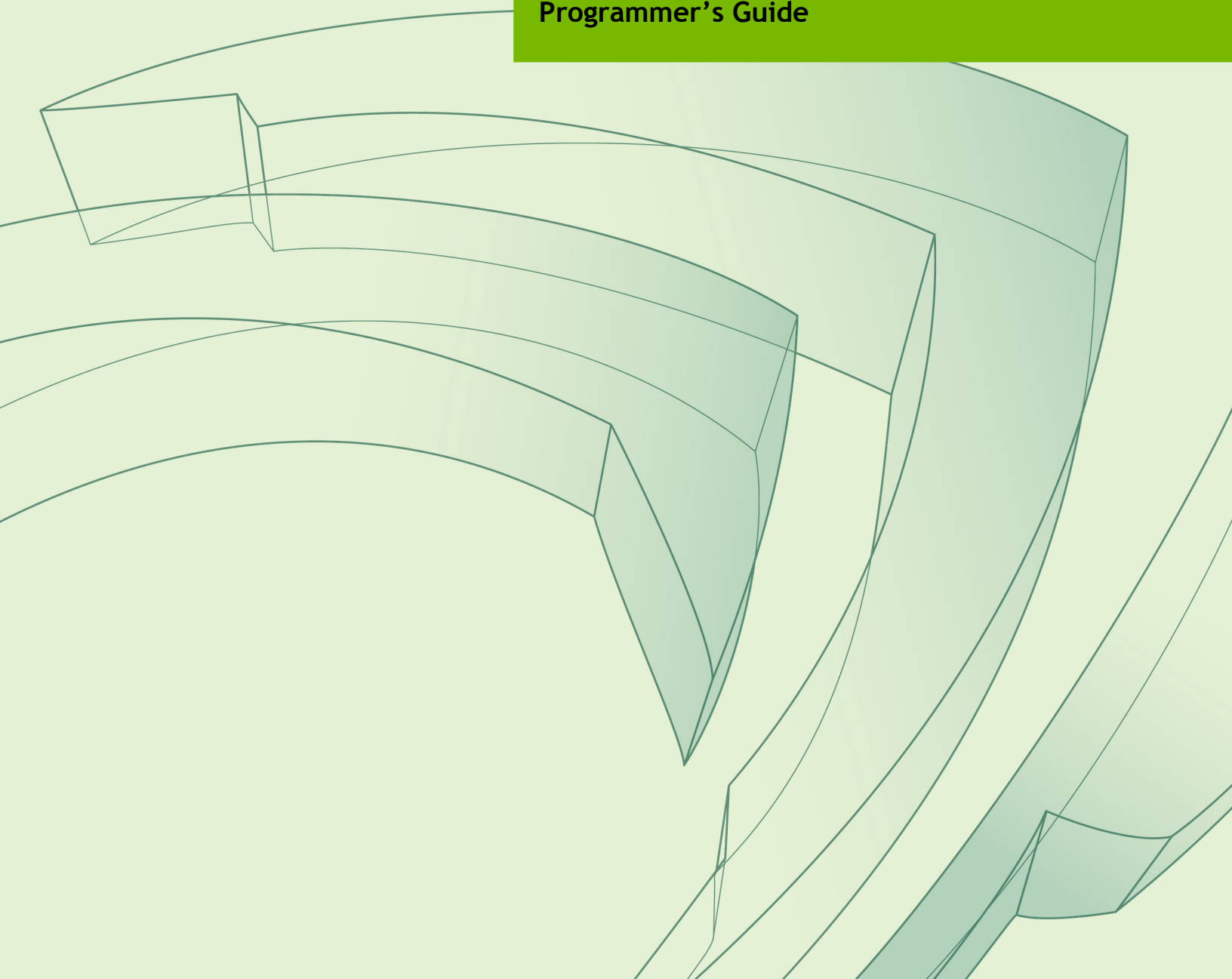
# QUADRO SDI OUTPUT

PG-03776-001_v06 | May 2011

## Programmer's Guide



# DOCUMENT CHANGE HISTORY

PG-03776-001_v06

| Version | Date | Authors | Description of Change |
|---|---|---|---|
| 01 | January 24, 2008 | TT, SM | Initial Release |
| 02 | August 14, 2009 | TT, SM | •API Change<br>•New template |
| 03 | January 15, 2010 | TT, SM | The following information added in this revision:<br>Chapter 6 *Ancillary Data*<br>Chapter 14 *Ancillary Data API* |
| 04 | June 17, 2010 | TT, SM | •Change to the code in *Chapter 12 NVAPI VIO*<br>•Updated Code Listing 25<br>•Updated code in Section 6.2<br>•Added Section 6.4 Audio<br>•Updated Table 10-2 |
| 05 | November 8, 2010 | TT, SM | •Minor text edits<br>•Added Section 5.1 “GPU Selection”<br>•Added Sub-Section 6.4.3 “Determining the Number of Audio Samples per Frame”<br>•Added Sub-Section 6.4.4 “Specifying Audio Data”<br>•Added Sub-Section 10.3.4 “Color Space Conversion” |
| 06 | May 26, 2011 | TT, SM | •Minor text edits<br>•Updated Code Listing 32, Code Listing 33, and Code Listing 35<br>•Added note to Sub-Section 6.4.4 “Specifying Audio Data” |

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# 1 GETTING STARTED

Application programming of the NVIDIA Quadro® FX SDI is broken into two principle parts, device control and data transfer. Device control handles the hardware configuration as well as the starting and stopping of data transfers while data transfer is the sequence of operations that send graphics data to the video device for output.

The Quadro® FX SDI displays graphics data that has been rendered by the graphics processing unit (GPU) into one or more OpenGL Frame Buffer Objects (FBO) or application controlled pbuffers using traditional OpenGL programming techniques. The resulting standard definition or high definition serial digital video output can be 8, 10, or 12-bit. 10-bit and 12-bit video output must originate from a 16-bit per-component floating-point render target while 8-bit data can originate from either an 8-bit per-component integer or a 16-bit per-component floating-point render target. Color data in an 8-bit FBO or pbuffer should be integer data in the range of 0 to 255, while data placed by an application into a 16-bit floating point pbuffer or FBO should be 16-bit float data in the range of 0 to 1.

# 2 DEVICE CONTROL APIS

## 2.1 WINDOWS

On systems running the Microsoft Windows Operating System, hardware setup and control is handled by the VIO commands of NVAPI, NVIDIA's universal control API. Use of NVAPI requires the inclusion of the following include and library files. These files are packaged within the NVIDA Quadro SDI SDK.

```
nvapi.h
nvapi.lib
```

Use of the NVAPI to control the Quadro SDI device is described in Chapter 4 *Device Setup and Control*. For additional information on NVAPI, refer to the NVAPI Online Help documentation.

**Note:** Previous versions of the SDK utilized the NvCPL API for device control. This API has been deprecated in favor of NVAPI in order to support Windows XP64, Windows Vista and Windows 7.

## 2.2 LINUX

On Linux-based systems, hardware setup and control is enabled by the `NV-CONTROL X` extension. Use of the `NV-CONTROL X` extension requires the following include files. These files are packaged within the `nvidia-settings-1.0.tar.gz` archive that is included with the NVIDIA SDI SDK or display driver.

```
NVCtrlLib.h
NVCtrl.h
```

Control of the Quadro SDI device with the `NV-CONTROL X` Extension is described in Chapter 4 *Device Setup and Control*. Additional information on the `NV-CONTROL X` Extension can be found in the `NV-CONTROL-API.txt` document included in the archive listed previously.

# 3 OPENGL EXTENSIONS

Data transfer is enabled by extensions to OpenGL. The `GL_NV_present_video` extension provides a mechanism for the displaying of textures and renderbuffers on the Quadro SDI output. This extension is supported on both Windows and Linux systems. The `WGL_NV_video_out` extension sends pbuffers to the SDI device in the case of Windows while the `GLX_NV_video_out` extension provides the same capabilities on Linux systems. An application must utilize only one of the extensions as the two extensions cannot be used together.

In addition to the OpenGL extensions, other useful extensions include the following:

- `ARB_occlusion_query`
- `EXT_timer_query`
- `EXT_framebuffer_object`
- `ARB_pixel_format`
- `ARB_pbuffer`
- `NV_float_buffer`

**Note:** The `WGL video out` or `GLX video out` OpenGL extensions cannot be utilized with the `GL present video` OpenGL extension. An application must choose and utilize a single programming paradigm.

Additional information on these OpenGL extensions can be found in the extension specifications located at http://developers.nvidia.com or http://www.opengl.org/.

# 4 DEVICE SETUP AND CONTROL

Before graphics data can be transferred to the Quadro SDI for scan out as serial digital video, the video device must be properly configured for the desired video signal format, data format, timing, color space and genlock or framelock synchronization. This hardware configuration is performed by NVAPI on Microsoft Windows-based systems and the `NV-CONTROL X` extension on Linux-based systems. The remainder of this section will describe the step by step process required to configure the video device. For additional information on the functions described, refer to the *NVAPI Online Help* or `NV-CONTROL` extension specification and included files.

## 4.1 INITIALIZE NVAPI

Prior to using NVAPI on Windows, it is necessary to initialize NVAPI. This is done by calling `NvAPI_Initialize()` as shown in the following Code Listing.

### Code Listing 1: Initializing NVAPI

```
// Initialize NVAPI
if (NvAPI_Initialize() != NVAPI_OK) {
      MessageBox(NULL, "Error Initializing NVAPI.", "Error", MB_OK);
      return E_FAIL;
}
```

**Note:** Structures passed to NVAPI functions for returning NVAPI state must be initialized to 0. This is done in the Code Listings in this document by calling memset().

## 4.2 DETERMINING VIDEO CAPABILITES

On Windows, prior to configuring a video device, an application must query the available video I/O topologies and locate a video device with the capability `NVVIOCAPS_VIDOUT_SDI`. The procedure for doing this is outlined in Code Listing 2. Once a video device with the desired capabilities is found, it is important to save the VIO handle as this is the handle that will be passed to other NVAPI VIO functions for configuring and controlling the device.

### Code Listing 2: Locating an SDI Output Device on Windows

```
// Query Available Video I/O Topologies
memset(&l_vioTopos, 0, sizeof(l_vioTopos));
l_vioTopos.version = NVVIOTOPOLOGY_VER;
if (NvAPI_VIO_QueryTopology(&l_vioTopos) != NVAPI_OK) {
      MessageBox(NULL, "Video I/O Unsupported.", "Error", MB_OK);
      return E_FAIL;
}

// Cycle through all SDI topologies looking for the first
// available SDI output device topology.
l_bFound = FALSE;
i = 0;
while ((i < l_vioTopos.vioTotalDeviceCount) && (!l_bFound)) {

      // Get video I/O capabilities for current video I/O target.
      memset(&l_vioCaps, 0, sizeof(l_vioCaps));
      l_vioCaps.version = NVVIOCAPS_VER;
      if (NvAPI_VIO_GetCapabilities(l_vioTopos.vioTarget[i].hVioHandle,
        &l_vioCaps) != NVAPI_OK) {
            MessageBox(NULL, "Video I/O Unsupported.", "Error", MB_OK);
            return E_FAIL;
      }

      // If video output device found, save VIO handle and set flag.
      if (l_vioCaps.adapterCaps & NVVIOCAPS_VIDOUT_SDI) {
            m_vioHandle = l_vioTopos.vioTarget[i].hVioHandle;
            m_physicalGPU = l_vioTopologies.vioTarget[i].hPhysicalGpu;
            l_bFound = TRUE;
      } else {
            i++;
      }
} // while i < vioTotalDeviceCount

// If no video output device found, return error.
if (!l_bFound) {
      MessageBox(NULL, "No SDI video output devices found.", "Error",
MB_OK);
      return E_FAIL;
}
```

On Linux, use the `XNVCTRLQueryAttribute` function to query `NV_CTRL_GVO_SUPPORTED` to determine if the X screen supports video output. This call will fail if video output is not supported on the current X screen, or if the video output is already in use by the desktop or another application.

### Code Listing 3: Using NV_CONTROL-X Extension to Query Video Output Capabilities

```
If (!XNVCTRLQueryAttribute(dpy, screen, 0,
                           NV_CTRL_GVO_SUPPORTED, &value)) {
      return FALSE;
} else {
      return TRUE;
}
```

## 4.3 OPENING THE VIDEO DEVICE

Once the availability of a SDI video output device has been confirmed, the next step is to open the video device by calling `NvAPI_VIO_Open()`. This is demonstrated in Code Listing 4. In this example, `NVVIOCLASS_SDI` indicates that the device is an SDI device while `NVVIOOWNERTYPE_APPLICATION` indicates that the device will be controlled by an application rather than the desktop or NVIDIA control panel.

### Code Listing 4: Opening the Video Device

```
// Open the video output device.
if (NvAPI_VIO_Open(m_vioHandle, NVVIOCLASS_SDI,
                   NVVIOOWNERTYPE_APPLICATION) != NVAPI_OK) {
      MessageBox(NULL, "Cannot open SDI output device.", "Error",
                   MB_OK);
      return E_FAIL;
}
```

# 4.4 CONFIGURING THE VIDEO DEVICE

After opening a video device, the device must be configured for the desired video output mode, format, timing, color space, genlock or frame lock characteristics and any other required video parameters. Code Listing 5 shows a simple example of device configuration for RGBA 4:4:4:4 input and 1080i YCrCbA 4:2:2:4 video output with composite tri-level sync.

**Note:** On the Quadro SDI products, because both the analog and digital SDI sync share a common BNC connector, the sync source (analog or SDI) must be specified, before the incoming signal format can be detected.

## Code Listing 5: Configuring a Video Device on Windows

```
NVVIOCONFIG l_vioConfig;
l_vioConfig.version = NVVIOCONFIG_VER;
l_vioConfig.nvvioConfigType = NVVIOCONFIGTYPE_OUT;
l_vioConfig.fields = NVVIOCONFIG_SIGNALFORMAT |
                     NVVIOCONFIG_DATAFORMAT |
                     NVVIOCONFIG_SYNCSOURCEENABLE |
NVVIOCONFIG_COMPOSITESYNCTYPE;
l_vioConfig.vioConfig.outConfig.signalFormat =
                     NVVIOSIGNALFORMAT_1080I_59_94_SMPTE274;
l_vioConfig.vioConfig.outConfig.dataFormat =
                     NVVIODATAFORMAT_R8B8B8A8_TO_YCRCBA4224;
l_vioConfig.vioConfig.outConfig.syncEnable = TRUE;
l_vioConfig.vioConfig.outConfig.syncSource =
                     NVGVOSYNCSOURCE_COMPSYNC;

// Set configuration
l_ret = NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig);
if (l_ret != NVAPI_OK) {
      return E_FAIL;
}

// Configure external sync parameters
NvU32 l_wait;
NVVIOSTATUS l_vioStatus;
l_vioConfig.fields = 0; // reset fields

// Trigger redetection of sync format
if (NvAPI_VIO_SyncFormatDetect(m_vioHandle, &l_wait)!= NVAPI_OK) {
      return E_FAIL;
}

// Wait for sync detection to complete
Sleep(l_wait);

// Get sync signal format
l_vioStatus.version = NVVIOSTATUS_VER;
```

```
if (NvAPI_VIO_Status(m_vioHandle, &l_vioStatus) != NVAPI_OK) {
      return E_FAIL;
}

// Verify that incoming sync is compatible with outgoing signal
if (frameLock) {
      if (l_vioStatus.vioStatus.outStatus.syncFormat !=
            l_vioConfig.vioConfig.outConfig.signalFormat) {
            return E_FAIL;
      }
      l_vioConfig.vioConfig.outConfig.frameLockEnable = FALSE;
      l_vioConfig.fields |= NVVIOCONFIG_FRAMELOCKENABLE;
} else {  // Framelock Case
      NvU32 l_compatible;
      if (NvAPI_VIO_IsFrameLockModeCompatible(m_vioHandle,
                        l_vioStatus.vioStatus.outStatus.syncFormat,
                        l_vioConfig.vioConfig.outConfig.signalFormat,
                        &l_compatible) != NVAPI_OK) {
            return E_FAIL;
      }

      if (l_compatible) {
            l_vioConfig.vioConfig.outConfig.frameLockEnable =
                     TRUE;
            l_vioConfig.fields |= NVVIOCONFIG_FRAMELOCKENABLE;
      } else {
            return E_FAIL;
      }
}

l_vioConfig.vioConfig.outConfig.syncEnable =
                        l_vioStatus.vioStatus.outStatus.syncEnable;
l_vioConfig.vioConfig.outConfig.syncSource =
                        l_vioStatus.vioStatus.outStatus.syncSource;

switch(l_vioStatus.vioStatus.outStatus.syncSource) {
      case NVVIOSYNCSOURCE_SDISYNC:
            l_vioConfig.fields |= NVVIOCONFIG_SYNCSOURCEENABLE;
            break;
      case NVVIOSYNCSOURCE_COMPSYNC:
            l_vioConfig.vioConfig.outConfig.compositeSyncType =
                        NVVIOCOMPSYNCTYPE_AUTO;
            l_gvoConfig.fields |=
                   (NVVIOCONFIG_SYNCSOURCEENABLE |
                    NVVIOCONFIG_COMPOSITESYNCTYPE);
            break;
} // switch

// Sync delay
NVVIOSYNCDELAY l_vioSyncDelay;
memset(&l_vioSyncDelay, 0, sizeof(l_vioSyncDelay));
l_vioSyncDelay.version = NVVIOSYNCDELAY_VER;
```

```
l_vioSyncDelay.horizontalDelay = hDelay;
l_vioSyncDelay.verticalDelay = vDelay;
l_vioConfig.fields |= NVVIOCONFIG_SYNCDELAY;
l_vioConfig.vioConfig.outConfig.syncDelay = l_gvoSyncDelay;

// Setup external sync
if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig) != NVAPI_OK) {
      return E_FAIL;
}
```

On Linux, the video device is configured using `XNVCTRLSetAttribute`. The following example configures the video device for RGBA 4:4:4:4 input and 1080i YCrCbA 4:2:2:4 video output with composite tri-level sync.

## Code Listing 6: Configuring a Video Device on Linux

```
screen = DefaultScreen(dpy);

// Set video signal format
XNVCTRLSetAttribute(dpy, screen, 0,
                  NV_CTRL_GVO_OUTPUT_VIDEO_FORMAT,
                  NV_CTRL_GVO_VIDEO_FORMAT_1080I_59_94_SMPTE274);

// Set video data format
XNVCTRLSetAttribute(dpy, screen, 0,
                  NV_CTRL_GVO_DATA_FORMAT,
                  NV_CTRL_GVO_DATA_FORMAT_R8G8B8A8_TO_YCRCBA4224);

// Enable genlock
XNVCTRLSetAttribute(dpy, screen, 0,
                  NV_CTRL_GVO_SYNC_MODE,
                  NV_CTRL_GVO_SYNC_MODE_GENLOCK);

// Set sync type to composite.
XNVCTRLSetAttribute(dpy, screen, 0,
                  NV_CTRL_GVO_SYNC_SOURCE,
                  NV_CTRL_GVO_SYNC_SOURCE_COMPOSITE);

XFlush(dpy);

// Sleep to allow time for sync detection
sleep(2);

// Detect input sync.
XNVCTRLQueryAttribute(dpy, screen, 0,
                           NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECTED,
                           &val);

// If valid sync detected, query input video format.
If (val) {
XNVCTRLQueryAttribute(dpy, screen
                            NV_CTRL_GVO_INPUT_VIDEO_FORMAT
```

```
                                    &val);
}
```

# 5 DATA TRANSFER

In programmable mode, the source for video output data is rendered into an 8-bit integer or 16-bit floating point frame buffer object (FBO) or pbuffer render target. For 10-bit or 12-bit video output, a 16-bit per-component floating-point render target must be utilized. For 8-bit output, either an 8-bit integer or 16-bit floating-point per-component render target may be used. An application may utilize a single render target or multiple render targets configured in a ring buffer in order to send data to a single video device. In order to send data to multiple video devices, multiple render targets are required.

This section describes the steps required to setup the render targets into which the application should render OpenGL. An application should use either frame buffer objects or pbuffers for data transfer and not combine the two techniques.

## 5.1 GPU SELECTION

In system configurations where there are multiple output device/GPU pairs present it is important to make sure that the GPU and the output card that's connected to that GPU are addressed when configuring and using the output.

To do that the NvAPI/NVCtrl selection of the GPU should correspond to the OpenGL selection.

On Windows this is done using the GPU affinity extension as illustrated in the following code listing.

### Code Listing 7: Selecting the GPU that is connected to the Output Card on Windows

```
while(wglEnumGpusNV(GPUindex,&GPUHandle)) // First call this
                                  //function to get a handle to the gpu
{
      //get detailed GPU info
      while(wglEnumGpuDevicesNV(GPUHandle,DisplayIdx,&gpuDevice))
      {

      NvAPI_GetAssociatedNvidiaDisplayHandle(gpuDevice.DeviceName,
            &hNvDisplay);
      NvAPI_GetPhysicalGPUsFromDisplay(hNvDisplay,&hNvPhysicalGPU,
            &count);
      if(m_hPhysicalGpu == hNvPhysicalGPU)
      {
            //save the GPU affinity GPU handle to use
            // for creating the OpenGL context
            m_gpuHandle = GPUHandle;
            break;
      }
      …
}
//Now an OpenGL context can be created
HGPUNV handles[2];
handles[0] = hGpu;
handles[1] = NULL;
// Create Affinity context
hDC = wglCreateAffinityDCNV(handles);
setPixelFormat(hDC);
// Create rendering context from the affinity device context
hRC = wglCreateContext(hDC);
// Make the affinity context current
wglMakeCurrent(hDC, hRC);
```

On Linux things are much simpler since all the important `NVCtrl X` extension calls and the GLX context creating call are already using an X screen as one of the parameters.

## 5.2 BUFFER OBJECT INITIALIZATION

Use of the `GL_NV_present_video` extension to send GPU rendered content to the SDI device requires the use of one or more buffer objects. These buffer objects can be texture objects or renderbuffers bound to one or more frame buffer objects (FBOs). Creation of an FBO with a texture or render buffer attachment is demonstrated in Code Listing 8.

## Code Listing 8: Configuring a Frame Buffer Object

```
GLuint fboId;
GLuit textureObject;
GLuint renderbufferIds[2];
glGenRenderbuffersEXT(numRenderbuffers, renderbufferIds);

glBindRenderbufferEXT(GL_RENDERBUFFER_EXT, renderbufferIds[0]);

glRenderbufferStorageEXT(GL_RENDERBUFFER_EXT, GL_RGBA8,
                              width, height);

if (depth) {
         glBindRenderbufferEXT(GL_RENDERBUFFER_EXT,
                               renderbufferIds[1]);

         glRenderbufferStorageEXT(GL_RENDERBUFFER_EXT,
                                  GL_DEPTH_COMPONENT,
                                  width, height);
}

glGenFramebuffersEXT(1, &fboId);

glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, fboId);

if (!textureObject) {
          glFramebufferRenderbufferEXT(GL_FRAMEBUFFER_EXT,
                                       GL_COLOR_ATTACHMENT0_EXT,
                                       GL_RENDERBUFFER_EXT,
                                       renderbufferIds[0]);
} else {
          glBindTexture(GL_TEXTURE_RECTANGLE_NV, textureObject);
          glFramebufferTexture2DEXT(GL_FRAMEBUFFER_EXT,
                                    GL_COLOR_ATTACHMENT0_EXT,
                                     GL_TEXTURE_RECTANGLE_NV,
                                    textureObject, 0 );
}

if (depth) {
         glFramebufferRenderbufferEXT(GL_FRAMEBUFFER_EXT,
                                      GL_DEPTH_ATTACHMENT_EXT,
                                      GL_RENDERBUFFER_EXT,
                                      renderbufferIds[1]);
}

glBindRenderbufferEXT(GL_RENDERBUFFER_EXT, 0);
glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, 0);
```

Creation of an FBO is identical on both Windows and Linux, and requires only a current OpenGL context. In the previous code listing example, when a texture object is specified, it is attached as `COLOR_ATTACHMENT0`, otherwise, a renderbuffer is used. For more information on FBO creation and usage, refer to the `GL_EXT_framebuffer_object` specification.
In order for an application to render into an FBO render target, the target must first be bound using the command in Code Listing 9.

## Code Listing 9: Configuring a Frame Buffer Object

```
glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, fboId);
```

Either before or after buffer object creation, the SDI video device must be bound in OpenGL. The procedure for enumerating the available video devices and binding one of them is outlined in Code Listing 10.

## Code Listing 10: Binding a Video Device

```
// Enumerate the available video devices and
// bind to the first one found
HVIDEOOUTPUTDEVICENV *videoDevices;

// Get list of available video devices.
int numDevices = wglEnumerateVideoDevicesNV(ghWinDC, NULL);

if (numDevices <= 0) {
        MessageBox(NULL, "wglEnumerateVideoDevicesNV() did not return
any devices.", "Error", MB_OK);
        exit(1);
}

videoDevices = (HVIDEOOUTPUTDEVICENV *)malloc(numDevices *
                                        sizeof(HVIDEOOUTPUTDEVICENV));

if (!videoDevices) {
        fprintf(stderr, "malloc failed.  OOM?");
        exit(1);
}

if (numDevices != wglEnumerateVideoDevicesNV(ghWinDC,
                                                videoDevices)) {
        free(videoDevices);
        MessageBox(NULL, "Invonsistent results from
                    wglEnumerateVideoDevicesNV()", "Error", MB_OK);
        exit(1);
}

//Bind the first device found.
if (!wglBindVideoDeviceNV(ghWinDC, 1, videoDevices[0], NULL)) {
   free(videoDevices);
```

```
        MessageBox(NULL, "Failed to bind a videoDevice to slot 0.\n",
                   "Error", MB_OK);
            exit(1);
}

// Free list of available video devices, don't need it anymore.
free(videoDevices);
```

## 5.3 PBUFFER INITIALIZATION

On Windows, the first step in the initialization of the pbuffer is to use the function `wglChoosePixelFormatARB()` to choose a compatible pixel format. For Quadro SDI video output from a pbuffer render target, the list of attributes specified as the second argument to this function must include `WGL_DRAW_TO_PBUFFER` as well as one of `WGL_BIND_TO_VIDEO_RGB_NV`, `WGL_BIND_TO_VIDEO_RGBA_NV`, or `WGL_BIND_TO_VIDEO_RGB_AND_DEPTH_NV`. Code Listing 11 and Code Listing 12 illustrate this procedure for both the 8-bit and 16-bit cases.

**Note:** In the 16-bit floating point per-component case, `WGL_FLOAT_COMPONENTS_NV` must also be specified in the attribute list.

### Code Listing 11: Choosing an 8-bit Pixel Format

```
int format = 0;
int nformats = 0;
int attribList = {
            WGL_RED_BITS_ARB, 8,
            WGL_GREEN_BITS_ARB, 8,
            WGL_BLUE_BITS_ARB, 8,
            WGL_ALPHA_BITS_ARB, 8,
            WGL_STENCIL_BITS_ARB, 8,
            WGL_DEPTH_BITS_ARB, 24,
            WGL_DRAW_TO_PBUFFER_ARB, true,
            WGL_BIND_TO_VIDEO_RGBA_NV, true,
            0 };

wglChoosePixelFormatARB(hDC, attribList, 1, &format, &nformats);
```

## Code Listing 12: Choosing a 16-bit Floating Point Pixel Format

```
int format = 0;
int nformats = 0;
int attribList = {
            WGL_RED_BITS_ARB, 16,
            WGL_GREEN_BITS_ARB, 16,
            WGL_BLUE_BITS_ARB, 16,
            WGL_ALPHA_BITS_ARB, 16,
            WGL_STENCIL_BITS_ARB, 8,
            WGL_DEPTH_BITS_ARB, 24,
            WGL_DRAW_TO_PBUFFER_ARB, true,
            WGL_BIND_TO_VIDEO_RGBA_NV, true,
            WGL_FLOAT_COMPONENTS_NV, true,
            0}

wglChoosePixelFormat(hDC, attribList, 1, &format, &nformats);
```

Once an available pixel format that meets the requirements has been specified, a pbuffer can be created using the `wglCreatePbufferARB()` function. For video output, the attribute list specified as the final argument must contain one of `WGL_BIND_TO_VIDEO_RGB_NV`, `WGL_BIND_TO_VIDEO_RGBA_NV`, or `WGL_BIND_TO_VIDEO_RGB_AND_DEPTH_NV`. Code Listing 13 demonstrates pbuffer creation.

## Code Listing 13: Creating a Pbuffer

```
attribList[0] = WGL_BIND_TO_VIDEO_RGBA_NV;
attribList[1] = true;
attribList[2] = 0;

hPbuf = wglCreatePbufferARB(hDC, format, width, height,
                            attribList);
```

Once one or more pbuffers has been created using the above procedure, each of these pbuffers must be bound to the video device so that subsequent OpenGL rendering is sent to the video output device. Prior to binding however, it is necessary to identify the video devices available using the `wglGetVideoDeviceNV()` function from the `WGL_NV_video_out` extension.

## Code Listing 14: Get Video Devices Available on the System

```
HPVIDEODEV hpDevList;

if ((wglGetVideoDeviceNV(hDC, 1, &hpDevList) != GL_NOERROR) {

      // Handle error.
}
```

Once a video device has been identified, bind the application pbuffers using the `wglBindVideoImageNV()` command. The final argument to this function must be one of `WGL_VIDEO_OUT_COLOR_NV`, `WGL_VIDEO_OUT_ALPHA_NV`, `WGL_VIDEO_OUT_COLOR_AND_ALPHA_NV` or `WGL_VIDEO_OUT_COLOR_AND_DEPTH._NV`. This argument specifies the data within the pbuffer that will ultimately get transferred to the video out device. In Code Listing 15, the color and alpha portions of the pbuffer specified by `hPbuf` are bound to the video device.

## Code Listing 15: Binding a Pbuffer to a Video Device

```
if ((wglBindVideoImageNV(hpDevList, hPbuf,
      WGL_VIDEO_OUT_COLOR_AND_ALPHA) != GL_NOERROR) {

      // Handle error.
}
```

On Linux, a pbuffer is created using a combination of `glxChooseFBConfig()` to choose compatible frame buffer configurations and `glXCreatePbuffer()` to create a pbuffer of the width and height required. This process for both an 8-bit integer and a 16-bit floating point pbuffer is outlined in Code Listing 16 and Code Listing 17.

**Note:** Once `glXChooseFBConfig` returns the list of compatible frame buffer configurations, an application must traverse the list to find a configuration of the desired color depth.

