# LLGL

1.00 Alpha

Generated by Doxygen 1.8.11

# Contents

# Chapter 1

# LLGL 1.00 Alpha Documentation

## LLGL (Low Level Graphics Library)

### Overview

- **Version**: 1.00 Alpha
- **License**: 3-Clause BSD License

### Progress

- **OpenGL Renderer**: ∼70% done
- **Direct3D 12 Renderer**: ∼5% done
- **Direct3D 11 Renderer**: not started yet
- **Vulkan Renderer**: not started yet

### Getting Started

```
#include <LLGL/LLGL.h>

int main()
{
    // Create a window to render into
    LLGL::WindowDescriptor windowDesc;

    windowDesc.title    = L"LLGL Example";
    windowDesc.visible  = true;
    windowDesc.centered = true;
    windowDesc.width    = 640;
    windowDesc.height   = 480;

    auto window = LLGL::Window::Create(windowDesc);

    // Add keyboard/mouse event listener
    auto input = std::make_shared<LLGL::Input>();
    window->AddEventListener(input);

    //TO BE CONTINUED ...

    // Main loop
    while (window->ProcessEvents() && !input->KeyPressed(LLGL::Key::Escape))
    {

        // Draw with OpenGL, or Direct3D, or Vulkan, or whatever ...

    }

    return 0;
}
```

## Thin Abstraction Layer

```
// Interface:
RenderContext::DrawIndexed(unsigned int numVertices, unsigned int firstIndex);

// OpenGL Implementation:
void GLRenderContext::DrawIndexed(unsigned int numVertices, unsigned int firstIndex)
{
    glDrawElements(
        renderState_.drawMode,
        static_cast<GLsizei>(numVertices),
        renderState_.indexBufferDataType,
        (reinterpret_cast<const GLvoid*>(firstIndex * renderState_.indexBufferStride))
    );
}

// Direct3D 11 Implementation
void D3D11RenderContext::DrawIndexed(unsigned int numVertices, unsigned int firstIndex)
{
    context_->DrawIndexed(numVertices, 0, firstIndex);
}

// Direct3D 12 Implementation
void D3D12RenderContext::DrawIndexed(unsigned int numVertices, unsigned int firstIndex)
{
    commandList_->DrawIndexedInstanced(numVertices, 1, firstIndex, 0, 0);
}

// Vulkan Implementation
void VKRenderContext::DrawIndexed(unsigned int numVertices, unsigned int firstIndex)
{
    vkCmdDrawIndexed(commandBuffer_, numVertices, 1, firstIndex, 0, 0);
}
```

# Chapter 2

# Namespace Index

## 2.1 Namespace List

Here is a list of all namespaces with brief descriptions:

# Chapter 3

# Hierarchical Index

## 3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

# Chapter 4

# Class Index

## 4.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

# Chapter 5

# File Index

## 5.1 File List

Here is a list of all files with brief descriptions:

# Chapter 6

# Namespace Documentation

## 6.1 LLGL Namespace Reference

### Namespaces

- Desktop
- Log

### Classes

- struct AntiAliasingDescriptor
- struct BlendDescriptor

  *Blending state descriptor structure.*
- struct BlendTargetDescriptor

  *Blend target state descriptor structure.*
- class Buffer

  *Hardware buffer interface.*
- struct BufferDescriptor

  *Hardware buffer descriptor structure.*
- struct ClearBuffersFlags

  *Render context clear buffer flags.*
- class Color

  *Base color class with N components.*
- class Color< T, 3u >

  *RGB color class with components: r, g, and b.*
- class Color< T, 4u >

  *RGBA color class with components: r, g, b, and a.*
- class ComputePipeline

  *Compute pipeline interface.*
- struct ComputePipelineDescriptor

  *Compute pipeline descriptor structure.*
- struct ConstantBufferViewDescriptor

  *Constant buffer shader-view descriptor structure.*
- struct DepthDescriptor

  *Depth state descriptor structure.*

- union GraphicsAPIDependentStateDescriptor

    *Low-level graphics API dependent state descriptor union.*
- class GraphicsPipeline

    *Graphics pipeline interface.*
- struct GraphicsPipelineDescriptor

    *Graphics pipeline descriptor structure.*
- struct ImageDescriptor

    *Image descriptor structure.*
- class IndexFormat
- class Input
- struct NativeContextHandle

    *Linux native context handle structure.*
- struct NativeHandle

    *Linux native handle structure.*
- struct ProfileOpenGLDescriptor
- class Query

    *Query interface.*
- struct QueryDescriptor

    *Query descriptor structure.*
- struct RasterizerDescriptor

    *Rasterizer state descriptor structure.*
- class RenderContext

    *Render context interface.*
- struct RenderContextDescriptor
- struct RendererID

    *Renderer identification number enumeration.*
- struct RendererInfo

    *Renderer basic information structure.*
- struct RenderingCaps

    *Rendering capabilities structure.*
- class RenderingDebugger

    *Rendering debugger interface.*
- class RenderingProfiler

    *Rendering profiler model class.*
- class RenderSystem

    *Render system interface.*
- struct RenderSystemConfiguration

    *Render system configuration structure.*
- class RenderTarget

    *Render target interface.*
- struct RenderTargetAttachmentDescriptor

    *Render target attachment descriptor structure.*
- class Sampler

    *Sampler interface.*
- struct SamplerDescriptor

    *Texture sampler descriptor structure.*
- struct Scissor

    *Scissor dimensions.*
- class Shader

    *Shader interface.*
- struct ShaderCompileFlags

*Shader compilation flags enumeration.*

- struct ShaderDisassembleFlags

  *Shader disassemble flags enumeration.*
- class ShaderProgram

  *Shader program interface.*
- union ShaderSource

  *Shader source code union.*
- struct ShaderStageFlags

  *Shader stage flags.*
- class ShaderUniform

  *Shader uniform setter interface.*
- struct StencilDescriptor

  *Stencil state descriptor structure.*
- struct StencilFaceDescriptor

  *Stencil face descriptor structure.*
- struct StorageBufferViewDescriptor

  *Storage buffer shader-view descriptor structure.*
- struct SubTextureDescriptor

  *Sub-texture descriptor structure.*
- class Texture

  *Texture interface.*
- struct TextureDescriptor

  *Texture descriptor structure.*
- class Timer
- struct UniformDescriptor

  *Shader uniform descriptor structure.*
- struct VertexAttribute

  *Vertex attribute class.*
- class VertexFormat

  *Vertex format descriptor class.*
- struct VideoAdapterDescriptor

  *Video adapter descriptor structure.*
- struct VideoDisplayMode

  *Video display mode structure.*
- struct VideoModeDescriptor
- struct VideoOutput

  *Video output structure.*
- struct Viewport

  *Viewport dimensions.*
- struct VsyncDescriptor
- class Window
- struct WindowDescriptor

  *Window descriptor structure.*

## Typedefs

- template< typename T >
  using ColorRGBT = Color< T, 3 >
- using ColorRGB = ColorRGBT< Gs::Real >
- using ColorRGBb = ColorRGBT< bool >
- using ColorRGBf = ColorRGBT< float >
- using ColorRGBd = ColorRGBT< double >
- using ColorRGBub = ColorRGBT< unsigned char >
- template< typename T >
  using ColorRGBAT = Color< T, 4 >
- using ColorRGBA = ColorRGBAT< Gs::Real >
- using ColorRGBAb = ColorRGBAT< bool >
- using ColorRGBAf = ColorRGBAT< float >
- using ColorRGBAd = ColorRGBAT< double >
- using ColorRGBAub = ColorRGBAT< unsigned char >
- using ByteBuffer = std::unique_ptr< char[ ]>

  *Common byte buffer type.*
- using DebugCallback = std::function< void(const std::string &type, const std::string &message)>

  *Debug callback function interface.*
- using Point = Gs::Vector2i

  *2D point (integer)*
- using Size = Gs::Vector2i

  *2D size (integer)*

## Enumerations

- enum BufferType {
  BufferType::Vertex, BufferType::Index, BufferType::Constant, BufferType::Storage,
  BufferType::StreamOutput }

  *Hardware buffer type enumeration.*
- enum StorageBufferType {
  StorageBufferType::Generic, StorageBufferType::Buffer, StorageBufferType::StructuredBuffer, Storage←
  BufferType::ByteAddressBuffer,
  StorageBufferType::RWBuffer, StorageBufferType::RWStructuredBuffer, StorageBufferType::RWByte←
  AddressBuffer, StorageBufferType::AppendStructuredBuffer,
  StorageBufferType::ConsumeStructuredBuffer }

  *Storage buffer type enumeration.*
- enum PrimitiveTopology {
  PrimitiveTopology::PointList, PrimitiveTopology::LineList, PrimitiveTopology::LineStrip, PrimitiveTopology::←
  LineLoop,
  PrimitiveTopology::LineListAdjacency, PrimitiveTopology::LineStripAdjacency, PrimitiveTopology::Triangle←
  List, PrimitiveTopology::TriangleStrip,
  PrimitiveTopology::TriangleFan, PrimitiveTopology::TriangleListAdjacency, PrimitiveTopology::TriangleStrip←
  Adjacency, PrimitiveTopology::Patches1,
  PrimitiveTopology::Patches2, PrimitiveTopology::Patches3, PrimitiveTopology::Patches4, Primitive←
  Topology::Patches5,
  PrimitiveTopology::Patches6, PrimitiveTopology::Patches7, PrimitiveTopology::Patches8, Primitive←
  Topology::Patches9,
  PrimitiveTopology::Patches10, PrimitiveTopology::Patches11, PrimitiveTopology::Patches12, Primitive←
  Topology::Patches13,
  PrimitiveTopology::Patches14, PrimitiveTopology::Patches15, PrimitiveTopology::Patches16, Primitive←
  Topology::Patches17,
  PrimitiveTopology::Patches18, PrimitiveTopology::Patches19, PrimitiveTopology::Patches20, Primitive←

Topology::Patches21,
PrimitiveTopology::Patches22, PrimitiveTopology::Patches23, PrimitiveTopology::Patches24, Primitive←
Topology::Patches25,
PrimitiveTopology::Patches26, PrimitiveTopology::Patches27, PrimitiveTopology::Patches28, Primitive←
Topology::Patches29,
PrimitiveTopology::Patches30, PrimitiveTopology::Patches31, PrimitiveTopology::Patches32 }

*Primitive topology enumeration.*

- enum CompareOp {
CompareOp::Never, CompareOp::Less, CompareOp::Equal, CompareOp::LessEqual,
CompareOp::Greater, CompareOp::NotEqual, CompareOp::GreaterEqual, CompareOp::Ever }

  *Compare operations enumeration.*

- enum StencilOp {
StencilOp::Keep, StencilOp::Zero, StencilOp::Replace, StencilOp::IncClamp,
StencilOp::DecClamp, StencilOp::Invert, StencilOp::IncWrap, StencilOp::DecWrap }

  *Stencil operations enumeration.*

- enum BlendOp {
BlendOp::Zero, BlendOp::One, BlendOp::SrcColor, BlendOp::InvSrcColor,
BlendOp::SrcAlpha, BlendOp::InvSrcAlpha, BlendOp::DestColor, BlendOp::InvDestColor,
BlendOp::DestAlpha, BlendOp::InvDestAlpha }

  *Blending operations enumeration.*

- enum BlendArithmetic {
BlendArithmetic::Add, BlendArithmetic::Subtract, BlendArithmetic::RevSubtract, BlendArithmetic::Min,
BlendArithmetic::Max }

  *Blending arithmetic operations enumeration.*

- enum PolygonMode { PolygonMode::Fill, PolygonMode::Wireframe, PolygonMode::Points }

  *Polygon filling modes enumeration.*

- enum CullMode { CullMode::Disabled, CullMode::Front, CullMode::Back }

  *Polygon culling modes enumeration.*

- enum DataType {
DataType::Int8, DataType::UInt8, DataType::Int16, DataType::UInt16,
DataType::Int32, DataType::UInt32, DataType::Float, DataType::Double }

  *Renderer data types enumeration.*

- enum ImageFormat {
ImageFormat::R, ImageFormat::RG, ImageFormat::RGB, ImageFormat::BGR,
ImageFormat::RGBA, ImageFormat::BGRA, ImageFormat::Depth, ImageFormat::DepthStencil,
ImageFormat::CompressedRGB, ImageFormat::CompressedRGBA }

  *Image format used to write texture data.*

- enum Key {

Key::LButton, Key::RButton, Key::Cancel, Key::MButton,
Key::XButton1, Key::XButton2, Key::Back, Key::Tab,
Key::Clear, Key::Return, Key::Shift, Key::Control,
Key::Menu, Key::Pause, Key::Capital, Key::Escape,
Key::Space, Key::PageUp, Key::PageDown, Key::End,
Key::Home, Key::Left, Key::Up, Key::Right,
Key::Down, Key::Select, Key::Print, Key::Exe,
Key::Snapshot, Key::Insert, Key::Delete, Key::Help,
Key::D0, Key::D1, Key::D2, Key::D3,
Key::D4, Key::D5, Key::D6, Key::D7,
Key::D8, Key::D9, Key::A, Key::B,
Key::C, Key::D, Key::E, Key::F,
Key::G, Key::H, Key::I, Key::J,
Key::K, Key::L, Key::M, Key::N,
Key::O, Key::P, Key::Q, Key::R,
Key::S, Key::T, Key::U, Key::V,
Key::W, Key::X, Key::Y, Key::Z,
Key::LWin, Key::RWin, Key::Apps, Key::Sleep,
Key::Keypad0, Key::Keypad1, Key::Keypad2, Key::Keypad3,
Key::Keypad4, Key::Keypad5, Key::Keypad6, Key::Keypad7,
Key::Keypad8, Key::Keypad9, Key::KeypadMultiply, Key::KeypadPlus,
Key::KeypadSeparator, Key::KeypadMinus, Key::KeypadDecimal, Key::KeypadDivide,
Key::F1, Key::F2, Key::F3, Key::F4,
Key::F5, Key::F6, Key::F7, Key::F8,
Key::F9, Key::F10, Key::F11, Key::F12,
Key::F13, Key::F14, Key::F15, Key::F16,
Key::F17, Key::F18, Key::F19, Key::F20,
Key::F21, Key::F22, Key::F23, Key::F24,
Key::NumLock, Key::ScrollLock, Key::LShift, Key::RShift,
Key::LControl, Key::RControl, Key::LMenu, Key::RMenu,
Key::BrowserBack, Key::BrowserForward, Key::BrowserRefresh, Key::BrowserStop,
Key::BrowserSearch, Key::BrowserFavorits, Key::BrowserHome, Key::VolumeMute,
Key::VolumeDown, Key::VolumeUp, Key::MediaNextTrack, Key::MediaPrevTrack,
Key::MediaStop, Key::MediaPlayPause, Key::LaunchMail, Key::LaunchMediaSelect,
Key::LaunchApp1, Key::LaunchApp2, Key::Plus, Key::Comma,
Key::Minus, Key::Period, Key::Exponent, Key::Attn,
Key::CrSel, Key::ExSel, Key::ErEOF, Key::Play,
Key::Zoom, Key::NoName, Key::PA1, Key::OEMClear }

*Input key codes.*

- enum QueryType {
QueryType::SamplesPassed, QueryType::AnySamplesPassed, QueryType::AnySamplesPassedConservative,
QueryType::PrimitivesGenerated,
QueryType::TimeElapsed, QueryType::StreamOutPrimitivesWritten, QueryType::StreamOutOverflow,
QueryType::VerticesSubmitted,
QueryType::PrimitivesSubmitted, QueryType::VertexShaderInvocations, QueryType::TessControlShader↩
Invocations, QueryType::TessEvaluationShaderInvocations,
QueryType::GeometryShaderInvocations, QueryType::FragmentShaderInvocations, QueryType::Compute↩
ShaderInvocations, QueryType::GeometryPrimitivesGenerated,
QueryType::ClippingInputPrimitives, QueryType::ClippingOutputPrimitives }

  *Query type enumeration.*

- enum OpenGLVersion {
OpenGLVersion::OpenGL_Latest = 0, OpenGLVersion::OpenGL_1_0 = 100, OpenGLVersion::OpenGL_1_1
= 110, OpenGLVersion::OpenGL_1_2 = 120,
OpenGLVersion::OpenGL_1_3 = 130, OpenGLVersion::OpenGL_1_4 = 140, OpenGLVersion::OpenGL_1_5
= 150, OpenGLVersion::OpenGL_2_0 = 200,
OpenGLVersion::OpenGL_2_1 = 210, OpenGLVersion::OpenGL_3_0 = 300, OpenGLVersion::OpenGL_3_1
= 310, OpenGLVersion::OpenGL_3_2 = 320,
OpenGLVersion::OpenGL_3_3 = 330, OpenGLVersion::OpenGL_4_0 = 400, OpenGLVersion::OpenGL_4_1

= 410, OpenGLVersion::OpenGL_4_2 = 420, OpenGLVersion::OpenGL_4_3 = 430, OpenGLVersion::OpenGL_4_4 = 440, OpenGLVersion::OpenGL_4_5 = 450 }
- enum SwapChainMode { SwapChainMode::SingleBuffering = 1, SwapChainMode::DoubleBuffering = 2, SwapChainMode::TripleBuffering = 3 }

  *Swap chain mode enumeration.*
- enum RenderConditionMode { RenderConditionMode::Wait, RenderConditionMode::NoWait, RenderConditionMode::ByRegionWait, RenderConditionMode::ByRegionNoWait, RenderConditionMode::WaitInverted, RenderConditionMode::NoWaitInverted, RenderConditionMode::By←RegionWaitInverted, RenderConditionMode::ByRegionNoWaitInverted }

  *Render condition mode enumeration.*
- enum ErrorType { ErrorType::InvalidArgument, ErrorType::InvalidState, ErrorType::UnsupportedFeature }

  *Rendering debugger error types enumeration.*
- enum WarningType { WarningType::ImproperArgument, WarningType::ImproperState, WarningType::←PointlessOperation }
- enum BufferUsage { BufferUsage::Static, BufferUsage::Dynamic }

  *Hardware buffer usage enumeration.*
- enum BufferCPUAccess { BufferCPUAccess::ReadOnly, BufferCPUAccess::WriteOnly, BufferCPUAccess←::ReadWrite }

  *Hardware buffer CPU acccess enumeration.*
- enum ShadingLanguage { ShadingLanguage::Unsupported = 0, ShadingLanguage::GLSL_110 = 110, ShadingLanguage::GLSL_120 = 120, ShadingLanguage::GLSL_130 = 130, ShadingLanguage::GLSL_140 = 140, ShadingLanguage::GLSL_150 = 150, ShadingLanguage::GLSL_330 = 330, ShadingLanguage::GLSL_400 = 400, ShadingLanguage::GLSL_410 = 410, ShadingLanguage::GLSL_420 = 420, ShadingLanguage::GLSL_430 = 430, ShadingLanguage::GLSL_440 = 440, ShadingLanguage::GLSL_450 = 450, ShadingLanguage::HLSL_2_0 = 100200, ShadingLanguage::HLSL←_2_0a = 100201, ShadingLanguage::HLSL_2_0b = 100202, ShadingLanguage::HLSL_3_0 = 100300, ShadingLanguage::HLSL_4_0 = 100400, ShadingLanguage::HL←SL_4_1 = 100410, ShadingLanguage::HLSL_5_0 = 100500 }

  *Shading language version enumation.*
- enum ScreenOrigin { ScreenOrigin::LowerLeft, ScreenOrigin::UpperLeft }

  *Screen coordinate system origin enumeration.*
- enum ClippingRange { ClippingRange::MinusOneToOne, ClippingRange::ZeroToOne }

  *Clipping depth range enumeration.*
- enum TextureWrap { TextureWrap::Repeat, TextureWrap::Mirror, TextureWrap::Clamp, TextureWrap::Border, TextureWrap::MirrorOnce }

  *Texture coordinate wrap enumeration.*
- enum TextureFilter { TextureFilter::Nearest, TextureFilter::Linear }

  *Texture sampling filter enumeration.*
- enum ShaderType { ShaderType::Vertex, ShaderType::TessControl, ShaderType::TessEvaluation, ShaderType::Geometry, ShaderType::Fragment, ShaderType::Compute }

  *Shader type enumeration.*
- enum UniformType { UniformType::Float, UniformType::Float2, UniformType::Float3, UniformType::Float4, UniformType::Double, UniformType::Double2, UniformType::Double3, UniformType::Double4, UniformType::Int, UniformType::Int2, UniformType::Int3, UniformType::Int4, UniformType::Float2x2, UniformType::Float3x3, UniformType::Float4x4, UniformType::Double2x2, UniformType::Double3x3, UniformType::Double4x4, UniformType::Sampler1D, UniformType::Sampler2D, UniformType::Sampler3D, UniformType::SamplerCube }

  *Shader uniform type enumeration.*

- enum TextureType {
  TextureType::Undefined, TextureType::Texture1D, TextureType::Texture2D, TextureType::Texture3D,
  TextureType::TextureCube, TextureType::Texture1DArray, TextureType::Texture2DArray, TextureType::↩
  TextureCubeArray }

  *Texture type enumeration.*
- enum TextureFormat {
  TextureFormat::Unknown, TextureFormat::DepthComponent, TextureFormat::DepthStencil, TextureFormat↩
  ::R,
  TextureFormat::RG, TextureFormat::RGB, TextureFormat::RGBA, TextureFormat::R8,
  TextureFormat::R8Sgn, TextureFormat::R16, TextureFormat::R16Sgn, TextureFormat::R16Float,
  TextureFormat::R32UInt, TextureFormat::R32SInt, TextureFormat::R32Float, TextureFormat::RG8,
  TextureFormat::RG8Sgn, TextureFormat::RG16, TextureFormat::RG16Sgn, TextureFormat::RG16Float,
  TextureFormat::RG32UInt, TextureFormat::RG32SInt, TextureFormat::RG32Float, TextureFormat::RGB8,
  TextureFormat::RGB8Sgn, TextureFormat::RGB16, TextureFormat::RGB16Sgn, TextureFormat::RGB16↩
  Float,
  TextureFormat::RGB32UInt, TextureFormat::RGB32SInt, TextureFormat::RGB32Float, TextureFormat::RG↩
  BA8,
  TextureFormat::RGBA8Sgn, TextureFormat::RGBA16, TextureFormat::RGBA16Sgn, TextureFormat::RGB↩
  A16Float,
  TextureFormat::RGBA32UInt, TextureFormat::RGBA32SInt, TextureFormat::RGBA32Float, TextureFormat↩
  ::RGB_DXT1,
  TextureFormat::RGBA_DXT1, TextureFormat::RGBA_DXT3, TextureFormat::RGBA_DXT5 }

  *Hardware texture format enumeration.*
- enum AxisDirection {
  AxisDirection::XPos = 0, AxisDirection::XNeg, AxisDirection::YPos, AxisDirection::YNeg,
  AxisDirection::ZPos, AxisDirection::ZNeg }

  *Axis direction (also used for texture cube face).*

## Functions

- template<typename T >
  T MaxColorValue ()

  *Returns the maximal color value for the data type T. By default 1.*
- template<>
  unsigned char MaxColorValue< unsigned char > ()

  *Specialized version. For unsigned 8-bit integers, the return value is 255.*
- template<>
  bool MaxColorValue< bool > ()

  *Specialized version. For booleans, the return value is true.*
- template<typename T , std::size_t N>
  Color< T, N > operator+ (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > operator- (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > operator∗ (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > operator/ (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > operator∗ (const Color< T, N > &lhs, const T &rhs)
- template<typename T , std::size_t N>
  Color< T, N > operator∗ (const T &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > operator/ (const Color< T, N > &lhs, const T &rhs)
- template<typename T , std::size_t N>
  bool operator== (const Color< T, N > &lhs, const Color< T, N > &rhs)

- template<typename T , std::size_t N>
  bool operator!= (const Color< T, N > &lhs, const Color< T, N > &rhs)
- LLGL_EXPORT std::size_t DataTypeSize (const DataType dataType)

  *Returns the size (in bytes) of the specified data type.*
- LLGL_EXPORT std::size_t ImageFormatSize (const ImageFormat imageFormat)

  *Returns the size (in number of components) of the specified image format.*
- LLGL_EXPORT bool IsCompressedFormat (const ImageFormat format)

  *Returns true if the specified color format is a compressed format, i.e. either ImageFormat::CompressedRGB, or ImageFormat::CompressedRGBA.*
- LLGL_EXPORT bool IsDepthStencilFormat (const ImageFormat format)

  *Returns true if the specified color foramt is a depth-stencil format, i.e. either ImageFormat::Depth or ImageFormat↩ ::DepthStencil.*
- LLGL_EXPORT ByteBuffer ConvertImageBuffer (ImageFormat srcFormat, DataType srcDataType, const void ∗srcBuffer, std::size_t srcBufferSize, ImageFormat dstFormat, DataType dstDataType, std::size_t thread↩ Count=0)

  *Converts the image format and data type of the source image (only uncompressed color formats).*
- LLGL_EXPORT bool operator== (const VsyncDescriptor &lhs, const VsyncDescriptor &rhs)
- LLGL_EXPORT bool operator!= (const VsyncDescriptor &lhs, const VsyncDescriptor &rhs)
- LLGL_EXPORT bool operator== (const VideoModeDescriptor &lhs, const VideoModeDescriptor &rhs)
- LLGL_EXPORT bool operator!= (const VideoModeDescriptor &lhs, const VideoModeDescriptor &rhs)
- LLGL_EXPORT int NumMipLevels (const Gs::Vector3i &textureSize)

  *Returns the number of MIP-map levels for a texture with the specified size.*
- LLGL_EXPORT bool IsCompressedFormat (const TextureFormat format)

  *Returns true if the specified texture format is a compressed format, i.e. either TextureFormat::RGB_DXT1, Texture↩ Format::RGBA_DXT1, TextureFormat::RGBA_DXT3, or TextureFormat::RGBA_DXT5.*
- LLGL_EXPORT bool operator== (const VertexAttribute &lhs, const VertexAttribute &rhs)
- LLGL_EXPORT bool operator!= (const VertexAttribute &lhs, const VertexAttribute &rhs)
- LLGL_EXPORT bool operator== (const VideoDisplayMode &lhs, const VideoDisplayMode &rhs)
- LLGL_EXPORT bool CompareSWO (const VideoDisplayMode &lhs, const VideoDisplayMode &rhs)

  *Compares the two video display modes in a strict-weak-order (SWO) fashion.*

## 6.1.1 Typedef Documentation

### 6.1.1.1 using **LLGL::ByteBuffer** = typedef std::unique_ptr<char[ ]>

Common byte buffer type.

**Remarks**

Commonly this would be an std::vector<char>, but the buffer conversion is an optimized process, where the default initialization of an std::vector is undesired. Therefore, the byte buffer type is an std::unique_↩ ptr<char[ ]>.

**See also**

ConvertImageBuffer

#### 6.1.1.2 using **LLGL::ColorRGB** = typedef **ColorRGBT**<Gs::Real>

#### 6.1.1.3 using **LLGL::ColorRGBA** = typedef **ColorRGBAT**<Gs::Real>

#### 6.1.1.4 using **LLGL::ColorRGBAb** = typedef **ColorRGBAT**<bool>

#### 6.1.1.5 using **LLGL::ColorRGBAd** = typedef **ColorRGBAT**<double>

#### 6.1.1.6 using **LLGL::ColorRGBAf** = typedef **ColorRGBAT**<float>

#### 6.1.1.7 template<typename T > using **LLGL::ColorRGBAT** = typedef **Color**<T, 4>

#### 6.1.1.8 using **LLGL::ColorRGBAub** = typedef **ColorRGBAT**<unsigned char>

#### 6.1.1.9 using **LLGL::ColorRGBb** = typedef **ColorRGBT**<bool>

#### 6.1.1.10 using **LLGL::ColorRGBd** = typedef **ColorRGBT**<double>

#### 6.1.1.11 using **LLGL::ColorRGBf** = typedef **ColorRGBT**<float>

#### 6.1.1.12 template<typename T > using **LLGL::ColorRGBT** = typedef **Color**<T, 3>

#### 6.1.1.13 using **LLGL::ColorRGBub** = typedef **ColorRGBT**<unsigned char>

#### 6.1.1.14 using **LLGL::DebugCallback** = typedef std::function<void(const std::string& type, const std::string& message)>

Debug callback function interface.

**Parameters**

| | | |
|---|---|---|
| `in` | *type* | Descriptive type of the message. |
| `in` | *message* | Specifies the debug output message. |

**Remarks**

This output is renderer dependent.

#### 6.1.1.15 using **LLGL::Point** = typedef Gs::Vector2i

2D point (integer)

#### 6.1.1.16 using **LLGL::Size** = typedef Gs::Vector2i

2D size (integer)

### 6.1.2 Enumeration Type Documentation

#### 6.1.2.1 enum LLGL::AxisDirection [strong]

Axis direction (also used for texture cube face).

**Enumerator**

| | |
|---|---|
| ***XPos*** | X+ direction. |
| ***XNeg*** | X- direction. |
| ***YPos*** | Y+ direction. |
| ***YNeg*** | Y- direction. |
| ***ZPos*** | Z+ direction. |
| ***ZNeg*** | Z- direction. |

#### 6.1.2.2 enum LLGL::BlendArithmetic [strong]

Blending arithmetic operations enumeration.

**Enumerator**

| | |
|---|---|
| ***Add*** | Add source 1 and source 2. This is the default for all renderers. |
| ***Subtract*** | Subtract source 1 from source 2. |
| ***RevSubtract*** | Subtract source 2 from source 1. |
| ***Min*** | Find the minimum of source 1 and source 2. |
| ***Max*** | Find the maximum of source 1 and source 2. |

#### 6.1.2.3 enum LLGL::BlendOp [strong]

Blending operations enumeration.

**Enumerator**

***Zero***

***One***

***SrcColor***

***InvSrcColor***

***SrcAlpha***

***InvSrcAlpha***

***DestColor***

***InvDestColor***

***DestAlpha***

***InvDestAlpha***

#### 6.1.2.4 enum LLGL::BufferCPUAccess [strong]

Hardware buffer CPU acccess enumeration.

**See also**

RenderSystem::MapBuffer

**Enumerator**

***ReadOnly*** CPU read access only.

***WriteOnly*** CPU write access only.

***ReadWrite*** CPU read and write access.

#### 6.1.2.5 enum LLGL::BufferType [strong]

Hardware buffer type enumeration.

**Enumerator**

***Vertex*** Vertex buffer type.

***Index*** Index buffer type.

***Constant*** Constant buffer type (also called "Uniform Buffer Object").

***Storage*** Storage buffer type (also called "Shader Storage Buffer Object" or "Read/Write Buffer").

***StreamOutput*** Stream output buffer type (also called "Transform Feedback Buffer").

#### 6.1.2.6 enum LLGL::BufferUsage [strong]

Hardware buffer usage enumeration.

**Remarks**

For OpenGL, the buffer usage is just a hint to the GL server. For Direct3D, the buffer usage is crucial during buffer creation.

**See also**

RenderSystem::CreateVertexBuffer
RenderSystem::CreateIndexBuffer
RenderSystem::CreateConstantBuffer
RenderSystem::CreateStorageBuffer

**Enumerator**

***Static*** The hardware buffer will be rarely changed by the client but often used by the hardware.

**Remarks**

For Direct3D 11, a buffer can use the static buffer usage, if always the entire buffer will be updated. Otherwise, the dynamic buffer usage must be used.

***Dynamic*** The hardware buffer will be often changed by the client (e.g. almost every frame).

**Remarks**

For Direct3D 11, a buffer must use the dynamic buffer usage, if it will only partially be updated at any time.

#### 6.1.2.7 enum **LLGL::ClippingRange** `[strong]`

Clipping depth range enumeration.

**Enumerator**

***MinusOneToOne*** Clipping depth is in the range [-1, 1] (default in OpenGL).

***ZeroToOne*** Clipping depth is in the range [0, 1] (default in Direct3D).

#### 6.1.2.8 enum **LLGL::CompareOp** `[strong]`

Compare operations enumeration.

**Remarks**

This operation is used for depth-test and stencil-test.

**Enumerator**

***Never*** Compare test never succeeds.

***Less*** Compare test succeeds if the left-hand-side is less than the right-hand-side.

***Equal*** Compare test succeeds if the left-hand-side is euqal to the right-hand-side.

***LessEqual*** Compare test succeeds if the left-hand-side is less than or equal to the right-hand-side.

***Greater*** Compare test succeeds if the left-hand-side is greater than the right-hand-side.

***NotEqual*** Compare test succeeds if the left-hand-side is not equal to the right-hand-side.

***GreaterEqual*** Compare test succeeds if the left-hand-side is greater than or equal to the right-hand-side.

***Ever*** Compare test always succeeds. (Can not be called "Always" due to conflict with X11 lib on Linux).

#### 6.1.2.9 enum **LLGL::CullMode** `[strong]`

Polygon culling modes enumeration.

**Enumerator**

***Disabled*** No culling.

***Front*** Front face culling.

***Back*** Back face culling.

#### 6.1.2.10 enum **LLGL::DataType** `[strong]`

Renderer data types enumeration.

**Enumerator**

***Int8*** 8-bit signed integer (char).

***UInt8*** 8-bit unsigned integer (unsigned char).

***Int16*** 16-bit signed integer (short).

***UInt16*** 16-bit unsigned integer (unsigned short).

***Int32*** 32-bit signed integer (int).

***UInt32*** 32-bit unsigned integer (unsiged int).

***Float*** 32-bit floating-point (float).

***Double*** 64-bit real type (double).

#### 6.1.2.11 enum LLGL::ErrorType [strong]

Rendering debugger error types enumeration.

**Enumerator**

***InvalidArgument*** Error due to invalid argument (e.g. creating a graphics pipeline without a valid shader program being specified).

***InvalidState*** Error due to invalid render state (e.g. rendering without a valid graphics pipeline).

***UnsupportedFeature*** Error due to use of unsupported feature (e.g. drawing with hardware instancing when the renderer hardware does not support it).

#### 6.1.2.12 enum LLGL::ImageFormat [strong]

Image format used to write texture data.

**Enumerator**

***R*** Single color component: Red.

***RG*** Two color components: Red, Green.

***RGB*** Three color components: Red, Green, Blue.

***BGR*** Three color components: Blue, Green, Red.

***RGBA*** Four color components: Red, Green, Blue, Alpha.

***BGRA*** Four color components: Blue, Green, Red, Alpha.

***Depth*** 32-bit depth component.

***DepthStencil*** 24-bit depth- and 8-bit stencil component.

***CompressedRGB*** Generic compressed format with three color components: Red, Green, Blue.

***CompressedRGBA*** Generic compressed format with four color components: Red, Green, Blue, Alpha.

#### 6.1.2.13 enum LLGL::Key [strong]

Input key codes.

