

# User Manual **NanoLib**

## C++

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## 1 Document aim and conventions

This document describes the setup and use of the *NanoLib* library and contains a reference to all classes and functions for programming your own control software for Nanotec controllers. We use the following typefaces:

Underlined text marks a cross reference or hyperlink.

- Example 1: For exact instructions on the NanoLibAccessor, see Setup.
- Example 2: Install the lxxat driver and connect the CAN-to-USB adapter.

*Italic text* means: This is a *named object*, a *menu path / item*, a *tab / file name* or (if necessary) a *foreign-language* expression.

- Example 1: Select *File > New > Blank Document*. Open the *Tool* tab and select *Comment*.
- Example 2: This document divides users (= *Nutzer; usuario; utente; utilisateur; utente* etc.) from:
  - Third-party user (= *Drittnutzer; tercero usuario; terceiro utente; tiers utilisateur; terzo utente* etc.).
  - End user (= *Endnutzer; usuario final; utente final; utilisateur final; utente finale* etc.).

Courier marks code blocks or programming commands.

- Example 1: Via Bash, call `sudo make install` to copy shared objects; then call `ldconfig`.
- Example 2: Use the following NanoLibAccessor function to change the logging level in NanoLib:

```
//
    ***** C++ variant *****
void setLoggingLevel(LogLevel level);
```

**Bold text** emphasizes individual words of **critical** importance. Alternatively, bracketed exclamation marks emphasize the critical(!) importance.

- Example 1: Protect yourself, others and your equipment. Follow our **general** safety notes that are generally applicable to **all** Nanotec products.
- Example 2: For your own protection, also follow **specific** safety notes that apply to **this** specific product.

The verb *to co-click* means a click via secondary mouse key to open a context menu etc.

- Example 1: Co-click on the file, select *Rename*, and rename the file.
- Example 2: To check the properties, co-click on the file and select *Properties*.

## 2 Before you start

Before you start using *NanoLib*, do prepare your PC and inform yourself about the intended use and the library limitations.

### 2.1 System and hardware requirements

#### NOTICE



#### Malfunction from 32-bit operation!

- ▶ Use, and consistently maintain, a 64-bit system.
- ▶ Follow valid OEM instructions.

*NanoLib 1.2.0* supports all Nanotec products with CANopen, Modbus RTU (also USB on virtual *com* port), Modbus TCP, EtherCat, and Profinet. For **older** NanoLibs: See changelog in the imprint. At **your** risk only: legacy-system use. **Note:** Follow valid OEM instructions to set the latency as low as possible if you face problems when using an FTDI-based USB adapter.

#### Requirements (64-bit system mandatory)

Windows 10 or 11 w/ *Visual Studio*

- C++ *redistributables* 2017 or higher
- CANopen: *Ixxat* VCI driver (optional)
- EtherCat module / Profinet DCP: *Npcap* or *WinPcap*
- RESTful module: *Npcap*, *WinPcap*, or admin permission to communicate w/ Ethernet bootloaders

Linux w/ *Ubuntu 18 to 24* (all x64 and arm64)

- Kernel headers and *libpopt-dev* packet
- Profinet DCP: `CAP_NET_ADMIN` and `CAP_NET_RAW` abilities
- CANopen: *Ixxat* ECI driver or *Peak* PCAN-USB adapter
- EtherCat: `CAP_NET_ADMIN`, `CAP_NET_RAW` and `CAP_SYS_NICE` abilities
- RESTful: `CAP_NET_ADMIN` ability to communicate w/ Ethernet bootloaders (also recommended: `CAP_NET_RAW`)

#### Language, fieldbus adapters, cables

C++ GCC 7 or higher

- EtherCAT: *Ethernet cable*
- VCP / USB hub: *now uniform USB*
- USB mass storage: *USB cable*
- REST: *Ethernet cable*
- CANopen: *Ixxat USB-to-CAN V2*; *Nanotec ZK-USB-CAN-1*. **No** *Ixxat* support for *Ubuntu* on *arm64*
- Modbus RTU: *Nanotec ZK-USB-RS-485-1* or equivalent adapter; USB cable on virtual *com* port (VCP)
- Modbus TCP: *Ethernet cable as per product datasheet*

### 2.2 Intended use and audience

*NanoLib* is a program library and software component for the operation of, and communication with, Nanotec controllers in a wide range of industrial applications – and for duly skilled programmers only.

Due to real-time incapable hardware (PC) and operating system, *NanoLib* is not for use in applications that need synchronous multi-axis movement or are generally time-sensitive.

In no case may you integrate *NanoLib* as a safety component into a product or system. On delivery to end users, you must add corresponding warning notices and instructions for safe use and safe operation to each product with a Nanotec-manufactured component. You must pass all Nanotec-issued warning notices right to the end user.

### 2.3 Scope of delivery and warranty

*NanoLib* comes as a \*.zip folder from our download website for either EMEA / APAC or AMERICA. Duly store and unzip your download before setup. The *NanoLib* package contains:

- Interface headers as source code (API)
- Libraries that facilitate communication: *nanolibm\_[yourfieldbus].dll* etc.
- Core functions as libraries in binary format: *nanolib.dll*
- Example project: *NanolibExample.sln* (Visual Studio project) and *nanolib\_example.cpp* (main file)

For scope of warranty, please observe a) our terms and conditions for either EMEA / APAC or AMERICA and b) all license terms. **Note:** Nanotec is not liable for faulty or undue quality, handling, installation, operation, use, and maintenance of third-party equipment! For due safety, always follow valid OEM instructions.

### 3 The *NanoLib* architecture

*NanoLib*'s modular software structure lets you arrange freely customizable motor controller / fieldbus functions around a strictly pre-built core. *NanoLib* contains the following modules:

| <b>User interface (API)</b>  | <b>NanoLib core</b>   | <b>Communication libraries</b>   |
|--|---|--|
| Interface and helper classes which   | Libraries which   | Fieldbus-specific libraries which  |
| <ul style="list-style-type: none"> <li>■ access you to your controller's OD (object dictionary)</li> <li>■ base on the <i>NanoLib</i> core functionalities.</li> </ul> | <ul style="list-style-type: none"> <li>■ implement the API functionality</li> <li>■ interact with bus libraries.</li> </ul> | <ul style="list-style-type: none"> <li>■ do interface between <i>NanoLib</i> core and bus hardware.</li> </ul> |

#### 3.1 User interface

The user interface consists of header interface files you can use to access the controller parameters. The user interface classes as described in the [Classes / functions reference](#) allow you to:

- Connect to both the hardware (fieldbus adapter) and the controller device.
- Access the OD of the device, to read/write the controller parameters.

#### 3.2 *NanoLib* core

The *NanoLib* core comes with the import library *nanolib.lib*. It implements the user interface functionality and is responsible for:

- Loading and managing the communication libraries.
- Providing the user interface functionalities in the [NanoLibAccessor](#). This communication entry point defines a set of operations you can execute on the *NanoLib* core and communication libraries.

#### 3.3 Communication libraries

In addition to *nanotec.services.nanolib.dll* (useful for your optional *Plug & Drive Studio*), *NanoLib* offers the following communication libraries:

- |                               |                                   |                                |
|-------------------------------|-----------------------------------|--------------------------------|
| ■ <i>nanolibm_canopen.dll</i> | ■ <i>nanolibm_ethernet.dll</i>    | ■ <i>nanolibm_usbmsc.dll</i>   |
| ■ <i>nanolibm_modbus.dll</i>  | ■ <i>nanolibm_restful-api.dll</i> | ■ <i>nanolibm_profinet.dll</i> |

All libraries lay a hardware abstraction layer between core and controller. The core loads them at startup from the designated project folder and uses them to establish communication with the controller by corresponding protocol.

## 4 Getting started

Read how to set up *NanoLib* for your operating system duly and how to connect hardware as needed.

### 4.1 Prepare your system

Before installing the adapter drivers, do prepare your PC along the operating system first. To prepare the PC along your Windows OS, install *MS Visual Studio* with C++ extensions. To install *make* and *gcc* by *Linux Bash*, call `sudo apt install build-essentials`. Do then enable `CAP_NET_ADMIN`, `CAP_NET_RAW`, and `CAP_SYS_NICE` capabilities for the application that uses *NanoLib*:

1. Call `sudo setcap 'cap_net_admin,cap_net_raw,cap_sys_nice+eip' <application_name>`.
2. Only then, install your adapter drivers.

### 4.2 Install the *Ixxat* adapter driver for Windows

Only after due driver installation, you may use *Ixxat's USB-to-CAN V2* adapter. Read the USB drives' product manual, to learn if / how to activate the virtual comport (VCP).

1. Download and install *Ixxat's VCI 4* driver for Windows from [www.ixxat.com](http://www.ixxat.com).
2. Connect *Ixxat's USB-to-CAN V2* compact adapter to the PC via USB.
3. By Device Manager: Check if both driver and adapter are duly installed/recognized.

### 4.3 Install the *Peak* adapter driver for Windows

Only after due driver installation, you may use *Peak's PCAN-USB* adapter. Read the USB drives' product manual, to learn if / how to activate the virtual comport (VCP).

1. Download and install the Windows device driver setup (= installation package w/ device drivers, tools, and APIs) from <http://www.peak-system.com>.
2. Connect *Peak's PCAN-USB* adapter to the PC via USB.
3. By Device Manager: Check if both driver and adapter are duly installed/recognized.

### 4.4 Install the *Ixxat* adapter driver for Linux

Only after due driver installation, you may use *Ixxat's USB-to-CAN V2* adapter. **Note:** Other supported adapters need your permissions by `sudo chmod +777/dev/ttyACM* (* device number)`. Read the USB drives' product manual, to learn if / how to activate the virtual comport (VCP).

1. Install the software needed for the ECI driver and demo application:

```
sudo apt-get update
apt-get install libusb-1.0-0-dev libusb-0.1-4 libc6 libstdc++6 libgcc1 build-essential
```

2. Download the ECI-for-Linux driver from [www.ixxat.com](http://www.ixxat.com). Unzip it via:

```
unzip eci_driver_linux_amd64.zip
```

3. Install the driver via:

```
cd /EciLinux_amd/src/KernelModule
sudo make install-usb
```

4. Check for successful driver installation by compiling and starting the demo application:

```
cd /EciLinux_amd/src/EciDemos/
sudo make
cd /EciLinux_amd/bin/release/
./LinuxEciDemo
```



## 4.5 Install the *Peak* adapter driver for Linux

Only after due driver installation, you may use Peak's *PCAN-USB* adapter. **Note:** Other supported adapters need your permissions by `sudo chmod +777/dev/ttyACM* (* device number)`. Read the USB drives' product manual, to learn if / how to activate the virtual comport (VCP).

1. Check if your Linux has kernel headers: `ls /usr/src/linux-headers-`uname -r``. **If not**, install them:

```
sudo apt-get install linux-headers-`uname -r`
```

2. Only now, install the *libpopt-dev* packet:

```
sudo apt-get install libpopt-dev
```

3. Download the needed driver package (*peak-linux-driver-xxx.tar.gz*) from [www.peak-system.com](http://www.peak-system.com).

4. To unpack it, use:

```
tar xzf peak-linux-driver-xxx.tar.gz
```

5. In the unpacked folder: Compile and install the drivers, PCAN base library, etc.:

```
make all
```

```
sudo make install
```

6. To check the function, plug the PCAN-USB adapter in.

- a) Check the kernel module:

```
lsmod | grep pcan
```

- b) ... and the shared library:

```
ls -l /usr/lib/libpcan*
```

**Note:** If USB3 problems occur, use a USB2 port.

## 4.6 Connect your hardware

To be able to run a NanoLib project, connect a compatible Nanotec controller to the PC using your adapter.

1. By a suitable cable, connect your adapter to the controller.
2. Connect the adapter to the PC according to the adapter data sheet.
3. Power on the controller using a suitable power supply.
4. If needed, change the Nanotec controller's communication settings as instructed in its product manual.

## 4.7 Load *NanoLib*

For a first start with quick-and-easy basics, you may (but must not) use our example project.

1. Depending on your region: Download NanoLib from our website for either [EMEA / APAC](#) or [AMERICA](#).
2. Unzip the package's files / folders and do select one option:
  - **For quick-and easy basics:** See [Starting the example project](#).
  - **For advanced customizing in Windows:** See [Creating your own Windows project](#).
  - **For advanced customizing in Linux:** See [Creating your own Linux project](#).

## 5 Starting the example project

With *NanoLib* duly loaded, the example project shows you through NanoLib usage with a Nanotec controller. **Note:** For each step, comments in the provided example code explain the functions used. The example project *NanolibExample.sln* consists of:

- *nanolib\_example\_program.cpp* (entry point)
- *nanolib\_example\_program.hpp* (main program)
- *nanolib\_helper.hpp* and *.cpp* (helper class for wrapping the NanoLib accessor)
- *nanolib\_sampler\_example* (optional example for sampler use)

An example to demonstrate the logging function is in the *NanolibLoggingCallbackExample* folder. You can find more examples, with some motion commands for various operation modes, in the *Knowledge Base* at nanotec.com. All are usable in Windows or Linux.