## Code Listing 16: Creating an 8-bit Pbuffer on Linux

```
GLXFBConfig *configs, config;
int nelements;
int config_list[] = { GLX_DRAWABLE_TYPE, GLX_PBUFFER_BIT,
                      GLX_ALPHA_SIZE, 8,
                      GLX_DOUBLE_BUFFER, GL_TRUE,
                      GLX_RENDER_TYPE, GLX_RGBA_BIT,
                      None };
int pbuffer_list[8];

configs = glXChooseFBConfig(dpy, 0, config_list, &nelements);

// Find a config with the right number of color bits.
for (i = 0; i < nelements; i++) {
```

```
      int attr;
      if (glXGetFBConfigAttrib(dpy, configs[i],
                               GLX_RED_SIZE, &attr)) {
      // Handle error
      }

      if (attr != 8)
              continue;

      if (glXGetFBConfigAttrib(dpy, configs[i],
                              GLX_GREEN_SIZE, &attr)) {
            // Handle error
      }

      if (attr != 8)
            continue;

      if (glXGetFBConfigAttrib(dpy, configs[i],
                              GLX_BLUE_SIZE, &attr)) {
           // Handle error
      }

      if (attr != 8)
            continue;

      if (glXGetFBConfigAttrib(dpy, configs[i],
                               GLX_ALPHA_SIZE, &attr)) {
           // Handle error

      if (attr != 8)
              continue;

      break;
}

if (i == nelements) {
          printf("No 8-bit FBConfigs found\n");
          return -1;
}

// Config found
config = configs[i];

// Don't need the config list anymore so free it.
XFree(configs);
configs = NULL;

pbuffer_list[0] = GLX_PBUFFER_WIDTH;
pbuffer_list[1] = gWidth;
pbuffer_list[2] = GLX_PBUFFER_HEIGHT;
pbuffer_list[3] = gHeight;
```

```
pbuffer_list[4] = None;

pbuffer = glXCreatePbuffer(dpy, config, pbuffer_list);

// Create rendering context for GLX_RGBA_TYPE pbuffer.
context = glXCreateNewContext(dpy, config,
                              GLX_RGBA_TYPE, 0, True);
```

## Code Listing 17: Creating a 16-bit Floating Point Pbuffer on Linux

```
GLXFBConfig *configs, config;
int nelements;
int config_list[] = { GLX_DRAWABLE_BIT, GLX_PBUFFER_BIT,
                      GLX_DOUBLEBUFFER, GL_TRUE,
                      GLX_RENDER_TYPE, GLX_RGBA_FLOAT_BIT_ARB,
                      GLX_RED_SIZE, 16,
                      GLX_GREEN_SIZE, 16,
                      GLX_BLUE_SIZE, 16,
                      None };
int pbuffer_list[8];

configs = glXChooseFBConfig(dpy, 0, config_list, &nelements);

// Find a config with the right number of color bits.
for (i = 0; i < nelements; i++) {

      int attr;
      if (glXGetFBConfigAttrib(dpy, configs[i],
                               GLX_RED_SIZE, &attr)) {
            // Handle error
      }

      if (attr != 16)
            continue;

      if (glXGetFBConfigAttrib(dpy, configs[i],
                                    GLX_GREEN_SIZE, &attr)) {
            // Handle error
      }

      if (attr != 16)
            continue;

      if (glXGetFBConfigAttrib(dpy, configs[i],
                                    GLX_BLUE_SIZE, &attr)) {
            // Handle error
      }

      if (attr != 16)
            continue;
```

```
      if (glXGetFBConfigAttrib(dpy, configs[i],
                               GLX_ALPHA_SIZE, &attr)) {
            // Handle error
      }

      if (attr != 16)
            continue;

      break;
}

if (i == nelements) {
      printf("No 16-bit FBConfigs found\n");
      return -1;
}

// Config found
config = configs[i];

// Don't need the config list anymore so free it.
XFree(configs);
configs = NULL;


pbuffer_list[0] = GLX_PBUFFER_WIDTH;
pbuffer_list[1] = gWidth;
pbuffer_list[2] = GLX_PBUFFER_HEIGHT;
pbuffer_list[3] = gHeight;
pbuffer_list[4] = None;

// Create pbuffer
pbuffer = glXCreatePbuffer(dpy, config, pbuffer_list);

// Create rendering context for GLX_RGBA_FLOAT_TYPE_ARB pbuffer.
context = glXCreateNewContext(dpy, config,
                              GLX_RGBA_FLOAT_TYPE_ARB, 0, True);
```

**Note:** Checking the proper color depth of the chosen FBConfig is required as glXChooseFBConfig in recent Linux drivers returns deeper FBConfigs at the beginning of the resulting list. As a result 32-bit FBConfigs appear earlier in the list than FP16 or 8-bit integer configs. The change was made to bring the behavior of glXChooseFBConfig inline with the specification.

After creating one or more pbuffers using the procedure described in Code Listing 17, each of these pbuffers must be bound to the video device so that subsequent OpenGL rendering into that pbuffer is sent to the video output device. Prior to binding the pbuffer however, it is necessary to identify the video devices available using the `glXGetVideoDeviceNV()` function from the `GLX_NV_video_out` extension.

## Code Listing 18: Getting Video Devices Available on a Linux System

```
GLXVideoDeviceNV video_device;

if (glXGetVideoDeviceNV(dpy, 0, 1, &video_device) {
    // Handle error.
}
```

Once a video device has been identified, bind the application pbuffers using the `glXBindVideoImageNV()` command. The final argument to this function must be one of `GLX_VIDEO_OUT_COLOR_NV`, `GLX_VIDEO_OUT_ALPHA_NV`, `GLX_VIDEO_OUT_COLOR_AND_ALPHA_NV` or `GLX_VIDEO_OUT_COLOR_AND_DEPTH_NV`. This argument specifies the data within the pbuffer that will ultimately get transferred to the video out device. In Code Listing 19, the color and alpha portions of the pbuffer specified by `hPbuf` are bound to the video device.

## Code Listing 19: Binding a Pbuffer to a Linux Video Device

```
if (glXBindVideoImageNV(dpy, video_device,
                        pbuffer, GLX_VIDEO_OUT_COLOR_NV)) {
    // Handle error.
}
```

Once the pbuffers are bound to the video device, video transfers can be started as described in *Starting Video Transfers*. The procedure for sending frames/fields of data to the device is described in the section entitled *Sending FBO Data and Sending Pbuffer Data*.

## 5.4 STARTING VIDEO TRANSFERS

Once a video device has been configured, and the OpenGL pbuffer(s) required for data transfer have been allocated and bound to the device, the next step is to commence video transfers. This step is only required on Windows. The code to do this is listed in Code Listing 20.

### Code Listing 20: Starting VideoTransfers

```
if (( m_vioHandle ) && !(NvAPI_VIO_IsRunning(m_vioHandle))){
      if ( NvAPI_VIO_Start( m_vioHandle ) != NVAPI_OK ) {
            MessageBox(NULL, "Error starting video devices.",
                              "Error", MB_OK);
            return E_FAIL;
      }
}
```

## 5.5 SENDING FBO DATA

Once GPU rendering is complete, the contents of the render buffer or texture objects is queued to the SDI video device with either the `glPresentFrameKeyedNV()` or `glPresentFrameDualFillNV()` functions.

```
void glPresentFrameKeyedNV(uint video_slot,
                           uint64EXT minPresentTime,
                           uint beginPresentTimeId,
                           uint presentDurationId,
                           enum type,
                           enum target0, uint fill0, uint key0,
                           enum target1, uint fill1, uint key1);
```

`glPresentFrameKeyedNV` should be utilized to display single- or dual-link fill or fill and key data. The `video_slot` parameter specifies the video output slot in the current rendering context on which this frame should be presented. The value of `minPresentTime` should be set to either the earliest time in nanoseconds that the frame should become visible on the SDI output, or the special value of 0 which indicates that the frame should be presented at the next vertical retrace.

Frame presentation is always queued until the vertical blanking period of the SDI device. At that time, the SDI device will display the:

- Last presented frame if there are no additional frames queued to present.
- Next frame in the queue with the minimum presentation time of 0.
- The last frame in the queue that has a minimum presentation time past the current time.

Queued frames are always consumed in the order in which they were sent. Any consumed frames not displayed are discarded.

The values of `beginPresentTimeId` and `presentDurationId` represent valid query objects. These should be utilized to query the time at which the frame is displayed on the SDI device and the number of vertical retrace intervals that the frame was presented. Use of these query objects will be discussed in more detail in Section 8.1.2. These values should be set to 0 if they are unused.

The parameter type indicates the type of data to be displayed. Valid values for type are `GL_FIELDS_NV` and `GL_FRAME_NV. When GL_FIELDS_NV` is specified, both fields must be specified by target0, fill0, key0, target1, fill1 and key1 in order to complete the frame. In the case of `GL_FRAME_NV`, only target0, fill0 and key0 should be utilized to specify the frame data.

The parameters target0 and target1 indicate the data object type and can be one of `GL_TEXTURE_2D, GL_TEXTURE_RECTAGLE, GL_RENDERBUFER_EXT` or `GL_NONE`. The values of fill0 and fill1 name the objects of the corresponding type from which the color data will be read while key0 and key1 name the objects from which the key channel data will be read. In the case that there is no key channel data to display, the values of key0 and key1 should be set to `GL_NONE`. In this case, the key data is taken from the alpha channel of the specified fill object. In the case that the type specified is `GL_FRAME_NV`, target1, fill1 and key1 should be specified as `GL_NONE`.

```
void glPresentFrameDualFillNV(uint video_slot,
                              uint64EXT minPresentTime,
                              uint beginPresentTimeId,
                              uint presentDurationId,
                              enum type,
                              enum target0, uint fill0,
                              enum target1, uint fill1,
                              enum target2, uint fill2,
                              enum target3, uint fill3);
```

glPresentFrameDualFillNV() should be utilized to display two channels of single-link fill data. This operating mode is useful for presenting two completely different fill channels or two fill channels in stereo, where one eye is presented on one channel while the other eye is presented on the other SDI channel.

glPresentFrameDualFillNV() operates similarly to PresentFrameKeyedNV() described above. The parameters target0, fill0, target1 and fill1 specify the data for the first SDI channel while target2, fill2, target3 and fill3 specify the data for the second SDI channel. In the case that type is GL_FRAME_NV, only target0, fill0, target2 and fill2 need to be specified with other parameters set to GL_NONE. In the case of GL_FIELDS_NV, all parameters must be utilized to specify the fields for each SDI channel.

The following code examples demonstrate the use of these functions. For more information regarding these functions, please refer to the GL_NV_present_video OpenGL extension specification.

In Code Listing 21, the contents of a texture object is interpreted as a complete frame with the GL_FRAME_NV enum and displayed as both the video fill and key channels.

## Code Listing 21: Sending a Texture Object to the Video Device

```
// Unbind frame buffer object
glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, 0);

// Send texture object to SDI device
glPresentFrameKeyedNV(1, 0,
                      presentTimeID, presentDurationID,
                      GL_FRAME_NV,
                      GL_TEXTURE_RECTANGLE_NV, gTO, 0,
                      GL_NONE, 0, 0);
```

This code example, specifies that the texture object should be displayed on video slot 1 at the next vertical retrace. The query objects presentTimeID and presentDurationID return the time at which the frame is displayed on the SDI device and the number of vertical retrace intervals during which the frame is displayed. These timer query objects can then be utilized to determine if frame has been dropped or duplicated. More information about synchronization and catching irregularities can be found in Section 8.1.2.

Code Listing 22 specifies the fill for two video channels for the case in which the Quadro SDI is configured to display two fill channels rather than a fill and a key channel. In this example, two render buffers containing complete frames are displayed on video slot 1 at the next vertical retrace of the SDI device.

### Code Listing 22: Sending Two Video Fill Channels

```
glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, fbo1Id);
drawPattern1();
glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, 0);

glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, fbo2Id);
drawPattern2();
glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, 0);

glPresentFrameDualFillNV(1, 0, 0, 0, GL_FRAME_NV,
                         GL_RENDERBUFFER_EXT, renderbuffer1Id,
                         GL_NONE, 0,
                         GL_RENDERBUFFER_EXT, renderbuffer2Id,
                         GL_NONE,0);
```

## 5.6 SENDING PBUFFER DATA

On Windows, an application sends graphics data to the video device by rendering frames or fields into a pbuffer and then calling `wglSendPbufferToVideoNV()` to indicate that OpenGL rendering is complete and that the pbuffer is ready to be scanned out by the video device. The call to this function should typically be placed at the end of the application draw loop.

```
BOOL wglSendPbufferToVideoNV (HPBUFFERARB hPbuffer,
                              int iBufferType,
                              unsigned long *pulCounterPbuffer,
                              BOOL bBlock);
```

The parameter `hPbuffer` is the handle of the pbuffer. Both frames and fields can be sent to the video device as indicated by the value of `iBufferType` and the relative size of the pbuffer as outlined in Table 5-1 and Table 5-2.

### Table 5-1. Pbuffer Size = Field

| iBufferType | Pbuffer Size = Field |
|---|---|
| WGL_VIDEO_OUT_FIELD_1 | Field 0 |
| WGL_VIDEO_OUT_FIELD_2 | Field 1 |
| WGL_VIDEO_OUT_FRAME | Half height frame |
| WGL_VIDEO_OUT_STACKED_FIELDS_1_2 | Half height frame |
| WGL_VIDEO_OUT_STACKED_FIELDS_2_1 | Half height frame |

Table 5-2. Pbuffer Size = Frame

| iBufferType | Pbuffer Size = Frame |
|---|---|
| WGL_VIDEO_OUT_FIELD_1 | Even lines to Field 0 |
| WGL_VIDEO_OUT_FIELD_2 | Odd lines to Field 1 |
| WGL_VIDEO_OUT_FRAME | Full frame |
| WGL_VIDEO_OUT_STACKED_FIELDS_1_2 | Upper half to Field 2<br>Bottom half to Field 1 |
| WGL_VIDEO_OUT_STACKED_FIELDS_2_1 | Upper half to Field 1<br>Bottom half to Field 2 |

The parameter `pulCounterPbuffer` returns the count of the pbuffer sent. This value should always increment and can be used to calculate if frames or fields have been dropped or duplicated as described in Section 8.1.1. The value of `bBlock` indicates if the function should queue the pbuffer and return immediately or wait until the pbuffer is actually scanned out by the SDI device. The following example sends a frame of graphics data to the video device.

## Code Listing 23: Sending a Frame of Data to the Video Device

```
if ((wglSendPbufferToVideoNV(hpBuf, WGL_VIDEO_OUT_FRAME,
     &gBufCount, TRUE) != GL_NOERROR) {
      // Handle error.
}
```

In this example, the fourth argument to `wglSendPbufferToVideoNV()` is set to **TRUE** to indicate that this function call should block until video scan out of this frame is complete. This aids in the synchronization of graphics and video in applications that utilize only a single pbuffer.

**Note:** Color data in an 8-bit pbuffer should be integer data in the range of 1 to 256 while data placed by an application into a 16-bit floating point pbuffer should be 16-bit float data in the range of 0 to 1.

On Linux, the procedure of sending a pbuffer containing a field or frame to the video output is identical to that for Windows except for the function used. On Linux, the function `glXSendPbufferToVideoNV()` is utilized as illustrated in the following example.

```
int glXSendPbufferToVideoNV(Display *dpy, GLXPbuffer pbuf,
                            int iBufferType,
                            unsigned long *pulCounterPbuffer,
                            GLboolean bBlock);
```

### Code Listing 24: Sending a Frame of Data to the Linux Video Device

```
glXSendPbufferToVideoNV(dpy, pbuffer,
                        GLX_VIDEO_OUT_FRAME_NV,
                         &gBufCount, GL_FALSE);
```

## 5.7 STOPPING VIDEO TRANSFERS AND CLOSING THE VIDEO DEVICE

On Windows, once an application has completed all video transfers and no longer needs access to a video device, an application should stop sending and release any OpenGL resources prior to closing the device with NVAPI. If the `WGL_video_out` OpenGL extension is in use, the pbuffer and video device should be released as shown in Code Listing 25.

### Code Listing 25: Releasing Bound OpenGL Resources

```
wglReleaseVideoImageNV(gPBuffer.getHandle(),
                        WGL_VIDEO_OUT_COLOR_AND_ALPHA_NV);

wglReleaseVideoDeviceNV(ghpDevList[0]);
```

In the case of the `GL_present_video` extension, no formal releasing of OpenGL resources is required. However, in both cases, once the OpenGL resources are released, then the video device can be stopped and closed as shown in Code Listing 26.

### Code Listing 26: Closing the Video Device on Windows

```
if ( m_vioHandle ) {
      NvAPI_VIO_Close(m_vioHandle);
}
```

On Linux there are no requirements within the `CONTROL-X` extension to stop video transfers and close the device. However, one must unbind any associated pbuffers and release the video device using the appropriate `GLX_NV_video_out` functions, prior to deleting the pbuffers. This is outlined Code Listing 27.

## Code Listing 27: Releasing Bound OpenGL Resources on Linux

```
glXReleaseVideoImageNV(dpy, pbuffer);

glXReleaseVideoDeviceNV(dpy, 0, video_device);

glXDestroyPbuffer(dpy, pbuffer);
```

# 6 ANCILLARY DATA

Ancillary data can be sent to the Quadro SDI device by using the NVIDIA SDI Ancillary Data API. This API is defined in `ANCapi.h` in the SDK include directory. Applications designed for the Microsoft Windows operating system must statically link against `ANCapi.lib`. to utilize the ancillary data API. Linux application must link with `libanc.a`. The library files can be found in the appropriate lib folder in the SDK. Since the API is shared between Windows and Linux the details described in the remainder of this chapter apply to both operating systems except where noted.

## 6.1 GETTING STARTED

Prior to sending ancillary data to the SDI device, the ancillary data API must be initialized. This must be done after the OpenGL initialization of the SDI device. Initialization is performed by calling the `NvVIOANCAPI_InitializeGVO` function.

### Code Listing 28: Initializing Ancillary Data API on Windows

```
// Initialize ANC API
if (NvVIOANCAPI_InitializeGVO(gSDIout.getHandle()) != NVAPI_OK) {
      return E_FAIL;
}
```

### Code Listing 29: Initializing Ancillary Data API on Linux

```
// Initialize ANC API
if (NvVIOANCAPI_InitializeGVO(dpy, screen) == NVAPI_OK){
   init = 1;
}
```

## 6.2 BASICS

Ancillary data is sent do the Quadro SDI device per frame by filling in the corresponding fields in the following structure and setting the fields mask to indicate those fields with valid data to be sent.

```
// Per Frame
typedef struct tagNVVIOANCDATAFRAME {
      NvU32 version;              // Structure version
      NvU32 fields;               // Field mask
      NVVIOANCAUDIOGROUP  AudioGroup1; // Audio group 1
      NVVIOANCAUDIOGROUP  AudioGroup2; // Audio group 2
      NVVIOANCAUDIOGROUP  AudioGroup3; // Audio group 3
      NVVIOANCAUDIOGROUP  AudioGroup4; // Audio group 4
      NvU32 LTCTimecode;          // RP188
      NvU32 LTCUserBytes;
      NvU32 VITCTimecode;
      NvU32 VITCUserBytes;
      NvU32 FilmTimecode;
      NvU32 FilmUserBytes;
      NvU32 ProductionTimecode;    // RP201
      NvU32 ProductionUserBytes;   // RP201
      NvU32 FrameID;
      NvU32 numCustomPackets;
      NVVIOANCDATAPACKET *CustomPackets;
} NVVIOANCDATAFRAME;
```

Once the ancillary data for a frame has been placed into the structure it is sent to the SDI device with the `NvVIOANCAPI_SendANCData()` function as shown in the Code Listing 30.

**Note**: As of Release 3.2 of the NVIDIA Quadro SDI SDK, only VITC and custom data packets are supported by the ancillary data API.

### Code Listing 30: Sending Ancillary Data to the SDI Device

```
// Send ANC data
NvVIOANCAPI_SendANCData(NULL, &ancData);
```

This call should be made by an application prior to call `glPresentFrameKeyed()` or `glPresentFrameDualFill()`.

# 6.3 TIME CODE

The following code example shows how an application can send VITC time code as defined by SMPTE 12M-1999 to the SDI device. The time code data as well as relevant bit flags are packed into the 32-bit `VITCTimecode` field as documented and demonstrated in the following code example.

## Code Listing 31: Specifying Time Code Data

```
NVVIOANCDATAFRAME ancData = {0};

static int counter = 0;

// Set field mask
ancData.version = NVVIOANCDATAFRAME_VERSION;
ancData.fields = NVVIOANCDATAFRAME_VITC;

// Generate timecode here
int frameTens = myTimeCode.frame() / 10;
int frameUnits = myTimeCode.frame() % 10;
int secondTens = myTimeCode.second() / 10;
int secondUnits = myTimeCode.second() % 10;
int minuteTens = myTimeCode.minute() / 10;
int minuteUnits = myTimeCode.minute() % 10;
int hourTens = myTimeCode.hour() / 10;
int hourUnits = myTimeCode.hour() % 10;

// Set relevant bits here
short dropFrame = 1;
short colorFrame = 1;
short fieldPhase = 0;
short bg0 = 1;
short bg1 = 0;
short bg2 = 1;
// Per SMPTE 12M-1999, shift values to the appropriate
// bit positions.
//
// Bit  Assigment         60-field TV  50-field TV  24-frame Film
// ---  ----------------  -----------  -----------  -------------
// 0    Frame Units  (1)
// 1    Frame Units  (2)
// 2    Frame Units  (4)
// 3    Frame Units  (8)
// 4    Frame Tens   (1)
// 5    Frame Tens   (2)
// 6    Flag               Drop Frame   Unused       Unused
// 7    Flag               Color Frame  Color Frame  Unused
// 8    Second Units (1)
// 9    Second Units (2)
// 10   Second Units (4)
// 11   Second Units (8)
```

```
// 12   Second Tens  (1)
// 13   Second Tens  (2)
// 14   Second Tens  (4)
// 15   Flag              Field/Phase  Binary Group 0 Phase
// 16   Minute Units  (1)
// 17   Minute Units  (2)
// 18   Minute Units  (4)
// 19   Minute Units  (8)
// 20   Minute Tens   (1)
// 21   Minute Tens   (2)
// 22   Minute Tens   (4)
// 23   Flag               Binary Group 0 Binary Group 2 Binary Group
0
// 24   Hours Units   (1)
// 25   Hours Units   (2)
// 26   Hours Units   (4)
// 27   Hours Units   (8)
// 28   Hours Tens    (1)
// 29   Hours Tens    (2)
// 30   Flag               Binary Group 1  Binary Group 1 Binary Group
1
// 31   Flag               Binary Group 2  Field/Phase Binary Group 2

// For example only, not all bits are relevant for all signal
// formats.
ancData.VITCTimecode = hourTens << 29 | hourUnits << 25 |
                       minuteTens << 20 | minuteUnits << 16 |
                       secondTens << 12 | secondUnits << 8 |
                       frameTens << 4 | frameUnits;
ancData.VITCTimecode |= dropFrame << 6;
ancData.VITCTimecode |= colorFrame << 7;
ancData.VITCTimecode |= fieldPhase << 15;
ancData.VITCTimecode |= bg0 << 23;
ancData.VITCTimecode |= bg1 << 30;
ancData.VITCTimecode |= bg2 << 31;
```

## 6.4 AUDIO

Audio data is sent to the Quadro SDI output device as raw PCM audio samples package into ancillary data packets according to the SMPTE 272M specification for standard definition video signal formats or the SMPTE 299M specification for high definition video signal formats. The Quadro SDI output devices supports up to 16 channels of 24-bit audio at 48 KHz.

### 6.4.1 SMPTE 272M – Standard Definition Audio

In the case of standard definition audio data, SMPTE 272M places up to 20-bits of audio data along with the block sync (Z), validity (V), user (U), channel (C), and parity (P) bits into a 32-bit AES subframe. The API requires that the 20-bit audio data and associated bits also be packed into 32-bits as illustrated Code Listing 32.

Code Listing 32: Formatting SMPTE 272M Audio Data

```
// SD Audio should be split across 3 ANC words like so:
//
// X:
//    b9       - !b8 (Computed by HW)
//    b8 (b8)  - aud 5
//    b7 (b7)  - aud 4
//    b6 (b6)  - aud 3
//    b5 (b5)  - aud 2
//    b4 (b4)  - aud 1
//    b3 (b3)  - aud 0 (LSB)
//    b2 (b2)  - ch1  00 = channel 1, 01 = channel 2,
//    b1 (b1)  - ch0  10 = channel 3, 11 = channel 4
//    b0 (b0)  - Z
//
// X+1:
//    b9       - !b8 (Computed by FPGA)
//    b8 (b17) - aud 14
//    b7 (b16) - aud 13
//    b6 (b15) - aud 12
//    b5 (b14) - aud 11
//    b4 (b13) - aud 10
//    b3 (b12) - aud 9
//    b2 (b11) - aud 8
//    b1 (b10) - aud 7
//    b0 (b9)  - aud 6
//
// X+2:
//    b9       - !b8 (Computed by FPGA)
//    b8 (b26) - P - Parity for bits 0-25 of sample.
//    b7 (b25) - C - Channel status bit.
//    b6 (b24) - U - User bit.
//    b5 (b23) - V - Sample validity bit.
//    b4 (b22) - aud 19 (MSB)
//    b3 (b21) - aud 18
//    b2 (b20) - aud 17
//    b1 (b19) - aud 16
//    b0 (b18) - aud 15
//        ^
//        `- bit order in 'sample'

// XXX Since we use a 16 bit audio source here
//     (input is NvU16), move the 16 bits into
//     the upper part of the audio data's 20 bits.
```

```
sample = ((C & 0x1) << 25) | // AES channel status (C) bit
         ((U & 0x1) << 24) | // AES user data (U) bit
         ((V & 0x1) << 23) | // AES sample validity (V) bit
         ((((NvU32)(*input)) & 0xffff) << 7); // AES sample data

// Add Z / block sync
if (curFrame == 0) {
    sample |= (0x1 <<  0);  // AES block sync (Z bit)
}
```

The channel numbers are added and the 26-bit even parity are computed by the Quadro SDI output device prior to embedding the audio data into the Quadro SDI output stream.

## 6.4.2 SMPTE 299M – High Definition Audio

SMPTE 299M specifies that up to 24-bits of audio data along with the block sync (Z), validity (V), user (U), and channel (C) as well as parity (P) bits be packed into four 10-bit ancillary data words. The API requires that this audio data and related bits sans the parity bits be packaged into a single 32-bit value for passing to the Quadro SDI output device. The parity bits are computed by the Quadro SDI output device. This packaging is shown in Code Listing 33.

### Code Listing 33: Formatting SMPTE 299M Audio Data

```
// HD Audio should be split across 4 ANC words like so:
//
// UDWx:
//    b9       - !b8 (Computed by HW)
//    b8       - Even parity of b0-b7 (Computed by HW)
//    b7 (b7)  - aud 3
//    b6 (b6)  - aud 2
//    b5 (b5)  - aud 1
//    b4 (b4)  - aud 0 (LSB)
//    b3 (b3)  - Z
//    b2 (b2)  - 0
//    b1 (b1)  - 0
//    b0 (b0)  - 0
//
// UDWx+1:
//    b9       - !b8 (Computed by HW)
//    b8       - Even parity of b0-b7 (Computed by HW)
//    b7 (b15) - aud 11
//    b6 (b14) - aud 10
//    b5 (b13) - aud 9
//    b4 (b12) - aud 8
//    b3 (b11) - aud 7
//    b2 (b10) - aud 6
//    b1 (b9)  - aud 5
//    b0 (b8)  - aud 4
//
```

```
// UDWx+2:
//    b9       - !b8 (Computed by HW)
//    b8       - Even parity of b0-b7 (Computed by HW)
//    b7 (b23) - aud 19
//    b6 (b22) - aud 18
//    b5 (b21) - aud 17
//    b4 (b20) - aud 16
//    b3 (b19) - aud 15
//    b2 (b18) - aud 14
//    b1 (b17) - aud 13
//    b0 (b16) - aud 12
//
// UDWx+3:
//    b9       - !b8 (Computed by HW)
//    b8       - Even parity of b0-b7 (Computed by HW)
//    b7 (b31) - P - Parity for bits 0-30 of sample
//    b6 (b30) - C - Channel status bit.
//    b5 (b29) - U - User bit.
//    b4 (b28) - V - Sample validity bit.
//    b3 (b27) - aud 23 (MSB)
//    b2 (b26) - aud 22
//    b1 (b25) - aud 21
//    b0 (b24) - aud 20
//          ^
//          `- bit order in 'sample'
//

//
// Add subframe for first channel.
//

// XXX Since we use a 16 bit audio source here
//     (input is NvU16), move the 16 bits into
//     the upper part of the audio data 24 bits.

sample = ((C & 0x1) << 30) | // AES channel status (C) bit
         ((U & 0x1) << 29) | // AES user data (U) bit
         ((V & 0x1) << 28) | // AES sample validity (V) bit
         ((((NvU32)(*input)) & 0xffff) << 12); // AES sample data

// Add Z / block sync
if (curFrame == 0) {
    sample |= (0x1 << 3);
}
// Compute and add parity
P = ComputeParity(sample);
sample |= (P & 0x1) << 31;
```

### 6.4.3 Determining the Number of Audio Samples per Frame

It is the responsibility of the application to send the required number of audio samples per frame. Sending an insufficient number of samples will result in breaks in the audio stream. To determine the number of required audio samples per frame for a given video signal format and the length of the audio frame sequence, an application should use `NvVIOANCAPI_NumAudioSamples` as demonstrated in the following code sample.

**Note**: As specified by the SMPTE 272M and 299M specifications, 1000/1001 signal formats have an uneven number of audio samples per frame. In this case, the number of audio samples per frame varies over a sequence of frames and the position of the frame as specified by the frame sequence number dictates the number of required audio samples.

Code Listing 34: Determining Number of Audio Samples / Frame

```
// Determine the length of the audio sample sequence.
NvVIOANCAPI_NumAudioSamples(getHandle(),
                            NVVIOANCAUDIO_SAMPLING_RATE_48_0,
                            (NvU32 *)&m_uiSequenceLength,
                            NULL);

// Allocate/reallocate required memory for the array to hold the
// number of  audio samples for each frame in a sequence.
if (m_uiNumAudioSamples)
      free(m_uiNumAudioSamples);

m_uiNumAudioSamples = (unsigned int*)calloc((size_t)m_uiSequenceLength,
sizeof(NvU32));

// Determine number of audio samples based on signal format
// and audio sampling rate.
NvVIOANCAPI_NumAudioSamples(getHandle(),
                             NVVIOANCAUDIO_SAMPLING_RATE_48_0,
                            (NvU32 *)&m_uiSequenceLength,
                            (NvU32 *)m_uiNumAudioSamples);
```

### 6.4.4 Specifying Audio Data

Once the raw PCM audio data is packed as described, it is inserted into the `NVVIOANCDATAFRAME` structure as shown in Code Listing 35. Each group of four audio channels also has an associated 32-bit control value. This 32-bit variable permits the specification of the active channels, frame numbers and other controls within the SMPTE per-frame audio control packet that accompanies the audio data packets for the specified audio group.

**Note**: When inserting audio data into the NVVIOANCDATAFRAME structure for each frame in an audio frame sequence it is important to set the correct frame sequence number and only insert the number of audio samples required for the current frame. Not setting the correct frame sequence number or sending the improper number of samples for the current frame will result in audio dropouts.

