and signal on the frame lock ports are different from Ethernet signals. ***Do not connect a Frame lock port to an Ethernet card or network hub.*** Doing so can cause damage to the hardware.

2 Designate one of the cards to be the server device. The remaining cards are client devices.

- The server determines the trigger pulse for the client devices. The trigger pulse can be derived from the V-sync of the server video, or from an external timing source.
- To synchronize the displays to an external timing source, connect the external source signal to the **House Sync** connector (BNC) of the server graphics card.

Figure 2.2 shows an example of 4 systems connected together with an external sync source connected to the server device.

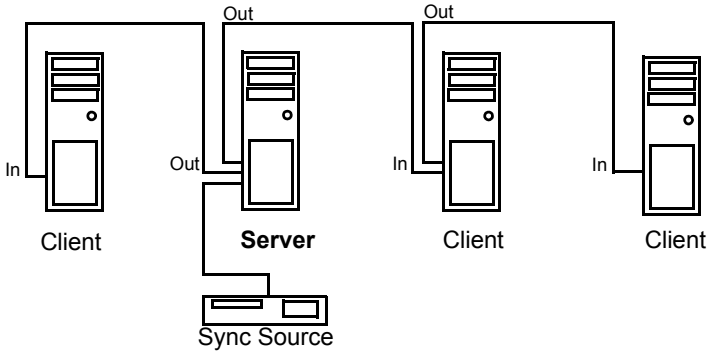

Figure 2.2 Example of Frame Lock Hardware Connections

Set Up the Server

1 Start the system that you have designated as the server, then open the Windows Display Properties control panel and click Settings>Advanced to navigate to the NVIDIA graphics display properties page.

2 Click the **Frame Synchronization** tree item from the slide-out tray.

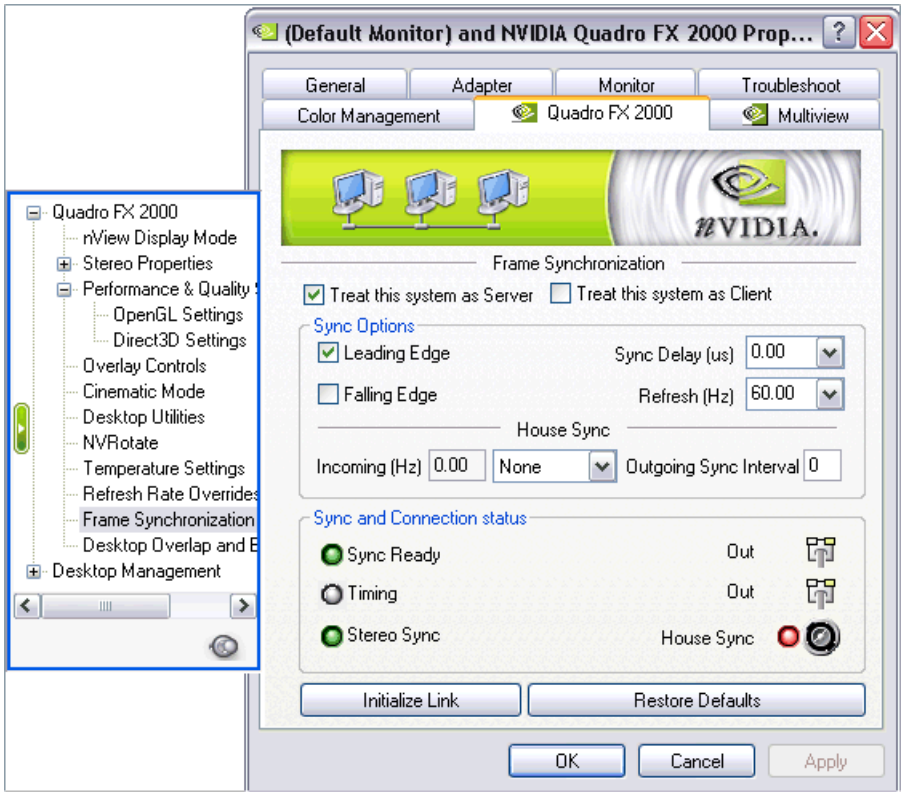

Figure 2.3 Frame Synchronization Page

3 Check the **Treat this system as Server** check box.

4 Configure the Sync Pulse Frequency

If using the House Sync:

- Click the House Sync list box arrow and then click the item corresponding to the signal source format—TTL (3.3 volt level), NTSC/PAL, or HDTV.
- To generate a sync pulse frequency that is the result of sampling the house sync, enter a number in the **Outgoing Sync Interval** box.