### In Windows with Visual Studio

1. Open the *NanolibExample.sln* file.
2. Open the *nanolib\_example.cpp*.
3. Compile and run the example code.

### In Linux via Bash

1. Unzip the source file, navigate to the folder with unzipped content. The main file for the example is *src/nanolib\_example.cpp*.
2. In the bash, call:
  - a. "sudo make install" to copy the shared objects and call ldconfig.
  - b. "make all" to build the test executable.
3. The *bin* folder contains an executable *example* file. By bash: Go to the output folder and type *./example*.
  - If no error occurs, your shared objects are now duly installed, and your library is ready for use.
  - If the error reads *./example: error while loading shared libraries: libnanolib.so: cannot open shared object file: No such file or directory*, the shared objects' installation failed. In this case, follow the next steps.
4. Create a new folder within */usr/local/lib* (admin rights needed). Into the bash, thus type:

```
sudo mkdir /usr/local/lib/nanotec
```

5. Copy all shared objects from the zip file's *lib* folder:

```
install ./lib/*.so /usr/local/lib/nanotec/
```

6. Check the content of the target folder with:

```
ls -al /usr/local/lib/nanotec/
```

→ It should list the shared object files from the *lib* folder.

7. Run *ldconfig* on this folder:

```
sudo ldconfig /usr/local/lib/nanotec/
```

The main example demonstrates the typical workflow for handling a controller:

1. Check the PC for connected hardware (adapters) and list them.
2. Establish connection to an adapter.
3. Scan the bus for connected controller devices.
4. Connect to a device.
5. Read/write from/to the controller's object dictionary (examples provided in *objectDictionaryAccessExamples()*).
6. Close the connection *first* to the device, *then* to the adapter.

## 6 Creating your own Windows project

Create, compile and run your own Windows project to use *NanoLib*.

### 6.1 Import *NanoLib*

Import the *NanoLib* header files and libraries via MS Visual Studio.

1. Open Visual Studio.
2. Via *Create new project > Console App C++ > Next*: Select a project type.
3. Name your project (here: *NanolibTest*) to create a project folder in the Solution Explorer.
4. Select *Finish*.
5. Open the windows file explorer and navigate to the new created project folder.
6. Create two new folders, *inc* and *lib*.
7. Open the NanoLib package folder.
8. From there: Copy the header files from the *include* folder into your project folder *inc* and all *.lib* and *.dll* files to your new project folder *lib*.
9. Check your project folder for due structure, for example:



### 6.2 Configure your project

Use the Solution Explorer in MS Visual Studio to set up *NanoLib* projects. **Note:** For correct NanoLib operation, select the release (not debug!) configuration in Visual C++ project settings; then build and link the project with VC runtimes of C++ redistributables **[2022]**.

1. In the Solution Explorer: Go to your project folder (here: *NanolibTest*).
2. Co-click the folder to open the context menu.
3. Select *Properties*.
4. Activate *All configurations* and *All platforms*.
5. Select *C/C++* and go to *Additional Include Directories*.
6. Insert: `$(ProjectDir)Nanolib/includes;%(AdditionalIncludeDirectories)`
7. Select *Linker* and go to *Additional Library Directories*.
8. Insert: `$(ProjectDir)Nanolib;%(AdditionalLibraryDirectories)`
9. Extend *Linker* and select *Input*.
10. Go to *Additional Dependencies* and insert: `nanolib.lib;%(AdditionalDependencies)`
11. Confirm via *OK*.

12. Go to *Configuration > C++ > Language > Language Standard > ISO C++17 Standard* and set the language standard to *C++17 (/std:c++17)*.

### 6.3 Build your project

Build your *NanoLib* project in MS Visual Studio.

1. Open the main \*.cpp file (here: *nanolib\_example.cpp*) and edit the code, if needs be.
2. Select *Build > Configuration Manager*.
3. Change *Active solution platforms* to *x64*.
4. Confirm via *Close*.
5. Select *Build > Build solution*.
6. No error? Check if your compile output duly reports:

```
1>----- Clean started: Project: NanolibTest, Configuration: Debug x64 -----  
===== Clean: 1 succeeded, 0 failed, 0 skipped =====
```

## 7 Creating your own Linux project

Create, compile and run your own Linux project to use *NanoLib*.

1. In the unzipped NanoLib installation kit: Open `<root>/nanotec_nanolib`.
2. Find all shared objects in the `tar.gz` file.
3. Select one option: Install each *lib* either with a Makefile or by hand.

### 7.1 Install the shared objects with Makefile

Use Makefile with Linux Bash to auto-install all default `*.so` files.

1. Via Bash: Go to the folder containing the `makefile`.
2. Copy the shared objects via:

```
sudo make install
```

3. Confirm via:

```
ldconfig
```

### 7.2 Install the shared objects by hand

Use a Bash to install all `*.so` files of *NanoLib* manually.

1. Via Bash: Create a new folder within `/usr/local/lib`.
2. Admin rights needed! Type:

```
sudo mkdir /usr/local/lib/nanotec
```

3. Change to the unzipped installation package folder.
4. Copy all shared objects from the `lib` folder via:

```
install ./nanotec_nanolib/lib/*.so /usr/local/lib/nanotec/
```

5. Check the content of the target folder via:

```
ls -al /usr/local/lib/nanotec/
```

6. Check if all shared objects from the `lib` folder are listed.
7. Run `ldconfig` on this folder via:

```
sudo ldconfig /usr/local/lib/nanotec/
```

### 7.3 Create your project

With your shared objects installed: Create a new project for your Linux *NanoLib*.

1. Via Bash: Create a new project folder (here: *NanoLibTest*) via:

```
mkdir NanoLibTest
cd NanoLibTest
```

2. Copy the header files to an include folder (here: `inc`) via:

```
mkdir inc
cp /<PLACE WHERE THE CONTENT OF THE ZIP FILE IS>/nanotec_nanolib/inc/*.hpp
inc
```

3. Create a main file (*NanoLibTest.cpp*) via:

```
#include "accessor_factory.hpp"
#include <iostream>
```

```
int main(){
    nlc::NanoLibAccessor *accessor = getNanoLibAccessor();
    nlc::ResultBusHwIds result =
        accessor->listAvailableBusHardware();
    if(result.hasError()) { std::cout <<
        result.getError() << std::endl; }
    else{ std::cout << "Success" << std::endl;
        }
    delete accessor;
    return 0;
}
```

#### 4. Check your project folder for due structure:

```
├── NanoLibTest
│   ├── inc
│   │   ├── accessor_factory.hpp
│   │   ├── busHardware_id.hpp
│   │   ├── ...
│   │   ├── od_index.hpp
│   │   └── result.hpp
│   └── NanoLibTest.cpp
```

## 7.4 Compile and test your project

Make your Linux *NanoLib* ready for use via Bash.

#### 1. Via Bash: Compile the main file via:

```
g++ -Wall -Wextra -pedantic -I./inc -c NanoLibTest.cpp -o
    NanoLibTest
```

#### 2. Link the executable together via:

```
g++ -Wall -Wextra -pedantic -I./inc -o test NanoLibTest.o -
    L/usr/local/lib/nanotec -lnanolib -ldl
```

#### 3. Run the test program via:

```
./test
```

#### 4. Check if your Bash duly reports:

```
success
```

## 8 Classes / functions reference

Find here a list of *NanoLib*'s user interface classes and their member functions. The typical description of a function includes a short introduction, the function definition and a parameter / return list:

### ExampleFunction ()

Tells you briefly what the function does.

```
virtual void nlc::NanoLibAccessor::ExampleFunction (Param_a const & param_a,
  Param_b const & param_B)
```

|            |                   |                               |
|------------|-------------------|-------------------------------|
| Parameters | <i>param_a</i>    | Additional comment if needed. |
|            | <i>param_b</i>    |                               |
| Returns    | <i>ResultVoid</i> | Additional comment if needed. |

## 8.1 NanoLibAccessor

Interface class used as entry point to the *NanoLib*. A typical workflow looks like this:

1. Start by scanning for hardware with `NanoLibAccessor.listAvailableBusHardware ()`.
2. Set the communication settings with `BusHardwareOptions ()`.
3. Open the hardware connection with `NanoLibAccessor.openBusHardwareWithProtocol ()`.
4. Scan the bus for connected devices with `NanoLibAccessor.scanDevices ()`.
5. Add a device with `NanoLibAccessor.addDevice ()`.
6. Connect to the device with `NanoLibAccessor.connectDevice ()`.
7. After finishing the operation, disconnect the device with `NanoLibAccessor.disconnectDevice ()`.
8. Remove the device with `NanoLibAccessor.removeDevice ()`.
9. Close the hardware connection with `NanoLibAccessor.closeBusHardware ()`.

NanoLibAccessor has the following public member functions:

### listAvailableBusHardware ()

Use this function to list available fieldbus hardware.

```
virtual ResultBusHwIds nlc::NanoLibAccessor::listAvailableBusHardware ()
```

|         |                       |                                       |
|---------|-----------------------|---------------------------------------|
| Returns | <i>ResultBusHwIds</i> | Delivers a <u>fieldbus ID array</u> . |
|---------|-----------------------|---------------------------------------|

### openBusHardwareWithProtocol ()

Use this function to connect bus hardware.

```
virtual ResultVoid nlc::NanoLibAccessor::openBusHardwareWithProtocol
  (BusHardwareId const & busHwId, BusHardwareOptions const & busHwOpt)
```

|            |                   |   |
|------------|-------------------|---|
| Parameters | <i>busHwId</i>    | Specifies the <u>fieldbus</u> to open.        |
|            | <i>busHwOpt</i>   | Specifies <u>fieldbus opening options</u> .   |
| Returns    | <i>ResultVoid</i> | Confirms that a <u>void function</u> has run. |

### isBusHardwareOpen ()

Use this function to check if your fieldbus hardware connection is open.

```
virtual ResultVoid nlc::NanoLibAccessor::openBusHardwareWithProtocol (const
  BusHardwareId & busHwId, const BusHardwareOptions & busHwOpt)
```

|            |                      |   |
|------------|----------------------|---|
| Parameters | <i>BusHardwareId</i> | Specifies each <u>fieldbus</u> to open. |
| Returns    | <i>true</i>          | Hardware is open.                       |
|            | <i>false</i>         | Hardware is closed.                     |

### getProtocolSpecificAccessor ()

Use this function to get the protocol-specific accessor object.

```
virtual ResultVoid nlc::NanoLibAccessor::getProtocolSpecificAccessor
  (BusHardwareId const & busHwId)
```

|            |                   |  |
|------------|-------------------|--|
| Parameters | <i>busHwId</i>    | Specifies the <u>fieldbus</u> to get the accessor for. |
| Returns    | <i>ResultVoid</i> | Confirms that a <u>void function</u> has run.          |

### getProfinetDCP ()

Use this function to return a reference to Profinet DCP interface.

```
virtual ProfinetDCP & getProfinetDCP ()
```

|         |                    |
|---------|--------------------|
| Returns | <u>ProfinetDCP</u> |
|---------|--------------------|

### getSamplerInterface ()

Use this function to get a reference to the sampler interface.

```
virtual SamplerInterface & getSamplerInterface ()
```

|         |                         |   |
|---------|-------------------------|---|
| Returns | <i>SamplerInterface</i> | Refers to the <u>sampler interface</u> class. |
|---------|-------------------------|---|

### setBusState ()

Use this function to set the bus-protocol-specific state.

```
virtual ResultVoid nlc::NanoLibAccessor::setBusState (const BusHardwareId &
  busHwId, const std::string & state)
```

|            |                   |   |
|------------|-------------------|---|
| Parameters | <i>busHwId</i>    | Specifies the <u>fieldbus</u> to open.          |
|            | <i>state</i>      | Assigns a bus-specific state as a string value. |
| Returns    | <i>ResultVoid</i> | Confirms that a <u>void function</u> has run.   |

### scanDevices ()

Use this function to scan for devices in the network.

```
virtual ResultDeviceIds nlc::NanoLibAccessor::scanDevices (const BusHardwareId
  & busHwId, NlcScanBusCallback* callback)
```

|            |                        |  |
|------------|------------------------|--|
| Parameters | <i>busHwId</i>         | Specifies the <u>fieldbus</u> to scan.     |
|            | <i>callback</i>        | <u>NlcScanBusCallback</u> progress tracer. |
| Returns    | <i>ResultDeviceIds</i> | Delivers a <u>device ID</u> array.         |
|            | <i>IOError</i>         | Informs that a device is not found.        |



**addDevice ()**

Use this function to add a bus device described by *deviceId* to *NanoLib*'s internal device list, and to return *deviceHandle* for it.

```
virtual ResultDeviceHandle nlc::NanoLibAccessor::addDevice (DeviceId const &
  deviceId)
```

|            |                           |  |
|------------|---------------------------|--|
| Parameters | <i>deviceId</i>           | Specifies the device to add to the list. |
| Returns    | <i>ResultDeviceHandle</i> | Delivers a <u>device handle</u> .        |

**connectDevice ()**

Use this function to connect a device by *deviceHandle*.

```
virtual ResultVoid nlc::NanoLibAccessor::connectDevice (DeviceHandle const
  deviceHandle)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device <i>NanoLib</i> connects to. |
| Returns    | <i>ResultVoid</i>   | Confirms that a <u>void function</u> has run.         |
|            | <i>IOError</i>      | Informs that a device is not found.                   |

**getDeviceName ()**

Use this function to get a device's name by *deviceHandle*.

