

Easy OpenGL

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# Chapter 1

## Introduction

This project provides a low-level OpenGL abstraction implemented in modern C++, using try-catch based error handling and classes representing various OpenGL objects.

### 1.1 Recommended Setup

The recommended setup is to have your main code class inherit from `egl::WindowContext` and implement your logic in the provided virtual run function.

Calling `egl::WindowContext::useContext` is recommended to avoid potential errors.

Inside of `egl::WindowContext::run` any Easy OpenGL functionality can be used safely.



# Chapter 2

## Directory Hierarchy

### 2.1 Directories

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# **Chapter 3**

## **Namespace Index**

### **3.1 Namespace List**

Here is a list of all namespaces with brief descriptions:

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# Chapter 4

## Hierarchical Index

### 4.1 Class Hierarchy

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

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egl::ProgramLinkError . . . . .	37
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# Chapter 5

## Data Structure Index

### 5.1 Data Structures

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# Chapter 6

## File Index

### 6.1 File List

Here is a list of all files with brief descriptions:

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# Chapter 7

## Directory Documentation

### 7.1 inc/EGL Directory Reference

#### Files

- file [buffer.h](#)
- file [debug.h](#)
- file [program.h](#)
- file [shader.h](#)
- file [vertexBuffer.h](#)
- file [windowContext.h](#)

### 7.2 inc Directory Reference

#### Directories

- directory [EGL](#)



# Chapter 8

## Namespace Documentation

### 8.1 egl Namespace Reference

#### Data Structures

- class [Buffer](#)  
*Exception thrown when [Program](#) linking fails.*
- class [ProgramLinkError](#)
- class [ProgramValidateError](#)  
*Exception thrown when [Program](#) validation fails, mainly used in debug builds.*
- class [Program](#)  
*[Program](#) class to abstract OpenGL [Shader](#) Programs.*
- class [ShaderCompileError](#)  
*Exception thrown when [Shader](#) compilation fails.*
- class [Shader](#)  
*[Shader](#) class to abstract OpenGL Shaders.*
- class [VertexBuffer](#)
- class [WindowContext](#)  
*An abstract class to contain an window based application.*

#### Enumerations

- enum class [BufferType](#) {  
    [Array](#) , [AtomicCounter](#) , [CopyRead](#) , [CopyWrite](#) ,  
    [DispatchIndirect](#) , [DrawIndirect](#) , [ElementArray](#) , [PixelPack](#) ,  
    [PixelUnpack](#) , [Query](#) , [ShaderStorage](#) , [Texture](#) ,  
    [TransformFeedback](#) , [Uniform](#) }  
*Enum to indicate the type of [Buffer](#).*
- enum class [BufferUsage](#) {  
    [StreamDraw](#) , [StreamRead](#) , [StreamCopy](#) , [StaticDraw](#) ,  
    [StaticRead](#) , [StaticCopy](#) , [DynamicDraw](#) , [DynamicRead](#) ,  
    [DynamicCopy](#) }  
*Enum to indicate [Buffer](#) Usage.*
- enum class [MapUsage](#) : uint32\_t {  
    [None](#) = 0 , [Read](#) = 1 << 0 , [Write](#) = 1 << 1 , [Persistent](#) = 1 << 2 ,  
    [Coherent](#) = 1 << 3 , [InvalidRange](#) = 1 << 4 , [InvalidateBuffer](#) = 1 << 5 , [FlushExplicit](#) = 1 << 6 ,  
    [Unsynchronized](#) = 1 << 7 }

- *Enum flags to indicate Buffer map usage.*
- enum class `BufferFlag` : `uint32_t` {
   
`None` = 0 , `DynamicStorage` = 1 << 0 , `MapRead` = 1 << 1 , `MapWrite` = 1 << 2 ,
   
`MapPersistent` = 1 << 3 , `MapCoherent` = 1 << 4 , `ClientStorage` = 1 << 5 }
- Enum flags for explicit Buffer usage in setStorage.*
- enum class `ShaderType` {
   
`Fragment` , `Vertex` , `Geometry` , `TessEvaluation` ,
   
`TessControl` , `Compute` }
- ShaderType enum to indicate usage.*

## Functions

- `MapUsage operator| (MapUsage a, MapUsage b)`
  - `MapUsage operator& (MapUsage a, MapUsage b)`
  - `MapUsage & operator|= (MapUsage &a, MapUsage b)`
  - `BufferFlag operator| (BufferFlag a, BufferFlag b)`
  - `BufferFlag operator& (BufferFlag a, BufferFlag b)`
  - `BufferFlag & operator|= (BufferFlag &a, BufferFlag b)`
  - unsigned int `toGLenum (BufferType type)`
    - Converts a `BufferType` enum into a `GLenum`.
  - unsigned int `toGLenum (BufferUsage usage)`
    - Converts a `BufferUsage` enum into a `GLenum`.
  - unsigned int `toGLenum (MapUsage usage)`
    - Converts a `MapUsage` enum into a `GLenum`.
  - unsigned int `toGLenum (BufferFlag flag)`
    - Converts a `BufferFlag` enum into a `GLenum`.
  - bool `validateMapUsage (MapUsage usage, std::string &error)`
    - Checks if the given `MapUsage` flag combination is valid.
  - bool `validateBufferFlag (BufferFlag flag, std::string &error)`
    - Checks if the given `BufferFlag` flag combination is valid.
  - const char \* `glErrorString (unsigned int err)`
    - Gets a c-style string from from a OpenGL enum.
  - void `glCheckError (const char *func, const char *file, int line)`
    - Checks and prints if any OpenGL error has occurred.
  - constexpr std::string `shaderTypeToString (ShaderType type)`
    - Converts the `ShaderType` enum into a `std::string`.
  - unsigned int `toGLenum (ShaderType type)`
    - Converts the `ShaderType` enum into an OpenGL enum.
  - bool `initGLFW ()`
    - Initialize GLFW.
  - void `terminateGLFW ()`
    - Terminates GLFW.
  - void `pollEvents ()`
    - Polls GLFW events.

## 8.1.1 Enumeration Type Documentation

### 8.1.1.1 BufferFlag

```
enum class egl::BufferFlag : uint32_t [strong]
```

Enum flags for explicit [Buffer](#) usage in `setStorage`.

#### Enumerator

None	
DynamicStorage	Indicates that the contents of the data store may be updated after creation through calls to <code>glBufferSubData</code> .
MapRead	Indicates that the data store may be mapped by the client for read access and a pointer in the client's address space obtained that may be read from.
MapWrite	Indicates that the data store may be mapped by the client for write access and a pointer in the client's address space obtained that may be written through.
MapPersistent	Indicates that the client may request that the server read from or write to the buffer while it is mapped. The client's pointer to the data store remains valid so long as the data store is mapped, even during execution of drawing or dispatch commands.
MapCoherent	Indicates that shared access to buffers that are simultaneously mapped for client access and are used by the server will be coherent, so long as that mapping is performed using <code>glMapBufferRange</code> .
ClientStorage	When all other criteria for the buffer storage allocation are met, this bit may be used by an implementation to determine whether to use storage that is local to the server or to the client to serve as the backing store for the buffer.

### 8.1.1.2 BufferType

```
enum class egl::BufferType [strong]
```

Enum to indicate the type of [Buffer](#).

#### Enumerator

Array	Vertex attributes.
AtomicCounter	Atomic counter storage.
CopyRead	<a href="#">Buffer</a> copy source.
CopyWrite	<a href="#">Buffer</a> copy destination.
DispatchIndirect	Indirect compute dispatch commands.
DrawIndirect	Indirect command arguments.
ElementArray	Vertex array indices.
PixelPack	Pixel read target.
PixelUnpack	Texture data source.
Query	Query result buffer.
ShaderStorage	Read-write storage for shaders.
Texture	Texture data buffer.

TransformFeedback	Transform feedback buffer.
Uniform	Uniform block storage.

### 8.1.1.3 BufferUsage

```
enum class egl::BufferUsage [strong]
```

Enum to indicate [Buffer](#) Usage.

The Usage of a [Buffer](#) can be split into two parts as follows:

The frequency of usage may be one of these:

Stream

- The data store contents will be modified once and used at most a few times.

Static

- The data store contents will be modified once and used many times.

Dynamic

- The data store contents will be modified repeatedly and used many times.

The nature of usage may be one of these:

Draw

- The data store contents are modified by the application, and used as the source for GL drawing and image specification commands.