  This is the number of sync generator pulses to receive before forwarding the *next* sync pulse to the client devices. For example, if the house sync frequency is 120 Hz, then entering **1** in the Outgoing Sync Interval box results in a 60 Hz sync pulse.

If using the internal sync:

Click the **Refresh** list box arrow and then click the frequency you want to use for the sync pulse.

The sync pulse frequency (refresh rate) must be supported by all the displays that are frame locked to the server.

5 Specify the Sync Trigger Points

You can control whether the sync pulse coincides with the leading edge, the falling edge, or both the leading and falling edge of the source sync signal.

In the Sync Options section, click the check box corresponding to the edge that you want to use as the trigger.

6 Click **Apply** to activate the changes.

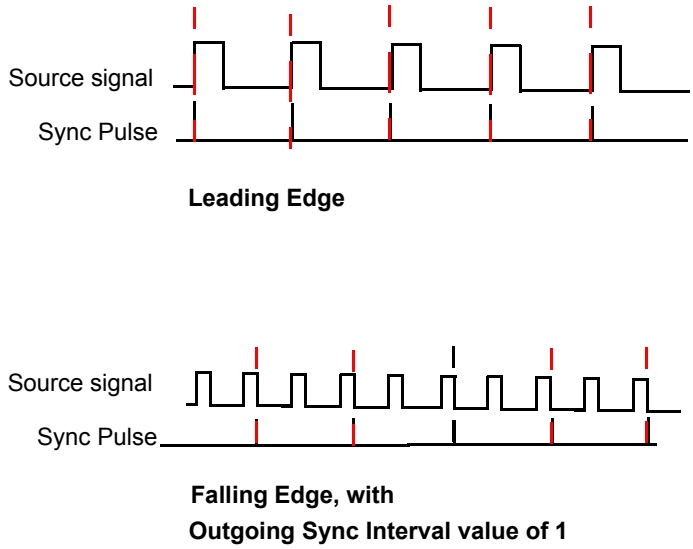

Figure 2.4 Trigger Point Options

Set Up the Clients

Using the OpenGL Extensions

You can set up the slave devices using the OpenGL extensions. See "Using the OpenGL Extensions" on page 11.

Using the Frame Synchronization page

1 For each slave system, start the system and then open the Windows Display Properties control panel and click Settings>Advanced to navigate to the NVIDIA graphics display properties page.

2 Click the Frame Synchronization tree item from the slide-out tray.

3 Click the **Treat this system as Client** check box.

4 If the next display downstream requires a slight delay, enter the sync offset (in microseconds) in the Sync Delay box.

The sync offset is the delay between the source trigger point and the actual sync pulse. See Figure 2.5.

The value can be in the range of 0 to the time needed to display an entire frame.

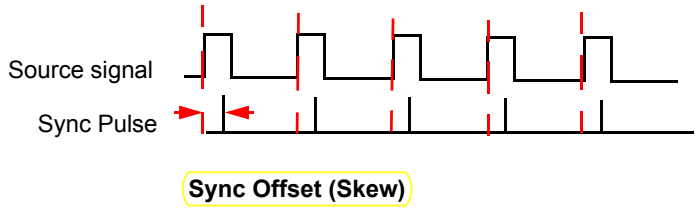

Figure 2.5 Offset Applied to Sync Pulse

5 Click **Apply** to activate the changes.

Testing the Connections

To test the connections, click **Initialize Link** on the Server control panel.

Sync Status

- **Sync Ready** - Green indicates that a sync pulse is present.
- **Timing** - Indicates whether the timing is locked to the sync signal. Green indicates that the slave device is in sync with the master device.