**Enumerator**

***LButton*** Left mouse button.

***RButton*** Right mouse button.

***Cancel*** Control-break processing.

***MButton*** Middle mouse button (three-button mouse).

***XButton1*** Windows 2000/XP: X1 mouse button.

***XButton2*** Windows 2000/XP: X2 mouse button.

***Back*** BACKSPACE key.

***Tab*** TAB key.

***Clear*** CLEAR key.

***Return*** RETURN (or ENTER) key.

***Shift*** SHIFT key.

| | |
|---|---|
| ***Control*** | CTRL key. |
| ***Menu*** | ALT key. |
| ***Pause*** | PAUSE key. |
| ***Capital*** | CAPS LOCK key. |
| ***Escape*** | Escape (ESC) key. |
| ***Space*** | Space key. |
| ***PageUp*** | Page up key. |
| ***PageDown*** | Page down key. |
| ***End*** | END key. |
| ***Home*** | HOME (or POS1) key. |
| ***Left*** | Left arrow key. |
| ***Up*** | Up arrow key. |
| ***Right*** | Right arrow key. |
| ***Down*** | Down arrow key. |
| ***Select*** | Select key. |
| ***Print*** | Print key. |
| ***Exe*** | Execute key. |
| ***Snapshot*** | Snapshot key. |
| ***Insert*** | Insert key. |
| ***Delete*** | Delete key. |
| ***Help*** | Help key. |
| ***D0*** | Digit 0. |
| ***D1*** | Digit 1. |
| ***D2*** | Digit 2. |
| ***D3*** | Digit 3. |
| ***D4*** | Digit 4. |
| ***D5*** | Digit 5. |
| ***D6*** | Digit 6. |
| ***D7*** | Digit 7. |
| ***D8*** | Digit 8. |
| ***D9*** | Digit 9. |
| ***A*** | Letter A. |
| ***B*** | Letter B. |
| ***C*** | Letter C. |
| ***D*** | Letter D. |
| ***E*** | Letter E. |
| ***F*** | Letter F. |
| ***G*** | Letter G. |
| ***H*** | Letter H. |
| ***I*** | Letter I. |
| ***J*** | Letter J. |
| ***K*** | Letter K. |
| ***L*** | Letter L. |
| ***M*** | Letter M. |
| ***N*** | Letter N. |

***O*** Letter O.

***P*** Letter P.

***Q*** Letter Q.

***R*** Letter R.

***S*** Letter S.

***T*** Letter T.

***U*** Letter U.

***V*** Letter V.

***W*** Letter W.

***X*** Letter X.

***Y*** Letter Y.

***Z*** Letter Z.

***LWin*** Left Windows key.

***RWin*** Rigth Windows key.

***Apps*** Application key.

***Sleep*** Sleep key.

***Keypad0*** Keypad 0 key.

***Keypad1*** Keypad 1 key.

***Keypad2*** Keypad 2 key.

***Keypad3*** Keypad 3 key.

***Keypad4*** Keypad 4 key.

***Keypad5*** Keypad 5 key.

***Keypad6*** Keypad 6 key.

***Keypad7*** Keypad 7 key.

***Keypad8*** Keypad 8 key.

***Keypad9*** Keypad 9 key.

***KeypadMultiply*** Keypad multiply '∗'.

***KeypadPlus*** Keypad plus '+'.

***KeypadSeparator*** Keypad separator.

***KeypadMinus*** Keypad minus '-'.

***KeypadDecimal*** Keypad decimal ',' or '.' (depends on language).

***KeypadDivide*** Keypad divide '/'.

***F1*** F1 function key.

***F2*** F2 function key.

***F3*** F3 function key.

***F4*** F4 function key.

***F5*** F5 function key.

***F6*** F6 function key.

***F7*** F7 function key.

***F8*** F8 function key.

***F9*** F9 function key.

***F10*** F10 function key.

***F11*** F11 function key.

***F12*** F12 function key.

***F13*** F13 function key.

| | |
|---|---|
| ***F14*** | F14 function key. |
| ***F15*** | F15 function key. |
| ***F16*** | F16 function key. |
| ***F17*** | F17 function key. |
| ***F18*** | F18 function key. |
| ***F19*** | F19 function key. |
| ***F20*** | F20 function key. |
| ***F21*** | F21 function key. |
| ***F22*** | F22 function key. |
| ***F23*** | F23 function key. |
| ***F24*** | F24 function key. |
| ***NumLock*** | Num lock key. |
| ***ScrollLock*** | Scroll lock key. |
| ***LShift*** | Left shift key. |
| ***RShift*** | Right shift key. |
| ***LControl*** | Left control (CTRL) key. |
| ***RControl*** | Right control (CTRL) key. |
| ***LMenu*** | Left menu key. |
| ***RMenu*** | Right menu key. |
| ***BrowserBack*** | |
| ***BrowserForward*** | |
| ***BrowserRefresh*** | |
| ***BrowserStop*** | |
| ***BrowserSearch*** | |
| ***BrowserFavorits*** | |
| ***BrowserHome*** | |
| ***VolumeMute*** | |
| ***VolumeDown*** | |
| ***VolumeUp*** | |
| ***MediaNextTrack*** | |
| ***MediaPrevTrack*** | |
| ***MediaStop*** | |
| ***MediaPlayPause*** | |
| ***LaunchMail*** | |
| ***LaunchMediaSelect*** | |
| ***LaunchApp1*** | |
| ***LaunchApp2*** | |
| ***Plus*** | '+' |
| ***Comma*** | ',' |
| ***Minus*** | '-' |
| ***Period*** | '.' |
| ***Exponent*** | '^' |
| ***Attn*** | |
| ***CrSel*** | |
| ***ExSel*** | |

***ErEOF***

***Play***

***Zoom***

***NoName***

***PA1***

***OEMClear***

#### 6.1.2.14 enum LLGL::OpenGLVersion [strong]

**Enumerator**

***OpenGL_Latest*** Latest available OpenGL version (on the host platform).

***OpenGL_1_0*** OpenGL 1.0, released in Jan, 1992.

***OpenGL_1_1*** OpenGL 1.1, released in Mar, 1997.

***OpenGL_1_2*** OpenGL 1.2, released in Mar, 1998.

***OpenGL_1_3*** OpenGL 1.3, released in Aug, 2001.

***OpenGL_1_4*** OpenGL 1.4, released in Jul, 2002.

***OpenGL_1_5*** OpenGL 1.5, released in Jul, 2003.

***OpenGL_2_0*** OpenGL 2.0, released in Sep, 2004.

***OpenGL_2_1*** OpenGL 2.1, released in Jul, 2006.

***OpenGL_3_0*** OpenGL 3.0, released in Aug, 2008 (known as "Longs Peak").

***OpenGL_3_1*** OpenGL 3.1, released in Mar, 2009 (known as "Longs Peak Reloaded").

***OpenGL_3_2*** OpenGL 3.2, released in Aug, 2009.

***OpenGL_3_3*** OpenGL 3.3, released in Mar, 2010.

***OpenGL_4_0*** OpenGL 4.0, released in Mar, 2010 (alongside with OpenGL 3.3).

***OpenGL_4_1*** OpenGL 4.1, released in Jul, 2010.

***OpenGL_4_2*** OpenGL 4.2, released in Aug, 2011.

***OpenGL_4_3*** OpenGL 4.3, released in Aug, 2012.

***OpenGL_4_4*** OpenGL 4.4, released in Jul, 2013.

***OpenGL_4_5*** OpenGL 4.5, released in Aug, 2014.

#### 6.1.2.15 enum LLGL::PolygonMode [strong]

Polygon filling modes enumeration.

**Enumerator**

***Fill*** Draw filled polygon.

***Wireframe*** Draw triangle edges only.

***Points*** Draw vertex points only.

**Note**

Only supported with: OpenGL.

#### 6.1.2.16 enum LLGL::PrimitiveTopology [strong]

Primitive topology enumeration.

**Enumerator**

***PointList*** Point list.

***LineList*** Line list where each line has its own two vertices.

***LineStrip*** Line strip where each line after the first one begins with the previous vertex.

***LineLoop*** Line loop which is similiar to line strip but the last line ends with the first vertex.

**Note**

Only supported with: OpenGL.

***LineListAdjacency*** Adjacency line list.

***LineStripAdjacency*** Adjacency line strips.

***TriangleList*** Triangle list where each triangle has its own three vertices.

***TriangleStrip*** Triangle strip where each triangle after the first one begins with the previous vertex.

***TriangleFan*** Triangle fan where each triangle uses the first vertex, the previous vertex, and a new vertex.

**Note**

Only supported with: OpenGL.

***TriangleListAdjacency*** Adjacency triangle list.

***TriangleStripAdjacency*** Adjacency triangle strips.

***Patches1*** Patches with 1 control point.

***Patches2*** Patches with 2 control points.

***Patches3*** Patches with 3 control points.

***Patches4*** Patches with 4 control points.

***Patches5*** Patches with 5 control points.

***Patches6*** Patches with 6 control points.

***Patches7*** Patches with 7 control points.

***Patches8*** Patches with 8 control points.

***Patches9*** Patches with 9 control points.

***Patches10*** Patches with 10 control points.

***Patches11*** Patches with 11 control points.

***Patches12*** Patches with 12 control points.

***Patches13*** Patches with 13 control points.

***Patches14*** Patches with 14 control points.

***Patches15*** Patches with 15 control points.

***Patches16*** Patches with 16 control points.

***Patches17*** Patches with 17 control points.

***Patches18*** Patches with 18 control points.

***Patches19*** Patches with 19 control points.

***Patches20*** Patches with 20 control points.

***Patches21*** Patches with 21 control points.

***Patches22*** Patches with 22 control points.

***Patches23*** Patches with 23 control points.

***Patches24*** Patches with 24 control points.

***Patches25*** Patches with 25 control points.

***Patches26*** Patches with 26 control points.

***Patches27*** Patches with 27 control points.

***Patches28*** Patches with 28 control points.

***Patches29*** Patches with 29 control points.

***Patches30*** Patches with 30 control points.

***Patches31*** Patches with 31 control points.

***Patches32*** Patches with 32 control points.

#### 6.1.2.17 enum **LLGL::QueryType** `[strong]`

Query type enumeration.

**Enumerator**

***SamplesPassed*** Number of samples that passed the depth test. This can be used as render condition.

***AnySamplesPassed*** Non-zero if any samples passed the depth test. This can be used as render condition.

***AnySamplesPassedConservative*** Non-zero if any samples passed the depth test within a conservative rasterization. This can be used as render condition.

***PrimitivesGenerated*** Number of generated primitives which are send to the rasterizer (either emitted from the geometry or vertex shader).

***TimeElapsed*** Elapsed time (in nanoseconds) between the begin- and end query command.

***StreamOutPrimitivesWritten*** Number of vertices that have been written into a stream output (also called "Transform Feedback").

***StreamOutOverflow*** Non-zero if any of the streaming output buffers (also called "Transform Feedback Buffers") has an overflow.

***VerticesSubmitted*** Number of vertices submitted to the input-assembly.

***PrimitivesSubmitted*** Number of primitives submitted to the input-assembly.

***VertexShaderInvocations*** Number of vertex shader invocations.

***TessControlShaderInvocations*** Number of tessellation-control shader invocations.

***TessEvaluationShaderInvocations*** Number of tessellation-evaluation shader invocations.

***GeometryShaderInvocations*** Number of geometry shader invocations.

***FragmentShaderInvocations*** Number of fragment shader invocations.

***ComputeShaderInvocations*** Number of compute shader invocations.

***GeometryPrimitivesGenerated*** Number of primitives generated by the geometry shader.

***ClippingInputPrimitives*** Number of primitives that reached the primitive clipping stage.

***ClippingOutputPrimitives*** Number of primitives that passed the primitive clipping stage.

#### 6.1.2.18 enum LLGL::RenderConditionMode `[strong]`

Render condition mode enumeration.

**Remarks**

The condition is determined by the type of the Query object.

**See also**

RenderContext::BeginRenderCondition

**Enumerator**

***Wait*** Wait until the occlusion query result is available, before conditional rendering begins.

***NoWait*** Do not wait until the occlusion query result is available, before conditional rendering begins.

***ByRegionWait*** Similar to Wait, but the renderer may discard the results of commands for any framebuffer region that did not contribute to the occlusion query.

***ByRegionNoWait*** Similar to NoWait, but the renderer may discard the results of commands for any framebuffer region that did not contribute to the occlusion query.

***WaitInverted*** Same as Wait, but the condition is inverted.

***NoWaitInverted*** Same as NoWait, but the condition is inverted.

***ByRegionWaitInverted*** Same as ByRegionWait, but the condition is inverted.

***ByRegionNoWaitInverted*** Same as ByRegionNoWait, but the condition is inverted.

#### 6.1.2.19 enum LLGL::ScreenOrigin `[strong]`

Screen coordinate system origin enumeration.

**Enumerator**

***LowerLeft*** Screen origin is in the lower-left (default in OpenGL).

***UpperLeft*** Screen origin is in the upper-left (default in Direct3D).

#### 6.1.2.20 enum LLGL::ShaderType `[strong]`

Shader type enumeration.

**Enumerator**

***Vertex*** Vertex shader type.

***TessControl*** Tessellation control shader type (also "Hull Shader").

***TessEvaluation*** Tessellation evaluation shader type (also "Domain Shader").

***Geometry*** Geometry shader type.

***Fragment*** Fragment shader type (also "Pixel Shader").

***Compute*** Compute shader type.

#### 6.1.2.21 enum **LLGL::ShadingLanguage** `[strong]`

Shading language version enumation.

**Remarks**

These enumeration entries can be casted to an integer to get the respective version number. GLSL versions range from 110 (v.1.10) to 450 (v.4.50), and HLSL version range from 100200 (v.2.0) to 100500 (v.5.0).

**Enumerator**

| | |
|---|---|
| ***Unsupported*** | Enumeration entry if shaders are not supported. |
| ***GLSL_110*** | GLSL 1.10 (since OpenGL 2.0). |
| ***GLSL_120*** | GLSL 1.20 (since OpenGL 2.1). |
| ***GLSL_130*** | GLSL 1.30 (since OpenGL 3.0). |
| ***GLSL_140*** | GLSL 1.40 (since OpenGL 3.1). |
| ***GLSL_150*** | GLSL 1.50 (since OpenGL 3.2). |
| ***GLSL_330*** | GLSL 3.30 (since OpenGL 3.3). |
| ***GLSL_400*** | GLSL 4.00 (since OpenGL 4.0). |
| ***GLSL_410*** | GLSL 4.10 (since OpenGL 4.1). |
| ***GLSL_420*** | GLSL 4.20 (since OpenGL 4.2). |
| ***GLSL_430*** | GLSL 4.30 (since OpenGL 4.3). |
| ***GLSL_440*** | GLSL 4.40 (since OpenGL 4.4). |
| ***GLSL_450*** | GLSL 4.50 (since OpenGL 4.5). |
| ***HLSL_2_0*** | HLSL 2.0 (since Direct3D 9). |
| ***HLSL_2_0a*** | HLSL 2.0a (since Direct3D 9a). |
| ***HLSL_2_0b*** | HLSL 2.0b (since Direct3D 9b). |
| ***HLSL_3_0*** | HLSL 3.0 (since Direct3D 9c). |
| ***HLSL_4_0*** | HLSL 4.0 (since Direct3D 10). |
| ***HLSL_4_1*** | HLSL 4.1 (since Direct3D 10.1). |
| ***HLSL_5_0*** | HLSL 5.0 (since Direct3D 11). |

#### 6.1.2.22 enum **LLGL::StencilOp** `[strong]`

Stencil operations enumeration.

**Enumerator**

***Keep***

***Zero***

***Replace***

***IncClamp***

***DecClamp***

***Invert***

***IncWrap***

***DecWrap***

#### 6.1.2.23 enum LLGL::StorageBufferType [strong]

Storage buffer type enumeration.

**Remarks**

The generic type is for OpenGL, the others for Direct3D.

**Enumerator**

***Generic*** Generic storage buffer type.

**Note**

Only supported with: OpenGL.

***Buffer*** Typed buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

***StructuredBuffer*** Structured buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

***ByteAddressBuffer*** Byte-address buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

***RWBuffer*** Typed read/write buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

***RWStructuredBuffer*** Structured read/write buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

***RWByteAddressBuffer*** Byte-address read/write buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

***AppendStructuredBuffer*** Append structured buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

***ConsumeStructuredBuffer*** Consume structured buffer.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

#### 6.1.2.24 enum LLGL::SwapChainMode [strong]

Swap chain mode enumeration.

**Enumerator**

***SingleBuffering*** Single buffering. This is almost no longer used.

***DoubleBuffering*** Double buffering. This is the default for most renderers.

***TripleBuffering*** Triple buffering. Triple buffering can only be used for Direct3D renderers.

#### 6.1.2.25 enum LLGL::TextureFilter [strong]

Texture sampling filter enumeration.

**Enumerator**

***Nearest*** Take the nearest sample.

***Linear*** Interpolate between two samples.

#### 6.1.2.26 enum LLGL::TextureFormat [strong]

Hardware texture format enumeration.

**Note**

All integral 32-bit formats are un-normalized!

**Enumerator**

***Unknown*** Unknown texture format.

***DepthComponent*** Base format: depth component.

***DepthStencil*** Base format: depth- and stencil components.

***R*** Base format: red component.

***RG*** Base format: red and green components.

***RGB*** Base format: red, green, and blue components.

**Note**

Only supported with: OpenGL.

***RGBA*** Base format: red, green, blue, and alpha components.

***R8*** Sized format: red 8-bit normalized unsigned integer component.

***R8Sgn*** Sized format: red 8-bit normalized signed integer component.

***R16*** Sized format: red 16-bit normalized unsigned interger component.

***R16Sgn*** Sized format: red 16-bit normalized signed interger component.

***R16Float*** Sized format: red 16-bit floating point component.

***R32UInt*** Sized format: red 32-bit un-normalized unsigned interger component.

***R32SInt*** Sized format: red 32-bit un-normalized signed interger component.

***R32Float*** Sized format: red 32-bit floating point component.

***RG8*** Sized format: red, green 8-bit normalized unsigned integer components.

***RG8Sgn*** Sized format: red, green 8-bit normalized signed integer components.

***RG16*** Sized format: red, green 16-bit normalized unsigned interger components.

***RG16Sgn*** Sized format: red, green 16-bit normalized signed interger components.

***RG16Float*** Sized format: red, green 16-bit floating point components.

***RG32UInt*** Sized format: red, green 32-bit un-normalized unsigned interger components.

***RG32SInt*** Sized format: red, green 32-bit un-normalized signed interger components.

***RG32Float*** Sized format: red, green 32-bit floating point components.

***RGB8*** Sized format: red, green, blue 8-bit normalized unsigned integer components.

**Note**

Only supported with: OpenGL.

***RGB8Sgn*** Sized format: red, green, blue 8-bit normalized signed integer components.

**Note**

Only supported with: OpenGL.

***RGB16*** Sized format: red, green, blue 16-bit normalized unsigned interger components.

**Note**

Only supported with: OpenGL.

***RGB16Sgn*** Sized format: red, green, blue 16-bit normalized signed interger components.

**Note**

Only supported with: OpenGL.

***RGB16Float*** Sized format: red, green, blue 16-bit floating point components.

**Note**

Only supported with: OpenGL.

***RGB32UInt*** Sized format: red, green, blue 32-bit un-normalized unsigned interger components.

***RGB32SInt*** Sized format: red, green, blue 32-bit un-normalized signed interger components.

***RGB32Float*** Sized format: red, green, blue 32-bit floating point components.

***RGBA8*** Sized format: red, green, blue, alpha 8-bit normalized unsigned integer components.

***RGBA8Sgn*** Sized format: red, green, blue, alpha 8-bit normalized signed integer components.

***RGBA16*** Sized format: red, green, blue, alpha 16-bit normalized unsigned interger components.

***RGBA16Sgn*** Sized format: red, green, blue, alpha 16-bit normalized signed interger components.

***RGBA16Float*** Sized format: red, green, blue, alpha 16-bit floating point components.

***RGBA32UInt*** Sized format: red, green, blue, alpha 32-bit un-normalized unsigned interger components.

***RGBA32SInt*** Sized format: red, green, blue, alpha 32-bit un-normalized signed interger components.

***RGBA32Float*** Sized format: red, green, blue, alpha 32-bit floating point components.

***RGB_DXT1*** Compressed format: RGB S3TC DXT1.

***RGBA_DXT1*** Compressed format: RGBA S3TC DXT1.

***RGBA_DXT3*** Compressed format: RGBA S3TC DXT3.

***RGBA_DXT5*** Compressed format: RGBA S3TC DXT5.

#### 6.1.2.27 enum LLGL::TextureType [strong]

Texture type enumeration.

**Enumerator**

***Undefined*** Initial value of a Texture object.

***Texture1D*** 1-Dimensional texture.

***Texture2D*** 2-Dimensional texture.

***Texture3D*** 3-Dimensional texture.

***TextureCube*** Cube texture.

***Texture1DArray*** 1-Dimensional array texture.

***Texture2DArray*** 2-Dimensional array texture.

***TextureCubeArray*** Cube array texture.

#### 6.1.2.28 enum LLGL::TextureWrap [strong]

Texture coordinate wrap enumeration.

**Enumerator**

***Repeat*** Repeat texture coordinates within the interval [0, 1).

***Mirror*** Flip texture coordinates at ever integer junction.

***Clamp*** Clamp texture coordinates to the interval [0, 1].

***Border*** Clamp texture coordinates to their border.

***MirrorOnce*** Takes the absolute value of the texture coordinates and then clamps it to the interval [0, 1], i.e. mirror around 0.

#### 6.1.2.29 enum LLGL::UniformType [strong]

Shader uniform type enumeration.

**Enumerator**

***Float*** float uniform.

***Float2*** float2/ vec2 uniform.

***Float3*** float3/ vec3 uniform.

***Float4*** float4/ vec4 uniform.

***Double*** double uniform.

***Double2*** double2/ dvec2 uniform.

***Double3*** double3/ dvec3 uniform.

***Double4*** double4/ dvec4 uniform.

***Int*** int uniform.

***Int2*** int2/ ivec2 uniform.

***Int3*** int3/ ivec3 uniform.

***Int4*** int4/ ivec4 uniform.

***Float2x2*** float2x2/ mat2 uniform.

***Float3x3*** float3x3/ mat3 uniform.

***Float4x4*** float4x4/ mat4 uniform.

***Double2x2*** double2x2/ dmat2 uniform.

***Double3x3*** double3x3/ dmat3 uniform.

***Double4x4*** double4x4/ dmat4 uniform.

***Sampler1D*** sampler1D uniform.

***Sampler2D*** sampler2D uniform.

***Sampler3D*** sampler3D uniform.

***SamplerCube*** samplerCube uniform.

#### 6.1.2.30 enum LLGL::WarningType [strong]

**Enumerator**

***ImproperArgument*** Warning due to improper argument (e.g. generating 4 vertices while having triangle list as primitive topology).

***ImproperState*** Warning due to improper state (e.g. rendering while viewport is not visible).

***PointlessOperation*** Warning due to a operation without any effect (e.g. drawing with 0 vertices).

### 6.1.3 Function Documentation

#### 6.1.3.1 LLGL_EXPORT bool LLGL::CompareSWO ( const VideoDisplayMode & *lhs*, const VideoDisplayMode & *rhs* )

Compares the two video display modes in a strict-weak-order (SWO) fashion.

#### 6.1.3.2 LLGL_EXPORT ByteBuffer LLGL::ConvertImageBuffer ( ImageFormat *srcFormat*, DataType *srcDataType*, const void ∗ *srcBuffer*, std::size_t *srcBufferSize*, ImageFormat *dstFormat*, DataType *dstDataType*, std::size_t *threadCount* = `0` )

Converts the image format and data type of the source image (only uncompressed color formats).

**Parameters**

| | | |
|---|---|---|
| `in` | *srcFormat* | Specifies the source image format. |
| `in` | *srcDataType* | Specifies the source data type. |
| `in` | *srcBuffer* | Pointer to the source image buffer which is to be converted. |
| `in` | *srcBufferSize* | Specifies the size (in bytes) of the source image buffer. |
| `in` | *dstFormat* | Specifies the destination image format. |
| `in` | *dstDataType* | Specifies the destination data type. |
| `in` | *threadCount* | Specifies the number of threads to use for conversion. If this is less than 2, no multi-threading is used. If this is 'maxThreadCount', the maximal count of threads the system supports will be used (e.g. 4 on a quad-core processor). By default 0. |

**Returns**

Byte buffer with the converted image data or null if no conversion is necessary. This can be casted to the respective target data type (e.g. "unsigned char", "int", "float" etc.).

**Remarks**

Compressed images and depth-stencil images can not be converted.

**Exceptions**

| | |
|---|---|
| *std::invalid_argument* | If a compressed image format is specified either as source or destination, if a depth-stencil format is specified either as source or destination, if the source buffer size is not a multiple of the source data type size times the image format size, or if 'srcBuffer' is a null pointer. |

**See also**

maxThreadCount
ByteBuffer
DataTypeSize

### 6.1.3.3 LLGL_EXPORT std::size_t LLGL::DataTypeSize ( const DataType *dataType* )

Returns the size (in bytes) of the specified data type.

### 6.1.3.4 LLGL_EXPORT std::size_t LLGL::ImageFormatSize ( const ImageFormat *imageFormat* )

Returns the size (in number of components) of the specified image format.

**Parameters**

| | | |
|---|---|---|
| `in` | *imageFormat* | Specifies the image format. |

**Returns**

Number of components of the specified image format, or 0 if 'imageFormat' specifies a compressed color format.

**See also**

IsCompressedFormat(const ImageFormat)

### 6.1.3.5 LLGL_EXPORT bool LLGL::IsCompressedFormat ( const ImageFormat *format* )

Returns true if the specified color format is a compressed format, i.e. either ImageFormat::CompressedRGB, or ImageFormat::CompressedRGBA.

**See also**

ImageFormat

### 6.1.3.6 LLGL_EXPORT bool LLGL::IsCompressedFormat ( const TextureFormat *format* )

Returns true if the specified texture format is a compressed format, i.e. either TextureFormat::RGB_DXT1, Texture↩ Format::RGBA_DXT1, TextureFormat::RGBA_DXT3, or TextureFormat::RGBA_DXT5.

**See also**

TextureFormat

#### 6.1.3.7 LLGL_EXPORT bool LLGL::IsDepthStencilFormat ( const ImageFormat *format* )

Returns true if the specified color foramt is a depth-stencil format, i.e. either ImageFormat::Depth or ImageFormat↩ ::DepthStencil.

#### 6.1.3.8 template<typename T > T LLGL::MaxColorValue ( ) [inline]

Returns the maximal color value for the data type T. By default 1.

#### 6.1.3.9 template<> bool LLGL::MaxColorValue< bool >( ) [inline]

Specialized version. For booleans, the return value is true.

#### 6.1.3.10 template<> unsigned char LLGL::MaxColorValue< unsigned char >( ) [inline]

Specialized version. For unsigned 8-bit integers, the return value is 255.

#### 6.1.3.11 LLGL_EXPORT int LLGL::NumMipLevels ( const Gs::Vector3i & *textureSize* )

Returns the number of MIP-map levels for a texture with the specified size.

**Returns**

1 + floor(log2(max{ x, y, z })).

#### 6.1.3.12 LLGL_EXPORT bool LLGL::operator!= ( const VertexAttribute & *lhs*, const VertexAttribute & *rhs* )

#### 6.1.3.13 LLGL_EXPORT bool LLGL::operator!= ( const VsyncDescriptor & *lhs*, const VsyncDescriptor & *rhs* )

#### 6.1.3.14 LLGL_EXPORT bool LLGL::operator!= ( const VideoModeDescriptor & *lhs*, const VideoModeDescriptor & *rhs* )

#### 6.1.3.15 template<typename T , std::size_t N> bool LLGL::operator!= ( const Color< T, N > & *lhs*, const Color< T, N > & *rhs* )

#### 6.1.3.16 template<typename T , std::size_t N> Color<T, N> LLGL::operator∗ ( const Color< T, N > & *lhs*, const Color< T, N > & *rhs* )

#### 6.1.3.17 template<typename T , std::size_t N> Color<T, N> LLGL::operator∗ ( const Color< T, N > & *lhs*, const T & *rhs* )

#### 6.1.3.18 template<typename T , std::size_t N> Color<T, N> LLGL::operator∗ ( const T & *lhs*, const Color< T, N > & *rhs* )

#### 6.1.3.19 template<typename T , std::size_t N> Color<T, N> LLGL::operator+ ( const Color< T, N > & *lhs*, const Color< T, N > & *rhs* )

#### 6.1.3.20 template<typename T , std::size_t N> Color<T, N> LLGL::operator- ( const Color< T, N > & *lhs*, const Color< T, N > & *rhs* )

#### 6.1.3.21 template<typename T , std::size_t N> Color<T, N> LLGL::operator/ ( const Color< T, N > & *lhs*, const Color< T, N > & *rhs* )

#### 6.1.3.22 template<typename T , std::size_t N> Color<T, N> LLGL::operator/ ( const Color< T, N > & *lhs*, const T & *rhs* )

#### 6.1.3.23 LLGL_EXPORT bool LLGL::operator== ( const VertexAttribute & *lhs*, const VertexAttribute & *rhs* )

#### 6.1.3.24 LLGL_EXPORT bool LLGL::operator== ( const VideoDisplayMode & *lhs*, const VideoDisplayMode & *rhs* )

#### 6.1.3.25 LLGL_EXPORT bool LLGL::operator== ( const VsyncDescriptor & *lhs*, const VsyncDescriptor & *rhs* )

#### 6.1.3.26 LLGL_EXPORT bool LLGL::operator== ( const VideoModeDescriptor & *lhs*, const VideoModeDescriptor & *rhs* )

#### 6.1.3.27 template<typename T , std::size_t N> bool LLGL::operator== ( const Color< T, N > & *lhs*, const Color< T, N > & *rhs* )

## 6.2 LLGL::Desktop Namespace Reference

### Functions

- LLGL_EXPORT Size GetResolution ()

  *Returns the desktop resolution.*
- LLGL_EXPORT int GetColorDepth ()

  *Returns the desktop color depth (bits per pixel).*
- LLGL_EXPORT bool SetVideoMode (const VideoModeDescriptor &videoMode)

  *Sets the new specified video mode for the desktop (resolution and fullscreen mode).*
- LLGL_EXPORT bool ResetVideoMode ()

  *Restes the standard video mode for the desktop.*

### 6.2.1 Function Documentation

#### 6.2.1.1 LLGL_EXPORT int LLGL::Desktop::GetColorDepth ( )

Returns the desktop color depth (bits per pixel).

#### 6.2.1.2 LLGL_EXPORT Size LLGL::Desktop::GetResolution ( )

Returns the desktop resolution.

#### 6.2.1.3 LLGL_EXPORT bool LLGL::Desktop::ResetVideoMode ( )

Restes the standard video mode for the desktop.

#### 6.2.1.4 LLGL_EXPORT bool LLGL::Desktop::SetVideoMode ( const VideoModeDescriptor & *videoMode* )

Sets the new specified video mode for the desktop (resolution and fullscreen mode).

## 6.3 LLGL::Log Namespace Reference

### Functions

- LLGL_EXPORT void SetStdOut (std::ostream &stream)

  *Sets the standard output stream. By default std::cout.*
- LLGL_EXPORT void SetStdErr (std::ostream &stream)

  *Sets the standard output stream for error and warning messages. By default std::cerr.*
- LLGL_EXPORT std::ostream & StdOut ()

  *Returns the standard output stream.*
- LLGL_EXPORT std::ostream & StdErr ()

  *Returns the standard output stream for error and warning messages.*

### 6.3.1 Function Documentation

#### 6.3.1.1 LLGL_EXPORT void LLGL::Log::SetStdErr ( std::ostream & *stream* )

Sets the standard output stream for error and warning messages. By default std::cerr.

#### 6.3.1.2 LLGL_EXPORT void LLGL::Log::SetStdOut ( std::ostream & *stream* )

Sets the standard output stream. By default std::cout.

#### 6.3.1.3 LLGL_EXPORT std::ostream& LLGL::Log::StdErr ( )

Returns the standard output stream for error and warning messages.

#### 6.3.1.4 LLGL_EXPORT std::ostream& LLGL::Log::StdOut ( )

Returns the standard output stream.

# Chapter 7

# Class Documentation

## 7.1 LLGL::AntiAliasingDescriptor Struct Reference

```
#include <RenderContextDescriptor.h>
```

### Public Attributes

- bool enabled = false

  *Specifies whether multi-sampling is enabled or disabled. By default disabled.*
- unsigned int samples = 1

  *Number of samples used for multi-sampling. By default 1.*

### 7.1.1 Member Data Documentation

#### 7.1.1.1 bool LLGL::AntiAliasingDescriptor::enabled = false

Specifies whether multi-sampling is enabled or disabled. By default disabled.

#### 7.1.1.2 unsigned int LLGL::AntiAliasingDescriptor::samples = 1

Number of samples used for multi-sampling. By default 1.

The documentation for this struct was generated from the following file:

- RenderContextDescriptor.h

## 7.2 LLGL::BlendDescriptor Struct Reference

Blending state descriptor structure.

```
#include <GraphicsPipelineFlags.h>
```

### Public Attributes

- bool blendEnabled = false

    *Specifies whether blending is enabled or disabled. This applies to all blending targets.*
- std::vector< BlendTargetDescriptor > targets

    *Render-target blend states. A maximum of 8 targets is supported. Further targets will be ignored.*

### 7.2.1 Detailed Description

Blending state descriptor structure.

### 7.2.2 Member Data Documentation

#### 7.2.2.1 bool LLGL::BlendDescriptor::blendEnabled = false

Specifies whether blending is enabled or disabled. This applies to all blending targets.

#### 7.2.2.2 std::vector<BlendTargetDescriptor> LLGL::BlendDescriptor::targets

Render-target blend states. A maximum of 8 targets is supported. Further targets will be ignored.

The documentation for this struct was generated from the following file:

- GraphicsPipelineFlags.h

## 7.3 LLGL::BlendTargetDescriptor Struct Reference

Blend target state descriptor structure.

```
#include <GraphicsPipelineFlags.h>
```

### Public Attributes

- BlendOp srcColor = BlendOp::SrcAlpha

    *Source color blending operation.*
- BlendOp destColor = BlendOp::InvSrcAlpha

    *Destination color blending operation.*
- BlendArithmetic colorArithmetic = BlendArithmetic::Add

    *Color blending arithmetic.*
- BlendOp srcAlpha = BlendOp::SrcAlpha

    *Source alpha blending operation.*
- BlendOp destAlpha = BlendOp::InvSrcAlpha

    *Destination alpha blending operation.*
- BlendArithmetic alphaArithmetic = BlendArithmetic::Add

    *Alpha blending arithmetic.*
- ColorRGBAb colorMask

    *Specifies which color components are enabled for writing. By default (true, true, true, true).*

### 7.3.1 Detailed Description

Blend target state descriptor structure.

### 7.3.2 Member Data Documentation

#### 7.3.2.1 BlendArithmetic LLGL::BlendTargetDescriptor::alphaArithmetic = BlendArithmetic::Add

Alpha blending arithmetic.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

#### 7.3.2.2 BlendArithmetic LLGL::BlendTargetDescriptor::colorArithmetic = BlendArithmetic::Add

Color blending arithmetic.

**Note**

Only supported with: Direct3D 11, Direct3D 12.

#### 7.3.2.3 ColorRGBAb LLGL::BlendTargetDescriptor::colorMask

Specifies which color components are enabled for writing. By default (true, true, true, true).

#### 7.3.2.4 BlendOp LLGL::BlendTargetDescriptor::destAlpha = BlendOp::InvSrcAlpha

Destination alpha blending operation.

#### 7.3.2.5 BlendOp LLGL::BlendTargetDescriptor::destColor = BlendOp::InvSrcAlpha

Destination color blending operation.

#### 7.3.2.6 BlendOp LLGL::BlendTargetDescriptor::srcAlpha = BlendOp::SrcAlpha

Source alpha blending operation.

#### 7.3.2.7 BlendOp LLGL::BlendTargetDescriptor::srcColor = BlendOp::SrcAlpha

Source color blending operation.

The documentation for this struct was generated from the following file:

- GraphicsPipelineFlags.h

## 7.4 LLGL::Buffer Class Reference

Hardware buffer interface.

```
#include <Buffer.h>
```

### Public Member Functions

- Buffer (const Buffer &)=delete
- Buffer & operator= (const Buffer &)=delete
- virtual ∼Buffer ()
- BufferType GetType () const

    *Returns the type of this buffer.*

### Protected Member Functions

- Buffer (const BufferType type)

### 7.4.1 Detailed Description

Hardware buffer interface.

### 7.4.2 Constructor & Destructor Documentation

#### 7.4.2.1 LLGL::Buffer::Buffer ( const Buffer & ) `[delete]`

#### 7.4.2.2 virtual LLGL::Buffer::∼Buffer ( ) `[virtual]`

#### 7.4.2.3 LLGL::Buffer::Buffer ( const BufferType *type* ) `[protected]`

### 7.4.3 Member Function Documentation

#### 7.4.3.1 BufferType LLGL::Buffer::GetType ( ) const `[inline]`

Returns the type of this buffer.

#### 7.4.3.2 Buffer& LLGL::Buffer::operator= ( const Buffer & ) `[delete]`

The documentation for this class was generated from the following file:

- Buffer.h

## 7.5 LLGL::BufferDescriptor Struct Reference

Hardware buffer descriptor structure.

```
#include <BufferFlags.h>
```

### Classes

- struct IndexBufferDescriptor
- struct StorageBufferDescriptor
- struct VertexBufferDescriptor

  *Vertex buffer descriptor structure.*

### Public Attributes

- BufferType type = BufferType::Vertex

  *Hardware buffer type. By default BufferType::Vertex.*
- unsigned int size = 0

  *Buffer size (in bytes). By default 0.*
- BufferUsage usage = BufferUsage::Static

  *Buffer usage. By default BufferUsage::Static.*
- VertexBufferDescriptor vertexBufferDesc

  *Vertex buffer type descriptor appendix.*
- IndexBufferDescriptor indexBufferDesc

  *Index buffer type descriptor appendix.*
- StorageBufferDescriptor storageBufferDesc

  *Storage buffer type descriptor appendix.*

### 7.5.1 Detailed Description

Hardware buffer descriptor structure.

### 7.5.2 Member Data Documentation

#### 7.5.2.1 IndexBufferDescriptor LLGL::BufferDescriptor::indexBufferDesc

Index buffer type descriptor appendix.

#### 7.5.2.2 unsigned int LLGL::BufferDescriptor::size = 0

Buffer size (in bytes). By default 0.

#### 7.5.2.3 StorageBufferDescriptor LLGL::BufferDescriptor::storageBufferDesc

Storage buffer type descriptor appendix.

#### 7.5.2.4 BufferType LLGL::BufferDescriptor::type = BufferType::Vertex

Hardware buffer type. By default BufferType::Vertex.

#### 7.5.2.5 BufferUsage LLGL::BufferDescriptor::usage = BufferUsage::Static

Buffer usage. By default BufferUsage::Static.

#### 7.5.2.6 VertexBufferDescriptor LLGL::BufferDescriptor::vertexBufferDesc

Vertex buffer type descriptor appendix.

The documentation for this struct was generated from the following file:

- BufferFlags.h

## 7.6 LLGL::ClearBuffersFlags Struct Reference

Render context clear buffer flags.

```
#include <RenderContextFlags.h>
```

**Public Types**

- enum { Color = (1 << 0), Depth = (1 << 1), Stencil = (1 << 2) }

### 7.6.1 Detailed Description

Render context clear buffer flags.

**See also**

RenderContext::ClearBuffers

### 7.6.2 Member Enumeration Documentation

#### 7.6.2.1 anonymous enum

**Enumerator**

***Color***
***Depth***
***Stencil***

The documentation for this struct was generated from the following file:

- RenderContextFlags.h

## 7.7 LLGL::Color< T, N > Class Template Reference

Base color class with N components.

```
#include <Color.h>
```

### Public Member Functions

- Color ()
- Color (const Color< T, N > &rhs)
- Color (Gs::UninitializeTag)
- Color< T, N > & operator+= (const Color< T, N > &rhs)
- Color< T, N > & operator-= (const Color< T, N > &rhs)
- Color< T, N > & operator∗= (const Color< T, N > &rhs)
- Color< T, N > & operator/= (const Color< T, N > &rhs)
- Color< T, N > & operator∗= (const T &rhs)
- Color< T, N > & operator/= (const T &rhs)
- T & operator[ ] (std::size_t component)

  *Returns the specified vector component.*
- const T & operator[ ] (std::size_t component) const

  *Returns the specified vector component.*
- Color< T, N > operator- () const
- template<typename C >
  Color< C, N > Cast () const
- T ∗ Ptr ()

  *Returns a pointer to the first element of this vector.*
- const T ∗ Ptr () const

  *Returns a constant pointer to the first element of this vector.*

### Static Public Attributes

- static const std::size_t components = N

  *Specifies the number of vector components.*

### 7.7.1 Detailed Description

**template<typename T, std::size_t N>**
**class LLGL::Color< T, N >**

Base color class with N components.

#### Template Parameters

| | |
|---|---|
| *T* | Specifies the data type of the vector components. This should be a primitive data type such as float, double, int etc. |
| *N* | Specifies the number of components. There are specialized templates for N = 3, and 4. |

## 7.7.2 Constructor & Destructor Documentation

#### 7.7.2.1 template<typename T, std::size_t N> LLGL::Color< T, N >::Color ( ) [inline]

#### 7.7.2.2 template<typename T, std::size_t N> LLGL::Color< T, N >::Color ( const Color< T, N > & *rhs* ) [inline]

#### 7.7.2.3 template<typename T, std::size_t N> LLGL::Color< T, N >::Color ( Gs::UninitializeTag ) [inline]

## 7.7.3 Member Function Documentation

#### 7.7.3.1 template<typename T, std::size_t N> template<typename C > Color<C, N> LLGL::Color< T, N >::Cast ( ) const [inline]

Returns a type casted instance of this vector.