## Code Listing 35: Specifying Audio Data

```
static int frameSequenceNum = 0;

// Audio Channels 1-4
m_AncData.fields |= NVVIOANCDATAFRAME_AUDIO_GROUP_1;
m_AncData.AudioGroup1.audioCntrl.activeChannels =
     NVVIOANCAUDIO_ACTIVE_CH1 | NVVIOANCAUDIO_ACTIVE_CH2 |
     NVVIOANCAUDIO_ACTIVE_CH3 | NVVIOANCAUDIO_ACTIVE_CH4;
m_AncData.AudioGroup1.audioCntrl.asynchronous = 1;

// Set audio parameters.
m_AncData.AudioGroup1.audioCntrl.asynchronous = 0;
m_AncData.AudioGroup1.audioCntrl.frameNumber1_2 = frameSequenceNum + 1;
m_AncData.AudioGroup1.audioCntrl.frameNumber3_4 = frameSequenceNum + 1;
m_AncData.AudioGroup1.audioCntrl.rate =
     NVVIOANCAUDIO_SAMPLING_RATE_48_0;

// Check for the case where the number of valid samples does not match
// the number of audio samples expected for this frame in the sequence.
if (m_pRingBuffer->NumValidSamples(0) !=
m_uiNumAudioSamples[frameSequenceNum]) {
    printf("Audio Sample Mismatch -- ExpectedNumSamples: %d
NumValidSamples: %d\n",  m_uiNumAudioSamples[frameSequenceNum],
m_pRingBuffer->NumValidSamples(0));
}

// Assign data buffers from ring buffer
m_AncData.AudioGroup1.numAudioSamples =
     m_pRingBuffer->NumValidSamples(0);
m_AncData.AudioGroup1.audioData[0] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup1.audioData[1] = m_pRingBuffer->GetBuffer(1);
m_AncData.AudioGroup1.audioData[2] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup1.audioData[3] = m_pRingBuffer->GetBuffer(1);

// Audio Channels 5-8
m_AncData.fields |= NVVIOANCDATAFRAME_AUDIO_GROUP_2;
m_AncData.AudioGroup2.audioCntrl.activeChannels =
     NVVIOANCAUDIO_ACTIVE_CH1 | NVVIOANCAUDIO_ACTIVE_CH2 |
     NVVIOANCAUDIO_ACTIVE_CH3 | NVVIOANCAUDIO_ACTIVE_CH4;
m_AncData.AudioGroup2.audioCntrl.asynchronous = 1;

// Set audio parameters.
m_AncData.AudioGroup2.audioCntrl.asynchronous = 0;
m_AncData.AudioGroup2.audioCntrl.frameNumber1_2 = frameSequenceNum + 1;
```

```
m_AncData.AudioGroup2.audioCntrl.frameNumber3_4 = frameSequenceNum + 1;
m_AncData.AudioGroup2.audioCntrl.rate =
     NVVIOANCAUDIO_SAMPLING_RATE_48_0;

// Assign data buffers from ring buffer
m_AncData.AudioGroup2.numAudioSamples =
     m_pRingBuffer->NumValidSamples(0);
m_AncData.AudioGroup2.audioData[0] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup2.audioData[1] = m_pRingBuffer->GetBuffer(1);
m_AncData.AudioGroup2.audioData[2] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup2.audioData[3] = m_pRingBuffer->GetBuffer(1);

// Audio Channels 9-12
m_AncData.fields |= NVVIOANCDATAFRAME_AUDIO_GROUP_3;
m_AncData.AudioGroup3.audioCntrl.activeChannels =
      NVVIOANCAUDIO_ACTIVE_CH1 | NVVIOANCAUDIO_ACTIVE_CH2 |

     NVVIOANCAUDIO_ACTIVE_CH3 | NVVIOANCAUDIO_ACTIVE_CH4;
m_AncData.AudioGroup3.audioCntrl.asynchronous = 1;

// Set audio parameters.
m_AncData.AudioGroup3.audioCntrl.asynchronous = 0;
m_AncData.AudioGroup3.audioCntrl.frameNumber1_2 = frameSequenceNum + 1;
m_AncData.AudioGroup3.audioCntrl.frameNumber3_4 = frameSequenceNum + 1;
m_AncData.AudioGroup3.audioCntrl.rate =
     NVVIOANCAUDIO_SAMPLING_RATE_48_0;

// Assign data buffers from ring buffer
m_AncData.AudioGroup3.numAudioSamples =
     m_pRingBuffer->NumValidSamples(0);
m_AncData.AudioGroup3.audioData[0] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup3.audioData[1] = m_pRingBuffer->GetBuffer(1);
m_AncData.AudioGroup3.audioData[2] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup3.audioData[3] = m_pRingBuffer->GetBuffer(1);

// Audio Channels 13-16
m_AncData.fields |= NVVIOANCDATAFRAME_AUDIO_GROUP_4;
m_AncData.AudioGroup4.audioCntrl.activeChannels =
     NVVIOANCAUDIO_ACTIVE_CH1 | NVVIOANCAUDIO_ACTIVE_CH2 |
     NVVIOANCAUDIO_ACTIVE_CH3 | NVVIOANCAUDIO_ACTIVE_CH4;

m_AncData.AudioGroup4.audioCntrl.asynchronous = 1;

// Set audio parameters.
m_AncData.AudioGroup4.audioCntrl.asynchronous = 1;
m_AncData.AudioGroup4.audioCntrl.frameNumber1_2 = frameSequenceNum + 1;
m_AncData.AudioGroup4.audioCntrl.frameNumber3_4 = frameSequenceNum + 1;
m_AncData.AudioGroup4.audioCntrl.rate =
     NVVIOANCAUDIO_SAMPLING_RATE_48_0;

// Assign data buffers from ring buffer
m_AncData.AudioGroup4.numAudioSamples =
```

```
     m_pRingBuffer->NumValidSamples(0);
m_AncData.AudioGroup4.audioData[0] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup4.audioData[1] = m_pRingBuffer->GetBuffer(1);
m_AncData.AudioGroup4.audioData[2] = m_pRingBuffer->GetBuffer(0);
m_AncData.AudioGroup4.audioData[3] = m_pRingBuffer->GetBuffer(1);

// Increment frame sequence number.
// When sequence length reached, reset.
frameSequenceNum++;
if (frameSequenceNum == m_uiSequenceLength)
    frameSequenceNum = 0;
```

# 6.5 CUSTOM DATA

An application can also send custom ancillary data packets. In this case, in addition to specifying the custom data, an application must also specify the ancillary data packet data identification (DID, secondary data identification (SDID) and data count (DC) words as well as the checksum (CS) word for each custom data packet. Custom ancillary data packets are placed in the VANC region of the video stream. Code Listing 36 illustrates how this can be done.

## Code Listing 36: Specifying Custom Data

```
// Create custom packet(s)
ancData.fields |= NVVIOANCDATAFRAME_CUSTOM;

#define NUM_CUSTOM_PACKETS 255

NVVIOANCDATAPACKET customPackets[NUM_CUSTOM_PACKETS];

for (int i = 0; i < NUM_CUSTOM_PACKETS; i++) {
     customPackets[i].version = NVVIOANCDATAPACKET_VERSION;
     customPackets[i].DID = 0x69;
     customPackets[i].SDID = 0x69;
     customPackets[i].DC = 0xff;
     customPackets[i].CS = 0x0;  //

for (NvU8 j = 0; j < customPackets[i].DC; j++) {
     customPackets[i].data[j] = j;
    }
}

ancData.numCustomPackets = NUM_CUSTOM_PACKETS;
ancData.CustomPackets = &customPackets[0];
```

## 6.6 CLEAN UP

When the video signal format changes, an application must release and then reinitialize the ancillary data API. This is necessary in order for the state to be set properly for the new video signal format. The API is release by calling `NvVIOANCAPI_ReleaseGVO()`.

# 7 VIDEO COMPOSITING

The Quadro SDI supports programmable 2D compositing. This operating mode combines the image data from the incoming video stream with the GPU-rendered image based upon the values in a third image known as a matte or key channel. The Quadro SDI supports the following compositing methods.

**Note**: 2D compositing is any supported when the signal format of the incoming video matches the outgoing signal format and the outgoing SDI video signal is genlocked to the input signal. Scaling or retiming the video input to match the video output signal format is not supported.

## 7.1 ALPHA COMPOSITING

In the case of alpha compositing, the application provides the key / matte channel per field / frame in the alpha channel of the OpenGL graphics stream. When the application enables alpha compositing via the API, the Quadro SDI simply executes the function below to compute the final pixel color.

***output color = input video color * (1 - alpha) + input graphics color * (alpha)***

When the value of the key or matte is strictly 1 or 0, the compositing is complete replacement. When the key value is between 0 and 1, the two images (video and graphics) would be blended. The above formula is executed for each and every pixel in the SDI output stream.

In configuration of the SDI device, alpha compositing is enabled as follows:

```
l_vioConfig.fields = 0;
l_vioConfig.fields = NVVIOCONFIG_COMPOSITE;
l_vioConfig.vioConfig.outConfig.enableComposite = TRUE;
l_vioConfig.fields = NVVIOCONFIG_ALPHAKEYCOMPOSITE;
l_vioConfig.vioConfig.outConfig.enableAlphaKeyComposite |= TRUE;

if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig)!= NVAPI_OK) {
      return E_FAIL;
}
```

OpenGL must be configured to provide an alpha channel to the SDI device. In the case of sending pbuffer data with `WGL/GLX_send_video` this is done by specifying `VIDEO_OUT_COLOR_AND_ALPHA` to the bind command as follows:

```
// Bind pbuffer to video device.
if (!wglBindVideoImageNV(ghpDevList[0], gPBuffer.getHandle(),
     WGL_VIDEO_OUT_COLOR_AND_ALPHA_NV)) {
// Handle error.
}
```

In the case of the `GL_present_video` extension, the format of the buffer object or texture must contain an alpha channel. Typical formats to create such a buffer object or texture would be either `GL_RGBA8` or `GL_RGBA16F_ARB`.

## 7.2 CHROMA-KEYING

To perform chroma keying, the application can specify up to two (Cr,Cb) pairs that represent the starting and ending chroma values for replacement within the video stream. Chroma keying is enabled with the ranges specified using the control API as follows.

```
// Cr composite ranges
l_vioConfig.fields = 0; // reset fields
l_vioConfig.fields = NVVIOCONFIG_COMPOSITE |
                     NVVIOCONFIG_COMPOSITE_CR;
l_vioConfig.vioConfig.outConfig.enableComposite = TRUE;
l_vioConfig.vioConfig.outConfig.compRange.uEnabled = TRUE;

l_vioConfig.vioConfig.outConfig.compRange.uRange = 0;
l_vioConfig.vioConfig.outConfig.compRange.uMin = crCompRange[0];
l_vioConfig.vioConfig.outConfig.compRange.uMax = crCompRange[1];

if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig)!= NVAPI_OK) {
      return E_FAIL;
}

l_vioConfig.vioConfig.outConfig.compRange.uRange = 1;
```

```
l_vioConfig.vioConfig.outConfig.compRange.uMin = crCompRange[2];
l_vioConfig.vioConfig.outConfig.compRange.uMax = crCompRange[3];

if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig)!= NVAPI_OK) {
      return E_FAIL;
}

// Cb composite ranges
l_vioConfig.fields = 0; // reset fields
l_vioConfig.fields = NVVIOCONFIG_COMPOSITE |
                     NVVIOCONFIG_COMPOSITE_CB;
l_vioConfig.vioConfig.outConfig.enableComposite = TRUE;
l_vioConfig.vioConfig.outConfig.compRange.uEnabled = TRUE;

l_vioConfig.vioConfig.outConfig.compRange.uRange = 0;
l_vioConfig.vioConfig.outConfig.compRange.uMin = cbCompRange[0];
l_vioConfig.vioConfig.outConfig.compRange.uMax = cbCompRange[1];

if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig)!= NVAPI_OK) {
            return E_FAIL;
}


l_vioConfig.vioConfig.outConfig.compRange.uRange = 1;
l_vioConfig.vioConfig.outConfig.compRange.uMin = cbCompRange[2];
l_vioConfig.vioConfig.outConfig.compRange.uMax = cbCompRange[3];

if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig)!= NVAPI_OK) {
            return E_FAIL;
}
```

When the application enables chroma keying, the Quadro SDI examines the chroma (Cr and Cb) for each incoming video pixel. If the (Cr, Cb) value for that pixel is within one of the specified ranges, the color of that pixel is replaced with the pixel color from the GPU.

## 7.3 LUMA-KEYING

For luma keying, the application specifies up to two pairs of luma (Y) values via the API. These values represent the starting and ending luma values for replacement. Luma keying is enabled with the range specified as follows.

```
// Y composite ranges
l_vioConfig.fields = 0; // reset fields

l_vioConfig.fields = NVVIOCONFIG_COMPOSITE |
                     NVVIOCONFIG_COMPOSITE_Y;
l_vioConfig.vioConfig.outConfig.enableComposite = TRUE;
l_vioConfig.vioConfig.outConfig.compRange.uEnabled = TRUE;

l_vioConfig.vioConfig.outConfig.compRange.uRange = 0;
l_vioConfig.vioConfig.outConfig.compRange.uMin = yCompRange[0];
l_vioConfig.vioConfig.outConfig.compRange.uMax = yCompRange[1];

if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig)!= NVAPI_OK) {
      return E_FAIL;
}

l_vioConfig.vioConfig.outConfig.compRange.uRange = 1;
l_vioConfig.vioConfig.outConfig.compRange.uMin = yCompRange[2];
l_vioConfig.vioConfig.outConfig.compRange.uMax = yCompRange[3];

if (NvAPI_VIO_SetConfig(m_vioHandle, &l_vioConfig)!= NVAPI_OK) {
      return E_FAIL;
}
```

When luma compositing is enabled, the Quadro SDI compares the luma (Y) for each incoming video pixel to the specified ranges. If the value for that pixel is within a specified range, the color or that pixel is replaced with the pixel color from the GPU.

# 8 CHANGING THE VIDEO DEVICE CONFIGURATION

Changes to the SDI video device configuration can be made using `NvAPI_VIO_SetConfig()` and `XNVCTRLSetAttribute()` as outlined in the section entitled *Configuring the Video Device.* Some configuration parameters may be changed during video transfers while for other changes, video output must first be stopped with OpenGL resources released before the new configuration parameters can take affect. Table 8-1 shows those parameters that maybe changed during video transfers and those that cannot be changed during video transfers.

## Table 8-1. Changeable and Unchangeable Configuration Parameters

| Changeable | Unchangeable |
|---|---|
| Color space conversion | Signal format |
| Gamma correction | Data format |
| Synchronization | Flip queue length |
| Compositing | |

# 9 DEVICE FEEDBACK

The `WGL_NV_video_out/GLX_NV_video_out` as well as the `GL_NV_present_video` extensions provides device feedback. This functionality provides the following information to the calling application.

- Number of buffers queued for SDI scanout.
- Vertical retrace interval count.
- Time at which a frame was scanned out.
- Number of vertical retrace intervals during which the same frame was scanned out.

This information can subsequently be used by an application to determine the video transfer latency within the system and if frames on the SDI output have been dropped or duplicated. Applications can then use this information to make adjustments in the data sent to the SDI device.

## 9.1 DETERMINING THE NUMBER OF QUEUED BUFFERS

The driver software for the Quadro SDI maintains a collection of internal buffers. These internal buffers permit an application to queue a frame and continue in order to begin processing future frames. The default number of buffers is five. To change this default number of internal buffers, see the advanced topic *Specifying Internal Buffer Queue Length,* later in this document.

### 9.1.1 Using the GLX/WGL_video_out Extension

Applications that utilize the `wglSendPbufferToVideoNV()` or `glXSendPbufferToVideoNV()` functions within the `WGL_video_out or GLX_video_out` extensions should set the `bBlock` argument to `GL_FALSE` in order to queue buffers, otherwise if blocking is specified, the number queued buffers will always be 1. An application should then call `wglGetVideoInfoNV()` or `glxGetVideoInfoNV()` in order to retrieve the number of vertical blanks since the start of video transfers along with the count of the current buffer being scanned out.

```
BOOL wglGetVideoInfoNV (HPVIDEODEV hpVideoDevice,
                        unsigned long *pulCounterOutputVideo,
                        unsigned long *pulCounterOutputPbuffer);

int glXGetVideoInfoNV(Display *dpy, int screen,
                      GLXVideoDeviceNV VideoDevice,
                      unsigned long *pulCounterOutputVideo,
                      unsigned long *pulCounterOutputPbuffer);
```

To determine the current number of full buffers queued, an application should subtract the value of `pulCounterOutputVideo` from the value of `pulCounterPbuffer` returned from `wglSendPbufferToVideoNV()` or `glXSendPbufferToVideoNV()` as outlined in Code Listing 37.

#### Code Listing 37: Determing the Number of Queued Buffers

```
unsigned long l_ulNumVertBlanks;
unsigned long l_ulNumBufs;
int l_uiNumBufsQueued = 0;

wglGetVideoInfoNV(ghpDevList[0],&l_ulNumBufs,
                  &l_ulNumVertBlanks);
.
.
.
l_bRes = wglSendPbufferToVideoNV(hpBuf, l_iBufType, &gBufCount,
                                 FALSE);
l_uiNumBufsQueued = gBufCount - l_ulNumBufs;
```

### 9.1.2 Using the GL_present_video Extension

In the case of applications that utilize `glPresentFrameKeyedNV()` or `glPresentFrameDualFillNV()` provided by the `GL_NV_present_video` extension, the number of queued buffers can be determined by subtracting the time at which the buffer was sent from the time at which the buffer was presented or scanned out and then divide this value by the presentation interval.

The time at which a buffer is sent can be determined utilizing one of the query functions below by specifying `pname` as `GL_CURRENT_TIME_NV`.

```
void GetVideoivNV(uint video_slot, enum pname,
                  int *params);

void GetVideouivNV(uint video_slot, enum pname,
                   uint *params);

void GetVideoi64vNV(uint video_slot, enum pname,
                    int64EXT *params);

void GetVideoui64vNV(uint video_slot, enum pname,
                     uint64EXT *params);
```

The current time on the Quadro SDI output device in nanoseconds is then returned in the value of `params`.

The present or scanout time for a particular buffer is determined by querying, using one of the functions above with the query target `GL_PRESENT_TIME_NV`, the value of the query object specified as `beginPresentTimeID` in the call to `glPresentFrameKeyedNV()` or `glPresentFrameDualFillNV()`. The value returned is then the time in nanoseconds that the frame first started scanning out. The results of the query will not be available until frame starts scanning out. For that reason, it is best to manage query objects as a circular buffer as outlined in Code Listing 38.

The presentation interval can be determined be subtracting the current present time from the last present time. The resulting value is the time between the scanout of two subsequent frames. This time should match the expected time for the chosen video signal format. For example, the presentation interval for 1080i5994 should be roughly 33 msec while for 720p60 the presentation interval should be 16 msec, and the presentation for 1080p24 should be approximately 40 msec.

## Code Listing 38: Determining Number of Buffers Queued

```
static int cur_query = 0;
static bool queryTime = GL_FALSE;
GLuint64EXT presentTime;
static GLuint64EXT lastPresentTime = 0;
GLuint durationTime;
static GLuint64EXT sendTime[NUM_QUERIES];
GLuint presentTimeID = gPresentID[cur_query];
GLuint presentDurationID = gDurationID[cur_query];

cur_query++;

// Query video present time and duration.  Only do this once
// we have been through the query loop once to ensure that
// results are available.
if (queryTime) {
      glGetQueryObjectui64vEXT(presentTimeID,
           GL_QUERY_RESULT_ARB, &presentTime);
      glGetQueryObjectuivARB(presentDurationID,
           GL_QUERY_RESULT_ARB, &durationTime);

      float latency = (presentTime - sendTime[cur_query]) *
                      .000001;
      float presentationInterval = (presentTime –
                                    lastPresentTime) * .000001;
      int bufsQueued = (int)(latency / presentationInterval);

      fprintf(stderr, "send time: %I64d  present time: %I64d  latency:
%f msec  present interval: %f msec  buffs queued: %d  duration: %d
frame\n",
      sendTime[cur_query], presentTime, latency,
      presentationInterval, bufsQueued, durationTime);

      lastPresentTime = presentTime;
}

// Query send time
glGetVideoui64vNV(1, GL_CURRENT_TIME_NV, &sendTime[cur_query]);

// Draw to video
glPresentFrameKeyedNV(1, 0,
                      presentTimeID, presentDurationID,
                      GL_FRAME_NV,
                      GL_TEXTURE_RECTANGLE_NV, gTO, 0,
                      GL_NONE, 0, 0);

if (cur_query == NUM_QUERIES) {
      cur_query = 0;0
      queryTime = GL_TRUE;
}
```

# 9.2 DETECTING DUPLICATE FRAMES

A duplicate frame will occur on the SDI output when a new frame is not ready in the queue at the time of the vertical retrace. This will happen when an application's draw time exceeds the time period between subsequent vertical retrace events on the outgoing SDI video signal. When a new frame is not sent prior to the next vertical retrace, one of two possible scenarios takes place. If, there is a frame already queued, then that frame is sent and the number of queued buffers is reduced by one. In this case, there will be no repeated frame on the SDI video output. In the case that the internal buffer queue is empty, the last sent frame will be scanned out again by the SDI video device. This will display as a duplicate frame.

**Note**: Internally, the Quadro SDI device only displays complete interlaced or progressively scanned frames. As such, only complete frames are displayed. In the case of interlace video this behavior prevents the intermixing of fields from different video frames.

## 9.2.1 Using the GLX/WGL_video_out Extension

When an application uses the `WGL_NV_video_out or GLX_NV_video` out extensions, dropped frames or fields or missed vsync events are detected by catching unexpected results in the value of the vsync counter `pulCounterOutputVideo` returned `wglGetVideoInfoNV()` or `glXGetVideoInfoNV()`. When these functions are called each time in the draw loop, the value of `pulCounterOutputVideo` should increment by 1 in the case of a progressive video format or when rendering fields in an interlaced video format and by 2 when rendering frames in an interlaced video format. An example of checking for dropped frames within the draw loop is outlined in Code Listing 39.

### Code Listing 39: Detecting a Dropped/Duplicate Frame

```
unsigned long l_ulNumVertBlanks;
unsigned long l_ulNumBufs;
static unsigned long l_ulLastNumBufs = 0;
static unsigned long l_ulLastSent = 0;
static unsigned long l_ulLastNumVertBlanks = 0;

wglGetVideoInfoNV(ghpDevList[0], &l_ulNumBufs,
                  &l_ulNumVertBlanks);

if (gbInterlaced) {
      if (!options.field) {
            l_iBufType = WGL_VIDEO_OUT_FRAME;
            l_iVsyncDiff = 2;
            l_bBlock = options.block;
      } else {
            l_iBufType = l_bField1 ? WGL_VIDEO_OUT_FIELD_1 :
                        WGL_VIDEO_OUT_FIELD_2;
```

```
            l_bField1 = l_bField1 ? 0 : 1;
            l_bBlock = options.block; //l_bField1 ? FALSE : TRUE;
            l_iVsyncDiff = 1;
            }
} else {
      l_iBufType = WGL_VIDEO_OUT_FRAME;
      l_iVsyncDiff = 2;
      l_bBlock = options.block;
}

wglSendPbufferToVideoNV(hpBuf, l_iBufType, &gBufCount, l_bBlock);

if ((l_ulNumVertBlanks != l_ulLastNumVertBlanks) &&
    (l_ulNumVertBlanks != (l_ulLastNumVertBlanks +
                           l_iVsyncDiff)))
            fprintf(stderr, "Warning:Dropped/Duplicate Frame\n");

l_ulLastNumVertBlanks = l_ulNumVertBlanks;
```

When in the case of a progressive video format, or when rendering fields, the vsync counter increments by more than one during subsequent execution of the draw loop, then a vertical retrace was missed. When rendering frames in an interleaved video format, if the vsync counter increments by more than two during subsequent execution of the draw loop, then a vertical retrace was missed. Now, to know if a duplicated frame or field is actually displayed on the SDI video output, this information must be used in coordination with the number of queued buffers as determined in Code Listing 36.

### 9.2.2 Using the GL_present_video Extension

When an application uses the `GL_NV_present_video` extension, a query object is utilized to determine if a frame is duplicated on the SDI output. This is demonstrated in Code Listing 38.

# 10 ADVANCED TOPICS

This chapter outlines the use of some advanced features of the Quadro SDI.

## 10.1 WORKING WITH TWO VIDEO CHANNELS

The Quadro SDI, in addition to operating in a dual-link configuration, can also be programmed to output the same video signal or two different video signals on the two video output jacks.

### 10.1.1 Dual-Link Operation

The SMPTE standard defines dual-link video data formats. These formats utilize two video outputs in combination to deliver the complete video signal to the receiving device. The Quadro SDI software driver automatically recognizes these dual-link video formats when they are specified by an application and splits the resulting data across the two video channels. No special programming is required by the application to operate in this mode.

### 10.1.2 Two Independent Video Channels

The video outputs of the Quadro SDI can also be configured to output two independent video data signals. In this operating mode, an application must first configure the Quadro SDI for dual outputs. To do this, the SDI device should be configured similarly to the single channel operating mode except for the data format. In this case, the data format must be set to one of the dual formats as shown in Code Listing 40.

### Code Listing 40: Configuring the SDI Device to Output Two Independent Video Channels

```
l_gvoConfig.dataFormat=
NVGVODATAFORMAT_DUAL_R8G8B8_TO_DUAL_YCRCB422;
```

Once configured, an application must utilize separate render targets for each video channel. The application draw loop would then bind and update each render target in turn prior to utilizing `glPresentFrameDualFillNV()` to send the rendered data to the SDI device as demonstrated in Code Listing 41.

### Code Listing 41: Sending Two Independent Video Channels

```
gFBO1.bind(gWidth, gHeight);
drawChannel1();
gFBO1.unbind();

gFBO2.bind(gWidth, gHeight);
drawChannel2();
gFBO2.unbind();

glPresentFrameDualFillNV(1, 0, 0, 0, GL_FRAME_NV,
      GL_RENDERBUFFER_EXT, gFBO1.renderbufferIds[0],
      GL_NONE, 0,
      GL_RENDERBUFFER_EXT, gFBO2.renderbufferIds[0],
      GL_NONE, 0);
```

## 10.2 SENDING THE DESKTOP TO VIDEO OUTPUT

In addition to sending the contents of one or more pbuffers, buffer objects or textures as video output data, the desktop, or a region of the desktop can be displayed on the SDI video output from within an application. This mode of operation permits an application to control the Quadro SDI output in much the same was as the control panel.

The programming of this operating mode is similar as that described in Chapter 4 except that this usage model requires the specification of `NVVIOOWNERTYPE_DESKTOP` to `NvAPI_VIO_Open()`. Once the desktop is opened, the video output device is configured similarly to the buffer object case as outlined in code sample 4 except that in the desktop case, an application can initialize the `NVGVOOUTPUTREGION` structure to define the region of the desktop area that will be visible on the video output. Initialization of the Quadro SDI for desktop output to video from within an application is outlined in Code Listing 42. This example sends a 1280 × 720 rectangular area of the desktop with the top left corner at location `(gX, gY)` to the Quadro SDI output as 720p5994 SDI video output.

### Code Listing 42: Configuring Desktop Video Output

```
// Open the SDI device for desktop output
if (NvAPI_VIO_Open(hVIO, NVVIOCLASS_SDI, NVVIOOWNERTYPE_DESKTOP)
      != NVAPI_OK) {
      return E_FAIL;
}

// Configure video output parameters
NVVIOCONFIG l_vioConfig;
memset(&l_vioConfig, 0, sizeof(l_vioConfig));
l_vioConfig.version = NVVIOCONFIG_VER;
l_vioConfig.fields = NVVIOCONFIG_SIGNALFORMAT |
                     NVVIOCONFIG_DATAFORMAT |
                     NVVIOCONFIG_OUTPUTREGION;

// Video output signal format
l_vioConfig.vioConfig.outConfig.signalFormat =
                            NVVIOSIGNALFORMAT_720P_5994_SMPTE274;

// Video output data format
l_vioConfig.vioConfig.outConfig.dataFormat =
                            NVVIODATAFORMAT_R8G8B8_TO_YCRCB422;

// Desktop region to output
NVVIOOUTPUTREGION l_vioOutputRegion;
l_vioOutputRegion.x = gX;
l_vioOutputRegion.y = gY;
l_vioOutputRegion.width = 1280;
l_vioOutputRegion.height = 720;

// Set configuration
if (NvAPI_VIO_SetConfig(hVIO, &l_vioConfig) != NVAPI_OK) {
      return E_FAIL;
}
```

## 10.3 COLOR SPACE CONVERSION

The Quadro SDI automatically performs ITU Rec. 601 or 709 color space conversion from RGB to YCrCb when required by the specified data format. This color space conversion is performed according to the following formula:

$$Y = offset_{Y} + scale_{Y} * (r_{y}*R + g_{y}*G + b_{y}*B)$$
$$Cb = offset_{cb} + scale_{cb} * (r_{cb}*R + g_{cb}*G + b_{cb}*B)$$
$$Cr = offset_{cr} + scale_{cr} * (r_{cr}*R + g_{cr}*G + b_{cr}*B)$$

where ***scale*** controls the magnitude of the resulting output range and ***offset*** controls the position of the result within that range. These values should be within -1.0 and 1.0.

The Quadro SDI processes the input values at 12-bit precision. In the case of 8-bit input data, the data is shifted up by 4 bits and the top 4 MSB bits are copied to the least 4 LSB bits. For 16-bit per-component input data, only the upper 12 bits are processed. The RGB data values come from the GPU output. The coefficient, offset and scale values are determined as described in the following sections.

## 10.3.1 Coefficients

The coefficients as well as the offsets in the formulas above are signed 16-bit integers which represent the values from -1.999 to +1.999. Each coefficient effectively has 14 bits of precision which should be adequate to provide high precision. All multiplications and additions are performed without truncation. Truncation only occurs at the final stage at which time 10-bit or 12-bit output values are extracted.

### Table 10-1. SD ITU 601 Coefficients

| | R | G | B |
|---|---|---|---|
| Y | 0.2989 | 0.5865 | 0.1150 |
| $C_b$ | -0.1684 | -0.3310 | 0.5000 |
| $C_r$ | 0.5000 | -0.4181 | -0.08095 |

### Table 10-2. HD ITU 709 Coefficients

| | R | G | B |
|---|---|---|---|
| Y | 0.2130 | 0.7156 | 0.0723 |
| $C_b$ | 0.5000 | -0.4535 | -0.0455 |
| $C_r$ | -0.1145 | -0.38450 | 0.5000 |

Custom coefficients may also be programmed via the API as outlined in Code Listing 43 and Code Listing 41. For applications that wish to scale the results within a particular range, the scale values must be considered in the computation of the coefficient values.

## 10.3.2 Scale

By default, the Quadro SDI performs color space conversion into what is commonly referred to as **Video Range**. In the 10-bit case, Y ranges [64 – 940] and CrCb [64 – 960]. The default ***scale*** values are then computed as follows.

$$scale_y = (940 - 64) / 1024 = 0.85547$$
$$scale_{cr} = (960 - 64) / 1024 = 0.875$$
$$scale_{cb} = (960 - 64) / 1024 = 0.875$$

In the 8-bit case, Y ranges from 16 – 235 while CrCb ranges from 16 – 240. The default ***scale*** values for **Video Range** are then similar:

$$scale_y = (235 - 16) / 256 = 0.85547$$
$$scale_{cr} = (240 - 16) / 256 = 0.875$$
$$scale_{cb} = (240 - 16) / 256 = 0.875$$

To perform color space conversion into what is frequently referred to as **Film Range** or **Full Range** a custom color space conversion must be specified via the API. In the case of 10-bit full range, Y and CrCb ranges [4,1019]. The scale values are then computed as follows:

$$scale_y = (1019 - 4) / 1024 = 0.992$$
$$scale_{cr} = (1019 - 4) / 1024 = 0.992$$
$$scale_{cb} = (1019 - 4) / 1024 = 0.992$$

## 10.3.3 Offset

The value of $offset_y$ is calculated as the ratio of the minimum value of luma within the range to the maximum value of luma within the range. In the case of 10-bit **Video Range**, $offset_y$ calculated as follows:

$$offset_y = (64 / 1024) = 0.0625$$

Meanwhile, the values of $offset_{cr}$ and $offset_{cb}$ are calculated as the middle point of the range divided by the maximum value in the range. Therefore, in the case of the 10-bit **Video Range**, the following calculation is used:

$$offset_{cr} = offset_{cb} = ((64 + 960) / 2) / 1024 = 0.5$$

Another way to think about $offset_{cr}$ and $offset_{cb}$ is as the value required to move the minimum result from the matrix multiplication and scale into the range of [0-1].

In the case of **Full Range** the 10-bit offset values are then computed as follows:

$$offset_y = (4 / 1019) = 0.003925417$$
$$offset_{cr} = offset_{cb} = ((4 + 1019) / 2) / 1024 = 0.5$$

An application can override this default color space conversion behavior as outlined in Code Listing 43 for Windows and Code Listing 44 for Linux. However, applications should be aware that the final SDI output color range is always clamped to the following legal values.

**8-bit Range: 4 – 251**
**10-bit Range: 4 – 1019**
**12-bit Range: 16 - 4079**

**Note:** Refer to Chapter 11 for a summary of the matrix coefficients as well as scale and offset values for typical full and video range color space conversions.