  Server

  - Green: The timing is locked to the house sync.
  - Grey: The timing is locked to the internal V-Sync.

  Client

  - Green: The timing is locked to the signal on the frame lock connector.
  - Red: Either no signal on the frame lock connector is detected, or the lock to the signal has been lost.
- **Stereo** - The meaning of the stereo indicator depends on whether the system is a client or server:
  - Server: Always green indicates that it is in sync with a timing signal.
  - Client: Steady green indicates that its stereo is locked to the server's stereo signal.

Connection Status

The panel indicates the status of the RJ45 ports and the BNC connection. See Figure 2.6.

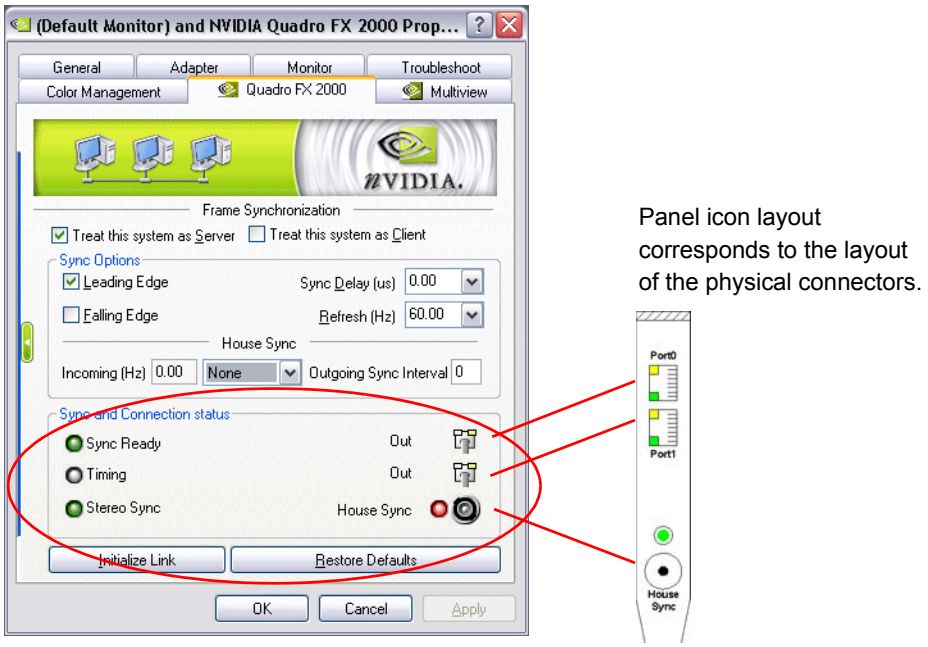

Figure 2.6 Connection Status Indicators

- The two RJ45 frame lock connectors are represented by the connector icons .

In		The connector is receiving the sync signal from another card.
Out		The connector is sending the sync signal to another card.

  - **Out/Out** is the normal indicator for the server device.
  - **In/Out** or **Out/In** is the normal indicator for client devices.
  - **In/In** indicates that there is no connection at any of the connectors of the client device, or the system is not selected as a server or client, and is not Frame-lock enabled.
- House Sync - Green indicates that a signal is present at the BNC connector.

Swap Sync

The application controls synchronization of buffer swaps (swap sync) between applications. Proper connection and synchronization of the timing signal are required for correct synchronization of buffer swaps.

See "Using the OpenGL Extensions" on page 11 for instructions on how an application can use the extensions to accomplish swap sync.

CHAPTER 3

USING THE OPENGL EXTENSIONS

This chapter explains how to use the OpenGL extensions supported by the NVIDIA driver for accomplishing frame synchronization of applications.

- "Frame Synchronization Using the OpenGL Extensions" on page 11 explains the principles behind swap groups, and describes the OpenGL extensions to use to control frame lock and swap sync functions.
- "OpenGL Extensions" on page 16 details the API calls for the extensions.

Frame Synchronization Using the OpenGL Extensions

Swap sync refers to the synchronization of buffer swaps of multiple application windows. By means of swap sync, applications running on multiple systems can synchronize the application buffer swaps between all the systems.