Read

- The data store contents are modified by reading data from the GL, and used to return that data when queried by the application.

Copy

- The data store contents are modified by reading data from the GL, and used as the source for GL drawing and image specification commands.

#### Enumerator

StreamDraw	
------------	--

StreamRead	
StreamCopy	
StaticDraw	
StaticRead	
StaticCopy	
DynamicDraw	
DynamicRead	
DynamicCopy	

#### 8.1.1.4 MapUsage

```
enum class egl::MapUsage : uint32_t [strong]
```

Enum flags to indicate [Buffer](#) map usage.

##### Enumerator

None	
Read	Indicates that the returned pointer may be used to read buffer object data.
Write	Indicates that the returned pointer may be used to modify buffer object data.
Persistent	Indicates that the mapping is to be made in a persistent fashion and that the client intends to hold and use the returned pointer during subsequent GL operation.
Coherent	Indicates that a persistent mapping is also to be coherent. Coherent maps guarantee that the effect of writes to a buffer's data store by either the client or server will eventually become visible to the other without further intervention from the application.
InvalidRange	Indicates that the previous contents of the specified range may be discarded. Data within this range are undefined with the exception of subsequently written data.
InvalidateBuffer	Indicates that the previous contents of the entire buffer may be discarded. Data within the entire buffer are undefined with the exception of subsequently written data.
FlushExplicit	Indicates that one or more discrete subranges of the mapping may be modified. When this flag is set, modifications to each subrange must be explicitly flushed by calling <code>glFlushMappedBufferRange</code> .
Unsynchronized	Indicates that the GL should not attempt to synchronize pending operations on the buffer prior to returning from <code>glMapBufferRange</code> or <code>glMapNamedBufferRange</code> .

#### 8.1.1.5 ShaderType

```
enum class egl::ShaderType [strong]
```

[ShaderType](#) enum to indicate usage.

##### Enumerator

Fragment	A <a href="#">Shader</a> that is intended to run on the programmable fragment processor.
Vertex	A <a href="#">Shader</a> that is intended to run on the programmable vertex processor.

Geometry	A <a href="#">Shader</a> that is intended to run on the programmable geometry processor.
TessEvaluation	A <a href="#">Shader</a> that is intended to run on the programmable tessellation processor in the evaluation stage.
TessControl	A <a href="#">Shader</a> that is intended to run on the programmable tessellation processor in the control stage.
Compute	A <a href="#">Shader</a> intended to run on the programmable compute processor.

## 8.1.2 Function Documentation

### 8.1.2.1 glCheckError()

```
void egl::glCheckError (
    const char * func,
    const char * file,
    int line)
```

Checks and prints if any OpenGL error has occurred.

Iterates over the OpenGL error flags with glGetError and prints them until no error are found anymore.

#### Note

Mainly used in the GL\_CALL macro in the backend of the Easy OpenGL abstraction.

#### Parameters

<i>func</i>	The line of code that is being checked as a c-style string for debug output
<i>file</i>	The file in which this function was called as a c-style string for debug output
<i>line</i>	The line on which this function was called for debug output

### 8.1.2.2 glErrorString()

```
const char * egl::glErrorString (
    unsigned int err)
```

Gets a c-style string from from a OpenGL enum.

#### Note

Returns "UNKNOWN\_ERROR" if the error is not known.

Mainly used in the GL\_CALL macro in the backend of the Easy OpenGL abstraction.

#### Parameters

<i>err</i>	OpenGL error enum to get the string of
------------	--

#### Returns

c-style NULL terminated string

### 8.1.2.3 initGLFW()

```
bool egl::initGLFW ()
```

Initialize GLFW.

Sets up error callbacks and calls glfwInit.

#### Note

`egl::initGLFW` is not thread safe and may only be called from the main thread.

#### Returns

true if GLFW has been successfully initialized.

### 8.1.2.4 operator&() [1/2]

```
BufferFlag egl::operator& (
    BufferFlag a,
    BufferFlag b) [inline]
```

### 8.1.2.5 operator&() [2/2]

```
MapUsage egl::operator& (
    MapUsage a,
    MapUsage b) [inline]
```

### 8.1.2.6 operator"|"() [1/2]

```
BufferFlag egl::operator| (
    BufferFlag a,
    BufferFlag b) [inline]
```

### 8.1.2.7 operator"|"() [2/2]

```
MapUsage egl::operator| (
    MapUsage a,
    MapUsage b) [inline]
```

### 8.1.2.8 operator"|=() [1/2]

```
BufferFlag & egl::operator|= (
    BufferFlag & a,
    BufferFlag b) [inline]
```

### 8.1.2.9 operator" |=() [2/2]

```
MapUsage & egl::operator|= (
    MapUsage & a,
    MapUsage b) [inline]
```

### 8.1.2.10 pollEvents()

```
void egl::pollEvents ()
```

Polls GLFW events.

#### Note

`egl::pollEvents` is not thread safe and may only be called from the main thread.

### 8.1.2.11 shaderTypeToString()

```
std::string egl::shaderTypeToString (
    ShaderType type) [constexpr]
```

Converts the `ShaderType` enum into a `std::string`.

#### Parameters

<code>type</code>	The <code>ShaderType</code> to convert to a <code>std::string</code> .
-------------------	--

#### Returns

The name of the given `ShaderType` (if unknown "INVALID" is returned).

### 8.1.2.12 terminateGLFW()

```
void egl::terminateGLFW ()
```

Terminates GLFW.

#### Note

`egl::terminateGLFW` is not thread safe and may only be called from the main thread.

### 8.1.2.13 toGLenum() [1/5]

```
unsigned int egl::toGLenum (
    BufferFlag flag)
```

Converts a `BufferFlag` enum into a `GLenum`.

### 8.1.2.14 toGLenum() [2/5]

```
unsigned int egl::toGLenum (
    BufferType type)
```

Converts a [BufferType](#) enum into a GLenum.

#### Exceptions

<code>std::invalid_argument</code>	If the <a href="#">BufferType</a> is invalid.
------------------------------------	---

### 8.1.2.15 toGLenum() [3/5]

```
unsigned int egl::toGLenum (
    BufferUsage usage)
```

Converts a [BufferUsage](#) enum into a GLenum.

#### Exceptions

<code>std::invalid_argument</code>	If the <a href="#">BufferUsage</a> is invalid.
------------------------------------	--

### 8.1.2.16 toGLenum() [4/5]

```
unsigned int egl::toGLenum (
    MapUsage usage)
```

Converts a [MapUsage](#) enum into a GLenum.

### 8.1.2.17 toGLenum() [5/5]

```
unsigned int egl::toGLenum (
    ShaderType type)
```

Converts the [ShaderType](#) enum into an OpenGL enum.

#### Exceptions

<code>std::logic_error</code>	If the <a href="#">ShaderType</a> is invalid.
-------------------------------	---

#### Parameters

<code>type</code>	The <a href="#">ShaderType</a> to convert to a std::string.
-------------------	---

#### Returns

The resulting OpenGL enum.

### 8.1.2.18 validateBufferFlag()

```
bool egl::validateBufferFlag (
    BufferFlag flag,
    std::string & error)
```

Checks if the given [BufferFlag](#) flag combination is valid.

#### Parameters

<i>flag</i>	<a href="#">BufferFlag</a> flag combination to check
<i>error</i>	Error string output if the combination is invalid

#### Returns

true if the [BufferFlag](#) combination is valid

### 8.1.2.19 validateMapUsage()

```
bool egl::validateMapUsage (
    MapUsage usage,
    std::string & error)
```

Checks if the given [MapUsage](#) flag combination is valid.