**Template Parameters**

| | |
|---|---|
| *C* | Specifies the static cast type. |

#### 7.7.3.2 template<typename T, std::size_t N> Color<T, N>& LLGL::Color< T, N >::operator*= ( const Color< T, N > & *rhs* ) [inline]

#### 7.7.3.3 template<typename T, std::size_t N> Color<T, N>& LLGL::Color< T, N >::operator*= ( const T & *rhs* ) [inline]

#### 7.7.3.4 template<typename T, std::size_t N> Color<T, N>& LLGL::Color< T, N >::operator+= ( const Color< T, N > & *rhs* ) [inline]

#### 7.7.3.5 template<typename T, std::size_t N> Color<T, N> LLGL::Color< T, N >::operator- ( ) const [inline]

#### 7.7.3.6 template<typename T, std::size_t N> Color<T, N>& LLGL::Color< T, N >::operator-= ( const Color< T, N > & *rhs* ) [inline]

#### 7.7.3.7 template<typename T, std::size_t N> Color<T, N>& LLGL::Color< T, N >::operator/= ( const Color< T, N > & *rhs* ) [inline]

#### 7.7.3.8 template<typename T, std::size_t N> Color<T, N>& LLGL::Color< T, N >::operator/= ( const T & *rhs* ) [inline]

#### 7.7.3.9 template<typename T, std::size_t N> T& LLGL::Color< T, N >::operator[ ] ( std::size_t *component* ) [inline]

Returns the specified vector component.

**Parameters**

| | | |
|---|---|---|
| `in` | *component* | Specifies the vector component index. This must be in the range [0, N). |

#### 7.7.3.10 template<typename T, std::size_t N> const T& **LLGL::Color**< T, N >::operator[ ] ( std::size_t *component* ) const `[inline]`

Returns the specified vector component.

**Parameters**

| | | |
|---|---|---|
| `in` | *component* | Specifies the vector component index. This must be in the range [0, N). |

#### 7.7.3.11 template<typename T, std::size_t N> T∗ **LLGL::Color**< T, N >::Ptr ( ) `[inline]`

Returns a pointer to the first element of this vector.

#### 7.7.3.12 template<typename T, std::size_t N> const T∗ **LLGL::Color**< T, N >::Ptr ( ) const `[inline]`

Returns a constant pointer to the first element of this vector.

### 7.7.4 Member Data Documentation

#### 7.7.4.1 template<typename T, std::size_t N> const std::size_t **LLGL::Color**< T, N >::components = N `[static]`

Specifies the number of vector components.

The documentation for this class was generated from the following file:

- Color.h

## 7.8 LLGL::Color< T, 3u > Class Template Reference

RGB color class with components: r, g, and b.

```
#include <ColorRGB.h>
```

## Public Member Functions

- Color ()
- Color (const Color< T, 3 > &rhs)
- Color (const T &scalar)
- Color (const T &r, const T &g, const T &b)
- Color (Gs::UninitializeTag)
- Color< T, 3 > & operator+= (const Color< T, 3 > &rhs)
- Color< T, 3 > & operator-= (const Color< T, 3 > &rhs)
- Color< T, 3 > & operator∗= (const Color< T, 3 > &rhs)
- Color< T, 3 > & operator/= (const Color< T, 3 > &rhs)
- Color< T, 3 > & operator∗= (const T &rhs)
- Color< T, 3 > & operator/= (const T &rhs)
- Color< T, 3 > operator- () const
- T & operator[ ] (std::size_t component)

    *Returns the specified color component.*
- const T & operator[ ] (std::size_t component) const

    *Returns the specified color component.*
- template<typename C >
  Color< C, 3 > Cast () const

    *Returns a type casted instance of this color.*
- T ∗ Ptr ()

    *Returns a pointer to the first element of this color.*
- const T ∗ Ptr () const

    *Returns a constant pointer to the first element of this color.*

## Public Attributes

- T r
- T g
- T b

## Static Public Attributes

- static const std::size_t components = 3

    *Specifies the number of color components.*

### 7.8.1 Detailed Description

**template<typename T>**
**class LLGL::Color< T, 3u >**

RGB color class with components: r, g, and b.

**Remarks**

Color components are default initialized with their maximal value, i.e. for floating-points, the initial value is 1.0, because this its maximal color value, but for unsigned-bytes, the initial value is 255.

### 7.8.2 Constructor & Destructor Documentation

#### 7.8.2.1 template<typename T > LLGL::Color< T, 3u >::Color ( ) [inline]

#### 7.8.2.2 template<typename T > LLGL::Color< T, 3u >::Color ( const Color< T, 3 > & *rhs* ) [inline]

#### 7.8.2.3 template<typename T > LLGL::Color< T, 3u >::Color ( const T & *scalar* ) [inline], [explicit]

#### 7.8.2.4 template<typename T > LLGL::Color< T, 3u >::Color ( const T & *r*, const T & *g*, const T & *b* ) [inline]

#### 7.8.2.5 template<typename T > LLGL::Color< T, 3u >::Color ( Gs::UninitializeTag ) [inline]

### 7.8.3 Member Function Documentation

#### 7.8.3.1 template<typename T > template<typename C > Color<C, 3> LLGL::Color< T, 3u >::Cast ( ) const [inline]

Returns a type casted instance of this color.

**Remarks**

All color components will be scaled to the range of the new color type.

**Template Parameters**

| | |
|---|---|
| *C* | Specifies the static cast type. |

#### 7.8.3.2 template<typename T > Color<T, 3>& LLGL::Color< T, 3u >::operator*= ( const Color< T, 3 > & *rhs* ) [inline]

#### 7.8.3.3 template<typename T > Color<T, 3>& LLGL::Color< T, 3u >::operator*= ( const T & *rhs* ) [inline]

#### 7.8.3.4 template<typename T > Color<T, 3>& LLGL::Color< T, 3u >::operator+= ( const Color< T, 3 > & *rhs* ) [inline]

#### 7.8.3.5 template<typename T > Color<T, 3> LLGL::Color< T, 3u >::operator- ( ) const [inline]

#### 7.8.3.6 template<typename T > Color<T, 3>& LLGL::Color< T, 3u >::operator-= ( const Color< T, 3 > & *rhs* ) [inline]

#### 7.8.3.7 template<typename T > Color<T, 3>& LLGL::Color< T, 3u >::operator/= ( const Color< T, 3 > & *rhs* ) [inline]

#### 7.8.3.8 template<typename T > Color<T, 3>& LLGL::Color< T, 3u >::operator/= ( const T & *rhs* ) [inline]

#### 7.8.3.9 template<typename T > T& LLGL::Color< T, 3u >::operator[] ( std::size_t *component* ) [inline]

Returns the specified color component.

**Parameters**

| | | |
|---|---|---|
| in | *component* | Specifies the color component index. This must be 0, 1, or 2. |

#### 7.8.3.10 template<typename T > const T& LLGL::Color< T, 3u >::operator[ ] ( std::size_t *component* ) const [inline]

Returns the specified color component.

**Parameters**

| | | |
|---|---|---|
| in | *component* | Specifies the color component index. This must be 0, 1, or 2. |

#### 7.8.3.11 template<typename T > T∗ LLGL::Color< T, 3u >::Ptr ( ) [inline]

Returns a pointer to the first element of this color.

#### 7.8.3.12 template<typename T > const T∗ LLGL::Color< T, 3u >::Ptr ( ) const [inline]

Returns a constant pointer to the first element of this color.

### 7.8.4 Member Data Documentation

#### 7.8.4.1 template<typename T > T LLGL::Color< T, 3u >::b

#### 7.8.4.2 template<typename T > const std::size_t LLGL::Color< T, 3u >::components = 3 [static]

Specifies the number of color components.

#### 7.8.4.3 template<typename T > T LLGL::Color< T, 3u >::g

#### 7.8.4.4 template<typename T > T LLGL::Color< T, 3u >::r

The documentation for this class was generated from the following file:

- ColorRGB.h

## 7.9 LLGL::Color< T, 4u > Class Template Reference

RGBA color class with components: r, g, b, and a.

```
#include <ColorRGBA.h>
```

## Public Member Functions

- Color ()
- Color (const Color< T, 4 > &rhs)
- Color (const T &brightness)
- Color (const T &r, const T &g, const T &b)
- Color (const T &r, const T &g, const T &b, const T &a)
- Color (Gs::UninitializeTag)
- Color< T, 4 > & operator+= (const Color< T, 4 > &rhs)
- Color< T, 4 > & operator-= (const Color< T, 4 > &rhs)
- Color< T, 4 > & operator∗= (const Color< T, 4 > &rhs)
- Color< T, 4 > & operator/= (const Color< T, 4 > &rhs)
- Color< T, 4 > & operator∗= (const T &rhs)
- Color< T, 4 > & operator/= (const T &rhs)
- Color< T, 4 > operator- () const
- T & operator[ ] (std::size_t component)

  *Returns the specified color component.*
- const T & operator[ ] (std::size_t component) const

  *Returns the specified color component.*
- template<typename C >
  Color< C, 4 > Cast () const

  *Returns a type casted instance of this color.*
- T ∗ Ptr ()

  *Returns a pointer to the first element of this color.*
- const T ∗ Ptr () const

  *Returns a constant pointer to the first element of this color.*

## Public Attributes

- T r
- T g
- T b
- T a

## Static Public Attributes

- static const std::size_t components = 4

  *Specifies the number of color components.*

### 7.9.1 Detailed Description

**template<typename T>**
**class LLGL::Color< T, 4u >**

RGBA color class with components: r, g, b, and a.

**Remarks**

Color components are default initialized with their maximal value, i.e. for floating-points, the initial value is 1.0, because this its maximal color value, but for unsigned-bytes, the initial value is 255.

### 7.9.2 Constructor & Destructor Documentation

#### 7.9.2.1 template< typename T > LLGL::Color< T, 4u >::Color ( ) [inline]

#### 7.9.2.2 template< typename T > LLGL::Color< T, 4u >::Color ( const Color< T, 4 > & *rhs* ) [inline]

#### 7.9.2.3 template< typename T > LLGL::Color< T, 4u >::Color ( const T & *brightness* ) [inline], [explicit]

#### 7.9.2.4 template< typename T > LLGL::Color< T, 4u >::Color ( const T & *r*, const T & *g*, const T & *b* ) [inline]

#### 7.9.2.5 template< typename T > LLGL::Color< T, 4u >::Color ( const T & *r*, const T & *g*, const T & *b*, const T & *a* ) [inline]

#### 7.9.2.6 template< typename T > LLGL::Color< T, 4u >::Color ( Gs::UninitializeTag ) [inline]

### 7.9.3 Member Function Documentation

#### 7.9.3.1 template< typename T > template< typename C > Color<C, 4> LLGL::Color< T, 4u >::Cast ( ) const [inline]

Returns a type casted instance of this color.

**Remarks**

All color components will be scaled to the range of the new color type.

**Template Parameters**

| | |
|---|---|
| *C* | Specifies the static cast type. |

#### 7.9.3.2 template< typename T > Color<T, 4>& LLGL::Color< T, 4u >::operator*= ( const Color< T, 4 > & *rhs* ) [inline]

#### 7.9.3.3 template< typename T > Color<T, 4>& LLGL::Color< T, 4u >::operator*= ( const T & *rhs* ) [inline]

#### 7.9.3.4 template< typename T > Color<T, 4>& LLGL::Color< T, 4u >::operator+= ( const Color< T, 4 > & *rhs* ) [inline]

#### 7.9.3.5 template< typename T > Color<T, 4> LLGL::Color< T, 4u >::operator- ( ) const [inline]

#### 7.9.3.6 template< typename T > Color<T, 4>& LLGL::Color< T, 4u >::operator-= ( const Color< T, 4 > & *rhs* ) [inline]

#### 7.9.3.7 template< typename T > Color<T, 4>& LLGL::Color< T, 4u >::operator/= ( const Color< T, 4 > & *rhs* ) [inline]

#### 7.9.3.8 template<typename T > Color<T, 4>& LLGL::Color< T, 4u >::operator/= ( const T & *rhs* ) [inline]

#### 7.9.3.9 template<typename T > T& LLGL::Color< T, 4u >::operator[ ] ( std::size_t *component* ) [inline]

Returns the specified color component.

**Parameters**

| | | |
|---|---|---|
| in | *component* | Specifies the color component index. This must be 0, 1, 2, or 3. |

#### 7.9.3.10 template<typename T > const T& LLGL::Color< T, 4u >::operator[ ] ( std::size_t *component* ) const [inline]

Returns the specified color component.

**Parameters**

| | | |
|---|---|---|
| in | *component* | Specifies the color component index. This must be 0, 1, 2, or 3. |

#### 7.9.3.11 template<typename T > T∗ LLGL::Color< T, 4u >::Ptr ( ) [inline]

Returns a pointer to the first element of this color.

#### 7.9.3.12 template<typename T > const T∗ LLGL::Color< T, 4u >::Ptr ( ) const [inline]

Returns a constant pointer to the first element of this color.

### 7.9.4 Member Data Documentation

#### 7.9.4.1 template<typename T > T LLGL::Color< T, 4u >::a

#### 7.9.4.2 template<typename T > T LLGL::Color< T, 4u >::b

#### 7.9.4.3 template<typename T > const std::size_t LLGL::Color< T, 4u >::components = 4 [static]

Specifies the number of color components.

#### 7.9.4.4 template<typename T > T LLGL::Color< T, 4u >::g

#### 7.9.4.5 template<typename T > T LLGL::Color< T, 4u >::r

The documentation for this class was generated from the following file:

- ColorRGBA.h

## 7.10 LLGL::ComputePipeline Class Reference

Compute pipeline interface.

```
#include <ComputePipeline.h>
```

### Public Member Functions

- virtual ∼ComputePipeline ()

### 7.10.1 Detailed Description

Compute pipeline interface.

### 7.10.2 Constructor & Destructor Documentation

#### 7.10.2.1 virtual LLGL::ComputePipeline::∼ComputePipeline ( ) `[inline], [virtual]`

The documentation for this class was generated from the following file:

- ComputePipeline.h

## 7.11 LLGL::ComputePipelineDescriptor Struct Reference

Compute pipeline descriptor structure.

```
#include <ComputePipeline.h>
```

### Public Member Functions

- ComputePipelineDescriptor ()=default
- ComputePipelineDescriptor (ShaderProgram ∗shaderProgram)

### Public Attributes

- ShaderProgram ∗ shaderProgram = nullptr

  *Pointer to the shader program for the compute pipeline.*

### 7.11.1 Detailed Description

Compute pipeline descriptor structure.

### 7.11.2 Constructor & Destructor Documentation

#### 7.11.2.1 LLGL::ComputePipelineDescriptor::ComputePipelineDescriptor ( ) [default]

#### 7.11.2.2 LLGL::ComputePipelineDescriptor::ComputePipelineDescriptor ( ShaderProgram ∗ *shaderProgram* ) [inline]

### 7.11.3 Member Data Documentation

#### 7.11.3.1 ShaderProgram∗ LLGL::ComputePipelineDescriptor::shaderProgram = nullptr

Pointer to the shader program for the compute pipeline.

**Remarks**

This must never be null when "RenderSystem::CreateComputePipeline" is called with this structure.

**See also**

RenderSystem::CreateComputePipeline
RenderSystem::CreateShaderProgram

The documentation for this struct was generated from the following file:

- ComputePipeline.h

## 7.12 LLGL::ConstantBufferViewDescriptor Struct Reference

Constant buffer shader-view descriptor structure.

```
#include <BufferFlags.h>
```

### Public Attributes

- std::string name

  *Constant buffer name.*
- unsigned int index = 0

  *Index of the constant buffer within the respective shader.*
- unsigned int size = 0

  *Buffer size (in bytes).*

### 7.12.1 Detailed Description

Constant buffer shader-view descriptor structure.

**Remarks**

This structure is used to describe the view of a constant buffer within a shader.

### 7.12.2 Member Data Documentation

#### 7.12.2.1 unsigned int LLGL::ConstantBufferViewDescriptor::index = 0

Index of the constant buffer within the respective shader.

#### 7.12.2.2 std::string LLGL::ConstantBufferViewDescriptor::name

Constant buffer name.

#### 7.12.2.3 unsigned int LLGL::ConstantBufferViewDescriptor::size = 0

Buffer size (in bytes).

The documentation for this struct was generated from the following file:

- BufferFlags.h

## 7.13 LLGL::RenderingProfiler::Counter Class Reference

```
#include <RenderingProfiler.h>
```

### Public Types

- using ValueType = unsigned int

### Public Member Functions

- void Inc ()
- void Inc (ValueType value)
- void Reset ()
- ValueType Count () const
- operator unsigned int () const

### 7.13.1 Member Typedef Documentation

#### 7.13.1.1 using **LLGL::RenderingProfiler::Counter::ValueType** = unsigned int

### 7.13.2 Member Function Documentation

#### 7.13.2.1 **ValueType** LLGL::RenderingProfiler::Counter::Count ( ) const `[inline]`

#### 7.13.2.2 void LLGL::RenderingProfiler::Counter::Inc ( ) `[inline]`

#### 7.13.2.3 void LLGL::RenderingProfiler::Counter::Inc ( **ValueType** *value* ) `[inline]`

#### 7.13.2.4 LLGL::RenderingProfiler::Counter::operator unsigned int ( ) const `[inline]`

#### 7.13.2.5 void LLGL::RenderingProfiler::Counter::Reset ( ) `[inline]`

The documentation for this class was generated from the following file:

- RenderingProfiler.h

## 7.14 LLGL::DepthDescriptor Struct Reference

Depth state descriptor structure.

```
#include <GraphicsPipelineFlags.h>
```

### Public Attributes

- bool testEnabled = false

  *Specifies whether the depth test is enabled or disabled. By default disabled.*
- bool writeEnabled = false

  *Specifies whether writing to the depth buffer is enabled or disabled. By default disabled.*
- CompareOp compareOp = CompareOp::Less

  *Specifies the depth test comparison function. By default CompareOp::Less.*

### 7.14.1 Detailed Description

Depth state descriptor structure.

### 7.14.2 Member Data Documentation

#### 7.14.2.1 CompareOp LLGL::DepthDescriptor::compareOp = CompareOp::Less

Specifies the depth test comparison function. By default CompareOp::Less.

#### 7.14.2.2 bool LLGL::DepthDescriptor::testEnabled = false

Specifies whether the depth test is enabled or disabled. By default disabled.

#### 7.14.2.3 bool LLGL::DepthDescriptor::writeEnabled = false

Specifies whether writing to the depth buffer is enabled or disabled. By default disabled.

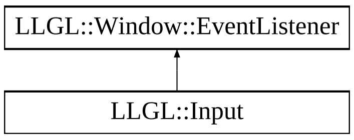
The documentation for this struct was generated from the following file:

- GraphicsPipelineFlags.h

## 7.15 LLGL::Window::EventListener Class Reference

```
#include <Window.h>
```

Inheritance diagram for LLGL::Window::EventListener:



## Public Member Functions

- virtual ∼EventListener ()

## Protected Member Functions

- virtual void OnProcessEvents (Window &sender)
- virtual void OnKeyDown (Window &sender, Key keyCode)
- virtual void OnKeyUp (Window &sender, Key keyCode)
- virtual void OnDoubleClick (Window &sender, Key keyCode)
- virtual void OnChar (Window &sender, wchar_t chr)
- virtual void OnWheelMotion (Window &sender, int motion)
- virtual void OnLocalMotion (Window &sender, const Point &position)
- virtual void OnGlobalMotion (Window &sender, const Point &motion)
- virtual void OnResize (Window &sender, const Size &clientAreaSize)
- virtual bool OnQuit (Window &sender)

  *Returns true if the specified window can quit, i.e. "ProcessEvents" returns false from now on.*

## Friends

- class Window

### 7.15.1 Constructor & Destructor Documentation

#### 7.15.1.1 virtual LLGL::Window::EventListener::∼EventListener ( ) `[virtual]`

### 7.15.2 Member Function Documentation

#### 7.15.2.1 virtual void LLGL::Window::EventListener::OnChar ( Window & *sender,* wchar_t *chr* ) `[protected]`, `[virtual]`

#### 7.15.2.2 virtual void LLGL::Window::EventListener::OnDoubleClick ( Window & *sender,* Key *keyCode* ) `[protected]`, `[virtual]`

#### 7.15.2.3 virtual void LLGL::Window::EventListener::OnGlobalMotion ( Window & *sender,* const Point & *motion* ) `[protected]`, `[virtual]`

#### 7.15.2.4 virtual void LLGL::Window::EventListener::OnKeyDown ( Window & *sender,* Key *keyCode* ) `[protected]`, `[virtual]`

#### 7.15.2.5 virtual void LLGL::Window::EventListener::OnKeyUp ( Window & *sender,* Key *keyCode* ) `[protected]`, `[virtual]`

#### 7.15.2.6 virtual void LLGL::Window::EventListener::OnLocalMotion ( Window & *sender,* const Point & *position* ) `[protected]`, `[virtual]`

#### 7.15.2.7 virtual void LLGL::Window::EventListener::OnProcessEvents ( Window & *sender* ) `[protected]`, `[virtual]`

#### 7.15.2.8 virtual bool LLGL::Window::EventListener::OnQuit ( Window & *sender* ) `[protected]`, `[virtual]`

Returns true if the specified window can quit, i.e. "ProcessEvents" returns false from now on.

#### 7.15.2.9 virtual void LLGL::Window::EventListener::OnResize ( **Window** & *sender*, const **Size** & *clientAreaSize* ) `[protected]`, `[virtual]`

#### 7.15.2.10 virtual void LLGL::Window::EventListener::OnWheelMotion ( **Window** & *sender*, int *motion* ) `[protected]`, `[virtual]`

### 7.15.3 Friends And Related Function Documentation

#### 7.15.3.1 friend class **Window** `[friend]`

The documentation for this class was generated from the following file:

- Window.h

## 7.16 LLGL::ShaderSource::GLSL Struct Reference

Shader source descriptor for GLSL.

`#include <ShaderFlags.h>`

### Public Attributes

- const std::string & sourceCode

  *Shader source code string.*

### 7.16.1 Detailed Description

Shader source descriptor for GLSL.

### 7.16.2 Member Data Documentation

#### 7.16.2.1 const std::string& LLGL::ShaderSource::GLSL::sourceCode

Shader source code string.

The documentation for this struct was generated from the following file:

- ShaderFlags.h

## 7.17 LLGL::GraphicsAPIDependentStateDescriptor Union Reference

Low-level graphics API dependent state descriptor union.

`#include <RenderContextFlags.h>`

### Classes

- struct StateOpenGLDescriptor

### Public Member Functions

- GraphicsAPIDependentStateDescriptor ()

### Public Attributes

- struct LLGL::GraphicsAPIDependentStateDescriptor::StateOpenGLDescriptor stateOpenGL

### 7.17.1 Detailed Description

Low-level graphics API dependent state descriptor union.

**See also**

RenderContext::SetGraphicsAPIDependentState

### 7.17.2 Constructor & Destructor Documentation

#### 7.17.2.1 LLGL::GraphicsAPIDependentStateDescriptor::GraphicsAPIDependentStateDescriptor ( ) `[inline]`

### 7.17.3 Member Data Documentation

#### 7.17.3.1 struct LLGL::GraphicsAPIDependentStateDescriptor::StateOpenGLDescriptor LLGL::GraphicsAPIDependentStateDescriptor::stateOpenGL

The documentation for this union was generated from the following file:

- RenderContextFlags.h

## 7.18 LLGL::GraphicsPipeline Class Reference

Graphics pipeline interface.

`#include <GraphicsPipeline.h>`

### Public Member Functions

- virtual ∼GraphicsPipeline ()

### 7.18.1 Detailed Description

Graphics pipeline interface.

### 7.18.2 Constructor & Destructor Documentation

#### 7.18.2.1 virtual LLGL::GraphicsPipeline::∼GraphicsPipeline ( ) `[inline]`, `[virtual]`

The documentation for this class was generated from the following file:

- GraphicsPipeline.h

## 7.19 LLGL::GraphicsPipelineDescriptor Struct Reference

Graphics pipeline descriptor structure.

`#include <GraphicsPipelineFlags.h>`

### Public Attributes

- ShaderProgram ∗ shaderProgram = nullptr

  *Pointer to the shader program for the graphics pipeline.*
- PrimitiveTopology primitiveTopology = PrimitiveTopology::TriangleList

  *Specifies the primitive topology and ordering of the primitive data. By default PrimitiveTopology::TriangleList.*
- DepthDescriptor depth

  *Specifies the depth state descriptor.*
- StencilDescriptor stencil

  *Specifies the stencil state descriptor.*
- RasterizerDescriptor rasterizer

  *Specifies the rasterizer state descriptor.*
- BlendDescriptor blend

  *Specifies the blending state descriptor.*

### 7.19.1 Detailed Description

Graphics pipeline descriptor structure.

**Remarks**

This structure describes the entire graphics pipeline: viewports, depth-/ stencil-/ rasterizer-/ blend states, shader stages etc.

### 7.19.2 Member Data Documentation

#### 7.19.2.1 BlendDescriptor LLGL::GraphicsPipelineDescriptor::blend

Specifies the blending state descriptor.

#### 7.19.2.2 DepthDescriptor LLGL::GraphicsPipelineDescriptor::depth

Specifies the depth state descriptor.

#### 7.19.2.3 PrimitiveTopology LLGL::GraphicsPipelineDescriptor::primitiveTopology = PrimitiveTopology::TriangleList

Specifies the primitive topology and ordering of the primitive data. By default PrimitiveTopology::TriangleList.

**See also**

PrimitiveTopology

#### 7.19.2.4 RasterizerDescriptor LLGL::GraphicsPipelineDescriptor::rasterizer

Specifies the rasterizer state descriptor.

#### 7.19.2.5 ShaderProgram* LLGL::GraphicsPipelineDescriptor::shaderProgram = nullptr

Pointer to the shader program for the graphics pipeline.

**Remarks**

This must never be null when "RenderSystem::CreateGraphicsPipeline" is called with this structure.

**See also**

RenderSystem::CreateGraphicsPipeline
RenderSystem::CreateShaderProgram

#### 7.19.2.6 StencilDescriptor LLGL::GraphicsPipelineDescriptor::stencil

Specifies the stencil state descriptor.

The documentation for this struct was generated from the following file:

- GraphicsPipelineFlags.h

## 7.20 LLGL::ShaderSource::HLSL Struct Reference

Shader source descriptor for HLSL.

```
#include <ShaderFlags.h>
```

### Public Attributes

- const std::string & sourceCode

  *Shader source code string.*
- std::string entryPoint

  *Shader entry point (this is the name of the shader main function).*
- std::string target

  *Shader version target (see `https://msdn.microsoft.com/en-us/library/windows/desktop/jj215820(v=vs.`↩
  `85).aspx`).*
- int flags

  *Optional compilation flags. This can be a bitwise OR combination of the 'ShaderCompileFlags' enumeration entries.*

## 7.20.1 Detailed Description

Shader source descriptor for HLSL.

## 7.20.2 Member Data Documentation

### 7.20.2.1 std::string LLGL::ShaderSource::HLSL::entryPoint

Shader entry point (this is the name of the shader main function).

### 7.20.2.2 int LLGL::ShaderSource::HLSL::flags

Optional compilation flags. This can be a bitwise OR combination of the 'ShaderCompileFlags' enumeration entries.

### 7.20.2.3 const std::string& LLGL::ShaderSource::HLSL::sourceCode

Shader source code string.

### 7.20.2.4 std::string LLGL::ShaderSource::HLSL::target

Shader version target (see `https://msdn.microsoft.com/en-us/library/windows/desktop/jj215820(v=vs`
`85).aspx`).

The documentation for this struct was generated from the following file:

- ShaderFlags.h

## 7.21 LLGL::ImageDescriptor Struct Reference

Image descriptor structure.

`#include <Image.h>`

## Public Member Functions

- ImageDescriptor ()=default
- ImageDescriptor (ImageFormat format, DataType dataType, const void ∗buffer)
- ImageDescriptor (ImageFormat format, const void ∗buffer, unsigned int compressedSize)

  *Constructor for compressed image data.*

## Public Attributes

- ImageFormat format = ImageFormat::RGBA

  *Specifies the image format. By default ImageFormat::RGBA.*
- DataType dataType = DataType::UInt8

  *Specifies the image data type. This must be DataType::UInt8 for compressed images.*
- const void ∗ buffer = nullptr

  *Pointer to the image buffer.*
- unsigned int compressedSize = 0

  *Specifies the size (in bytes) of a compressed image. This must be 0 for uncompressed images.*

### 7.21.1 Detailed Description

Image descriptor structure.

**Remarks**

This kind of 'Image' is mainly used to fill the image data of a hardware texture.

### 7.21.2 Constructor & Destructor Documentation

#### 7.21.2.1 LLGL::ImageDescriptor::ImageDescriptor ( ) `[default]`

#### 7.21.2.2 LLGL::ImageDescriptor::ImageDescriptor ( ImageFormat *format*, DataType *dataType*, const void ∗ *buffer* ) `[inline]`

#### 7.21.2.3 LLGL::ImageDescriptor::ImageDescriptor ( ImageFormat *format*, const void ∗ *buffer*, unsigned int *compressedSize* ) `[inline]`

Constructor for compressed image data.

### 7.21.3 Member Data Documentation

#### 7.21.3.1 const void∗ LLGL::ImageDescriptor::buffer = nullptr

Pointer to the image buffer.

#### 7.21.3.2 unsigned int LLGL::ImageDescriptor::compressedSize = 0

Specifies the size (in bytes) of a compressed image. This must be 0 for uncompressed images.

#### 7.21.3.3 DataType LLGL::ImageDescriptor::dataType = DataType::UInt8

Specifies the image data type. This must be DataType::UInt8 for compressed images.

#### 7.21.3.4 ImageFormat LLGL::ImageDescriptor::format = ImageFormat::RGBA

Specifies the image format. By default ImageFormat::RGBA.

The documentation for this struct was generated from the following file:

- Image.h

## 7.22 LLGL::BufferDescriptor::IndexBufferDescriptor Struct Reference

```
#include <BufferFlags.h>
```

### Public Attributes

- IndexFormat indexFormat
  *Specifies the index format layout, which is basically only the data type of each index.*

### 7.22.1 Member Data Documentation

#### 7.22.1.1 IndexFormat LLGL::BufferDescriptor::IndexBufferDescriptor::indexFormat

Specifies the index format layout, which is basically only the data type of each index.

**Remarks**

The only valid format types for an index buffer are: DataType::UByte, DataType::UShort, and DataType::UInt.

**See also**

DataType

The documentation for this struct was generated from the following file:

- BufferFlags.h

## 7.23 LLGL::IndexFormat Class Reference

```
#include <IndexFormat.h>
```

### Public Member Functions

- IndexFormat ()=default
- IndexFormat (const DataType dataType)
- DataType GetDataType () const

  *Returns the data type of this index format.*
- unsigned int GetFormatSize () const

  *Returns the size of this vertex format (in bytes).*

### 7.23.1 Constructor & Destructor Documentation

#### 7.23.1.1 LLGL::IndexFormat::IndexFormat ( ) `[default]`

#### 7.23.1.2 LLGL::IndexFormat::IndexFormat ( const DataType *dataType* )

### 7.23.2 Member Function Documentation

#### 7.23.2.1 DataType LLGL::IndexFormat::GetDataType ( ) const `[inline]`

Returns the data type of this index format.

#### 7.23.2.2 unsigned int LLGL::IndexFormat::GetFormatSize ( ) const `[inline]`

Returns the size of this vertex format (in bytes).

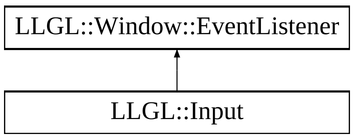
The documentation for this class was generated from the following file:

- IndexFormat.h

## 7.24 LLGL::Input Class Reference

```
#include <Input.h>
```

Inheritance diagram for LLGL::Input:



## Public Member Functions

- Input ()
- bool KeyPressed (Key keyCode) const

    *Returns true if the specified key is currently being pressed down.*
- bool KeyDown (Key keyCode) const

    *Returns true if the specified key was pressed down in the previous event processing.*
- bool KeyUp (Key keyCode) const

    *Returns true if the specified key was released in the previous event processing.*
- bool KeyDoubleClick (Key keyCode) const

    *Returns true if the specified key was double clicked.*
- const Point & GetMousePosition () const

    *Returns the local mouse position.*
- const Point & GetMouseMotion () const

    *Returns the global mouse motion.*
- int GetWheelMotion () const

    *Returns the mouse wheel motion.*
- const std::wstring & GetEnteredChars () const

    *Returns the entered characters.*

## Additional Inherited Members

### 7.24.1 Constructor & Destructor Documentation

#### 7.24.1.1 LLGL::Input::Input ( )

### 7.24.2 Member Function Documentation

#### 7.24.2.1 const std::wstring& LLGL::Input::GetEnteredChars ( ) const [inline]

Returns the entered characters.

#### 7.24.2.2 const Point& LLGL::Input::GetMouseMotion ( ) const [inline]

Returns the global mouse motion.

#### 7.24.2.3 const Point& LLGL::Input::GetMousePosition ( ) const [inline]

Returns the local mouse position.

#### 7.24.2.4 int LLGL::Input::GetWheelMotion ( ) const [inline]

Returns the mouse wheel motion.

#### 7.24.2.5 bool LLGL::Input::KeyDoubleClick ( Key *keyCode* ) const

Returns true if the specified key was double clicked.

**Remarks**

This can only be true for the key codes: Key::LButton, Key::RButton, and Key::MButton.

#### 7.24.2.6 bool LLGL::Input::KeyDown ( Key *keyCode* ) const

Returns true if the specified key was pressed down in the previous event processing.

#### 7.24.2.7 bool LLGL::Input::KeyPressed ( Key *keyCode* ) const

Returns true if the specified key is currently being pressed down.

#### 7.24.2.8 bool LLGL::Input::KeyUp ( Key *keyCode* ) const

Returns true if the specified key was released in the previous event processing.

The documentation for this class was generated from the following file:

- Input.h

## 7.25 LLGL::RenderingDebugger::Message Class Reference

Rendering debugger message class.

```
#include <RenderingDebugger.h>
```

### Public Member Functions

- Message ()=default
- Message (const Message &)=default
- Message & operator= (const Message &)=default
- Message (const std::string &text, const std::string &source)
- void Block ()
- void BlockAfter (std::size_t occurrences)
- const std::string & GetText () const
- const std::string & GetSource () const
- std::size_t GetOccurrences () const
- bool IsBlocked () const

### Protected Member Functions

- void IncOccurrence ()

## Friends

- class RenderingDebugger

### 7.25.1 Detailed Description

Rendering debugger message class.

### 7.25.2 Constructor & Destructor Documentation

#### 7.25.2.1 LLGL::RenderingDebugger::Message::Message ( ) [default]

#### 7.25.2.2 LLGL::RenderingDebugger::Message::Message ( const Message & ) [default]

#### 7.25.2.3 LLGL::RenderingDebugger::Message::Message ( const std::string & *text*, const std::string & *source* )

### 7.25.3 Member Function Documentation

#### 7.25.3.1 void LLGL::RenderingDebugger::Message::Block ( )

#### 7.25.3.2 void LLGL::RenderingDebugger::Message::BlockAfter ( std::size_t *occurrences* )

#### 7.25.3.3 std::size_t LLGL::RenderingDebugger::Message::GetOccurrences ( ) const [inline]

#### 7.25.3.4 const std::string& LLGL::RenderingDebugger::Message::GetSource ( ) const [inline]

#### 7.25.3.5 const std::string& LLGL::RenderingDebugger::Message::GetText ( ) const [inline]

#### 7.25.3.6 void LLGL::RenderingDebugger::Message::IncOccurrence ( ) [protected]

#### 7.25.3.7 bool LLGL::RenderingDebugger::Message::IsBlocked ( ) const [inline]

#### 7.25.3.8 Message& LLGL::RenderingDebugger::Message::operator= ( const Message & ) [default]

### 7.25.4 Friends And Related Function Documentation

#### 7.25.4.1 friend class RenderingDebugger [friend]

The documentation for this class was generated from the following file:

- RenderingDebugger.h

## 7.26 LLGL::NativeContextHandle Struct Reference

Linux native context handle structure.

`#include <LinuxNativeHandle.h>`

### Public Attributes

- ::Display ∗ display
- ::Window parentWindow
- ::XVisualInfo ∗ visual
- ::Colormap colorMap
- int screen
- NSWindow ∗ parentWindow
- HWND parentWindow

### 7.26.1 Detailed Description

Linux native context handle structure.

Win32 native context handle structure.

MacOS native context handle structure.

### 7.26.2 Member Data Documentation

#### 7.26.2.1 ::Colormap LLGL::NativeContextHandle::colorMap

#### 7.26.2.2 ::Display∗ LLGL::NativeContextHandle::display

#### 7.26.2.3 HWND LLGL::NativeContextHandle::parentWindow

#### 7.26.2.4 NSWindow∗ LLGL::NativeContextHandle::parentWindow

#### 7.26.2.5 ::Window LLGL::NativeContextHandle::parentWindow

#### 7.26.2.6 int LLGL::NativeContextHandle::screen

#### 7.26.2.7 ::XVisualInfo∗ LLGL::NativeContextHandle::visual

The documentation for this struct was generated from the following files:

- LinuxNativeHandle.h
- MacOSNativeHandle.h
- Win32NativeHandle.h

## 7.27 LLGL::NativeHandle Struct Reference

Linux native handle structure.

```
#include <LinuxNativeHandle.h>
```

### Public Attributes

- ::Display ∗ display
- ::Window window
- ::XVisualInfo ∗ visual
- NSWindow ∗ window
- HWND window

### 7.27.1 Detailed Description

Linux native handle structure.

Win32 native handle structure.

MacOS native handle structure.