```
virtual ResultString nlc::NanoLibAccessor::getDeviceName (DeviceHandle const
  deviceHandle)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device <i>NanoLib</i> gets the name for. |
| Returns    | <i>ResultString</i> | Delivers device names as a <u>string</u> .                  |

**getDeviceProductCode ()**

Use this function to get a device's product code by *deviceHandle*.

```
virtual ResultInt nlc::NanoLibAccessor::getDeviceProductCode (DeviceHandle
  const deviceHandle)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device <i>NanoLib</i> gets the product code for. |
| Returns    | <i>ResultInt</i>    | Delivers product codes as an <u>integer</u> .                       |

**getDeviceVendorId ()**

Use this function to get the device vendor ID by *deviceHandle*.

```
virtual ResultInt nlc::NanoLibAccessor::getDeviceVendorId (DeviceHandle const
  deviceHandle)
```

|            |                            |  |
|------------|----------------------------|--|
| Parameters | <i>deviceHandle</i>        | Specifies what bus device <i>NanoLib</i> gets the vendor ID for. |
| Returns    | <i>ResultInt</i>           | Delivers vendor ID's as an <u>integer</u> .                      |
|            | <i>ResourceUnavailable</i> | Informs that <u>no data</u> is found.                            |

**getDeviceId ()**

Use this function to get a specific device's ID from the *NanoLib* internal list.

```
virtual ResultDeviceId nlc::NanoLibAccessor::getDeviceId (DeviceHandle const deviceHandle)
```

Parameters *deviceHandle* Specifies what bus device NanoLib gets the device ID for.  
 Returns *ResultDeviceId* Delivers a device ID.

**getDeviceIds ()**

Use this function to get all devices' ID from the *NanoLib* internal list.

```
virtual ResultDeviceIds nlc::NanoLibAccessor::getDeviceIds ()
```

Returns *ResultDeviceIds* Delivers a device ID list.

**getDeviceUid ()**

Use this function to get a device's unique ID (96 bit / 12 bytes) by *deviceHandle*.

```
virtual ResultArrayByte nlc::NanoLibAccessor::getDeviceUid (DeviceHandle const deviceHandle)
```

Parameters *deviceHandle* Specifies what bus device NanoLib gets the unique ID for.  
 Returns *ResultArrayByte* Delivers unique ID's as a byte array.  
*ResourceUnavailable* Informs that no data is found.

**getDeviceSerialNumber ()**

Use this function to get a device's serial number by *deviceHandle*.

```
virtual ResultString NanolibAccessor::getDeviceSerialNumber (DeviceHandle const deviceHandle)
```

Parameters *deviceHandle* Specifies what bus device NanoLib gets the serial number for.  
 Returns *ResultString* Delivers serial numbers as a string.  
*ResourceUnavailable* Informs that no data is found.

**getDeviceHardwareGroup ()**

Use this function to get a bus device's hardware group by *deviceHandle*.

```
virtual ResultDeviceId nlc::NanoLibAccessor::getDeviceHardwareGroup (DeviceHandle const deviceHandle)
```

Parameters *deviceHandle* Specifies what bus device NanoLib gets the hardware group for.  
 Returns *ResultInt* Delivers hardware groups as an integer.

**getDeviceHardwareVersion ()**

Use this function to get a bus device's hardware version by *deviceHandle*.

```
virtual ResultDeviceId nlc::NanoLibAccessor::getDeviceHardwareVersion (DeviceHandle const deviceHandle)
```

|            |   |   |
|------------|---|---|
| Parameters | <i>deviceHandle</i>                               | Specifies what bus device NanoLib gets the hardware version for.                    |
| Returns    | <i>ResultString</i><br><i>ResourceUnavailable</i> | Delivers device names as a <u>string</u> .<br>Informs that <u>no data</u> is found. |

### getDeviceFirmwareBuildId ()

Use this function to get a bus device's firmware build ID by *deviceHandle*.

```
virtual ResultDeviceId nlc::NanoLibAccessor::getDeviceFirmwareBuildId
(DeviceHandle const deviceHandle)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib gets the firmware build ID for. |
| Returns    | <i>ResultString</i> | Delivers device names as a <u>string</u> .                        |

### getDeviceBootloaderVersion ()

Use this function to get a bus device's bootloader version by *deviceHandle*.

```
virtual ResultInt nlc::NanoLibAccessor::getDeviceBootloaderVersion
(DeviceHandle const deviceHandle)
```

|            |  |  |
|------------|--|--|
| Parameters | <i>deviceHandle</i>                            | Specifies what bus device NanoLib gets the bootloader version for.                           |
| Returns    | <i>ResultInt</i><br><i>ResourceUnavailable</i> | Delivers bootloader versions as an <u>integer</u> .<br>Informs that <u>no data</u> is found. |

### getDeviceBootloaderBuildId ()

Use this function to get a bus device's bootloader build ID by *deviceHandle*.

```
virtual ResultDeviceId nlc::NanoLibAccessor:: (DeviceHandle const
deviceHandle)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib gets the bootloader build ID for. |
| Returns    | <i>ResultString</i> | Delivers device names as a <u>string</u> .                          |

### rebootDevice ()

Use this function to reboot the device by *deviceHandle*.

```
virtual ResultVoid nlc::NanoLibAccessor::rebootDevice (const DeviceHandle
deviceHandle)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies the <u>fieldbus</u> to reboot.      |
| Returns    | <i>ResultVoid</i>   | Confirms that a <u>void function</u> has run. |

### getDeviceState ()

Use this function to get the device-protocol-specific state.

```
virtual ResultString nlc::NanoLibAccessor::getDeviceState (DeviceHandle const
deviceHandle)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib gets the state for. |
|------------|---------------------|---|

Returns *ResultString* Delivers device names as a string.

### setDeviceState ()

Use this function to set the device-protocol-specific state.

```
virtual ResultVoid nlc::NanoLibAccessor::setDeviceState (const DeviceHandle
deviceHandle, const std::string & state)
```

Parameters *deviceHandle* Specifies what bus device NanoLib sets the state for.  
*state* Assigns a bus-specific state as a string value.  
 Returns *ResultVoid* Confirms that a void function has run.

### getConnectionState ()

Use this function to get a specific device's last known connection state by *deviceHandle* (= *Disconnected*, *Connected*, *ConnectedBootloader*)

```
virtual ResultConnectionState nlc::NanoLibAccessor::getConnectionState
(DeviceHandle const deviceHandle)
```

Parameters *deviceHandle* Specifies what bus device NanoLib gets the connection state for.  
 Returns *ResultConnectionState* Delivers a connection state (= *Disconnected*, *Connected*, *ConnectedBootloader*).

### checkConnectionState ()

Only if the last known state was not *Disconnected*: Use this function to check and possibly update a specific device's connection state by *deviceHandle* and by testing several mode-specific operations.

```
virtual ResultConnectionState nlc::NanoLibAccessor::checkConnectionState
(DeviceHandle const deviceHandle)
```

Parameters *deviceHandle* Specifies what bus device NanoLib checks the connection state for.  
 Returns *ResultConnectionState* Delivers a connection state (= not *Disconnected*).

### assignObjectDictionary ()

Use this **manual** function to assign an object dictionary (OD) to *deviceHandle* on your **own**.

```
virtual ResultObjectDictionary nlc::NanoLibAccessor::assignObjectDictionary
(DeviceHandle const deviceHandle, ObjectDictionary const & objectDictionary)
```

Parameters *deviceHandle* Specifies what bus device NanoLib assigns the OD to.  
*objectDictionary*  
 Returns *ResultObjectDictionary* Shows the properties of an object dictionary.

### autoAssignObjectDictionary ()

Use this **automatism** to let **NanoLib** assign an object dictionary (OD) to *deviceHandle*. On finding and loading a suitable OD, NanoLib automatically assigns it to the device. **Note:** If a compatible OD is already loaded in the object library, NanoLib will automatically use it without scanning the submitted directory.

```
virtual ResultObjectDictionary
nlc::NanoLibAccessor::autoAssignObjectDictionary (DeviceHandle const
deviceHandle, const std::string & dictionariesLocationPath)
```

|            |                                 |  |
|------------|---------------------------------|--|
| Parameters | <i>deviceHandle</i>             | Specifies for which bus device NanoLib shall automatically scan for suitable OD's. |
|            | <i>dictionariesLocationPath</i> | Specifies the path to the OD directory.  |
| Returns    | <i>ResultObjectDictionary</i>   | Shows the <u>properties of an object dictionary</u> .                              |

### getAssignedObjectDictionary ()

Use this function to get the object dictionary assigned to a device by *deviceHandle*.

```
virtual ResultObjectDictionary
  nlc::NanoLibAccessor::getAssignedObjectDictionary (DeviceHandle const device
  Handle)
```

|            |                               |   |
|------------|-------------------------------|---|
| Parameters | <i>deviceHandle</i>           | Specifies what bus device NanoLib gets the assigned OD for. |
| Returns    | <i>ResultObjectDictionary</i> | Shows the <u>properties of an object dictionary</u> .       |

### getObjectDictionaryLibrary ()

This function returns an OdLibrary reference.

```
virtual OdLibrary& nlc::NanoLibAccessor::getObjectDictionaryLibrary ()
```

|         |                       |  |
|---------|-----------------------|--|
| Returns | <i>OdLibrary&amp;</i> | Opens the entire OD library and its object dictionaries. |
|---------|-----------------------|--|

### setLoggingLevel ()

Use this function to set the needed log detailing (and log file size). Default level is *Info*.

```
virtual void nlc::NanoLibAccessor::setLoggingLevel (LogLevel level)
```

|            |              |  |
|------------|--------------|--|
| Parameters | <i>level</i> | The following log detailings are possible: |
|------------|--------------|--|

- 0 = *Trace*    Lowest level (largest log file); logs any feasible detail, plus software start / stop.
- 1 = *Debug*    Logs debug information (= interim results, content sent or received, etc.)
- 2 = *Info*      Default level; logs informational messages.
- 3 = *Warn*     Logs problems that did occur but **won't** stop the current algorithm.
- 4 = *Error*    Logs just severe trouble that **did** stop the algorithm.
- 5 = *Critical* Highest level (smallest log file); turns logging **off**; no further log at all.
- 6 = *Off*      No logging at all.

### setLoggingCallback ()

Use this function to set a logging callback pointer and log module (= library) for that callback (not for the logger itself).

```
virtual void nlc::NanoLibAccessor::setLoggingCallback (NlcLoggingCallback*
  callback, const nlc::LogModule & logModule)
```

|            |                  |   |
|------------|------------------|---|
| Parameters | <i>*callback</i> | Sets a callback pointer.                          |
|            | <i>logModule</i> | Tunes the callback (not logger!) to your library. |

- 0 = *NanolibCore*    Activates a callback for NanoLib's core only.
- 1 = *NanolibCANopen*    Activates a CANopen-only callback.
- 2 = *NanolibModbus*    Activates a Modbus-only callback.
- 3 = *NanolibEtherCAT*    Activates an EtherCAT-only callback.

- 4 = *NanolibRest*      Activates a REST-only callback.  
 5 = *NanolibUSB*      Activates a USB-only callback.

### unsetLoggingCallback ()

Use this function to cancel a [logging callback](#) pointer.

```
virtual void nlc::NanoLibAccessor::unsetLoggingCallback ()
```

### readNumber ()

Use this function to read a numeric value from the object dictionary.

```
virtual ResultInt nlc::NanoLibAccessor::readNumber (const DeviceHandle  
deviceHandle, const OdIndex odIndex)
```

- |            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib reads from.   |
|            | <i>odIndex</i>      | Specifies the <a href="#">(sub-) index</a> to read from.  |
| Returns    | <i>ResultInt</i>    | Delivers an <a href="#">uninterpreted numeric value</a> (can be signed, unsigned, fix16.16 bit values). |

### readNumberArray ()

Use this function to read numeric arrays from the object dictionary.

```
virtual ResultArrayInt nlc::NanoLibAccessor::readNumberArray (const  
DeviceHandle deviceHandle, const uint16_t index)
```

- |            |                       |   |
|------------|-----------------------|---|
| Parameters | <i>deviceHandle</i>   | Specifies what bus device NanoLib reads from. |
|            | <i>index</i>          | Array object index.                           |
| Returns    | <i>ResultArrayInt</i> | Delivers an <a href="#">integer array</a> .   |

### readBytes ()

Use this function to read arbitrary bytes (domain object data) from the object dictionary.

```
virtual ResultArrayByte nlc::NanoLibAccessor::readBytes (const DeviceHandle  
deviceHandle, const OdIndex odIndex)
```

- |            |                        |  |
|------------|------------------------|--|
| Parameters | <i>deviceHandle</i>    | Specifies what bus device NanoLib reads from.            |
|            | <i>odIndex</i>         | Specifies the <a href="#">(sub-) index</a> to read from. |
| Returns    | <i>ResultArrayByte</i> | Delivers a <a href="#">byte array</a> .                  |

### readString ()

Use this function to read strings from the object directory.