#### Parameters

<i>usage</i>	<a href="#">MapUsage</a> flag combination to check
<i>error</i>	Error string output if the combination is invalid

#### Returns

true if the [MapUsage](#) combination is valid

# Chapter 9

## Data Structure Documentation

### 9.1 egl::Buffer Class Reference

```
#include <buffer.h>
```

#### Public Member Functions

- `Buffer ()=delete`
- `Buffer (BufferType type)`  
*Construct a new `Buffer` object of given type.*
- `Buffer (Buffer &&other)`
- `Buffer (const Buffer &other)=delete`
- `~Buffer () noexcept`
- `void bind () const`  
*Binds the `Buffer` to the appropriate binding point.*
- `int64_t size () const`  
*Returns the size in bytes of the `Buffer`.*
- `BufferType getType () const`  
*Get the Type of the `Buffer`.*
- `void setData (int64_t size, const void *data, BufferUsage usage)`  
*Set the data of the `Buffer` with a given usage.*
- template<typename T>  
`void setData (std::vector< T > data, BufferUsage usage)`  
*Set the data of the `Buffer` with a given usage.*
- `void setStorage (int64_t size, const void *data, BufferFlag flags)`  
*Set the data of the `Buffer` with given `Buffer` flags.*
- template<typename T>  
`void setStorage (std::vector< T > data, BufferFlag flags)`  
*Set the data of the `Buffer` with given `Buffer` flags.*
- `void setSubData (int64_t offset, int64_t size, const void *data)`  
*Set a subset of the data in the `Buffer`.*
- `void getSubData (int64_t offset, int64_t size, void *data)`  
*Get a subset of the data in the `Buffer`.*
- `void * map (int64_t offset, int64_t length, MapUsage access)`  
*Map a part of the `Buffer` data to the client's address space.*
- `void unmap ()`  
*Unmaps the `Buffer`.*
- `Buffer & operator= (Buffer &&other)`
- `Buffer & operator= (const Buffer &other)=delete`

## Protected Member Functions

- void `_delete()`
- void `_check()`

## Protected Attributes

- unsigned int `_id` = 0
- bool `_mapped` = false
- `MapUsage _mapUsage = MapUsage::None`
- `BufferFlag _flags = BufferFlag::None`
- `BufferType _type`

## 9.1.1 Constructor & Destructor Documentation

### 9.1.1.1 `Buffer()` [1/4]

```
egl::Buffer::Buffer () [delete]
```

### 9.1.1.2 `Buffer()` [2/4]

```
egl::Buffer::Buffer (  
    BufferType type)
```

Construct a new `Buffer` object of given type.

### 9.1.1.3 `Buffer()` [3/4]

```
egl::Buffer::Buffer (  
    Buffer && other)
```

### 9.1.1.4 `Buffer()` [4/4]

```
egl::Buffer::Buffer (  
    const Buffer & other) [delete]
```

### 9.1.1.5 `~Buffer()`

```
egl::Buffer::~Buffer () [noexcept]
```

## 9.1.2 Member Function Documentation

### 9.1.2.1 `_check()`

```
void egl::Buffer::_check () [protected]
```

### 9.1.2.2 `_delete()`

```
void egl::Buffer::_delete () [protected]
```

### 9.1.2.3 `bind()`

```
void egl::Buffer::bind () const
```

Binds the [Buffer](#) to the appropriate binding point.

### 9.1.2.4 `getSubData()`

```
void egl::Buffer::getSubData (
    int64_t offset,
    int64_t size,
    void * data)
```

Get a subset of the data in the [Buffer](#).

#### Exceptions

<code>std::runtime_error</code>	If offset is negative
<code>std::runtime_error</code>	If size is negative
<code>std::runtime_error</code>	If offset + size is greater than the size of the <a href="#">Buffer</a>
<code>std::runtime_error</code>	If the <a href="#">Buffer</a> is mapped and <a href="#">MapUsage::Persistent</a> is not set

#### Parameters

<code>offset</code>	The offset of the start of the subset to get in bytes
<code>size</code>	The size of the subset to get in bytes
<code>data</code>	The destination of the data of the subset (must be at least size bytes big)

### 9.1.2.5 `getType()`

```
BufferType egl::Buffer::getType () const
```

Get the Type of the [Buffer](#).

### 9.1.2.6 map()

```
void * egl::Buffer::map (
    int64_t offset,
    int64_t length,
    MapUsage access)
```

Map a part of the [Buffer](#) data to the client's address space.

#### Exceptions

<code>std::runtime_error</code>	If the <a href="#">Buffer</a> was already mapped
<code>std::runtime_error</code>	If length is less than or equal to 0
<code>std::runtime_error</code>	If offset is less than 0
<code>std::runtime_error</code>	If length + offset is greater than the size of the <a href="#">Buffer</a>
<code>std::runtime_error</code>	If the <a href="#">MapUsage</a> is invalid
<code>std::runtime_error</code>	If <a href="#">MapUsage::Persistent</a> was requested without <a href="#">BufferFlag::MapPersistent</a> being set through <a href="#">setStorage</a>
<code>std::runtime_error</code>	If mapping failed and a nullptr was returned

#### Parameters

<code>offset</code>	The offset of the map range into the <a href="#">Buffer</a> in bytes
<code>length</code>	The length of the map range in the <a href="#">Buffer</a> in bytes
<code>access</code>	The usage of the mapped range

#### Returns

A pointer to the beginning of the mapped range

### 9.1.2.7 operator=() [1/2]

```
Buffer & egl::Buffer::operator= (
    Buffer && other)
```

### 9.1.2.8 operator=() [2/2]

```
Buffer & egl::Buffer::operator= (
    const Buffer & other) [delete]
```

### 9.1.2.9 setData() [1/2]

```
void egl::Buffer::setData (
    int64_t size,
    const void * data,
    BufferUsage usage)
```

Set the data of the [Buffer](#) with a given usage.

#### Exceptions

<code>std::runtime_error</code>	If size is negative
---------------------------------	---------------------

#### Parameters

<code>size</code>	The size of the data in bytes
<code>data</code>	The data to store in the <a href="#">Buffer</a> (must have at least size bytes of data)
<code>usage</code>	The usage hint of the <a href="#">Buffer</a>

### 9.1.2.10 setData() [2/2]

```
template<typename T>
void egl::Buffer::setData (
    std::vector< T > data,
    BufferUsage usage) [inline]
```

Set the data of the [Buffer](#) with a given usage.

#### Parameters

<code>data</code>	The data to store in the <a href="#">Buffer</a>
<code>usage</code>	The usage hint of the <a href="#">Buffer</a>

### 9.1.2.11 setStorage() [1/2]

```
void egl::Buffer::setStorage (
    int64_t size,
    const void * data,
    BufferFlag flags)
```

Set the data of the [Buffer](#) with given [Buffer](#) flags.

#### Exceptions

<code>std::runtime_error</code>	If size is not greater than 0
<code>std::runtime_error</code>	If the <a href="#">BufferFlag</a> combination is invalid

**Parameters**

<i>size</i>	The size of the data in bytes
<i>data</i>	The data to store in the <a href="#">Buffer</a> (must have at least size bytes of data)
<i>flags</i>	The <a href="#">Buffer</a> usage flags

**9.1.2.12 setStorage() [2/2]**

```
template<typename T>
void egl::Buffer::setStorage (
    std::vector< T > data,
    BufferFlag flags) [inline]
```

Set the data of the [Buffer](#) with given [Buffer](#) flags.

**Exceptions**

<i>std::runtime_error</i>	If size is not greater than 0
<i>std::runtime_error</i>	If the <a href="#">BufferFlag</a> combination is invalid

**Parameters**

<i>data</i>	The data to store in the <a href="#">Buffer</a>
<i>flags</i>	The <a href="#">Buffer</a> usage flags

**9.1.2.13 setSubData()**

```
void egl::Buffer::setSubData (
    int64_t offset,
    int64_t size,
    const void * data)
```

Set a subset of the data in the [Buffer](#).

**Exceptions**

<i>std::runtime_error</i>	If offset is negativ
<i>std::runtime_error</i>	If size is negativ
<i>std::runtime_error</i>	If offset + size is greater than the size of the <a href="#">Buffer</a>
<i>std::runtime_error</i>	If the <a href="#">Buffer</a> is mapped and <a href="#">MapUsage::Persistent</a> is not set

**Parameters**

<i>offset</i>	The offset of the start of the subset to set in bytes
<i>size</i>	The size of the subset to set in bytes

<code>data</code>	The data of the subset (must have at least size bytes of data)
-------------------	--

### 9.1.2.14 `size()`

```
int64_t egl::Buffer::size () const
```

Returns the size in bytes of the [Buffer](#).

### 9.1.2.15 `unmap()`

```
void egl::Buffer::unmap ()
```

Unmaps the [Buffer](#).