### 7.27.2 Member Data Documentation

#### 7.27.2.1 ::Display∗ LLGL::NativeHandle::display

#### 7.27.2.2 ::XVisualInfo∗ LLGL::NativeHandle::visual

#### 7.27.2.3 NSWindow∗ LLGL::NativeHandle::window

#### 7.27.2.4 HWND LLGL::NativeHandle::window

#### 7.27.2.5 ::Window LLGL::NativeHandle::window

The documentation for this struct was generated from the following files:

- LinuxNativeHandle.h
- MacOSNativeHandle.h
- Win32NativeHandle.h

## 7.28 LLGL::ProfileOpenGLDescriptor Struct Reference

```
#include <RenderContextDescriptor.h>
```

## Public Attributes

- bool extProfile = false

  *Specifies whether an extended renderer profile is to be used. By default false.*
- bool coreProfile = false

  *Specifies whether to use 'OpenGL Core Profile', instead of 'OpenGL Compatibility Profile'. By default disbaled.*
- bool debugDump = false

  *Specifies whether the hardware renderer will produce debug dump. By default disabled.*
- OpenGLVersion version = OpenGLVersion::OpenGL_Latest

  *OpenGL version to create the render context with.*

### 7.28.1 Member Data Documentation

#### 7.28.1.1 bool LLGL::ProfileOpenGLDescriptor::coreProfile = false

Specifies whether to use 'OpenGL Core Profile', instead of 'OpenGL Compatibility Profile'. By default disbaled.

**Remarks**

This requires 'extProfile' to be enabled.

#### 7.28.1.2 bool LLGL::ProfileOpenGLDescriptor::debugDump = false

Specifies whether the hardware renderer will produce debug dump. By default disabled.

#### 7.28.1.3 bool LLGL::ProfileOpenGLDescriptor::extProfile = false

Specifies whether an extended renderer profile is to be used. By default false.

#### 7.28.1.4 OpenGLVersion LLGL::ProfileOpenGLDescriptor::version = OpenGLVersion::OpenGL_Latest

OpenGL version to create the render context with.

**Remarks**

This required 'coreProfile' to be enabled.

The documentation for this struct was generated from the following file:

- RenderContextDescriptor.h

## 7.29 LLGL::Query Class Reference

Query interface.

```
#include <Query.h>
```

## Public Member Functions

- Query (const Query &)=delete
- Query & operator= (const Query &)=delete
- virtual ∼Query ()
- QueryType GetType () const

  *Returns the type of this query.*

## Protected Member Functions

- Query (const QueryType type)

### 7.29.1 Detailed Description

Query interface.

### 7.29.2 Constructor & Destructor Documentation

#### 7.29.2.1 LLGL::Query::Query ( const Query & ) [delete]

#### 7.29.2.2 virtual LLGL::Query::∼Query ( ) [virtual]

#### 7.29.2.3 LLGL::Query::Query ( const QueryType *type* ) [protected]

### 7.29.3 Member Function Documentation

#### 7.29.3.1 QueryType LLGL::Query::GetType ( ) const [inline]

Returns the type of this query.

#### 7.29.3.2 Query& LLGL::Query::operator= ( const Query & ) [delete]

The documentation for this class was generated from the following file:

- Query.h

## 7.30 LLGL::QueryDescriptor Struct Reference

Query descriptor structure.

```
#include <QueryFlags.h>
```

### Public Member Functions

- QueryDescriptor ()=default
- QueryDescriptor (QueryType type, bool renderCondition=false)

### Public Attributes

- QueryType type = QueryType::SamplesPassed

  *Specifies the type of the query. By default QueryType::SamplesPassed (occlusion query).*
- bool renderCondition = false

  *Specifies whether the query is to be used as a render condition. By default false.*

### 7.30.1 Detailed Description

Query descriptor structure.

### 7.30.2 Constructor & Destructor Documentation

#### 7.30.2.1 LLGL::QueryDescriptor::QueryDescriptor ( ) [default]

#### 7.30.2.2 LLGL::QueryDescriptor::QueryDescriptor ( QueryType *type*, bool *renderCondition* = false ) [inline]

### 7.30.3 Member Data Documentation

#### 7.30.3.1 bool LLGL::QueryDescriptor::renderCondition = false

Specifies whether the query is to be used as a render condition. By default false.

**Remarks**

If this is true, 'type' can only have one of the following values: QueryType::SamplesPassed, QueryType::Any↩
SamplesPassed, QueryType::AnySamplesPassedConservative, or QueryType::StreamOutOverflow.

#### 7.30.3.2 QueryType LLGL::QueryDescriptor::type = QueryType::SamplesPassed

Specifies the type of the query. By default QueryType::SamplesPassed (occlusion query).

The documentation for this struct was generated from the following file:

- QueryFlags.h

## 7.31 LLGL::RasterizerDescriptor Struct Reference

Rasterizer state descriptor structure.

```
#include <GraphicsPipelineFlags.h>
```

### Public Attributes

- PolygonMode polygonMode = PolygonMode::Fill

  *Polygon render mode. By default PolygonMode::Fill.*
- CullMode cullMode = CullMode::Disabled
- int depthBias = 0
- float depthBiasClamp = 0.0f
- float slopeScaledDepthBias = 0.0f
- unsigned int samples = 1

  *Number of samples for multi-sample anti-aliasing (MSAA).*
- bool frontCCW = false

  *If true, front facing polygons are in counter-clock-wise winding, otherwise in clock-wise winding.*
- bool depthClampEnabled = false
- bool scissorTestEnabled = false
- bool multiSampleEnabled = false
- bool antiAliasedLineEnabled = false
- bool conservativeRasterization = false

  *If ture, conservative rasterization is enabled.*

## 7.31.1 Detailed Description

Rasterizer state descriptor structure.

## 7.31.2 Member Data Documentation

#### 7.31.2.1 bool LLGL::RasterizerDescriptor::antiAliasedLineEnabled = false

#### 7.31.2.2 bool LLGL::RasterizerDescriptor::conservativeRasterization = false

If ture, conservative rasterization is enabled.

**Note**

Only supported with: Direct3D 12 (or OpenGL if the extension "GL_NV_conservative_raster" or "GL_INTE↩ L_conservative_rasterization" is supported).

**See also**

https://www.opengl.org/registry/specs/NV/conservative_raster.txt
https://www.opengl.org/registry/specs/INTEL/conservative_rasterization.↩ txt

#### 7.31.2.3 CullMode LLGL::RasterizerDescriptor::cullMode = CullMode::Disabled

#### 7.31.2.4 int LLGL::RasterizerDescriptor::depthBias = 0

#### 7.31.2.5 float LLGL::RasterizerDescriptor::depthBiasClamp = 0.0f

#### 7.31.2.6 bool LLGL::RasterizerDescriptor::depthClampEnabled = false

#### 7.31.2.7 bool LLGL::RasterizerDescriptor::frontCCW = false

If true, front facing polygons are in counter-clock-wise winding, otherwise in clock-wise winding.

#### 7.31.2.8 bool LLGL::RasterizerDescriptor::multiSampleEnabled = false

#### 7.31.2.9 PolygonMode LLGL::RasterizerDescriptor::polygonMode = PolygonMode::Fill

Polygon render mode. By default PolygonMode::Fill.

#### 7.31.2.10 unsigned int LLGL::RasterizerDescriptor::samples = 1

Number of samples for multi-sample anti-aliasing (MSAA).

**See also**

multiSampleEnabled

**Note**

Only supported with: Direct3D 11, Direct3D 12.

#### 7.31.2.11 bool LLGL::RasterizerDescriptor::scissorTestEnabled = false

#### 7.31.2.12 float LLGL::RasterizerDescriptor::slopeScaledDepthBias = 0.0f

The documentation for this struct was generated from the following file:

- GraphicsPipelineFlags.h

## 7.32 LLGL::RenderContext Class Reference

Render context interface.

```
#include <RenderContext.h>
```

## Public Member Functions

- RenderContext (const RenderContext &)=delete
- RenderContext & operator= (const RenderContext &)=delete
- virtual ∼RenderContext ()
- virtual void Present ()=0

    *Presents the current frame on the screen.*
- Window & GetWindow () const

    *Returns the window which is used to draw all content.*
- virtual void SetGraphicsAPIDependentState (const GraphicsAPIDependentStateDescriptor &state)=0

    *Sets a few low-level graphics API dependent states.*
- virtual void SetVideoMode (const VideoModeDescriptor &videoModeDesc)

    *Sets the new video mode for this render context.*
- virtual void SetVsync (const VsyncDescriptor &vsyncDesc)=0

    *Sets the new vertical-sychronization (Vsync) configuration for this render context.*
- const VideoModeDescriptor & GetVideoMode () const

    *Returns the video mode for this render context.*
- virtual void SetViewport (const Viewport &viewport)=0

    *Sets a single viewport.*
- virtual void SetViewportArray (const std::vector< Viewport > &viewports)=0

    *Sets the array of viewports.*
- virtual void SetScissor (const Scissor &scissor)=0

    *Sets a single scissor rectangle.*
- virtual void SetScissorArray (const std::vector< Scissor > &scissors)=0

    *Sets the specified scissor rectangles.*
- virtual void SetClearColor (const ColorRGBAf &color)=0

    *Sets the new value to clear the color buffer. By default black (0, 0, 0, 0).*
- virtual void SetClearDepth (float depth)=0

    *Sets the new value to clear the depth buffer with. By default 1.0.*
- virtual void SetClearStencil (int stencil)=0

    *Sets the new value to clear the stencil buffer. By default 0.*
- virtual void ClearBuffers (long flags)=0

    *Clears the specified frame buffers.*
- virtual void SetVertexBuffer (Buffer &buffer)=0

    *Sets the specified vertex buffer for subsequent drawing operations.*
- virtual void SetIndexBuffer (Buffer &buffer)=0

    *Sets the active index buffer for subsequent drawing operations.*
- virtual void SetConstantBuffer (Buffer &buffer, unsigned int slot, long shaderStageFlags=ShaderStageFlags↩ ::AllStages)=0

    *Sets the active constant buffer of the specified slot index for subsequent drawing and compute operations.*
- virtual void SetStorageBuffer (Buffer &buffer, unsigned int slot)=0

    *Sets the active storage buffer of the specified slot index for subsequent drawing and compute operations.*
- virtual void ∗ MapBuffer (Buffer &buffer, const BufferCPUAccess access)=0

    *Maps the specified buffer from GPU to CPU memory space.*
- virtual void UnmapBuffer (Buffer &buffer)=0

    *Unmaps the specified buffer.*
- virtual void SetTexture (Texture &texture, unsigned int slot, long shaderStageFlags=ShaderStageFlags::All↩ Stages)=0

    *Sets the active texture of the specified slot index for subsequent drawing and compute operations.*
- virtual void SetSampler (Sampler &sampler, unsigned int slot, long shaderStageFlags=ShaderStageFlags↩ ::AllStages)=0

*Sets the active sampler of the specified slot index for subsequent drawing and compute operations.*

- virtual void SetRenderTarget (RenderTarget &renderTarget)=0

    *Sets the active render target.*
- virtual void UnsetRenderTarget ()=0

    *Unsets the previously set render target.*
- virtual void SetGraphicsPipeline (GraphicsPipeline &graphicsPipeline)=0

    *Sets the active graphics pipeline state.*
- virtual void SetComputePipeline (ComputePipeline &computePipeline)=0

    *Sets the active compute pipeline state.*
- virtual void BeginQuery (Query &query)=0

    *Begins the specified query.*
- virtual void EndQuery (Query &query)=0

    *Ends the specified query.*
- virtual bool QueryResult (Query &query, std::uint64_t &result)=0

    *Queries the result of the specified Query object.*
- virtual void BeginRenderCondition (Query &query, const RenderConditionMode mode)=0

    *Begins conditional rendering with the specified query object.*
- virtual void EndRenderCondition ()=0

    *Ends the current render condition.*
- virtual void Draw (unsigned int numVertices, unsigned int firstVertex)=0

    *Draws the specified amount of primitives from the currently set vertex buffer.*
- virtual void DrawIndexed (unsigned int numVertices, unsigned int firstIndex)=0
- virtual void DrawIndexed (unsigned int numVertices, unsigned int firstIndex, int vertexOffset)=0

    *Draws the specified amount of primitives from the currently set vertex- and index buffers.*
- virtual void DrawInstanced (unsigned int numVertices, unsigned int firstVertex, unsigned int numInstances)=0
- virtual void DrawInstanced (unsigned int numVertices, unsigned int firstVertex, unsigned int numInstances, unsigned int instanceOffset)=0

    *Draws the specified amount of instances of primitives from the currently set vertex buffer.*
- virtual void DrawIndexedInstanced (unsigned int numVertices, unsigned int numInstances, unsigned int first↩ Index)=0
- virtual void DrawIndexedInstanced (unsigned int numVertices, unsigned int numInstances, unsigned int first↩ Index, int vertexOffset)=0
- virtual void DrawIndexedInstanced (unsigned int numVertices, unsigned int numInstances, unsigned int first↩ Index, int vertexOffset, unsigned int instanceOffset)=0

    *Draws the specified amount of instances of primitives from the currently set vertex- and index buffers.*
- virtual void DispatchCompute (const Gs::Vector3ui &threadGroupSize)=0

    *Dispachtes a compute command.*
- virtual void SyncGPU ()=0

    *Synchronizes the GPU, i.e. waits until the GPU has completed all pending commands.*

## Protected Member Functions

- RenderContext ()=default
- void SetWindow (const std::shared_ptr< Window > &window, VideoModeDescriptor &videoModeDesc, const void ∗windowContext)
- void ShareWindowAndVideoMode (RenderContext &other)

    *Shares the window and video mode with another render context.*

### 7.32.1 Detailed Description

Render context interface.

**Remarks**

The render context is the main interface for drawing and compute operations.

### 7.32.2 Constructor & Destructor Documentation

#### 7.32.2.1 LLGL::RenderContext::RenderContext ( const RenderContext & ) [delete]

#### 7.32.2.2 virtual LLGL::RenderContext::∼RenderContext ( ) [virtual]

#### 7.32.2.3 LLGL::RenderContext::RenderContext ( ) [protected], [default]

### 7.32.3 Member Function Documentation

#### 7.32.3.1 virtual void LLGL::RenderContext::BeginQuery ( Query & *query* ) [pure virtual]

Begins the specified query.

**Parameters**

| | | |
|---|---|---|
| in | *query* | Specifies the query to begin with. This must be same query object as in the subsequent "EndQuery" function call, to end the query operation. |

**Remarks**

The "BeginQuery" and "EndQuery" functions can be wrapped around any drawing and/or compute operation. This can an occlusion query for instance, which determines how many fragments have passed the depth test.

**See also**

RenderSystem::CreateQuery
EndQuery
QueryResult

#### 7.32.3.2 virtual void LLGL::RenderContext::BeginRenderCondition ( Query & *query,* const RenderConditionMode *mode* ) [pure virtual]

Begins conditional rendering with the specified query object.

**Parameters**

| | | |
|---|---|---|
| in | *query* | Specifies the query object which is to be used as render condition. This must be an occlusion query, i.e. it's type must be either QueryType::SamplesPassed, QueryType::AnySamplesPassed, or QueryType::AnySamplesPassedConservative. |
| in | *mode* | Specifies the mode of the render conidition. |

**Remarks**

Here is a usage example:

```
context->BeginQuery(*occlusionQuery);
// draw bounding box ...
context->EndQuery(*occlusionQuery);
context->BeginRenderConidtion(*occlusionQuery, LLGL::RenderConditionMode::Wait
      );
// draw actual object ...
context->EndRenderConidtion();
```

**See also**

QueryType
RenderConditionMode

#### 7.32.3.3 virtual void LLGL::RenderContext::ClearBuffers ( long *flags* ) [pure virtual]

Clears the specified frame buffers.

**Parameters**

| | | |
|---|---|---|
| in | *flags* | Specifies the clear buffer flags. This can be a bitwise OR combination of the "ClearBuffersFlags" enumeration entries. |

**Remarks**

To specify the clear values for each buffer use the respective "SetClear..." function

**See also**

ClearBuffersFlags
SetClearColor
SetClearDepth
SetClearStencil

#### 7.32.3.4 virtual void LLGL::RenderContext::DispatchCompute ( const Gs::Vector3ui & *threadGroupSize* ) [pure virtual]

Dispachtes a compute command.

**Parameters**

| | | |
|---|---|---|
| in | *threadGroupSize* | Specifies the number of thread groups, where the number of threads per group is specified statically within the compute shader. |

**See also**

SetComputePipeline

#### 7.32.3.5 virtual void LLGL::RenderContext::Draw ( unsigned int *numVertices*, unsigned int *firstVertex* ) `[pure virtual]`

Draws the specified amount of primitives from the currently set vertex buffer.

**Parameters**

| | | |
|---|---|---|
| `in` | *numVertices* | Specifies the number of vertices to generate. |
| `in` | *firstVertex* | Specifies the zero-based offset of the first vertex from the vertex buffer. |

#### 7.32.3.6 virtual void LLGL::RenderContext::DrawIndexed ( unsigned int *numVertices*, unsigned int *firstIndex* ) `[pure virtual]`

**See also**

DrawIndexed(unsigned int, unsigned int, int)

#### 7.32.3.7 virtual void LLGL::RenderContext::DrawIndexed ( unsigned int *numVertices*, unsigned int *firstIndex*, int *vertexOffset* ) `[pure virtual]`

Draws the specified amount of primitives from the currently set vertex- and index buffers.

**Parameters**

| | | |
|---|---|---|
| `in` | *numVertices* | Specifies the number of vertices to generate. |
| `in` | *firstIndex* | Specifies the zero-based offset of the first index from the index buffer. |
| `in` | *vertexOffset* | Specifies the base vertex offset (positive or negative) which is added to each index from the index buffer. |

#### 7.32.3.8 virtual void LLGL::RenderContext::DrawIndexedInstanced ( unsigned int *numVertices*, unsigned int *numInstances*, unsigned int *firstIndex* ) `[pure virtual]`

**See also**

DrawIndexedInstanced(unsigned int, unsigned int, unsigned int, int, unsigned int)

#### 7.32.3.9 virtual void LLGL::RenderContext::DrawIndexedInstanced ( unsigned int *numVertices*, unsigned int *numInstances*, unsigned int *firstIndex*, int *vertexOffset* ) `[pure virtual]`

**See also**

DrawIndexedInstanced(unsigned int, unsigned int, unsigned int, int, unsigned int)

#### 7.32.3.10 virtual void LLGL::RenderContext::DrawIndexedInstanced ( unsigned int *numVertices*, unsigned int *numInstances*, unsigned int *firstIndex*, int *vertexOffset*, unsigned int *instanceOffset* ) `[pure virtual]`

Draws the specified amount of instances of primitives from the currently set vertex- and index buffers.

**Parameters**

| | | |
|---|---|---|
| in | *numVertices* | Specifies the number of vertices to generate. |
| in | *numInstances* | Specifies the number of instances to generate. |
| in | *firstIndex* | Specifies the zero-based offset of the first index from the index buffer. |
| in | *vertexOffset* | Specifies the base vertex offset (positive or negative) which is added to each index from the index buffer. |
| in | *instanceOffset* | Specifies the zero-based instance offset which is added to each instance ID. |

#### 7.32.3.11 virtual void LLGL::RenderContext::DrawInstanced ( unsigned int *numVertices*, unsigned int *firstVertex*, unsigned int *numInstances* ) `[pure virtual]`

**See also**

DrawInstanced(unsigned int, unsigned int, unsigned int, unsigned int)

#### 7.32.3.12 virtual void LLGL::RenderContext::DrawInstanced ( unsigned int *numVertices*, unsigned int *firstVertex*, unsigned int *numInstances*, unsigned int *instanceOffset* ) `[pure virtual]`

Draws the specified amount of instances of primitives from the currently set vertex buffer.

**Parameters**

| | | |
|---|---|---|
| in | *numVertices* | Specifies the number of vertices to generate. |
| in | *firstVertex* | Specifies the zero-based offset of the first vertex from the vertex buffer. |
| in | *numInstances* | Specifies the number of instances to generate. |
| in | *instanceOffset* | Specifies the zero-based instance offset which is added to each instance ID. |

#### 7.32.3.13 virtual void LLGL::RenderContext::EndQuery ( Query & *query* ) `[pure virtual]`

Ends the specified query.

**See also**

RenderSystem::CreateQuery
BeginQuery
QueryResult

#### 7.32.3.14 virtual void LLGL::RenderContext::EndRenderCondition ( ) `[pure virtual]`

Ends the current render condition.

**See also**

BeginRenderCondition

#### 7.32.3.15 const VideoModeDescriptor& LLGL::RenderContext::GetVideoMode ( ) const [inline]

Returns the video mode for this render context.

#### 7.32.3.16 Window& LLGL::RenderContext::GetWindow ( ) const [inline]

Returns the window which is used to draw all content.

#### 7.32.3.17 virtual void∗ LLGL::RenderContext::MapBuffer ( Buffer & *buffer*, const BufferCPUAccess *access* ) [pure virtual]

Maps the specified buffer from GPU to CPU memory space.

**Parameters**

| | | |
|---|---|---|
| in | *buffer* | Specifies the buffer which is to be mapped. |
| in | *access* | Specifies the CPU buffer access requirement, i.e. if the CPU can read and/or write the mapped memory. |

**Returns**

Raw pointer to the mapped memory block. You should be aware of the storage buffer size, to not cause memory violations.

**See also**

UnmapBuffer

#### 7.32.3.18 RenderContext& LLGL::RenderContext::operator= ( const RenderContext & ) [delete]

#### 7.32.3.19 virtual void LLGL::RenderContext::Present ( ) [pure virtual]

Presents the current frame on the screen.

#### 7.32.3.20 virtual bool LLGL::RenderContext::QueryResult ( Query & *query*, std::uint64_t & *result* ) [pure virtual]

Queries the result of the specified Query object.

**Parameters**

| | | |
|---|---|---|
| in,out | *query* | Specifies the Query object whose result is to be queried. |
| out | *result* | Specifies the output result. |

**Returns**

True if the result is available, otherwise false in which case 'result' is not modified.

#### 7.32.3.21 virtual void LLGL::RenderContext::SetClearColor ( const ColorRGBAf & *color* ) [pure virtual]

Sets the new value to clear the color buffer. By default black (0, 0, 0, 0).

#### 7.32.3.22 virtual void LLGL::RenderContext::SetClearDepth ( float *depth* ) [pure virtual]

Sets the new value to clear the depth buffer with. By default 1.0.

#### 7.32.3.23 virtual void LLGL::RenderContext::SetClearStencil ( int *stencil* ) [pure virtual]

Sets the new value to clear the stencil buffer. By default 0.

#### 7.32.3.24 virtual void LLGL::RenderContext::SetComputePipeline ( ComputePipeline & *computePipeline* ) [pure virtual]

Sets the active compute pipeline state.

**Parameters**

| | | |
|---|---|---|
| in | *computePipeline* | Specifies the compuite pipeline state to set. |

**Remarks**

This will set the compute shader states. A valid compute pipeline must always be set before any compute operation can be performed.

**See also**

RenderSystem::CreateComputePipeline

#### 7.32.3.25 virtual void LLGL::RenderContext::SetConstantBuffer ( Buffer & *buffer*, unsigned int *slot*, long *shaderStageFlags* = ShaderStageFlags::AllStages ) [pure virtual]

Sets the active constant buffer of the specified slot index for subsequent drawing and compute operations.

**Parameters**

| | | |
|---|---|---|
| in | *buffer* | Specifies the constant buffer to set. This must not be an unspecified constant buffer, i.e. it must be initialized with either the initial data in the "RenderSystem::CreateBuffer" function or with the "RenderSystem::WriteBuffer" function. |
| in | *slot* | Specifies the slot index where to put the constant buffer. |
| in | *shaderStageFlags* | Specifies at which shader stages the constant buffer is to be set. By default all shader stages are affected. |

**See also**

RenderSystem::WriteBuffer
ShaderStageFlags

#### 7.32.3.26 virtual void LLGL::RenderContext::SetGraphicsAPIDependentState ( const **GraphicsAPIDependentState↩ Descriptor** & *state* ) `[pure virtual]`

Sets a few low-level graphics API dependent states.

**Remarks**

This is mainly used to work around uniform render target behavior between different low-level graphics APIs such as OpenGL and Direct3D.

#### 7.32.3.27 virtual void LLGL::RenderContext::SetGraphicsPipeline ( **GraphicsPipeline** & *graphicsPipeline* ) `[pure virtual]`

Sets the active graphics pipeline state.

**Parameters**

| | | |
|---|---|---|
| `in` | *graphicsPipeline* | Specifies the graphics pipeline state to set. |

**Remarks**

This will set all blending-, rasterizer-, depth-, stencil-, and shader states. A valid graphics pipeline must always be set before any drawing operation can be performed.

**See also**

RenderSystem::CreateGraphicsPipeline

#### 7.32.3.28 virtual void LLGL::RenderContext::SetIndexBuffer ( **Buffer** & *buffer* ) `[pure virtual]`

Sets the active index buffer for subsequent drawing operations.

**Parameters**

| | | |
|---|---|---|
| `in` | *buffer* | Specifies the index buffer to set. This must not be an unspecified index buffer, i.e. it must be initialized with either the initial data in the "RenderSystem::CreateBuffer" function or with the "RenderSystem::WriteBuffer" function. |

**Remarks**

An active index buffer is only required for any "DrawIndexed" or "DrawIndexedInstanced" draw call.

**See also**

RenderSystem::WriteIndexBuffer

#### 7.32.3.29 virtual void LLGL::RenderContext::SetRenderTarget ( **RenderTarget** & *renderTarget* ) `[pure virtual]`

Sets the active render target.

**Parameters**

| | | |
|---|---|---|
| `in` | *renderTarget* | Specifies the render target to set. |

**Remarks**

Subsequent drawing operations will be rendered into the textures that are attached to the specified render target.

**Note**

If the specified render-target has not the same resolution as this render context, the viewports and scissor rectangles may be invalidated!

**See also**

UnsetRenderTarget

#### 7.32.3.30 virtual void LLGL::RenderContext::SetSampler ( **Sampler** & *sampler,* unsigned int *slot,* long *shaderStageFlags* = **ShaderStageFlags::AllStages** ) `[pure virtual]`

Sets the active sampler of the specified slot index for subsequent drawing and compute operations.

**Parameters**

| | | |
|---|---|---|
| `in` | *sampler* | Specifies the sampler to set. |
| `in` | *slot* | Specifies the slot index where to put the sampler. |

**See also**

RenderSystem::CreateSampler

#### 7.32.3.31 virtual void LLGL::RenderContext::SetScissor ( const **Scissor** & *scissor* ) `[pure virtual]`

Sets a single scissor rectangle.

**Remarks**

Similar to SetScissorArray but only a single scissor rectangle is set.

**See also**

SetScissorArray

#### 7.32.3.32 virtual void LLGL::RenderContext::SetScissorArray ( const std::vector< Scissor > & *scissors* ) [pure virtual]

Sets the specified scissor rectangles.

**Parameters**

| | | |
|---|---|---|
| in | *scissors* | Specifies the list of scissor rectangles. |

**Remarks**

This function behaves differently on the OpenGL render system, depending on the state configured with the "SetGraphicsAPIDependentState" function. If 'stateOpenGL.screenSpaceOriginLowerLeft' is false, the origin of each scissor rectangle is on the upper-left (like for all other render systems). If 'stateOpenGL.screen←SpaceOriginLowerLeft' is true, the origin of each scissor rectangle is on the lower-left.

**See also**

SetGraphicsAPIDependentState

#### 7.32.3.33 virtual void LLGL::RenderContext::SetStorageBuffer ( Buffer & *buffer,* unsigned int *slot* ) [pure virtual]

Sets the active storage buffer of the specified slot index for subsequent drawing and compute operations.

**Parameters**

| | | |
|---|---|---|
| in | *storageBuffer* | Specifies the storage buffer to set. This must not be an unspecified storage buffer, i.e. it must be initialized with either the initial data in the "RenderSystem::CreateStorageBuffer" function or with the "RenderSystem::WriteStorageBuffer" function. |
| in | *slot* | Specifies the slot index where to put the storage buffer. |

**See also**

RenderSystem::WriteStorageBuffer

#### 7.32.3.34 virtual void LLGL::RenderContext::SetTexture ( Texture & *texture,* unsigned int *slot,* long *shaderStageFlags* = ShaderStageFlags::AllStages ) [pure virtual]

Sets the active texture of the specified slot index for subsequent drawing and compute operations.

**Parameters**

| | | |
|---|---|---|
| in | *texture* | Specifies the texture to set. |
| in | *slot* | Specifies the slot index where to put the texture. |

#### 7.32.3.35 virtual void LLGL::RenderContext::SetVertexBuffer ( Buffer & *buffer* ) [pure virtual]

Sets the specified vertex buffer for subsequent drawing operations.

**Parameters**

| | | |
|---|---|---|
| in | *buffer* | Specifies the vertex buffer to set. This must not be an unspecified vertex buffer, i.e. it must be initialized with either the initial data in the "RenderSystem::CreateBuffer" function or with the "RenderSystem::WriteBuffer" function. |

**See also**

RenderSystem::WriteBuffer

#### 7.32.3.36 virtual void LLGL::RenderContext::SetVideoMode ( const VideoModeDescriptor & *videoModeDesc* ) [virtual]

Sets the new video mode for this render context.

**Remarks**

This may invalidate the currently set render target.

**See also**

SetRenderTarget

#### 7.32.3.37 virtual void LLGL::RenderContext::SetViewport ( const Viewport & *viewport* ) [pure virtual]

Sets a single viewport.

**Remarks**

Similar to SetViewportArray but only a single viewport is set.

**See also**

SetViewportArray

#### 7.32.3.38 virtual void LLGL::RenderContext::SetViewportArray ( const std::vector< Viewport > & *viewports* ) [pure virtual]

Sets the array of viewports.

**Parameters**

| | | |
|---|---|---|
| in | *viewports* | Specifies the array of viewports. |

**Remarks**

This function behaves differently on the OpenGL render system, depending on the state configured with the "SetGraphicsAPIDependentState" function. If 'stateOpenGL.screenSpaceOriginLowerLeft' is false, the origin of each viewport is on the upper-left (like for all other render systems). If 'stateOpenGL.screenSpaceOrigin↩LowerLeft' is true, the origin of each viewport is on the lower-left.

**See also**

SetGraphicsAPIDependentState

#### 7.32.3.39 virtual void LLGL::RenderContext::SetVsync ( const VsyncDescriptor & *vsyncDesc* ) [pure virtual]

Sets the new vertical-sychronization (Vsync) configuration for this render context.

#### 7.32.3.40 void LLGL::RenderContext::SetWindow ( const std::shared_ptr< Window > & *window,* VideoModeDescriptor & *videoModeDesc,* const void ∗ *windowContext* ) [protected]

#### 7.32.3.41 void LLGL::RenderContext::ShareWindowAndVideoMode ( RenderContext & *other* ) [protected]

Shares the window and video mode with another render context.

**Note**

This is only used by the renderer debug layer.

#### 7.32.3.42 virtual void LLGL::RenderContext::SyncGPU ( ) [pure virtual]

Synchronizes the GPU, i.e. waits until the GPU has completed all pending commands.

#### 7.32.3.43 virtual void LLGL::RenderContext::UnmapBuffer ( Buffer & *buffer* ) [pure virtual]

Unmaps the specified buffer.

**See also**

MapBuffer

#### 7.32.3.44 virtual void LLGL::RenderContext::UnsetRenderTarget ( ) [pure virtual]

Unsets the previously set render target.

**Remarks**

Subsequent drawing operations will be rendered into the main framebuffer, which can then be presented onto the screen.

**See also**

SetRenderTarget

The documentation for this class was generated from the following file:

- RenderContext.h

## 7.33 LLGL::RenderContextDescriptor Struct Reference

```
#include <RenderContextDescriptor.h>
```

### Public Attributes

- VsyncDescriptor vsync
  *Vertical-synchronization (Vsync) descriptor.*
- AntiAliasingDescriptor antiAliasing
  *Multi-sample anti-aliasing descriptor.*
- VideoModeDescriptor videoMode
  *Video mode descriptor.*
- ProfileOpenGLDescriptor profileOpenGL
  *OpenGL profile descriptor (to switch between compatability or core profile).*
- DebugCallback debugCallback
  *Debuging callback descriptor.*

### 7.33.1 Member Data Documentation

#### 7.33.1.1 AntiAliasingDescriptor LLGL::RenderContextDescriptor::antiAliasing

Multi-sample anti-aliasing descriptor.

#### 7.33.1.2 DebugCallback LLGL::RenderContextDescriptor::debugCallback

Debuging callback descriptor.

#### 7.33.1.3 ProfileOpenGLDescriptor LLGL::RenderContextDescriptor::profileOpenGL

OpenGL profile descriptor (to switch between compatability or core profile).

#### 7.33.1.4 VideoModeDescriptor LLGL::RenderContextDescriptor::videoMode

Video mode descriptor.

#### 7.33.1.5 VsyncDescriptor LLGL::RenderContextDescriptor::vsync

Vertical-synchronization (Vsync) descriptor.

The documentation for this struct was generated from the following file:

- RenderContextDescriptor.h

## 7.34 LLGL::RendererID Struct Reference

Renderer identification number enumeration.

```
#include <RenderSystemFlags.h>
```

### Static Public Attributes

- static const unsigned int OpenGL = 0x00000001

  *ID number for the OpenGL renderer.*
- static const unsigned int Direct3D11 = 0x00000002

  *ID number for the Direct3D 11 renderer.*
- static const unsigned int Direct3D12 = 0x00000003

  *ID number for the Direct3D 12 renderer.*
- static const unsigned int Vulkan = 0x00000004

  *ID number for the Vulkan renderer.*

### 7.34.1 Detailed Description

Renderer identification number enumeration.

**See also**

RendererInfo::rendererID

### 7.34.2 Member Data Documentation

#### 7.34.2.1 const unsigned int LLGL::RendererID::Direct3D11 = 0x00000002 [static]

ID number for the Direct3D 11 renderer.

#### 7.34.2.2 const unsigned int LLGL::RendererID::Direct3D12 = 0x00000003 `[static]`

ID number for the Direct3D 12 renderer.

#### 7.34.2.3 const unsigned int LLGL::RendererID::OpenGL = 0x00000001 `[static]`

ID number for the OpenGL renderer.

#### 7.34.2.4 const unsigned int LLGL::RendererID::Vulkan = 0x00000004 `[static]`

ID number for the Vulkan renderer.

The documentation for this struct was generated from the following file:

- RenderSystemFlags.h

## 7.35 LLGL::RendererInfo Struct Reference

Renderer basic information structure.

`#include <RenderSystemFlags.h>`

### Public Attributes

- std::string rendererName

  *Rendering API name and version (e.g. "OpenGL 4.5.0").*
- std::string deviceName

  *Renderer device name (e.g. "GeForce GTX 1070/PCIe/SSE2").*
- std::string vendorName

  *Vendor name of the renderer device (e.g. "NVIDIA Corporation").*
- std::string shadingLanguageName

  *Shading language version (e.g. "GLSL 4.50").*
- unsigned int rendererID = 0

  *Rendering API identification number.*

### 7.35.1 Detailed Description

Renderer basic information structure.

### 7.35.2 Member Data Documentation

#### 7.35.2.1 std::string LLGL::RendererInfo::deviceName

Renderer device name (e.g. "GeForce GTX 1070/PCIe/SSE2").

#### 7.35.2.2 unsigned int LLGL::RendererInfo::rendererID = 0

Rendering API identification number.

**Remarks**

This can be value of the RendererID entries. Since the render system is modular, a new render system can use its own ID number.

**See also**

RendererID

#### 7.35.2.3 std::string LLGL::RendererInfo::rendererName

Rendering API name and version (e.g. "OpenGL 4.5.0").

#### 7.35.2.4 std::string LLGL::RendererInfo::shadingLanguageName

Shading language version (e.g. "GLSL 4.50").

#### 7.35.2.5 std::string LLGL::RendererInfo::vendorName

Vendor name of the renderer device (e.g. "NVIDIA Corporation").

The documentation for this struct was generated from the following file:

- RenderSystemFlags.h

## 7.36 LLGL::RenderingCaps Struct Reference

Rendering capabilities structure.

```
#include <RenderSystemFlags.h>
```

## Public Attributes

- ScreenOrigin screenOrigin = ScreenOrigin::UpperLeft

  *Screen coordinate system origin.*
- ClippingRange clippingRange = ClippingRange::ZeroToOne

  *Clipping depth range.*
- ShadingLanguage shadingLanguage = ShadingLanguage::Unsupported

  *Latest suppported shading language.*
- bool hasRenderTargets = false

  *Specifies whether render targets (also "frame buffer objects") are supported.*
- bool has3DTextures = false

  *Specifies whether 3D textures are supported.*
- bool hasCubeTextures = false

  *Specifies whether cube textures are supported.*
- bool hasTextureArrays = false

  *Specifies whether 1D- and 2D array textures are supported.*
- bool hasCubeTextureArrays = false

  *Specifies whether cube array textures are supported.*
- bool hasSamplers = false

  *Specifies whether samplers are supported.*
- bool hasConstantBuffers = false

  *Specifies whether constant buffers (also "uniform buffer objects") are supported.*
- bool hasStorageBuffers = false

  *Specifies whether storage buffers (also "read/write buffers") are supported.*
- bool hasUniforms = false

  *Specifies whether individual shader uniforms are supported (typically only for OpenGL 2.0+).*
- bool hasGeometryShaders = false

  *Specifies whether geometry shaders are supported.*
- bool hasTessellationShaders = false

  *Specifies whether tessellation shaders are supported.*
- bool hasComputeShaders = false

  *Speciifes whether compute shaders are supported.*
- bool hasInstancing = false

  *Specifies whether hardware instancing is supported.*
- bool hasOffsetInstancing = false

  *Specifies whether hardware instancing with instance offsets is supported.*
- bool hasViewportArrays = false

  *Specifies whether multiple viewports, depth-ranges, and scissors are supported at once.*
- bool hasConservativeRasterization = false

  *Specifies whether conservative rasterization is supported.*
- unsigned int maxNumTextureArrayLayers = 0

  *Specifies maximum number of texture array layers (for 1D-, 2D-, and cube textures).*
- unsigned int maxNumRenderTargetAttachments = 0

  *Specifies maximum number of attachment points for each render target.*
- unsigned int maxConstantBufferSize = 0

  *Specifies maximum size (in bytes) of each constant buffer.*
- int maxPatchVertices = 0

  *Specifies maximum number of patch control points.*
- int max1DTextureSize = 0

  *Specifies maximum size of each 1D texture.*
- int max2DTextureSize = 0

*Specifies maximum size of each 2D texture (for width and height).*
- int max3DTextureSize = 0

  *Specifies maximum size of each 3D texture (for width, height, and depth).*
- int maxCubeTextureSize = 0

  *Specifies maximum size of each cube texture (for width and height).*
- int maxAnisotropy = 0

  *Specifies maximum anisotropy texture filter.*
- Gs::Vector3ui maxNumComputeShaderWorkGroups

  *Specifies maximum number of work groups in a compute shader.*
- Gs::Vector3ui maxComputeShaderWorkGroupSize

  *Specifies maximum work group size in a compute shader.*

## 7.36.1 Detailed Description

Rendering capabilities structure.