## Code Listing 43: Specifying a Custom Color Space Conversion on Windows

```
.
.
.
// Colorspace Conversion
if (gbCSC) {
      l_vioConfig.fields |= NVVIOCONFIG_CSCOVERRIDE;
      l_vioConfig.vioConfig.outConfig.cscOverride = TRUE;
      l_vioConfig.fields |= NVVIOCONFIG_COLORCONVERSION;
      l_vioConfig.vioConfig.outConfig.colorConversion.version =
                                        NVVIOCOLORCONVERSION_VER;
      l_vioConfig.vioConfig.outConfig.colorConversion.colorOffset[0] =

0.0625;
      l_vioConfig.vioConfig.outConfig.colorConversion.colorOffset[1] =
                                                                  0.5;
      l_vioConfig.vioConfig.outConfig.colorConversion.colorOffset[2] =
                                                                  0.5;
      l_vioConfig.vioConfig.outConfig.colorConversion.colorScale[0] =

0.85547;
      l_vioConfig.vioConfig.outConfig.colorConversion.colorScale[1] =
                                                                  0.875;
      l_vioConfig.vioConfig.outConfig.colorConversion.colorScale[2] =
                                                                  0.875;
      l_vioConfig.vioConfig.outConfig.colorConversion.compositeSafe =
                                                                  TRUE;

      switch(geVideoFormat) {

        // ITU 709
        case VIDEO_FORMAT_1080P:
        case VIDEO_FORMAT_1080I:
        case VIDEO_FORMAT_720P:

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[0][0]
=
0.2130f;
      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[0][1]
=
0.7156f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[0][2]
=
  0.0725f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[1][0]
=
  0.5000f;
```

```
      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[1][1]
=
  -0.4542f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[1][2]
=
  -0.0455f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[2][0]
=
 -0.1146f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[2][1]
=
 -0.3850f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[2][2]
=
 0.5000f;
           break;

       // ITU 601
       case VIDEO_FORMAT_487I:
       case VIDEO_FORMAT_576I:

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[0][0]
=
  0.2991f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[0][1]
=
  0.5870f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[0][2]
=
  0.1150f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[1][0]
=
  0.5000f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[1][1]
=
  -0.4185f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[1][2]
=
  -0.0810f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[2][0]
=
 -0.1685;
```

```
      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[2][1]
=
 -0.3310f;

      l_vioConfig.vioConfig.outConfig.colorConversion.colorMatrix[2][2]
=
 0.5000f;
            break;

      }  // switch
} else {
      l_vioConfig.fields |= NVGVOCONFIG_CSCOVERRIDE;
      l_vioConfig.vioConfig.outConfig.cscOverride = FALSE;
} // if

.
.
.
// Set configuration
      if (NvAPI_VIO_SetConfig(hVIO, &l_vioConfig) != NVAPI_OK) {
            return E_FAIL;
}
```

Once an application specifies a custom color space conversion matrix for a given data format, that matrix remains in effect until it is redefined, or at which point `cscOverride` is set to **FALSE** indicating that the default color space conversion for the given data format should be utilized.

## Code Listing 44: Specifying a Custom Color Space Conversion on Linux

```
// Setup color CSC matrix and offsets
if (op->csc) {
    switch(op->video_format) {
        case VIDEO_FORMAT_487I:
        case VIDEO_FORMAT_576I:
            colorMat[0][0] =  0.2991f;
            colorMat[0][1] =  0.5870f;
            colorMat[0][2] =  0.1150f;
            colorMat[1][0] =  0.5000f;
            colorMat[1][1] = -0.4185f;
            colorMat[1][2] = -0.0810f;
            colorMat[2][0] = -0.1685f;
            colorMat[2][1] = -0.3310f;
            colorMat[2][2] =  0.5000f;
            break;

        case VIDEO_FORMAT_720P:
        case VIDEO_FORMAT_1080I:
            colorMat[0][0] =  0.2130f;
            colorMat[0][1] =  0.7156f;
```

```
            colorMat[0][2] =  0.0725f;
            colorMat[1][0] =  0.5000f;
            colorMat[1][1] = -0.4542f;
            colorMat[1][2] = -0.0455f;
            colorMat[2][0] = -0.1146f;
            colorMat[2][1] = -0.3350f;
            colorMat[2][2] =  0.5000f;
            break;
    } // switch

    colorOffset[0] = 0.0625;
    colorOffset[1] = 0.5;
    colorOffset[2] = 0.5;
    colorScale[0] = 0.0625;
    colorScale[1] = 0.875;
    colorScale[2] = 0.875;

    XNVCTRLSetGvoColorConversion(dpy, screen, colorMat,
                                 colorOffset, colorScale);

    XNVCTRLSetAttribute(dpy, screen, 0,
                        NV_CTRL_GVO_OVERRIDE_HW_CSC,
                        NV_CTRL_GVO_OVERRIDE_HW_CSC_TRUE);
} else {
    XNVCTRLSetAttribute(dpy, screen, 0,
                        NV_CTRL_GVO_OVERRIDE_HW_CSC,
                        NV_CTRL_GVO_OVERRIDE_HW_CSC_FALSE);
}
```

## 10.3.4 Typical Color Space Conversions

This section describes the matrix coefficients and scale and offset values for common video and full range color space conversions.

RGB [0,219] from ITU-R BT.601 Y'[0,219]CrCb[0,224]

=

RGB [0,255] from ITU-R BT.601 Y'[0,219]CrCb[0.224]

=

| Offset (8-bit) | Offset (10-bit) |
|---|---|
| Y = 16/235 = 0.068 | Y = 64/940 = 0.068 |
| Cb = (240+16)/2 / (255) = 0.5 | Cb = (960+64)/2 / (1023) = 0.5 |
| Cr = (240+16)/2 / (255) = 0.5 | Cr = (960+64)/2 / (1023) = 0.5 |

| Scale (8-bit) | Scale (10-bit) |
|---|---|
| Y = (235-16) / 256 = 0.85546875 | Y = (940-64) / 1024 = 0.85546875 |
| Cb = (240-16) / 256 = 0.875 | Cb = (960-64) / 1024 = 0.875 |
| Cr = (240-16) / 256 = 0.875 | Cr = (260-64) / 1024 = 0.875 |

RGB[0,255] from ITU-R BT.601 Y'CrCb[0,255]

=

RGB[0,255] from ITU-R BT.601 Y'CrCb[0,247]

=

| Offset (8-bit) | Offset(10-bit) |
|---|---|
| Y = 4/251 = 0.015936 | Y = 4/1019 = 0.0039254 |
| Cb = (251+4)/2 / (255) = 0.5 | Cb = (1019+4)/2 / (1023) = 0.5 |
| Cr = (251+4)/2 / (255) = 0.5 | Cr = (1019+4)/2 / (1023) = 0.5 |

| Scale (8-bit) | Scale (10-bit) |
|---|---|
| Y = (251-4) / 256 = 0.964844 | Y = (1019-4) / 1024 = 0.99121 |
| Cb = (251-4) / 256 = 0.964844 | Cb = (1019-4) / 1024 = 0.99121 |
| Cr = (251-4) / 256 = 0.964844 | Cr = (1019-4) / 1024 = 0.99121 |

RGB [0,219] from ITU-R BT.709 Y'[0,219]CrCb[0,224]

=

RGB [0,255] from ITU-R BT.709 Y'[0,219]CrCb[0,224]

=

| Offset (8-bit) | Offset (10-bit) |
|---|---|
| Y = 16/235 = 0.068 | Y = 64/940 = 0.068 |
| Cb = (240+16)/2 / (255) = 0.5 | Cb = (960+64)/2 / (1023) = 0.5 |
| Cr = (240+16)/2 / (255) = 0.5 | Cr = (960+64)/2 / (1023) = 0.5 |

| Scale (8-bit) | Scale (10-bit) |
|---|---|
| Y = (235-16) / 256 = 0.85546875 | Y = (940-64) / 1024 = 0.85546875 |
| Cb = (240-16) / 256 = 0.875 | Cb = (960-64) / 1024 = 0.875 |
| Cr = (240-16) / 256 = 0.875 | Cr = (260-64) / 1024 = 0.875 |

RGB[0,255] from ITU-R BT.709 [0,255]

=

RGB[0,255] from ITU-R BT.709 [0,247]

=

| Offset (8-bit) | Offset(10-bit) |
|---|---|
| Y = 4/251 = 0.015936 | Y = 4/1019 = 0.0039254 |
| Cb = (251+4)/2 / (255) = 0.5 | Cb = (1019+4)/2 / (1023) = 0.5 |
| Cr = (251+4)/2 / (255) = 0.5 | Cr = (1019+4)/2 / (1023) = 0.5 |

| Scale (8-bit) | Scale (10-bit) |
|---|---|
| Y = (251-4) / 256 = 0.964844 | Y = (1019-4) / 1024 = 0.99121 |
| Cb = (251-4) / 256 = 0.964844 | Cb = (1019-4) / 1024 = 0.99121 |
| Cr = (251-4) / 256 = 0.964844 | Cr = (1019-4) / 1024 = 0.99121 |

# 10.4 FULL-SCENE ANTIALIASING

Full-scene antialiasing (FSAA) is required when computer-generated images are utilized in video and broadcast applications in order to remove the stair step artifacts caused by high-frequency transitions commonly found in point-sampled images. FSAA is implemented using a multisampling technique where the GPU uses multiple color samples to calculate the final pixel color. An application can utilize multisampling with both pbuffers and buffer objects as described in the next section.

## 10.4.1 Pbuffer Multi-Sampling

An application sending pbuffers to the SDI device with the `WGL_video_out` or `GLX_video_out` OpenGL extensions that wishes to apply FSAA to the SDI video output must request a multi-sampled pixel format for pbuffer creation. Once a multi-sampled pbuffer is created, multisampling must be enabled within OpenGL. These steps are outlined in Code Listing 45.

## Code Listing 45: Requesting a Multi-Sampled Pixel Format During Pbuffer Creation

```
// Request multisampled pixel format.
int attribList = {
            WGL_RED_BITS_ARB, 8,
            WGL_GREEN_BITS_ARB, 8,
            WGL_BLUE_BITS_ARB, 8,
            WGL_ALPHA_BITS_ARB, 8,
            WGL_STENCIL_BITS_ARB, 8,
            WGL_DEPTH_BITS_ARB, 24,
            WGL_SAMPLE_BUFFERS_ARB, GL_TRUE,
            WGL_SAMPLES_ARB, num_samples,
            WGL_DRAW_TO_PBUFFER_ARB, true,
            WGL_BIND_TO_VIDEO_RGBA_NV, true,
            0 };

wglChoosePixelFormat(hWindowDC, attribList, NULL, 1, &format,
&nformats);

.
.
.

// Enable multisampling.
if (gbFSAA) {
            glEnable(GL_MULTISAMPLE_ARB);
}
```

In Code Listing 45, **num_samples**, can be specified as1, 2, 4, 8 or 16, the number of desired samples per pixel. The greater the number, the more samples per pixel and improved image quality. However, the application programmer should be aware, that increasing the number of samples per pixel increases the video memory requirements of the application and in some cases, especially in the cases of HD video formats, the capacity of video memory may be exceeded. This may lead to reduced performance caused by swapping of textures and other video data to main memory, or pbuffer creation may fail due to lack of available video memory.

When the multi-sampled pbuffer is sent to the SDI video device with either `wglSendPbufferToVideoNV()` or `glxSendPbufferToVideoNV()`, the driver will automatically do the down sample blit prior to the SDI scanout.

For more information on multisampling, refer to the `GL_ARB_multisample` extension specification.

## 10.4.2 Multi-Sampling with Buffer Objects

An application that wishes to use multisampling with buffer objects will utilize the capabilities enabled by the `GL_EXT_framebuffer_multisample` OpenGL extension. Unlike in the case of pbuffers, the application must perform the down sample bit and filter operation prior to sending the buffer objects to the SDI device.

The first step is to create an additional multi-sampled buffer object during OpenGL initialization. Frame buffer object creation is identical to that shown in Code Listing 8, except for the specification of render buffer storage as demonstrated in Code Listing 46.

### Code Listing 46: Requesting Multi-Sample Render Buffer Storage

```
if (num_samples > 1) {

      glRenderbufferStorageMultisampleEXT(GL_RENDERBUFFER_EXT,
                                          num_samples, texFormat,
                                          width, height);
} else {
      glRenderbufferStorageEXT(GL_RENDERBUFFER_EXT, texFormat,
width, height);
}
```

Then, in the draw loop, the Code Listing 47 performs the down sample and filter from the multi-sample buffer object to the normal non-multi-sample buffer object prior to presenting the final buffer object to the SDI video device.

### Code Listing 47: Buffer Object Blit and Down Sample

```
// Bind buffer object
if (options.fsaa == 1)
      glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, gFBO);
else
      glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, gFBOMultiSampled)

      glEnable(GL_MULTISAMPLE);
 // Draw frame content here
.
.
.

if (options.fsaa == 1){

      // Unbind FBO
      glBindFramebufferEXT(GL_FRAMEBUFFER_EXT, 0);

} else {

      // If using multisample render buffer,
      // then blit to downsample and filter
      glBindFramebufferEXT(GL_READ_FRAMEBUFFER_EXT,
                           gFBOMultiSampled);
      glBindFramebufferEXT(GL_DRAW_FRAMEBUFFER_EXT,
```

```
                              gFBO);

      glBlitFramebufferEXT(0, 0, gWidth, gHeight,
                              0, 0, gWidth, gHeight,
                              GL_COLOR_BUFFER_BIT |
                              GL_DEPTH_BUFFER_BIT |
                              GL_STENCIL_BUFFER_BIT,
                              GL_NEAREST);

      glDisable(GL_MULTISAMPLE);

      // Unbind FBOs
      glBindFramebufferEXT(GL_READ_FRAMEBUFFER_EXT, 0);
      glBindFramebufferEXT(GL_DRAW_FRAMEBUFFER_EXT, 0);

      // Present final frame to the video device
      .
      .
      .
}
```

# 10.5CALCULATING VIDEO MEMORY USAGE

When creating any graphics application, it is important to consider the graphics or video memory requirements of that application. Graphics or video memory is the physical memory that is located on the graphics card. Once the graphics memory footprint of an application exceeds the available memory on the card, the driver can no longer allocate buffers, textures and other graphics objects. In some cases, like in the case of pbuffer allocation, a memory allocation will simply fail within an application, in other cases, graphics objects will be swapped to system memory leading to reduced application performance. Table 10-3 demonstrates the calculation of the amount of video memory required by an application. This example represents a typical usage scenario for 1080i HD output with a 1920 × 1080 visible frame buffer, and a single 4× multi-sampled 1920 × 1080 pbuffer.

**Note**: The SDI device allocates 5 internal FP16 (2 bytes per component) buffers. These buffers permit an application to render up to five frames or fields ahead of the SDI scanout in the case when wglSendPbufferToVideoNV() and glXSendPbufferToVideoNV() are specified not to block.

Table 10-3. Video Memory Required by an Application

| | | | | | | |
|---|---|---|---|---|---|---|
| **Framebuffer** | **Width:** | **1920** | **Height:** | **1080** | | |
| Color :<br>(32-bit RGBA, double buffered) | 1920 x 1080 x 4 x 2 / 1024 / 1024 = | | | | | 15.82 MB |
| Depth :<br>(32-bit with packed stencil) | 1920 x 1080 x 4 / 1024 / 1024 = | | | | | 7.91 MB |
| Overlay :<br>(16-bit front + back) | 1920 x 1080 x 2 x 2 / 1024 / 1024= | | | | | 7.91 MB |
| **Total:** | | | | | | 31.64 MB |
| **Pbuffer** | **Width:** | **1920** | **Height:** | **1080** | **Samples Per Pixel:** | **4** |
| Color:<br>(32-bit RGBA, double buffered) | 1920 x 1080 x 4 x 4 x 2 / 1024 / 1024 = | | | | | 63.28 MB |
| Depth:<br>(32-bit with packed stencil) | 1920 x 1080 x 4 x 4 / 1024 / 1024 = | | | | | 31.64 MB |
| **Total:** | | | | | | 94.92 MB |
| **SDI Video** | **Width:** | **1920** | **Height:** | **1080** | **Num Buffers:** | **5** |
| | 1920 x 1080 x 8 x 5 / 1024 / 1024 = | | | | | 79.10 MB |
| | | | | | | |
| **Grand Total:** | | | | | | 205.66 MB |

# 10.6 WORKING WITH GREATER THAN 8 BITS PER COMPONENT

SMPTE specifications support the transmission of greater than 8-bit per-component data as an SDI video signal. Applications wishing to transmit greater than 8-bit per-component data may do so by sending FP16 buffer objects or pbuffers to the Quadro SDI. FP16 is native GPU hardware format with a signed floating point format with a 10-bit matissa and a 5-bit exponent. After a FP16 render target has been obtained, the render buffer, texture object or pbuffer must be filled with 16-bit floating point data prior to transfer. In some cases, this may require that the application image data be converted from integer to floating point. The data format specified in the video device configuration determines the expected render target type.

# 10.7 DATA INTEGRITY CHECK

The Quadro SDI provides the capability to test the integrity of the data cable between the graphics card and the SDI daughter board. When this mode is enabled, the SDI daughter card compares the color value of each pixel on a line to the color of the first pixel on that line and returns a count of the number of mismatched pixels. Due to the serial structure of the data cable, this test is designed to catch cases where the quality of the cable introduces errors into the data stream. An application that wishes to utilize this mode to verify the integrity of the data cable should display a test pattern that draws pixels of the identical color on each output line and be structured in the following form:

**Note:** This feature is only available on the Quadro FX 4500, Quadro FX 5500, Quadro FX 4600 and Quadro FX 5600 SDI.

## Code Listing 48: Basic Code Structure for Data Integrity Check

```
void runDataIntegrityCheck()
{
      // Initialize video device
      initializeVideo();

      // Initialize OpenGL state
      initializeGL();

      // Draw initial frames
      for (int I = 0; I < 30; i++) {
            drawPattern();
}

      // Enable data integrity checking
      enableDataCheck();

      // Draw remaining frames
      for (int i = 0; i < gNumFrames; i++) {
            drawPattern();
      }

      // Check errors
      checkErrors();

      // Disabled data integrity checking
      disableDataCheck();

      // Draw last frame
      drawPattern();
```

```
      // Cleanup OpenGL state
      cleanupGL;

      // Release video device.
      cleanupVideo();
}
```

The data integrity check mode is a hardware state enabled and disabled by calling `NvGvoConfigSet()` much the same way as other video control parameters are set by an application. Examples of functions that demonstrate the enabling and disabling of the data integrity check are shown in Code Listing 49.

## Code Listing 49: Enabling and Disabling the Data Integrity Check on Windows

```
//
// Enable data integrity check
//
HRESULT
enableDataCheck(GLvoid)
{
      NVVIOCONFIG l_vioConfig;
      memset(&l_vioConfig, 0, sizeof(l_vioConfig));
      l_vioConfig.version = NVVIOCONFIG_VER;

      l_vioConfig.fields = 0;
      l_vioConfig.fields = NVVIOCONFIG_DATAINTEGRITYCHECK;
      l_vioConfig.vioConfig.outConfig.enableDataIntegrityCheck =
                                                            TRUE;

      // Set configuration
      if (NvAPI_VIO_SetConfig(g_hVIO, &l_vioConfig) != NVAPI_OK){
            return E_FAIL;
      }

      return S_OK;
}


//
// Disable data integrity check
//
HRESULT
disableDataCheck(GLvoid)
{
      NVVIOCONFIG l_vioConfig;
      memset(&l_vioConfig, 0, sizeof(l_vioConfig));
      l_vioConfig.version = NVVIOCONFIG_VER;

      l_vioConfig.fields = 0;
      l_vioConfig.fields = NVVIOCONFIG_DATAINTEGRITYCHECK;
      l_vioConfig.vioConfig.outConfig.enableDataIntegrityCheck =
```

```
                                                                  FALSE;

      // Set configuration
      if (NvAPI_VIO_SetConfig(g_hVIO, &l_vioConfig)!= NVAPI_OK) {
            return E_FAIL;
      }

      return S_OK;
}
```

# 10.8 COMPOSITE SYNC TERMINATION

The Quadro SDI also provides the capability to enable and disable termination of the composite sync signal by calling `NvGvoConfigSet()` the same way that other video control parameters are set within an application. Examples of functions that demonstrate the enabling and disabling of composite sync termination are shown in Code Listing 50.

## Code Listing 50: Enabling and Disabling Composite Sync Termination on Windows

```
//
// Enable composite sync termination
//
HRESULT
enableSyncTermination(GLvoid)
{
      NVVIOCONFIG l_vioConfig;
      memset(&l_vioConfig, 0, sizeof(l_vioConfig));
      l_vioConfig.version = NVVIOCONFIG_VER;

      l_vioConfig.fields = 0;
      l_vioConfig.fields = NVVIOCONFIG_COMPOSITETERMINATE;
      l_vioConfig.vioConfig.outConfig.compositeTerminate = TRUE;

      // Set configuration
      if (NvAPI_VIO_SetConfig(hVIO, &l_vioConfig)!= NVAPI_OK) {
            return E_FAIL;
      }

      return S_OK;
}


//
// Disable composite sync termination
//
HRESULT
```

```
disableSyncTermination(GLvoid)
{
      NVVIOCONFIG l_vioConfig;
      memset(&l_vioConfig, 0, sizeof(l_vioConfig));
      l_vioConfig.version = NVVIOCONFIG_VER;

      l_vioConfig.fields = 0;
      l_vioConfig.fields = NVVIOCONFIG_COMPOSITETERMINATE;
      l_vioConfig.vioConfig.outConfig.compositeTerminate = FALSE;

      // Set configuration
      if (NvAPI_VIO_SetConfig(hVIO, &l_vioConfig)!= NVAPI_OK) {
            return E_FAIL;
      }

      return S_OK;
}
```

# 10.9 SPECIFYING THE INTERNAL BUFFER QUEUE LENGTH

The driver software for the Quadro SDI maintains a collection of internal buffers. The default number of buffers is five. This internal buffer queue permits applications that do not set the `bBlock` argument to **TRUE** in `wglSendPbufferToVideoNV()` or `glXSendPbufferToVideoNV()` to render and send frames or fields ahead of when they will be scanned out by the SDI video device. On Windows XP, the number of internal buffers can be queried using `NvAPI_VIO_GetConfig()` as outlined in Code Listing 51.

## Code Listing 51: Querying the Number of Internal Buffers on Windows

```
//
// Get flip queue length
//
HRESULT
getFlipQueueLength()
{
      NVVIOCONFIG l_vioConfig;
      memset(&l_vioConfig, 0, sizeof(l_vioConfig));
      l_vioConfig.version = NVVIOCONFIG_VER;

      l_vioConfig.fields = 0;
      l_vioConfig.fields = NVVIOCONFIG_FLIPQUEUELENGTH;


      // Get configuration
      if (NvAPI_VIO_GetConfig(hVIO, &l_vioConfig)!= NVAPI_OK) {
```

```
        return E_FAIL;
        }
        return S_OK;
}
```

At the time that the video output device is configured and prior to calling either `wglBindVideoImageNV()` or `glXBindVideoImageNV()`, this number of internal buffers can be specified by an application using `NvAPI_VIO_SetConfig()`. The number of internal buffers specified must be between two and seven.

## Code Listing 52: Setting the Number of Internal Buffers on Windows

```
//
// Set flip queue length
//
HRESULT
setFlipQueueLength(unsigned int uiFQL)
{
        NVVIOCONFIG l_vioConfig;
        memset(&l_vioConfig, 0, sizeof(l_vioConfig));
        l_vioConfig.version = NVVIOCONFIG_VER;

        l_vioConfig.fields = 0;
        l_vioConfig.fields = NVVIOCONFIG_FLIPQUEUELENGTH;
        l_vioConfig.vioConfig.outConfig.flipQueueLength = numBuffers;

        // Set configuration
        if (NvAPI_VIO_SetConfig(hVIO, &l_vioConfig)!= NVAPI_OK) {
                return E_FAIL;
        }
        return S_OK;
}
```

On Linux, the number of internal buffers can be specified with `XNVCTRLsetAttribute()` as demonstrated.

```
// Set number of internal buffers

XNVCTRLSetAttribute(dpy, screen, 0, NV_CTRL_GVO_FLIP_QUEUE_SIZE, 2);
```

# 11 NV_PRESENT_VIDEO

```
/* NV_present_video */
#define GL_FRAME_NV                                             0x8E26
#define GL_FIELDS_NV                                            0x8E27
#define GL_CURRENT_TIME_NV                                      0x8E28
#define GL_NUM_FILL_STREAMS_NV                                  0x8E29
#define GL_PRESENT_TIME_NV                                      0x8E2A
#define GL_PRESENT_DURATION_NV                                  0x8E2B

#ifndef GL_NV_present_video
#define GL_NV_present_video 1
#ifdef GL_GLEXT_PROTOTYPES
GLAPI void GLAPIENTRY glPresentFrameKeyedNV (GLuint video_slot,
GLuint64EXT minPresentTime, GLuint beginPresentTimeId, GLuint
presentDurationId, GLenum type, GLenum target0, GLuint fill0, GLuint
key0, GLenum target1, GLuint fill1, GLuint key1);
GLAPI void GLAPIENTRY glPresentFrameDualFillNV (GLuint video_slot,
GLuint64EXT minPresentTime, GLuint beginPresentTimeId, GLuint
presentDurationId, GLenum type, GLenum target0, GLuint fill0, GLenum
target1, GLuint fill1, GLenum target2, GLuint fill2, GLenum target3,
GLuint fill3);
GLAPI void GLAPIENTRY glGetVideoivNV (GLuint video_slot, GLenum pname,
GLint *params);
GLAPI void GLAPIENTRY glGetVideouivNV (GLuint video_slot, GLenum pname,
GLuint *params);
GLAPI void GLAPIENTRY glGetVideoi64vNV (GLuint video_slot, GLenum
pname, GLint64EXT *params);
GLAPI void GLAPIENTRY glGetVideoui64vNV (GLuint video_slot, GLenum
pname, GLuint64EXT *params);
#endif /* GL_GLEXT_PROTOTYPES */
typedef void (GLAPIENTRYP PFNGLPRESENTFRAMEKEYEDNVPROC) (GLuint
video_slot, GLuint64EXT minPresentTime, GLuint beginPresentTimeId,
GLuint presentDurationId, GLenum type, GLenum target0, GLuint fill0,
GLuint key0, GLenum target1, GLuint fill1, GLuint key1);
typedef void (GLAPIENTRYP PFNGLPRESENTFRAMEDUALFILLNVPROC) (GLuint
video_slot, GLuint64EXT minPresentTime, GLuint beginPresentTimeId,
```

```
GLuint presentDurationId, GLenum type, GLenum target0, GLuint fill0,
GLenum target1, GLuint fill1, GLenum target2, GLuint fill2, GLenum
target3, GLuint fill3);
typedef void (GLAPIENTRYP PFNGLGETVIDEOIVNVPROC) (GLuint video_slot,
GLenum pname, GLint *params);
typedef void (GLAPIENTRYP PFNGLGETVIDEOUIVNVPROC) (GLuint video_slot,
GLenum pname, GLuint *params);
typedef void (GLAPIENTRYP PFNGLGETVIDEOI64VNVPROC) (GLuint video_slot,
GLenum pname, GLint64EXT *params);
typedef void (GLAPIENTRYP PFNGLGETVIDEOUI64VNVPROC) (GLuint video_slot,
GLenum pname, GLuint64EXT *params);
#endif

#ifndef GLX_NV_present_video
#define GLX_NV_present_video
#ifdef GLX_GLXEXT_PROTOTYPES
extern unsigned int *glXEnumerateVideoDevicesNV(Display *dpy,
                                                int screen,
                                                int *nelements);
extern int glXBindVideoDeviceNV(Display *dpy,
                                unsigned int video_slot,
                                unsigned int video_device,
                                const int *attrib_list);
#endif
typedef unsigned int* ( * PFNGLXENUMERATEVIDEODEVICESNVPROC) (Display
*dpy,
                                                              int
screen,
                                                              int
*nelements);
typedef int ( * PFNGLXBINDVIDEODEVICENVPROC) (Display *dpy,
                                              unsigned int video_slot,
                                              unsigned int
video_device,
                                              const int *attrib_list);
#endif

/* NV_present_video */
#define WGL_NUM_VIDEO_SLOTS_NV            0x20F0

/* WGL_NV_present_video */
typedef INT (GLAPI * PFNWGLENUMERATEVIDEODEVICESNVPROC) (HDC hDC,
HVIDEOOUTPUTDEVICENV *phDeviceList);
typedef BOOL (GLAPI * PFNWGLBINDVIDEODEVICENVPROC) (HDC hDC, UINT
uVideoSlot, HVIDEOOUTPUTDEVICENV hVideoDevice, const int *
piAttribList);
typedef BOOL (GLAPI * PFNWGLQUERYCURRENTCONTEXTNVPROC) (INT iAttribute,
INT *piValue);
```