#### Exceptions

<code>std::runtime_error</code>	If OpenGL signalled data corruption
---------------------------------	-------------------------------------

## 9.1.3 Field Documentation

### 9.1.3.1 `_flags`

```
BufferFlag egl::Buffer::_flags = BufferFlag::None [protected]
```

### 9.1.3.2 `_id`

```
unsigned int egl::Buffer::_id = 0 [protected]
```

### 9.1.3.3 `_mapped`

```
bool egl::Buffer::_mapped = false [protected]
```

### 9.1.3.4 `_mapUsage`

```
MapUsage egl::Buffer::_mapUsage = MapUsage::None [protected]
```

### 9.1.3.5 `_type`

```
BufferType egl::Buffer::_type [protected]
```

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

- inc/EGL/[buffer.h](#)

## 9.2 egl::Program Class Reference

[Program](#) class to abstract OpenGL [Shader](#) Programs.

```
#include <program.h>
```

### Public Member Functions

- [Program \(\)](#)  
*Construct an empty Program object.*
- [Program \(Program &&other\)](#)
- [Program \(const Program &\)=delete](#)
- [~Program \(\)](#)
- [void reset \(\)](#)  
*Resets the Program to an empty State.*
- [bool attached \(const Shader &shader\)](#)  
*Checks if the given Shader is attached to the Program.*
- [void attach \(const Shader &shader\)](#)  
*Attaches Shader to Program for linking.*
- [void detach \(const Shader &shader\)](#)  
*Detaches Shader from Program for linking.*
- [bool linked \(\) const](#)  
*Gets if the Program has been successfully linked.*
- [void link \(\)](#)  
*Links all attached Shaders and creates a valid Program.*
- [void bind \(\)](#)  
*Binds this Program.*
- [Program & operator= \(Program &&other\)](#)
- [Program & operator= \(const Program &\)=delete](#)

### Static Public Member Functions

- [static void unbind \(\)](#)  
*Unbinds a Program by binding id 0.*

### Protected Member Functions

- [void \\_delete \(\)](#)
- [void \\_check \(\)](#)
- [void \\_ensure \(\)](#)
- [std::string \\_getError \(\)](#)

### Protected Attributes

- [unsigned int \\_id = 0](#)
- [bool \\_linked = false](#)

## 9.2.1 Detailed Description

[Program](#) class to abstract OpenGL [Shader](#) Programs.

### Warning

[Program](#) must be deconstructed before the OpenGL context is destroyed.

This class is not guaranteed to be thread-safe.

### Note

This class owns the underlying OpenGL [Program](#) object and releases it upon destruction or [reset\(\)](#).

## 9.2.2 Constructor & Destructor Documentation

### 9.2.2.1 Program() [1/3]

```
egl::Program::Program ()
```

Construct an empty [Program](#) object.

### 9.2.2.2 Program() [2/3]

```
egl::Program::Program (
    Program && other)
```

### 9.2.2.3 Program() [3/3]

```
egl::Program::Program (
    const Program & ) [delete]
```

### 9.2.2.4 ~Program()

```
egl::Program::~Program ()
```

## 9.2.3 Member Function Documentation

### 9.2.3.1 \_check()

```
void egl::Program::_check () [protected]
```

### 9.2.3.2 \_delete()

```
void egl::Program::_delete () [protected]
```

### 9.2.3.3 `_ensure()`

```
void egl::Program::_ensure () [protected]
```

### 9.2.3.4 `_getError()`

```
std::string egl::Program::_getError () [protected]
```

### 9.2.3.5 `attach()`

```
void egl::Program::attach (
    const Shader & shader)
```

Attaches [Shader](#) to [Program](#) for linking.

#### Note

Attaching a [Shader](#) invalidates the current link state.

#### Warning

Attaching a destroyed [Shader](#) is undefined behavior.

Attached Shaders must outlive the [Program](#) (at least until linking).

#### Exceptions

<code>std::runtime_error</code>	If the <a href="#">Shader</a> has already been attached.
<code>std::logic_error</code>	If the current <a href="#">Program</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).

#### Parameters

<code>shader</code>	The <a href="#">Shader</a> that should be attached to the <a href="#">Program</a> .
---------------------	---

### 9.2.3.6 `attached()`

```
bool egl::Program::attached (
    const Shader & shader)
```

Checks if the given [Shader](#) is attached to the [Program](#).

#### Parameters

<code>shader</code>	The <a href="#">Shader</a> to check.
---------------------	--------------------------------------

**Exceptions**

<i>std::logic_error</i>	If the current <a href="#">Program</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).
-------------------------	--

**Returns**

true if the [Shader](#) is attached, false otherwise.

**9.2.3.7 bind()**

```
void egl::Program::bind ()
```

Binds this [Program](#).

**Exceptions**

<i>std::logic_error</i>	If the current <a href="#">Program</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).
<i>std::runtime_error</i>	If the <a href="#">Program</a> was not linked to avoid invalid usage.

**9.2.3.8 detach()**

```
void egl::Program::detach (
    const Shader & shader)
```

Detaches [Shader](#) from [Program](#) for linking.

**Note**

Detaching a [Shader](#) invalidates the current link state.

**Exceptions**

<i>std::runtime_error</i>	If the <a href="#">Shader</a> was not attached.
<i>std::logic_error</i>	If the current <a href="#">Program</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).

**Parameters**

<i>shader</i>	The <a href="#">Shader</a> that should be detached from the <a href="#">Program</a> .
---------------	---

### 9.2.3.9 link()

```
void egl::Program::link ()
```

Links all attached Shaders and creates a valid [Program](#).

#### Exceptions

<i>std::logic_error</i>	If the current <a href="#">Program</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).
<i>egl::ProgramLinkError</i>	If the <a href="#">Program</a> fails to link. The <a href="#">Program</a> remains in a valid state afterwards.
<i>egl::ProgramValidateError</i>	If the <a href="#">Program</a> fails to validate. This only occurs when DEBUG_BUILD is defined else the validity is not checked.

### 9.2.3.10 linked()

```
bool egl::Program::linked () const [inline]
```

Gets if the [Program](#) has been successfully linked.

#### Returns

true if the [Program](#) is linked, false otherwise.

### 9.2.3.11 operator=() [1/2]

```
Program & egl::Program::operator= (
    const Program & ) [delete]
```

### 9.2.3.12 operator=() [2/2]

```
Program & egl::Program::operator= (
    Program && other)
```

### 9.2.3.13 reset()

```
void egl::Program::reset ()
```

Resets the [Program](#) to an empty State.

#### Exceptions

<i>std::runtime_error</i>	If OpenGL failed to create a new <a href="#">Program</a> .
---------------------------	--

### 9.2.3.14 unbind()

```
void egl::Program::unbind () [static]
```

Unbinds a [Program](#) by binding id 0.

## 9.2.4 Field Documentation

### 9.2.4.1 \_id

```
unsigned int egl::Program::_id = 0 [protected]
```

### 9.2.4.2 \_linked

```
bool egl::Program::_linked = false [protected]
```

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

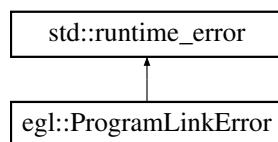
- inc/EGL/program.h

## 9.3 egl::ProgramLinkError Class Reference

Exception thrown when [Program](#) linking fails.

```
#include <program.h>
```

Inheritance diagram for egl::ProgramLinkError:



### Public Member Functions

- [ProgramLinkError](#) (const std::string &infoLog)  
*Construct a new Program Link Error object.*

### 9.3.1 Detailed Description

Exception thrown when [Program](#) linking fails.

### 9.3.2 Constructor & Destructor Documentation

#### 9.3.2.1 ProgramLinkError()

```
egl::ProgramLinkError::ProgramLinkError (
    const std::string & infoLog) [inline]
```

Construct a new [Program](#) Link Error object.

##### Parameters

<i>infoLog</i>	InfoLog buffer from glGetProgramInfoLog.
----------------	--

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

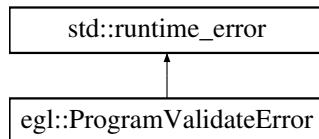
- inc/EGL/program.h

## 9.4 egl::ProgramValidationError Class Reference

Exception thrown when [Program](#) validation fails, mainly used in debug builds.

```
#include <program.h>
```

Inheritance diagram for egl::ProgramValidationError:



### Public Member Functions

- [ProgramValidationError](#) (const std::string &infoLog)

*Construct a new [Program](#) Validate Error object.*

#### 9.4.1 Detailed Description

Exception thrown when [Program](#) validation fails, mainly used in debug builds.

## 9.4.2 Constructor & Destructor Documentation

### 9.4.2.1 ProgramValidateError()

```
egl::ProgramValidateError::ProgramValidateError (
    const std::string & infoLog) [inline]
```

Construct a new [Program](#) Validate Error object.