## 7.36.2 Member Data Documentation

### 7.36.2.1 ClippingRange LLGL::RenderingCaps::clippingRange = ClippingRange::ZeroToOne

Clipping depth range.

### 7.36.2.2 bool LLGL::RenderingCaps::has3DTextures = false

Specifies whether 3D textures are supported.

### 7.36.2.3 bool LLGL::RenderingCaps::hasComputeShaders = false

Speciifes whether compute shaders are supported.

### 7.36.2.4 bool LLGL::RenderingCaps::hasConservativeRasterization = false

Specifies whether conservative rasterization is supported.

### 7.36.2.5 bool LLGL::RenderingCaps::hasConstantBuffers = false

Specifies whether constant buffers (also "uniform buffer objects") are supported.

### 7.36.2.6 bool LLGL::RenderingCaps::hasCubeTextureArrays = false

Specifies whether cube array textures are supported.

#### 7.36.2.7 bool LLGL::RenderingCaps::hasCubeTextures = false

Specifies whether cube textures are supported.

#### 7.36.2.8 bool LLGL::RenderingCaps::hasGeometryShaders = false

Specifies whether geometry shaders are supported.

#### 7.36.2.9 bool LLGL::RenderingCaps::hasInstancing = false

Specifies whether hardware instancing is supported.

#### 7.36.2.10 bool LLGL::RenderingCaps::hasOffsetInstancing = false

Specifies whether hardware instancing with instance offsets is supported.

#### 7.36.2.11 bool LLGL::RenderingCaps::hasRenderTargets = false

Specifies whether render targets (also "frame buffer objects") are supported.

#### 7.36.2.12 bool LLGL::RenderingCaps::hasSamplers = false

Specifies whether samplers are supported.

#### 7.36.2.13 bool LLGL::RenderingCaps::hasStorageBuffers = false

Specifies whether storage buffers (also "read/write buffers") are supported.

#### 7.36.2.14 bool LLGL::RenderingCaps::hasTessellationShaders = false

Specifies whether tessellation shaders are supported.

#### 7.36.2.15 bool LLGL::RenderingCaps::hasTextureArrays = false

Specifies whether 1D- and 2D array textures are supported.

#### 7.36.2.16 bool LLGL::RenderingCaps::hasUniforms = false

Specifies whether individual shader uniforms are supported (typically only for OpenGL 2.0+).

#### 7.36.2.17 bool LLGL::RenderingCaps::hasViewportArrays = false

Specifies whether multiple viewports, depth-ranges, and scissors are supported at once.

#### 7.36.2.18 int LLGL::RenderingCaps::max1DTextureSize = 0

Specifies maximum size of each 1D texture.

#### 7.36.2.19 int LLGL::RenderingCaps::max2DTextureSize = 0

Specifies maximum size of each 2D texture (for width and height).

#### 7.36.2.20 int LLGL::RenderingCaps::max3DTextureSize = 0

Specifies maximum size of each 3D texture (for width, height, and depth).

#### 7.36.2.21 int LLGL::RenderingCaps::maxAnisotropy = 0

Specifies maximum anisotropy texture filter.

#### 7.36.2.22 Gs::Vector3ui LLGL::RenderingCaps::maxComputeShaderWorkGroupSize

Specifies maximum work group size in a compute shader.

#### 7.36.2.23 unsigned int LLGL::RenderingCaps::maxConstantBufferSize = 0

Specifies maximum size (in bytes) of each constant buffer.

#### 7.36.2.24 int LLGL::RenderingCaps::maxCubeTextureSize = 0

Specifies maximum size of each cube texture (for width and height).

#### 7.36.2.25 Gs::Vector3ui LLGL::RenderingCaps::maxNumComputeShaderWorkGroups

Specifies maximum number of work groups in a compute shader.

#### 7.36.2.26 unsigned int LLGL::RenderingCaps::maxNumRenderTargetAttachments = 0

Specifies maximum number of attachment points for each render target.

#### 7.36.2.27 unsigned int LLGL::RenderingCaps::maxNumTextureArrayLayers = 0

Specifies maximum number of texture array layers (for 1D-, 2D-, and cube textures).

#### 7.36.2.28 int LLGL::RenderingCaps::maxPatchVertices = 0

Specifies maximum number of patch control points.

#### 7.36.2.29 ScreenOrigin LLGL::RenderingCaps::screenOrigin = ScreenOrigin::UpperLeft

Screen coordinate system origin.

**Remarks**

This determines the coordinate space of viewports, scissors, and framebuffers.

#### 7.36.2.30 ShadingLanguage LLGL::RenderingCaps::shadingLanguage = ShadingLanguage::Unsupported

Latest suppported shading language.

The documentation for this struct was generated from the following file:

- RenderSystemFlags.h

## 7.37 LLGL::RenderingDebugger Class Reference

Rendering debugger interface.

`#include <RenderingDebugger.h>`

### Classes

- class Message
  *Rendering debugger message class.*

### Public Member Functions

- virtual ∼RenderingDebugger ()
- void PostError (ErrorType type, const std::string &message, const std::string &source)
  *Posts an error message.*
- void PostWarning (WarningType type, const std::string &message, const std::string &source)
  *Posts a warning message.*

### Protected Member Functions

- RenderingDebugger ()=default
- virtual void OnError (ErrorType type, Message &message)
- virtual void OnWarning (WarningType type, Message &message)

## 7.37.1 Detailed Description

Rendering debugger interface.

**Remarks**

This can be used to profile the renderer draw calls and buffer updates.

## 7.37.2 Constructor & Destructor Documentation

#### 7.37.2.1 virtual LLGL::RenderingDebugger::∼RenderingDebugger ( ) `[virtual]`

#### 7.37.2.2 LLGL::RenderingDebugger::RenderingDebugger ( ) `[protected]`, `[default]`

## 7.37.3 Member Function Documentation

#### 7.37.3.1 virtual void LLGL::RenderingDebugger::OnError ( **ErrorType** *type*, **Message** & *message* ) `[protected]`, `[virtual]`

#### 7.37.3.2 virtual void LLGL::RenderingDebugger::OnWarning ( **WarningType** *type*, **Message** & *message* ) `[protected]`, `[virtual]`

#### 7.37.3.3 void LLGL::RenderingDebugger::PostError ( **ErrorType** *type*, const std::string & *message*, const std::string & *source* )

Posts an error message.

**Parameters**

| | | |
|---|---|---|
| `in` | *type* | Specifies the type of error. |
| `in` | *message* | Specifies the string which describes the failure. |
| `in` | *source* | Specifies the string which describes the source (typically the function where the failure happend). |

#### 7.37.3.4 void LLGL::RenderingDebugger::PostWarning ( **WarningType** *type*, const std::string & *message*, const std::string & *source* )

Posts a warning message.

**Parameters**

| | | |
|---|---|---|
| in | *type* | Specifies the type of error. |
| in | *message* | Specifies the string which describes the warning. |
| in | *source* | Specifies the string which describes the source (typically the function where the failure happend). |

The documentation for this class was generated from the following file:

- RenderingDebugger.h

## 7.38 LLGL::RenderingProfiler Class Reference

Rendering profiler model class.

`#include <RenderingProfiler.h>`

### Classes

- class Counter

### Public Member Functions

- void ResetCounters ()

  *Resets all counters.*
- void RecordDrawCall (const PrimitiveTopology topology, Counter::ValueType numVertices)
- void RecordDrawCall (const PrimitiveTopology topology, Counter::ValueType numVertices, Counter::Value↩ Type numInstances)

### Public Attributes

- Counter writeVertexBuffer
- Counter writeIndexBuffer
- Counter writeConstantBuffer
- Counter writeStorageBuffer
- Counter mapConstantBuffer
- Counter mapStorageBuffer
- Counter setVertexBuffer
- Counter setIndexBuffer
- Counter setConstantBuffer
- Counter setStorageBuffer
- Counter setGraphicsPipeline
- Counter setComputePipeline
- Counter setTexture
- Counter setSampler
- Counter setRenderTarget
- Counter drawCalls
- Counter dispatchComputeCalls
- Counter renderedPoints
- Counter renderedLines
- Counter renderedTriangles
- Counter renderedPatches

### 7.38.1 Detailed Description

Rendering profiler model class.

**Remarks**

This can be used to profile the renderer draw calls and buffer updates.

### 7.38.2 Member Function Documentation

#### 7.38.2.1 void LLGL::RenderingProfiler::RecordDrawCall ( const PrimitiveTopology *topology,* Counter::ValueType *numVertices* )

#### 7.38.2.2 void LLGL::RenderingProfiler::RecordDrawCall ( const PrimitiveTopology *topology,* Counter::ValueType *numVertices,* Counter::ValueType *numInstances* )

#### 7.38.2.3 void LLGL::RenderingProfiler::ResetCounters ( )

Resets all counters.

**See also**

Counter::Reset

### 7.38.3 Member Data Documentation

#### 7.38.3.1 Counter LLGL::RenderingProfiler::dispatchComputeCalls

#### 7.38.3.2 Counter LLGL::RenderingProfiler::drawCalls

#### 7.38.3.3 Counter LLGL::RenderingProfiler::mapConstantBuffer

#### 7.38.3.4 Counter LLGL::RenderingProfiler::mapStorageBuffer

#### 7.38.3.5 Counter LLGL::RenderingProfiler::renderedLines

#### 7.38.3.6 Counter LLGL::RenderingProfiler::renderedPatches

#### 7.38.3.7 Counter LLGL::RenderingProfiler::renderedPoints

#### 7.38.3.8 Counter LLGL::RenderingProfiler::renderedTriangles

#### 7.38.3.9 Counter LLGL::RenderingProfiler::setComputePipeline

#### 7.38.3.10 Counter LLGL::RenderingProfiler::setConstantBuffer

#### 7.38.3.11 Counter LLGL::RenderingProfiler::setGraphicsPipeline

#### 7.38.3.12 Counter LLGL::RenderingProfiler::setIndexBuffer

#### 7.38.3.13 Counter LLGL::RenderingProfiler::setRenderTarget

#### 7.38.3.14 Counter LLGL::RenderingProfiler::setSampler

#### 7.38.3.15 Counter LLGL::RenderingProfiler::setStorageBuffer

#### 7.38.3.16 Counter LLGL::RenderingProfiler::setTexture

#### 7.38.3.17 Counter LLGL::RenderingProfiler::setVertexBuffer

#### 7.38.3.18 Counter LLGL::RenderingProfiler::writeConstantBuffer

#### 7.38.3.19 Counter LLGL::RenderingProfiler::writeIndexBuffer

#### 7.38.3.20 Counter LLGL::RenderingProfiler::writeStorageBuffer

#### 7.38.3.21 Counter LLGL::RenderingProfiler::writeVertexBuffer

The documentation for this class was generated from the following file:

- RenderingProfiler.h

## 7.39 LLGL::RenderSystem Class Reference

Render system interface.

```
#include <RenderSystem.h>
```

### Public Member Functions

- RenderSystem (const RenderSystem &)=delete
- RenderSystem & operator= (const RenderSystem &)=delete
- virtual ∼RenderSystem ()
- const std::string & GetName () const

  *Returns the name of this render system.*
- const RendererInfo & GetRendererInfo () const

  *Returns basic renderer information.*
- const RenderingCaps & GetRenderingCaps () const

  *Returns the rendering capabilities.*
- virtual void SetConfiguration (const RenderSystemConfiguration &config)

  *Sets the basic configuration.*
- const RenderSystemConfiguration & GetConfiguration () const

*Returns the basic configuration.*

- virtual RenderContext ∗ CreateRenderContext (const RenderContextDescriptor &desc, const std::shared_↩ ptr< Window > &window=nullptr)=0

  *Creates a new render context and returns the raw pointer.*
- virtual void Release (RenderContext &renderContext)=0

  *Releases the specified render context. This will all release all resources, that are associated with this render context.*
- bool MakeCurrent (RenderContext ∗renderContext)

  *Makes the specified render context to the current one.*
- RenderContext ∗ GetCurrentContext () const

  *Returns the current render context. This may also be null.*
- virtual Buffer ∗ CreateBuffer (const BufferDescriptor &desc, const void ∗initialData=nullptr)=0

  *Creates a new generic hardware buffer.*
- virtual void Release (Buffer &buffer)=0

  *Releases the specified buffer object.*
- virtual void WriteBuffer (Buffer &buffer, const void ∗data, std::size_t dataSize, std::size_t offset)=0

  *Updates the data of the specified buffer.*
- virtual Texture ∗ CreateTexture (const TextureDescriptor &textureDesc, const ImageDescriptor ∗image↩ Desc=nullptr)=0

  *Creates a new texture.*
- virtual void Release (Texture &texture)=0
- virtual TextureDescriptor QueryTextureDescriptor (const Texture &texture)=0

  *Queries a descriptor of the specified texture.*
- virtual void WriteTexture (Texture &texture, const SubTextureDescriptor &subTextureDesc, const Image↩ Descriptor &imageDesc)=0

  *Updates the image data of the specified texture.*
- virtual void ReadTexture (const Texture &texture, int mipLevel, ImageFormat imageFormat, DataType data↩ Type, void ∗buffer)=0

  *Reads the image data from the specified texture.*
- virtual void GenerateMips (Texture &texture)=0

  *Generates the MIP ("Multum in Parvo") maps for the specified texture.*
- virtual Sampler ∗ CreateSampler (const SamplerDescriptor &desc)=0

  *Creates a new Sampler object.*
- virtual void Release (Sampler &sampler)=0

  *Releases the specified Sampler object. After this call, the specified object must no longer be used.*
- virtual RenderTarget ∗ CreateRenderTarget (unsigned int multiSamples=0)=0

  *Creates a new RenderTarget object with the specified number of samples.*
- virtual void Release (RenderTarget &renderTarget)=0

  *Releases the specified RenderTarget object. After this call, the specified object must no longer be used.*
- virtual Shader ∗ CreateShader (const ShaderType type)=0

  *Creates a new and empty shader.*
- virtual ShaderProgram ∗ CreateShaderProgram ()=0

  *Creates a new and empty shader program.*
- virtual void Release (Shader &shader)=0
- virtual void Release (ShaderProgram &shaderProgram)=0
- virtual GraphicsPipeline ∗ CreateGraphicsPipeline (const GraphicsPipelineDescriptor &desc)=0

  *Creates a new and initialized graphics pipeline state object.*
- virtual ComputePipeline ∗ CreateComputePipeline (const ComputePipelineDescriptor &desc)=0

  *Creates a new and initialized compute pipeline state object.*
- virtual void Release (GraphicsPipeline &graphicsPipeline)=0
- virtual void Release (ComputePipeline &computePipeline)=0
- virtual Query ∗ CreateQuery (const QueryDescriptor &desc)=0

  *Creates a new query.*
- virtual void Release (Query &query)=0

## Static Public Member Functions

- static std::vector< std::string > FindModules ()

  *Returns the list of all available render system modules for the current platform (e.g. on Windows this might be { "OpenGL", "Direct3D11", "Direct3D12" }, but on MacOS it might be only { "OpenGL" }).*
- static std::shared_ptr< RenderSystem > Load (const std::string &moduleName, RenderingProfiler ∗profiler=nullptr, RenderingDebugger ∗debugger=nullptr)

  *Loads a new render system from the specified module.*

## Protected Member Functions

- RenderSystem ()=default
- virtual bool OnMakeCurrent (RenderContext ∗renderContext)

  *Callback when a new render context is about to be made the current one.*
- std::vector< ColorRGBAub > GetDefaultTextureImageRGBAub (int numPixels) const

  *Creates an RGBA unsigned-byte image buffer for the specified number of pixels.*
- void AssertCreateBuffer (const BufferDescriptor &desc)

  *Validates the specified buffer descriptor to be used for buffer creation.*
- void SetRendererInfo (const RendererInfo &info)

  *Sets the renderer information.*
- void SetRenderingCaps (const RenderingCaps &caps)

  *Sets the rendering capabilities.*

## 7.39.1 Detailed Description

Render system interface.

**Remarks**

This is the main interface for the entire renderer. It manages the ownership of all graphics objects and is used to create, modify, and delete all those objects. The main functions for most graphics objects are "Create...", "Write...", and "Release":

```
// Create and initialize vertex buffer
auto vertexBuffer = renderSystem->CreateVertexBuffer(*vertexBuffer, ...);

// Modify data
renderSystem->WriteVertexBuffer(*vertexBuffer, modificationData, ...);

// Release object
renderSystem->Release(*vertexBuffer);
```

## 7.39.2 Constructor & Destructor Documentation

### 7.39.2.1 LLGL::RenderSystem::RenderSystem ( const RenderSystem & ) [delete]

### 7.39.2.2 virtual LLGL::RenderSystem::∼RenderSystem ( ) [virtual]

### 7.39.2.3 LLGL::RenderSystem::RenderSystem ( ) [protected], [default]

## 7.39.3 Member Function Documentation

### 7.39.3.1 void LLGL::RenderSystem::AssertCreateBuffer ( const BufferDescriptor & *desc* ) [protected]

Validates the specified buffer descriptor to be used for buffer creation.

#### 7.39.3.2 virtual Buffer∗ LLGL::RenderSystem::CreateBuffer ( const BufferDescriptor & *desc,* const void ∗ *initialData =* nullptr ) [pure virtual]

Creates a new generic hardware buffer.

**Parameters**

| | | |
|---|---|---|
| in | *desc* | Specifies the vertex buffer descriptor. |
| in | *initialData* | Optional raw pointer to the data with which the buffer is to be initialized. This may also be null, to only initialize the size of the buffer. In this case, the buffer must be initialized with the "WriteBuffer" function before it is used for drawing operations. By default null. |

**See also**

WriteBuffer

#### 7.39.3.3 virtual **ComputePipeline**∗ LLGL::RenderSystem::CreateComputePipeline ( const **ComputePipelineDescriptor** & *desc* ) `[pure virtual]`

Creates a new and initialized compute pipeline state object.

**Parameters**

| | | |
|---|---|---|
| in | *desc* | Specifies the compute pipeline descriptor. This will describe the shader states. The "shaderProgram" member of the descriptor must never be null! |

**See also**

ComputePipelineDescriptor

#### 7.39.3.4 virtual **GraphicsPipeline**∗ LLGL::RenderSystem::CreateGraphicsPipeline ( const **GraphicsPipelineDescriptor** & *desc* ) `[pure virtual]`

Creates a new and initialized graphics pipeline state object.

**Parameters**

| | | |
|---|---|---|
| in | *desc* | Specifies the graphics pipeline descriptor. This will describe the entire pipeline state, i.e. the blending-, rasterizer-, depth-, stencil- and shader states. The "shaderProgram" member of the descriptor must never be null! |

**See also**

GraphicsPipelineDescriptor

#### 7.39.3.5 virtual **Query**∗ LLGL::RenderSystem::CreateQuery ( const **QueryDescriptor** & *desc* ) `[pure virtual]`

Creates a new query.

#### 7.39.3.6 virtual **RenderContext**∗ LLGL::RenderSystem::CreateRenderContext ( const **RenderContextDescriptor** & *desc,* const std::shared_ptr< **Window** > & *window* = `nullptr` ) `[pure virtual]`

Creates a new render context and returns the raw pointer.

**Remarks**

The render system takes the ownership of this object. All render contexts are deleted in the destructor of this render system.

#### 7.39.3.7 virtual **RenderTarget**∗ LLGL::RenderSystem::CreateRenderTarget ( unsigned int *multiSamples* = `0` ) `[pure virtual]`

Creates a new RenderTarget object with the specified number of samples.

**Exceptions**

| | |
|---|---|
| *std::runtime_error* | If the renderer does not support RenderTarget objects (e.g. if OpenGL 2.1 or lower is used). |

#### 7.39.3.8 virtual **Sampler**∗ LLGL::RenderSystem::CreateSampler ( const **SamplerDescriptor** & *desc* ) `[pure virtual]`

Creates a new Sampler object.

**Exceptions**

| | |
|---|---|
| *std::runtime_error* | If the renderer does not support Sampler objects (e.g. if OpenGL 3.1 or lower is used). |

**See also**

RenderContext::QueryRenderingCaps

#### 7.39.3.9 virtual **Shader**∗ LLGL::RenderSystem::CreateShader ( const **ShaderType** *type* ) `[pure virtual]`

Creates a new and empty shader.

**Parameters**

| | | |
|---|---|---|
| `in` | *type* | Specifies the type of the shader, i.e. if it is either a vertex or fragment shader or the like. |

**See also**

Shader

#### 7.39.3.10 virtual **ShaderProgram**∗ LLGL::RenderSystem::CreateShaderProgram ( ) `[pure virtual]`

Creates a new and empty shader program.

**Remarks**

At least one shader must be attached to a shader program to be used for a graphics or compute pipeline.

**See also**

ShaderProgram

#### 7.39.3.11 virtual **Texture**∗ LLGL::RenderSystem::CreateTexture ( const **TextureDescriptor** & *textureDesc*, const **ImageDescriptor** ∗ *imageDesc* = `nullptr` ) `[pure virtual]`

Creates a new texture.

**Parameters**

| | | |
|---|---|---|
| `in` | *textureDesc* | Specifies the texture descriptor. |
| `in` | *imageDesc* | Optional pointer to the image data descriptor. If this is null, the texture will be initialized with the currently configured default image color. If this is non-null, it is used to initialize the texture data. |

**Remarks**

If the texture type of the descriptor is not an array texture the number of layers will be ignored.

**See also**

WriteTexture
RenderSystemConfiguration::defaultImageColor

#### 7.39.3.12 static std::vector<std::string> LLGL::RenderSystem::FindModules ( ) `[static]`

Returns the list of all available render system modules for the current platform (e.g. on Windows this might be { "OpenGL", "Direct3D11", "Direct3D12" }, but on MacOS it might be only { "OpenGL" }).

#### 7.39.3.13 virtual void LLGL::RenderSystem::GenerateMips ( **Texture** & *texture* ) `[pure virtual]`

Generates the MIP ("Multum in Parvo") maps for the specified texture.

**See also**

`https://developer.valvesoftware.com/wiki/MIP_Mapping`

#### 7.39.3.14 const RenderSystemConfiguration& LLGL::RenderSystem::GetConfiguration ( ) const [inline]

Returns the basic configuration.

**See also**

SetConfiguration

#### 7.39.3.15 RenderContext∗ LLGL::RenderSystem::GetCurrentContext ( ) const [inline]

Returns the current render context. This may also be null.

#### 7.39.3.16 std::vector<ColorRGBAub> LLGL::RenderSystem::GetDefaultTextureImageRGBAub ( int *numPixels* ) const [protected]

Creates an RGBA unsigned-byte image buffer for the specified number of pixels.

#### 7.39.3.17 const std::string& LLGL::RenderSystem::GetName ( ) const [inline]

Returns the name of this render system.

#### 7.39.3.18 const RendererInfo& LLGL::RenderSystem::GetRendererInfo ( ) const [inline]

Returns basic renderer information.

**Remarks**

The validity of these information is only guaranteed if this function is called after a valid render context has been created. Otherwise the behavior is undefined!

#### 7.39.3.19 const RenderingCaps& LLGL::RenderSystem::GetRenderingCaps ( ) const [inline]

Returns the rendering capabilities.

**Remarks**

The validity of these information is only guaranteed if this function is called after a valid render context has been created. Otherwise the behavior is undefined!

#### 7.39.3.20 static std::shared_ptr<RenderSystem> LLGL::RenderSystem::Load ( const std::string & *moduleName*, RenderingProfiler ∗ *profiler* = nullptr, RenderingDebugger ∗ *debugger* = nullptr ) [static]

Loads a new render system from the specified module.

**Parameters**

| | | |
|---|---|---|
| in | *moduleName* | Specifies the name from which the new render system is to be loaded. This denotes a dynamic library (∗.dll-files on Windows, ∗.so-files on Unix systems). If compiled in debug mode, the postfix "D" is appended to the module name. Moreover, the platform dependent file extension is always added automatically as well as the prefix "LLGL_", i.e. a module name "OpenGL" will be translated to "LLGL_OpenGLD.dll", if compiled on Windows in Debug mode. |
| in | *profiler* | Optional pointer to a rendering profiler. If this is used, the counters of the profiler must be reset manually. This is only supported if LLGL was compiled with the "LLGL_ENABLE_DEBUG_LAYER" flag. |
| in | *debugger* | Optional pointer to a rendering debugger. This is only supported if LLGL was compiled with the "LLGL_ENABLE_DEBUG_LAYER" flag. |

**Remarks**

Usually the return type is a std::unique_ptr, but LLGL needs to keep track of the existance of this render system because only a single instance can be loaded at a time. So a std::weak_ptr is stored internally to check if it has been expired (see `http://en.cppreference.com/w/cpp/memory/weak_ptr/expired`), and this type can only refer to a std::shared_ptr.

**Exceptions**

| | |
|---|---|
| *std::runtime_error* | If loading the render system from the specified module failed. |
| *std::runtime_error* | If there is already a loaded instance of a render system (make sure there are no more shared pointers references to the previous render system!) |

### 7.39.3.21 bool LLGL::RenderSystem::MakeCurrent ( RenderContext ∗ *renderContext* )

Makes the specified render context to the current one.

**Parameters**

| | | |
|---|---|---|
| in | *renderContext* | Specifies the new current render context. If this is null, no render context is active. |

**Returns**

True on success, otherwise false.

**Remarks**

Never draw anything, while no render context is active!

### 7.39.3.22 virtual bool LLGL::RenderSystem::OnMakeCurrent ( RenderContext ∗ *renderContext* ) [protected], [virtual]

Callback when a new render context is about to be made the current one.

**Remarks**

At this point, "GetCurrentContext" returns still the previous render context.

#### 7.39.3.23 RenderSystem& LLGL::RenderSystem::operator= ( const RenderSystem & ) [delete]

#### 7.39.3.24 virtual TextureDescriptor LLGL::RenderSystem::QueryTextureDescriptor ( const Texture & *texture* ) [pure virtual]

Queries a descriptor of the specified texture.

**Remarks**

This can be used to query the type and dimension size of the texture.

**See also**

TextureDescriptor

#### 7.39.3.25 virtual void LLGL::RenderSystem::ReadTexture ( const Texture & *texture*, int *mipLevel*, ImageFormat *imageFormat*, DataType *dataType*, void * *buffer* ) [pure virtual]

Reads the image data from the specified texture.

**Parameters**

| | | |
|---|---|---|
| in | *texture* | Specifies the texture object to read from. |
| in | *mipLevel* | Specifies the MIP-level from which to read the image data. |
| in | *imageFormat* | Specifies the output image format. |
| in | *dataType* | Specifies the output data type. |
| out | *buffer* | Specifies the output image buffer. This must be a pointer to a memory block, which is large enough to fit all the image data. |

**Remarks**

Depending on the image format, data type, and texture size, the output image container must be allocated with enough memory size. The "QueryTextureDescriptor" function can be used to determine the texture dimensions.

```
std::vector<LLGL::ColorRGBAub> image(textureWidth*textureHeight);
renderSystem->ReadTexture(texture, 0, LLGL::ImageFormat::RGBA,
      LLGL::DataType::UInt8, image.data());
```

**See also**

QueryTextureDescriptor

#### 7.39.3.26 virtual void LLGL::RenderSystem::Release ( RenderContext & *renderContext* ) [pure virtual]

Releases the specified render context. This will all release all resources, that are associated with this render context.

#### 7.39.3.27 virtual void LLGL::RenderSystem::Release ( **Buffer** & *buffer* ) [pure virtual]

Releases the specified buffer object.

#### 7.39.3.28 virtual void LLGL::RenderSystem::Release ( **Texture** & *texture* ) [pure virtual]

#### 7.39.3.29 virtual void LLGL::RenderSystem::Release ( **Sampler** & *sampler* ) [pure virtual]

Releases the specified Sampler object. After this call, the specified object must no longer be used.

#### 7.39.3.30 virtual void LLGL::RenderSystem::Release ( **RenderTarget** & *renderTarget* ) [pure virtual]

Releases the specified RenderTarget object. After this call, the specified object must no longer be used.

#### 7.39.3.31 virtual void LLGL::RenderSystem::Release ( **Shader** & *shader* ) [pure virtual]

#### 7.39.3.32 virtual void LLGL::RenderSystem::Release ( **ShaderProgram** & *shaderProgram* ) [pure virtual]

#### 7.39.3.33 virtual void LLGL::RenderSystem::Release ( **GraphicsPipeline** & *graphicsPipeline* ) [pure virtual]

#### 7.39.3.34 virtual void LLGL::RenderSystem::Release ( **ComputePipeline** & *computePipeline* ) [pure virtual]

#### 7.39.3.35 virtual void LLGL::RenderSystem::Release ( **Query** & *query* ) [pure virtual]

#### 7.39.3.36 virtual void LLGL::RenderSystem::SetConfiguration ( const **RenderSystemConfiguration** & *config* ) [virtual]

Sets the basic configuration.

**Remarks**

This can be used to change the behavior of default initializion of textures for instance.

**See also**

RenderSystemConfiguration

#### 7.39.3.37 void LLGL::RenderSystem::SetRendererInfo ( const **RendererInfo** & *info* ) [protected]

Sets the renderer information.

#### 7.39.3.38 void LLGL::RenderSystem::SetRenderingCaps ( const **RenderingCaps** & *caps* ) [protected]

Sets the rendering capabilities.

#### 7.39.3.39 virtual void LLGL::RenderSystem::WriteBuffer ( **Buffer** & *buffer,* const void ∗ *data,* std::size_t *dataSize,* std::size_t *offset* ) [pure virtual]

Updates the data of the specified buffer.

**Parameters**

| | | |
|---|---|---|
| in | *buffer* | Specifies the buffer whose data is to be updated. |
| in | *data* | Raw pointer to the data with which the buffer is to be updated. This must not be null! |
| in | *dataSize* | Specifies the size (in bytes) of the data block which is to be updated. This must be less then or equal to the size of the buffer. |
| in | *offset* | Specifies the offset (in bytes) at which the buffer is to be updated. This offset plus the data block size (i.e. 'offset + dataSize') must be less than or equal to the size of the buffer. |

#### 7.39.3.40 virtual void LLGL::RenderSystem::WriteTexture ( **Texture** & *texture*, const **SubTextureDescriptor** & *subTextureDesc*, const **ImageDescriptor** & *imageDesc* ) `[pure virtual]`

Updates the image data of the specified texture.

**Parameters**

| | | |
|---|---|---|
| in | *texture* | Specifies the texture whose data is to be updated. |
| in | *subTextureDesc* | Specifies the sub-texture descriptor. |
| in | *imageDesc* | Specifies the image data descriptor. Its "data" member must not be null! |

The documentation for this class was generated from the following file:

- RenderSystem.h

## 7.40 LLGL::RenderSystemConfiguration Struct Reference

Render system configuration structure.

`#include <RenderSystemFlags.h>`

### Public Attributes

- ColorRGBAub defaultImageColor { 0, 0, 0, 0 }

  *Specifies the default color for an uninitialized textures. The default value is black (0, 0, 0, 0).*
- std::size_t threadCount = maxThreadCount

  *Specifies the number of threads that will be used internally by the render system. By default maxThreadCount.*

### 7.40.1 Detailed Description

Render system configuration structure.

### 7.40.2 Member Data Documentation

#### 7.40.2.1 ColorRGBAub LLGL::RenderSystemConfiguration::defaultImageColor { 0, 0, 0, 0 }

Specifies the default color for an uninitialized textures. The default value is black (0, 0, 0, 0).

**Remarks**

This will be used when a texture is created and no initial image data is specified.

#### 7.40.2.2 std::size_t LLGL::RenderSystemConfiguration::threadCount = maxThreadCount

Specifies the number of threads that will be used internally by the render system. By default maxThreadCount.

**Remarks**

This is mainly used by the Direct3D render systems, e.g. inside the "CreateTexture" and "WriteTexture" functions to convert the image data into the respective hardware texture format. OpenGL does this automatically.

**See also**

maxThreadCount

The documentation for this struct was generated from the following file:

- RenderSystemFlags.h

## 7.41 LLGL::RenderTarget Class Reference

Render target interface.

```
#include <RenderTarget.h>
```

### Public Member Functions

- virtual ∼RenderTarget ()
- virtual void AttachDepthBuffer (const Gs::Vector2i &size)=0

  *Attaches an internal depth buffer to this render target.*
- virtual void AttachStencilBuffer (const Gs::Vector2i &size)=0

  *Attaches an internal stencil buffer to this render target.*
- virtual void AttachDepthStencilBuffer (const Gs::Vector2i &size)=0

  *Attaches an internal depth-stencil buffer to this render target.*
- virtual void AttachTexture (Texture &texture, const RenderTargetAttachmentDescriptor &attachmentDesc)=0

  *Attaches the specified texture to this render target.*
- virtual void DetachAll ()=0

  *Detaches all textures and depth-stencil buffers from this render target.*
- const Gs::Vector2i & GetResolution () const

  *Returns the frame buffer resolution.*

## Protected Member Functions

- void ApplyResolution (const Gs::Vector2i &resolution)
- void ApplyMipResolution (Texture &texture, int mipLevel)
- void ResetResolution ()

## 7.41.1 Detailed Description

Render target interface.

**Remarks**

A render target in the broader sense is a composition of Texture objects which can be specified as the destination for drawing operations. After a texture has been attached to a render target, its image content is undefined until something has been rendered into the render target.

## 7.41.2 Constructor & Destructor Documentation

### 7.41.2.1 virtual LLGL::RenderTarget::∼RenderTarget ( ) `[virtual]`

## 7.41.3 Member Function Documentation

### 7.41.3.1 void LLGL::RenderTarget::ApplyMipResolution ( Texture & *texture,* int *mipLevel* ) `[protected]`

### 7.41.3.2 void LLGL::RenderTarget::ApplyResolution ( const Gs::Vector2i & *resolution* ) `[protected]`

### 7.41.3.3 virtual void LLGL::RenderTarget::AttachDepthBuffer ( const Gs::Vector2i & *size* ) `[pure virtual]`

Attaches an internal depth buffer to this render target.

**Parameters**

| | | |
|---|---|---|
| `in` | *size* | Specifies the size of the depth buffer. This must be the same as for all other attachemnts. |

**Remarks**

Only a single depth buffer, stencil buffer, or depth-stencil buffer can be attached.

**See also**

AttachDepthStencilBuffer

### 7.41.3.4 virtual void LLGL::RenderTarget::AttachDepthStencilBuffer ( const Gs::Vector2i & *size* ) `[pure virtual]`

Attaches an internal depth-stencil buffer to this render target.

**Remarks**

Only a single depth buffer, stencil buffer, or depth-stencil buffer can be attached.

**See also**

AttachDepthBuffer

#### 7.41.3.5 virtual void LLGL::RenderTarget::AttachStencilBuffer ( const Gs::Vector2i & *size* ) [pure virtual]

Attaches an internal stencil buffer to this render target.

**Remarks**

Only a single depth buffer, stencil buffer, or depth-stencil buffer can be attached.

**See also**

AttachDepthBuffer

#### 7.41.3.6 virtual void LLGL::RenderTarget::AttachTexture ( Texture & *texture*, const RenderTargetAttachmentDescriptor & *attachmentDesc* ) [pure virtual]

Attaches the specified texture to this render target.

**Parameters**

| | | |
|---|---|---|
| in | *attachmnetDesc* | Specifies the attachment descriptor. Unused members will be ignored, e.g. the 'layer' member is ignored when a non-array texture is passed. |

#### 7.41.3.7 virtual void LLGL::RenderTarget::DetachAll ( ) [pure virtual]

Detaches all textures and depth-stencil buffers from this render target.

#### 7.41.3.8 const Gs::Vector2i& LLGL::RenderTarget::GetResolution ( ) const [inline]

Returns the frame buffer resolution.

**Remarks**

This will be determined by the first texture attachment. Every further attachment must have the same size.

#### 7.41.3.9 void LLGL::RenderTarget::ResetResolution ( ) [protected]

The documentation for this class was generated from the following file:

- RenderTarget.h

## 7.42 LLGL::RenderTargetAttachmentDescriptor Struct Reference

Render target attachment descriptor structure.

```
#include <RenderTarget.h>
```

### Public Attributes

- int mipLevel = 0

  *MIP-map level.*
- int layer = 0

  *Array texture layer.*
- AxisDirection cubeFace = AxisDirection::XPos

  *Cube texture face.*

### 7.42.1 Detailed Description

Render target attachment descriptor structure.

### 7.42.2 Member Data Documentation

#### 7.42.2.1 AxisDirection LLGL::RenderTargetAttachmentDescriptor::cubeFace = AxisDirection::XPos

Cube texture face.

#### 7.42.2.2 int LLGL::RenderTargetAttachmentDescriptor::layer = 0

Array texture layer.

#### 7.42.2.3 int LLGL::RenderTargetAttachmentDescriptor::mipLevel = 0

MIP-map level.

The documentation for this struct was generated from the following file:

- RenderTarget.h

## 7.43 LLGL::Sampler Class Reference

Sampler interface.

```
#include <Sampler.h>
```

### Public Member Functions

- Sampler (const Sampler &)=delete
- Sampler & operator= (const Sampler &)=delete
- virtual ∼Sampler ()

### Protected Member Functions

- Sampler ()=default

### 7.43.1 Detailed Description

Sampler interface.