# 12 NVAPI VIO

```
typedef NvU32   NVVIOOWNERID;   // Unique identifier for VIO owner
(process identifier or NVVIOOWNERID_NONE)
#define NVVIOOWNERID_NONE  0    // Unregistered ownerId

typedef enum _NVVIOOWNERTYPE    // Owner type for device
{
    NVVIOOWNERTYPE_NONE,        //  No owner for device
    NVVIOOWNERTYPE_APPLICATION, //  Application owns device
    NVVIOOWNERTYPE_DESKTOP,     //  Desktop transparent mode owns
device (not applicable for video input)
}NVVIOOWNERTYPE;

// Access rights for NvAPI_VIO_Open()
#define NVVIO_O_READ  0x00000000      // Read access             (not
applicable for video output)
#define NVVIO_O_WRITE_EXCLUSIVE  0x00010001      // Write exclusive
access  (not applicable for video input)

#define NVVIO_VALID_ACCESSRIGHTS ( NVVIO_O_READ | \
                                   NVVIO_O_WRITE_EXCLUSIVE )


// VIO_DATA.ulOwnerID high-bit is set only if device has been
initialized by VIOAPI
// examined at NvAPI_GetCapabilities|NvAPI_VIO_Open to determine if
settings need to be applied from registry or POR state read
#define NVVIO_OWNERID_INITIALIZED  0x80000000

// VIO_DATA.ulOwnerID next-bit is set only if device is currently in
exclusive write access mode from NvAPI_VIO_Open()
#define NVVIO_OWNERID_EXCLUSIVE    0x40000000

// VIO_DATA.ulOwnerID lower bits are:
//  NVGVOOWNERTYPE_xxx enumerations indicating use context
#define NVVIO_OWNERID_TYPEMASK     0x0FFFFFFF // mask for
NVVIOOWNERTYPE_xxx
```

```
//--------------------------------------------------------------------------
// Enumerations
//--------------------------------------------------------------------------

// Video signal format and resolution
typedef enum _NVVIOSIGNALFORMAT
{
    NVVIOSIGNALFORMAT_NONE,                                         //
Invalid signal format
    NVVIOSIGNALFORMAT_487I_59_94_SMPTE259_NTSC,     // 01  487i
59.94Hz  (SMPTE259) NTSC
    NVVIOSIGNALFORMAT_576I_50_00_SMPTE259_PAL,      // 02  576i
50.00Hz  (SMPTE259) PAL
    NVVIOSIGNALFORMAT_1035I_59_94_SMPTE260,         // 03  1035i
59.94Hz  (SMPTE260)
    NVVIOSIGNALFORMAT_1035I_60_00_SMPTE260,         // 04  1035i
60.00Hz  (SMPTE260)
    NVVIOSIGNALFORMAT_1080I_50_00_SMPTE295,         // 05  1080i
50.00Hz  (SMPTE295)
    NVVIOSIGNALFORMAT_1080I_60_00_SMPTE274,         // 06  1080i
60.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080I_59_94_SMPTE274,         // 07  1080i
59.94Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080I_50_00_SMPTE274,         // 08  1080i
50.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080P_30_00_SMPTE274,         // 09  1080p
30.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080P_29_97_SMPTE274,         // 10  1080p
29.97Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080P_25_00_SMPTE274,         // 11  1080p
25.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080P_24_00_SMPTE274,         // 12  1080p
24.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080P_23_976_SMPTE274,        // 13  1080p
23.976Hz (SMPTE274)
    NVVIOSIGNALFORMAT_720P_60_00_SMPTE296,          // 14  720p
60.00Hz  (SMPTE296)
    NVVIOSIGNALFORMAT_720P_59_94_SMPTE296,          // 15  720p
59.94Hz  (SMPTE296)
    NVVIOSIGNALFORMAT_720P_50_00_SMPTE296,          // 16  720p
50.00Hz  (SMPTE296)
    NVVIOSIGNALFORMAT_1080I_48_00_SMPTE274,         // 17  1080I
48.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080I_47_96_SMPTE274,         // 18  1080I
47.96Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_720P_30_00_SMPTE296,          // 19  720p
30.00Hz  (SMPTE296)
    NVVIOSIGNALFORMAT_720P_29_97_SMPTE296,          // 20  720p
29.97Hz  (SMPTE296)
    NVVIOSIGNALFORMAT_720P_25_00_SMPTE296,          // 21  720p
25.00Hz  (SMPTE296)
    NVVIOSIGNALFORMAT_720P_24_00_SMPTE296,          // 22  720p
24.00Hz  (SMPTE296)
```

```
    NVVIOSIGNALFORMAT_720P_23_98_SMPTE296,          // 23  720p
23.98Hz  (SMPTE296)
    NVVIOSIGNALFORMAT_2048P_30_00_SMPTE372,         // 24  2048p
30.00Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048P_29_97_SMPTE372,         // 25  2048p
29.97Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048I_60_00_SMPTE372,         // 26  2048i
60.00Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048I_59_94_SMPTE372,         // 27  2048i
59.94Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048P_25_00_SMPTE372,         // 28  2048p
25.00Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048I_50_00_SMPTE372,         // 29  2048i
50.00Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048P_24_00_SMPTE372,         // 30  2048p
24.00Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048P_23_98_SMPTE372,         // 31  2048p
23.98Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048I_48_00_SMPTE372,         // 32  2048i
48.00Hz  (SMPTE372)
    NVVIOSIGNALFORMAT_2048I_47_96_SMPTE372,         // 33  2048i
47.96Hz  (SMPTE372)

    NVVIOSIGNALFORMAT_1080PSF_25_00_SMPTE274,       // 34  1080PsF
25.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080PSF_29_97_SMPTE274,       // 35  1080PsF
29.97Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080PSF_30_00_SMPTE274,       // 36  1080PsF
30.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080PSF_24_00_SMPTE274,       // 37  1080PsF
24.00Hz  (SMPTE274)
    NVVIOSIGNALFORMAT_1080PSF_23_98_SMPTE274,       // 38  1080PsF
23.98Hz  (SMPTE274)

    NVVIOSIGNALFORMAT_1080P_50_00_SMPTE274_3G_LEVEL_A, // 39  1080P
50.00Hz  (SMPTE274) 3G Level A
    NVVIOSIGNALFORMAT_1080P_59_94_SMPTE274_3G_LEVEL_A, // 40  1080P
59.94Hz  (SMPTE274) 3G Level A
    NVVIOSIGNALFORMAT_1080P_60_00_SMPTE274_3G_LEVEL_A, // 41  1080P
60.00Hz  (SMPTE274) 3G Level A

    NVVIOSIGNALFORMAT_1080P_60_00_SMPTE274_3G_LEVEL_B, // 42  1080p
60.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_1080I_60_00_SMPTE274_3G_LEVEL_B, // 43  1080i
60.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048I_60_00_SMPTE372_3G_LEVEL_B, // 44  2048i
60.00Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080P_50_00_SMPTE274_3G_LEVEL_B, // 45  1080p
50.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_1080I_50_00_SMPTE274_3G_LEVEL_B, // 46  1080i
50.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048I_50_00_SMPTE372_3G_LEVEL_B, // 47  2048i
50.00Hz  (SMPTE372) 3G Level B
```

```
    NVVIOSIGNALFORMAT_1080P_30_00_SMPTE274_3G_LEVEL_B, // 48  1080p
30.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048P_30_00_SMPTE372_3G_LEVEL_B, // 49  2048p
30.00Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080P_25_00_SMPTE274_3G_LEVEL_B, // 50  1080p
25.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048P_25_00_SMPTE372_3G_LEVEL_B, // 51  2048p
25.00Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080P_24_00_SMPTE274_3G_LEVEL_B, // 52  1080p
24.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048P_24_00_SMPTE372_3G_LEVEL_B, // 53  2048p
24.00Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080I_48_00_SMPTE274_3G_LEVEL_B, // 54  1080i
48.00Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048I_48_00_SMPTE372_3G_LEVEL_B, // 55  2048i
48.00Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080P_59_94_SMPTE274_3G_LEVEL_B, // 56  1080p
59.94Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_1080I_59_94_SMPTE274_3G_LEVEL_B, // 57  1080i
59.94Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048I_59_94_SMPTE372_3G_LEVEL_B, // 58  2048i
59.94Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080P_29_97_SMPTE274_3G_LEVEL_B, // 59  1080p
29.97Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048P_29_97_SMPTE372_3G_LEVEL_B, // 60  2048p
29.97Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080P_23_98_SMPTE274_3G_LEVEL_B, // 61  1080p
29.98Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048P_23_98_SMPTE372_3G_LEVEL_B, // 62  2048p
29.98Hz  (SMPTE372) 3G Level B
    NVVIOSIGNALFORMAT_1080I_47_96_SMPTE274_3G_LEVEL_B, // 63  1080i
47.96Hz  (SMPTE274) 3G Level B
    NVVIOSIGNALFORMAT_2048I_47_96_SMPTE372_3G_LEVEL_B, // 64  2048i
47.96Hz  (SMPTE372) 3G Level B

    NVVIOSIGNALFORMAT_END  // 65  To indicate end of signal format list
}NVVIOSIGNALFORMAT;

// SMPTE standards format
typedef enum _NVVIOVIDEOSTANDARD
{
    NVVIOVIDEOSTANDARD_SMPTE259,       // SMPTE259
    NVVIOVIDEOSTANDARD_SMPTE260,       // SMPTE260
    NVVIOVIDEOSTANDARD_SMPTE274,       // SMPTE274
    NVVIOVIDEOSTANDARD_SMPTE295,       // SMPTE295
    NVVIOVIDEOSTANDARD_SMPTE296,       // SMPTE296
    NVVIOVIDEOSTANDARD_SMPTE372,       // SMPTE372
}NVVIOVIDEOSTANDARD;

// HD or SD video type
typedef enum _NVVIOVIDEOTYPE
{
    NVVIOVIDEOTYPE_SD,       // Standard-definition (SD)
    NVVIOVIDEOTYPE_HD,       // High-definition     (HD)
```

```
}NVVIOVIDEOTYPE;

// Interlace mode
typedef enum _NVVIOINTERLACEMODE
{
    NVVIOINTERLACEMODE_PROGRESSIVE, // Progressive                (p)
    NVVIOINTERLACEMODE_INTERLACE,   // Interlace                  (i)
    NVVIOINTERLACEMODE_PSF,         // Progressive Segment Frame (psf)
}NVVIOINTERLACEMODE;

// Video data format
typedef enum _NVVIODATAFORMAT
{
    NVVIODATAFORMAT_UNKNOWN   = -1,           // Invalid DataFormat
    NVVIODATAFORMAT_R8G8B8_TO_YCRCB444,       // R8:G8:B8
=> YCrCb  (4:4:4)
    NVVIODATAFORMAT_R8G8B8A8_TO_YCRCBA4444,   // R8:G8:B8:A8
=> YCrCbA (4:4:4:4)
    NVVIODATAFORMAT_R8G8B8Z10_TO_YCRCBZ4444,  // R8:G8:B8:Z10
=> YCrCbZ (4:4:4:4)
    NVVIODATAFORMAT_R8G8B8_TO_YCRCB422,       // R8:G8:B8
=> YCrCb  (4:2:2)
    NVVIODATAFORMAT_R8G8B8A8_TO_YCRCBA4224,   // R8:G8:B8:A8
=> YCrCbA (4:2:2:4)
    NVVIODATAFORMAT_R8G8B8Z10_TO_YCRCBZ4224,  // R8:G8:B8:Z10
=> YCrCbZ (4:2:2:4)
    NVVIODATAFORMAT_X8X8X8_444_PASSTHRU,      // R8:G8:B8
=> RGB    (4:4:4)
    NVVIODATAFORMAT_X8X8X8A8_4444_PASSTHRU,   // R8:G8:B8:A8
=> RGBA   (4:4:4:4)
    NVVIODATAFORMAT_X8X8X8Z10_4444_PASSTHRU,  // R8:G8:B8:Z10
=> RGBZ   (4:4:4:4)
    NVVIODATAFORMAT_X10X10X10_444_PASSTHRU,   // Y10:CR10:CB10
=> YCrCb  (4:4:4)
    NVVIODATAFORMAT_X10X8X8_444_PASSTHRU,     // Y10:CR8:CB8
=> YCrCb  (4:4:4)
    NVVIODATAFORMAT_X10X8X8A10_4444_PASSTHRU,  // Y10:CR8:CB8:A10
=> YCrCbA (4:4:4:4)
    NVVIODATAFORMAT_X10X8X8Z10_4444_PASSTHRU,  // Y10:CR8:CB8:Z10
=> YCrCbZ (4:4:4:4)
    NVVIODATAFORMAT_DUAL_R8G8B8_TO_DUAL_YCRCB422,       // R8:G8:B8 +
R8:G8:B8     => YCrCb  (4:2:2 + 4:2:2)
    NVVIODATAFORMAT_DUAL_X8X8X8_TO_DUAL_422_PASSTHRU,   // Y8:CR8:CB8 +
Y8:CR8:CB8 => YCrCb  (4:2:2 + 4:2:2)
    NVVIODATAFORMAT_R10G10B10_TO_YCRCB422,       // R10:G10:B10
=> YCrCb  (4:2:2)
    NVVIODATAFORMAT_R10G10B10_TO_YCRCB444,       // R10:G10:B10
=> YCrCb  (4:4:4)
    NVVIODATAFORMAT_Y12CR12CB12_TO_YCRCB444,     // Y12:CR12:CB12
=> YCrCb  (4:4:4)
    NVVIODATAFORMAT_Y12CR12CB12_TO_YCRCB422,     // Y12:CR12:CB12
=> YCrCb  (4:2:2)
    NVVIODATAFORMAT_Y10CR10CB10_TO_YCRCB422,     // Y10:CR10:CB10
=> YCrCb  (4:2:2)
```

```
    NVVIODATAFORMAT_Y8CR8CB8_TO_YCRCB422,       // Y8:CR8:CB8
=> YCrCb  (4:2:2)
    NVVIODATAFORMAT_Y10CR8CB8A10_TO_YCRCBA4224, // Y10:CR8:CB8:A10
=> YCrCbA (4:2:2:4)
    NVVIODATAFORMAT_R10G10B10_TO_RGB444,        // R10:G10:B10
=> RGB    (4:4:4)
    NVVIODATAFORMAT_R12G12B12_TO_RGB444,        // R12:G12:B12
=> RGB    (4:4:4)
}NVVIODATAFORMAT;

// Video output area
typedef enum _NVVIOOUTPUTAREA
{
    NVVIOOUTPUTAREA_FULLSIZE,       // Output to entire video
resolution (full size)
    NVVIOOUTPUTAREA_SAFEACTION,     // Output to centered 90% of video
resolution (safe action)
    NVVIOOUTPUTAREA_SAFETITLE,      // Output to centered 80% of video
resolution (safe title)
}NVVIOOUTPUTAREA;

// Synchronization source
typedef enum _NVVIOSYNCSOURCE
{
    NVVIOSYNCSOURCE_SDISYNC,       // SDI Sync  (Digital input)
    NVVIOSYNCSOURCE_COMPSYNC,      // COMP Sync (Composite input)
}NVVIOSYNCSOURCE;

// Composite synchronization type
typedef enum _NVVIOCOMPSYNCTYPE
{
    NVVIOCOMPSYNCTYPE_AUTO,       // Auto-detect
    NVVIOCOMPSYNCTYPE_BILEVEL,    // Bi-level signal
    NVVIOCOMPSYNCTYPE_TRILEVEL,   // Tri-level signal
}NVVIOCOMPSYNCTYPE;

// Video input output status
typedef enum _NVVIOINPUTOUTPUTSTATUS
{
    NVINPUTOUTPUTSTATUS_OFF,       // Not in use
    NVINPUTOUTPUTSTATUS_ERROR,     // Error detected
    NVINPUTOUTPUTSTATUS_SDI_SD,    // SDI (standard-definition)
    NVINPUTOUTPUTSTATUS_SDI_HD,    // SDI (high-definition)
}NVVIOINPUTOUTPUTSTATUS;

// Synchronization input status
typedef enum _NVVIOSYNCSTATUS
{
    NVVIOSYNCSTATUS_OFF,         // Sync not detected
    NVVIOSYNCSTATUS_ERROR,       // Error detected
    NVVIOSYNCSTATUS_SYNCLOSS,    // Genlock in use, format mismatch
with output
    NVVIOSYNCSTATUS_COMPOSITE,   // Composite sync
```

```
    NVVIOSYNCSTATUS_SDI_SD,        // SDI sync (standard-definition)
    NVVIOSYNCSTATUS_SDI_HD,        // SDI sync (high-definition)
}NVVIOSYNCSTATUS;

//Video Capture Status
typedef enum _NVVIOCAPTURESTATUS
{
    NVVIOSTATUS_STOPPED,        // Sync not detected
    NVVIOSTATUS_RUNNING,        // Error detected
    NVVIOSTATUS_ERROR,          // Genlock in use, format mismatch with
output
}NVVIOCAPTURESTATUS;

//Video Capture Status
typedef enum _NVVIOSTATUSTYPE
{
    NVVIOSTATUSTYPE_IN,         // Input Status
    NVVIOSTATUSTYPE_OUT,        // Output Status
}NVVIOSTATUSTYPE;

#define NVAPI_MAX_VIO_DEVICES                 8   // Assumption,
maximum 4 SDI input and 4 SDI output cards supported on a system
#define NVAPI_MAX_VIO_JACKS                   4   // 4 physical jacks
supported on each SDI input card.
#define NVAPI_MAX_VIO_CHANNELS_PER_JACK       2   // Each physical jack
an on SDI input card can have
                                                  // two "channels" in
the case of "3G" VideoFormats, as specified
                                                  // by SMPTE 425; for
non-3G VideoFormats, only the first channel within
                                                  // a physical jack is
valid
#define NVAPI_MAX_VIO_STREAMS                 4   // 4 Streams, 1 per
physical jack
#define NVAPI_MIN_VIO_STREAMS                 1
#define NVAPI_MAX_VIO_LINKS_PER_STREAM        2   // SDI input supports
a max of 2 links per stream
#define NVAPI_MAX_FRAMELOCK_MAPPING_MODES     20
#define NVAPI_GVI_MIN_RAW_CAPTURE_IMAGES      1   // Min number of
capture images
#define NVAPI_GVI_MAX_RAW_CAPTURE_IMAGES      32  // Max number of
capture images
#define NVAPI_GVI_DEFAULT_RAW_CAPTURE_IMAGES  5   // Default number of
capture images

// Data Signal notification events. These need a event handler in RM.
// Register/Unregister and PopEvent NVAPI's are already available.

// Device configuration
typedef enum _NVVIOCONFIGTYPE
{
    NVVIOCONFIGTYPE_IN,         // Input Status
    NVVIOCONFIGTYPE_OUT,        // Output Status
```

```
}NVVIOCONFIGTYPE;

typedef enum _NVVIOCOLORSPACE
{
    NVVIOCOLORSPACE_UNKNOWN,
    NVVIOCOLORSPACE_YCBCR,
    NVVIOCOLORSPACE_YCBCRA,
    NVVIOCOLORSPACE_YCBCRD,
    NVVIOCOLORSPACE_GBR,
    NVVIOCOLORSPACE_GBRA,
    NVVIOCOLORSPACE_GBRD,
} NVVIOCOLORSPACE;

// Component sampling
typedef enum _NVVIOCOMPONENTSAMPLING
{
    NVVIOCOMPONENTSAMPLING_UNKNOWN,
    NVVIOCOMPONENTSAMPLING_4444,
    NVVIOCOMPONENTSAMPLING_4224,
    NVVIOCOMPONENTSAMPLING_444,
    NVVIOCOMPONENTSAMPLING_422
} NVVIOCOMPONENTSAMPLING;

typedef enum _NVVIOBITSPERCOMPONENT
{
    NVVIOBITSPERCOMPONENT_UNKNOWN,
    NVVIOBITSPERCOMPONENT_8,
    NVVIOBITSPERCOMPONENT_10,
    NVVIOBITSPERCOMPONENT_12,
} NVVIOBITSPERCOMPONENT;

typedef enum _NVVIOLINKID
{
    NVVIOLINKID_UNKNOWN,
    NVVIOLINKID_A,
    NVVIOLINKID_B,
    NVVIOLINKID_C,
    NVVIOLINKID_D
} NVVIOLINKID;

//--------------------------------------------------------------------------
// Structures
//--------------------------------------------------------------------------

#define NVVIOCAPS_VIDOUT_SDI                0x00000001      // Supports
Serial Digital Interface (SDI) output
#define NVVIOCAPS_SYNC_INTERNAL             0x00000100      // Supports
Internal timing source
#define NVVIOCAPS_SYNC_GENLOCK              0x00000200      // Supports
Genlock timing source
#define NVVIOCAPS_SYNCSRC_SDI               0x00001000      // Supports
Serial Digital Interface (SDI) synchronization input
```

```
#define NVVIOCAPS_SYNCSRC_COMP              0x00002000      // Supports
Composite synchronization input
#define NVVIOCAPS_OUTPUTMODE_DESKTOP        0x00010000      // Supports
Desktop transparent mode
#define NVVIOCAPS_OUTPUTMODE_OPENGL         0x00020000      // Supports
OpenGL application mode
#define NVVIOCAPS_VIDIN_SDI                 0x00100000      // Supports
Serial Digital Interface (SDI) input

#define NVVIOCLASS_SDI                      0x00000001      // SDI-
class interface: SDI output with two genlock inputs

// Device capabilities
typedef struct _NVVIOCAPS
{
    NvU32             version;            // Structure version
    NvAPI_String      adapterName;        // Graphics adapter name
    NvU32             adapterClass;       // Graphics adapter classes
(NVVIOCLASS_SDI mask)
    NvU32             adapterCaps;        // Graphics adapter
capabilities (NVVIOCAPS_* mask)
    NvU32             dipSwitch;          // On-board DIP switch
settings bits
    NvU32             dipSwitchReserved;  // On-board DIP switch
settings reserved bits
    NvU32             boardID;            // Board ID
    struct                                //
    {                                     // Driver version
        NvU32          majorVersion;      // Major version
        NvU32          minorVersion;      // Minor version
    } driver;                             //
    struct                                //
    {                                     // Firmware version
        NvU32          majorVersion;      // Major version
        NvU32          minorVersion;      // Minor version
    } firmWare;                           //
    NVVIOOWNERID      ownerId;            // Unique identifier for
owner of video output (NVVIOOWNERID_INVALID if free running)
    NVVIOOWNERTYPE    ownerType;          // Owner type (OpenGL
application or Desktop mode)
} NVVIOCAPS;

#define NVVIOCAPS_VER   MAKE_NVAPI_VERSION(NVVIOCAPS,1)

// Input channel status
typedef struct _NVVIOCHANNELSTATUS
{
    NvU32                   smpte352;          // 4-byte SMPTE 352 video
payload identifier
    NVVIOSIGNALFORMAT       signalFormat;      // Signal format
    NVVIOBITSPERCOMPONENT   bitsPerComponent;  // Bits per component
    NVVIOCOMPONENTSAMPLING  samplingFormat;    // Sampling format
    NVVIOCOLORSPACE         colorSpace;        // Color space
```

```
    NVVIOLINKID            linkID;            // Link ID
} NVVIOCHANNELSTATUS;

// Input device status
typedef struct _NVVIOINPUTSTATUS
{
    NVVIOCHANNELSTATUS
vidIn[NVAPI_MAX_VIO_JACKS][NVAPI_MAX_VIO_CHANNELS_PER_JACK];     //
Video input status per channel within a jack
    NVVIOCAPTURESTATUS     captureStatus;     // status of video
capture
} NVVIOINPUTSTATUS;

// Output device status
typedef struct _NVVIOOUTPUTSTATUS
{
    NVVIOINPUTOUTPUTSTATUS  vid1Out;     // Video 1 output status
    NVVIOINPUTOUTPUTSTATUS  vid2Out;     // Video 2 output status
    NVVIOSYNCSTATUS         sdiSyncIn;   // SDI sync input status
    NVVIOSYNCSTATUS         compSyncIn;  // Composite sync input status
    NvU32                    syncEnable;  // Sync enable (TRUE if using
syncSource)
    NVVIOSYNCSOURCE         syncSource;  // Sync source
    NVVIOSIGNALFORMAT        syncFormat;  // Sync format
    NvU32 frameLockEnable;                // Framelock enable flag
    NvU32 outputVideoLocked;              // Output locked status
    NvU32 dataIntegrityCheckErrorCount;   // Data integrity check error
count
    NvU32 dataIntegrityCheckEnabled;      // Data integrity check
status enabled
    NvU32 dataIntegrityCheckFailed;       // Data integrity check
status failed
    NvU32 uSyncSourceLocked;              // genlocked to framelocked
to ref signal
    NvU32 uPowerOn;                       // TRUE: indicates there is
sufficient power
} NVVIOOUTPUTSTATUS;

// Video device status.
typedef struct _NVVIOSTATUS
{
    NvU32 version;                        // Structure version
    NVVIOSTATUSTYPE nvvioStatusType;      // Input or Output status
    union
    {
        NVVIOINPUTSTATUS  inStatus;       //  Input device status
        NVVIOOUTPUTSTATUS outStatus;      //  Output device status
    }vioStatus;
} NVVIOSTATUS;

#define NVVIOSTATUS_VER   MAKE_NVAPI_VERSION(NVVIOSTATUS,1)

// Output region
```

```
typedef struct _NVVIOOUTPUTREGION
{
    NvU32              x;         // Horizontal origin in pixels
    NvU32              y;         // Vertical origin in pixels
    NvU32              width;     // Width of region in pixels
    NvU32              height;    // Height of region in pixels
} NVVIOOUTPUTREGION;

// Gamma ramp (8-bit index)
typedef struct _NVVIOGAMMARAMP8
{
    NvU16 uRed[256];    // Red channel gamma ramp (8-bit index, 16-bit
values)
    NvU16 uGreen[256];  // Green channel gamma ramp (8-bit index, 16-
bit values)
    NvU16 uBlue[256];   // Blue channel gamma ramp (8-bit index, 16-bit
values)
} NVVIOGAMMARAMP8;

// Gamma ramp (10-bit index)
typedef struct _NVVIOGAMMARAMP10
{
    NvU16 uRed[1024];    // Red channel gamma ramp (10-bit index, 16-
bit values)
    NvU16 uGreen[1024];  // Green channel gamma ramp (10-bit index, 16-
bit values)
    NvU16 uBlue[1024];   // Blue channel gamma ramp (10-bit index, 16-
bit values)
} NVVIOGAMMARAMP10;

// Sync delay
typedef struct _NVVIOSYNCDELAY
{
    NvU32 version;          // Structure version
    NvU32 horizontalDelay;  // Horizontal delay in pixels
    NvU32 verticalDelay;    // Vertical delay in lines
} NVVIOSYNCDELAY;

#define NVVIOSYNCDELAY_VER   MAKE_NVAPI_VERSION(NVVIOSYNCDELAY,1)


// Video mode information
typedef struct _NVVIOVIDEOMODE
{
    NvU32 horizontalPixels;  // Horizontal resolution (in pixels)
    NvU32 verticalLines;     // Vertical resolution for frame (in
lines)
    float fFrameRate;       // Frame rate
    NVVIOINTERLACEMODE   interlaceMode;   // Interlace mode
    NVVIOVIDEOSTANDARD   videoStandard;   // SMPTE standards format
    NVVIOVIDEOTYPE       videoType;       // HD or SD signal
classification
} NVVIOVIDEOMODE;
```

```
// Signal format details
typedef struct _NVVIOSIGNALFORMATDETAIL
{
    NVVIOSIGNALFORMAT    signalFormat;  // Signal format enumerated
value
    NVVIOVIDEOMODE       videoMode;     // Video mode for signal format
}NVVIOSIGNALFORMATDETAIL;

// Buffer formats
#define NVVIOBUFFERFORMAT_R8G8B8                 0x00000001   //
R8:G8:B8
#define NVVIOBUFFERFORMAT_R8G8B8Z24              0x00000002   //
R8:G8:B8:Z24
#define NVVIOBUFFERFORMAT_R8G8B8A8               0x00000004   //
R8:G8:B8:A8
#define NVVIOBUFFERFORMAT_R8G8B8A8Z24            0x00000008   //
R8:G8:B8:A8:Z24
#define NVVIOBUFFERFORMAT_R16FPG16FPB16FP        0x00000010   //
R16FP:G16FP:B16FP
#define NVVIOBUFFERFORMAT_R16FPG16FPB16FPZ24     0x00000020   //
R16FP:G16FP:B16FP:Z24
#define NVVIOBUFFERFORMAT_R16FPG16FPB16FPA16FP   0x00000040   //
R16FP:G16FP:B16FP:A16FP
#define NVVIOBUFFERFORMAT_R16FPG16FPB16FPA16FPZ24 0x00000080   //
R16FP:G16FP:B16FP:A16FP:Z24

// Data format details
typedef struct _NVVIODATAFORMATDETAIL
{
    NVVIODATAFORMAT   dataFormat;   // Data format enumerated value
    NvU32             vioCaps;      // Data format capabilities
(NVVIOCAPS_* mask)
}NVVIODATAFORMATDETAIL;

// Colorspace conversion
typedef struct _NVVIOCOLORCONVERSION
{
    NvU32       version;            //  Structure version
    float       colorMatrix[3][3];  //  Output[n] =
    float       colorOffset[3];     //  Input[0] * colorMatrix[n][0] +
    float       colorScale[3];      //  Input[1] * colorMatrix[n][1] +
                                    //  Input[2] * colorMatrix[n][2] +
                                    //  OutputRange * colorOffset[n]
                                    //  where OutputRange is the
standard magnitude of
                                    //  Output[n][n] and colorMatrix
and colorOffset
                                    //  values are within the range -
1.0 to +1.0
    NvU32      compositeSafe;       //  compositeSafe constrains
luminance range when using composite output
} NVVIOCOLORCONVERSION;
```

```
#define NVVIOCOLORCONVERSION_VER
MAKE_NVAPI_VERSION(NVVIOCOLORCONVERSION,1)

// Gamma correction
typedef struct _NVVIOGAMMACORRECTION
{
    NvU32            version;       // Structure version
    NvU32            vioGammaCorrectionType;  // Gamma correction type
(8-bit or 10-bit)
    union                           // Gamma correction:
    {
        NVVIOGAMMARAMP8  gammaRamp8;    // Gamma ramp (8-bit index, 16-
bit values)
        NVVIOGAMMARAMP10 gammaRamp10;   // Gamma ramp (10-bit index,
16-bit values)
    }gammaRamp;
    float            fGammaValueR;
      // Red Gamma value within gamma ranges. 0.5 - 6.0
    float            fGammaValueG;
      // Green Gamma value within gamma ranges. 0.5 - 6.0
    float            fGammaValueB;
      // Blue Gamma value within gamma ranges. 0.5 - 6.0
} NVVIOGAMMACORRECTION;

#define NVVIOGAMMACORRECTION_VER
MAKE_NVAPI_VERSION(NVVIOGAMMACORRECTION,1)

#define MAX_NUM_COMPOSITE_RANGE      2   // maximum number of ranges
per channel

typedef struct _NVVIOCOMPOSITERANGE
{
    NvU32   uRange;
    NvU32   uEnabled;
    NvU32   uMin;
    NvU32   uMax;
} NVVIOCOMPOSITERANGE;


// Device configuration (fields masks indicating NVVIOCONFIG fields to
use for NvVioGet/Set/Test/CreateDefaultConfig())
#define NVVIOCONFIG_SIGNALFORMAT            0x00000001      // fields:
signalFormat
#define NVVIOCONFIG_DATAFORMAT              0x00000002      // fields:
dataFormat
#define NVVIOCONFIG_OUTPUTREGION            0x00000004      // fields:
outputRegion
#define NVVIOCONFIG_OUTPUTAREA              0x00000008      // fields:
outputArea
#define NVVIOCONFIG_COLORCONVERSION         0x00000010      // fields:
colorConversion
```

```
#define NVVIOCONFIG_GAMMACORRECTION         0x00000020      // fields:
gammaCorrection
#define NVVIOCONFIG_SYNCSOURCEENABLE        0x00000040      // fields:
syncSource and syncEnable
#define NVVIOCONFIG_SYNCDELAY               0x00000080      // fields:
syncDelay
#define NVVIOCONFIG_COMPOSITESYNCTYPE       0x00000100      // fields:
compositeSyncType
#define NVVIOCONFIG_FRAMELOCKENABLE         0x00000200      // fields:
EnableFramelock
#define NVVIOCONFIG_422FILTER               0x00000400      // fields:
bEnable422Filter
#define NVVIOCONFIG_COMPOSITETERMINATE      0x00000800      // fields:
bCompositeTerminate
#define NVVIOCONFIG_DATAINTEGRITYCHECK      0x00001000      // fields:
bEnableDataIntegrityCheck
#define NVVIOCONFIG_CSCOVERRIDE             0x00002000      // fields:
colorConversion override
#define NVVIOCONFIG_FLIPQUEUELENGTH         0x00004000      // fields:
flipqueuelength control
#define NVVIOCONFIG_ANCTIMECODEGENERATION   0x00008000      // fields:
bEnableANCTimeCodeGeneration
#define NVVIOCONFIG_COMPOSITE               0x00010000      // fields:
bEnableComposite
#define NVVIOCONFIG_ALPHAKEYCOMPOSITE       0x00020000      // fields:
bEnableAlphaKeyComposite
#define NVVIOCONFIG_COMPOSITE_Y             0x00040000      // fields:
compRange
#define NVVIOCONFIG_COMPOSITE_CR            0x00080000      // fields:
compRange
#define NVVIOCONFIG_COMPOSITE_CB            0x00100000      // fields:
compRange
#define NVVIOCONFIG_FULL_COLOR_RANGE        0x00200000      // fields:
bEnableFullColorRange
#define NVVIOCONFIG_RGB_DATA                0x00400000      // fields:
bEnableRGBData
#define NVVIOCONFIG_RESERVED_SDIOUTPUTENABLE         0x00800000      //
fields: bEnableSDIOutput
#define NVVIOCONFIG_STREAMS                 0x01000000      // fields:
streams

// Don't forget to update NVVIOCONFIG_VALIDFIELDS in
NvVIOApiInternals.h when NVVIOCONFIG_ALLFIELDS changes.
#define NVVIOCONFIG_ALLFIELDS   ( NVVIOCONFIG_SIGNALFORMAT          | \
                                  NVVIOCONFIG_DATAFORMAT            | \
                                  NVVIOCONFIG_OUTPUTREGION          | \
                                  NVVIOCONFIG_OUTPUTAREA            | \
                                  NVVIOCONFIG_COLORCONVERSION       | \
                                  NVVIOCONFIG_GAMMACORRECTION       | \
                                  NVVIOCONFIG_SYNCSOURCEENABLE      | \
                                  NVVIOCONFIG_SYNCDELAY             | \
                                  NVVIOCONFIG_COMPOSITESYNCTYPE     | \
                                  NVVIOCONFIG_FRAMELOCKENABLE       | \
                                  NVVIOCONFIG_422FILTER             | \
```

```
                                    NVVIOCONFIG_COMPOSITETERMINATE    | \
                                    NVVIOCONFIG_DATAINTEGRITYCHECK    | \
                                    NVVIOCONFIG_CSCOVERRIDE           | \
                                    NVVIOCONFIG_FLIPQUEUELENGTH       | \
                                    NVVIOCONFIG_ANCTIMECODEGENERATION | \
                                    NVVIOCONFIG_COMPOSITE             | \
                                    NVVIOCONFIG_ALPHAKEYCOMPOSITE     | \
                                    NVVIOCONFIG_COMPOSITE_Y           | \
                                    NVVIOCONFIG_COMPOSITE_CR          | \
                                    NVVIOCONFIG_COMPOSITE_CB          | \
                                    NVVIOCONFIG_FULL_COLOR_RANGE      | \
                                    NVVIOCONFIG_RGB_DATA              | \
                                    NVVIOCONFIG_RESERVED_SDIOUTPUTENABLE
| \
                                    NVVIOCONFIG_STREAMS)

#define NVVIOCONFIG_VALIDFIELDS  ( NVVIOCONFIG_SIGNALFORMAT          |
\
                                     NVVIOCONFIG_DATAFORMAT           |
\
                                     NVVIOCONFIG_OUTPUTREGION         |
\
                                     NVVIOCONFIG_OUTPUTAREA           |
\
                                     NVVIOCONFIG_COLORCONVERSION      |
\
                                     NVVIOCONFIG_GAMMACORRECTION      |
\
                                     NVVIOCONFIG_SYNCSOURCEENABLE     |
\
                                     NVVIOCONFIG_SYNCDELAY            |
\
                                     NVVIOCONFIG_COMPOSITESYNCTYPE    |
\
                                     NVVIOCONFIG_FRAMELOCKENABLE      |
\
                                     NVVIOCONFIG_RESERVED_SDIOUTPUTENABLE
| \
                                     NVVIOCONFIG_422FILTER            |
\
                                     NVVIOCONFIG_COMPOSITETERMINATE   |
\
                                     NVVIOCONFIG_DATAINTEGRITYCHECK   |
\
                                     NVVIOCONFIG_CSCOVERRIDE          |
\
                                     NVVIOCONFIG_FLIPQUEUELENGTH      |
\
                                     NVVIOCONFIG_ANCTIMECODEGENERATION |
\
                                     NVVIOCONFIG_COMPOSITE            |
\
                                     NVVIOCONFIG_ALPHAKEYCOMPOSITE    |
\
```

```
                                    NVVIOCONFIG_COMPOSITE_Y           |
\
                                    NVVIOCONFIG_COMPOSITE_CR          |
\
                                    NVVIOCONFIG_COMPOSITE_CB          |
\
                                    NVVIOCONFIG_FULL_COLOR_RANGE      |
\
                                    NVVIOCONFIG_RGB_DATA              |
\
                                    NVVIOCONFIG_RESERVED_SDIOUTPUTENABLE
| \
                                    NVVIOCONFIG_STREAMS)

#define NVVIOCONFIG_DRIVERFIELDS ( NVVIOCONFIG_OUTPUTREGION          |
\
                                    NVVIOCONFIG_OUTPUTAREA            |
\
                                    NVVIOCONFIG_COLORCONVERSION       |
\
                                    NVVIOCONFIG_FLIPQUEUELENGTH)

#define NVVIOCONFIG_GAMMAFIELDS  ( NVVIOCONFIG_GAMMACORRECTION       )

#define NVVIOCONFIG_RMCTRLFIELDS ( NVVIOCONFIG_SIGNALFORMAT          |
\
                                    NVVIOCONFIG_DATAFORMAT            |
\
                                    NVVIOCONFIG_SYNCSOURCEENABLE      |
\
                                    NVVIOCONFIG_COMPOSITESYNCTYPE     |
\
                                    NVVIOCONFIG_FRAMELOCKENABLE       |
\
                                    NVVIOCONFIG_422FILTER             |
\
                                    NVVIOCONFIG_COMPOSITETERMINATE    |
\
                                    NVVIOCONFIG_DATAINTEGRITYCHECK    |
\
                                    NVVIOCONFIG_COMPOSITE             |
\
                                    NVVIOCONFIG_ALPHAKEYCOMPOSITE     |
\
                                    NVVIOCONFIG_COMPOSITE_Y           |
\
                                    NVVIOCONFIG_COMPOSITE_CR          |
\
                                    NVVIOCONFIG_COMPOSITE_CB)

#define NVVIOCONFIG_RMSKEWFIELDS ( NVVIOCONFIG_SYNCDELAY             )

#define NVVIOCONFIG_ALLOWSDIRUNNING_FIELDS (
NVVIOCONFIG_DATAINTEGRITYCHECK     | \
```

```
                                                NVVIOCONFIG_SYNCDELAY
| \
                                                NVVIOCONFIG_CSCOVERRIDE
| \
NVVIOCONFIG_ANCTIMECODEGENERATION  | \
                                                NVVIOCONFIG_COMPOSITE
| \
NVVIOCONFIG_ALPHAKEYCOMPOSITE      | \
                                                NVVIOCONFIG_COMPOSITE_Y
| \
                                                NVVIOCONFIG_COMPOSITE_CR
| \
                                                NVVIOCONFIG_COMPOSITE_CB)

 #define NVVIOCONFIG_RMMODESET_FIELDS ( NVVIOCONFIG_SIGNALFORMAT
| \
                                        NVVIOCONFIG_DATAFORMAT
| \
                                        NVVIOCONFIG_SYNCSOURCEENABLE
| \
                                        NVVIOCONFIG_FRAMELOCKENABLE
| \
                                        NVVIOCONFIG_COMPOSITESYNCTYPE )


// Output device configuration
// No members can be deleted from below structure. Only add new members
at the
// end of the structure
typedef struct _NVVIOOUTPUTCONFIG
{
    NVVIOSIGNALFORMAT    signalFormat;    // Signal format for video
output
    NVVIODATAFORMAT      dataFormat;      // Data format for video
output
    NVVIOOUTPUTREGION    outputRegion;    // Region for video output
(Desktop mode)
    NVVIOOUTPUTAREA      outputArea;      // Usable resolution for
video output (safe area)
    NVVIOCOLORCONVERSION colorConversion; // Color conversion.
    NVVIOGAMMACORRECTION gammaCorrection;
    NvU32                syncEnable;      // Sync enable (TRUE to use
syncSource)
    NVVIOSYNCSOURCE      syncSource;      // Sync source
    NVVIOSYNCDELAY       syncDelay;       // Sync delay
    NVVIOCOMPSYNCTYPE    compositeSyncType;   // Composite sync type
    NvU32                frameLockEnable;     // Flag indicating
whether framelock was on/off
    NvU32                psfSignalFormat;     // Inidcates whether
contained format is PSF Signal format
    NvU32                enable422Filter;     // Enables/Disables 4:2:2
filter
```

```
    NvU32                compositeTerminate;     // Composite
termination
    NvU32                enableDataIntegrityCheck;   // Enable data
integrity check: true - enable, false - disable
    NvU32                cscOverride;                // Use provided
CSC color matrix to overwrite
    NvU32                flipQueueLength;            // Number of
buffers used for the internal flipqueue
    NvU32                enableANCTimeCodeGeneration;     // Enable SDI
ANC time code generation
    NvU32                enableComposite;             // Enable
composite
    NvU32                enableAlphaKeyComposite;     // Enable Alpha
key composite
    NVVIOCOMPOSITERANGE  compRange;                   // Composite
ranges
    NvU8                 reservedData[256];           // Inicates last
stored SDI output state TRUE-ON / FALSE-OFF
    NvU32                enableFullColorRange;        // Flag
indicating Full Color Range
    NvU32                enableRGBData;               // Indicates data
is in RGB format
} NVVIOOUTPUTCONFIG;

// Stream configuration
typedef struct _NVVIOSTREAM
{
    NvU32                   bitsPerComponent;  // Bits per component
    NVVIOCOMPONENTSAMPLING  sampling;          // Sampling
    NvU32                   expansionEnable;   // Enable/disable 4:2:2-
>4:4:4 expansion
    NvU32                   numLinks;          // Number of active
links
    struct
    {
        NvU32               jack;              // This stream's link[i]
will use the specified (0-based) channel within the
        NvU32               channel;           // specified (0-based)
jack
    } links[NVAPI_MAX_VIO_LINKS_PER_STREAM];
} NVVIOSTREAM;

// Input device configuration
typedef struct _NVVIOINPUTCONFIG
{
    NvU32                numRawCaptureImages;    // numRawCaptureImages
is the number of frames to keep in the capture queue.
                                                 // must be between
NVAPI_GVI_MIN_RAW_CAPTURE_IMAGES and NVAPI_GVI_MAX_RAW_CAPTURE_IMAGES,
    NVVIOSIGNALFORMAT    signalFormat;           // Signal format.
                                                 // Please note that
both numRawCaptureImages and signalFormat should be set together.
    NvU32                numStreams;             // Number of active
streams.
```

```
    NVVIOSTREAM          streams[NVAPI_MAX_VIO_STREAMS];       //
Stream configurations
} NVVIOINPUTCONFIG;

typedef struct _NVVIOCONFIG
{
    NvU32                version;         // Structure version
    NvU32                fields;          // Caller sets to
NVVIOCONFIG_* mask for fields to use
    NVVIOCONFIGTYPE      nvvioConfigType; // Input or Output
configuration
    union
    {
        NVVIOINPUTCONFIG  inConfig;       //  Input device
configuration
        NVVIOOUTPUTCONFIG outConfig;      //  Output device
configuration
    }vioConfig;
} NVVIOCONFIG;

#define NVVIOCONFIG_VER   MAKE_NVAPI_VERSION(NVVIOCONFIG,1)

typedef struct
{
    NvPhysicalGpuHandle    hPhysicalGpu;  //handle to Physical GPU
(This could be NULL for GVI device if its not binded)
    NvVioHandle  hVioHandle;             //handle to SDI Input/Output
device
    NvU32 vioId;                         //device Id of SDI
Input/Output device
    NvU32 outputId;                       //deviceMask of the SDI
display connected to GVO device.

//outputId will be 0 for GVI device.
} NVVIOTOPOLOGYTARGET;


typedef struct _NV_VIO_TOPOLOGY
{
    NvU32                       version;
    NvU32                       vioTotalDeviceCount;
//How many vio targets are valid
    NVVIOTOPOLOGYTARGET         vioTarget[NVAPI_MAX_VIO_DEVICES];
//Array of vio targets
}NV_VIO_TOPOLOGY, NVVIOTOPOLOGY;

#define NV_VIO_TOPOLOGY_VER  MAKE_NVAPI_VERSION(NV_VIO_TOPOLOGY,1)
#define NVVIOTOPOLOGY_VER    MAKE_NVAPI_VERSION(NVVIOTOPOLOGY,1)

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_GetCapabilities
//
// Description: Determine graphics adapter video I/O capabilities.
```

```
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN] - The caller provides the SDI device
handle as input.
//              pAdapterCaps[OUT] - Pointer to receive capabilities
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - NVVIOCAPS struct
version used by the app is not compatible
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_GetCapabilities(NvVioHandle hVioHandle,
                                          NVVIOCAPS *pAdapterCaps);

//---------------------------------------------------------------------
// Function:    NvAPI_VIO_Open
//
// Description: Open graphics adapter for video I/O operations
//              using the OpenGL application interface.  Read
operations
//              are permitted in this mode by multiple clients, but
Write
//              operations are application exclusive.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]     - The caller provides the SDI
output device handle as input.
//              vioClass[IN]        - Class interface (NVVIOCLASS_*
value)
//              ownerType[IN]       - user should specify the ownerType
( NVVIOOWNERTYPE_APPLICATION or NVVIOOWNERTYPE_DESKTOP)
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                 - Access denied for
requested access
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_Open(NvVioHandle       hVioHandle,
                               NvU32             vioClass,
```

```
                                NVVIOOWNERTYPE    ownerType);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_Close
//
// Description: Closes graphics adapter for Graphics to Video
operations
//              using the OpenGL application interface.  Closing an
//              OpenGL handle releases the device.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]  - The caller provides the SDI output
device handle as input.
//              bRelease         - boolean value to decide on keeping
or releasing ownership
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                 - Access denied for
requested access
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_Close(NvVioHandle       hVioHandle,
                                NvU32             bRelease);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_Status
//
// Description: Get Video I/O LED status.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN] - The caller provides the SDI device
handle as input.
//              pStatus(OUT)   - returns pointer to the NVVIOSTATUS
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Invalid structure
version
//              NVAPI_NOT_SUPPORTED               - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//--------------------------------------------------------------------------
```

```
NVAPI_INTERFACE NvAPI_VIO_Status(NvVioHandle     hVioHandle,
                                 NVVIOSTATUS     *pStatus);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_SyncFormatDetect
//
// Description: Detects Video I/O incoming sync video format.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN] - The caller provides the SDI device
handle as input.
//              pWait(OUT)     - Pointer to receive milliseconds to
wait
//                               before VIOStatus will return detected
//                               syncFormat.
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_NOT_SUPPORTED               - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_SyncFormatDetect(NvVioHandle hVioHandle,
                                           NvU32       *pWait);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_GetConfig
//
// Description: Get Graphics to Video configuration.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN] - The caller provides the SDI device
handle as input.
//              pConfig(OUT)    - Pointer to Graphics to Video
configuration
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Invalid structure
version
//              NVAPI_NOT_SUPPORTED               - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_GetConfig(NvVioHandle        hVioHandle,
```

```
                                    NVVIOCONFIG        *pConfig);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_SetConfig
//
// Description: Set Graphics to Video configuration.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]     - The caller provides the SDI
device handle as input.
//              pConfig(IN)         - Pointer to Graphics to Video
config
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT             - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Stucture version
invalid
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                        - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                  - Access denied for
requested access
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_SetConfig(NvVioHandle            hVioHandle,
                                    const NVVIOCONFIG      *pConfig);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_SetCSC
//
// Description: Set colorspace conversion parameters.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]     - The caller provides the SDI
device handle as input.
//              pCSC(IN)            - Pointer to CSC parameters
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT             - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Stucture version
invalid
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                        - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                  - Access denied for
requested access
```

```
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_SetCSC(NvVioHandle           hVioHandle,
                                 NVVIOCOLORCONVERSION  *pCSC);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_GetCSC
//
// Description: Get colorspace conversion parameters.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]     - The caller provides the SDI
device handle as input.
//              pCSC(OUT)           - Pointer to CSC parameters
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT             - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Stucture version
invalid
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                        - NVAPI Random errors
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_GetCSC(NvVioHandle           hVioHandle,
                                 NVVIOCOLORCONVERSION  *pCSC);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_SetGamma
//
// Description: Set gamma conversion parameters.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]     - The caller provides the SDI
device handle as input.
//              pGamma(IN)          - Pointer to gamma parameters
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT             - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Stucture version
invalid
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                        - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                  - Access denied for
requested access
//--------------------------------------------------------------------------
```

```
NVAPI_INTERFACE NvAPI_VIO_SetGamma(NvVioHandle           hVioHandle,
                                   NVVIOGAMMACORRECTION  *pGamma);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_GetGamma
//
// Description: Get gamma conversion parameters.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]     - The caller provides the SDI
device handle as input.
//              pGamma(OUT)         - Pointer to gamma parameters
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT             - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Stucture version
invalid
//              NVAPI_NOT_SUPPORTED                - Video I/O not
supported
//              NVAPI_ERROR                        - NVAPI Random errors
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_GetGamma(NvVioHandle           hVioHandle,
                                   NVVIOGAMMACORRECTION* pGamma);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_SetSyncDelay
//
// Description: Set sync delay parameters.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN] - The caller provides the SDI device
handle as input.
//              pSyncDelay(IN)  - const Pointer to sync delay
parameters
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT             - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Stucture version
invalid
//              NVAPI_ERROR                        - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                  - Access denied for
requested access
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_SetSyncDelay(NvVioHandle hVioHandle,
                                   const NVVIOSYNCDELAY   *pSyncDelay);
```

```
//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_GetSyncDelay
//
// Description: Get sync delay parameters.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]     - The caller provides the SDI
device handle as input.
//              pSyncDelay(OUT)     - Pointer to sync delay parameters
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT             - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Stucture version
invalid
//              NVAPI_ERROR                        - NVAPI Random errors
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_GetSyncDelay(NvVioHandle hVioHandle,
                                       NVVIOSYNCDELAY   *pSyncDelay);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_IsRunning
//
// Description: Determine if Video I/O is running.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]            - The caller provides the
SDI device handle as input.
//
// Returns:     NVAPI_DRIVER_RUNNING       - Video I/O running
//              NVAPI_DRIVER_NOTRUNNING    - Video I/O not running
//--------------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_IsRunning(NvVioHandle hVioHandle);

//--------------------------------------------------------------------------
// Function:    NvAPI_VIO_Start
//
// Description: Start Video I/O.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]    - The caller provides the SDI device
handle as input.
//
// Returns:     NVAPI_OK                           - Success
//              NVAPI_API_NOT_INTIALIZED           - NVAPI Not
Initialized
```

```
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_NOT_SUPPORTED               - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                 - Access denied for
requested access
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_Start(NvVioHandle hVioHandle);

//---------------------------------------------------------------------
// Function:    NvAPI_VIO_Stop
//
// Description: Stop Video I/O.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]    - The caller provides the SDI device
handle as input.
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_NOT_SUPPORTED               - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//              NVAPI_DEVICE_BUSY                 - Access denied for
requested access
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_Stop(NvVioHandle hVioHandle);


//---------------------------------------------------------------------
// Function:    NvAPI_VIO_IsFrameLockModeCompatible
//
// Description: Checkes whether modes are compatible in framelock mode
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]         - The caller provides the SDI
device handle as input.
//              srcEnumIndex(IN)        - Source Enumeration index
//              destEnumIndex(IN)       - Destination Enumeration index
//              pbCompatible(OUT)       - Pointer to receive
compatability
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
```

```
//              NVAPI_NOT_SUPPORTED               - Video I/O not
supported
//              NVAPI_ERROR                       - NVAPI Random errors
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_IsFrameLockModeCompatible(NvVioHandle
                                                    hVioHandle,
                                                    NvU32
                                                    srcEnumIndex,
                                                    NvU32
                                                    destEnumIndex,
                                                    NvU32*
                                                    pbCompatible);

//---------------------------------------------------------------------
// Function:    NvAPI_VIO_EnumDevices
//
// Description: Enumerate all valid SDI topologies
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[OUT]                  - User passes the
pointer of NvVioHandle[] array to get handles to all the connected vio
devices.
//              vioDeviceCount[OUT]               - User gets total
number of VIO devices connected to the system.
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_ERROR                       - NVAPI Random errors
//              NVAPI_NVIDIA_DEVICE_NOT_FOUND     - No SDI Device found
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_EnumDevices(NvVioHandle
                                      hVioHandle[NVAPI_MAX_VIO_DEVICES],
                                       Nv32 *vioDeviceCount);


//---------------------------------------------------------------------
// Function:    NvAPI_VIO_QueryTopology
//
// Description: Enumerate all valid SDI topologies
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  pNvVIOTopology[OUT]       - User passes the pointer to
NVVIOTOPOLOGY to fetch all valid SDI Topologies.
//
// Returns:     NVAPI_OK                          - Success
//              NVAPI_API_NOT_INTIALIZED          - NVAPI Not
Initialized
```

```
//              NVAPI_INVALID_ARGUMENT            - Arguments passed to
API are not valid
//              NVAPI_INCOMPATIBLE_STRUCT_VERSION - Invalid structure
version
//              NVAPI_ERROR                       - NVAPI Random errors
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_QueryTopology(NV_VIO_TOPOLOGY
                                        *pNvVIOTopology);


//---------------------------------------------------------------------
// Function:    NvAPI_VIO_EnumSignalFormats
//
// Description: Enumerate signal formats supported by Video I/O.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]          - The caller provides the SDI
device handle as input.
//              enumIndex(IN)            - Enumeration index
//              pSignalFormatDetail(OUT) - Pointer to receive detail or
NULL
//
// Returns:     NVAPI_OK                 - Success
//              NVAPI_END_ENUMERATION    - No more signal formats to
enumerate
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_EnumSignalFormats(NvVioHandle hVioHandle,
                                            NvU32 enumIndex,
                                            NVVIOSIGNALFORMATDETAIL
                                            *pSignalFormatDetail);

//---------------------------------------------------------------------
// Function:    NvAPI_VIO_EnumDataFormats
//
// Description: Enumerate data formats supported by Video I/O.
//
//  SUPPORTED OS: Windows XP and higher
//
// Parameters:  NvVioHandle[IN]        - The caller provides the SDI
device handle as input.
//              enumIndex(IN)          - Enumeration index
//              pDataFormatDetail(OUT) - Pointer to receive detail or
NULL
//
// Returns:     NVAPI_OK               - Success
//              NVAPI_END_ENUMERATION  - No more data formats to
enumerate
//              NVAPI_NOT_SUPPORTED    - Unsupported NVVIODATAFORMAT_
enumeration
//---------------------------------------------------------------------
NVAPI_INTERFACE NvAPI_VIO_EnumDataFormats(NvVioHandle hVioHandle,
                                          NvU32 enumIndex,
```

```
                                                NVVIODATAFORMATDETAIL
                                                *pDataFormatDetail);
```