Swap sync requires

- proper connection and synchronization of the timing signals
- a mechanism for binding several windows together so that buffer swaps can be synchronized across all windows

About Buffer Swaps

Key Points and Definitions

Buffer swaps are performed on windows.

- **Swap Groups**

  If buffer swaps must be synchronized across several windows on a single system, you can define a "group" that consists of the specified windows.

- **Swap Barriers**

  If buffer swaps must be synchronized across several systems, you can define a “barrier” that consists of the specified groups.

Buffer Swap Criteria

The criteria for buffer swaps involves when a window is ready to swap and when a group is ready to swap.

Window Buffer Swaps

Any `hDC` that is not a window—such as a non-visible rendering buffer—is always ready, otherwise the following criteria must be satisfied before a buffer swap for a window can be performed:

- The window itself must be ready, meaning:
  - A buffer swap command has been issued for it.
  - Its swap interval has elapsed.
- If the window belongs to a group, all the windows in the group must be ready.
- If the window belongs to a group and that group is bound to a barrier, all groups bound to that barrier must be ready.

Group and Barrier Buffer Swaps

- Buffer swaps for all windows in a swap group take place concurrently, and buffer swaps for all groups using a barrier take place concurrently.

  For barrier swaps, the vertical retraces of the screens of all the groups must also be synchronized, otherwise there is no guarantee of concurrency between groups.
- An implementation may support a limited number of swap groups and barriers, and may have restrictions on where the users of a barrier can reside.

  For example, an implementation may allow the users to reside on different display devices or even hosts. An implementation may return zero for any of **maxGroups** and **maxBarriers** returned by `QueryMaxSwapGroupsNV` if swap groups or barriers are not available in that implementation or on that host.

Frame Counter

The implementation provides a universal counter, or frame counter, among all systems that are locked together by swap groups/barriers. It is based on the internal synchronization signal which triggers the buffer swap.

- To obtain the current frame count, call `QueryFrameCountNV`().
- To reset the frame count back to zero, call, `ResetFrameCountNV`().

  In a system that has an NVIDIA frame-lock device installed and enabled, `ResetFrameCountNV()` succeeds only when the frame lock device is configured as a Master device.

Enabling and Configuring Frame Lock

See the section "OpenGL Extensions" on page 16 for detailed API descriptions of the extensions referred to in this section.

Enabling Frame Lock

Each display that is intended to be part of a frame-lock network must be enabled.

- To enable, call

  `wglEnableGenlockI3D()`

- To disable, call

  `wglDisableGenlockI3D()`

  This call should be made before changing frame sync parameters in order to avoid synchronization problems.

- To query the state of a display, call

  `wglIsEnabledGenlockI3D()`

Configuring the Sync Trigger

The start of each frame[1] is synchronized to the sync trigger pulse. This pulse can be based on the vertical retrace signal of the frame lock device configured as the Master device, or it can be derived from an external video signal, like a house sync signal. Configuring the trigger pulse involves:

- Selecting the sync source signal
- Deriving the trigger pulse from the sync source based on the sync source edge, sampling frequency, and an optional delay

Select the Sync Source

- To select the source signal upon which to base the trigger pulse, call

  `wglGenlockSourceI3D()`

  and specify either the internal sync signal or an external sync signal.

- To query the sync source, call

  `wglGetGenlockSourceI3D()`

1. The current hardware does not support triggering on field data, so you cannot specify triggering on left-only or right-only frames.

Configure the Trigger Pulse

The trigger pulse is derived from the sync source, and is the signal to which all frame-lock enabled boards are synchronized. Specify the trigger pulse as follows:

- **Set An Edge Mode**

  Set the sync pulse to coincide with the leading edge, the falling edge, or both the leading and falling edge of the source sync signal, by calling

  `wglGenlockSourceEdgeI3D()`

  and specifying either the rising edge, the falling edge, or both edges.

  To query the edge mode, call `wglGetGenlockSourceEdgeI3D()`.