```
virtual ResultString nlc::NanoLibAccessor::readString (const DeviceHandle  
deviceHandle, const OdIndex odIndex)
```

- |            |                     |  |
|------------|---------------------|--|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib reads from.            |
|            | <i>odIndex</i>      | Specifies the <a href="#">(sub-) index</a> to read from. |
| Returns    | <i>ResultString</i> | Delivers device names as a <a href="#">string</a> .      |

### writeNumber ()

Use this function to write numeric values to the object directory.

```
virtual ResultVoid nlc::NanoLibAccessor::writeNumber (const DeviceHandle
  deviceHandle, int64_t value, const OdIndex odIndex, unsigned int bitLength)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib writes to.                  |
|            | <i>value</i>        | The uninterpreted value (can be signed, unsigned, fix 16.16). |
|            | <i>odIndex</i>      | Specifies the <u>(sub-) index</u> to read from.               |
|            | <i>bitLength</i>    | Length in bit.  |
| Returns    | <i>ResultVoid</i>   | Confirms that a <u>void function</u> has run.                 |

### writeBytes ()

Use this function to write arbitrary bytes (domain object data) to the object directory.

```
virtual ResultVoid nlc::NanoLibAccessor::writeBytes (const DeviceHandle
  deviceHandle, const std::vector <uint8_t> & data, const OdIndex odIndex)
```

|            |                     |   |
|------------|---------------------|---|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib writes to.    |
|            | <i>data</i>         | Byte vector / array.                            |
|            | <i>odIndex</i>      | Specifies the <u>(sub-) index</u> to read from. |
| Returns    | <i>ResultVoid</i>   | Confirms that a <u>void function</u> has run.   |

### uploadFirmware ()

Use this function to update your controller firmware.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadFirmware (const DeviceHandle
  deviceHandle, const std::vector <uint8_t> & fwData, NlcDataTransferCallback*
  callback)
```

|            |                                |   |
|------------|--------------------------------|---|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib updates.    |
|            | <i>fwData</i>                  | Array containing firmware data.               |
|            | <i>NlcDataTransferCallback</i> | A <u>data progress</u> tracer.                |
| Returns    | <i>ResultVoid</i>              | Confirms that a <u>void function</u> has run. |

### uploadFirmwareFromFile ()

Use this function to update your controller firmware by uploading its file.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadFirmwareFromFile (const
  DeviceHandle deviceHandle, const std::string & absoluteFilePath,
  NlcDataTransferCallback* callback)
```

|            |                                |  |
|------------|--------------------------------|--|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib updates.           |
|            | <i>absoluteFilePath</i>        | Path to file containing firmware data (std::string). |
|            | <i>NlcDataTransferCallback</i> | A <u>data progress</u> tracer.                       |
| Returns    | <i>ResultVoid</i>              | Confirms that a <u>void function</u> has run.        |

### uploadBootloader ()

Use this function to update your controller bootloader.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadBootloader (const DeviceHandle
  deviceHandle, const std::vector <uint8_t> & btData, NlcDataTransferCallback*
  callback)
```

|            |                                |  |
|------------|--------------------------------|--|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib updates.             |
|            | <i>btData</i>                  | Array containing bootloader data.                      |
|            | <i>NlcDataTransferCallback</i> | A <a href="#">data progress</a> tracer.                |
| Returns    | <i>ResultVoid</i>              | Confirms that a <a href="#">void function</a> has run. |

### uploadBootloaderFromFile ()

Use this function to update your controller bootloader by uploading its file.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadBootloaderFromFile (const
  DeviceHandle deviceHandle, const std::string & bootloaderAbsolutePath,
  NlcDataTransferCallback* callback)
```

|            |                                |  |
|------------|--------------------------------|--|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib updates.             |
|            | <i>bootloaderAbsolutePath</i>  | Path to file containing bootloader data (std::string). |
|            | <i>NlcDataTransferCallback</i> | A <a href="#">data progress</a> tracer.                |
| Returns    | <i>ResultVoid</i>              | Confirms that a <a href="#">void function</a> has run. |

### uploadBootloaderFirmware ()

Use this function to update your controller bootloader and firmware.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadBootloaderFirmware (const
  DeviceHandle deviceHandle, const std::vector <uint8_t> & btData, const
  std::vector <uint8_t> & fwData, NlcDataTransferCallback* callback)
```

|            |                                |  |
|------------|--------------------------------|--|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib updates.             |
|            | <i>btData</i>                  | Array containing bootloader data.                      |
|            | <i>fwData</i>                  | Array containing firmware data.                        |
|            | <i>NlcDataTransferCallback</i> | A <a href="#">data progress</a> tracer.                |
| Returns    | <i>ResultVoid</i>              | Confirms that a <a href="#">void function</a> has run. |

### uploadBootloaderFirmwareFromFile ()

Use this function to update your controller bootloader and firmware by uploading the files.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadBootloaderFirmwareFromFile
  (const DeviceHandle deviceHandle, const std::string &
  bootloaderAbsolutePath, const std::string & absoluteFilePath,
  NlcDataTransferCallback* callback)
```

|            |                                |  |
|------------|--------------------------------|--|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib updates.             |
|            | <i>bootloaderAbsolutePath</i>  | Path to file containing bootloader data (std::string). |
|            | <i>absoluteFilePath</i>        | Path to file containing firmware data (uint8_t).       |
|            | <i>NlcDataTransferCallback</i> | A <a href="#">data progress</a> tracer.                |
| Returns    | <i>ResultVoid</i>              | Confirms that a <a href="#">void function</a> has run. |



### uploadNanoJ ()

Use this public function to upload the NanoJ program to your controller.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadNanoJ (DeviceHandle const
  deviceHandle, std::vector <uint8_t> const & vmmData, NlcDataTransferCallback*
  callback)
```

|            |                                |  |
|------------|--------------------------------|--|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib uploads to.          |
|            | <i>vmmData</i>                 | Array containing NanoJ data.                           |
|            | <i>NlcDataTransferCallback</i> | A <a href="#">data progress</a> tracer.                |
| Returns    | <i>ResultVoid</i>              | Confirms that a <a href="#">void function</a> has run. |

### uploadNanoJFromFile ()

Use this public function to upload the NanoJ program to your controller by uploading the file.

```
virtual ResultVoid nlc::NanoLibAccessor::uploadNanoJFromFile (const
  DeviceHandle deviceHandle, const std::string & absoluteFilePath,
  NlcDataTransferCallback* callback)
```

|            |                                |  |
|------------|--------------------------------|--|
| Parameters | <i>deviceHandle</i>            | Specifies what bus device NanoLib uploads to.          |
|            | <i>absoluteFilePath</i>        | Path to file containing NanoJ data (std::string).      |
|            | <i>NlcDataTransferCallback</i> | A <a href="#">data progress</a> tracer.                |
| Returns    | <i>ResultVoid</i>              | Confirms that a <a href="#">void function</a> has run. |

### disconnectDevice ()

Use this function to disconnect your device by *deviceHandle*.

```
virtual ResultVoid nlc::NanoLibAccessor::disconnectDevice (DeviceHandle const
  deviceHandle)
```

|            |                     |  |
|------------|---------------------|--|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib disconnects from.    |
| Returns    | <i>ResultVoid</i>   | Confirms that a <a href="#">void function</a> has run. |

### removeDevice ()

Use this function to remove your device from *NanoLib*'s internal device list.

```
virtual ResultVoid nlc::NanoLibAccessor::removeDevice (const DeviceHandle
  deviceHandle)
```

|            |                     |  |
|------------|---------------------|--|
| Parameters | <i>deviceHandle</i> | Specifies what bus device NanoLib delists.             |
| Returns    | <i>ResultVoid</i>   | Confirms that a <a href="#">void function</a> has run. |

### closeBusHardware ()

Use this function to disconnect from your fieldbus hardware.

```
virtual ResultVoid nlc::NanoLibAccessor::closeBusHardware (BusHardwareId const
  & busHwId)
```

|            |                   |  |
|------------|-------------------|--|
| Parameters | <i>busHwId</i>    | Specifies the <a href="#">fieldbus</a> to disconnect from. |
| Returns    | <i>ResultVoid</i> | Confirms that a <a href="#">void function</a> has run.     |

## 8.2 BusHardwareId

Use this class to identify a bus hardware one-to-one or to distinguish different bus hardware from each other. This class (without setter functions to be immutable from creation on) also holds information on:

- Hardware (= adapter name, network adapter etc.)
- Protocol to use (= Modbus TCP, CANopen etc.)
- Bus hardware specifier (= serial port name, MAC address etc.)
- Friendly name

### BusHardwareId () [1/3]

Constructor that creates a new bus hardware ID object.

```
nlc::BusHardwareId::BusHardwareId (std::string const & busHardware_,
std::string const & protocol_, std::string const & hardwareSpecifier_,
std::string const & name_)
```

|            |                                |   |
|------------|--------------------------------|---|
| Parameters | <i>busHardware_</i>            | Hardware type (= ZK-USB-CAN-1 etc.).                          |
|            | <i>protocol_</i>               | Bus communication protocol (= CANopen etc.).                  |
|            | <i>hardwareSpecifier_</i>      | The specifier of a hardware (= COM3 etc.).                    |
|            | <i>extraHardwareSpecifier_</i> | The extra specifier of the hardware (say, USB location info). |
|            | <i>name_</i>                   | A friendly name (= <i>AdapterName (Port)</i> etc. ).          |

### BusHardwareId () [2/3]

Constructor that creates a new bus hardware ID object, with the option for an extra hardware specifier.

```
nlc::BusHardwareId::BusHardwareId (std::string const & busHardware_,
std::string const & protocol_, std::string const & hardwareSpecifier_,
std::string const & extraHardwareSpecifier_, std::string const & name_)
```

|            |                                |   |
|------------|--------------------------------|---|
| Parameters | <i>busHardware_</i>            | Hardware type (= ZK-USB-CAN-1 etc.).                          |
|            | <i>protocol_</i>               | Bus communication protocol (= CANopen etc.).                  |
|            | <i>hardwareSpecifier_</i>      | The specifier of a hardware (= COM3 etc.).                    |
|            | <i>extraHardwareSpecifier_</i> | The extra specifier of the hardware (say, USB location info). |
|            | <i>name_</i>                   | A friendly name (= <i>AdapterName (Port)</i> etc. ).          |

### BusHardwareId () [3/3]

Constructor that copies an existing *busHardwareId*.

```
nlc::BusHardwareId::BusHardwareId (BusHardwareId const &)
```

```
nlc::BusHardwareId::BusHardwareId (BusHardwareId const &)
```

|            |                      |   |
|------------|----------------------|---|
| Parameters | <i>busHardwareId</i> | Names the bus hardware ID to copy from. |
|------------|----------------------|---|

### equals ()

Compares a new bus hardware ID to existing ones.

```
bool nlc::BusHardwareId::equals (BusHardwareId const & other) const
```

|            |              |                                   |
|------------|--------------|-----------------------------------|
| Parameters | <i>other</i> | Another object of the same class. |
| Returns    | <i>true</i>  | If both are equal in all values.  |

*false*

If the values differ.

### **getBusHardware ()**

Reads out the bus hardware string.

```
std::string nlc::BusHardwareId::getBusHardware () const
```

Returns *string*

### **getHardwareSpecifier ()**

Reads out the bus hardware's specifier string (= network name etc.).

```
std::string nlc::BusHardwareId::getHardwareSpecifier () const
```

Returns *string*

### **getExtraHardwareSpecifier ()**

Reads out the bus extra hardware's specifier string (= MAC address etc.).

```
std::string nlc::BusHardwareId::getExtraHardwareSpecifier () const
```

Returns *string*

### **getName ()**

Reads out the bus hardware's friendly name.

```
std::string nlc::BusHardwareId::getName () const
```

Returns *string*

### **getProtocol ()**

Reads out the bus protocol string.

```
std::string nlc::BusHardwareId::getProtocol () const
```

Returns *string*

### **toString ()**

Returns the bus hardware ID as a string.

```
std::string nlc::BusHardwareId::toString () const
```

Returns *string*

## **8.3 BusHardwareOptions**

Find in this class, in a key-value list of strings, all options needed to open a bus hardware.

### BusHardwareOptions () [1/2]

Constructs a new bus hardware option object.

```
nlc::BusHardwareOptions::BusHardwareOptions ()
```

Use the function `addOption ()` to add key-value pairs.

### BusHardwareOptions () [2/2]

Constructs a new bus hardware options object with the key-value map already in place.

```
nlc::BusHardwareOptions::BusHardwareOptions (std::map <std::string,
std::string> const & options)
```

Parameters *options* A map with options for the bus hardware to operate.

### addOption ()

Creates additional keys and values.

```
void nlc::BusHardwareOptions::addOption (std::string const & key, std::string
const & value)
```

Parameters *key* Example: BAUD\_RATE\_OPTIONS\_NAME, see *bus\_hw\_options\_defaults*  
*value* Example: BAUD\_RATE\_1000K, see *bus\_hw\_options\_defaults*

### equals ()

Compares the BusHardwareOptions to existing ones.