# 13 NV CONTROL VIO CONTROLS

```
/**************************************************************************
****/

/*
 * Attribute Targets
 *
 * Targets define attribute groups.  For example, some attributes are
only
 * valid to set on a GPU, others are only valid when talking about an
 * X Screen.  Target types are then what is used to identify the target
 * group of the attribute you wish to set/query.
 *
 * Here are the supported target types:
 */

#define NV_CTRL_TARGET_TYPE_X_SCREEN   0
#define NV_CTRL_TARGET_TYPE_GPU        1
#define NV_CTRL_TARGET_TYPE_FRAMELOCK  2
#define NV_CTRL_TARGET_TYPE_VCSC       3 /* Visual Computing System */
#define NV_CTRL_TARGET_TYPE_GVI        4


/**************************************************************************
****/

/*
 * Attributes
 *
 * Some attributes may only be read; some may require a display_mask
 * argument and others may be valid only for specific target types.
 * This information is encoded in the "permission" comment after each
 * attribute #define, and can be queried at run time with
 * XNVCTRLQueryValidAttributeValues() and/or
 * XNVCTRLQueryValidTargetAttributeValues()
 *
```

```
 * Key to Integer Attribute "Permissions":
 *
 * R: The attribute is readable (in general, all attributes will be
 *    readable)
 *
 * W: The attribute is writable (attributes may not be writable for
 *    various reasons: they represent static system information, they
 *    can only be changed by changing an XF86Config option, etc).
 *
 * D: The attribute requires the display mask argument.  The
 *    attributes NV_CTRL_CONNECTED_DISPLAYS and
NV_CTRL_ENABLED_DISPLAYS
 *    will be a bitmask of what display devices are connected and what
 *    display devices are enabled for use in X, respectively.  Each bit
 *    in the bitmask represents a display device; it is these bits
which
 *    should be used as the display_mask when dealing with attributes
 *    designated with "D" below.  For attributes that do not require
the
 *    display mask, the argument is ignored.
 *
 * G: The attribute may be queried using an NV_CTRL_TARGET_TYPE_GPU
 *    target type via XNVCTRLQueryTargetAttribute().
 *
 * F: The attribute may be queried using an
NV_CTRL_TARGET_TYPE_FRAMELOCK
 *    target type via XNVCTRLQueryTargetAttribute().
 *
 * X: When Xinerama is enabled, this attribute is kept consistent
across
 *    all Physical X Screens;  Assignment of this attribute will be
 *    broadcast by the NVIDIA X Driver to all X Screens.
 *
 * V: The attribute may be queried using an NV_CTRL_TARGET_TYPE_VCSC
 *    target type via XNVCTRLQueryTargetAttribute().
 *
 * I: The attribute may be queried using an NV_CTRL_TARGET_TYPE_GVI
target type
 *    via XNVCTRLQueryTargetAttribute().
 *
 * NOTE: Unless mentioned otherwise, all attributes may be queried
using
 *       an NV_CTRL_TARGET_TYPE_X_SCREEN target type via
 *       XNVCTRLQueryTargetAttribute().
 */


/**************************************************************************
****/

/*
 * Integer attributes:
 *
```

```
 * Integer attributes can be queried through the
XNVCTRLQueryAttribute() and
 * XNVCTRLQueryTargetAttribute() function calls.
 *
 * Integer attributes can be set through the XNVCTRLSetAttribute() and
 * XNVCTRLSetTargetAttribute() function calls.
 *
 * Unless otherwise noted, all integer attributes can be queried/set
 * using an NV_CTRL_TARGET_TYPE_X_SCREEN target.  Attributes that
cannot
 * take an NV_CTRL_TARGET_TYPE_X_SCREEN also cannot be queried/set
through
 * XNVCTRLQueryAttribute()/XNVCTRLSetAttribute() (Since these assume
 * an X Screen target).
 */



/**************************************************************************
****/
/*
 * The NV_CTRL_GVO_* integer attributes are used to configure GVO
 * (Graphics to Video Out).  This functionality is available, for
 * example, on the Quadro FX 4000 SDI graphics board.
 *
 * The following is a typical usage pattern for the GVO attributes:
 *
 * - query NV_CTRL_GVO_SUPPORTED to determine if the X screen supports
GV0.
 *
 * - specify NV_CTRL_GVO_SYNC_MODE (one of FREE_RUNNING, GENLOCK, or
 * FRAMELOCK); if you specify GENLOCK or FRAMELOCK, you should also
 * specify NV_CTRL_GVO_SYNC_SOURCE.
 *
 * - Use NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECTED and
 * NV_CTRL_GVO_SDI_SYNC_INPUT_DETECTED to detect what input syncs are
 * present.
 *
 * (If no analog sync is detected but it is known that a valid
 * bi-level or tri-level sync is connected set
 * NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECT_MODE appropriately and
 * retest with NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECTED).
 *
 * - if syncing to input sync, query the
 * NV_CTRL_GVIO_DETECTED_VIDEO_FORMAT attribute; note that Input video
 * format can only be queried after SYNC_SOURCE is specified.
 *
 * - specify the NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT
 *
 * - specify the NV_CTRL_GVO_DATA_FORMAT
 *
 * - specify any custom Color Space Conversion (CSC) matrix, offset,
 * and scale with XNVCTRLSetGvoColorConversion().
```

```
 *
 * - if using the GLX_NV_video_out extension to display one or more
 * pbuffers, call glXGetVideoDeviceNV() to lock the GVO output for use
 * by the GLX client; then bind the pbuffer(s) to the GVO output with
 * glXBindVideoImageNV() and send pbuffers to the GVO output with
 * glXSendPbufferToVideoNV(); see the GLX_NV_video_out spec for more
 * details.
 *
 * - if, rather than using the GLX_NV_video_out extension to display
 * GLX pbuffers on the GVO output, you wish display the X screen on
 * the GVO output, set NV_CTRL_GVO_DISPLAY_X_SCREEN to
 * NV_CTRL_GVO_DISPLAY_X_SCREEN_ENABLE.
 *
 * Note that setting most GVO attributes only causes the value to be
 * cached in the X server.  The values will be flushed to the hardware
 * either when NV_CTRL_GVO_DISPLAY_X_SCREEN is enabled, or when a GLX
 * pbuffer is bound to the GVO output (with glXBindVideoImageNV()).
 *
 * Note that GLX_NV_video_out and NV_CTRL_GVO_DISPLAY_X_SCREEN are
 * mutually exclusive.  If NV_CTRL_GVO_DISPLAY_X_SCREEN is enabled,
 * then glXGetVideoDeviceNV will fail.  Similarly, if a GLX client has
 * locked the GVO output (via glXGetVideoDeviceNV), then
 * NV_CTRL_GVO_DISPLAY_X_SCREEN will fail.  The NV_CTRL_GVO_GLX_LOCKED
 * event will be sent when a GLX client locks the GVO output.
 *
 */


/*
 * NV_CTRL_GVO_SUPPORTED - returns whether this X screen supports GVO;
 * if this screen does not support GVO output, then all other GVO
 * attributes are unavailable.
 */

#define NV_CTRL_GVO_SUPPORTED                                   67  /*
R-- */
#define NV_CTRL_GVO_SUPPORTED_FALSE                             0
#define NV_CTRL_GVO_SUPPORTED_TRUE                              1


/*
 * NV_CTRL_GVO_SYNC_MODE - selects the GVO sync mode; possible values
 * are:
 *
 * FREE_RUNNING - GVO does not sync to any external signal
 *
 * GENLOCK - the GVO output is genlocked to an incoming sync signal;
 * genlocking locks at hsync.  This requires that the output video
 * format exactly match the incoming sync video format.
 *
 * FRAMELOCK - the GVO output is frame locked to an incoming sync
 * signal; frame locking locks at vsync.  This requires that the output
```

```
 * video format have the same refresh rate as the incoming sync video
 * format.
 */

#define NV_CTRL_GVO_SYNC_MODE                                    68  /*
RW- */
#define NV_CTRL_GVO_SYNC_MODE_FREE_RUNNING                       0
#define NV_CTRL_GVO_SYNC_MODE_GENLOCK                            1
#define NV_CTRL_GVO_SYNC_MODE_FRAMELOCK                          2


/*
 * NV_CTRL_GVO_SYNC_SOURCE - if NV_CTRL_GVO_SYNC_MODE is set to either
 * GENLOCK or FRAMELOCK, this controls which sync source is used as
 * the incoming sync signal (either Composite or SDI).  If
 * NV_CTRL_GVO_SYNC_MODE is FREE_RUNNING, this attribute has no
 * effect.
 */

#define NV_CTRL_GVO_SYNC_SOURCE                                  69  /*
RW- */
#define NV_CTRL_GVO_SYNC_SOURCE_COMPOSITE                        0
#define NV_CTRL_GVO_SYNC_SOURCE_SDI                              1


/*
 * NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT - specifies the desired output
video
 * format for GVO devices or the desired input video format for GVI
devices.
 *
 * Note that for GVO, the valid video formats may vary depending on
 * the NV_CTRL_GVO_SYNC_MODE and the incoming sync video format.  See
 * the definition of NV_CTRL_GVO_SYNC_MODE.
 *
 * Note that when querying the ValidValues for this data type, the
 * values are reported as bits within a bitmask
 * (ATTRIBUTE_TYPE_INT_BITS); unfortunately, there are more valid
 * value bits than will fit in a single 32-bit value.  To solve this,
 * query the ValidValues for NV_CTRL_GVIO_OUTPUT_VIDEO_FORMAT to check
 * which of the first 31 VIDEO_FORMATS are valid, then query the
 * ValidValues for NV_CTRL_GVIO_OUTPUT_VIDEO_FORMAT2 to check which of
 * the VIDEO_FORMATS with value 32 and higher are valid.
 */

#define NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT                      70  /*
RW--I */

#define NV_CTRL_GVIO_VIDEO_FORMAT_NONE                           0
#define NV_CTRL_GVIO_VIDEO_FORMAT_487I_59_94_SMPTE259_NTSC       1
#define NV_CTRL_GVIO_VIDEO_FORMAT_576I_50_00_SMPTE259_PAL        2
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_59_94_SMPTE296            3
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_60_00_SMPTE296            4
```

```
#define NV_CTRL_GVIO_VIDEO_FORMAT_1035I_59_94_SMPTE260          5
#define NV_CTRL_GVIO_VIDEO_FORMAT_1035I_60_00_SMPTE260          6
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_50_00_SMPTE295          7
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_50_00_SMPTE274          8
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_59_94_SMPTE274          9
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_60_00_SMPTE274          10
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_23_976_SMPTE274         11
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_24_00_SMPTE274          12
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_25_00_SMPTE274          13
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_29_97_SMPTE274          14
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_30_00_SMPTE274          15
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_50_00_SMPTE296           16
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_48_00_SMPTE274          17
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_47_96_SMPTE274          18
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_30_00_SMPTE296           19
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_29_97_SMPTE296           20
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_25_00_SMPTE296           21
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_24_00_SMPTE296           22
#define NV_CTRL_GVIO_VIDEO_FORMAT_720P_23_98_SMPTE296           23
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080PSF_25_00_SMPTE274        24
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080PSF_29_97_SMPTE274        25
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080PSF_30_00_SMPTE274        26
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080PSF_24_00_SMPTE274        27
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080PSF_23_98_SMPTE274        28
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_30_00_SMPTE372          29
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_29_97_SMPTE372          30
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_60_00_SMPTE372          31
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_59_94_SMPTE372          32
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_25_00_SMPTE372          33
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_50_00_SMPTE372          34
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_24_00_SMPTE372          35
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_23_98_SMPTE372          36
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_48_00_SMPTE372          37
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_47_96_SMPTE372          38
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_50_00_3G_LEVEL_A_SMPTE274  39
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_59_94_3G_LEVEL_A_SMPTE274  40
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_60_00_3G_LEVEL_A_SMPTE274  41
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_60_00_3G_LEVEL_B_SMPTE274  42
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_60_00_3G_LEVEL_B_SMPTE274  43
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_60_00_3G_LEVEL_B_SMPTE372  44
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_50_00_3G_LEVEL_B_SMPTE274  45
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_50_00_3G_LEVEL_B_SMPTE274  46
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_50_00_3G_LEVEL_B_SMPTE372  47
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_30_00_3G_LEVEL_B_SMPTE274  48
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_30_00_3G_LEVEL_B_SMPTE372  49
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_25_00_3G_LEVEL_B_SMPTE274  50
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_25_00_3G_LEVEL_B_SMPTE372  51
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_24_00_3G_LEVEL_B_SMPTE274  52
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_24_00_3G_LEVEL_B_SMPTE372  53
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_48_00_3G_LEVEL_B_SMPTE274  54
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_48_00_3G_LEVEL_B_SMPTE372  55
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_59_94_3G_LEVEL_B_SMPTE274  56
```

```
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_59_94_3G_LEVEL_B_SMPTE274  57
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_59_94_3G_LEVEL_B_SMPTE372  58
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_29_97_3G_LEVEL_B_SMPTE274  59
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_29_97_3G_LEVEL_B_SMPTE372  60
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080P_23_98_3G_LEVEL_B_SMPTE274  61
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048P_23_98_3G_LEVEL_B_SMPTE372  62
#define NV_CTRL_GVIO_VIDEO_FORMAT_1080I_47_96_3G_LEVEL_B_SMPTE274  63
#define NV_CTRL_GVIO_VIDEO_FORMAT_2048I_47_96_3G_LEVEL_B_SMPTE372  64

/*
 * The following are deprecated; NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT
and the
 * corresponding NV_CTRL_GVIO_* formats should be used instead.
 */
#define NV_CTRL_GVO_OUTPUT_VIDEO_FORMAT                           70  /*
RW- */

#define NV_CTRL_GVO_VIDEO_FORMAT_NONE                             0
#define NV_CTRL_GVO_VIDEO_FORMAT_487I_59_94_SMPTE259_NTSC         1
#define NV_CTRL_GVO_VIDEO_FORMAT_576I_50_00_SMPTE259_PAL          2
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_59_94_SMPTE296              3
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_60_00_SMPTE296              4
#define NV_CTRL_GVO_VIDEO_FORMAT_1035I_59_94_SMPTE260             5
#define NV_CTRL_GVO_VIDEO_FORMAT_1035I_60_00_SMPTE260             6
#define NV_CTRL_GVO_VIDEO_FORMAT_1080I_50_00_SMPTE295             7
#define NV_CTRL_GVO_VIDEO_FORMAT_1080I_50_00_SMPTE274             8
#define NV_CTRL_GVO_VIDEO_FORMAT_1080I_59_94_SMPTE274             9
#define NV_CTRL_GVO_VIDEO_FORMAT_1080I_60_00_SMPTE274             10
#define NV_CTRL_GVO_VIDEO_FORMAT_1080P_23_976_SMPTE274            11
#define NV_CTRL_GVO_VIDEO_FORMAT_1080P_24_00_SMPTE274             12
#define NV_CTRL_GVO_VIDEO_FORMAT_1080P_25_00_SMPTE274             13
#define NV_CTRL_GVO_VIDEO_FORMAT_1080P_29_97_SMPTE274             14
#define NV_CTRL_GVO_VIDEO_FORMAT_1080P_30_00_SMPTE274             15
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_50_00_SMPTE296              16
#define NV_CTRL_GVO_VIDEO_FORMAT_1080I_48_00_SMPTE274             17
#define NV_CTRL_GVO_VIDEO_FORMAT_1080I_47_96_SMPTE274             18
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_30_00_SMPTE296              19
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_29_97_SMPTE296              20
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_25_00_SMPTE296              21
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_24_00_SMPTE296              22
#define NV_CTRL_GVO_VIDEO_FORMAT_720P_23_98_SMPTE296              23
#define NV_CTRL_GVO_VIDEO_FORMAT_1080PSF_25_00_SMPTE274           24
#define NV_CTRL_GVO_VIDEO_FORMAT_1080PSF_29_97_SMPTE274           25
#define NV_CTRL_GVO_VIDEO_FORMAT_1080PSF_30_00_SMPTE274           26
#define NV_CTRL_GVO_VIDEO_FORMAT_1080PSF_24_00_SMPTE274           27
#define NV_CTRL_GVO_VIDEO_FORMAT_1080PSF_23_98_SMPTE274           28
#define NV_CTRL_GVO_VIDEO_FORMAT_2048P_30_00_SMPTE372             29
#define NV_CTRL_GVO_VIDEO_FORMAT_2048P_29_97_SMPTE372             30
#define NV_CTRL_GVO_VIDEO_FORMAT_2048I_60_00_SMPTE372             31
#define NV_CTRL_GVO_VIDEO_FORMAT_2048I_59_94_SMPTE372             32
#define NV_CTRL_GVO_VIDEO_FORMAT_2048P_25_00_SMPTE372             33
#define NV_CTRL_GVO_VIDEO_FORMAT_2048I_50_00_SMPTE372             34
```

```
#define NV_CTRL_GVO_VIDEO_FORMAT_2048P_24_00_SMPTE372           35
#define NV_CTRL_GVO_VIDEO_FORMAT_2048P_23_98_SMPTE372           36
#define NV_CTRL_GVO_VIDEO_FORMAT_2048I_48_00_SMPTE372           37
#define NV_CTRL_GVO_VIDEO_FORMAT_2048I_47_96_SMPTE372           38

/*
 * NV_CTRL_GVIO_DETECTED_VIDEO_FORMAT - indicates the input video
format
 * detected for GVO or GVI devices; the possible values are the
 * NV_CTRL_GVIO_VIDEO_FORMAT constants.
 *
 * For GVI devices, the jack number should be specified in the lower
 * 16 bits of the "display_mask" parameter, while the channel number
should be
 * specified in the upper 16 bits.
 */

#define NV_CTRL_GVIO_DETECTED_VIDEO_FORMAT                      71  /*
R--I */

/*
 * The following is deprecated.  Use
NV_CTRL_GVIO_DETECTED_VIDEO_FORMAT,
 * instead.
 */
#define NV_CTRL_GVO_INPUT_VIDEO_FORMAT                          71  /*
R-- */

/*
 * NV_CTRL_GVO_DATA_FORMAT - This controls how the data in the source
 * (either the X screen or the GLX pbuffer) is interpretted and
 * displayed.
 *
 * Note: some of the below DATA_FORMATS have been renamed.  For
 * example, R8G8B8_TO_RGB444 has been renamed to X8X8X8_444_PASSTHRU.
 * This is to more accurately reflect DATA_FORMATS where the
 * per-channel data could be either RGB or YCrCb -- the point is that
 * the driver and GVO hardware do not perform any implicit color space
 * conversion on the data; it is passed through to the SDI out.
 */

#define NV_CTRL_GVO_DATA_FORMAT                                 72  /*
RW- */
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8_TO_YCRCB444              0
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8A8_TO_YCRCBA4444          1
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8Z10_TO_YCRCBZ4444         2
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8_TO_YCRCB422              3
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8A8_TO_YCRCBA4224          4
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8Z10_TO_YCRCBZ4224         5
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8_TO_RGB444                6 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X8X8X8_444_PASSTHRU             6
```

```
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8A8_TO_RGBA4444            7 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X8X8X8A8_4444_PASSTHRU          7
#define NV_CTRL_GVO_DATA_FORMAT_R8G8B8Z10_TO_RGBZ4444           8 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X8X8X8Z8_4444_PASSTHRU          8
#define NV_CTRL_GVO_DATA_FORMAT_Y10CR10CB10_TO_YCRCB444         9 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X10X10X10_444_PASSTHRU          9
#define NV_CTRL_GVO_DATA_FORMAT_Y10CR8CB8_TO_YCRCB444           10 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X10X8X8_444_PASSTHRU            10
#define NV_CTRL_GVO_DATA_FORMAT_Y10CR8CB8A10_TO_YCRCBA4444      11 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X10X8X8A10_4444_PASSTHRU        11
#define NV_CTRL_GVO_DATA_FORMAT_Y10CR8CB8Z10_TO_YCRCBZ4444      12 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X10X8X8Z10_4444_PASSTHRU        12
#define NV_CTRL_GVO_DATA_FORMAT_DUAL_R8G8B8_TO_DUAL_YCRCB422    13
#define NV_CTRL_GVO_DATA_FORMAT_DUAL_Y8CR8CB8_TO_DUAL_YCRCB422  14 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_DUAL_X8X8X8_TO_DUAL_422_PASSTHRU 14
#define NV_CTRL_GVO_DATA_FORMAT_R10G10B10_TO_YCRCB422           15
#define NV_CTRL_GVO_DATA_FORMAT_R10G10B10_TO_YCRCB444           16
#define NV_CTRL_GVO_DATA_FORMAT_Y12CR12CB12_TO_YCRCB444         17 //
renamed
#define NV_CTRL_GVO_DATA_FORMAT_X12X12X12_444_PASSTHRU          17
#define NV_CTRL_GVO_DATA_FORMAT_R12G12B12_TO_YCRCB444           18
#define NV_CTRL_GVO_DATA_FORMAT_X8X8X8_422_PASSTHRU             19
#define NV_CTRL_GVO_DATA_FORMAT_X8X8X8A8_4224_PASSTHRU          20
#define NV_CTRL_GVO_DATA_FORMAT_X8X8X8Z8_4224_PASSTHRU          21
#define NV_CTRL_GVO_DATA_FORMAT_X10X10X10_422_PASSTHRU          22
#define NV_CTRL_GVO_DATA_FORMAT_X10X8X8_422_PASSTHRU            23
#define NV_CTRL_GVO_DATA_FORMAT_X10X8X8A10_4224_PASSTHRU        24
#define NV_CTRL_GVO_DATA_FORMAT_X10X8X8Z10_4224_PASSTHRU        25
#define NV_CTRL_GVO_DATA_FORMAT_X12X12X12_422_PASSTHRU          26
#define NV_CTRL_GVO_DATA_FORMAT_R12G12B12_TO_YCRCB422           27

/*
 * NV_CTRL_GVO_DISPLAY_X_SCREEN - enable/disable GVO output of the X
 * screen (in Clone mode).  At this point, all the GVO attributes that
 * have been cached in the X server are flushed to the hardware and GVO
is
 * enabled.  Note that this attribute can fail to be set if a GLX
 * client has locked the GVO output (via glXGetVideoDeviceNV).  Note
 * that due to the inherit race conditions in this locking strategy,
 * NV_CTRL_GVO_DISPLAY_X_SCREEN can fail unexpectantly.  In the
 * failing situation, X will not return an X error.  Instead, you
 * should query the value of NV_CTRL_GVO_DISPLAY_X_SCREEN after
 * setting it to confirm that the setting was applied.
 *
 * NOTE: This attribute is related to the NV_CTRL_GVO_LOCK_OWNER
 *       attribute.  When NV_CTRL_GVO_DISPLAY_X_SCREEN is enabled,
```

```
 *       the GVO device will be locked by NV_CTRL_GVO_LOCK_OWNER_CLONE.
 *       see NV_CTRL_GVO_LOCK_OWNER for detais.
 */

#define NV_CTRL_GVO_DISPLAY_X_SCREEN                            73  /*
RW- */
#define NV_CTRL_GVO_DISPLAY_X_SCREEN_ENABLE                     1
#define NV_CTRL_GVO_DISPLAY_X_SCREEN_DISABLE                    0


/*
 * NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECTED - indicates whether
 * Composite Sync input is detected.
 */

#define NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECTED               74  /*
R-- */
#define NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECTED_FALSE         0
#define NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECTED_TRUE          1


/*
 * NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECT_MODE - get/set the
 * Composite Sync input detect mode.
 */

#define NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECT_MODE            75  /*
RW- */
#define NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECT_MODE_AUTO       0
#define NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECT_MODE_BI_LEVEL   1
#define NV_CTRL_GVO_COMPOSITE_SYNC_INPUT_DETECT_MODE_TRI_LEVEL  2


/*
 * NV_CTRL_GVO_SYNC_INPUT_DETECTED - indicates whether SDI Sync input
 * is detected, and what type.
 */

#define NV_CTRL_GVO_SDI_SYNC_INPUT_DETECTED                     76  /*
R-- */
#define NV_CTRL_GVO_SDI_SYNC_INPUT_DETECTED_NONE                0
#define NV_CTRL_GVO_SDI_SYNC_INPUT_DETECTED_HD                  1
#define NV_CTRL_GVO_SDI_SYNC_INPUT_DETECTED_SD                  2


/*
 * NV_CTRL_GVO_VIDEO_OUTPUTS - indicates which GVO video output
 * connectors are currently outputing data.
 */

#define NV_CTRL_GVO_VIDEO_OUTPUTS                               77  /*
R-- */
#define NV_CTRL_GVO_VIDEO_OUTPUTS_NONE                          0
```

```
#define NV_CTRL_GVO_VIDEO_OUTPUTS_VIDEO1                          1
#define NV_CTRL_GVO_VIDEO_OUTPUTS_VIDEO2                          2
#define NV_CTRL_GVO_VIDEO_OUTPUTS_VIDEO_BOTH                      3


/*
 * NV_CTRL_GVO_FPGA_VERSION - indicates the version of the Firmware on
 * the GVO device.  Deprecated; use
 * NV_CTRL_STRING_GVIO_FIRMWARE_VERSION instead.
 */

#define NV_CTRL_GVO_FIRMWARE_VERSION                              78  /*
R-- */


/*
 * NV_CTRL_GVO_SYNC_DELAY_PIXELS - controls the delay between the
 * input sync and the output sync in numbers of pixels from hsync;
 * this is a 12 bit value.
 *
 * If the NV_CTRL_GVO_CAPABILITIES_ADVANCE_SYNC_SKEW bit is set,
 * then setting this value will set an advance instead of a delay.
 */

#define NV_CTRL_GVO_SYNC_DELAY_PIXELS                             79  /*
RW- */


/*
 * NV_CTRL_GVO_SYNC_DELAY_LINES - controls the delay between the input
 * sync and the output sync in numbers of lines from vsync; this is a
 * 12 bit value.
 *
 * If the NV_CTRL_GVO_CAPABILITIES_ADVANCE_SYNC_SKEW bit is set,
 * then setting this value will set an advance instead of a delay.
 */

#define NV_CTRL_GVO_SYNC_DELAY_LINES                              80  /*
RW- */


/*
 * NV_CTRL_GVO_INPUT_VIDEO_FORMAT_REACQUIRE - must be set for a period
 * of about 2 seconds for the new InputVideoFormat to be properly
 * locked to.  In nvidia-settings, we do a reacquire whenever genlock
 * or frame lock mode is entered into, when the user clicks the
 * "detect" button.  This value can be written, but always reads back
 * _FALSE.
 */

#define NV_CTRL_GVO_INPUT_VIDEO_FORMAT_REACQUIRE                  81  /*
-W- */
```

```
#define NV_CTRL_GVO_INPUT_VIDEO_FORMAT_REACQUIRE_FALSE          0
#define NV_CTRL_GVO_INPUT_VIDEO_FORMAT_REACQUIRE_TRUE           1


/*
 * NV_CTRL_GVO_GLX_LOCKED - indicates that GVO configurability is
locked by
 * GLX;  this occurs when the GLX_NV_video_out function calls
 * glXGetVideoDeviceNV().  All GVO output resources are locked until
 * either glXReleaseVideoDeviceNV() is called or the X Display used
 * when calling glXGetVideoDeviceNV() is closed.
 *
 * When GVO is locked, setting of the following GVO NV-CONTROL
attributes will
 * not happen immediately and will instead be cached.  The GVO resource
will
 * need to be disabled/released and re-enabled/claimed for the values
to be
 * flushed. These attributes are:
 *    NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT
 *    NV_CTRL_GVO_DATA_FORMAT
 *    NV_CTRL_GVO_FLIP_QUEUE_SIZE
 *
 * XXX This is deprecated, please see NV_CTRL_GVO_LOCK_OWNER
 */

#define NV_CTRL_GVO_GLX_LOCKED                                  82  /*
R-- */
#define NV_CTRL_GVO_GLX_LOCKED_FALSE                            0
#define NV_CTRL_GVO_GLX_LOCKED_TRUE                             1


/*
 * NV_CTRL_GVIO_VIDEO_FORMAT_{WIDTH,HEIGHT,REFRESH_RATE} - query the
 * width, height, and refresh rate for the specified
 * NV_CTRL_GVIO_VIDEO_FORMAT_*.  So that this can be queried with
 * existing interfaces, XNVCTRLQueryAttribute() should be used, and
 * the video format specified in the display_mask field; eg:
 *
 * XNVCTRLQueryAttribute (dpy,
 *                        screen,
 *
NV_CTRL_GVIO_VIDEO_FORMAT_487I_59_94_SMPTE259_NTSC,
 *                        NV_CTRL_GVIO_VIDEO_FORMAT_WIDTH,
 *                        &value);
 *