#### Parameters

<i>infoLog</i>	InfoLog buffer from glGetProgramInfoLog.
----------------	--

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

- inc/EGL/program.h

## 9.5 egl::Shader Class Reference

[Shader](#) class to abstract OpenGL Shaders.

```
#include <shader.h>
```

#### Public Member Functions

- [Shader \(\)=delete](#)
- [Shader \(ShaderType type\)](#)

*Construct a new [Shader](#) object of given type.*
- [Shader \(ShaderType type, const char \\*src\)](#)

*Constructs and compiles a new [Shader](#) object of given type.*
- [Shader \(ShaderType type, const std::string &src\)](#)

*Constructs and compiles a new [Shader](#) object of given type.*
- [Shader \(ShaderType type, std::istream &in\)](#)

*Constructs and compiles a new [Shader](#) object of given type.*
- [Shader \(ShaderType type, std::istream &&in\)](#)

*Constructs and compiles a new [Shader](#) object of given type.*
- [Shader \(Shader &&other\)](#)
- [Shader \(const Shader &other\)=delete](#)
- [~Shader \(\) noexcept](#)
- [void reset \(\)](#)

*Resets the [Shader](#) to an empty state.*
- [bool compiled \(\) const](#)

*Gets if the [Shader](#) has been successfully compiled.*
- [ShaderType getType \(\) const](#)

*Get the type of the [Shader](#).*
- [void compile \(const char \\*src\)](#)

*Compiles the [Shader](#) with the given source.*
- [void compile \(std::istream &in\)](#)

*Compiles the [Shader](#) with the given source input stream.*
- [void compile \(std::istream &&in\)](#)

*Compiles the [Shader](#) with the given source input stream.*
- [void compile \(const std::string &str\)](#)

*Compiles the [Shader](#) with the given source.*
- [Shader & operator= \(Shader &&other\)](#)
- [Shader & operator= \(const Shader &other\)=delete](#)

## Data Fields

- friend [Program](#)

## Protected Member Functions

- void [\\_delete \(\)](#)
- void [\\_check \(\)](#)
- void [\\_ensure \(\)](#)
- std::string [\\_getError \(\)](#)

## Protected Attributes

- unsigned int [\\_id](#) = 0
- [ShaderType \\_type](#)
- bool [\\_compiled](#) = false

### 9.5.1 Detailed Description

[Shader](#) class to abstract OpenGL Shaders.

#### Warning

[Shader](#) must be deconstructed before the OpenGL context is destroyed.

This class is not guaranteed to be thread-safe.

#### Note

This class owns the underlying OpenGL [Shader](#) object and releases it upon destruction or [reset\(\)](#).

### 9.5.2 Constructor & Destructor Documentation

#### 9.5.2.1 [Shader\(\)](#) [1/8]

```
egl::Shader::Shader () [delete]
```

### 9.5.2.2 Shader() [2/8]

```
egl::Shader::Shader (
    ShaderType type)
```

Construct a new [Shader](#) object of given type.

#### Exceptions

<i>std::logic_error</i>	If the given <a href="#">ShaderType</a> is invalid.
<i>std::runtime_error</i>	If OpenGL failed to create a <a href="#">Shader</a> object.

### 9.5.2.3 Shader() [3/8]

```
egl::Shader::Shader (
    ShaderType type,
    const char * src)
```

Constructs and compiles a new [Shader](#) object of given type.

#### Exceptions

<i>std::logic_error</i>	If the given <a href="#">ShaderType</a> is invalid.
<i>std::runtime_error</i>	If OpenGL failed to create a <a href="#">Shader</a> object.
<i>std::invalid_argument</i>	If the <a href="#">Shader</a> source is NULL.
<i>egl::ShaderCompileError</i>	If the <a href="#">Shader</a> fails to compile.

### 9.5.2.4 Shader() [4/8]

```
egl::Shader::Shader (
    ShaderType type,
    const std::string & src)
```

Constructs and compiles a new [Shader](#) object of given type.

#### Exceptions

<i>std::logic_error</i>	If the given <a href="#">ShaderType</a> is invalid.
<i>std::runtime_error</i>	If OpenGL failed to create a <a href="#">Shader</a> object.
<i>std::invalid_argument</i>	If the <a href="#">Shader</a> source is NULL.
<i>egl::ShaderCompileError</i>	If the <a href="#">Shader</a> fails to compile.

### 9.5.2.5 `Shader()` [5/8]

```
egl::Shader::Shader (
    ShaderType type,
    std::istream & in)
```

Constructs and compiles a new `Shader` object of given type.

#### Exceptions

<code>std::logic_error</code>	If the given <code>ShaderType</code> is invalid.
<code>std::runtime_error</code>	If OpenGL failed to create a <code>Shader</code> object.
<code>std::invalid_argument</code>	If the istream is not good().
<code>std::invalid_argument</code>	If in fails to read the <code>Shader</code> source.
<code>std::invalid_argument</code>	If the given input stream is invalid.
<code>std::invalid_argument</code>	If the <code>Shader</code> source is NULL.
<code>egl::ShaderCompileError</code>	If the <code>Shader</code> fails to compile.

### 9.5.2.6 `Shader()` [6/8]

```
egl::Shader::Shader (
    ShaderType type,
    std::istream && in)
```

Constructs and compiles a new `Shader` object of given type.

#### Exceptions

<code>std::logic_error</code>	If the given <code>ShaderType</code> is invalid.
<code>std::runtime_error</code>	If OpenGL failed to create a <code>Shader</code> object.
<code>std::invalid_argument</code>	If the istream is not good().
<code>std::invalid_argument</code>	If in fails to read the <code>Shader</code> source.
<code>std::invalid_argument</code>	If the given input stream is invalid.
<code>std::invalid_argument</code>	If the <code>Shader</code> source is NULL.
<code>egl::ShaderCompileError</code>	If the <code>Shader</code> fails to compile.

### 9.5.2.7 `Shader()` [7/8]

```
egl::Shader::Shader (
    Shader && other)
```

### 9.5.2.8 `Shader()` [8/8]

```
egl::Shader::Shader (
    const Shader & other) [delete]
```

### 9.5.2.9 ~Shader()

```
egl::Shader::~Shader () [noexcept]
```

## 9.5.3 Member Function Documentation

### 9.5.3.1 \_check()

```
void egl::Shader::_check () [protected]
```

### 9.5.3.2 \_delete()

```
void egl::Shader::_delete () [protected]
```

### 9.5.3.3 \_ensure()

```
void egl::Shader::_ensure () [protected]
```

### 9.5.3.4 \_getError()

```
std::string egl::Shader::_getError () [protected]
```

### 9.5.3.5 compile() [1/4]

```
void egl::Shader::compile (
    const char * src)
```

Compiles the [Shader](#) with the given source.

#### Exceptions

<i>std::invalid_argument</i>	If the <a href="#">Shader</a> source is NULL.
<i>std::logic_error</i>	If the current <a href="#">Shader</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).
<i>egl::ShaderCompileError</i>	If the <a href="#">Shader</a> fails to compile.

#### Parameters

<i>src</i>	Null terminated c-style string to compile.
------------	--

### 9.5.3.6 compile() [2/4]

```
void egl::Shader::compile (
    const std::string & str)
```

Compiles the [Shader](#) with the given source.

#### Exceptions

<i>std::invalid_argument</i>	If the given input stream is invalid.
<i>std::invalid_argument</i>	If the <a href="#">Shader</a> source is NULL.
<i>std::logic_error</i>	If the current <a href="#">Shader</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).
<i>egl::ShaderCompileError</i>	If the <a href="#">Shader</a> fails to compile.

#### Parameters

<i>str</i>	Source to compile.
------------	--------------------

### 9.5.3.7 compile() [3/4]

```
void egl::Shader::compile (
    std::istream && in)
```

Compiles the [Shader](#) with the given source input stream.

#### Note

Reads the entire stream and compiles it.

#### Exceptions

<i>std::invalid_argument</i>	If the istream is not good().
<i>std::invalid_argument</i>	If in fails to read the <a href="#">Shader</a> source.
<i>std::invalid_argument</i>	If the <a href="#">Shader</a> source is NULL.
<i>std::logic_error</i>	If the current <a href="#">Shader</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).
<i>egl::ShaderCompileError</i>	If the <a href="#">Shader</a> fails to compile.

#### Parameters

<i>in</i>	Input stream to compile.
-----------	--------------------------

**9.5.3.8 compile() [4/4]**

```
void egl::Shader::compile (
    std::istream & in)
```

Compiles the [Shader](#) with the given source input stream.