```
bool nlc::BusHardwareOptions::equals (BusHardwareOptions const & other) const
```

Parameters *other* Another object of the same class.  
 Returns *true* If the other object has all of the exact same options.  
*false* If the other object has different keys or values.

### getOptions ()

Reads out all added key-value pairs.

```
std::map <std::string, std::string> nlc::BusHardwareOptions::getOptions ()
const
```

Returns *string map*

### toString ()

Returns all keys / values as a string.

```
std::string nlc::BusHardwareId::toString () const
```

Returns *string*

## 8.4 BusHwOptionsDefault

This default configuration options class has the following public attributes:

```

const CanBus           canBus = CanBus ()
const Serial          serial = Serial ()
const RESTfulBus     restfulBus = RESTfulBus()
const EtherCATBus    ethercatBus = EtherCATBus()

```

## 8.5 CanBaudRate

Struct that contains CAN bus baudrates in the following public attributes:

```

const std::string      BAUD_RATE_1000K = "1000k"
const std::string      BAUD_RATE_800K  = "800k"
const std::string      BAUD_RATE_500K  = "500k"
const std::string      BAUD_RATE_250K  = "250k"
const std::string      BAUD_RATE_125K  = "125k"
const std::string      BAUD_RATE_100K  = "100k"
const std::string      BAUD_RATE_50K   = "50k"
const std::string      BAUD_RATE_20K   = "20k"
const std::string      BAUD_RATE_10K   = "10k"
const std::string      BAUD_RATE_5K    = "5k"

```

## 8.6 CanBus

Default configuration options class with the following public attributes:

```

const std::string      BAUD_RATE_OPTIONS_NAME = "can adapter baud rate"
const CanBaudRate     baudRate = CanBaudRate ()
const lxxat            ixxat = lxxat ()

```

## 8.7 CanOpenNmtService

For the NMT service, this struct contains the CANopen NMT states as string values in the following public attributes:

```

const std::string      START = "START"
const std::string      STOP  = "STOP"
const std::string      PRE_OPERATIONAL = "PRE_OPERATIONAL"
const std::string      RESET = "RESET"
const std::string      RESET_COMMUNICATION = "RESET_COMMUNICATION"

```

## 8.8 CanOpenNmtState

This struct contains the CANopen NMT states as string values in the following public attributes:

```

const std::string      STOPPED = "STOPPED"
const std::string      PRE_OPERATIONAL = "PRE_OPERATIONAL"
const std::string      OPERATIONAL = "OPERATIONAL"
const std::string      INITIALIZATION = "INITIALIZATION"
const std::string      UNKNOWN = "UNKNOWN"

```

## 8.9 EtherCATBus struct

This struct contains the EtherCAT communication configuration options in the following public attributes:

|  |   |
|--|---|
| <pre>const std::string NETWORK_FIRMWARE_STATE_OPTION_NAME = "Network Firmware State"</pre>               | <p>Network state treated as firmware mode. Acceptable values (default = PRE_OPERATIONAL):</p> <ul style="list-style-type: none"> <li>■ EtherCATState::PRE_OPERATIONAL</li> <li>■ EtherCATState::SAFE_OPERATIONAL</li> <li>■ EtherCATState::OPERATIONAL</li> </ul> |
| <pre>const std::string DEFAULT_NETWORK_FIRMWARE_STATE = "PRE_OPERATIONAL"</pre>                          |   |
| <pre>const std::string EXCLUSIVE_LOCK_TIMEOUT_OPTION_NAME = "Shared Lock Timeout"</pre>                  | <p>Timeout in milliseconds to acquire exclusive lock on the network (default = 500 ms).</p>   |
| <pre>const unsigned int DEFAULT_EXCLUSIVE_LOCK_TIMEOUT = "500"</pre>                                     |   |
| <pre>const std::string SHARED_LOCK_TIMEOUT_OPTION_NAME = "Shared Lock Timeout"</pre>                     | <p>Timeout in milliseconds to acquire shared lock on the network (default = 250 ms).</p>  |
| <pre>const unsigned int DEFAULT_SHARED_LOCK_TIMEOUT = "250"</pre>  |   |
| <pre>const std::string READ_TIMEOUT_OPTION_NAME = "Read Timeout"</pre>                                   | <p>Timeout in milliseconds for a read operation (default = 700 ms).</p>   |
| <pre>const unsigned int DEFAULT_READ_TIMEOUT = "700"</pre>   |   |
| <pre>const std::string WRITE_TIMEOUT_OPTION_NAME = "Write Timeout"</pre>                                 | <p>Timeout in milliseconds for a write operation (default = 200 ms).</p>  |
| <pre>const unsigned int DEFAULT_WRITE_TIMEOUT = "200"</pre>  |   |
| <pre>const std::string READ_WRITE_ATTEMPTS_OPTION_NAME = "Read/Write Attempts"</pre>                     | <p>Maximum read or write attempts (non-zero values only; default = 5).</p>  |
| <pre>const unsigned int DEFAULT_READ_WRITE_ATTEMPTS = "5"</pre>  |   |
| <pre>const std::string CHANGE_NETWORK_STATE_ATTEMPTS_OPTION_NAME = "Change Network State Attempts"</pre> | <p>Maximum number of attempts to alter the network state (non-zero values only; default = 10).</p>  |
| <pre>const unsigned int DEFAULT_CHANGE_NETWORK_STATE_ATTEMPTS = "10"</pre>                               |   |
| <pre>const std::string PDO_IO_ENABLED_OPTION_NAME = "PDO IO Enabled"</pre>                               | <p>Enables or disables PDO processing for digital in- / outputs ("True" or "False" only; default = "True").</p>   |
| <pre>const std::string DEFAULT_PDO_IO_ENABLED = "True"</pre>   |   |

## 8.10 EtherCATState struct

This struct contains the EtherCAT slave / network states as string values in the following public attributes.  
**Note:** Default state at power on is PRE\_OPERATIONAL; *NanoLib* can provide no reliable "OPERATIONAL" state in a non-realtime operating system:

|                              |  |
|------------------------------|--|
| <pre>const std::string</pre> | <pre>NONE = "NONE"</pre>                         |
| <pre>const std::string</pre> | <pre>INIT = "INIT"</pre>                         |
| <pre>const std::string</pre> | <pre>PRE_OPERATIONAL = "PRE_OPERATIONAL"</pre>   |
| <pre>const std::string</pre> | <pre>BOOT = "BOOT"</pre>                         |
| <pre>const std::string</pre> | <pre>SAFE_OPERATIONAL = "SAFE_OPERATIONAL"</pre> |
| <pre>const std::string</pre> | <pre>OPERATIONAL = "OPERATIONAL"</pre>           |

## 8.11 Ixxat

This struct holds all information for the *Ixxat* usb-to-can in the following public attributes:

```
const std::string          ADAPTER_BUS_NUMBER_OPTIONS_NAME = "ixxat adapter bus number"
const IxxatAdapterBusNumber adapterBusNumber = IxxatAdapterBusNumber ()
```

## 8.12 IxxatAdapterBusNumber

This struct holds the bus number for the *Ixxat* usb-to-can in the following public attributes:

```
const std::string          BUS_NUMBER_0_DEFAULT = "0"
const std::string          BUS_NUMBER_1 = "1"
const std::string          BUS_NUMBER_2 = "2"
const std::string          BUS_NUMBER_3 = "3"
```

## 8.13 Peak

This struct holds all information for the *Peak* usb-to-can in the following public attributes:

```
const std::string          ADAPTER_BUS_NUMBER_OPTIONS_NAME = "peak adapter bus number"
const PeakAdapterBusNumber adapterBusNumber = PeakAdapterBusNumber ()
```

## 8.14 PeakAdapterBusNumber

This struct holds the bus number for the *Peak* usb-to-can in the following public attributes:

```
const std::string          BUS_NUMBER_1_DEFAULT = std::to_string (PCAN_USBBUS1)
const std::string          BUS_NUMBER_2 = std::to_string (PCAN_USBBUS2)
const std::string          BUS_NUMBER_3 = std::to_string (PCAN_USBBUS3)
const std::string          BUS_NUMBER_4 = std::to_string (PCAN_USBBUS4)
const std::string          BUS_NUMBER_5 = std::to_string (PCAN_USBBUS5)
const std::string          BUS_NUMBER_6 = std::to_string (PCAN_USBBUS6)
const std::string          BUS_NUMBER_7 = std::to_string (PCAN_USBBUS7)
const std::string          BUS_NUMBER_8 = std::to_string (PCAN_USBBUS8)
const std::string          BUS_NUMBER_9 = std::to_string (PCAN_USBBUS9)
const std::string          BUS_NUMBER_10 = std::to_string (PCAN_USBBUS10)
const std::string          BUS_NUMBER_11 = std::to_string (PCAN_USBBUS11)
const std::string          BUS_NUMBER_12 = std::to_string (PCAN_USBBUS12)
const std::string          BUS_NUMBER_13 = std::to_string (PCAN_USBBUS13)
const std::string          BUS_NUMBER_14 = std::to_string (PCAN_USBBUS14)
const std::string          BUS_NUMBER_15 = std::to_string (PCAN_USBBUS15)
const std::string          BUS_NUMBER_16 = std::to_string (PCAN_USBBUS16)
```

## 8.15 DeviceHandle

This class represents a handle for controlling a device on a bus and has the following public member functions.

### DeviceHandle ()

```
DeviceHandle (uint32_t handle)
```

**equals ()**

Compares itself to a given device handle.

```
bool equals (DeviceHandle const other) const (uint32_t handle)
```

**toString ()**

Returns a string representation of the device handle.

```
std::string toString () const
```

**get ()**

Returns the device handle.

```
uint32_t get () const
```

**8.16 DeviceId**

Use this class (not immutable from creation on) to identify and distinguish devices on a bus:

- Hardware adapter identifier
- Device identifier
- Description

The meaning of device ID / description values depends on the bus. For example, a CAN bus may use the integer ID.

**DeviceId () [1/3]**

Constructs a new device ID object.

```
nlc::DeviceId::DeviceId (BusHardwareId const & busHardwareId_, unsigned int
deviceId_, std::string const & description_)
```

|            |                       |  |
|------------|-----------------------|--|
| Parameters | <i>busHardwareId_</i> | Identifier of the bus.                             |
|            | <i>deviceId_</i>      | An index; subject to bus (= CANopen node ID etc.). |
|            | <i>description_</i>   | A description (may be empty); subject to bus.      |

**DeviceId () [2/3]**

Constructs a new device ID object with extended ID options.

```
nlc::DeviceId::DeviceId (BusHardwareId const & busHardwareId, unsigned int
deviceId_, std::string const & description_ std::vector <uint8_t> const &
extraId_, std::string const & extraStringId_)
```

|            |                       |  |
|------------|-----------------------|--|
| Parameters | <i>busHardwareId_</i> | Identifier of the bus.                                       |
|            | <i>deviceId_</i>      | An index; subject to bus (= CANopen node ID etc.).           |
|            | <i>description_</i>   | A description (may be empty); subject to bus.                |
|            | <i>extraId_</i>       | An additional ID (may be empty); meaning depends on bus.     |
|            | <i>extraStringId_</i> | Additional string ID (may be empty); meaning depends on bus. |

**DeviceId () [3/3]**

Constructs a copy of a device ID object.

```
nlc::DeviceId::DeviceId (DeviceId const &)
```



Parameters *deviceId\_* Device ID to copy from.

### **equals ()**

Compares new to existing objects.

```
bool nlc::DeviceId::equals (DeviceId const & other) const
```

Returns *boolean*

### **getBusHardwareId ()**

Reads out the bus hardware ID.

```
BusHardwareId nlc::DeviceId::getBusHardwareId () const
```

Returns BusHardwareId

### **getDescription ()**

Reads out the device description (maybe unused).

```
std::string nlc::DeviceId::getDescription () const
```

Returns *string*

### **getDeviceId ()**

Reads out the device ID (maybe unused).

```
unsigned int nlc::DeviceId::getDeviceId () const
```

Returns *unsigned int*

### **toString ()**

Returns the object as a string.

```
std::string nlc::DeviceId::toString () const
```

Returns *string*

### **getExtraId ()**

Reads out the extra ID of the device (may be unused).

```
const std::vector <uint8_t>&getExtraId () const
```

Returns *vector<uint8\_t>* A vector of the additional extra ID's (may be empty); meaning depends on the bus.

### **getExtraStringId ()**

Reads out the extra string ID of the device (may be unused).

```
std::string getExtraStringId () const
```

Returns *string* The additional string ID (may be empty); meaning depends on the bus.

## 8.17 LogLevelConverter

This class returns your log level as a string.

```
static std::string toString (nlc::LogLevel logLevel)
```

## 8.18 LogModuleConverter

This class returns your library-specific log modulesetLoggingLevel () as a string.