 * Note that Refresh Rate is in milliHertz values
 */

#define NV_CTRL_GVIO_VIDEO_FORMAT_WIDTH                         83  /*
R--I */
#define NV_CTRL_GVIO_VIDEO_FORMAT_HEIGHT                        84  /*
R--I */
```

```
#define NV_CTRL_GVIO_VIDEO_FORMAT_REFRESH_RATE                    85  /*
R--I */

/* The following are deprecated; use the NV_CTRL_GVIO_* versions,
instead */
#define NV_CTRL_GVO_VIDEO_FORMAT_WIDTH                            83  /*
R-- */
#define NV_CTRL_GVO_VIDEO_FORMAT_HEIGHT                           84  /*
R-- */
#define NV_CTRL_GVO_VIDEO_FORMAT_REFRESH_RATE                     85  /*
R-- */


/*
 * NV_CTRL_GVO_X_SCREEN_PAN_[XY] - when GVO output of the X screen is
 * enabled, the pan x/y attributes control which portion of the X
 * screen is displayed by GVO.  These attributes can be updated while
 * GVO output is enabled, or before enabling GVO output.  The pan
 * values will be clamped so that GVO output is not panned beyond the
 * end of the X screen.
 */

#define NV_CTRL_GVO_X_SCREEN_PAN_X                                86  /*
RW- */
#define NV_CTRL_GVO_X_SCREEN_PAN_Y                                87  /*
RW- */

/*
 * NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT2 - this attribute is only
intended
 * to be used to query the ValidValues for
 * NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT above the first 31
VIDEO_FORMATS.
 * See NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT for details.
 */

#define NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT2                      227  /*
---GI */

/*
 * The following is deprecated; use
NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT2,
 * instead
 */
#define NV_CTRL_GVO_OUTPUT_VIDEO_FORMAT2                           227
/* --- */


/*
 * NV_CTRL_GVO_OVERRIDE_HW_CSC - Override the SDI hardware's Color
Space
 * Conversion with the values controlled through
```

```
 * XNVCTRLSetGvoColorConversion() and XNVCTRLGetGvoColorConversion().
If
 * this attribute is FALSE, then the values specified through
 * XNVCTRLSetGvoColorConversion() are ignored.
 */

#define NV_CTRL_GVO_OVERRIDE_HW_CSC                                228
/* RW- */
#define NV_CTRL_GVO_OVERRIDE_HW_CSC_FALSE                          0
#define NV_CTRL_GVO_OVERRIDE_HW_CSC_TRUE                           1


/*
 * NV_CTRL_GVO_CAPABILITIES - this read-only attribute describes GVO
 * capabilities that differ between NVIDIA SDI products.  This value
 * is a bitmask where each bit indicates whether that capability is
 * available.
 *
 * APPLY_CSC_IMMEDIATELY - whether the CSC matrix, offset, and scale
 * specified through XNVCTRLSetGvoColorConversion() will take affect
 * immediately, or only after SDI output is disabled and enabled
 * again.
 *
 * APPLY_CSC_TO_X_SCREEN - whether the CSC matrix, offset, and scale
 * specified through XNVCTRLSetGvoColorConversion() will also apply
 * to GVO output of an X screen, or only to OpenGL GVO output, as
 * enabled through the GLX_NV_video_out extension.
 *
 * COMPOSITE_TERMINATION - whether the 75 ohm termination of the
 * SDI composite input signal can be programmed through the
 * NV_CTRL_GVO_COMPOSITE_TERMINATION attribute.
 *
 * SHARED_SYNC_BNC - whether the SDI device has a single BNC
 * connector used for both (SDI & Composite) incoming signals.
 *
 * MULTIRATE_SYNC - whether the SDI device supports synchronization
 * of input and output video modes that match in being odd or even
 * modes (ie, AA.00 Hz modes can be synched to other BB.00 Hz modes and
 * AA.XX Hz can match to BB.YY Hz where .XX and .YY are not .00)
 */

#define NV_CTRL_GVO_CAPABILITIES                                   229
/* R-- */
#define NV_CTRL_GVO_CAPABILITIES_APPLY_CSC_IMMEDIATELY
0x00000001
#define NV_CTRL_GVO_CAPABILITIES_APPLY_CSC_TO_X_SCREEN
0x00000002
#define NV_CTRL_GVO_CAPABILITIES_COMPOSITE_TERMINATION
0x00000004
#define NV_CTRL_GVO_CAPABILITIES_SHARED_SYNC_BNC
0x00000008
#define NV_CTRL_GVO_CAPABILITIES_MULTIRATE_SYNC
0x00000010
```

```
#define NV_CTRL_GVO_CAPABILITIES_ADVANCE_SYNC_SKEW
0x00000020


/*
 * NV_CTRL_GVO_COMPOSITE_TERMINATION - enable or disable 75 ohm
 * termination of the SDI composite input signal.
 */

#define NV_CTRL_GVO_COMPOSITE_TERMINATION                          230
/* RW- */
#define NV_CTRL_GVO_COMPOSITE_TERMINATION_ENABLE                     1
#define NV_CTRL_GVO_COMPOSITE_TERMINATION_DISABLE                    0

/*
 * NV_CTRL_GVO_FLIP_QUEUE_SIZE - The Graphics to Video Out interface
 * exposed through NV-CONTROL and the GLX_NV_video_out extension uses
 * an internal flip queue when pbuffers are sent to the video device
 * (via glXSendPbufferToVideoNV()).  The NV_CTRL_GVO_FLIP_QUEUE_SIZE
 * can be used to query and assign the flip queue size.  This
 * attribute is applied to GLX when glXGetVideoDeviceNV() is called by
 * the application.
 */

#define NV_CTRL_GVO_FLIP_QUEUE_SIZE                                236 /*
RW- */

/*
 * NV_CTRL_GVO_LOCK_OWNER - indicates that the GVO device is available
 * or in use (by GLX, Clone Mode, TwinView etc).
 *
 * The GVO device is locked by GLX when the GLX_NV_video_out function
 * calls glXGetVideoDeviceNV().  The GVO device is then unlocked when
 * glXReleaseVideoDeviceNV() is called, or the X Display used when
calling
 * glXGetVideoDeviceNV() is closed.
 *
 * The GVO device is locked/unlocked for Clone mode use when the
 * attribute NV_CTRL_GVO_DISPLAY_X_SCREEN is enabled/disabled.
 *
 * The GVO device is locked/unlocked by TwinView mode, when the GVO
device is
 * associated/unassociated to/from an X screen through the
 * NV_CTRL_ASSOCIATED_DISPLAY_DEVICES attribute directly.
 *
 * When the GVO device is locked, setting of the following GVO NV-
CONTROL
 * attributes will not happen immediately and will instead be cached.
The
 * GVO resource will need to be disabled/released and re-
enabled/claimed for
 * the values to be flushed. These attributes are:
 *
```

```
 *    NV_CTRL_GVIO_REQUESTED_VIDEO_FORMAT
 *    NV_CTRL_GVO_DATA_FORMAT
 *    NV_CTRL_GVO_FLIP_QUEUE_SIZE
 */

#define NV_CTRL_GVO_LOCK_OWNER                                  257 /*
R-- */
#define NV_CTRL_GVO_LOCK_OWNER_NONE                               0
#define NV_CTRL_GVO_LOCK_OWNER_GLX                                1
#define NV_CTRL_GVO_LOCK_OWNER_CLONE                              2
#define NV_CTRL_GVO_LOCK_OWNER_X_SCREEN                           3
/*
 * NV_CTRL_GVO_OUTPUT_VIDEO_LOCKED - Returns whether or not the GVO
output
 * video is locked to the GPU.
 */

#define NV_CTRL_GVO_OUTPUT_VIDEO_LOCKED                         267 /*
R--- */
#define NV_CTRL_GVO_OUTPUT_VIDEO_LOCKED_FALSE                     0
#define NV_CTRL_GVO_OUTPUT_VIDEO_LOCKED_TRUE                      1


/*
 * NV_CTRL_GVO_SYNC_LOCK_STATUS - Returns whether or not the GVO device
 * is locked to the input ref signal.  If the sync mode is set to
 * NV_CTRL_GVO_SYNC_MODE_GENLOCK, then this returns the genlock
 * sync status, and if the sync mode is set to
NV_CTRL_GVO_SYNC_MODE_FRAMELOCK,
 * then this reports the frame lock status.
 */

#define NV_CTRL_GVO_SYNC_LOCK_STATUS                            268 /*
R--- */
#define NV_CTRL_GVO_SYNC_LOCK_STATUS_UNLOCKED                     0
#define NV_CTRL_GVO_SYNC_LOCK_STATUS_LOCKED                       1


/*
 * NV_CTRL_GVO_ANC_TIME_CODE_GENERATION - Allows SDI device to generate
 * time codes in the ANC region of the SDI video output stream.
 */

#define NV_CTRL_GVO_ANC_TIME_CODE_GENERATION                    269 /*
RW-- */
#define NV_CTRL_GVO_ANC_TIME_CODE_GENERATION_DISABLE              0
#define NV_CTRL_GVO_ANC_TIME_CODE_GENERATION_ENABLE               1


/*
 * NV_CTRL_GVO_COMPOSITE - Enables/Disables SDI compositing.  This
attribute
```

```
 * is only available when an SDI input source is detected and is in
genlock
 * mode.
 */

#define NV_CTRL_GVO_COMPOSITE                                    270 /*
RW-- */
#define NV_CTRL_GVO_COMPOSITE_DISABLE                              0
#define NV_CTRL_GVO_COMPOSITE_ENABLE                               1


/*
 * NV_CTRL_GVO_COMPOSITE_ALPHA_KEY - When compositing is enabled, this
 * enables/disables alpha blending.
 */

#define NV_CTRL_GVO_COMPOSITE_ALPHA_KEY                          271 /*
RW-- */
#define NV_CTRL_GVO_COMPOSITE_ALPHA_KEY_DISABLE                    0
#define NV_CTRL_GVO_COMPOSITE_ALPHA_KEY_ENABLE                     1


/*
 * NV_CTRL_GVO_COMPOSITE_LUMA_KEY_RANGE - Set the values of a luma
 * channel range.  This is a packed int that has the following format
 * (in order of high-bits to low bits):
 *
 * Range # (11 bits), (Enabled 1 bit), min value (10 bits), max value
(10 bits)
 *
 * To query the current values, pass the range # throught he
display_mask
 * variable.
 */

#define NV_CTRL_GVO_COMPOSITE_LUMA_KEY_RANGE                     272 /*
RW-- */

#define NV_CTRL_GVO_COMPOSITE_MAKE_RANGE(range, enable, min, max) \
    ((((min) & 0x3FF)   <<  0) |  \
     (((max) & 0x3FF)   << 10) |  \
     (((enable) & 0x1)  << 20) |  \
     (((range) & 0x7FF) << 21))

#define NV_CTRL_GVO_COMPOSITE_GET_RANGE(val, range, enable, min, max) \
    (min)    = ((val) >> 0)  & 0x3FF; \
    (max)    = ((val) >> 10) & 0x3FF; \
    (enable) = ((val) >> 20) & 0x1;   \
    (range)  = ((val) >> 21) & 0x7FF;


/*
 * NV_CTRL_GVO_COMPOSITE_CR_KEY_RANGE - Set the values of a CR
```

```
 * channel range.  This is a packed int that has the following format
 * (in order of high-bits to low bits):
 *
 * Range # (11 bits), (Enabled 1 bit), min value (10 bits), max value
(10 bits)
 *
 * To query the current values, pass the range # throught he
display_mask
 * variable.
 */

#define NV_CTRL_GVO_COMPOSITE_CR_KEY_RANGE                      273 /*
RW-- */


/*
 * NV_CTRL_GVO_COMPOSITE_CB_KEY_RANGE - Set the values of a CB
 * channel range.  This is a packed int that has the following format
 * (in order of high-bits to low bits):
 *
 * Range # (11 bits), (Enabled 1 bit), min value (10 bits), max value
(10 bits)
 *
 * To query the current values, pass the range # throught he
display_mask
 * variable.
 */

#define NV_CTRL_GVO_COMPOSITE_CB_KEY_RANGE                      274 /*
RW-- */


/*
 * NV_CTRL_GVO_COMPOSITE_NUM_KEY_RANGES - Returns the number of ranges
 * available for each channel (Y/Luma, Cr, and Cb.)
 */

#define NV_CTRL_GVO_COMPOSITE_NUM_KEY_RANGES                    275 /*
R--- */

/*
 * NV_CTRL_GVO_CSC_CHANGED_EVENT This attribute is sent as an event
 * when the color space conversion matrix has been altered by another
 * client.
 */

#define NV_CTRL_GVO_CSC_CHANGED_EVENT

/*
 * NV_CTRL_GVO_SYNC_TO_DISPLAY This attribute controls whether or not
 * the non-SDI display device will be sync'ed to the SDI display device
 * (when configured in TwinView, Clone Mode or when using the SDI
device
```

```
 * with OpenGL).
 */

#define NV_CTRL_GVO_SYNC_TO_DISPLAY                              296 /*
--- */
#define NV_CTRL_GVO_SYNC_TO_DISPLAY_DISABLE                      0
#define NV_CTRL_GVO_SYNC_TO_DISPLAY_ENABLE                       1

/*
 * NV_CTRL_IS_GVO_DISPLAY - returns whether or not a given display is
an
 * SDI device.
 */

#define NV_CTRL_IS_GVO_DISPLAY                                   300 /*
R-D */
#define NV_CTRL_IS_GVO_DISPLAY_FALSE                               0
#define NV_CTRL_IS_GVO_DISPLAY_TRUE                                1

/*
 * NV_CTRL_GVO_FULL_RANGE_COLOR - Allow full range color data [4-1019]
 * without clamping to [64-940].
 */

#define NV_CTRL_GVO_FULL_RANGE_COLOR                             302 /*
RW- */
#define NV_CTRL_GVO_FULL_RANGE_COLOR_DISABLED                      0
#define NV_CTRL_GVO_FULL_RANGE_COLOR_ENABLED                       1
/*
 * NV_CTRL_GVO_ENABLE_RGB_DATA - Allows clients to specify when
 * the GVO board should process colors as RGB when the output data
 * format is one of the NV_CTRL_GVO_DATA_FORMAT_???_PASSTRHU modes.
 */

#define NV_CTRL_GVO_ENABLE_RGB_DATA                              304 /*
RW- */
#define NV_CTRL_GVO_ENABLE_RGB_DATA_DISABLE                        0
#define NV_CTRL_GVO_ENABLE_RGB_DATA_ENABLE                         1

/*
 * NV_CTRL_GVI_NUM_JACKS - Returns the number of input BNC jacks
available
 * on a GVI device.
 */

#define NV_CTRL_GVI_NUM_JACKS                                    307 /*
R--I */

/*
 * NV_CTRL_GVI_MAX_LINKS_PER_STREAM - Returns the maximum supported
number of
 * links that can be tied to one stream.
 */
```

```
#define NV_CTRL_GVI_MAX_LINKS_PER_STREAM                          308 /*
R--I */

/*
 * NV_CTRL_GVI_DETECTED_CHANNEL_BITS_PER_COMPONENT - Returns the
detected
 * number of bits per component (BPC) of data on the given input jack+
 * channel.
 *
 * The jack number should be specified in the lower 16 bits of the
 * "display_mask" parameter, while the channel number should be
specified in
 * the upper 16 bits.
 */

#define NV_CTRL_GVI_DETECTED_CHANNEL_BITS_PER_COMPONENT         309 /*
R--I */
#define NV_CTRL_GVI_BITS_PER_COMPONENT_UNKNOWN                    0
#define NV_CTRL_GVI_BITS_PER_COMPONENT_8                          1
#define NV_CTRL_GVI_BITS_PER_COMPONENT_10                         2
#define NV_CTRL_GVI_BITS_PER_COMPONENT_12                         3

/*
 * NV_CTRL_GVI_REQUESTED_STREAM_BITS_PER_COMPONENT - Specify the number
of
 * bits per component (BPC) of data for the captured stream.
 * The stream number should be specified in the "display_mask"
parameter.
 */

#define NV_CTRL_GVI_REQUESTED_STREAM_BITS_PER_COMPONENT         310 /*
RW-I */

/*
 * NV_CTRL_GVI_DETECTED_CHANNEL_COMPONENT_SAMPLING - Returns the
detected
 * sampling format for the input jack+channel.
 *
 * The jack number should be specified in the lower 16 bits of the
 * "display_mask" parameter, while the channel number should be
specified in
 * the upper 16 bits.
 */

#define NV_CTRL_GVI_DETECTED_CHANNEL_COMPONENT_SAMPLING         311 /*
R--I */
#define NV_CTRL_GVI_COMPONENT_SAMPLING_UNKNOWN                    0
#define NV_CTRL_GVI_COMPONENT_SAMPLING_4444                       1
#define NV_CTRL_GVI_COMPONENT_SAMPLING_4224                       2
#define NV_CTRL_GVI_COMPONENT_SAMPLING_444                        3
#define NV_CTRL_GVI_COMPONENT_SAMPLING_422                        4
#define NV_CTRL_GVI_COMPONENT_SAMPLING_420                        5
```

```
/*
 * NV_CTRL_GVI_REQUESTED_COMPONENT_SAMPLING - Specify the sampling
format for
 * the captured stream.
 * The possible values are the NV_CTRL_GVI_DETECTED_COMPONENT_SAMPLING
 * constants.
 * The stream number should be specified in the "display_mask"
parameter.
 */

#define NV_CTRL_GVI_REQUESTED_STREAM_COMPONENT_SAMPLING         312 /*
RW-I */

/*
 * NV_CTRL_GVI_CHROMA_EXPAND - Enable or disable 4:2:2 -> 4:4:4 chroma
 * expansion for the captured stream.  This value is ignored when a
 * COMPONENT_SAMPLING format is selected that does not use chroma
subsampling.
 * The stream number should be specified in the "display_mask"
parameter.
 */

#define NV_CTRL_GVI_REQUESTED_STREAM_CHROMA_EXPAND              313 /*
RW-I */
#define NV_CTRL_GVI_CHROMA_EXPAND_FALSE                           0
#define NV_CTRL_GVI_CHROMA_EXPAND_TRUE                            1

/*
 * NV_CTRL_GVI_DETECTED_CHANNEL_COLOR_SPACE - Returns the detected
color space
 * of the input jack+channel.
 *
 * The jack number should be specified in the lower 16 bits of the
 * "display_mask" parameter, while the channel number should be
specified in
 * the upper 16 bits.
 */

#define NV_CTRL_GVI_DETECTED_CHANNEL_COLOR_SPACE                314 /*
R--I */
#define NV_CTRL_GVI_COLOR_SPACE_UNKNOWN                           0
#define NV_CTRL_GVI_COLOR_SPACE_GBR                               1
#define NV_CTRL_GVI_COLOR_SPACE_GBRA                              2
#define NV_CTRL_GVI_COLOR_SPACE_GBRD                              3
#define NV_CTRL_GVI_COLOR_SPACE_YCBCR                             4
#define NV_CTRL_GVI_COLOR_SPACE_YCBCRA                            5
#define NV_CTRL_GVI_COLOR_SPACE_YCBCRD                            6

/*
 * NV_CTRL_GVI_DETECTED_CHANNEL_LINK_ID - Returns the detected link
identifier
 * for the given input jack+channel.
```

```
 *
 * The jack number should be specified in the lower 16 bits of the
 * "display_mask" parameter, while the channel number should be
specified in
 * the upper 16 bits.
 */

#define NV_CTRL_GVI_DETECTED_CHANNEL_LINK_ID                    315 /*
R--I */
#define NV_CTRL_GVI_LINK_ID_UNKNOWN                           0xFFFF

/*
 * NV_CTRL_GVI_DETECTED_CHANNEL_SMPTE352_IDENTIFIER - Returns the 4-
byte
 * SMPTE 352 identifier from the given input jack+channel.
 *
 * The jack number should be specified in the lower 16 bits of the
 * "display_mask" parameter, while the channel number should be
specified in
 * the upper 16 bits.
 */

#define NV_CTRL_GVI_DETECTED_CHANNEL_SMPTE352_IDENTIFIER        316 /*
R--I */

/*
 * NV_CTRL_GVI_GLOBAL_IDENTIFIER - Returns a global identifier for the
 * GVI device.  This identifier can be used to relate GVI devices named
 * in NV-CONTROL with those enumerated in OpenGL.
 */

#define NV_CTRL_GVI_GLOBAL_IDENTIFIER                           317 /*
R--I */

/*
 * NV_CTRL_FRAMELOCK_SYNC_DELAY_RESOLUTION - Returns the number of
nanoseconds
 * that one unit of NV_CTRL_FRAMELOCK_SYNC_DELAY corresponds to.
 */
#define NV_CTRL_FRAMELOCK_SYNC_DELAY_RESOLUTION                 318 /*
R-- */

/*
 * NV_CTRL_GVI_SYNC_OUTPUT_FORMAT - Returns the output sync signal
 * from the GVI device.
 */

#define NV_CTRL_GVI_SYNC_OUTPUT_FORMAT                          335 /*
R--I */

/*
 * NV_CTRL_GVI_MAX_CHANNELS_PER_JACK  - Returns the maximum
```

```
 * supported number of (logical) channels within a single physical jack
of
 * a GVI device.  For most SDI video formats, there is only one channel
 * (channel 0).  But for 3G video formats (as specified in SMPTE 425),
 * as an example, there are two channels (channel 0 and channel 1) per
 * physical jack.
 */

#define NV_CTRL_GVI_MAX_CHANNELS_PER_JACK                        336 /*
R--I */

/*
 * NV_CTRL_GVI_MAX_STREAMS  - Returns the maximum number of streams
 * that can be configured on the GVI device.
 */

#define NV_CTRL_GVI_MAX_STREAMS                                  337 /*
R--I */

/*
 * NV_CTRL_GVI_NUM_CAPTURE_SURFACES - The GVI interface exposed through
 * NV-CONTROL and the GLX_NV_video_input extension uses internal
capture
 * surfaces when frames are read from the GVI device.  The
 * NV_CTRL_GVI_NUM_CAPTURE_SURFACES can be used to query and assign the
 * number of capture surfaces.  This attribute is applied when
 * glXBindVideoCaptureDeviceNV() is called by the application.
 *
 * A lower number of capture surfaces will mean less video memory is
used,
 * but can result in frames being dropped if the application cannot
keep up
 * with the capture device.  A higher number will prevent frames from
being
 * dropped, making capture more reliable but will consume move video
memory.
 */
#define NV_CTRL_GVI_NUM_CAPTURE_SURFACES                         338 /*
RW-I */

/**************************************************************************
****/

/*
 * String Attributes:
 *
 * String attributes can be queryied through the
XNVCTRLQueryStringAttribute()
 * and XNVCTRLQueryTargetStringAttribute() function calls.
 *
 * String attributes can be set through the XNVCTRLSetStringAttribute()
 * function call.  (There are currently no string attributes that can
be
```

```
 * set on non-X Screen targets.)
 *
 * Unless otherwise noted, all string attributes can be queried/set
using an
 * NV_CTRL_TARGET_TYPE_X_SCREEN target.  Attributes that cannot take an
 * NV_CTRL_TARGET_TYPE_X_SCREEN target also cannot be queried/set
through
 * XNVCTRLQueryStringAttribute()/XNVCTRLSetStringAttribute() (Since
 * these assume an X Screen target).
 */
/*
 * NV_CTRL_STRING_GVIO_FIRMWARE_VERSION - indicates the version of the
 * Firmware on the GVIO device.
 */

#define NV_CTRL_STRING_GVIO_FIRMWARE_VERSION                    8  /*
R--I */

/*
 * The following is deprecated; use
NV_CTRL_STRING_GVIO_FIRMWARE_VERSION,
 * instead
 */
#define NV_CTRL_STRING_GVO_FIRMWARE_VERSION                     8  /*
R-- */
/*
 * NV_CTRL_STRING_GVIO_VIDEO_FORMAT_NAME - query the name for the
specified
 * NV_CTRL_GVIO_VIDEO_FORMAT_*.  So that this can be queried with
existing
 * interfaces, XNVCTRLQueryStringAttribute() should be used, and the
video
 * format specified in the display_mask field; eg:
 *
 * XNVCTRLQueryStringAttribute(dpy,
 *                             screen,
 *
NV_CTRL_GVIO_VIDEO_FORMAT_720P_60_00_SMPTE296,
 *                             NV_CTRL_GVIO_VIDEO_FORMAT_NAME,
 *                             &name);
 */

#define NV_CTRL_STRING_GVIO_VIDEO_FORMAT_NAME                  33  /*
R--GI */

/*
 * The following is deprecated; use
NV_CTRL_STRING_GVIO_VIDEO_FORMAT_NAME,
 * instead
 */
#define NV_CTRL_STRING_GVO_VIDEO_FORMAT_NAME                   33  /*
R--- */
```

```
#define NV_CTRL_STRING_LAST_ATTRIBUTE \
        NV_CTRL_STRING_GVIO_VIDEO_FORMAT_NAME

/**************************************************************************
****/

/*
 * String Operation Attributes:
 *
 * These attributes are used with the XNVCTRLStringOperation()
 * function; a string is specified as input, and a string is returned
 * as output.
 *
 * Unless otherwise noted, all attributes can be operated upon using
 * an NV_CTRL_TARGET_TYPE_X_SCREEN target.
 */

/*
 * NV_CTRL_STRING_OPERATION_GVI_CONFIGURE_STREAMS - Configure the
streams-
 * to-jack+channel topology for a GVI (Graphics capture board).
 *
 * The string input to GVI_CONFIGURE_STREAMS may be NULL.  If this is
the
 * case, then the current topology is returned.
 *
 * If the input string to GVI_CONFIGURE_STREAMS is not NULL, the string
 * is interpreted as a semicolon (";") separated list of comma-
separated
 * lists of "option=value" pairs that define a stream's composition.
The
 * available options and their values are:
 *
 *   "stream": Defines which stream this comma-separated list
describes.
 *             Valid values are the integers between 0 and
 *             NV_CTRL_GVI_NUM_STREAMS-1 (inclusive).
 *
 *   "linkN":  Defines a jack+channel pair to use for the given link N.
 *             Valid options are the string "linkN", where N is an
integer
 *             between 0 and NV_CTRL_GVI_MAX_LINKS_PER_STREAM-1
(inclusive).
 *             Valid values for these options are strings of the form
 *             "jackX" and/or "jackX.Y", where X is an integer between
0 and
 *             NV_CTRL_GVI_NUM_JACKS-1 (inclusive), and Y (optional) is
an
 *             integer between 0 and NV_CTRL_GVI_MAX_CHANNELS_PER_JACK-
1
 *             (inclusive).
 *
 * An example input string might look like:
```

```
 *
 *   "stream=0, link0=jack0, link1=jack1; stream=1, link0=jack2.1"
 *
 *   This example specifies two streams, stream 0 and stream 1.  Stream
0
 *   is defined to capture link0 data from the first channel (channel
0) of
 *   BNC jack 0 and link1 data from the first channel of BNC jack 1.
The
 *   second stream (Stream 1) is defined to capture link0 data from
channel 1
 *   (second channel) of BNC jack 2.
 *
 * This example shows a possible configuration for capturing 3G input:
 *
 *   "stream=0, link0=jack0.0, link1=jack0.1"
 *
 * Applications should query the following attributes to determine
 * possible combinations:
 *
 *   NV_CTRL_GVI_MAX_STREAMS
 *   NV_CTRL_GVI_MAX_LINKS_PER_STREAM
 *   NV_CTRL_GVI_NUM_JACKS
 *   NV_CTRL_GVI_MAX_CHANNELS_PER_JACK
 *
 * Note: A jack+channel pair can only be tied to one link/stream.
 *
 * Upon successful configuration or querying of this attribute, a
string
 * representing the current topology for all known streams on the
device
 * will be returned.  On failure, NULL is returned.
 */

#define NV_CTRL_STRING_OPERATION_GVI_CONFIGURE_STREAMS         4 /* RW-
I */
/**************************************************************************
****/

/*
 * CTRLAttributeValidValuesRec -
 *
 * structure and related defines used by
 * XNVCTRLQueryValidAttributeValues() to describe the valid values of
 * a particular attribute.  The type field will be one of:
 *
 * ATTRIBUTE_TYPE_INTEGER : the attribute is an integer value; there
 * is no fixed range of valid values.
 *
 * ATTRIBUTE_TYPE_BITMASK : the attribute is an integer value,
 * interpretted as a bitmask.
 *
 * ATTRIBUTE_TYPE_BOOL : the attribute is a boolean, valid values are
```

```
 * either 1 (on/true) or 0 (off/false).
 *
 * ATTRIBUTE_TYPE_RANGE : the attribute can have any integer value
 * between NVCTRLAttributeValidValues.u.range.min and
 * NVCTRLAttributeValidValues.u.range.max (inclusive).
 *
 * ATTRIBUTE_TYPE_INT_BITS : the attribute can only have certain
 * integer values, indicated by which bits in
 * NVCTRLAttributeValidValues.u.bits.ints are on (for example: if bit
 * 0 is on, then 0 is a valid value; if bit 5 is on, then 5 is a valid
 * value, etc).  This is useful for attributes like NV_CTRL_FSAA_MODE,
 * which can only have certain values, depending on GPU.
 *
 *
 * The permissions field of NVCTRLAttributeValidValuesRec is a bitmask
 * that may contain:
 *
 * ATTRIBUTE_TYPE_READ      - Attribute may be read (queried.)
 * ATTRIBUTE_TYPE_WRITE     - Attribute may be written to (set.)
 * ATTRIBUTE_TYPE_DISPLAY   - Attribute requires a display mask.
 * ATTRIBUTE_TYPE_GPU       - Attribute is valid for GPU target types.
 * ATTRIBUTE_TYPE_FRAMELOCK - Attribute is valid for Frame Lock target
types.
 * ATTRIBUTE_TYPE_X_SCREEN  - Attribute is valid for X Screen target
types.
 * ATTRIBUTE_TYPE_XINERAMA  - Attribute will be made consistent for all
 *                            X Screens when the Xinerama extension is
enabled.
 * ATTRIBUTE_TYPE_VCSC      - Attribute is valid for Visual Computing
System
 *                            target types.
 * ATTRIBUTE_TYPE_GVI       - Attribute is valid for Graphics Video In
target
 *                            types.
 *
 *
 * See 'Key to Integer Attribute "Permissions"' at the top of this
 * file for a description of what these permission bits mean.
 */

#define ATTRIBUTE_TYPE_UNKNOWN   0
#define ATTRIBUTE_TYPE_INTEGER   1
#define ATTRIBUTE_TYPE_BITMASK   2
#define ATTRIBUTE_TYPE_BOOL      3
#define ATTRIBUTE_TYPE_RANGE     4
#define ATTRIBUTE_TYPE_INT_BITS  5

#define ATTRIBUTE_TYPE_READ       0x001
#define ATTRIBUTE_TYPE_WRITE      0x002
#define ATTRIBUTE_TYPE_DISPLAY    0x004
#define ATTRIBUTE_TYPE_GPU        0x008
#define ATTRIBUTE_TYPE_FRAMELOCK  0x010
#define ATTRIBUTE_TYPE_X_SCREEN   0x020
```

```
#define ATTRIBUTE_TYPE_XINERAMA   0x040
#define ATTRIBUTE_TYPE_VCSC       0x080
#define ATTRIBUTE_TYPE_GVI        0x100

typedef struct _NVCTRLAttributeValidValues {
    int type;
    union {
        struct {
            int min;
            int max;
        } range;
        struct {
            unsigned int ints;
        } bits;
    } u;
    unsigned int permissions;
} NVCTRLAttributeValidValuesRec;


/*************************************************************************
****/

/*
 * NV-CONTROL X event notification.
 *
 * To receive X event notifications dealing with NV-CONTROL, you should
 * call XNVCtrlSelectNotify() with one of the following set as the type
 * of event to receive (see NVCtrlLib.h for more information):
 */

#define ATTRIBUTE_CHANGED_EVENT                    0
#define TARGET_ATTRIBUTE_CHANGED_EVENT             1
#define TARGET_ATTRIBUTE_AVAILABILITY_CHANGED_EVENT 2
#define TARGET_STRING_ATTRIBUTE_CHANGED_EVENT      3
#define TARGET_BINARY_ATTRIBUTE_CHANGED_EVENT      4
```