**Note**

Reads the entire stream and compiles it.

**Exceptions**

<i>std::invalid_argument</i>	If the istream is not good().
<i>std::invalid_argument</i>	If in fails to read the <a href="#">Shader</a> source.
<i>std::invalid_argument</i>	If the <a href="#">Shader</a> source is NULL.
<i>std::logic_error</i>	If the current <a href="#">Shader</a> object does not exist ( <a href="#">reset()</a> is recommended to return to a valid state).
<a href="#">egl::ShaderCompileError</a>	If the <a href="#">Shader</a> fails to compile.

**Parameters**

<i>in</i>	Input stream to compile.
-----------	--------------------------

**9.5.3.9 compiled()**

```
bool egl::Shader::compiled () const [inline]
```

Gets if the [Shader](#) has been successfully compiled.

**9.5.3.10 getType()**

```
ShaderType egl::Shader::getType () const [inline]
```

Get the type of the [Shader](#).

**9.5.3.11 operator=() [1/2]**

```
Shader & egl::Shader::operator= (
    const Shader & other) [delete]
```

**9.5.3.12 operator=() [2/2]**

```
Shader & egl::Shader::operator= (
    Shader && other)
```

### 9.5.3.13 reset()

```
void egl::Shader::reset ()
```

Resets the [Shader](#) to an empty state.

#### Note

Reset creates an entirely new [Shader](#) object of the current type and therefore can be used to get a valid State as long as OpenGL doesn't fail to create a new [Shader](#) object.

#### Exceptions

<code>std::runtime_error</code>	If OpenGL failed to create a new <a href="#">Shader</a> object.
---------------------------------	---

## 9.5.4 Field Documentation

### 9.5.4.1 \_compiled

```
bool egl::Shader::_compiled = false [protected]
```

### 9.5.4.2 \_id

```
unsigned int egl::Shader::_id = 0 [protected]
```

### 9.5.4.3 \_type

```
ShaderType egl::Shader::_type [protected]
```

### 9.5.4.4 Program

```
friend egl::Shader::Program
```

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

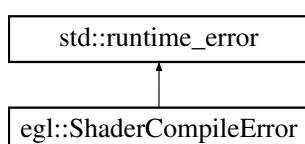
- inc/EGL/shader.h

## 9.6 egl::ShaderCompileError Class Reference

Exception thrown when [Shader](#) compilation fails.

```
#include <shader.h>
```

Inheritance diagram for egl::ShaderCompileError:



## Public Member Functions

- [ShaderCompileError \(ShaderType ShaderType, const std::string &infoLog\)](#)  
*Construct a new [Shader](#) Compile Error object.*

### 9.6.1 Detailed Description

Exception thrown when [Shader](#) compilation fails.

### 9.6.2 Constructor & Destructor Documentation

#### 9.6.2.1 ShaderCompileError()

```
egl::ShaderCompileError::ShaderCompileError (
    ShaderType ShaderType,
    const std::string & infoLog) [inline]
```

Construct a new [Shader](#) Compile Error object.

#### Parameters

<a href="#">ShaderType</a>	The type of <a href="#">Shader</a> that failed to compile.
<a href="#">infoLog</a>	InfoLog buffer from glGetShaderInfoLog.

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

- inc/EGL/shader.h

## 9.7 egl::VertexBuffer Class Reference

```
#include <vertexBuffer.h>
```

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

- inc/EGL/vertexBuffer.h

## 9.8 egl::WindowContext Class Reference

An abstract class to contain an window based application.

```
#include <windowContext.h>
```

## Public Member Functions

- `WindowContext (int width, int height, const char *windowName)`  
*Construct a new Window Context object with given height, width and name.*
- `WindowContext (WindowContext &&other)`
- `WindowContext (const WindowContext &other)=delete`
- `~WindowContext ()`
- `virtual void run ()=0`  
*Virtual run method to overload when implementing a child class.*
- `WindowContext & operator= (WindowContext &&other)`
- `WindowContext & operator= (const WindowContext &other)=delete`

## Protected Member Functions

- `void useContext ()`  
*Makes the owned window the current context.*
- `bool shouldClose ()`  
*Checks if the Window should close.*
- `void swapBuffers ()`  
*Swaps the display buffers.*

## Protected Attributes

- `GLFWwindow * window = NULL`  
*GLFW window handle for low level GLFW access.*

### 9.8.1 Detailed Description

An abstract class to contain an window based application.

Instantiates a window in the constructor using GLFW and destroys it once it goes out of scope. That window can be bound and used in the child class in the `WindowContext::run` method implementation containing the setup and rendering loop.

#### Note

Calling `useContext` is recommended in `run` to ensure the local context is used.

`egl::WindowContext` is not thread safe and may only be used on the main thread.

## 9.8.2 Constructor & Destructor Documentation

### 9.8.2.1 WindowContext() [1/3]

```
egl::WindowContext::WindowContext (
    int width,
    int height,
    const char * windowName)
```

Construct a new Window Context object with given height, width and name.

#### Exceptions

<code>std::runtime_error</code>	If GLFW could not create a Window.
<code>std::runtime_error</code>	If the GLFW Window is invalid.
<code>std::runtime_error</code>	If GLEW could not be initialized.

#### Parameters

<code>width</code>	Width of the Window in pixels.
<code>height</code>	Height of the Window in pixels.
<code>windowName</code>	C-style NULL terminated string window name.

### 9.8.2.2 WindowContext() [2/3]

```
egl::WindowContext::WindowContext (
    WindowContext && other)
```

### 9.8.2.3 WindowContext() [3/3]

```
egl::WindowContext::WindowContext (
    const WindowContext & other) [delete]
```

### 9.8.2.4 ~WindowContext()

```
egl::WindowContext::~WindowContext ()
```

## 9.8.3 Member Function Documentation

### 9.8.3.1 operator=() [1/2]

```
WindowContext & egl::WindowContext::operator= (
    const WindowContext & other) [delete]
```

### 9.8.3.2 operator=() [2/2]

```
WindowContext & egl::WindowContext::operator= (
    WindowContext && other)
```

### 9.8.3.3 run()

```
virtual void egl::WindowContext::run () [pure virtual]
```

Virtual run method to overload when implementing a child class.

Virtual run method to contain the rendering and window handling for your Application.

#### Note

Calling useContext is recommended in run to ensure the local context is used.

### 9.8.3.4 shouldClose()

```
bool egl::WindowContext::shouldClose () [protected]
```

Checks if the Window should close.

#### Exceptions

<code>std::runtime_error</code>	If the GLFW Window is invalid.
---------------------------------	--------------------------------

### 9.8.3.5 swapBuffers()

```
void egl::WindowContext::swapBuffers () [protected]
```

Swaps the display buffers.

#### Exceptions

<code>std::runtime_error</code>	If the GLFW Window is invalid.
---------------------------------	--------------------------------

### 9.8.3.6 useContext()

```
void egl::WindowContext::useContext () [protected]
```

Makes the owned window the current context.

#### Exceptions

<i>std::runtime_error</i>	If the GLFW window is invalid.
---------------------------	--------------------------------

## 9.8.4 Field Documentation

### 9.8.4.1 window

```
GLFWwindow* egl::WindowContext::window = NULL [protected]
```

GLFW window handle for low level GLFW access.