- **Set a Sampling Value**

  Set the sync pulse as a function of samplings of the source signal, by calling

  `wglGenlockSampleRateI3D()`

  and specifying every ***n***th source pulse to use for the trigger pulse. The minimum value is 1. The maximum value is 6. As an example, if a value of 2 is used, then every other source pulse would generate a trigger pulse.

  To query the sample value, call `wglGetGenlockSampleRateI3D()`.

- **Set an Optional Delay Value**

  If the next display downstream requires a slight delay, delay the trigger pulse (in pixels) by calling

  `wglGenlockSourceDelayI3D()`

  and specify a delay. The minimum delay value is 0. The maximum delay value is the number of pixel clocks needed to display an entire frame.

  To determine the maximum delay value:

  1. Call the function `wglQueryGenlockMaxSourceDelayI3D()` and obtain the values for maxLineDelay and maxPixelDelay.
  2. Calculate the maximum delay using the equation

     maxDelay = (maxLineDelay) x (maxPixelDelay)

Configuring for Swap Sync

Configuring Swap Groups

You can assign an OpenGL window to a swap group. There is a maximum number of allowable swap groups that can be created for any particular implementation.

- To determine the maximum swap group number, call

  `QueryMaxSwapGroupsNV()`

- To assign a window to a swap group, call

  `JoinSwapGroupNV()`

  and specify the swap group number.

  If `hDC` is already a member of a different group, it is implicitly removed from that group. If the swap group number is zero, the `hDC` is removed from the current group.

  To query the current swap group, call `QuerySwapGroupNV()`.

Configuring Swap Barriers

You can bind a group to a barrier. There is a maximum number of barriers that can be created.

- To determine the maximum barrier number, call

  `QueryMaxSwapGroupsNV()`

- To bind a group to a barrier, call

  `BindSwapBarrierNV()`

  and specify the group and barrier numbers.

  If the barrier number is zero, then the group in unbound from the current barrier.

  To query the current barrier, call `QuerySwapGroupNV()`.

OpenGL Extensions

This section describes the relevant OpenGL extensions supported by the NVIDIA display driver (to be shipped with the NVIDIA frame-lock hardware). The set of extensions supported for frame lock are exported as `WGL_I3D_genlock` and `WGL_NV_swap_group`.

These are exported in the WGL extension string which can be queried by `wglGetExtensionsStringARB`. This documentation covers the WGL versions of the extensions which are exported on Microsoft WindowsNT/XP systems. There is an equivalent Unix version of these extensions: `GLX_NV_swap_group`.

Exported WGL_I3D_genlock Functions

The exported functions for this extension are:

- `wglEnableGenlockI3D`
- `wglDisableGenlockI3D`
- `wglIsEnabledGenlockI3D`
- `wglGenlockSourceI3D`
- `wglGetGenlockSourceI3D`
- `wglGenlockSourceEdgeI3D`
- `wglGetGenlockSourceEdgeI3D`
- `wglGenlockSampleRateI3D`
- `wglGetGenlockSampleRateI3D`
- `wglGenlockSourceDelayI3D`
- `wglGetGenlockSourceDelayI3D`
- `wglQueryGenlockMaxSourceDelayI3D`

wglEnableGenlockI3D

This call enables genlock for all monitors connected to a device (device context `hDC`) of an OpenGL window. There is only a single genlock device for each graphics adapter regardless of the number of monitors supported by the adapter.

Function	`BOOL wglEnableGenlockI3D(HDC hDC)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Return Values	`TRUE: Success` `FALSE: Failure`

wglDisableGenlockI3D

This call disables genlock for a monitor.

Function	`BOOL wglDisableGenlockI3D(HDC hDC)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Return Values	`TRUE`: Success `FALSE`: Failure

wglIsEnabledGenlockI3D

This call queries the current genlock enable/disable state

Function	`BOOL wglIsEnabledGenlockI3D(HDC hDC, BOOL *pFlag)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Parameters Out	`*pFlag`: - 0 = Genlock is disabled. 1 = Genlock is enabled.
Return Values	`TRUE`: Success `FALSE`: Failure

wglGenlockSourceI3D

This call sets the sync source upon which the frame lock sync trigger is based.