```
static std::string toString (nlc::LogModule logModule)
```

```
static std::string toString (nlc::LogModule logModule)
```

## 8.19 ObjectDictionary

This class represents an object dictionary of a controller and has the following public member functions:

### getDeviceHandle ()

```
virtual ResultDeviceHandle getDeviceHandle () const
```

Returns *ResultDeviceHandle*

### getObject ()

```
virtual ResultObjectSubEntry getObject (OdIndex const odIndex)
```

Returns *ResultObjectSubEntry*

### getObjectEntry ()

```
virtual ResultObjectEntry getObjectEntry (uint16_t index)
```

Returns *ResultObjectEntry* Informs on an object's properties.

### getXmlFileName ()

```
virtual ResultString getXmlFileName () const
```

Returns *ResultString* Returns the XML file name as a string.

### readNumber ()

```
virtual ResultInt readNumber (OdIndex const odIndex)
```

Returns *ResultInt*

### readNumberArray ()

```
virtual ResultArrayInt readNumberArray (uint16_t const index)
```

Returns [ResultArrayInt](#)

### readString ()

```
virtual ResultString readString (OdIndex const odIndex)
```

Returns [ResultString](#)

### readBytes ()

```
virtual ResultArrayByte readBytes (OdIndex const odIndex)
```

Returns [ResultArrayByte](#)

### writeNumber ()

```
virtual ResultVoid writeNumber (OdIndex const odIndex, const int64_t value)
```

Returns [ResultVoid](#)

### writeBytes ()

```
virtual ResultVoid writeBytes (OdIndex const OdIndex, std::vector <uint8_t>
    const & data)
```

Returns [ResultVoid](#)

### Related Links

[OdIndex](#)

## 8.20 ObjectEntry

This class represents an object entry of the object dictionary, has the following static protected attribute and public member functions:

```
static nlc::ObjectSubEntry invalidObject
```

### getName ()

Reads out the name of the object as a string.

```
virtual std::string getName () const
```

### getPrivate ()

Checks if the object is private.

```
virtual bool getPrivate () const
```

### getIndex ()

Reads out the address of the object index.

```
virtual uint16_t getIndex () const
```

**getDataType ()**

Reads out the data type of the object.

```
virtual nlc::ObjectEntryDataType getDataType () const
```

**getObjectCode ()**

Reads out the object code:

|                  |      |
|------------------|------|
| <b>Null</b>      | 0x00 |
| <b>Deftype</b>   | 0x05 |
| <b>Defstruct</b> | 0x06 |
| <b>Var</b>       | 0x07 |
| <b>Array</b>     | 0x08 |
| <b>Record</b>    | 0x09 |

```
virtual nlc::ObjectCode getObjectCode () const
```

**getObjectSaveable ()**

Checks if the object is saveable and it's category (see product manual for more details):

APPLICATION, COMMUNICATION, DRIVE, MISC\_CONFIG, MODBUS\_RTU, NO, TUNING, CUSTOMER, ETHERNET, CANOPEN, VERIFY1020, UNKNOWN\_SAVEABLE\_TYPE

```
virtual nlc::ObjectSaveable getObjectSaveable () const
```

**getMaxSubIndex ()**

Reads out the number of subindices supported by this object.

```
virtual uint8_t getMaxSubIndex () const
```

**getSubEntry ()**

```
virtual nlc::ObjectSubEntry & getSubEntry (uint8_t subIndex)
```

See also [ObjectSubEntry](#).

**8.21 ObjectSubEntry**

This class represents an object sub-entry (subindex) of the object dictionary and has the following public member functions:

**getName ()**

Reads out the name of the object as a string.

```
virtual std::string getName () const
```

**getSubIndex ()**

Reads out the address of the subindex.

```
virtual uint8_t getSubIndex () const
```

**getDataType ()**

Reads out the data type of the object.

```
virtual nlc::ObjectEntryDataType getDataType () const
```

**getSdoAccess ()**

Checks if the subindex is accessible via SDO:

|                  |   |
|------------------|---|
| <b>ReadOnly</b>  | 1 |
| <b>WriteOnly</b> | 2 |
| <b>ReadWrite</b> | 3 |
| <b>NoAccess</b>  | 0 |

```
virtual nlc::ObjectSdoAccessAttribute getSdoAccess () const
```

**getPdoAccess ()**

Checks if the subindex is accessible/mappable via PDO:

|             |   |
|-------------|---|
| <b>Tx</b>   | 1 |
| <b>Rx</b>   | 2 |
| <b>TxRx</b> | 3 |
| <b>No</b>   | 0 |

```
virtual nlc::ObjectPdoAccessAttribute getPdoAccess () const
```

**getBitLength ()**

Checks the subindex length.

```
virtual uint32_t getBitLength () const
```

**getDefaultValueAsNumeric ()**

Reads out the default value of the subindex for numeric data types.

```
virtual ResultInt getDefaultValueAsNumeric (std::string const & key) const
```

**getDefaultValueAsString ()**

Reads out the default value of the subindex for string data types.

```
virtual ResultString getDefaultValueAsString (std::string const & key) const
```

**getDefaultValues ()**

Reads out the default values of the subindex.

```
virtual std::map <std::string, std::string> getDefaultValues () const
```

**readNumber ()**

Reads out the numeric actual value of the subindex.

```
virtual ResultInt readNumber () const
```

**readString ()**

Reads out the string actual value of the subindex.

```
virtual ResultString readString () const
```

**readBytes ()**

Reads out the actual value of the subindex in bytes.

```
virtual ResultArrayByte readBytes () const
```

**writeNumber ()**

Writes a numeric value in the subindex.

```
virtual ResultVoid writeNumber (const int64_t value) const
```

**writeBytes ()**

Writes a value in the subindex in bytes.

```
virtual ResultVoid writeBytes (std::vector <uint8_t> const & data) const
```

**8.22 OdIndex**

Use this class (immutable from creation on) to wrap and locate object directory indices / sub-indices. A device's OD has up to 65535 (0xFFFF) rows and 255 (0xFF) columns; with gaps between the discontinuous rows. See the CANopen standard and your product manual for more detail.

**OdIndex ()**

Constructs a new OdIndex object.

```
nlc::OdIndex::OdIndex (uint16_t index, uint8_t subIndex)
```

|            |                 |                                |
|------------|-----------------|--------------------------------|
| Parameters | <i>index</i>    | From 0 to 65535 (0xFFFF) incl. |
|            | <i>subindex</i> | From 0 to 255 (0xFF) incl.     |

**getIndex ()**

Reads out the index (from 0x0000 to 0xFFFF).

```
uint16_t nlc::OdIndex::getIndex () const
```

Returns *uint16\_t*

**getSubindex ()**

Reads out the sub-index (from 0x00 to 0xFF)

```
uint8_t nlc::OdIndex::getSubIndex () const
```

Returns `uint8_t`

### toString ()

Returns the index and subindex as a string. The string default `0xIIII:0xSS` reads as follows:

- I = index from 0x0000 to 0xFFFF
- S = sub-index from 0x00 to 0xFF

```
std::string nlc::OdIndex::toString () const
```

Returns `0xIIII:0xSS` Default string representation

## 8.23 OdLibrary

Use this programming interface to create instances of the *ObjectDictionary* class from XML. By *assignObjectDictionary*, you can then bind each instance to a specific device due to a uniquely created identifier. *ObjectDictionary* instances thus created are stored in the *OdLibrary* object to be accessed by index. The *OdLibrary* class loads *ObjectDictionary* items from file or array, stores them, and has the following public member functions:

### getObjectDictionaryCount ()

```
virtual uint32_t getObjectDictionaryCount () const
```

### getObjectDictionary ()

```
virtual ResultObjectDictionary getObjectDictionary (uint32_t odIndex)
```

Returns ResultObjectDictionary

### addObjectDictionaryFromFile ()

```
virtual ResultObjectDictionary addObjectDictionaryFromFile (std::string const & absoluteXmlFilePath)
```

Returns ResultObjectDictionary

### addObjectDictionary ()

```
virtual ResultObjectDictionary addObjectDictionary (std::vector <uint8_t> const & odXmlData, const std::string &xmlFilePath = std::string ())
```

Returns ResultObjectDictionary

## 8.24 OdTypesHelper

In addition to the following public member functions, this class contains custom data types. **Note:** To check your custom data types, look for the enum class *ObjectEntryDataType* in *od\_types.hpp*.

### uintToObjectCode ()

Converts unsigned integers to object code:

|                |      |
|----------------|------|
| <b>Null</b>    | 0x00 |
| <b>Deftype</b> | 0x05 |

|                  |      |
|------------------|------|
| <b>Defstruct</b> | 0x06 |
| <b>Var</b>       | 0x07 |
| <b>Array</b>     | 0x08 |
| <b>Record</b>    | 0x09 |

```
static ObjectCode uintToObjectCode (unsigned int objectCode)
```

### **isNumericDataType ()**

Informes if a data type is numeric or not.

```
static bool isNumericDataType (ObjectEntryDataType dataType)
```

### **isDefstructIndex ()**

Informes if an object is a definition structure index or not.

```
static bool isDefstructIndex (uint16_t typeNum)
```

### **isDeftypeIndex ()**

Informes if an object is a definition type index or not.

```
static bool isDeftypeIndex (uint16_t typeNum)
```

### **isComplexDataType ()**

Informes if a data type is complex or not.

```
static bool isComplexDataType (ObjectEntryDataType dataType)
```

### **uintToObjectEntryDataType ()**

Converts unsigned integers to OD data type.

```
static ObjectEntryDataType uintToObjectEntryDataType (uint16_t
objectDataType)
```

### **objectEntryDataTypeToString ()**

Converts OD data type to string.

```
static std::string objectEntryDataTypeToString (ObjectEntryDataType
odDataType)
```

### **stringToObjectEntryDatatype ()**

Converts string to OD data type if possible. Otherwise, returns UNKNOWN\_DATATYPE.

```
static ObjectEntryDataType stringToObjectEntryDatatype (std::string
dataTypeString)
```



### objectEntryDataTypeBitLength ()

Informs on bit length of an object entry data type.

```
static uint32_t objectEntryDataTypeBitLength (ObjectEntryDataType const &
dataTypes)
```

## 8.25 RESTfulBus struct

This struct contains the communication configuration options for the RESTful interface (over Ethernet). It contains the following public attributes:

```
const std::string      CONNECT_TIMEOUT_OPTION_NAME = "RESTful Connect Timeout"
const unsigned long    DEFAULT_CONNECT_TIMEOUT = 200
const std::string      REQUEST_TIMEOUT_OPTION_NAME = "RESTful Request Timeout"
const unsigned long    DEFAULT_REQUEST_TIMEOUT = 200
const std::string      RESPONSE_TIMEOUT_OPTION_NAME = "RESTful Response Timeout"
const unsigned long    DEFAULT_RESPONSE_TIMEOUT = 750
```

## 8.26 ProfinetDCP

Under **Linux**, the calling application needs `CAP_NET_ADMIN` and `CAP_NET_RAW` capabilities. To enable: `sudo setcap 'cap_net_admin,cap_net_raw+eip' ./executable`. In **Windows**, the ProfinetDCP interface uses WinPcap (tested with version 4.1.3) or Npcap (tested with versions 1.60 and 1.30). It thus searches the dynamically loaded `wpcap.dll` library in the following order (**Note**: no current Win10Pcap support):

1. `Nanolib.dll` directory
2. Windows system directory `SystemRoot%\System32`
3. Npcap installation directory `SystemRoot%\System32\Npcap`
4. Environment path

This class represents a Profinet DCP interface and has the following public member functions:

### getScanTimeout ()

Informs on a device scan timeout (default = 2000 ms).

```
virtual uint32_t nlc::ProfinetDCP::getScanTimeout () const
```

### setScanTimeout ()

Sets a device scan timeout (default = 2000 ms).

```
virtual void nlc::setScanTimeout (uint32_t timeoutMsec)
```

### getResponseTimeout ()

Informs on a device response timeout for setup, reset and blink operations (default = 1000 ms).

```
virtual uint32_t nlc::ProfinetDCP::getResponseTimeout () const
```

### setResponseTimeout ()

Informs on a device response timeout for setup, reset and blink operations (default = 1000 ms).

```
virtual void nlc::ProfinetDCP::setResponseTimeout (uint32_t timeoutMsec)
```

### isServiceAvailable ()

Use this function to check Profinet DCP service availability.

- Network adapter validity / availability
- Windows: WinPcap / Npcap availability
- Linux: CAP\_NET\_ADMIN / CAP\_NET\_RAW capabilities

```
virtual ResultVoid nlc::ProfinetDCP::isServiceAvailable (const BusHardwareId &
  busHardwareId)
```

|            |                      |  |
|------------|----------------------|--|
| Parameters | <i>BusHardwareId</i> | <u>Hardware ID</u> of Profinet DCP service to check. |
| Returns    | <i>true</i>          | Service is available.                                |
|            | <i>false</i>         | Service is unavailable.                              |

### scanProfinetDevices ()

Use this function to scan the hardware bus for the presence of Profinet devices.