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

- inc/EGL/windowContext.h



# Chapter 10

## File Documentation

### 10.1 inc/EGL/buffer.h File Reference

```
#include <string>
#include <stdexcept>
#include <cstdint>
#include <vector>
```

#### Data Structures

- class [egl::Buffer](#)

#### Namespaces

- namespace [egl](#)

#### Enumerations

- enum class [egl::BufferType](#) {  
 egl::Array , egl::AtomicCounter , egl::CopyRead , egl::CopyWrite ,  
 egl::DispatchIndirect , egl::DrawIndirect , egl::ElementArray , egl::PixelPack ,  
 egl::PixelUnpack , egl::Query , egl::ShaderStorage , egl::Texture ,  
 egl::TransformFeedback , egl::Uniform }  
  
*Enum to indicate the type of Buffer.*
- enum class [egl::BufferUsage](#) {  
 egl::StreamDraw , egl::StreamRead , egl::StreamCopy , egl::StaticDraw ,  
 egl::StaticRead , egl::StaticCopy , egl::DynamicDraw , egl::DynamicRead ,  
 egl::DynamicCopy }  
  
*Enum to indicate Buffer Usage.*
- enum class [egl::MapUsage](#) : uint32\_t {  
 egl::None = 0 , egl::Read = 1 << 0 , egl::Write = 1 << 1 , egl::Persistent = 1 << 2 ,  
 egl::Coherent = 1 << 3 , egl::InvalidRange = 1 << 4 , egl::InvalidateBuffer = 1 << 5 , egl::FlushExplicit = 1  
 << 6 ,  
 egl::Unsynchronized = 1 << 7 }  
  
*Enum flags to indicate Buffer map usage.*
- enum class [egl::BufferFlag](#) : uint32\_t {  
 egl::None = 0 , egl::DynamicStorage = 1 << 0 , egl::MapRead = 1 << 1 , egl::MapWrite = 1 << 2 ,  
 egl::MapPersistent = 1 << 3 , egl::MapCoherent = 1 << 4 , egl::ClientStorage = 1 << 5 }  
  
*Enum flags for explicit Buffer usage in setStorage.*

## Functions

- `MapUsage egl::operator| (MapUsage a, MapUsage b)`
- `MapUsage egl::operator& (MapUsage a, MapUsage b)`
- `MapUsage & egl::operator|= (MapUsage &a, MapUsage b)`
- `BufferFlag egl::operator| (BufferFlag a, BufferFlag b)`
- `BufferFlag egl::operator& (BufferFlag a, BufferFlag b)`
- `BufferFlag & egl::operator|= (BufferFlag &a, BufferFlag b)`
- `unsigned int egl::toGLenum (BufferType type)`  
`Converts a BufferType enum into a Glenum.`
- `unsigned int egl::toGLenum (BufferUsage usage)`  
`Converts a BufferUsage enum into a Glenum.`
- `unsigned int egl::toGLenum (MapUsage usage)`  
`Converts a MapUsage enum into a Glenum.`
- `unsigned int egl::toGLenum (BufferFlag flag)`  
`Converts a BufferFlag enum into a Glenum.`
- `bool egl::validateMapUsage (MapUsage usage, std::string &error)`  
`Checks if the given MapUsage flag combination is valid.`
- `bool egl::validateBufferFlag (BufferFlag flag, std::string &error)`  
`Checks if the given BufferFlag flag combination is valid.`

## 10.2 buffer.h

[Go to the documentation of this file.](#)

```

00001 #ifndef EGL_BUFFER_H
00002 #define EGL_BUFFER_H
00003
00004 #include <string>
00005 #include <stdexcept>
00006 #include <cstdint>
00007 #include <vector>
00008
00009 namespace egl {
00010
00014 enum class BufferType {
00015     Array,
00016     AtomicCounter,
00017     CopyRead,
00018     CopyWrite,
00019     DispatchIndirect,
00020     DrawIndirect,
00021     ElementArray,
00022     PixelPack,
00023     PixelUnpack,
00024     Query,
00025     ShaderStorage,
00026     Texture,
00027     TransformFeedback,
00028     Uniform
00029 };
00030
00059 enum class BufferUsage {
00060     StreamDraw,
00061     StreamRead,
00062     StreamCopy,
00063     StaticDraw,
00064     StaticRead,
00065     StaticCopy,
00066     DynamicDraw,
00067     DynamicRead,
00068     DynamicCopy
00069 };
00070
00074 enum class MapUsage : uint32_t {
00075     None          = 0,
00076     Read          = 1 << 0,
00077     Write         = 1 << 1,
00078     Persistent    = 1 << 2,

```

```
00079     Coherent          = 1 << 3,
00080     InvalidRange       = 1 << 4,
00081     InvalidateBuffer  = 1 << 5,
00082     FlushExplicit      = 1 << 6,
00083     Unsynchronized     = 1 << 7
00084 };
00085
00086 inline MapUsage operator|(MapUsage a, MapUsage b) {
00087     return static_cast<MapUsage>(
00088         static_cast<uint32_t>(a) | static_cast<uint32_t>(b)
00089     );
00090 }
00091
00092 inline MapUsage operator&(MapUsage a, MapUsage b) {
00093     return static_cast<MapUsage>(
00094         static_cast<uint32_t>(a) & static_cast<uint32_t>(b)
00095     );
00096 }
00097
00098 inline MapUsage& operator|=(MapUsage& a, MapUsage b) {
00099     a = a | b;
00100     return a;
00101 }
00102
00103 enum class BufferFlag : uint32_t {
00104     None          = 0,
00105     DynamicStorage = 1 << 0,
00106     MapRead        = 1 << 1,
00107     MapWrite        = 1 << 2,
00108     MapPersistent   = 1 << 3,
00109     MapCoherent     = 1 << 4,
00110     ClientStorage   = 1 << 5
00111 };
00112
00113 inline BufferFlag operator|(BufferFlag a, BufferFlag b) {
00114     return static_cast<BufferFlag>(
00115         static_cast<uint32_t>(a) | static_cast<uint32_t>(b)
00116     );
00117 }
00118
00119 inline BufferFlag operator&(BufferFlag a, BufferFlag b) {
00120     return static_cast<BufferFlag>(
00121         static_cast<uint32_t>(a) & static_cast<uint32_t>(b)
00122     );
00123 }
00124
00125 inline BufferFlag& operator|=(BufferFlag& a, BufferFlag b) {
00126     a = a | b;
00127     return a;
00128 }
00129
00130 unsigned int toGLenum(BufferType type);
00131
00132
00133 unsigned int toGLenum(BufferUsage usage);
00134
00135 unsigned int toGLenum(MapUsage usage);
00136
00137 unsigned int toGLenum(BufferFlag flag);
00138
00139
00140 bool validateMapUsage(MapUsage usage, std::string& error);
00141
00142 bool validateBufferFlag(BufferFlag flag, std::string& error);
00143
00144
00145 class Buffer {
00146 protected:
00147     unsigned int _id = 0;
00148     bool _mapped = false;
00149     MapUsage _mapUsage = MapUsage::None;
00150     BufferFlag _flags = BufferFlag::None;
00151     BufferType _type;
00152
00153     void _delete();
00154     void _check();
00155
00156 public:
00157     Buffer() = delete;
00158     Buffer(BufferType type);
00159     Buffer(Buffer&& other);
00160     Buffer(const Buffer& other) = delete;
00161     ~Buffer() noexcept;
00162
00163     void bind() const;
00164
00165     int64_t size() const;
00166
00167     BufferType getType() const;
00168 }
```

```

00222     void setData(int64_t size, const void* data, BufferUsage usage);
00223
00230     template <typename T>
00231     void setData(std::vector<T> data, BufferUsage usage) { setData(data.size() * sizeof(T),
00232     (void*)data.data(), usage); }
00232
00243     void setStorage(int64_t size, const void* data, BufferFlag flags);
00244
00254     template <typename T>
00255     void setStorage(std::vector<T> data, BufferFlag flags) { setStorage(data.size() * sizeof(T),
00256     (void*)data.data(), flags); }
00256
00269     void setSubData(int64_t offset, int64_t size, const void* data);
00270
00283     void getSubData(int64_t offset, int64_t size, void* data);
00284
00302     void* map(int64_t offset, int64_t length, MapUsage access);
00303
00309     void unmap();
00310
00311     Buffer& operator=(Buffer&& other);
00312     Buffer& operator=(const Buffer& other) = delete;
00313 };
00314
00315 }
00316
00317 #endif

```

## 10.3 inc/EGL/debug.h File Reference

### Namespaces

- namespace `egl`

### Macros

- `#define GL_CALL(x)`  
*Runs the given code and checks for errors.*
- `#define DEBUG_ONLY(x)`  
*Runs given code only if DEBUG\_BUILD is defined.*

### Functions

- `const char * egl::glErrorString (unsigned int err)`  
*Gets a c-style string from from a OpenGL enum.*
- `void egl::glCheckError (const char *func, const char *file, int line)`  
*Checks and prints if any OpenGL error has occurred.*

### 10.3.1 Macro Definition Documentation

#### 10.3.1.1 DEBUG\_ONLY

```
#define DEBUG_ONLY(
    x)
```

##### Value:

```
((void)0)
```

Runs given code only if DEBUG\_BUILD is defined.

### 10.3.1.2 GL\_CALL

```
#define GL_CALL(  
    x)
```

**Value:**

x

Runs the given code and checks for errors.

**Note**

For performance reasons `egl::glCheckError` is only called when `DEBUG_BUILD` is defined.