### 7.43.2 Constructor & Destructor Documentation

#### 7.43.2.1 LLGL::Sampler::Sampler ( const Sampler & ) `[delete]`

#### 7.43.2.2 virtual LLGL::Sampler::∼Sampler ( ) `[inline], [virtual]`

#### 7.43.2.3 LLGL::Sampler::Sampler ( ) `[protected], [default]`

### 7.43.3 Member Function Documentation

#### 7.43.3.1 Sampler& LLGL::Sampler::operator= ( const Sampler & ) `[delete]`

The documentation for this class was generated from the following file:

- Sampler.h

## 7.44 LLGL::SamplerDescriptor Struct Reference

Texture sampler descriptor structure.

`#include <SamplerFlags.h>`

## Public Attributes

- TextureWrap textureWrapU = TextureWrap::Repeat

  *Texture coordinate wrap mode in U direction. By default TextureWrap::Repeat.*
- TextureWrap textureWrapV = TextureWrap::Repeat

  *Texture coordinate wrap mode in V direction. By default TextureWrap::Repeat.*
- TextureWrap textureWrapW = TextureWrap::Repeat

  *Texture coordinate wrap mode in W direction. By default TextureWrap::Repeat.*
- TextureFilter minFilter = TextureFilter::Linear

  *Minification filter. By default TextureFilter::Linear.*
- TextureFilter magFilter = TextureFilter::Linear

  *Magnification filter. By default TextureFilter::Linear.*
- TextureFilter mipMapFilter = TextureFilter::Linear

  *MIP-mapping filter. By default TextureFilter::Linear.*
- bool mipMapping = true

  *Specifies whether MIP-maps are used or not. By default true.*
- float mipMapLODBias = 0.0f

  *MIP-mapping level-of-detail (LOD) bias (or rather offset). By default 0.*
- float minLOD = 0.0f

  *Lower end of the MIP-map range. By default 0.*
- float maxLOD = 1000.0f

  *Upper end of the MIP-map range. Must be greater than or equal to "minLOD". By default 1000.*
- unsigned int maxAnisotropy = 1

  *Maximal anisotropy in the range [1, 16].*
- bool depthCompare = false

  *Specifies whether the compare operation for depth textures is to be used or not. By default false.*
- CompareOp compareOp = CompareOp::Less

  *Compare operation for depth textures. By default CompareOp::Less.*
- ColorRGBAf borderColor = { 0.0f, 0.0f, 0.0f, 0.0f }

  *Border color. By default black (0, 0, 0, 0).*

## 7.44.1 Detailed Description

Texture sampler descriptor structure.

## 7.44.2 Member Data Documentation

### 7.44.2.1 ColorRGBAf LLGL::SamplerDescriptor::borderColor = { 0.0f, 0.0f, 0.0f, 0.0f }

Border color. By default black (0, 0, 0, 0).

### 7.44.2.2 CompareOp LLGL::SamplerDescriptor::compareOp = CompareOp::Less

Compare operation for depth textures. By default CompareOp::Less.

#### 7.44.2.3 bool LLGL::SamplerDescriptor::depthCompare = false

Specifies whether the compare operation for depth textures is to be used or not. By default false.

#### 7.44.2.4 TextureFilter LLGL::SamplerDescriptor::magFilter = TextureFilter::Linear

Magnification filter. By default TextureFilter::Linear.

#### 7.44.2.5 unsigned int LLGL::SamplerDescriptor::maxAnisotropy = 1

Maximal anisotropy in the range [1, 16].

#### 7.44.2.6 float LLGL::SamplerDescriptor::maxLOD = 1000.0f

Upper end of the MIP-map range. Must be greater than or equal to "minLOD". By default 1000.

#### 7.44.2.7 TextureFilter LLGL::SamplerDescriptor::minFilter = TextureFilter::Linear

Minification filter. By default TextureFilter::Linear.

#### 7.44.2.8 float LLGL::SamplerDescriptor::minLOD = 0.0f

Lower end of the MIP-map range. By default 0.

#### 7.44.2.9 TextureFilter LLGL::SamplerDescriptor::mipMapFilter = TextureFilter::Linear

MIP-mapping filter. By default TextureFilter::Linear.

#### 7.44.2.10 float LLGL::SamplerDescriptor::mipMapLODBias = 0.0f

MIP-mapping level-of-detail (LOD) bias (or rather offset). By default 0.

#### 7.44.2.11 bool LLGL::SamplerDescriptor::mipMapping = true

Specifies whether MIP-maps are used or not. By default true.

#### 7.44.2.12 TextureWrap LLGL::SamplerDescriptor::textureWrapU = TextureWrap::Repeat

Texture coordinate wrap mode in U direction. By default TextureWrap::Repeat.

#### 7.44.2.13 TextureWrap LLGL::SamplerDescriptor::textureWrapV = TextureWrap::Repeat

Texture coordinate wrap mode in V direction. By default TextureWrap::Repeat.

#### 7.44.2.14 TextureWrap LLGL::SamplerDescriptor::textureWrapW = TextureWrap::Repeat

Texture coordinate wrap mode in W direction. By default TextureWrap::Repeat.

The documentation for this struct was generated from the following file:

- SamplerFlags.h

## 7.45 LLGL::Scissor Struct Reference

Scissor dimensions.

```
#include <RenderContextFlags.h>
```

### Public Member Functions

- Scissor ()=default
- Scissor (const Scissor &)=default
- Scissor (int x, int y, int width, int height)

### Public Attributes

- int x = 0
- int y = 0
- int width = 0
- int height = 0

### 7.45.1 Detailed Description

Scissor dimensions.

**Remarks**

A scissor is in screen coordinates where the origin is in the left-top corner.

### 7.45.2 Constructor & Destructor Documentation

#### 7.45.2.1 LLGL::Scissor::Scissor ( ) [default]

#### 7.45.2.2 LLGL::Scissor::Scissor ( const Scissor & ) [default]

#### 7.45.2.3 LLGL::Scissor::Scissor ( int *x*, int *y*, int *width*, int *height* ) [inline]

### 7.45.3 Member Data Documentation

#### 7.45.3.1 int LLGL::Scissor::height = 0

#### 7.45.3.2 int LLGL::Scissor::width = 0

#### 7.45.3.3 int LLGL::Scissor::x = 0

#### 7.45.3.4 int LLGL::Scissor::y = 0

The documentation for this struct was generated from the following file:

- RenderContextFlags.h

## 7.46 LLGL::Shader Class Reference

Shader interface.

```
#include <Shader.h>
```

### Public Member Functions

- Shader (const Shader &)=delete
- Shader & operator= (const Shader &)=delete
- virtual ∼Shader ()
- virtual bool Compile (const ShaderSource &shaderSource)=0

  *Compiles the specified shader source.*
- virtual std::string Disassemble (int flags=0)

  *Disassembles the previously compiled shader byte code.*
- virtual std::string QueryInfoLog ()=0

  *Returns the information log after the shader compilation.*
- ShaderType GetType () const

  *Returns the type of this shader.*

### Protected Member Functions

- Shader (const ShaderType type)

### 7.46.1 Detailed Description

Shader interface.

### 7.46.2 Constructor & Destructor Documentation

#### 7.46.2.1 LLGL::Shader::Shader ( const Shader & ) [delete]

#### 7.46.2.2 virtual LLGL::Shader::∼Shader ( ) [virtual]

#### 7.46.2.3 LLGL::Shader::Shader ( const ShaderType *type* ) [protected]

### 7.46.3 Member Function Documentation

#### 7.46.3.1 virtual bool LLGL::Shader::Compile ( const ShaderSource & *shaderSource* ) [pure virtual]

Compiles the specified shader source.

**Parameters**

| | | |
|---|---|---|
| in | *shaderSource* | Specifies the shader source code. |

**Returns**

True on success, otherwise "QueryInfoLog" can be used to query the reason for failure.

**See also**

QueryInfoLog

#### 7.46.3.2 virtual std::string LLGL::Shader::Disassemble ( int *flags* = 0 ) [virtual]

Disassembles the previously compiled shader byte code.

**Parameters**

| | | |
|---|---|---|
| in | *flags* | Specifies optional disassemble flags. This can be a bitwise OR combination of the 'ShaderDisassembleFlags' enumeration entries. By default 0. |

**Returns**

Disassembled assembler code or an empty string if disassembling was not possible.

**Note**

Only supported with: Direct3D 11, Direct3D 12 (for HLSL).

#### 7.46.3.3 ShaderType LLGL::Shader::GetType ( ) const [inline]

Returns the type of this shader.

#### 7.46.3.4 Shader& LLGL::Shader::operator= ( const Shader & ) [delete]

#### 7.46.3.5 virtual std::string LLGL::Shader::QueryInfoLog ( ) [pure virtual]

Returns the information log after the shader compilation.

The documentation for this class was generated from the following file:

- Shader.h

## 7.47 LLGL::ShaderCompileFlags Struct Reference

Shader compilation flags enumeration.

```
#include <ShaderFlags.h>
```

### Public Types

- enum {
  Debug = (1 << 0), O1 = (1 << 1), O2 = (1 << 2), O3 = (1 << 3),
  WarnError = (1 << 4) }

### 7.47.1 Detailed Description

Shader compilation flags enumeration.

### 7.47.2 Member Enumeration Documentation

#### 7.47.2.1 anonymous enum

**Enumerator**

| | |
|---|---|
| ***Debug*** | Insert debug information. |
| ***O1*** | Optimization level 1. |
| ***O2*** | Optimization level 2. |
| ***O3*** | Optimization level 3. |
| ***WarnError*** | Warnings are treated as errors. |

The documentation for this struct was generated from the following file:

- ShaderFlags.h

## 7.48 LLGL::ShaderDisassembleFlags Struct Reference

Shader disassemble flags enumeration.

```
#include <ShaderFlags.h>
```

### Public Types

- enum { InstructionOnly = (1 << 0) }

### 7.48.1 Detailed Description

Shader disassemble flags enumeration.

### 7.48.2 Member Enumeration Documentation

#### 7.48.2.1 anonymous enum

**Enumerator**

| | |
|---|---|
| ***InstructionOnly*** | Show only instructions in disassembly output. |

The documentation for this struct was generated from the following file:

- ShaderFlags.h

## 7.49 LLGL::ShaderProgram Class Reference

Shader program interface.

```
#include <ShaderProgram.h>
```

## Public Member Functions

- ShaderProgram (const ShaderProgram &)=delete
- ShaderProgram & operator= (const ShaderProgram &)=delete
- virtual ∼ShaderProgram ()
- virtual void AttachShader (Shader &shader)=0

  *Attaches the specified shader to this shader program.*
- virtual bool LinkShaders ()=0

  *Links all attached shaders to the final shader program.*
- virtual std::string QueryInfoLog ()=0

  *Returns the information log after the shader linkage.*
- virtual std::vector< VertexAttribute > QueryVertexAttributes () const =0

  *Returns a list of vertex attributes, which describe all vertex attributes within this shader program.*
- virtual std::vector< ConstantBufferViewDescriptor > QueryConstantBuffers () const =0

  *Returns a list of constant buffer view descriptors, which describe all constant buffers within this shader program.*
- virtual std::vector< StorageBufferViewDescriptor > QueryStorageBuffers () const =0

  *Returns a list of storage buffer view descriptors, which describe all storage buffers within this shader program.*
- virtual std::vector< UniformDescriptor > QueryUniforms () const =0

  *Returns a list of uniform descriptors, which describe all uniforms within this shader program.*
- virtual void BindVertexAttributes (const std::vector< VertexAttribute > &vertexAttribs)=0

  *Binds the specified vertex attributes to this shader program.*
- virtual void BindConstantBuffer (const std::string &name, unsigned int bindingIndex)=0

  *Binds the specified constant buffer to this shader.*
- virtual void BindStorageBuffer (const std::string &name, unsigned int bindingIndex)=0

  *Binds the specified storage buffer to this shader.*
- virtual ShaderUniform ∗ LockShaderUniform ()=0

  *Locks the shader uniform handler.*
- virtual void UnlockShaderUniform ()=0

  *Unlocks the shader uniform handler.*

## Protected Member Functions

- ShaderProgram ()=default

## 7.49.1 Detailed Description

Shader program interface.

## 7.49.2 Constructor & Destructor Documentation

#### 7.49.2.1 LLGL::ShaderProgram::ShaderProgram ( const **ShaderProgram** & ) `[delete]`

#### 7.49.2.2 virtual LLGL::ShaderProgram::∼ShaderProgram ( ) `[inline]`, `[virtual]`

#### 7.49.2.3 LLGL::ShaderProgram::ShaderProgram ( ) `[protected]`, `[default]`

## 7.49.3 Member Function Documentation

#### 7.49.3.1 virtual void LLGL::ShaderProgram::AttachShader ( **Shader** & *shader* ) `[pure virtual]`

Attaches the specified shader to this shader program.

**Parameters**

| | | |
|---|---|---|
| in | *shader* | Specifies the shader which is to be attached to this shader program. Each shader type can only be added once for each shader program. |

**Remarks**

This must be called, before "LinkShaders" is called.

**Exceptions**

| | |
|---|---|
| *std::invalid_argument* | If a shader is attached to this shader program, which is not allowed in the current state. This will happend if a different shader of the same type has already been attached to this shader program for instance. |

**See also**

Shader::GetType

#### 7.49.3.2 virtual void LLGL::ShaderProgram::BindConstantBuffer ( const std::string & *name,* unsigned int *bindingIndex* ) `[pure virtual]`

Binds the specified constant buffer to this shader.

**Parameters**

| | | |
|---|---|---|
| in | *name* | Specifies the name of the constant buffer within this shader. |
| in | *bindingIndex* | Specifies the binding index. This index must match the index which will be used for "RenderContext::BindConstantBuffer". |

**Remarks**

This function is only necessary if the binding index does not match the default binding index of the constant buffer within the shader.

**See also**

QueryConstantBuffers
RenderContext::BindConstantBuffer

#### 7.49.3.3 virtual void LLGL::ShaderProgram::BindStorageBuffer ( const std::string & *name,* unsigned int *bindingIndex* ) `[pure virtual]`

Binds the specified storage buffer to this shader.

**Parameters**

| | | |
|---|---|---|
| in | *name* | Specifies the name of the storage buffer within this shader. |
| in | *bindingIndex* | Specifies the binding index. This index must match the index which will be used for "RenderContext::BindStorageBuffer". |

**Remarks**

This function is only necessary if the binding index does not match the default binding index of the storage buffer within the shader.

**See also**

RenderContext::BindStorageBuffer

#### 7.49.3.4 virtual void LLGL::ShaderProgram::BindVertexAttributes ( const std::vector< VertexAttribute > & *vertexAttribs* ) [pure virtual]

Binds the specified vertex attributes to this shader program.

**Parameters**

| | | |
|---|---|---|
| in | *vertexAttribs* | Specifies the vertex attributes. |

**Remarks**

This is only required for a shader program, which has an attached vertex shader. Moreover, this can only be called after shader compilation but before shader program linking!

**See also**

AttachShader(VertexShader&)
Shader::Compile
LinkShaders

**Exceptions**

| | |
|---|---|
| *std::invalid_argument* | If the name of an vertex attribute is invalid or the maximal number of available vertex attributes is exceeded. |

#### 7.49.3.5 virtual bool LLGL::ShaderProgram::LinkShaders ( ) [pure virtual]

Links all attached shaders to the final shader program.

**Returns**

True on success, otherwise "QueryInfoLog" can be used to query the reason for failure.

**Remarks**

Each attached shader must be compiled first!

**See also**

QueryInfoLog

#### 7.49.3.6 virtual ShaderUniform∗ LLGL::ShaderProgram::LockShaderUniform ( ) [pure virtual]

Locks the shader uniform handler.

**Returns**

Pointer to the shader uniform handler or null if the render system does not support individual shader uniforms.

**Remarks**

This must be called to set individual shader uniforms.

```
auto uniform = shaderProgram->LockShaderUniform();
if (uniform)
{
    uniform->SetUniform("mySampler1", 0);
    uniform->SetUniform("mySampler2", 1);
    uniform->SetUniform("projection", myProjectionMatrix);
}
shaderProgram->UnlockShaderUniform();
```

**Note**

Only a shader program from an OpenGL render system will return a non-null pointer!

#### 7.49.3.7 ShaderProgram& LLGL::ShaderProgram::operator= ( const ShaderProgram & ) [delete]

#### 7.49.3.8 virtual std::vector<ConstantBufferViewDescriptor> LLGL::ShaderProgram::QueryConstantBuffers ( ) const [pure virtual]

Returns a list of constant buffer view descriptors, which describe all constant buffers within this shader program.

**Remarks**

Also called "Uniform Buffer Object".

#### 7.49.3.9 virtual std::string LLGL::ShaderProgram::QueryInfoLog ( ) [pure virtual]

Returns the information log after the shader linkage.

#### 7.49.3.10 virtual std::vector<StorageBufferViewDescriptor> LLGL::ShaderProgram::QueryStorageBuffers ( ) const [pure virtual]

Returns a list of storage buffer view descriptors, which describe all storage buffers within this shader program.

**Remarks**

Also called "Shader Storage Buffer Object" or "Read/Write Buffer".

#### 7.49.3.11 virtual std::vector<UniformDescriptor> LLGL::ShaderProgram::QueryUniforms ( ) const [pure virtual]

Returns a list of uniform descriptors, which describe all uniforms within this shader program.

**Remarks**

Shader uniforms are only supported in OpenGL 2.0+.

#### 7.49.3.12 virtual std::vector<VertexAttribute> LLGL::ShaderProgram::QueryVertexAttributes ( ) const [pure virtual]

Returns a list of vertex attributes, which describe all vertex attributes within this shader program.

#### 7.49.3.13 virtual void LLGL::ShaderProgram::UnlockShaderUniform ( ) [pure virtual]

Unlocks the shader uniform handler.

**See also**

LockShaderUniform

The documentation for this class was generated from the following file:

- ShaderProgram.h

## 7.50 LLGL::ShaderSource Union Reference

Shader source code union.

```
#include <ShaderFlags.h>
```

### Classes

- struct GLSL

  *Shader source descriptor for GLSL.*
- struct HLSL

  *Shader source descriptor for HLSL.*

### Public Member Functions

- ShaderSource (const std::string &sourceCode)

  *Specifies the shader source code GLSL.*
- ShaderSource (const std::string &sourceCode, const std::string &entryPoint, const std::string &target, int flags=0)

  *Specifies the shader source code for HLSL.*
- ∼ShaderSource ()

### Public Attributes

- struct LLGL::ShaderSource::GLSL sourceGLSL
- struct LLGL::ShaderSource::HLSL sourceHLSL

## 7.50.1 Detailed Description

Shader source code union.

## 7.50.2 Constructor & Destructor Documentation

#### 7.50.2.1 LLGL::ShaderSource::ShaderSource ( const std::string & *sourceCode* ) [inline]

Specifies the shader source code GLSL.

**Parameters**

| | | |
|---|---|---|
| in | *sourceCode* | Specifies the shader source code. |

**Note**

Only supported with: OpenGL (for GLSL).

#### 7.50.2.2 LLGL::ShaderSource::ShaderSource ( const std::string & *sourceCode,* const std::string & *entryPoint,* const std::string & *target,* int *flags* = 0 ) [inline]

Specifies the shader source code for HLSL.

**Parameters**

| | | |
|---|---|---|
| in | *sourceCode* | Specifies the shader source code. |
| in | *entryPoint* | Specifies the shader entry point. |
| in | *target* | Specifies the shader version target (see `https://msdn.microsoft.com/en-us/library/windows/desktop/jj215820(v=vs.85).aspx`). |
| in | *flags* | Specifies optional compilation flags. This can be a bitwise OR combination of the 'ShaderCompileFlags' enumeration entries. By default 0. |

**Note**

Only supported with: Direct3D 11, Direct3D 12 (for HLSL).

#### 7.50.2.3 LLGL::ShaderSource::∼ShaderSource ( ) `[inline]`

### 7.50.3 Member Data Documentation

#### 7.50.3.1 struct **LLGL::ShaderSource::GLSL** LLGL::ShaderSource::sourceGLSL

#### 7.50.3.2 struct **LLGL::ShaderSource::HLSL** LLGL::ShaderSource::sourceHLSL

The documentation for this union was generated from the following file:

- ShaderFlags.h

## 7.51 LLGL::ShaderStageFlags Struct Reference

Shader stage flags.

`#include <ShaderFlags.h>`

### Public Types

- enum {
  VertexStage = (1 << 0), TessControlStage = (1 << 1), TessEvaluationStage = (1 << 2), GeometryStage = (1 << 3),
  FragmentStage = (1 << 4), ComputeStage = (1 << 5), AllTessStages = (TessControlStage | Tess←
  EvaluationStage), AllGraphicsStages = (VertexStage | AllTessStages | GeometryStage | FragmentStage),
  AllStages = (AllGraphicsStages | ComputeStage) }

### 7.51.1 Detailed Description

Shader stage flags.

**Remarks**

Specifies which shader stages are affected by a state change, e.g. at which shader stages a constant buffer is set. For the render systems, which do not support these flags, always all shader stages are affected.

**Note**

Only supported with: Direct3D 11

### 7.51.2 Member Enumeration Documentation

#### 7.51.2.1 anonymous enum

**Enumerator**

***VertexStage*** Specifies the vertex shader stage.

***TessControlStage*** Specifies the tessellation-control shader stage (also "Hull Shader").

***TessEvaluationStage*** Specifies the tessellation-evaluation shader stage (also "Domain Shader").

***GeometryStage*** Specifies the geometry shader stage.

***FragmentStage*** Specifies the fragment shader stage (also "Pixel Shader").

***ComputeStage*** Specifies the compute shader stage.

***AllTessStages*** Specifies all tessellation stages, i.e. tessellation-control-, tessellation-evaluation shader stages.

***AllGraphicsStages*** Specifies all graphics pipeline shader stages, i.e. vertex-, tessellation-, geometry-, and fragment shader stages.

***AllStages*** Specifies all shader stages.

The documentation for this struct was generated from the following file:

- ShaderFlags.h

## 7.52 LLGL::ShaderUniform Class Reference

Shader uniform setter interface.

`#include <ShaderUniform.h>`

### Public Member Functions

- virtual ∼ShaderUniform ()
- virtual void SetUniform (int location, const int value)=0
- virtual void SetUniform (int location, const Gs::Vector2i &value)=0
- virtual void SetUniform (int location, const Gs::Vector3i &value)=0
- virtual void SetUniform (int location, const Gs::Vector4i &value)=0
- virtual void SetUniform (int location, const float value)=0
- virtual void SetUniform (int location, const Gs::Vector2f &value)=0
- virtual void SetUniform (int location, const Gs::Vector3f &value)=0
- virtual void SetUniform (int location, const Gs::Vector4f &value)=0
- virtual void SetUniform (int location, const Gs::Matrix2f &value)=0
- virtual void SetUniform (int location, const Gs::Matrix3f &value)=0
- virtual void SetUniform (int location, const Gs::Matrix4f &value)=0
- virtual void SetUniform (const std::string &name, const int value)=0
- virtual void SetUniform (const std::string &name, const Gs::Vector2i &value)=0
- virtual void SetUniform (const std::string &name, const Gs::Vector3i &value)=0
- virtual void SetUniform (const std::string &name, const Gs::Vector4i &value)=0
- virtual void SetUniform (const std::string &name, const float value)=0
- virtual void SetUniform (const std::string &name, const Gs::Vector2f &value)=0
- virtual void SetUniform (const std::string &name, const Gs::Vector3f &value)=0

- virtual void SetUniform (const std::string &name, const Gs::Vector4f &value)=0
- virtual void SetUniform (const std::string &name, const Gs::Matrix2f &value)=0
- virtual void SetUniform (const std::string &name, const Gs::Matrix3f &value)=0
- virtual void SetUniform (const std::string &name, const Gs::Matrix4f &value)=0
- virtual void SetUniformArray (int location, const int ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Vector2i ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Vector3i ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Vector4i ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const float ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Vector2f ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Vector3f ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Vector4f ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Matrix2f ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Matrix3f ∗value, std::size_t count)=0
- virtual void SetUniformArray (int location, const Gs::Matrix4f ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const int ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Vector2i ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Vector3i ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Vector4i ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const float ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Vector2f ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Vector3f ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Vector4f ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Matrix2f ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Matrix3f ∗value, std::size_t count)=0
- virtual void SetUniformArray (const std::string &name, const Gs::Matrix4f ∗value, std::size_t count)=0

## 7.52.1 Detailed Description

Shader uniform setter interface.

**Remarks**

This is only used by the OpenGL render system.

## 7.52.2 Constructor & Destructor Documentation

### 7.52.2.1 virtual LLGL::ShaderUniform::∼ShaderUniform ( ) [inline], [virtual]

## 7.52.3 Member Function Documentation

### 7.52.3.1 virtual void LLGL::ShaderUniform::SetUniform ( int *location,* const int *value* ) [pure virtual]

### 7.52.3.2 virtual void LLGL::ShaderUniform::SetUniform ( int *location,* const Gs::Vector2i & *value* ) [pure virtual]

### 7.52.3.3 virtual void LLGL::ShaderUniform::SetUniform ( int *location,* const Gs::Vector3i & *value* ) [pure virtual]

### 7.52.3.4 virtual void LLGL::ShaderUniform::SetUniform ( int *location,* const Gs::Vector4i & *value* ) [pure virtual]

#### 7.52.3.5 virtual void LLGL::ShaderUniform::SetUniform ( int *location*, const float *value* ) [pure virtual]

#### 7.52.3.6 virtual void LLGL::ShaderUniform::SetUniform ( int *location*, const Gs::Vector2f & *value* ) [pure virtual]

#### 7.52.3.7 virtual void LLGL::ShaderUniform::SetUniform ( int *location*, const Gs::Vector3f & *value* ) [pure virtual]

#### 7.52.3.8 virtual void LLGL::ShaderUniform::SetUniform ( int *location*, const Gs::Vector4f & *value* ) [pure virtual]

#### 7.52.3.9 virtual void LLGL::ShaderUniform::SetUniform ( int *location*, const Gs::Matrix2f & *value* ) [pure virtual]

#### 7.52.3.10 virtual void LLGL::ShaderUniform::SetUniform ( int *location*, const Gs::Matrix3f & *value* ) [pure virtual]

#### 7.52.3.11 virtual void LLGL::ShaderUniform::SetUniform ( int *location*, const Gs::Matrix4f & *value* ) [pure virtual]

#### 7.52.3.12 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const int *value* ) [pure virtual]

#### 7.52.3.13 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Vector2i & *value* ) [pure virtual]

#### 7.52.3.14 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Vector3i & *value* ) [pure virtual]

#### 7.52.3.15 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Vector4i & *value* ) [pure virtual]

#### 7.52.3.16 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const float *value* ) [pure virtual]

#### 7.52.3.17 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Vector2f & *value* ) [pure virtual]

#### 7.52.3.18 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Vector3f & *value* ) [pure virtual]

#### 7.52.3.19 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Vector4f & *value* ) [pure virtual]

#### 7.52.3.20 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Matrix2f & *value* ) [pure virtual]

#### 7.52.3.21 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Matrix3f & *value* ) [pure virtual]

#### 7.52.3.22 virtual void LLGL::ShaderUniform::SetUniform ( const std::string & *name*, const Gs::Matrix4f & *value* ) [pure virtual]

#### 7.52.3.23 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const int ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.24 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Vector2i ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.25 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Vector3i ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.26 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Vector4i ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.27 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const float ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.28 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Vector2f ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.29 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Vector3f ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.30 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Vector4f ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.31 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Matrix2f ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.32 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Matrix3f ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.33 virtual void LLGL::ShaderUniform::SetUniformArray ( int *location*, const Gs::Matrix4f ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.34 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const int ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.35 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Vector2i ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.36 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Vector3i ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.37 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Vector4i ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.38 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const float ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.39 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Vector2f ∗ *value*, std::size_t *count* ) [pure virtual]

#### 7.52.3.40 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Vector3f ∗ *value*, std::size_t *count* ) `[pure virtual]`

#### 7.52.3.41 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Vector4f ∗ *value*, std::size_t *count* ) `[pure virtual]`

#### 7.52.3.42 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Matrix2f ∗ *value*, std::size_t *count* ) `[pure virtual]`

#### 7.52.3.43 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Matrix3f ∗ *value*, std::size_t *count* ) `[pure virtual]`

#### 7.52.3.44 virtual void LLGL::ShaderUniform::SetUniformArray ( const std::string & *name*, const Gs::Matrix4f ∗ *value*, std::size_t *count* ) `[pure virtual]`

The documentation for this class was generated from the following file:

- ShaderUniform.h

## 7.53 LLGL::GraphicsAPIDependentStateDescriptor::StateOpenGLDescriptor Struct Reference

```
#include <RenderContextFlags.h>
```

### Public Attributes

- bool screenSpaceOriginLowerLeft

  *Specifies whether the screen-space origin is on the lower-left. By default false.*
- bool invertFrontFace

  *Specifies whether to invert front-facing. By default false.*

### 7.53.1 Member Data Documentation

#### 7.53.1.1 bool LLGL::GraphicsAPIDependentStateDescriptor::StateOpenGLDescriptor::invertFrontFace

Specifies whether to invert front-facing. By default false.

**Remarks**

If this is true, the front facing (either GL_CW or GL_CCW) will be inverted, i.e. CCW becomes CW, and CW becomes CCW.

#### 7.53.1.2 bool LLGL::GraphicsAPIDependentStateDescriptor::StateOpenGLDescriptor::screenSpaceOriginLowerLeft

Specifies whether the screen-space origin is on the lower-left. By default false.

**Remarks**

If this is true, the viewports and scissor rectangles of OpenGL are NOT emulated to the upper-left, which is the default to be uniform with other rendering APIs such as Direct3D and Vulkan.

The documentation for this struct was generated from the following file:

- RenderContextFlags.h

## 7.54 LLGL::StencilDescriptor Struct Reference

Stencil state descriptor structure.

```
#include <GraphicsPipelineFlags.h>
```

### Public Attributes

- bool testEnabled = false

  *Specifies whether the stencil test is enabled or disabled.*
- StencilFaceDescriptor front

  *Specifies the front face settings for the stencil test.*
- StencilFaceDescriptor back

  *Specifies the back face settings for the stencil test.*

### 7.54.1 Detailed Description

Stencil state descriptor structure.

### 7.54.2 Member Data Documentation

#### 7.54.2.1 StencilFaceDescriptor LLGL::StencilDescriptor::back

Specifies the back face settings for the stencil test.

#### 7.54.2.2 StencilFaceDescriptor LLGL::StencilDescriptor::front

Specifies the front face settings for the stencil test.

#### 7.54.2.3 bool LLGL::StencilDescriptor::testEnabled = false

Specifies whether the stencil test is enabled or disabled.

The documentation for this struct was generated from the following file:

- GraphicsPipelineFlags.h

## 7.55 LLGL::StencilFaceDescriptor Struct Reference

Stencil face descriptor structure.

```
#include <GraphicsPipelineFlags.h>
```

### Public Attributes

- StencilOp stencilFailOp = StencilOp::Keep

    *Specifies the operation to take when the stencil test fails.*
- StencilOp depthFailOp = StencilOp::Keep

    *Specifies the operation to take when the stencil test passes but the depth test fails.*
- StencilOp depthPassOp = StencilOp::Keep

    *Specifies the operation to take when both the stencil test and the depth test pass.*
- CompareOp compareOp = CompareOp::Less

    *Specifies the stencil compare operation.*
- std::uint32_t compareMask = 0
- std::uint32_t writeMask = 0
- std::uint32_t reference = 0

    *Specifies the stencil reference value.*

### 7.55.1 Detailed Description

Stencil face descriptor structure.

### 7.55.2 Member Data Documentation

#### 7.55.2.1 std::uint32_t LLGL::StencilFaceDescriptor::compareMask = 0

#### 7.55.2.2 CompareOp LLGL::StencilFaceDescriptor::compareOp = CompareOp::Less

Specifies the stencil compare operation.

#### 7.55.2.3 StencilOp LLGL::StencilFaceDescriptor::depthFailOp = StencilOp::Keep

Specifies the operation to take when the stencil test passes but the depth test fails.

#### 7.55.2.4 StencilOp LLGL::StencilFaceDescriptor::depthPassOp = StencilOp::Keep

Specifies the operation to take when both the stencil test and the depth test pass.

#### 7.55.2.5 std::uint32_t LLGL::StencilFaceDescriptor::reference = 0

Specifies the stencil reference value.

**Note**

For Direct3D 11, only the stencil reference value of the "front" face will be used.

#### 7.55.2.6 StencilOp LLGL::StencilFaceDescriptor::stencilFailOp = StencilOp::Keep

Specifies the operation to take when the stencil test fails.

#### 7.55.2.7 std::uint32_t LLGL::StencilFaceDescriptor::writeMask = 0

The documentation for this struct was generated from the following file:

- GraphicsPipelineFlags.h

## 7.56 LLGL::BufferDescriptor::StorageBufferDescriptor Struct Reference

```
#include <BufferFlags.h>
```

### Public Attributes

- StorageBufferType storageType = StorageBufferType::Generic

  *Specifies the storage buffer type.*

### 7.56.1 Member Data Documentation

#### 7.56.1.1 StorageBufferType LLGL::BufferDescriptor::StorageBufferDescriptor::storageType = StorageBufferType::Generic

Specifies the storage buffer type.

**Remarks**

In OpenGL there are only generic storage buffers (or rather "Shader Storage Buffer Objects").

The documentation for this struct was generated from the following file:

- BufferFlags.h

## 7.57 LLGL::StorageBufferViewDescriptor Struct Reference

Storage buffer shader-view descriptor structure.

`#include <BufferFlags.h>`

### Public Attributes

- std::string name

  *Storage buffer name.*
- unsigned int index = 0

  *Index of the storage buffer within the respective shader.*
- StorageBufferType type = StorageBufferType::Buffer

  *Storage buffer type.*

### 7.57.1 Detailed Description

Storage buffer shader-view descriptor structure.

**Remarks**

This structure is used to describe the view of a storage buffer within a shader.

### 7.57.2 Member Data Documentation

#### 7.57.2.1 unsigned int LLGL::StorageBufferViewDescriptor::index = 0

Index of the storage buffer within the respective shader.

#### 7.57.2.2 std::string LLGL::StorageBufferViewDescriptor::name

Storage buffer name.

#### 7.57.2.3 StorageBufferType LLGL::StorageBufferViewDescriptor::type = StorageBufferType::Buffer

Storage buffer type.

**Remarks**

For the OpenGL render system, this type is always 'StorageBufferType::Buffer', since GLSL only supports generic shader storage buffers. Here is an example:

```
layout(std430, binding=0) buffer myBuffer
{
    vec4 myBufferArray[];
};
```

**Note**

Only supported with: Direct3D 11, Direct3D 12

The documentation for this struct was generated from the following file:

- BufferFlags.h

## 7.58 LLGL::SubTextureDescriptor Struct Reference

Sub-texture descriptor structure.

`#include <TextureFlags.h>`

### Classes

- struct Texture1DDescriptor
- struct Texture2DDescriptor
- struct Texture3DDescriptor
- struct TextureCubeDescriptor

### Public Member Functions

- SubTextureDescriptor ()
- ∼SubTextureDescriptor ()

### Public Attributes

- int mipLevel

  *Zero-based MIP-map level for the sub-texture.*
- union {
  Texture1DDescriptor texture1DDesc
  *Descriptor for 1D- and 1D-Array textures.*
  Texture2DDescriptor texture2DDesc
  *Descriptor for 2D- and 2D-Array textures.*
  Texture3DDescriptor texture3DDesc
  *Descriptor for 3D textures.*
  TextureCubeDescriptor textureCubeDesc
  *Descriptor for Cube- and Cube-Array textures.*
  };

### 7.58.1 Detailed Description

Sub-texture descriptor structure.

**Remarks**

This is used to write (or partially write) the image data of a texture MIP-map level.

### 7.58.2 Constructor & Destructor Documentation

#### 7.58.2.1 LLGL::SubTextureDescriptor::SubTextureDescriptor ( ) `[inline]`

#### 7.58.2.2 LLGL::SubTextureDescriptor::∼SubTextureDescriptor ( ) `[inline]`

### 7.58.3 Member Data Documentation

#### 7.58.3.1 union { ... }

#### 7.58.3.2 int LLGL::SubTextureDescriptor::mipLevel

Zero-based MIP-map level for the sub-texture.

#### 7.58.3.3 Texture1DDescriptor LLGL::SubTextureDescriptor::texture1DDesc

Descriptor for 1D- and 1D-Array textures.

#### 7.58.3.4 Texture2DDescriptor LLGL::SubTextureDescriptor::texture2DDesc

Descriptor for 2D- and 2D-Array textures.

#### 7.58.3.5 Texture3DDescriptor LLGL::SubTextureDescriptor::texture3DDesc

Descriptor for 3D textures.

#### 7.58.3.6 TextureCubeDescriptor LLGL::SubTextureDescriptor::textureCubeDesc

Descriptor for Cube- and Cube-Array textures.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.59 LLGL::Texture Class Reference

Texture interface.

```
#include <Texture.h>
```

### Public Member Functions

- Texture (const Texture &)=delete
- Texture & operator= (const Texture &)=delete
- virtual ∼Texture ()
- TextureType GetType () const

  *Returns the type of this texture.*
- virtual Gs::Vector3i QueryMipLevelSize (int mipLevel) const =0

  *Returns the texture size for the specified MIP-level.*

### Protected Member Functions

- Texture (const TextureType type)

### 7.59.1 Detailed Description

Texture interface.

## 7.59.2 Constructor & Destructor Documentation

#### 7.59.2.1 LLGL::Texture::Texture ( const Texture & ) `[delete]`

#### 7.59.2.2 virtual LLGL::Texture::∼Texture ( ) `[virtual]`

#### 7.59.2.3 LLGL::Texture::Texture ( const TextureType *type* ) `[protected]`

## 7.59.3 Member Function Documentation

#### 7.59.3.1 TextureType LLGL::Texture::GetType ( ) const `[inline]`

Returns the type of this texture.

#### 7.59.3.2 Texture& LLGL::Texture::operator= ( const Texture & ) `[delete]`

#### 7.59.3.3 virtual Gs::Vector3i LLGL::Texture::QueryMipLevelSize ( int *mipLevel* ) const `[pure virtual]`

Returns the texture size for the specified MIP-level.