# 14 ANCILLARY DATA API

```
////////////////////////////////////////////////////////////////////////
//////
// ANCAPI.H
//
// Header file for ANCAPI.CPP - This header file implements the NVIDIA
GVO
// ancillary data API for SDI.
//
//  This file will be exposed to 3rd party developers
//
// Platforms/OS - Windows XP, linux
//
////////////////////////////////////////////////////////////////////////
//////

#ifndef __NVANCAPI_H__
#define __NVANCAPI_H__

#ifdef _WIN32
#include "nvapi.h"
#endif

//----------------------------------------------------------------------
// NVIDIA Grapics to Video Out (GVO) Ancillary Data API
//----------------------------------------------------------------------

#ifdef  __cplusplus
    extern "C" {
#endif//__cplusplus

#ifndef IN
#   define IN
#endif//IN

#ifndef OUT
```

```
#   define OUT
#endif//OUT

#ifndef INOUT
#   define INOUT
#endif//INOUT

#ifdef _WIN32
#define NVVIOANCAPI_INTERFACE extern NvAPI_Status __cdecl
#else
#define NVVIOANCAPI_INTERFACE NvAPI_Status
#endif

#define DECLARE_HANDLE(name) struct name##__ { int unused; }; typedef
struct name##__ *name


// Need these nvapi.h defines on linux.
#ifndef _WIN32
typedef unsigned long long NvU64;
typedef unsigned int       NvU32;
typedef unsigned short     NvU16;
typedef long               NvS32;
typedef unsigned char      NvU8;

#define NVAPI_GENERIC_STRING_MAX    4096
#define NVAPI_LONG_STRING_MAX       256
#define NVAPI_SHORT_STRING_MAX      64

typedef char NvAPI_String[NVAPI_GENERIC_STRING_MAX];
typedef char NvAPI_LongString[NVAPI_LONG_STRING_MAX];
typedef char NvAPI_ShortString[NVAPI_SHORT_STRING_MAX];
#endif


//
// NVVIO Handle - NVVIO control handle
//
#ifndef _WIN32
DECLARE_HANDLE(NvVioHandle);            // NvVIO Device Handle
#endif

//
================================================================================
==================
// NvAPI Version Definition
// Maintain per structure specific version define using the
MAKE_NVAPI_VERSION macro.
// Usage: #define NVVIOANCDATAFRAME_VERSION
MAKE_NVAPI_VERSION(NVVIOANCDATAFRAME, 1)
//
================================================================================
==================
```

```
#define MAKE_NVAPI_VERSION(typeName,ver) (NvU32)(sizeof(typeName) |
((ver)<<16))
#define GET_NVAPI_VERSION(ver) (NvU32)((ver)>>16)
#define GET_NVAPI_SIZE(ver) (NvU32)((ver) & 0xffff)

//--------------------------------------------------------------------------
// Types
//--------------------------------------------------------------------------

//--------------------------------------------------------------------------
// Enumerations
//--------------------------------------------------------------------------

// ==================================================
// NvAPI Status Values
//    All NvAPI functions return one of these codes.
// ==================================================
#ifndef _WIN32
#ifndef NvAPI_Status
typedef enum
{
    NVAPI_OK                            =  0,      // Success
    NVAPI_ERROR                         = -1,      // Generic error
    NVAPI_LIBRARY_NOT_FOUND             = -2,      // nvapi.dll can not
be loaded
    NVAPI_NO_IMPLEMENTATION             = -3,      // not implemented
in current driver installation
    NVAPI_API_NOT_INTIALIZED            = -4,      // NvAPI_Initialize
has not been called (successfully)
    NVAPI_INVALID_ARGUMENT              = -5,      // invalid argument
    NVAPI_NVIDIA_DEVICE_NOT_FOUND       = -6,      // no NVIDIA display
driver was found
    NVAPI_END_ENUMERATION               = -7,      // no more to enum
    NVAPI_INVALID_HANDLE                = -8,      // invalid handle
    NVAPI_INCOMPATIBLE_STRUCT_VERSION   = -9,      // an argument's
structure version is not supported
    NVAPI_NOT_SUPPORTED                 = -10,     // Requested feature
not supported in the selected GPU
    NVAPI_PORTID_NOT_FOUND              = -11      // NO port ID found
for I2C transaction
} NvAPI_Status;
#endif
#endif

// Audio sample rate definitions - from SMPTE 299M-2004 Table 8
typedef enum
{
     NVVIOANCAUDIO_SAMPLING_RATE_48_0         = 0x0,
     NVVIOANCAUDIO_SAMPLING_RATE_44_1         = 0x1,
     NVGOVANCAUDIO_SAMPLING_RATE_32_0         = 0x2,
     NVVIOANCAUDIO_SAMPLING_RATE_FREE_RUNNING = 0x3
} NVVIOANCAUDIO_SAMPLE_RATE;
```

```
// Active channel definitions - from SMPTE 299M-2004 Table 9
typedef enum
{
    NVVIOANCAUDIO_ACTIVE_CH1    = 0x1,
    NVVIOANCAUDIO_ACTIVE_CH2    = 0x2,
    NVVIOANCAUDIO_ACTIVE_CH3    = 0x4,
    NVVIOANCAUDIO_ACTIVE_CH4    = 0x8
} NVVIOANCAUDIO_ACTIVE_CHANNEL;


//--------------------------------------------------------------------------
// Structures
//--------------------------------------------------------------------------

// Audio control
typedef struct tagNVVIOANCAUDIOCNTRL {
     NvU32 version;               // Structure version
     NvU8 frameNumber1_2;          // Frame number for channels 1 and 2
     NvU8 frameNumber3_4;          // Frame number for channels 3 and 4
     NvU8 rate;                   // Audio sample rate
     NvU8 asynchronous;           // 0 = synchronous, 1 = asynchronous
     NvU8 activeChannels;         // Bitwise OR of active channel
definitions
} NVVIOANCAUDIOCNTRL;

#define NVVIOANCAUDIOCNTRL_VERSION
MAKE_NVAPI_VERSION(NVVIOANCAUDIOCNTRL, 1)


// Audio group
typedef struct tagNVVIOANCAUDIOGROUP {
    NvU32 numAudioSamples;   // Number of valid audio samples / channel
    NvU32  *audioData[4];    // Data pointer for audio channels 1-4
    NVVIOANCAUDIOCNTRL audioCntrl;  // Controls for audio channels 1-4
} NVVIOANCAUDIOGROUP;

#define NVVIOANCAUDIOGROUP_VERSION
MAKE_NVAPI_VERSION(NVVIOANCAUDIOGROUP, 1)


// Per ANC Data Packet
typedef struct tagNVVIOANCDATAPACKET {
    NvU32 version;               // Structure version
    NvU16 DID;
    NvU16 SDID;
    NvU16 DC;
    NvU8  *data;                 // Should this be unsigned short?
    NvU16 CS;
} NVVIOANCDATAPACKET;

#define NVVIOANCDATAPACKET_VERSION
MAKE_NVAPI_VERSION(NVVIOANCDATAPACKET, 1)
```

```
// Data field mask definitions (Indicate NVVIOANCDATAFRAME fields in
use)
#define NVVIOANCDATAFRAME_AUDIO_GROUP_1 0x00000001
#define NVVIOANCDATAFRAME_AUDIO_GROUP_2 0x00000002
#define NVVIOANCDATAFRAME_AUDIO_GROUP_3 0x00000004
#define NVVIOANCDATAFRAME_AUDIO_GROUP_4 0x00000008
#define NVVIOANCDATAFRAME_LTC               0x00000010
#define NVVIOANCDATAFRAME_VITC              0x00000020
#define NVVIOANCDATAFRAME_FILM_TC           0x00000040
#define NVVIOANCDATAFRAME_PROD_TC           0x00000080
#define NVVIOANCDATAFRAME_FRAME_ID          0x00000100
#define NVVIOANCDATAFRAME_CUSTOM            0x00000200

// Per Frame
typedef struct tagNVVIOANCDATAFRAME {
    NvU32 version;                    // Structure version
    NvU32 fields;                    // Field mask
    NVVIOANCAUDIOGROUP  AudioGroup1; // Audio group 1
    NVVIOANCAUDIOGROUP  AudioGroup2; // Audio group 2
    NVVIOANCAUDIOGROUP  AudioGroup3; // Audio group 3
    NVVIOANCAUDIOGROUP  AudioGroup4; // Audio group 4
    NvU32 LTCTimecode;               // RP188
    NvU32 LTCUserBytes;
    NvU32 VITCTimecode;
    NvU32 VITCUserBytes;
    NvU32 FilmTimecode;
    NvU32 FilmUserBytes;
    NvU32 ProductionTimecode;        // RP201
    NvU32 ProductionUserBytes;       // RP201
    NvU32 FrameID;
    NvU32 numCustomPackets;
    NVVIOANCDATAPACKET *CustomPackets;
} NVVIOANCDATAFRAME;

#define NVVIOANCDATAFRAME_VERSION
MAKE_NVAPI_VERSION(NVVIOANCDATAFRAME, 1)

// Per Sequence
typedef struct tagNVVIOANCDATACONFIG {
    NvU32 version;               // Structure version
    NvU32 numAudioChannels;
    NvU32 audioRate;
} NVVIOANCDATACONFIG;

#define NVVIOANCDATACONFIG_VERSION
MAKE_NVAPI_VERSION(NVVIOANCDATACONFIG, 1)

//--------------------------------------------------------------------------
// Prototypes
//--------------------------------------------------------------------------
```

```
////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_InitializeGVO
//
//   DESCRIPTION: Initializes NV GVO ancillary data library. This
function must be
//                called before any other NV GVO ancillary data library
function.
//                This function queries the current video device state
and
//                initializes all internal data structures.
//
//
// RETURN STATUS: NVAPI_ERROR            Something is wrong during the
initialization process (generic error)
//                NVAPI_LIBRARYNOTFOUND  Can not load nvapi.dll
//                NVAPI_OK               Initialized
//
////////////////////////////////////////////////////////////////////////
////////
#ifdef _WIN32
NVVIOANCAPI_INTERFACE NvVIOANCAPI_InitializeGVO(NvVioHandle hVIO);
#else
NVVIOANCAPI_INTERFACE NvVIOANCAPI_InitializeGVO(Display *dpy, int
target_id);
#endif

////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_InitializeGVI
//
//   DESCRIPTION: Initializes NV GVI ancillary data library. This
function must be
//                called before any other NV GVI ancillary data library
function.
//                This function queries the current video device state
and
//                initializes all internal data structures.
//
//
// RETURN STATUS: NVAPI_ERROR            Something is wrong during the
initialization process (generic error)
//                NVAPI_LIBRARYNOTFOUND  Can not load nvapi.dll
//                NVAPI_OK               Initialized
//
////////////////////////////////////////////////////////////////////////
////////
#ifdef _WIN32
NVVIOANCAPI_INTERFACE NvVIOANCAPI_InitializeGVI(NvVioHandle hVIO);
#else
```

```
NVVIOANCAPI_INTERFACE NvVIOANCAPI_InitializeGVI(Display *dpy, int
target_id);
#endif

////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_ReleaseGVO
//
//   DESCRIPTION: Releases NV GVO ancillary data library. This function
must be
//                called to release all NV GVO ancillary data library
resources.
//
//
// RETURN STATUS: NVAPI_ERROR            Something went wrong
//                NVAPI_OK               All resources released
//
////////////////////////////////////////////////////////////////////////
////////#ifdef _WIN32
NVVIOANCAPI_INTERFACE NvVIOANCAPI_ReleaseGVO(NvVioHandle hVIO);

#else
NVVIOANCAPI_INTERFACE NvVIOANCAPI_ReleaseGVO(Display *dpy, int
target_id);
#endif
//
// FUNCTION NAME: NvVIOANCAPI_ReleaseGVI
//
//   DESCRIPTION: Releases NV GVI ancillary data library. This function
must be
//                called to release all NV GVO ancillary data library
resources.
//
//
// RETURN STATUS: NVAPI_ERROR            Something went wrong
//                NVAPI_OK               All resources released
//
////////////////////////////////////////////////////////////////////////
//////// #ifdef WIN32
NVVIOANCAPI_INTERFACE NvVIOANCAPI_ReleaseGVI(NvVioHandle hVIO);
#else
NVVIOANCAPI_INTERFACE NvVIOANCAPI_ReleaseGVI(Display *dpy, int
target_id);
#endif


////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_GetErrorMessage
//
```

```
//   DESCRIPTION: converts an NVVIOANCAPI error code into a null
terminated string
//
// RETURN STATUS: null terminated string (always, never NULL)
//
////////////////////////////////////////////////////////////////////////
////////
NVVIOANCAPI_INTERFACE NvVIOANCAPI_GetErrorMessage(NvAPI_Status
nr,NvAPI_ShortString szDesc);

////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_GetInterfaceVersionString
//
//   DESCRIPTION: Returns a string describing the version of the
NVVIOANCAPI library.
//                Contents of the string are human readable.  Do not
assume a fixed
//                format.
//
// RETURN STATUS: User readable string giving info on NvAPI's version
//
////////////////////////////////////////////////////////////////////////
////////
NVVIOANCAPI_INTERFACE
NvVIOANCAPI_GetInterfaceVersionString(NvAPI_ShortString szVersion);


////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_SendANCData
//
//   DESCRIPTION: Sends ancillary data for current field or frame.
//
// RETURN STATUS: NVAPI_ERROR
//                NVAPI_OK
//
////////////////////////////////////////////////////////////////////////
////////
NVVIOANCAPI_INTERFACE NvVIOANCAPI_SendANCData(NvVioHandle handle,
NVVIOANCDATAFRAME *data);


////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_NumAudioSamples
//
//   DESCRIPTION: Return number of expected audio samples per channel
per frame
//                at the given sample rate.
```

```
//
// RETURN STATUS: NVAPI_ERROR
//                NVAPI_OK
//
//////////////////////////////////////////////////////////////////////////
////////
NVVIOANCAPI_INTERFACE NvVIOANCAPI_NumAudioSamples(NvVioHandle handle,
NVVIOANCAUDIO_SAMPLE_RATE rate, float *num);

//////////////////////////////////////////////////////////////////////////
////////
//
// FUNCTION NAME: NvVIOANCAPI_CaptureANCData
//
//   DESCRIPTION: Capture ancillary data for current field or frame.
//
// RETURN STATUS: NVAPI_ERROR
//                NVAPI_OK
//
//////////////////////////////////////////////////////////////////////////
////////
NVVIOANCAPI_INTERFACE NvVIOANCAPI_CaptureANCData(NvVioHandle handle,
NVVIOANCDATAFRAME *data);

#ifdef __cplusplus
}; //extern "C" {
#endif

#endif  // __NVANCAPI_H__
```

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