```
virtual ResultProfinetDevices scanProfinetDevices (const BusHardwareId &
  busHardwareId)
```

|            |                              |   |
|------------|------------------------------|---|
| Parameters | <i>BusHardwareId</i>         | Specifies each <u>fieldbus</u> to open. |
| Returns    | <u>ResultProfinetDevices</u> | Hardware is open.                       |

### setupProfinetDevice ()

Establishes the following device settings:

- Device name
- IP address
- Network mask
- Default gateway

```
virtual ResultVoid nlc::setupProfinetDevice (const BusHardwareId &
  busHardwareId, const ProfinetDevice struct &profinetDevice, bool
  savePermanent)
```

### resetProfinetDevice ()

Stops the device and resets it to factory defaults.

```
virtual ResultVoid nlc::resetProfinetDevice (const BusHardwareId &
  busHardwareId, const ProfinetDevice &profinetDevice)
```

### blinkProfinetDevice ()

Commands the Profinet device to start blinking its Profinet LED.

```
virtual ResultVoid nlc::blinkProfinetDevice (const BusHardwareId &
  busHardwareId, const ProfinetDevice &profinetDevice)
```

### validateProfinetDeviceIp ()

Use this function to check device's IP address.

```
virtual ResultVoid validateProfinetDeviceIp (const BusHardwareId
  &busHardwareId, const ProfinetDevice &profinetDevice)
```

|            |                       |   |
|------------|-----------------------|---|
| Parameters | <i>BusHardwareId</i>  | Specifies the hardware ID to check.               |
|            | <i>ProfinetDevice</i> | Specifies the <u>Profinet device</u> to validate. |

Returns *ResultVoid*

## 8.27 ProfinetDevice struct

The Profinet device data have the following public attributes:

|                          |                |
|--------------------------|----------------|
| std::string              | deviceName     |
| std::string              | deviceVendor   |
| std::array< uint8_t, 6 > | macAddress     |
| uint32_t                 | ipAddress      |
| uint32_t                 | netMask        |
| uint32_t                 | defaultGateway |

The MAC address is provided as array in format `macAddress = {xx, xx, xx, xx, xx, xx}`; whereas IP address, network mask and gateway are all interpreted as big endian hex numbers, such as:

|                           |            |
|---------------------------|------------|
| IP address: 192.168.0.2   | 0xC0A80002 |
| Network mask: 255.255.0.0 | 0xFFFF0000 |
| Gateway: 192.168.0.1      | 0xC0A80001 |

## 8.28 Result classes

Use the "optional" return values of these classes to check if a function call had success or not, and also locate the fail reasons. On success, the `hasError ()` function returns *false*. By `getResult ()`, you can read out the result value as per type (`ResultInt` etc.). If a call fails, you read out the reason by `getError ()`.

|                      |                     |                          |
|----------------------|---------------------|--------------------------|
| Protected attributes | <i>string</i>       | <code>errorString</code> |
|                      | <i>NlcErrorCode</i> | <code>errorCode</code>   |
|                      | <i>uint32_t</i>     | <code>exErrorCode</code> |

Also, this class has the following public member functions:

### hasError ()

Reads out a function call's success.

```
bool nlc::Result::hasError () const
```

|         |              |   |
|---------|--------------|---|
| Returns | <i>true</i>  | Failed call. Use <code>getError ()</code> to read out the value.      |
|         | <i>false</i> | Successful call. Use <code>getResult ()</code> to read out the value. |

### getError ()

Reads out the reason if a function call fails.

```
const std::string nlc::Result::getError () const
```

Returns *const string*

**result ()**

The following functions aid in defining the exact results:

```
Result (std::string const & errorString_)
```

```
Result (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
Result (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
Result (Result const & result)
```

**getErrorCode ()**

Read the [NlcErrorCode](#).

```
NlcErrorCode getErrorCode () const
```

**getExErrorCode ()**

```
uint32_t getExErrorCode () const
```

**8.28.1 ResultVoid**

*NanoLib* sends you an instance of this class if the function returns void. The class inherits the public functions and protected attributes from the [result class](#) and has the following public member functions:

**ResultVoid ()**

The following functions aid in defining the exact void result:

```
ResultVoid (std::string const &errorString_)
```

```
ResultVoid (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultVoid (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultVoid (Result const & result)
```

**8.28.2 ResultInt**

*NanoLib* sends you an instance of this class if the function returns an integer. The class inherits the public functions / protected attributes from the [result class](#) and has the following public member functions:

**getResult ()**

Returns the integer result if a function call had success.

```
int64_t getResult () const
```

Returns `int64_t`

## ResultInt ()

The following functions aid in defining the exact integer result:

```
ResultInt (int64_t result_)
```

```
ResultInt (std::string const & errorString_)
```

```
ResultInt (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultInt (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultInt (Result const & result)
```

### 8.28.3 ResultString

*NanoLib* sends you an instance of this class if the function returns a string. The class inherits the public functions / protected attributes from the [result class](#) and has the following public member functions:

#### getResult ()

Reads out the string result if a function call had success.

```
const std::string nlc::ResultString::getResult () const
```

Returns *const string*

#### ResultString ()

The following functions aid in defining the exact string result:

```
ResultString (std::string const & message, bool hasError_)
```

```
ResultString (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultString (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultString (Result const & result)
```

### 8.28.4 ResultArrayByte

*NanoLib* sends you an instance of this class if the function returns a byte array. The class inherits the public functions / protected attributes from the [result class](#) and has the following public member functions:

#### getResult ()

Reads out the byte vector if a function call had success.

```
const std::vector <uint8_t> nlc::ResultArrayByte::getResult () const
```

Returns *const vector<uint8\_t>*

### ResultArrayByte ()

The following functions aid in defining the exact byte array result:

```
ResultArrayByte (std::vector <uint8_t> const & result_)
```

```
ResultArrayByte (std::string const & errorString_)
```

```
ResultArrayByte (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultArrayByte (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultArrayByte (Result const & result)
```

### 8.28.5 ResultArrayInt

*NanoLib* sends you an instance of this class if the function returns an integer array. The class inherits the public functions / protected attributes from the [result class](#) and has the following public member functions:

#### getResult ()

Reads out the integer vector if a function call had success.

```
const std::vector <int64_t> nlc::ResultArrayInt::getResult () const
```

Returns *const vector<uint64\_t>*

### ResultArrayInt ()

The following functions aid in defining the exact integer array result:

```
ResultArrayInt (std::vector <int64_t> const & result_)
```

```
ResultArrayInt (std::string const & errorString_)
```

```
ResultArrayInt (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultArrayInt (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultArrayInt (Result const & result)
```

### 8.28.6 ResultBusHwIds

*NanoLib* sends you an instance of this class if the function returns a [bus hardware ID](#) array. The class inherits the public functions / protected attributes from the [result class](#) and has the following public member functions:

#### getResult ()

Reads out the bus-hardware-ID vector if a function call had success.

```
const std::vector <BusHardwareId> nlc::ResultBusHwIds::getResult () const
```

Parameters *const*  
*vector<BusHardwareId>*

## ResultBusHwIds ()

The following functions aid in defining the exact bus-hardware-ID-array result:

```
ResultBusHwIds (std::vector <BusHardwareId> const & result_)
```

```
ResultBusHwIds (std::string const & errorString_)
```

```
ResultBusHwIds (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultBusHwIds (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultBusHwIds (Result const & result)
```

### 8.28.7 ResultDeviceId

*NanoLib* sends you an instance of this class if the function returns a device ID. The class inherits the public functions / protected attributes from the result class and has the following public member functions:

#### getResult ()

Reads out the device ID vector if a function call had success.

```
DeviceId nlc::ResultDeviceId::getResult () const
```

Returns *const vector<DeviceId>*

#### ResultDeviceId ()

The following functions aid in defining the exact device ID result:

```
ResultDeviceId (DeviceId const & result_)
```

```
ResultDeviceId (std::string const & errorString_)
```

```
ResultDeviceId (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultDeviceId (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string errorString_)
```

```
ResultDeviceId (Result const & result)
```

### 8.28.8 ResultDeviceIds

*NanoLib* sends you an instance of this class if the function returns a device ID array. The class inherits the public functions / protected attributes from the result class and has the following public member functions:

#### getResult ()

Returns the device ID vector if a function call had success.

```
DeviceId nlc::ResultDeviceIds::getResult () const
```

Returns *const vector<DeviceId>*

### ResultDeviceIds ()

The following functions aid in defining the exact device-ID-array result:

```
ResultDeviceIds (std::vector <DeviceId> const & result_)
```

```
ResultDeviceIds (std::string const & errorString_)
```

```
ResultDeviceIds (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultDeviceIds (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultDeviceIds (Result const & result)
```

### 8.28.9 ResultDeviceHandle

*NanoLib* sends you an instance of this class if the function returns the value of a device handle. The class inherits the public functions / protected attributes from the result class and has the following public member functions:

#### getResult ()

Reads out the device handle if a function call had success.

```
DeviceHandle nlc::ResultDeviceHandle::getResult () const
```

Returns *DeviceHandle*

#### ResultDeviceHandle ()

The following functions aid in defining the exact device handle result:

```
ResultDeviceHandle (DeviceHandle const & result_)
```

```
ResultDeviceHandle (std::string const & errorString_)
```

```
ResultDeviceHandle (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultDeviceHandle (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultDeviceHandle (Result const & result)
```

### 8.28.10 ResultObjectDictionary

*NanoLib* sends you an instance of this class if the function returns the content of an object dictionary. The class inherits the public functions / protected attributes from the result class and has the following public member functions:

#### getResult ()

Reads out the device ID vector if a function call had success.

```
const nlc::ObjectDictionary & nlc::ResultObjectDictionary::getResult () const
```



Returns *const*  
*vector<ObjectDictionary>*

### ResultObjectDictionary ()

The following functions aid in defining the exact object dictionary result:

```
ResultObjectDictionary (nlc::ObjectDictionary const & result_)
```

```
ResultObjectDictionary (std::string const & errorString_)
```

```
ResultObjectDictionary (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultObjectDictionary (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultObjectDictionary (Result const & result)
```

### 8.28.11 ResultConnectionState

*NanoLib* sends you an instance of this class if the function returns a device-connection-state info. The class inherits the public functions / protected attributes from the [result class](#) and has the following public member functions:

#### getResult ()

Reads out the device handle if a function call had success.

```
DeviceConnectionStateInfo nlc::ResultConnectionState::getResult () const
```

Returns *DeviceConnectionStateInfo* Connected / Disconnected / ConnectedBootloader

### ResultConnectionState ()

The following functions aid in defining the exact connection state result:

```
ResultConnectionState (DeviceConnectionStateInfo const & result_)
```

```
ResultConnectionState (std::string const & errorString_)
```

```
ResultConnectionState (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultConnectionState (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultConnectionState (Result const & result)
```

### 8.28.12 ResultObjectEntry

*NanoLib* sends you an instance of this class if the function returns an [object entry](#). The class inherits the public functions / protected attributes from the [result class](#) and has the following public member functions:

**getResult ()**

Returns the device ID vector if a function call had success.

```
nlc::ObjectEntry const& nlc::ResultObjectEntry::getResult () const
```

Returns *const ObjectEntry*

**ResultObjectEntry ()**

The following functions aid in defining the exact object entry result:

```
ResultObjectEntry (nlc::ObjectEntry const & result_)
```

```
ResultObjectEntry (std::string const & errorString_)
```

```
ResultObjectEntry (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultObjectEntry (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultObjectEntry (Result const & result)
```

**8.28.13 ResultObjectSubEntry**

*NanoLib* sends you an instance of this class if the function returns an object sub-entry. The class inherits the public functions / protected attributes from the result class and has the following public member functions:

**getResult ()**

Returns the device ID vector if a function call had success.

```
nlc::ObjectSubEntry const & nlc::ResultObjectSubEntry::getResult () const
```

Returns *const ObjectSubEntry*

**ResultObjectSubEntry ()**

The following functions aid in defining the exact object sub-entry result:

```
ResultObjectSubEntry (nlc::ObjectEntry const & result_)
```

```
ResultObjectSubEntry (std::string const & errorString_)
```

```
ResultObjectSubEntry (NlcErrorCode const & errCode, std::string const & errorString_)
```

```
ResultObjectSubEntry (NlcErrorCode const & errCode, const uint32_t exErrCode, std::string const & errorString_)
```

```
ResultObjectSubEntry (Result const & result)
```

**8.28.14 ResultProfinetDevices**

*NanoLib* sends you an instance of this class if the function returns a Profinet device. The class inherits the public functions / protected attributes from the result class and has the following public member functions:

**getResult ()**

Reads out the Profinet device vector if a function call had success.

```
const std::vector <ProfinetDevice> & getResult () const
```

**ResultProfinetDevices ()**

The following functions aid in defining the exact Profinet devices.

```
ResultProfinetDevices (const std::vector <ProfinetDevice> & profinetDevices)
```

```
ResultProfinetDevices (const Result & result)
```

```
ResultProfinetDevices (const std::string &errorText, NlcErrorCode errorCode =  
NlcErrorCode::GeneralError, uint32_t extendedErrorCode = 0)
```

**8.28.15 ResultSampleDataArray**

*NanoLib* sends you an instance of this class if the function returns a sample data array. The class inherits the public functions / protected attributes from the result class and has the following public member functions:

**getResult ()**

Reads out the data array if a function call had success.