**Parameters**

| | | |
|---|---|---|
| `in` | *mipLevel* | Specifies the MIP-map level to querey from. The first and largest MIP-map is level zero. If this level is greater than or equal to the number of MIP-maps this texture has, the return value is undefined (i.e. depends on the render system). |

**See also**

RenderContext::GenerateMips

The documentation for this class was generated from the following file:

- Texture.h

## 7.60 LLGL::TextureDescriptor::Texture1DDescriptor Struct Reference

`#include <TextureFlags.h>`

### Public Attributes

- int width
  *Texture width.*
- unsigned int layers
  *Number of texture array layers.*

### 7.60.1 Member Data Documentation

#### 7.60.1.1 unsigned int LLGL::TextureDescriptor::Texture1DDescriptor::layers

Number of texture array layers.

#### 7.60.1.2 int LLGL::TextureDescriptor::Texture1DDescriptor::width

Texture width.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.61 LLGL::SubTextureDescriptor::Texture1DDescriptor Struct Reference

```
#include <TextureFlags.h>
```

### Public Attributes

- int x
  *Sub-texture X-axis offset.*
- unsigned int layerOffset
  *Zero-based layer offset.*
- int width
  *Sub-texture width.*
- unsigned int layers
  *Number of texture array layers.*

### 7.61.1 Member Data Documentation

#### 7.61.1.1 unsigned int LLGL::SubTextureDescriptor::Texture1DDescriptor::layerOffset

Zero-based layer offset.

#### 7.61.1.2 unsigned int LLGL::SubTextureDescriptor::Texture1DDescriptor::layers

Number of texture array layers.

#### 7.61.1.3 int LLGL::SubTextureDescriptor::Texture1DDescriptor::width

Sub-texture width.

#### 7.61.1.4 int LLGL::SubTextureDescriptor::Texture1DDescriptor::x

Sub-texture X-axis offset.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.62 LLGL::SubTextureDescriptor::Texture2DDescriptor Struct Reference

```
#include <TextureFlags.h>
```

### Public Attributes

- int x
  *Sub-texture X-axis offset.*
- int y
  *Sub-texture Y-axis offset.*
- unsigned int layerOffset
  *Zero-based layer offset.*
- int width
  *Sub-texture width.*
- int height
  *Sub-texture height.*
- unsigned int layers
  *Number of texture array layers.*

### 7.62.1 Member Data Documentation

#### 7.62.1.1 int LLGL::SubTextureDescriptor::Texture2DDescriptor::height

Sub-texture height.

#### 7.62.1.2 unsigned int LLGL::SubTextureDescriptor::Texture2DDescriptor::layerOffset

Zero-based layer offset.

#### 7.62.1.3 unsigned int LLGL::SubTextureDescriptor::Texture2DDescriptor::layers

Number of texture array layers.

#### 7.62.1.4 int LLGL::SubTextureDescriptor::Texture2DDescriptor::width

Sub-texture width.

#### 7.62.1.5 int LLGL::SubTextureDescriptor::Texture2DDescriptor::x

Sub-texture X-axis offset.

#### 7.62.1.6 int LLGL::SubTextureDescriptor::Texture2DDescriptor::y

Sub-texture Y-axis offset.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.63 LLGL::TextureDescriptor::Texture2DDescriptor Struct Reference

```
#include <TextureFlags.h>
```

### Public Attributes

- int width

    *Texture width.*
- int height

    *Texture height.*
- unsigned int layers

    *Number of texture array layers.*

### 7.63.1 Member Data Documentation

#### 7.63.1.1 int LLGL::TextureDescriptor::Texture2DDescriptor::height

Texture height.

#### 7.63.1.2 unsigned int LLGL::TextureDescriptor::Texture2DDescriptor::layers

Number of texture array layers.

#### 7.63.1.3 int LLGL::TextureDescriptor::Texture2DDescriptor::width

Texture width.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.64 LLGL::SubTextureDescriptor::Texture3DDescriptor Struct Reference

```
#include <TextureFlags.h>
```

### Public Attributes

- int x

  *Sub-texture X-axis offset.*
- int y

  *Sub-texture Y-axis offset.*
- int z

  *Sub-texture Z-axis offset.*
- int width

  *Sub-texture width.*
- int height

  *Sub-texture height.*
- int depth

  *Number of texture array layers.*

### 7.64.1 Member Data Documentation

#### 7.64.1.1 int LLGL::SubTextureDescriptor::Texture3DDescriptor::depth

Number of texture array layers.

#### 7.64.1.2 int LLGL::SubTextureDescriptor::Texture3DDescriptor::height

Sub-texture height.

#### 7.64.1.3 int LLGL::SubTextureDescriptor::Texture3DDescriptor::width

Sub-texture width.

#### 7.64.1.4 int LLGL::SubTextureDescriptor::Texture3DDescriptor::x

Sub-texture X-axis offset.

#### 7.64.1.5 int LLGL::SubTextureDescriptor::Texture3DDescriptor::y

Sub-texture Y-axis offset.

#### 7.64.1.6 int LLGL::SubTextureDescriptor::Texture3DDescriptor::z

Sub-texture Z-axis offset.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.65 LLGL::TextureDescriptor::Texture3DDescriptor Struct Reference

```
#include <TextureFlags.h>
```

### Public Attributes

- int width

  *Texture width.*
- int height

  *Texture height.*
- int depth

  *Texture depth.*

### 7.65.1 Member Data Documentation

#### 7.65.1.1 int LLGL::TextureDescriptor::Texture3DDescriptor::depth

Texture depth.

#### 7.65.1.2 int LLGL::TextureDescriptor::Texture3DDescriptor::height

Texture height.

#### 7.65.1.3 int LLGL::TextureDescriptor::Texture3DDescriptor::width

Texture width.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.66 LLGL::TextureDescriptor::TextureCubeDescriptor Struct Reference

```
#include <TextureFlags.h>
```

## Public Attributes

- int width

  *Texture width.*
- int height

  *Texture height.*
- unsigned int layers

  *Number of texture array layers (internally it will be a multiple of 6).*

### 7.66.1 Member Data Documentation

#### 7.66.1.1 int LLGL::TextureDescriptor::TextureCubeDescriptor::height

Texture height.

#### 7.66.1.2 unsigned int LLGL::TextureDescriptor::TextureCubeDescriptor::layers

Number of texture array layers (internally it will be a multiple of 6).

#### 7.66.1.3 int LLGL::TextureDescriptor::TextureCubeDescriptor::width

Texture width.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.67 LLGL::SubTextureDescriptor::TextureCubeDescriptor Struct Reference

```
#include <TextureFlags.h>
```

## Public Attributes

- int x

  *Sub-texture X-axis offset.*
- int y

  *Sub-texture Y-axis offset.*
- unsigned int layerOffset

  *Zero-based layer offset.*
- int width

  *Sub-texture width.*
- int height

  *Sub-texture height.*
- unsigned int cubeFaces

  *Number of cube-faces. To have all faces of N cube-texture layers, this value must be a N$*$6.*
- AxisDirection cubeFaceOffset

  *First cube face in the current layer.*

### 7.67.1 Member Data Documentation

#### 7.67.1.1 AxisDirection LLGL::SubTextureDescriptor::TextureCubeDescriptor::cubeFaceOffset

First cube face in the current layer.

#### 7.67.1.2 unsigned int LLGL::SubTextureDescriptor::TextureCubeDescriptor::cubeFaces

Number of cube-faces. To have all faces of N cube-texture layers, this value must be a N∗6.

#### 7.67.1.3 int LLGL::SubTextureDescriptor::TextureCubeDescriptor::height

Sub-texture height.

#### 7.67.1.4 unsigned int LLGL::SubTextureDescriptor::TextureCubeDescriptor::layerOffset

Zero-based layer offset.

#### 7.67.1.5 int LLGL::SubTextureDescriptor::TextureCubeDescriptor::width

Sub-texture width.

#### 7.67.1.6 int LLGL::SubTextureDescriptor::TextureCubeDescriptor::x

Sub-texture X-axis offset.

#### 7.67.1.7 int LLGL::SubTextureDescriptor::TextureCubeDescriptor::y

Sub-texture Y-axis offset.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.68 LLGL::TextureDescriptor Struct Reference

Texture descriptor structure.

```
#include <TextureFlags.h>
```

## Classes

- struct Texture1DDescriptor
- struct Texture2DDescriptor
- struct Texture3DDescriptor
- struct TextureCubeDescriptor

## Public Member Functions

- TextureDescriptor ()
- ∼TextureDescriptor ()

## Public Attributes

- TextureType type

  *Texture type.*
- TextureFormat format

  *Texture hardware format.*
- union {
  Texture1DDescriptor texture1DDesc
  *Descriptor for 1D- and 1D-Array textures.*
  Texture2DDescriptor texture2DDesc
  *Descriptor for 2D- and 2D-Array textures.*
  Texture3DDescriptor texture3DDesc
  *Descriptor for 3D textures.*
  TextureCubeDescriptor textureCubeDesc
  *Descriptor for Cube- and Cube-Array textures.*
  };

### 7.68.1 Detailed Description

Texture descriptor structure.

**Remarks**

This is used to specifiy the dimensions of a texture which is to be created.

### 7.68.2 Constructor & Destructor Documentation

#### 7.68.2.1 LLGL::TextureDescriptor::TextureDescriptor ( ) `[inline]`

#### 7.68.2.2 LLGL::TextureDescriptor::∼TextureDescriptor ( ) `[inline]`

### 7.68.3 Member Data Documentation

#### 7.68.3.1 union { ... }

#### 7.68.3.2 TextureFormat LLGL::TextureDescriptor::format

Texture hardware format.

#### 7.68.3.3 Texture1DDescriptor LLGL::TextureDescriptor::texture1DDesc

Descriptor for 1D- and 1D-Array textures.

#### 7.68.3.4 Texture2DDescriptor LLGL::TextureDescriptor::texture2DDesc

Descriptor for 2D- and 2D-Array textures.

#### 7.68.3.5 Texture3DDescriptor LLGL::TextureDescriptor::texture3DDesc

Descriptor for 3D textures.

#### 7.68.3.6 TextureCubeDescriptor LLGL::TextureDescriptor::textureCubeDesc

Descriptor for Cube- and Cube-Array textures.

#### 7.68.3.7 TextureType LLGL::TextureDescriptor::type

Texture type.

The documentation for this struct was generated from the following file:

- TextureFlags.h

## 7.69 LLGL::Timer Class Reference

```
#include <Timer.h>
```

### Public Types

- using FrameCount = unsigned long long

### Public Member Functions

- virtual ∼Timer ()
- virtual void Start ()=0

    *Starts the timer.*
- virtual double Stop ()=0

    *Stops the timer and returns the elapsed time since "Start" was called.*
- virtual double GetFrequency () const =0

    *Returns the frequency this timer can measure time (e.g. for milliseconds this is 1000.0).*
- void MeasureTime ()

    *Measures the time (elapsed time, and frame count) for each frame.*
- void ResetFrameCounter ()

    *Restes the frame counter.*
- double GetDeltaTime () const

    *Returns the elapsed time (in seconds) between the current and the previous frame.*
- FrameCount GetFrameCount () const

    *Returns the number of counted frames.*

## Static Public Member Functions

- static std::unique_ptr< Timer > Create ()

  *Creates a platform specific timer object.*

## 7.69.1 Member Typedef Documentation

### 7.69.1.1 using **LLGL::Timer::FrameCount** = unsigned long long

## 7.69.2 Constructor & Destructor Documentation

### 7.69.2.1 virtual LLGL::Timer::∼Timer ( ) `[virtual]`

## 7.69.3 Member Function Documentation

### 7.69.3.1 static std::unique_ptr<**Timer**> LLGL::Timer::Create ( ) `[static]`

Creates a platform specific timer object.

### 7.69.3.2 double LLGL::Timer::GetDeltaTime ( ) const `[inline]`

Returns the elapsed time (in seconds) between the current and the previous frame.

**Remarks**

This requires that "MeasureTime" is called once every frame.

**See also**

MeasureTime

### 7.69.3.3 **FrameCount** LLGL::Timer::GetFrameCount ( ) const `[inline]`

Returns the number of counted frames.

**Remarks**

This requires that "MeasureTime" is called once every frame.

**See also**

MeasureTime

#### 7.69.3.4 virtual double LLGL::Timer::GetFrequency ( ) const [pure virtual]

Returns the frequency this timer can measure time (e.g. for milliseconds this is 1000.0).

#### 7.69.3.5 void LLGL::Timer::MeasureTime ( )

Measures the time (elapsed time, and frame count) for each frame.

**See also**

GetDeltaTime
GetFrameCount()

#### 7.69.3.6 void LLGL::Timer::ResetFrameCounter ( )

Restes the frame counter.

**See also**

GetFrameCount

#### 7.69.3.7 virtual void LLGL::Timer::Start ( ) [pure virtual]

Starts the timer.

#### 7.69.3.8 virtual double LLGL::Timer::Stop ( ) [pure virtual]

Stops the timer and returns the elapsed time since "Start" was called.

The documentation for this class was generated from the following file:

- Timer.h

## 7.70 LLGL::UniformDescriptor Struct Reference

Shader uniform descriptor structure.

```
#include <ShaderUniform.h>
```

### Public Attributes

- std::string name
- UniformType type = UniformType::Float
- int location = 0
- unsigned int size = 0

### 7.70.1 Detailed Description

Shader uniform descriptor structure.

### 7.70.2 Member Data Documentation

#### 7.70.2.1 int LLGL::UniformDescriptor::location = 0

#### 7.70.2.2 std::string LLGL::UniformDescriptor::name

#### 7.70.2.3 unsigned int LLGL::UniformDescriptor::size = 0

#### 7.70.2.4 UniformType LLGL::UniformDescriptor::type = UniformType::Float

The documentation for this struct was generated from the following file:

- ShaderUniform.h

## 7.71 LLGL::VertexAttribute Struct Reference

Vertex attribute class.

```
#include <VertexAttribute.h>
```

### Public Attributes

- DataType dataType = DataType::Float

  *Data type of the vertex attribute components. By default DataType::Float.*
- bool conversion = false

  *Specifies whether non-floating-point data types are to be converted to floating-points. By default false.*
- bool perInstance = false

  *Specifies whether this is a per-instance data. If false, this is a per-vertex data.*
- unsigned int components = 4

  *Number of components: 1, 2, 3, or 4. By default 4.*
- unsigned int offset = 0

  *Byte offset for within each vertex. By default 0.*
- std::string name

  *Vertex attribute name (for GLSL) or semantic name (for HLSL).*
- unsigned int semanticIndex = 0

  *Semantic index (only relevant for HLSL).*

### 7.71.1 Detailed Description

Vertex attribute class.

### 7.71.2 Member Data Documentation

#### 7.71.2.1 unsigned int LLGL::VertexAttribute::components = 4

Number of components: 1, 2, 3, or 4. By default 4.

#### 7.71.2.2 bool LLGL::VertexAttribute::conversion = false

Specifies whether non-floating-point data types are to be converted to floating-points. By default false.

#### 7.71.2.3 DataType LLGL::VertexAttribute::dataType = DataType::Float

Data type of the vertex attribute components. By default DataType::Float.

#### 7.71.2.4 std::string LLGL::VertexAttribute::name

Vertex attribute name (for GLSL) or semantic name (for HLSL).

#### 7.71.2.5 unsigned int LLGL::VertexAttribute::offset = 0

Byte offset for within each vertex. By default 0.

#### 7.71.2.6 bool LLGL::VertexAttribute::perInstance = false

Specifies whether this is a per-instance data. If false, this is a per-vertex data.

#### 7.71.2.7 unsigned int LLGL::VertexAttribute::semanticIndex = 0

Semantic index (only relevant for HLSL).

The documentation for this struct was generated from the following file:

- VertexAttribute.h

## 7.72 LLGL::BufferDescriptor::VertexBufferDescriptor Struct Reference

Vertex buffer descriptor structure.

```
#include <BufferFlags.h>
```

## Public Attributes

- VertexFormat vertexFormat

    *Specifies the vertex format layout.*

### 7.72.1 Detailed Description

Vertex buffer descriptor structure.

### 7.72.2 Member Data Documentation

#### 7.72.2.1 VertexFormat LLGL::BufferDescriptor::VertexBufferDescriptor::vertexFormat

Specifies the vertex format layout.

**Remarks**

This is required to tell the renderer how the vertex attributes are stored inside the vertex buffer and it must be the same vertex format which is used for the respective graphics pipeline shader program.

The documentation for this struct was generated from the following file:

- BufferFlags.h

## 7.73 LLGL::VertexFormat Class Reference

Vertex format descriptor class.

```
#include <VertexFormat.h>
```

### Public Member Functions

- void AddAttribute (const std::string &name, const DataType dataType, unsigned int components, bool conversion=false, bool perInstance=false)

    *Adds a new vertex attribute to this vertex format with a specified name (used for GLSL).*
- void AddAttribute (const std::string &semanticName, unsigned int semanticIndex, const DataType dataType, unsigned int components, bool conversion=false, bool perInstance=false)

    *Adds a new vertex attribute to this vertex format with a specified semantic (used for HLSL).*
- const std::vector< VertexAttribute > & GetAttributes () const

    *Returns the list of all vertex attributes.*
- unsigned int GetFormatSize () const

    *Returns the size of this vertex format (in bytes).*

### 7.73.1 Detailed Description

Vertex format descriptor class.

**Remarks**

A vertex format is required to describe how the vertex attributes are supported inside a vertex buffer.

**See also**

VertexBuffer

### 7.73.2 Member Function Documentation

#### 7.73.2.1 void LLGL::VertexFormat::AddAttribute ( const std::string & *name*, const DataType *dataType*, unsigned int *components*, bool *conversion* = `false`, bool *perInstance* = `false` )

Adds a new vertex attribute to this vertex format with a specified name (used for GLSL).

**Parameters**

| | | |
|---|---|---|
| `in` | *name* | Specifies the attribute name. |
| `in` | *dataType* | Specifies the data type of the attribute components. |
| `in` | *components* | Specifies the number of attribute components. This must be 1, 2, 3, or 4. |
| `in` | *conversion* | Specifies whether to convert integral vertex attributes to normalized floating-point types. By default false. |
| `in` | *perInstance* | Specifies whether this is per-instance data. If false, this is per-vertex data. By default false. |

**Remarks**

This is equivalent to:

```
AddAttribute(name, 0, dataType, components, conversion);
```

**Exceptions**

| | |
|---|---|
| *std::invalid_argument* | If 'components' is neither 1, 2, 3, nor 4. |

**See also**

AddAttribute(const std::string&, unsigned int, const DataType, unsigned int, bool, bool)

#### 7.73.2.2 void LLGL::VertexFormat::AddAttribute ( const std::string & *semanticName*, unsigned int *semanticIndex*, const DataType *dataType*, unsigned int *components*, bool *conversion* = `false`, bool *perInstance* = `false` )

Adds a new vertex attribute to this vertex format with a specified semantic (used for HLSL).

**Parameters**

| | | |
|---|---|---|
| in | *semanticName* | Specifies the semantic name (For Direct3D). |
| in | *semanticIndex* | Specifies the semantic index (For Direct3D). |
| in | *dataType* | Specifies the data type of the attribute components. |
| in | *components* | Specifies the number of attribute components. This must be 1, 2, 3, or 4. |
| in | *conversion* | Specifies whether to convert integral vertex attributes to normalized floating-point types. By default false. |
| in | *perInstance* | Specifies whether this is per-instance data. If false, this is per-vertex data. By default false. |

**Exceptions**

| | |
|---|---|
| *std::invalid_argument* | If 'components' is neither 1, 2, 3, nor 4. |

#### 7.73.2.3 const std::vector< VertexAttribute >& LLGL::VertexFormat::GetAttributes ( ) const [inline]

Returns the list of all vertex attributes.

**See also**

AddAttribute

#### 7.73.2.4 unsigned int LLGL::VertexFormat::GetFormatSize ( ) const [inline]

Returns the size of this vertex format (in bytes).

The documentation for this class was generated from the following file:

- VertexFormat.h

## 7.74 LLGL::VideoAdapterDescriptor Struct Reference

Video adapter descriptor structure.

`#include <VideoAdapter.h>`

### Public Attributes

- std::wstring name

  *Hardware adapter name (name of the GPU).*
- std::string vendor

  *Vendor name.*
- unsigned long long videoMemory = 0

  *Video memory size (in bytes).*
- std::vector< VideoOutput > outputs

  *Adapter outputs.*

### 7.74.1 Detailed Description

Video adapter descriptor structure.

### 7.74.2 Member Data Documentation

#### 7.74.2.1 std::wstring LLGL::VideoAdapterDescriptor::name

Hardware adapter name (name of the GPU).

#### 7.74.2.2 std::vector<VideoOutput> LLGL::VideoAdapterDescriptor::outputs

Adapter outputs.

#### 7.74.2.3 std::string LLGL::VideoAdapterDescriptor::vendor

Vendor name.

#### 7.74.2.4 unsigned long long LLGL::VideoAdapterDescriptor::videoMemory = 0

Video memory size (in bytes).

The documentation for this struct was generated from the following file:

- VideoAdapter.h

## 7.75 LLGL::VideoDisplayMode Struct Reference

Video display mode structure.

```
#include <VideoAdapter.h>
```

### Public Attributes

- unsigned int width = 0

  *Display resolution width (in pixels).*
- unsigned int height = 0

  *Display resolution width (in height).*
- unsigned int refreshRate = 0

  *Refresh reate (in Hz).*

### 7.75.1 Detailed Description

Video display mode structure.

### 7.75.2 Member Data Documentation

#### 7.75.2.1 unsigned int LLGL::VideoDisplayMode::height = 0

Display resolution width (in height).

#### 7.75.2.2 unsigned int LLGL::VideoDisplayMode::refreshRate = 0

Refresh reate (in Hz).

#### 7.75.2.3 unsigned int LLGL::VideoDisplayMode::width = 0

Display resolution width (in pixels).

The documentation for this struct was generated from the following file:

- VideoAdapter.h

## 7.76 LLGL::VideoModeDescriptor Struct Reference

```
#include <RenderContextDescriptor.h>
```

### Public Attributes

- Size resolution

  *Screen resolution.*
- int colorDepth = 32

  *Color bit depth. Should be 24 or 32. By default 32.*
- bool fullscreen = false

  *Specifies whether to enable fullscreen mode or windowed mode. By default windowed mode.*
- SwapChainMode swapChainMode = SwapChainMode::DoubleBuffering

  *Swap chain buffering mode.*

### 7.76.1 Member Data Documentation

#### 7.76.1.1 int LLGL::VideoModeDescriptor::colorDepth = 32

Color bit depth. Should be 24 or 32. By default 32.

#### 7.76.1.2 bool LLGL::VideoModeDescriptor::fullscreen = false

Specifies whether to enable fullscreen mode or windowed mode. By default windowed mode.

#### 7.76.1.3 Size LLGL::VideoModeDescriptor::resolution

Screen resolution.

#### 7.76.1.4 SwapChainMode LLGL::VideoModeDescriptor::swapChainMode = SwapChainMode::DoubleBuffering

Swap chain buffering mode.

The documentation for this struct was generated from the following file:

- RenderContextDescriptor.h

## 7.77 LLGL::VideoOutput Struct Reference

Video output structure.

```
#include <VideoAdapter.h>
```

### Public Attributes

- std::vector< VideoDisplayMode > displayModes
    *Video display mode list.*

### 7.77.1 Detailed Description

Video output structure.

### 7.77.2 Member Data Documentation

#### 7.77.2.1 std::vector<VideoDisplayMode> LLGL::VideoOutput::displayModes

Video display mode list.

The documentation for this struct was generated from the following file:

- VideoAdapter.h

## 7.78 LLGL::Viewport Struct Reference

Viewport dimensions.

```
#include <RenderContextFlags.h>
```

### Public Member Functions

- Viewport ()=default
- Viewport (const Viewport &)=default
- Viewport (float x, float y, float width, float height)
- Viewport (float x, float y, float width, float height, float minDepth, float maxDepth)

### Public Attributes

- float x = 0.0f

  *Left-top X coordinate.*
- float y = 0.0f

  *Left-top Y coordinate.*
- float width = 0.0f

  *Right-bottom width.*
- float height = 0.0f

  *Right-bottom height.*
- float minDepth = 0.0f

  *Minimal depth range.*
- float maxDepth = 1.0f

  *Maximal depth range.*

## 7.78.1 Detailed Description

Viewport dimensions.

**Remarks**

A viewport is in screen coordinates where the origin is in the left-top corner.

## 7.78.2 Constructor & Destructor Documentation

#### 7.78.2.1 LLGL::Viewport::Viewport ( ) `[default]`

#### 7.78.2.2 LLGL::Viewport::Viewport ( const Viewport & ) `[default]`

#### 7.78.2.3 LLGL::Viewport::Viewport ( float *x*, float *y*, float *width*, float *height* ) `[inline]`

#### 7.78.2.4 LLGL::Viewport::Viewport ( float *x*, float *y*, float *width*, float *height*, float *minDepth*, float *maxDepth* ) `[inline]`

## 7.78.3 Member Data Documentation

#### 7.78.3.1 float LLGL::Viewport::height = 0.0f

Right-bottom height.

#### 7.78.3.2 float LLGL::Viewport::maxDepth = 1.0f

Maximal depth range.

#### 7.78.3.3 float LLGL::Viewport::minDepth = 0.0f

Minimal depth range.

#### 7.78.3.4 float LLGL::Viewport::width = 0.0f

Right-bottom width.

#### 7.78.3.5 float LLGL::Viewport::x = 0.0f

Left-top X coordinate.

#### 7.78.3.6 float LLGL::Viewport::y = 0.0f

Left-top Y coordinate.

The documentation for this struct was generated from the following file:

- RenderContextFlags.h

## 7.79 LLGL::VsyncDescriptor Struct Reference

```
#include <RenderContextDescriptor.h>
```

### Public Attributes

- bool enabled = false

  *Specifies whether vertical-synchronisation (Vsync) is enabled or disabled. By default disabled.*
- unsigned int refreshRate = 60

  *Refresh rate (in Hz). By default 60.*
- unsigned int interval = 1

  *Synchronisation interval. Can be 1, 2, 3, or 4. If Vsync is disabled, this value is implicit zero.*

### 7.79.1 Member Data Documentation

#### 7.79.1.1 bool LLGL::VsyncDescriptor::enabled = false

Specifies whether vertical-synchronisation (Vsync) is enabled or disabled. By default disabled.

#### 7.79.1.2 unsigned int LLGL::VsyncDescriptor::interval = 1

Synchronisation interval. Can be 1, 2, 3, or 4. If Vsync is disabled, this value is implicit zero.

#### 7.79.1.3 unsigned int LLGL::VsyncDescriptor::refreshRate = 60

Refresh rate (in Hz). By default 60.

The documentation for this struct was generated from the following file:

- RenderContextDescriptor.h

## 7.80 LLGL::Window Class Reference

```
#include <Window.h>
```

### Classes

- class EventListener

### Public Member Functions

- virtual ∼Window ()
- virtual void SetPosition (const Point &position)=0
- virtual Point GetPosition () const =0
- virtual void SetSize (const Size &size, bool useClientArea=true)=0
- virtual Size GetSize (bool useClientArea=true) const =0
- virtual void SetTitle (const std::wstring &title)=0
- virtual std::wstring GetTitle () const =0
- virtual void Show (bool show=true)=0
- virtual bool IsShown () const =0
- virtual WindowDescriptor QueryDesc () const =0

  *Query a window descriptor, which describes the current state of this window.*
- virtual void SetDesc (const WindowDescriptor &desc)=0

  *Sets the new window descriptor.*
- virtual void Recreate (const WindowDescriptor &desc)=0

  *Recreates the internal window object. This may invalidate the native handle previously returned by "GetNative←↩ Handle".*
- virtual void GetNativeHandle (void ∗nativeHandle) const =0

  *Returns the native window handle.*
- bool ProcessEvents ()

  *Processes the events for this window (i.e. mouse movement, key presses etc.).*
- void AddEventListener (const std::shared_ptr< EventListener > &eventListener)
- void RemoveEventListener (const EventListener ∗eventListener)
- void PostKeyDown (Key keyCode)
- void PostKeyUp (Key keyCode)
- void PostDoubleClick (Key keyCode)
- void PostChar (wchar_t chr)
- void PostWheelMotion (int motion)
- void PostLocalMotion (const Point &position)
- void PostGlobalMotion (const Point &motion)
- void PostResize (const Size &clientAreaSize)
- void PostQuit ()

  *Posts the 'OnQuit' event to all event listeners.*

## Static Public Member Functions

- static std::unique_ptr< Window > Create (const WindowDescriptor &desc)

## Protected Member Functions

- virtual void ProcessSystemEvents ()=0

## 7.80.1 Constructor & Destructor Documentation

### 7.80.1.1 virtual LLGL::Window::∼Window ( ) [virtual]

## 7.80.2 Member Function Documentation

### 7.80.2.1 void LLGL::Window::AddEventListener ( const std::shared_ptr< EventListener > & *eventListener* )

### 7.80.2.2 static std::unique_ptr<Window> LLGL::Window::Create ( const WindowDescriptor & *desc* ) [static]

### 7.80.2.3 virtual void LLGL::Window::GetNativeHandle ( void ∗ *nativeHandle* ) const [pure virtual]

Returns the native window handle.

**Remarks**

This must be casted to a platform specific structure:

```
#include <LLGL/Platform/NativeHandle.h>
//...
LLGL::NativeHandle handle;
window.GetNativeHandle(&handle);
```

### 7.80.2.4 virtual Point LLGL::Window::GetPosition ( ) const [pure virtual]

### 7.80.2.5 virtual Size LLGL::Window::GetSize ( bool *useClientArea* = true ) const [pure virtual]

### 7.80.2.6 virtual std::wstring LLGL::Window::GetTitle ( ) const [pure virtual]

### 7.80.2.7 virtual bool LLGL::Window::IsShown ( ) const [pure virtual]

### 7.80.2.8 void LLGL::Window::PostChar ( wchar_t *chr* )

### 7.80.2.9 void LLGL::Window::PostDoubleClick ( Key *keyCode* )

### 7.80.2.10 void LLGL::Window::PostGlobalMotion ( const Point & *motion* )

### 7.80.2.11 void LLGL::Window::PostKeyDown ( Key *keyCode* )

### 7.80.2.12 void LLGL::Window::PostKeyUp ( Key *keyCode* )

### 7.80.2.13 void LLGL::Window::PostLocalMotion ( const Point & *position* )

### 7.80.2.14 void LLGL::Window::PostQuit ( )

Posts the 'OnQuit' event to all event listeners.

**Remarks**

If at least one event listener returns false within the "OnQuit" callback, the window will not quit. If all event listener return true within the "OnQuit" callback, "ProcessEvents" will returns false from now on.

#### 7.80.2.15 void LLGL::Window::PostResize ( const Size & *clientAreaSize* )

#### 7.80.2.16 void LLGL::Window::PostWheelMotion ( int *motion* )

#### 7.80.2.17 bool LLGL::Window::ProcessEvents ( )

Processes the events for this window (i.e. mouse movement, key presses etc.).

**Returns**

Once the "PostQuit" function was called on this window object, this function returns false. This will happend, when the user clicks on the close button.

#### 7.80.2.18 virtual void LLGL::Window::ProcessSystemEvents ( ) [protected], [pure virtual]

#### 7.80.2.19 virtual WindowDescriptor LLGL::Window::QueryDesc ( ) const [pure virtual]

Query a window descriptor, which describes the current state of this window.

#### 7.80.2.20 virtual void LLGL::Window::Recreate ( const WindowDescriptor & *desc* ) [pure virtual]

Recreates the internal window object. This may invalidate the native handle previously returned by "GetNative↵Handle".

**See also**

GetNativeHandle

#### 7.80.2.21 void LLGL::Window::RemoveEventListener ( const EventListener ∗ *eventListener* )

#### 7.80.2.22 virtual void LLGL::Window::SetDesc ( const WindowDescriptor & *desc* ) [pure virtual]

Sets the new window descriptor.

#### 7.80.2.23 virtual void LLGL::Window::SetPosition ( const Point & *position* ) [pure virtual]

#### 7.80.2.24 virtual void LLGL::Window::SetSize ( const Size & *size*, bool *useClientArea* = true ) [pure virtual]

#### 7.80.2.25 virtual void LLGL::Window::SetTitle ( const std::wstring & *title* ) [pure virtual]

#### 7.80.2.26 virtual void LLGL::Window::Show ( bool *show* = true ) [pure virtual]

The documentation for this class was generated from the following file:

- Window.h

## 7.81 LLGL::WindowDescriptor Struct Reference

Window descriptor structure.

```
#include <Window.h>
```

### Public Attributes

- std::wstring title
- Point position

  *Window position (relative to the client area).*
- Size size

  *Client area size.*
- bool visible = false
- bool borderless = false
- bool resizable = false
- bool acceptDropFiles = false
- bool preventForPowerSafe = false
- bool centered = false
- const void ∗ windowContext = nullptr

  *Window context handle.*

### 7.81.1 Detailed Description

Window descriptor structure.

### 7.81.2 Member Data Documentation

#### 7.81.2.1 bool LLGL::WindowDescriptor::acceptDropFiles = false

#### 7.81.2.2 bool LLGL::WindowDescriptor::borderless = false

#### 7.81.2.3 bool LLGL::WindowDescriptor::centered = false

#### 7.81.2.4 Point LLGL::WindowDescriptor::position

Window position (relative to the client area).

#### 7.81.2.5 bool LLGL::WindowDescriptor::preventForPowerSafe = false

#### 7.81.2.6 bool LLGL::WindowDescriptor::resizable = false

#### 7.81.2.7 Size LLGL::WindowDescriptor::size

Client area size.

#### 7.81.2.8 std::wstring LLGL::WindowDescriptor::title

#### 7.81.2.9 bool LLGL::WindowDescriptor::visible = false

#### 7.81.2.10 const void∗ LLGL::WindowDescriptor::windowContext = nullptr

Window context handle.