**Warning**

The code is run in a scope below the current.

**Parameters**

x	The code to run before checking for errors
---	--

## 10.4 debug.h

[Go to the documentation of this file.](#)

```
00001 #ifndef EGL_DEBUG_H  
00002 #define EGL_DEBUG_H  
00003  
00004 namespace egl {  
00005  
00015 const char* glErrorString(unsigned int err);  
00016  
00028 void glCheckError(const char* func, const char* file, int line);  
00029  
00030 };  
00031  
00040  
00044  
00045 #ifdef DEBUG_BUILD  
00046  
00047     #define GL_CALL(x) do { x; egl::glCheckError(#x, __FILE__, __LINE__); } while(0)  
00048  
00049     #define DEBUG_ONLY(x) x  
00050  
00051 #else  
00052  
00053     #define GL_CALL(x) x  
00054  
00055     #define DEBUG_ONLY(x) ((void)0)  
00056  
00057 #endif  
00058  
00059 #endif
```

## 10.5 inc/EGL/mainpage.md File Reference

## 10.6 inc/EGL/program.h File Reference

```
#include <string>  
#include <stdexcept>
```

## Data Structures

- class `egl::ProgramLinkError`  
*Exception thrown when Program linking fails.*
- class `egl::ProgramValidateError`  
*Exception thrown when Program validation fails, mainly used in debug builds.*
- class `egl::Program`  
*Program class to abstract OpenGL Shader Programs.*

## Namespaces

- namespace `egl`

## 10.7 program.h

Go to the documentation of this file.

```

00001 #ifndef EGL_PROGRAM_H
00002 #define EGL_PROGRAM_H
00003
00004 #include <string>
00005 #include <stdexcept>
00006
00007 namespace egl {
00008
00009 class Shader;
00010
00014 class ProgramLinkError : public std::runtime_error {
00015 public:
00021     ProgramLinkError(const std::string& infoLog)
00022         : std::runtime_error(
00023             "Program link failed:\n" + infoLog) {}
00024 };
00025
00029 class ProgramValidateError : public std::runtime_error {
00030 public:
00036     ProgramValidateError(const std::string& infoLog)
00037         : std::runtime_error(
00038             "Program validation failed:\n" + infoLog) {}
00039 };
00040
00050 class Program {
00051 protected:
00052     unsigned int _id = 0;
00053     bool _linked = false;
00054
00055     void _delete();
00056     void _check();
00057     void _ensure();
00058     std::string _getError();
00059
00060 public:
00064     Program();
00065     Program(Program&& other);
00066     Program(const Program&) = delete; // OpenGL Programs are not copy safe
00067     ~Program();
00068
00074     void reset();
00075
00085     bool attached(const Shader& shader);
00086
00100    void attach(const Shader& shader);
00101
00112    void detach(const Shader& shader);
00113
00119    bool linked() const { return _linked; }
00120
00128    void link();
00129
00136    void bind();
00137
00141    static void unbind();
00142

```

```
00143     Program& operator=(Program&& other);
00144     Program& operator=(const Program&) = delete; // OpenGL Programs are not copy safe
00145 };
00146
00147 }
00148
00149 #endif
```

## 10.8 inc/EGL/shader.h File Reference

```
#include <string>
#include <stdexcept>
#include <iostream>
```

### Data Structures

- class `egl::ShaderCompileError`  
*Exception thrown when `Shader` compilation fails.*
- class `egl::Shader`  
*`Shader` class to abstract OpenGL Shaders.*

### Namespaces

- namespace `egl`

### Enumerations

- enum class `egl::ShaderType` {  
  `egl::Fragment` , `egl::Vertex` , `egl::Geometry` , `egl::TessEvaluation` ,  
  `egl::TessControl` , `egl::Compute` }  
*`ShaderType` enum to indicate usage.*

### Functions

- `constexpr std::string egl::shaderTypeToString (ShaderType type)`  
*Converts the `ShaderType` enum into a `std::string`.*
- `unsigned int egl::toGLenum (ShaderType type)`  
*Converts the `ShaderType` enum into an OpenGL enum.*

## 10.9 shader.h

[Go to the documentation of this file.](#)

```

00001 #ifndef EGL_SHADER_H
00002 #define EGL_SHADER_H
00003
00004 #include <string>
00005 #include <stdexcept>
00006 #include <iostream> // std::istream forward-declared
00007
00008 namespace egl {
00009
00010 class Program;
00011
00015 enum class ShaderType {
00016     Fragment,
00017     Vertex,
00018     Geometry,
00019     TessEvaluation,
00020     TessControl,
00021     Compute
00022 };
00023
00030 constexpr std::string shaderTypeToString(ShaderType type);
00031
00040 unsigned int toGLenum(ShaderType type);
00041
00045 class ShaderCompileError : public std::runtime_error {
00046 public:
00053     ShaderCompileError(ShaderType ShaderType,
00054             const std::string& infoLog)
00055         : std::runtime_error(
00056             "Shader compile failed (" + shaderTypeToString(ShaderType) + "):\n" + infoLog) {}
00057 };
00058
00068 class Shader {
00069 protected:
00070     unsigned int _id = 0;
00071     ShaderType _type;
00072     bool _compiled = false;
00073
00074     void _delete();
00075     void _check();
00076     void _ensure();
00077     std::string _getError();
00078
00079 public:
00080     Shader() = delete;
00081     Shader(ShaderType type);
00096     Shader(ShaderType type, const char* src);
00105     Shader(ShaderType type, const std::string& src);
00117     Shader(ShaderType type, std::istream& in);
00129     Shader(ShaderType type, std::istream&& in);
00130
00131     Shader(Shader&& other);
00132     Shader(const Shader& other) = delete; // OpenGL Shaders are not copy safe
00133     ~Shader() noexcept;
00134
00143     void reset();
00144
00148     bool compiled() const { return _compiled; }
00149
00153     ShaderType getType() const { return _type; }
00154
00164     void compile(const char* src);
00165
00179     void compile(std::istream& in);
00180
00194     void compile(std::istream&& in);
00195
00206     void compile(const std::string& str);
00207
00208     friend Program;
00209
00210     Shader& operator=(Shader&& other);
00211     Shader& operator=(const Shader& other) = delete; // OpenGL Shaders are not copy safe
00212 };
00213
00214 }
00215
00216 #endif

```

## 10.10 inc/EGL/vertexBuffer.h File Reference

### Data Structures

- class [egl::VertexBuffer](#)

### Namespaces

- namespace [egl](#)

## 10.11 vertexBuffer.h

[Go to the documentation of this file.](#)

```
00001 #ifndef EGL_VERTEX_BUFFER_H
00002 #define EGL_VERTEX_BUFFER_H
00003
00004 namespace egl {
00005
00006 class VertexBuffer {
00007 };
00008 }
00009
00010 }
00011
00012 #endif
```

## 10.12 inc/EGL/windowContext.h File Reference

```
#include <GLFW/glfw3.h>
```

### Data Structures

- class [egl::WindowContext](#)  
*An abstract class to contain an window based application.*

### Namespaces

- namespace [egl](#)

### Functions

- bool [egl::initGLFW \(\)](#)  
*Initialize GLFW.*
- void [egl::terminateGLFW \(\)](#)  
*Terminates GLFW.*
- void [egl::pollEvents \(\)](#)  
*Polls GLFW events.*

## 10.13 windowContext.h

[Go to the documentation of this file.](#)

```
00001 #ifndef WINDOW_CONTEXT
00002 #define WINDOW_CONTEXT
00003
00004 #include <GLFW/glfw3.h>
00005
00006 namespace egl {
00007
00017 bool initGLFW();
00018
00024 void terminateGLFW();
00025
00031 void pollEvents();
00032
00042 class WindowContext {
00043 private:
00044     bool _ownsGLFW = false;
00045
00046 protected:
00050     GLFWwindow* window = NULL;
00051
00057     void useContext();
00058
00064     bool shouldClose();
00065
00071     void swapBuffers();
00072
00073 public:
00085     WindowContext(int width, int height, const char* windowName);
00086     WindowContext(WindowContext&& other);
00087     WindowContext(const WindowContext& other) = delete;
00088     ~WindowContext();
00089
00097     virtual void run() = 0;
00098
00099     WindowContext& operator=(WindowContext&& other);
00100     WindowContext& operator=(const WindowContext& other) = delete;
00101 };
00102
00103 }
00104
00105 #endif
```

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