Function	`BOOL wglGenlockSourceI3D(HDC hDC, UINT uSource)`

Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
	`uSource` -
	`WGL_GENLOCK_SOURCE_MULTIVIEW_I3D`
	Select the internal sync signal as the sync source.
	`WGL_GENLOCK_SOURCE_EXTERNAL_SYNC_I3D`
	Select the external house sync as the sync source.

Parameters Out	
Return Values	`TRUE`: Success `FALSE`: Failure

wglGetGenlockSourceI3D

This call queries the current sync source.

Function	`BOOL wglGetGenlockSourceI3D(HDC hDC, UINT *uSource)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.

Parameters Out	`*uSource` -
	`WGL_GENLOCK_SOURCE_MULTIVIEW_I3D`
	The internal sync signal is the sync source.
	`WGL_GENLOCK_SOURCE_EXTERNAL_SYNC_I3D`
	The external house sync is the sync source.

Return Values	`TRUE`: Success `FALSE`: Failure

wglGenlockSourceEdgeI3D

This call synchronizes the trigger pulse to the edge or edges of the source signal.

Function	`BOOL wglGenlockSourceEdgeI3D(HDC hDC, UINT uEdge)`

Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
	`uEdge` -
	`WGL_GENLOCK_SOURCE_EDGE_FALLING_I3D`
	Selects the falling edge of the source.
	`WGL_GENLOCK_SOURCE_EDGE_RISING_I3D`
	Selects the rising edge of the source.
	`WGL_GENLOCK_SOURCE_EDGE_BOTH_I3D`
	Selects both edges of the source.

Parameters Out	
Return Values	`TRUE`: Success `FALSE`: Failure

wglGetGenlockSourceEdgeI3D

This call queries the current trigger pulse edge mode.

Function	`BOOL wglGetGenlockSourceEdgeI3D(HDC hDC, UINT *uEdge)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.

Parameters Out	`*uEdge` -
	`WGL_GENLOCK_SOURCE_EDGE_FALLING_I3D`
	Selects the falling edge of the source.
	`WGL_GENLOCK_SOURCE_EDGE_RISING_I3D`
	Selects the rising edge of the source.
	`WGL_GENLOCK_SOURCE_EDGE_BOTH_I3D`
	Selects both edges of the source.

Return Values	`TRUE`: Success `FALSE`: Failure

wglGenlockSampleRateI3D

This call sets the trigger pulse as a function of the specified sync source sampling rate.

Function	`BOOL wglGenlockSampleRateI3D(HDC hDC, UINT uRate)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card. `uRate` - Specifies every ***n***th pulse of the sync source signal to use for the trigger pulse. For example, if `uRate` were set to a value of 2, every other sync source pulse would generate a trigger pulse. `uRate` must be in the range of 1–6.
Parameters Out	
Return Values	`TRUE`: Success `FALSE`: Failure

wglGetGenlockSampleRateI3D

This call queries the current sync source sampling rate for the trigger pulse.

Function	`BOOL wglGetGenlockSampleRateI3D(HDC hDC, UINT *uRate)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Parameters Out	`*uRate` - The ***n***th pulse of the sync source used for the trigger pulse. For example, if `uRate` were set to a value of 2, every other sync source pulse would generate a trigger pulse.
Return Values	`TRUE`: Success `FALSE`: Failure

wglGenlockSourceDelayI3D

This call specifies the delay to apply to the trigger pulse.

Function	`BOOL wglGenlockSourceDelayI3D(HDC hDC, UINT uDelay)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card. `uDelay` - The delay, in pixels, from the sync source trigger edge to the actual trigger pulse.
Parameters Out	
Return Values	`TRUE`: Success `FALSE`: Failure

wglGetGenlockSourceDelayI3D

This call queries the current trigger pulse delay.