**Remarks**

If used, this must be casted from a platform specific structure:

```
#include <LLGL/Platform/NativeHandle.h>
//...
LLGL::NativeContextHandle handle;
//handle.parentWindow = ...
windowDesc.windowContext = reinterpret_cast<const void*>(&handle);
```

The documentation for this struct was generated from the following file:

- Window.h

# Chapter 8

# File Documentation

## 8.1 Buffer.h File Reference

```
#include "Export.h"
#include "BufferFlags.h"
```

### Classes

- class LLGL::Buffer

  *Hardware buffer interface.*

### Namespaces

- LLGL

## 8.2 BufferFlags.h File Reference

```
#include "Export.h"
#include "VertexFormat.h"
#include "IndexFormat.h"
#include "RenderSystemFlags.h"
#include <string>
```

### Classes

- struct LLGL::BufferDescriptor

  *Hardware buffer descriptor structure.*
- struct LLGL::BufferDescriptor::VertexBufferDescriptor

  *Vertex buffer descriptor structure.*
- struct LLGL::BufferDescriptor::IndexBufferDescriptor
- struct LLGL::BufferDescriptor::StorageBufferDescriptor
- struct LLGL::ConstantBufferViewDescriptor

  *Constant buffer shader-view descriptor structure.*
- struct LLGL::StorageBufferViewDescriptor

  *Storage buffer shader-view descriptor structure.*

### Namespaces

- LLGL

### Enumerations

- enum LLGL::BufferType {
  LLGL::BufferType::Vertex, LLGL::BufferType::Index, LLGL::BufferType::Constant, LLGL::BufferType::Storage, LLGL::BufferType::StreamOutput }

  *Hardware buffer type enumeration.*
- enum LLGL::StorageBufferType {
  LLGL::StorageBufferType::Generic, LLGL::StorageBufferType::Buffer, LLGL::StorageBufferType::Structured←Buffer, LLGL::StorageBufferType::ByteAddressBuffer,
  LLGL::StorageBufferType::RWBuffer, LLGL::StorageBufferType::RWStructuredBuffer, LLGL::Storage←BufferType::RWByteAddressBuffer, LLGL::StorageBufferType::AppendStructuredBuffer,
  LLGL::StorageBufferType::ConsumeStructuredBuffer }

  *Storage buffer type enumeration.*

## 8.3 Color.h File Reference

```
#include <Gauss/Real.h>
#include <Gauss/Assert.h>
#include <Gauss/Tags.h>
#include <Gauss/Equals.h>
#include <algorithm>
```

### Classes

- class LLGL::Color< T, N >

  *Base color class with N components.*

### Namespaces

- LLGL

### Functions

- template<typename T >
  T LLGL::MaxColorValue ()

  *Returns the maximal color value for the data type T. By default 1.*
- template<>
  unsigned char LLGL::MaxColorValue< unsigned char > ()

  *Specialized version. For unsigned 8-bit integers, the return value is 255.*
- template<>
  bool LLGL::MaxColorValue< bool > ()

  *Specialized version. For booleans, the return value is true.*
- template<typename T , std::size_t N>
  Color< T, N > LLGL::operator+ (const Color< T, N > &lhs, const Color< T, N > &rhs)

- template<typename T , std::size_t N>
  Color< T, N > LLGL::operator- (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > LLGL::operator∗ (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > LLGL::operator/ (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > LLGL::operator∗ (const Color< T, N > &lhs, const T &rhs)
- template<typename T , std::size_t N>
  Color< T, N > LLGL::operator∗ (const T &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  Color< T, N > LLGL::operator/ (const Color< T, N > &lhs, const T &rhs)
- template<typename T , std::size_t N>
  bool LLGL::operator== (const Color< T, N > &lhs, const Color< T, N > &rhs)
- template<typename T , std::size_t N>
  bool LLGL::operator!= (const Color< T, N > &lhs, const Color< T, N > &rhs)

## 8.4 ColorRGB.h File Reference

```
#include "Color.h"
```

### Classes

- class LLGL::Color< T, 3u >

  *RGB color class with components: r, g, and b.*

### Namespaces

- LLGL

### Typedefs

- template<typename T >
  using LLGL::ColorRGBT = Color< T, 3 >
- using LLGL::ColorRGB = ColorRGBT< Gs::Real >
- using LLGL::ColorRGBb = ColorRGBT< bool >
- using LLGL::ColorRGBf = ColorRGBT< float >
- using LLGL::ColorRGBd = ColorRGBT< double >
- using LLGL::ColorRGBub = ColorRGBT< unsigned char >

## 8.5 ColorRGBA.h File Reference

```
#include "Color.h"
```

### Classes

- class LLGL::Color< T, 4u >

  *RGBA color class with components: r, g, b, and a.*

### Namespaces

- LLGL

### Typedefs

- template<typename T >
  using LLGL::ColorRGBAT = Color< T, 4 >
- using LLGL::ColorRGBA = ColorRGBAT< Gs::Real >
- using LLGL::ColorRGBAb = ColorRGBAT< bool >
- using LLGL::ColorRGBAf = ColorRGBAT< float >
- using LLGL::ColorRGBAd = ColorRGBAT< double >
- using LLGL::ColorRGBAub = ColorRGBAT< unsigned char >

## 8.6 ComputePipeline.h File Reference

```
#include "Export.h"
```

### Classes

- struct LLGL::ComputePipelineDescriptor

  *Compute pipeline descriptor structure.*
- class LLGL::ComputePipeline

  *Compute pipeline interface.*

### Namespaces

- LLGL

## 8.7 Desktop.h File Reference

```
#include "Export.h"
#include "Types.h"
#include "RenderContextDescriptor.h"
```

### Namespaces

- LLGL
- LLGL::Desktop

### Functions

- LLGL_EXPORT Size LLGL::Desktop::GetResolution ()

  *Returns the desktop resolution.*
- LLGL_EXPORT int LLGL::Desktop::GetColorDepth ()

  *Returns the desktop color depth (bits per pixel).*
- LLGL_EXPORT bool LLGL::Desktop::SetVideoMode (const VideoModeDescriptor &videoMode)

  *Sets the new specified video mode for the desktop (resolution and fullscreen mode).*
- LLGL_EXPORT bool LLGL::Desktop::ResetVideoMode ()

  *Restes the standard video mode for the desktop.*

## 8.8 Export.h File Reference

### Macros

- #define LLGL_EXPORT

### 8.8.1 Macro Definition Documentation

#### 8.8.1.1 #define LLGL_EXPORT

## 8.9 GraphicsPipeline.h File Reference

```
#include "Export.h"
#include "GraphicsPipelineFlags.h"
```

### Classes

- class LLGL::GraphicsPipeline

  *Graphics pipeline interface.*

### Namespaces

- LLGL

## 8.10 GraphicsPipelineFlags.h File Reference

```
#include "Export.h"
#include "ColorRGBA.h"
#include <vector>
#include <cstdint>
```

## Classes

- struct LLGL::DepthDescriptor

  *Depth state descriptor structure.*
- struct LLGL::StencilFaceDescriptor

  *Stencil face descriptor structure.*
- struct LLGL::StencilDescriptor

  *Stencil state descriptor structure.*
- struct LLGL::RasterizerDescriptor

  *Rasterizer state descriptor structure.*
- struct LLGL::BlendTargetDescriptor

  *Blend target state descriptor structure.*
- struct LLGL::BlendDescriptor

  *Blending state descriptor structure.*
- struct LLGL::GraphicsPipelineDescriptor

  *Graphics pipeline descriptor structure.*

## Namespaces

- LLGL

## Enumerations

- enum LLGL::PrimitiveTopology {
  LLGL::PrimitiveTopology::PointList, LLGL::PrimitiveTopology::LineList, LLGL::PrimitiveTopology::LineStrip, LLGL::PrimitiveTopology::LineLoop,
  LLGL::PrimitiveTopology::LineListAdjacency, LLGL::PrimitiveTopology::LineStripAdjacency, LLGL::↩
  PrimitiveTopology::TriangleList, LLGL::PrimitiveTopology::TriangleStrip,
  LLGL::PrimitiveTopology::TriangleFan, LLGL::PrimitiveTopology::TriangleListAdjacency, LLGL::Primitive↩
  Topology::TriangleStripAdjacency, LLGL::PrimitiveTopology::Patches1,
  LLGL::PrimitiveTopology::Patches2, LLGL::PrimitiveTopology::Patches3, LLGL::PrimitiveTopology::Patches4, LLGL::PrimitiveTopology::Patches5,
  LLGL::PrimitiveTopology::Patches6, LLGL::PrimitiveTopology::Patches7, LLGL::PrimitiveTopology::Patches8, LLGL::PrimitiveTopology::Patches9,
  LLGL::PrimitiveTopology::Patches10, LLGL::PrimitiveTopology::Patches11, LLGL::PrimitiveTopology::↩
  Patches12, LLGL::PrimitiveTopology::Patches13,
  LLGL::PrimitiveTopology::Patches14, LLGL::PrimitiveTopology::Patches15, LLGL::PrimitiveTopology::↩
  Patches16, LLGL::PrimitiveTopology::Patches17,
  LLGL::PrimitiveTopology::Patches18, LLGL::PrimitiveTopology::Patches19, LLGL::PrimitiveTopology::↩
  Patches20, LLGL::PrimitiveTopology::Patches21,
  LLGL::PrimitiveTopology::Patches22, LLGL::PrimitiveTopology::Patches23, LLGL::PrimitiveTopology::↩
  Patches24, LLGL::PrimitiveTopology::Patches25,
  LLGL::PrimitiveTopology::Patches26, LLGL::PrimitiveTopology::Patches27, LLGL::PrimitiveTopology::↩
  Patches28, LLGL::PrimitiveTopology::Patches29,
  LLGL::PrimitiveTopology::Patches30, LLGL::PrimitiveTopology::Patches31, LLGL::PrimitiveTopology::↩
  Patches32 }

  *Primitive topology enumeration.*
- enum LLGL::CompareOp {
  LLGL::CompareOp::Never, LLGL::CompareOp::Less, LLGL::CompareOp::Equal, LLGL::CompareOp::↩
  LessEqual,
  LLGL::CompareOp::Greater, LLGL::CompareOp::NotEqual, LLGL::CompareOp::GreaterEqual, LLGL::↩
  CompareOp::Ever }

  *Compare operations enumeration.*

- enum LLGL::StencilOp {
  LLGL::StencilOp::Keep, LLGL::StencilOp::Zero, LLGL::StencilOp::Replace, LLGL::StencilOp::IncClamp,
  LLGL::StencilOp::DecClamp, LLGL::StencilOp::Invert, LLGL::StencilOp::IncWrap, LLGL::StencilOp::Dec←
  Wrap }

  *Stencil operations enumeration.*
- enum LLGL::BlendOp {
  LLGL::BlendOp::Zero, LLGL::BlendOp::One, LLGL::BlendOp::SrcColor, LLGL::BlendOp::InvSrcColor,
  LLGL::BlendOp::SrcAlpha, LLGL::BlendOp::InvSrcAlpha, LLGL::BlendOp::DestColor, LLGL::BlendOp::Inv←
  DestColor,
  LLGL::BlendOp::DestAlpha, LLGL::BlendOp::InvDestAlpha }

  *Blending operations enumeration.*
- enum LLGL::BlendArithmetic {
  LLGL::BlendArithmetic::Add, LLGL::BlendArithmetic::Subtract, LLGL::BlendArithmetic::RevSubtract, LLGL←
  ::BlendArithmetic::Min,
  LLGL::BlendArithmetic::Max }

  *Blending arithmetic operations enumeration.*
- enum LLGL::PolygonMode { LLGL::PolygonMode::Fill, LLGL::PolygonMode::Wireframe, LLGL::Polygon←
  Mode::Points }

  *Polygon filling modes enumeration.*
- enum LLGL::CullMode { LLGL::CullMode::Disabled, LLGL::CullMode::Front, LLGL::CullMode::Back }

  *Polygon culling modes enumeration.*

## 8.11 Image.h File Reference

```
#include "Export.h"
#include "RenderSystemFlags.h"
#include "TextureFlags.h"
#include <memory>
```

### Classes

- struct LLGL::ImageDescriptor

  *Image descriptor structure.*

### Namespaces

- LLGL

### Typedefs

- using LLGL::ByteBuffer = std::unique_ptr< char[ ]>

  *Common byte buffer type.*

### Enumerations

- enum LLGL::DataType {
LLGL::DataType::Int8, LLGL::DataType::UInt8, LLGL::DataType::Int16, LLGL::DataType::UInt16,
LLGL::DataType::Int32, LLGL::DataType::UInt32, LLGL::DataType::Float, LLGL::DataType::Double }

  *Renderer data types enumeration.*
- enum LLGL::ImageFormat {
LLGL::ImageFormat::R, LLGL::ImageFormat::RG, LLGL::ImageFormat::RGB, LLGL::ImageFormat::BGR,
LLGL::ImageFormat::RGBA, LLGL::ImageFormat::BGRA, LLGL::ImageFormat::Depth, LLGL::Image←
Format::DepthStencil,
LLGL::ImageFormat::CompressedRGB, LLGL::ImageFormat::CompressedRGBA }

  *Image format used to write texture data.*

### Functions

- LLGL_EXPORT std::size_t LLGL::DataTypeSize (const DataType dataType)

  *Returns the size (in bytes) of the specified data type.*
- LLGL_EXPORT std::size_t LLGL::ImageFormatSize (const ImageFormat imageFormat)

  *Returns the size (in number of components) of the specified image format.*
- LLGL_EXPORT bool LLGL::IsCompressedFormat (const ImageFormat format)

  *Returns true if the specified color format is a compressed format, i.e. either ImageFormat::CompressedRGB, or ImageFormat::CompressedRGBA.*
- LLGL_EXPORT bool LLGL::IsDepthStencilFormat (const ImageFormat format)

  *Returns true if the specified color foramt is a depth-stencil format, i.e. either ImageFormat::Depth or ImageFormat← ::DepthStencil.*
- LLGL_EXPORT ByteBuffer LLGL::ConvertImageBuffer (ImageFormat srcFormat, DataType srcDataType, const void ∗srcBuffer, std::size_t srcBufferSize, ImageFormat dstFormat, DataType dstDataType, std::size_t threadCount=0)

  *Converts the image format and data type of the source image (only uncompressed color formats).*

## 8.12 IndexFormat.h File Reference

```
#include "Export.h"
#include "Image.h"
```

### Classes

- class LLGL::IndexFormat

### Namespaces

- LLGL

## 8.13 Input.h File Reference

```
#include <LLGL/Window.h>
#include <LLGL/Types.h>
#include <array>
#include <string>
```

### Classes

- class LLGL::Input

### Namespaces

- LLGL

## 8.14 Key.h File Reference

### Namespaces

- LLGL

### Enumerations

- enum LLGL::Key {
  LLGL::Key::LButton, LLGL::Key::RButton, LLGL::Key::Cancel, LLGL::Key::MButton,
  LLGL::Key::XButton1, LLGL::Key::XButton2, LLGL::Key::Back, LLGL::Key::Tab,
  LLGL::Key::Clear, LLGL::Key::Return, LLGL::Key::Shift, LLGL::Key::Control,
  LLGL::Key::Menu, LLGL::Key::Pause, LLGL::Key::Capital, LLGL::Key::Escape,
  LLGL::Key::Space, LLGL::Key::PageUp, LLGL::Key::PageDown, LLGL::Key::End,
  LLGL::Key::Home, LLGL::Key::Left, LLGL::Key::Up, LLGL::Key::Right,
  LLGL::Key::Down, LLGL::Key::Select, LLGL::Key::Print, LLGL::Key::Exe,
  LLGL::Key::Snapshot, LLGL::Key::Insert, LLGL::Key::Delete, LLGL::Key::Help,
  LLGL::Key::D0, LLGL::Key::D1, LLGL::Key::D2, LLGL::Key::D3,
  LLGL::Key::D4, LLGL::Key::D5, LLGL::Key::D6, LLGL::Key::D7,
  LLGL::Key::D8, LLGL::Key::D9, LLGL::Key::A, LLGL::Key::B,
  LLGL::Key::C, LLGL::Key::D, LLGL::Key::E, LLGL::Key::F,
  LLGL::Key::G, LLGL::Key::H, LLGL::Key::I, LLGL::Key::J,
  LLGL::Key::K, LLGL::Key::L, LLGL::Key::M, LLGL::Key::N,
  LLGL::Key::O, LLGL::Key::P, LLGL::Key::Q, LLGL::Key::R,
  LLGL::Key::S, LLGL::Key::T, LLGL::Key::U, LLGL::Key::V,
  LLGL::Key::W, LLGL::Key::X, LLGL::Key::Y, LLGL::Key::Z,
  LLGL::Key::LWin, LLGL::Key::RWin, LLGL::Key::Apps, LLGL::Key::Sleep,
  LLGL::Key::Keypad0, LLGL::Key::Keypad1, LLGL::Key::Keypad2, LLGL::Key::Keypad3,
  LLGL::Key::Keypad4, LLGL::Key::Keypad5, LLGL::Key::Keypad6, LLGL::Key::Keypad7,
  LLGL::Key::Keypad8, LLGL::Key::Keypad9, LLGL::Key::KeypadMultiply, LLGL::Key::KeypadPlus,
  LLGL::Key::KeypadSeparator, LLGL::Key::KeypadMinus, LLGL::Key::KeypadDecimal, LLGL::Key::Keypad↵
  Divide,
  LLGL::Key::F1, LLGL::Key::F2, LLGL::Key::F3, LLGL::Key::F4,
  LLGL::Key::F5, LLGL::Key::F6, LLGL::Key::F7, LLGL::Key::F8,
  LLGL::Key::F9, LLGL::Key::F10, LLGL::Key::F11, LLGL::Key::F12,
  LLGL::Key::F13, LLGL::Key::F14, LLGL::Key::F15, LLGL::Key::F16,
  LLGL::Key::F17, LLGL::Key::F18, LLGL::Key::F19, LLGL::Key::F20,
  LLGL::Key::F21, LLGL::Key::F22, LLGL::Key::F23, LLGL::Key::F24,
  LLGL::Key::NumLock, LLGL::Key::ScrollLock, LLGL::Key::LShift, LLGL::Key::RShift,
  LLGL::Key::LControl, LLGL::Key::RControl, LLGL::Key::LMenu, LLGL::Key::RMenu,
  LLGL::Key::BrowserBack, LLGL::Key::BrowserForward, LLGL::Key::BrowserRefresh, LLGL::Key::Browser↵
  Stop,
  LLGL::Key::BrowserSearch, LLGL::Key::BrowserFavorits, LLGL::Key::BrowserHome, LLGL::Key::Volume↵

Mute,
LLGL::Key::VolumeDown, LLGL::Key::VolumeUp, LLGL::Key::MediaNextTrack, LLGL::Key::MediaPrevTrack,
LLGL::Key::MediaStop, LLGL::Key::MediaPlayPause, LLGL::Key::LaunchMail, LLGL::Key::LaunchMedia↩
Select,
LLGL::Key::LaunchApp1, LLGL::Key::LaunchApp2, LLGL::Key::Plus, LLGL::Key::Comma,
LLGL::Key::Minus, LLGL::Key::Period, LLGL::Key::Exponent, LLGL::Key::Attn,
LLGL::Key::CrSel, LLGL::Key::ExSel, LLGL::Key::ErEOF, LLGL::Key::Play,
LLGL::Key::Zoom, LLGL::Key::NoName, LLGL::Key::PA1, LLGL::Key::OEMClear }

*Input key codes.*

## 8.15 LinuxNativeHandle.h File Reference

```
#include <X11/Xlib.h>
#include <X11/Xutil.h>
```

### Classes

- struct LLGL::NativeHandle

  *Linux native handle structure.*
- struct LLGL::NativeContextHandle

  *Linux native context handle structure.*

### Namespaces

- LLGL

## 8.16 LLGL.h File Reference

```
#include "Window.h"
#include "Input.h"
#include "Timer.h"
#include "RenderSystem.h"
#include "ColorRGB.h"
#include "ColorRGBA.h"
#include "Desktop.h"
```

## 8.17 Log.h File Reference

```
#include "Export.h"
#include <ostream>
```

### Namespaces

- LLGL
- LLGL::Log

### Functions

- LLGL_EXPORT void LLGL::Log::SetStdOut (std::ostream &stream)

  *Sets the standard output stream. By default std::cout.*
- LLGL_EXPORT void LLGL::Log::SetStdErr (std::ostream &stream)

  *Sets the standard output stream for error and warning messages. By default std::cerr.*
- LLGL_EXPORT std::ostream & LLGL::Log::StdOut ()

  *Returns the standard output stream.*
- LLGL_EXPORT std::ostream & LLGL::Log::StdErr ()

  *Returns the standard output stream for error and warning messages.*

## 8.18 MacOSNativeHandle.h File Reference

```
#include <Cocoa/Cocoa.h>
```

### Classes

- struct LLGL::NativeHandle

  *Linux native handle structure.*
- struct LLGL::NativeContextHandle

  *Linux native context handle structure.*

### Namespaces

- LLGL

## 8.19 NativeHandle.h File Reference

## 8.20 Query.h File Reference

```
#include "Export.h"
#include "QueryFlags.h"
```

### Classes

- class LLGL::Query

  *Query interface.*

### Namespaces

- LLGL

## 8.21 QueryFlags.h File Reference

### Classes

- struct LLGL::QueryDescriptor

  *Query descriptor structure.*

### Namespaces

- LLGL

### Enumerations

- enum LLGL::QueryType {
  LLGL::QueryType::SamplesPassed, LLGL::QueryType::AnySamplesPassed, LLGL::QueryType::Any↩
  SamplesPassedConservative, LLGL::QueryType::PrimitivesGenerated,
  LLGL::QueryType::TimeElapsed, LLGL::QueryType::StreamOutPrimitivesWritten, LLGL::QueryType::↩
  StreamOutOverflow, LLGL::QueryType::VerticesSubmitted,
  LLGL::QueryType::PrimitivesSubmitted, LLGL::QueryType::VertexShaderInvocations, LLGL::QueryType::↩
  TessControlShaderInvocations, LLGL::QueryType::TessEvaluationShaderInvocations,
  LLGL::QueryType::GeometryShaderInvocations, LLGL::QueryType::FragmentShaderInvocations, LLGL::↩
  QueryType::ComputeShaderInvocations, LLGL::QueryType::GeometryPrimitivesGenerated,
  LLGL::QueryType::ClippingInputPrimitives, LLGL::QueryType::ClippingOutputPrimitives }

  *Query type enumeration.*

## 8.22 RenderContext.h File Reference

```
#include "Export.h"
#include "Window.h"
#include "RenderContextDescriptor.h"
#include "RenderContextFlags.h"
#include "RenderSystemFlags.h"
#include "ColorRGBA.h"
#include "Buffer.h"
#include "ShaderProgram.h"
#include "Texture.h"
#include "RenderTarget.h"
#include "GraphicsPipeline.h"
#include "ComputePipeline.h"
#include "Sampler.h"
#include "Query.h"
#include <Gauss/Vector3.h>
#include <string>
#include <map>
```

### Classes

- class LLGL::RenderContext

  *Render context interface.*

### Namespaces

- LLGL

## 8.23 RenderContextDescriptor.h File Reference

```
#include "Export.h"
#include "Types.h"
#include <functional>
```

### Classes

- struct LLGL::VsyncDescriptor
- struct LLGL::AntiAliasingDescriptor
- struct LLGL::VideoModeDescriptor
- struct LLGL::ProfileOpenGLDescriptor
- struct LLGL::RenderContextDescriptor

### Namespaces

- LLGL

### Typedefs

- using LLGL::DebugCallback = std::function< void(const std::string &type, const std::string &message)>

  *Debug callback function interface.*

### Enumerations

- enum LLGL::OpenGLVersion {
  LLGL::OpenGLVersion::OpenGL_Latest = 0, LLGL::OpenGLVersion::OpenGL_1_0 = 100, LLGL::OpenGL↩
  Version::OpenGL_1_1 = 110, LLGL::OpenGLVersion::OpenGL_1_2 = 120,
  LLGL::OpenGLVersion::OpenGL_1_3 = 130, LLGL::OpenGLVersion::OpenGL_1_4 = 140, LLGL::OpenGL↩
  Version::OpenGL_1_5 = 150, LLGL::OpenGLVersion::OpenGL_2_0 = 200,
  LLGL::OpenGLVersion::OpenGL_2_1 = 210, LLGL::OpenGLVersion::OpenGL_3_0 = 300, LLGL::OpenGL↩
  Version::OpenGL_3_1 = 310, LLGL::OpenGLVersion::OpenGL_3_2 = 320,
  LLGL::OpenGLVersion::OpenGL_3_3 = 330, LLGL::OpenGLVersion::OpenGL_4_0 = 400, LLGL::OpenGL↩
  Version::OpenGL_4_1 = 410, LLGL::OpenGLVersion::OpenGL_4_2 = 420,
  LLGL::OpenGLVersion::OpenGL_4_3 = 430, LLGL::OpenGLVersion::OpenGL_4_4 = 440, LLGL::OpenGL↩
  Version::OpenGL_4_5 = 450 }
- enum LLGL::SwapChainMode { LLGL::SwapChainMode::SingleBuffering = 1, LLGL::SwapChainMode::↩
  DoubleBuffering = 2, LLGL::SwapChainMode::TripleBuffering = 3 }

  *Swap chain mode enumeration.*

### Functions

- LLGL_EXPORT bool LLGL::operator== (const VsyncDescriptor &lhs, const VsyncDescriptor &rhs)
- LLGL_EXPORT bool LLGL::operator!= (const VsyncDescriptor &lhs, const VsyncDescriptor &rhs)
- LLGL_EXPORT bool LLGL::operator== (const VideoModeDescriptor &lhs, const VideoModeDescriptor &rhs)
- LLGL_EXPORT bool LLGL::operator!= (const VideoModeDescriptor &lhs, const VideoModeDescriptor &rhs)

## 8.24 RenderContextFlags.h File Reference

### Classes

- struct LLGL::ClearBuffersFlags

  *Render context clear buffer flags.*
- struct LLGL::Viewport

  *Viewport dimensions.*
- struct LLGL::Scissor

  *Scissor dimensions.*
- union LLGL::GraphicsAPIDependentStateDescriptor

  *Low-level graphics API dependent state descriptor union.*
- struct LLGL::GraphicsAPIDependentStateDescriptor::StateOpenGLDescriptor

### Namespaces

- LLGL

### Enumerations

- enum LLGL::RenderConditionMode {
  LLGL::RenderConditionMode::Wait, LLGL::RenderConditionMode::NoWait, LLGL::RenderConditionMode↩
  ::ByRegionWait, LLGL::RenderConditionMode::ByRegionNoWait,
  LLGL::RenderConditionMode::WaitInverted, LLGL::RenderConditionMode::NoWaitInverted, LLGL::↩
  RenderConditionMode::ByRegionWaitInverted, LLGL::RenderConditionMode::ByRegionNoWaitInverted }

  *Render condition mode enumeration.*

## 8.25 RenderingDebugger.h File Reference

```
#include "Export.h"
#include <map>
#include <string>
```

### Classes

- class LLGL::RenderingDebugger

  *Rendering debugger interface.*
- class LLGL::RenderingDebugger::Message

  *Rendering debugger message class.*

### Namespaces

- LLGL

### Enumerations

- enum LLGL::ErrorType { LLGL::ErrorType::InvalidArgument, LLGL::ErrorType::InvalidState, LLGL::Error↩ Type::UnsupportedFeature }

  *Rendering debugger error types enumeration.*
- enum LLGL::WarningType { LLGL::WarningType::ImproperArgument, LLGL::WarningType::ImproperState, LLGL::WarningType::PointlessOperation }

## 8.26 RenderingProfiler.h File Reference

```
#include "Export.h"
#include "RenderContextFlags.h"
#include "GraphicsPipelineFlags.h"
```

### Classes

- class LLGL::RenderingProfiler

  *Rendering profiler model class.*
- class LLGL::RenderingProfiler::Counter

### Namespaces

- LLGL

## 8.27 RenderSystem.h File Reference

```
#include "Export.h"
#include "RenderContext.h"
#include "RenderSystemFlags.h"
#include "RenderingProfiler.h"
#include "RenderingDebugger.h"
#include "Buffer.h"
#include "Texture.h"
#include "RenderTarget.h"
#include "ShaderProgram.h"
#include "GraphicsPipeline.h"
#include "ComputePipeline.h"
#include "Sampler.h"
#include "Query.h"
#include <string>
#include <memory>
#include <vector>
```

### Classes

- class LLGL::RenderSystem

  *Render system interface.*

### Namespaces

- LLGL

## 8.28 RenderSystemFlags.h File Reference

```
#include <Gauss/Vector3.h>
#include "ColorRGBA.h"
#include <cstddef>
```

### Classes

- struct LLGL::RenderSystemConfiguration

  *Render system configuration structure.*
- struct LLGL::RendererID

  *Renderer identification number enumeration.*
- struct LLGL::RendererInfo

  *Renderer basic information structure.*
- struct LLGL::RenderingCaps

  *Rendering capabilities structure.*

### Namespaces

- LLGL

### Enumerations

- enum LLGL::BufferUsage { LLGL::BufferUsage::Static, LLGL::BufferUsage::Dynamic }

  *Hardware buffer usage enumeration.*
- enum LLGL::BufferCPUAccess { LLGL::BufferCPUAccess::ReadOnly, LLGL::BufferCPUAccess::WriteOnly, LLGL::BufferCPUAccess::ReadWrite }

  *Hardware buffer CPU acccess enumeration.*
- enum LLGL::ShadingLanguage {
  LLGL::ShadingLanguage::Unsupported = 0, LLGL::ShadingLanguage::GLSL_110 = 110, LLGL::Shading↵
  Language::GLSL_120 = 120, LLGL::ShadingLanguage::GLSL_130 = 130,
  LLGL::ShadingLanguage::GLSL_140 = 140, LLGL::ShadingLanguage::GLSL_150 = 150, LLGL::Shading↵
  Language::GLSL_330 = 330, LLGL::ShadingLanguage::GLSL_400 = 400,
  LLGL::ShadingLanguage::GLSL_410 = 410, LLGL::ShadingLanguage::GLSL_420 = 420, LLGL::Shading↵
  Language::GLSL_430 = 430, LLGL::ShadingLanguage::GLSL_440 = 440,
  LLGL::ShadingLanguage::GLSL_450 = 450, LLGL::ShadingLanguage::HLSL_2_0 = 100200, LLGL::↵
  ShadingLanguage::HLSL_2_0a = 100201, LLGL::ShadingLanguage::HLSL_2_0b = 100202,
  LLGL::ShadingLanguage::HLSL_3_0 = 100300, LLGL::ShadingLanguage::HLSL_4_0 = 100400, LLGL::↵
  ShadingLanguage::HLSL_4_1 = 100410, LLGL::ShadingLanguage::HLSL_5_0 = 100500 }

  *Shading language version enumation.*
- enum LLGL::ScreenOrigin { LLGL::ScreenOrigin::LowerLeft, LLGL::ScreenOrigin::UpperLeft }

  *Screen coordinate system origin enumeration.*
- enum LLGL::ClippingRange { LLGL::ClippingRange::MinusOneToOne, LLGL::ClippingRange::ZeroToOne }

  *Clipping depth range enumeration.*

## 8.29 RenderTarget.h File Reference

```
#include "Export.h"
#include "TextureFlags.h"
#include <Gauss/Vector2.h>
```

### Classes

- struct LLGL::RenderTargetAttachmentDescriptor

  *Render target attachment descriptor structure.*
- class LLGL::RenderTarget

  *Render target interface.*

### Namespaces

- LLGL

## 8.30 Sampler.h File Reference

```
#include "Export.h"
#include "SamplerFlags.h"
```

### Classes

- class LLGL::Sampler

  *Sampler interface.*

### Namespaces

- LLGL

## 8.31 SamplerFlags.h File Reference

```
#include "Export.h"
#include "GraphicsPipelineFlags.h"
#include "ColorRGBA.h"
#include <cstddef>
```

### Classes

- struct LLGL::SamplerDescriptor

  *Texture sampler descriptor structure.*

### Namespaces

- LLGL

### Enumerations

- enum LLGL::TextureWrap {
  LLGL::TextureWrap::Repeat, LLGL::TextureWrap::Mirror, LLGL::TextureWrap::Clamp, LLGL::TextureWrap↩
  ::Border,
  LLGL::TextureWrap::MirrorOnce }

  *Texture coordinate wrap enumeration.*
- enum LLGL::TextureFilter { LLGL::TextureFilter::Nearest, LLGL::TextureFilter::Linear }

  *Texture sampling filter enumeration.*

## 8.32 Shader.h File Reference

```
#include "Export.h"
#include "ShaderFlags.h"
```

### Classes

- class LLGL::Shader

  *Shader interface.*

### Namespaces

- LLGL

## 8.33 ShaderFlags.h File Reference

```
#include "Export.h"
#include <string>
```

### Classes

- struct LLGL::ShaderCompileFlags

  *Shader compilation flags enumeration.*
- struct LLGL::ShaderDisassembleFlags

  *Shader disassemble flags enumeration.*
- struct LLGL::ShaderStageFlags

  *Shader stage flags.*
- union LLGL::ShaderSource

  *Shader source code union.*
- struct LLGL::ShaderSource::GLSL

  *Shader source descriptor for GLSL.*
- struct LLGL::ShaderSource::HLSL

  *Shader source descriptor for HLSL.*

### Namespaces

- LLGL

### Enumerations

- enum LLGL::ShaderType {
  LLGL::ShaderType::Vertex, LLGL::ShaderType::TessControl, LLGL::ShaderType::TessEvaluation, LLGL::↩
  ShaderType::Geometry,
  LLGL::ShaderType::Fragment, LLGL::ShaderType::Compute }

  *Shader type enumeration.*

## 8.34 ShaderProgram.h File Reference

```
#include "Export.h"
#include "Shader.h"
#include "VertexAttribute.h"
#include "BufferFlags.h"
#include "ShaderUniform.h"
#include <string>
#include <vector>
```

### Classes

- class LLGL::ShaderProgram

  *Shader program interface.*

### Namespaces

- LLGL

## 8.35 ShaderUniform.h File Reference

```
#include "Export.h"
#include <string>
#include <Gauss/Vector2.h>
#include <Gauss/Vector3.h>
#include <Gauss/Vector4.h>
#include <Gauss/Matrix.h>
```

### Classes

- struct LLGL::UniformDescriptor

  *Shader uniform descriptor structure.*
- class LLGL::ShaderUniform

  *Shader uniform setter interface.*

### Namespaces

- LLGL

### Enumerations

- enum LLGL::UniformType {
  LLGL::UniformType::Float, LLGL::UniformType::Float2, LLGL::UniformType::Float3, LLGL::UniformType::↩
  Float4,
  LLGL::UniformType::Double, LLGL::UniformType::Double2, LLGL::UniformType::Double3, LLGL::Uniform↩
  Type::Double4,
  LLGL::UniformType::Int, LLGL::UniformType::Int2, LLGL::UniformType::Int3, LLGL::UniformType::Int4,
  LLGL::UniformType::Float2x2, LLGL::UniformType::Float3x3, LLGL::UniformType::Float4x4, LLGL::↩
  UniformType::Double2x2,
  LLGL::UniformType::Double3x3, LLGL::UniformType::Double4x4, LLGL::UniformType::Sampler1D, LLGL::↩
  UniformType::Sampler2D,
  LLGL::UniformType::Sampler3D, LLGL::UniformType::SamplerCube }

  *Shader uniform type enumeration.*

## 8.36 Texture.h File Reference

```
#include "Export.h"
#include "Image.h"
#include "TextureFlags.h"
#include <Gauss/Vector3.h>
```

### Classes

- class LLGL::Texture

  *Texture interface.*

### Namespaces

- LLGL

## 8.37 TextureFlags.h File Reference

```
#include "Export.h"
#include <Gauss/Vector3.h>
#include <cstddef>
```

## Classes

- struct LLGL::TextureDescriptor

    *Texture descriptor structure.*
- struct LLGL::TextureDescriptor::Texture1DDescriptor
- struct LLGL::TextureDescriptor::Texture2DDescriptor
- struct LLGL::TextureDescriptor::Texture3DDescriptor
- struct LLGL::TextureDescriptor::TextureCubeDescriptor
- struct LLGL::SubTextureDescriptor

    *Sub-texture descriptor structure.*
- struct LLGL::SubTextureDescriptor::Texture1DDescriptor
- struct LLGL::SubTextureDescriptor::Texture2DDescriptor
- struct LLGL::SubTextureDescriptor::Texture3DDescriptor
- struct LLGL::SubTextureDescriptor::TextureCubeDescriptor

## Namespaces

- LLGL

## Enumerations

- enum LLGL::TextureType {
  LLGL::TextureType::Undefined, LLGL::TextureType::Texture1D, LLGL::TextureType::Texture2D, LLGL::↩
  TextureType::Texture3D,
  LLGL::TextureType::TextureCube, LLGL::TextureType::Texture1DArray, LLGL::TextureType::Texture2DArray,
  LLGL::TextureType::TextureCubeArray }

    *Texture type enumeration.*
- enum LLGL::TextureFormat {
  LLGL::TextureFormat::Unknown, LLGL::TextureFormat::DepthComponent, LLGL::TextureFormat::Depth↩
  Stencil, LLGL::TextureFormat::R,
  LLGL::TextureFormat::RG, LLGL::TextureFormat::RGB, LLGL::TextureFormat::RGBA, LLGL::Texture↩
  Format::R8,
  LLGL::TextureFormat::R8Sgn, LLGL::TextureFormat::R16, LLGL::TextureFormat::R16Sgn, LLGL::Texture↩
  Format::R16Float,
  LLGL::TextureFormat::R32UInt, LLGL::TextureFormat::R32SInt, LLGL::TextureFormat::R32Float, LLGL::↩
  TextureFormat::RG8,
  LLGL::TextureFormat::RG8Sgn, LLGL::TextureFormat::RG16, LLGL::TextureFormat::RG16Sgn, LLGL::↩
  TextureFormat::RG16Float,
  LLGL::TextureFormat::RG32UInt, LLGL::TextureFormat::RG32SInt, LLGL::TextureFormat::RG32Float, LL↩
  GL::TextureFormat::RGB8,
  LLGL::TextureFormat::RGB8Sgn, LLGL::TextureFormat::RGB16, LLGL::TextureFormat::RGB16Sgn, LLGL↩
  ::TextureFormat::RGB16Float,
  LLGL::TextureFormat::RGB32UInt, LLGL::TextureFormat::RGB32SInt, LLGL::TextureFormat::RGB32Float,
  LLGL::TextureFormat::RGBA8,
  LLGL::TextureFormat::RGBA8Sgn, LLGL::TextureFormat::RGBA16, LLGL::TextureFormat::RGBA16Sgn,
  LLGL::TextureFormat::RGBA16Float,
  LLGL::TextureFormat::RGBA32UInt, LLGL::TextureFormat::RGBA32SInt, LLGL::TextureFormat::RGBA32↩
  Float, LLGL::TextureFormat::RGB_DXT1,
  LLGL::TextureFormat::RGBA_DXT1, LLGL::TextureFormat::RGBA_DXT3, LLGL::TextureFormat::RGBA_↩
  DXT5 }

    *Hardware texture format enumeration.*
- enum LLGL::AxisDirection {
  LLGL::AxisDirection::XPos = 0, LLGL::AxisDirection::XNeg, LLGL::AxisDirection::YPos, LLGL::Axis↩
  Direction::YNeg,
  LLGL::AxisDirection::ZPos, LLGL::AxisDirection::ZNeg }

    *Axis direction (also used for texture cube face).*

### Functions

- LLGL_EXPORT int LLGL::NumMipLevels (const Gs::Vector3i &textureSize)

  *Returns the number of MIP-map levels for a texture with the specified size.*
- LLGL_EXPORT bool LLGL::IsCompressedFormat (const TextureFormat format)

  *Returns true if the specified texture format is a compressed format, i.e. either TextureFormat::RGB_DXT1, Texture↵Format::RGBA_DXT1, TextureFormat::RGBA_DXT3, or TextureFormat::RGBA_DXT5.*

## 8.38 Timer.h File Reference

```
#include <LLGL/Export.h>
#include <memory>
```

### Classes

- class LLGL::Timer

### Namespaces

- LLGL

## 8.39 Types.h File Reference

```
#include <Gauss/Vector2.h>
```

### Namespaces

- LLGL

### Typedefs

- using LLGL::Point = Gs::Vector2i

  *2D point (integer)*
- using LLGL::Size = Gs::Vector2i

  *2D size (integer)*

## 8.40 VertexAttribute.h File Reference

```
#include "Image.h"
#include <string>
```

### Classes

- struct LLGL::VertexAttribute

  *Vertex attribute class.*

### Namespaces

- LLGL

### Functions

- LLGL_EXPORT bool LLGL::operator== (const VertexAttribute &lhs, const VertexAttribute &rhs)
- LLGL_EXPORT bool LLGL::operator!= (const VertexAttribute &lhs, const VertexAttribute &rhs)

## 8.41 VertexFormat.h File Reference

```
#include "Export.h"
#include "Image.h"
#include "VertexAttribute.h"
#include <vector>
```

### Classes

- class LLGL::VertexFormat

  *Vertex format descriptor class.*

### Namespaces

- LLGL

## 8.42 VideoAdapter.h File Reference

```
#include "Export.h"
#include <vector>
#include <string>
```

### Classes

- struct LLGL::VideoDisplayMode

  *Video display mode structure.*
- struct LLGL::VideoOutput

  *Video output structure.*
- struct LLGL::VideoAdapterDescriptor

  *Video adapter descriptor structure.*

### Namespaces

- LLGL

### Functions

- LLGL_EXPORT bool LLGL::operator== (const VideoDisplayMode &lhs, const VideoDisplayMode &rhs)
- LLGL_EXPORT bool LLGL::CompareSWO (const VideoDisplayMode &lhs, const VideoDisplayMode &rhs)

  *Compares the two video display modes in a strict-weak-order (SWO) fashion.*

## 8.43 Win32NativeHandle.h File Reference

```
#include <Windows.h>
```

### Classes

- struct LLGL::NativeHandle

  *Linux native handle structure.*
- struct LLGL::NativeContextHandle

  *Linux native context handle structure.*

### Namespaces

- LLGL

## 8.44 Window.h File Reference

```
#include <string>
#include <memory>
#include <vector>
#include <LLGL/Export.h>
#include <LLGL/Key.h>
#include <LLGL/Types.h>
```

### Classes

- struct LLGL::WindowDescriptor

  *Window descriptor structure.*
- class LLGL::Window
- class LLGL::Window::EventListener

### Namespaces

- LLGL

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