Function	`BOOL wglGetGenlockSourceDelayI3D(HDC hDC, UINT *uDelay)`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Parameters Out	`*uDelay` - The delay, in pixels, from the sync source trigger edge to the actual trigger pulse.
Return Values	`TRUE`: Success `FALSE`: Failure

wglQueryGenlockMaxSourceDelayI3D

This call queries the maximum line and pixel delay. Use these values to calculate the maximum trigger pulse delay (`maxDelay`), using the equation

`maxDelay` = (`maxLineDelay`) x (`maxPixelDelay`).

Function	`BOOL wglQueryGenlockMaxSourceDelayI3D(HDC hDC,`
	`UINT *uMaxLineDelay,`
	`UINT *uMaxPixelDelay)`

Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Parameters Out	`*uMaxLineDelay` - The maximum number of raster scan lines per frame. This includes all visible and non-visible lines—such as vertical blanking lines— for all fields. `*uMaxPixelDelay` - The maximum number of pixels per raster scan line. This includes all visible and non-visible pixels such as horizontal blank.
Return Values	`TRUE`: Success `FALSE`: Failure

Exported WGL_NV_swap_group Functions

The exported functions for this extensions are:

- JoinSwapGroupNV
- BindSwapBarrierNV
- QuerySwapGroupNV
- QueryMaxSwapGroupsNV
- QueryFrameCountNV
- ResetFrameCountNV

JoinSwapGroupNV

This call adds the OpenGL window with the device context hDC to the swap group specified by group. If hDC is already a member of a different group, it is implicitly removed from that group first.

Function	`BOOL JoinSwapGroupNV(HDC hDC, GLuint group);`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
	`group` - Swap group number to which the device context is to be assigned. The value must be between 0 and `maxGroups` (see "QueryMaxSwapGroupsNV" on page 22). If 0, the device context is unbound from its current group.
Parameters Out	
Return Values	`TRUE`: Success
	`FALSE`: Failure

BindSwapBarrierNV

This call binds a swap group to a barrier.

Function	`BOOL BindSwapBarrierNV(GLuint group, GLuint barrier);`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
	`group` - Swap group number that is to be bound to a barrier.
	`barrier` - Barrier number to which the swap group is to be bound. Value must be between 0 and `maxBarrier` (see "QueryMaxSwapGroupsNV" on page 22).
Parameters Out	
Return Values	`TRUE`: Success
	`FALSE`: Failure

QuerySwapGroupNV

This call returns the swap group number and barrier number to which the device context is bound.

Function	`BOOL QuerySwapGroupNV(HDC hDC, GLuint *group, GLuint *barrier);`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Parameters Out	`*group` - The group number to which the device context is bound, or assigned.
	`*barrier` - The barrier number to which the device context is bound.
Return Values	`TRUE`: Success
	`FALSE`: Failure. In this case, `*group` and `*barrier` are undefined.

QueryMaxSwapGroupsNV

This call returns the maximum number of swap groups and swap barriers that are supported by the implementation.

Function	`BOOL QueryMaxSwapGroupsNV(HDC hDC, GLuint *maxGroups, GLuint *maxBarriers);`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Parameters Out	`*maxGroups` - The maximum group number supported by the implementation.
	`*maxBarriers` - The maximum barrier number supported by the implementation.
Return Values	`TRUE`: Success
	`FALSE`: Failure. In this case, `*maxGroups` and `*maxBarriers` are undefined.

QueryFrameCountNV

`QueryFrameCountNV` returns in `count` the current frame counter for `swapGroup`.

This call returns the current frame count of the swap group.

Function	`BOOL QueryFrameCountNV(HDC hDC, GLuint *count);`
Parameters In	`hDC` - Device context for the frame lock card, or for a window residing on the frame lock card.
Parameters Out	*count - The current frame count of the swap group.
Return Values	`TRUE`: Frame count successfully retrieved.
	`FALSE`: Frame count retrieval failed.

ResetFrameCountNV

This call resets to zero the frame count of the swap group. The call succeeds only on the master device.

Function	`BOOL ResetFrameCountNV(HDC hDC);`
Parameters In	`hDC` - Device context for the frame lock card, or a window residing on the frame lock card.
Parameters Out	
Return Values	`TRUE`: Frame counter is successfully reset. `FALSE`: Frame counter not successfully reset.