```
const std::vector <SampleData> & getResult () const
```

**ResultSampleDataArray ()**

The following functions aid in defining the exact Profinet devices.

```
ResultSampleDataArray (const std::vector <SampleData> & dataArray)
```

```
ResultSampleDataArray (const std::string &errorDesc, const NlcErrorCode  
errorCode = NlcErrorCode::GeneralError, const uint32_t extendedErrorCode = 0)
```

```
ResultSampleDataArray (const ResultSampleDataArray & other)
```

```
ResultSampleDataArray (const Result & result)
```

**8.28.16 ResultSamplerState**

*NanoLib* sends you an instance of this class if the function returns a sampler state. This class inherits the public functions / protected attributes from the result class and has the following public member functions:

**getResult ()**

Reads out the sampler state vector if a function call had success.

```
SamplerState getResult () const
```

Returns *SamplerState*> Unconfigured / Configured / Ready / Running / Completed / Failed / Cancelled

## ResultSamplerState ()

The following functions aid in defining the exact sampler state.

```
ResultSamplerState (const SamplerState state)
```

```
ResultSamplerState (const std::string & errorDesc,  
const NlcErrorCode errorCode = NlcErrorCode::GeneralError, const uint32_t  
extendedErrorCode = 0)
```

```
ResultSamplerState (const ResultSamplerState & other)
```

```
ResultSamplerState (const Result & result)
```

## 8.29 NlcErrorCode

If something goes wrong, the [result classes](#) report one of the error codes listed in this enumeration.

| Error code            | C: Category   D: Description   R: Reason   |
|-----------------------|--|
| Success               | <b>C:</b> None. <b>D:</b> No error. <b>R:</b> The operation completed successfully.  |
| GeneralError          | <b>C:</b> Unspecified. <b>D:</b> Unspecified error. <b>R:</b> Failure that fits no other category.   |
| BusUnavailable        | <b>C:</b> Bus. <b>D:</b> Hardware bus not available. <b>R:</b> Bus inexistent, cut-off or defect.  |
| CommunicationError    | <b>C:</b> Communication. <b>D:</b> Communication unreliable. <b>R:</b> Unexpected data, wrong CRC, frame or parity errors, etc.  |
| ProtocolError         | <b>C:</b> Protocol. <b>D:</b> Protocol error. <b>R:</b> Response after unsupported protocol option, device report unsupported protocol, error in the protocol (say, SDO segment sync bit), etc. <b>R:</b> A response or device report to unsupported protocol (options) or to errors in protocol (say, SDO segment sync bit), etc. <b>R:</b> Unsupported protocol (options) or error in protocol (say, SDO segment sync bit), etc. |
| ODDoesNotExist        | <b>C:</b> Object dictionary. <b>D:</b> OD address inexistent. <b>R:</b> No such address in the object dictionary.  |
| ODInvalidAccess       | <b>C:</b> Object dictionary. <b>D:</b> Access to OD address invalid. <b>R:</b> Attempt to write a read-only, or to read from a write-only, address.  |
| ODTypeMismatch        | <b>C:</b> Object dictionary. <b>D:</b> Type mismatch. <b>R:</b> Value unconverted to specified type, say, in an attempt to treat a string as a number.   |
| OperationAborted      | <b>C:</b> Application. <b>D:</b> Process aborted. <b>R:</b> Process cut by application request. Returns only on operation interrupt by callback function, say, from bus-scanning.  |
| OperationNotSupported | <b>C:</b> Common. <b>D:</b> Process unsupported. <b>R:</b> No hardware bus / device support.   |
| InvalidOperation      | <b>C:</b> Common. <b>D:</b> Process incorrect in current context, or invalid with current argument. <b>R:</b> A reconnect attempt to already connected buses / devices. A disconnect attempt to already disconnected ones. A bootloader operation attempt in firmware mode or vice versa.  |
| InvalidArguments      | <b>C:</b> Common. <b>D:</b> Argument invalid. <b>R:</b> Wrong logic or syntax.   |
| AccessDenied          | <b>C:</b> Common. <b>D:</b> Access is denied. <b>R:</b> Lack of rights or capabilities to perform the requested operation.   |
| ResourceNotFound      | <b>C:</b> Common. <b>D:</b> Specified item not found. <b>R:</b> Hardware bus, protocol, device, OD address on device, or file was not found.   |
| ResourceUnavailable   | <b>C:</b> Common. <b>D:</b> Specified item not found. <b>R:</b> busy, inexistent, cut-off or defect.   |
| OutOfMemory           | <b>C:</b> Common. <b>D:</b> Insufficient memory. <b>R:</b> Too little memory to process this command.  |
| TimeOutError          | <b>C:</b> Common. <b>D:</b> Process timed out. <b>R:</b> Return after time-out expired. Timeout may be a device response time, a time to gain shared or exclusive resource access, or a time to switch the bus / device to a suitable state.   |

### 8.30 NlcCallback

This parent class for callbacks has the following public member function:

#### callback ()

```
virtual ResultVoid callback ()
```

Returns [ResultVoid](#)

### 8.31 NlcDataTransferCallback

Use this callback class for data transfers (firmware update, NanoJ upload etc.).

1. For a firmware upload: Define a "co-class" extending this one with a custom callback method implementation.
2. Use the "co-class's" instances in *NanoLibAccessor.uploadFirmware ()* calls.

The main class itself has the following public member function:

#### callback ()

```
virtual ResultVoid callback (nlc::DataTransferInfo info, int32_t data)
```

Returns [ResultVoid](#)

### 8.32 NlcScanBusCallback

Use this callback class for bus scanning.

1. Define a "co-class" extending this one with a custom callback method implementation.
2. Use the "co-class's" instances in *NanoLibAccessor.scanDevices ()* calls.

The main class itself has the following public member function.

#### callback ()

```
virtual ResultVoid callback (nlc::BusScanInfo info, std::vector <DeviceId>
const & devicesFound, int32_t data)
```

Returns *ResultVoid*

### 8.33 NlcLoggingCallback

Use this callback class for logging callbacks.

1. Define a class that extends this class with a custom callback method implementation
2. Use a pointer to its instances in order to set a callback by *NanoLibAccessor > setLoggingCallback (...)*.

```
virtual void callback (const std::string & payload_str, const std::string &
formatted_str, const std::string & logger_name, const unsigned int log_level,
const std::uint64_t time_since_epoch, const size_t thread_id)
```

### 8.34 SamplerInterface

Use this class to configure, start and stop the sampler, or to get sampled data and fetch a sampler's status or last error. The class has the following public member functions.

**configure ()**

Configures a sampler.

```
virtual ResultVoid nlc::SamplerInterface::configure (const DeviceHandle
  deviceHandle, const SamplerConfiguration & samplerConfiguration)
```

|            |                                  |   |
|------------|----------------------------------|---|
| Parameters | [in] <i>deviceHandle</i>         | Specifies what device to configure the sampler for.       |
|            | [in] <i>samplerConfiguration</i> | Specifies the values of <u>configuration attributes</u> . |
| Returns    | <i>ResultVoid</i>                | Confirms that a <u>void function</u> has run.             |

**getData ()**

Gets the sampled data.

```
virtual ResultSampleDataArray nlc::SamplerInterface::getData (const
  DeviceHandle deviceHandle)
```

|            |                              |  |
|------------|------------------------------|--|
| Parameters | [in] <i>deviceHandle</i>     | Specifies what device to get the data for.   |
| Returns    | <i>ResultSampleDataArray</i> | Delivers the sampled data, which can be an empty array if <u>samplerNotify</u> is active on start. |

**getLastError ()**

Gets a sampler's last error.

```
virtual ResultVoid nlc::SamplerInterface::getLastError (const DeviceHandle
  deviceHandle)
```

|         |                   |   |
|---------|-------------------|---|
| Returns | <i>ResultVoid</i> | Confirms that a <u>void function</u> has run. |
|---------|-------------------|---|

**getState ()**

Gets a sampler's status.

```
virtual ResultSamplerState nlc::SamplerInterface::getState (const DeviceHandle
  deviceHandle)
```

|         |                           |                             |
|---------|---------------------------|-----------------------------|
| Returns | <u>ResultSamplerState</u> | Delivers the sampler state. |
|---------|---------------------------|-----------------------------|

**start ()**

Starts a sampler.

```
virtual ResultVoid nlc::SamplerInterface::start (const DeviceHandle
  deviceHandle, SamplerNotify* samplerNotify, int64_t applicationData)
```

|            |                             |   |
|------------|-----------------------------|---|
| Parameters | [in] <i>deviceHandle</i>    | Specifies what device to start the sampler for.   |
|            | [in] <u>SamplerNotify</u>   | Specifies what optional info to report (can be <i>nullptr</i> ).  |
|            | [in] <i>applicationData</i> | Option: Forwards application-related data (a user-defined 8-bit array of value / device ID / index, or a datetime, a variable's / function's pointer, etc.) to <i>samplerNotify</i> . |
| Returns    | <i>ResultVoid</i>           | Confirms that a <u>void function</u> has run.   |

**stop ()**

Stops a sampler.

```
virtual ResultVoid nlc::SamplerInterface::stop (const DeviceHandle
deviceHandle)
```

Parameters [in] *deviceHandle* Specifies what device to stop the sampler for.  
 Returns *ResultVoid* Confirms that a void function has run.

**8.35 SamplerConfiguration struct**

This struct contains the data sampler's configuration options (static or not).

**Public attributes**

|                         |  |  |
|-------------------------|--|--|
| std::vector <OdIndex>   | <i>trackedAddresses</i>                | Up to 12 OD addresses to be sampled.   |
| uint32_t                | <i>version</i>                         | A structure's version.   |
| uint32_t                | <i>durationMilliseconds</i>            | Sampling duration in ms, from 1 to 65535   |
| uint16_t                | <i>periodMilliseconds</i>              | Sampling period in ms.   |
| uint16_t                | <i>numberOfSamples</i>                 | Samples amount.  |
| uint16_t                | <i>preTriggerNumberOfSamples</i>       | Samples pre-trigger amount.  |
| bool                    | <i>usingSoftwareImplementation</i>     | Use software implementation.   |
| bool                    | <i>usingNewFWSamplerImplementation</i> | Use FW implementation for devices with a FW version v24xx or newer.  |
| SamplerMode             | <i>mode</i>                            | <i>Normal, repetitive</i> or <i>continuous</i> sampling.   |
| SamplerTriggerCondition | <i>triggerCondition</i>                | <b>Start trigger conditions:</b><br>TC_FALSE = 0x00<br>TC_TRUE = 0x01<br>TC_SET = 0x10<br>TC_CLEAR = 0x11<br>TC_RISING_EDGE = 0x12<br>TC_FALLING_EDGE = 0x13<br>TC_BIT_TOGGLE = 0x14<br>TC_GREATER = 0x15<br>TC_GREATER_OR_EQUAL = 0x16<br>TC_LESS = 0x17<br>TC_LESS_OR_EQUAL = 0x18<br>TC_EQUAL = 0x19<br>TC_NOT_EQUAL = 0x1A<br>TC_ONE_EDGE = 0x1B<br>TC_MULTI_EDGE = 0x1C, <b>OdIndex, triggerValue</b> |
| SamplerTrigger          | <i>SamplerTrigger</i>                  | A trigger to start a sampler?  |

**Static public attributes**

```
static constexpr size_t SAMPLER_CONFIGURATION_VERSION = 0x01000000
static constexpr size_t MAX_TRACKED_ADDRESSES = 12
```

**8.36 SamplerNotify**

Use this class to activate sampler notifications when you start a sampler. The class has the following public member function.

**notify ()**

Delivers a notification entry.

```
virtual void nlc::SamplerNotify::notify (const ResultVoid & lastError, const
  SamplerState samplerState, const std::vector <SampleData> & sampleDatas,
  int64_t applicationData)
```

|                                  |  |
|----------------------------------|--|
| Parameters [in] <i>lastError</i> | Reports the last error occurred while sampling.  |
| [in] <i>samplerState</i>         | Reports the sampler status at notification time: Unconfigured / Configured / Ready / Running / Completed / Failed / Cancelled. |
| [in] <i>sampleDatas</i>          | Reports the sampled-data array.  |
| [in] <i>applicationData</i>      | Reports application-specific data.   |

**8.37 SampleData struct**

This struct contains the sampled data.

|   |  |
|---|--|
| <i>uin64_t iterationNumber</i>          | Starts at 0 and only increases in repetitive mode. |
| <i>std::vector&lt;SampledValues&gt;</i> | Contains the array of sampled values.              |

**8.38 SampledValue struct**

This struct contains the sampled values.

|                                |   |
|--------------------------------|---|
| <i>in64_t value</i>            | Contains the value of a tracked OD address.                                     |
| <i>uin64_t CollectTimeMsec</i> | Contains the collection time in milliseconds, relative to the sample beginning. |

**8.39 SamplerTrigger struct**

This struct contains the trigger settings of the sampler.

|  |  |
|--|--|
| <i>SamplerTriggerCondition condition</i> | The trigger condition:<br>TC_FALSE = 0x00<br>TC_TRUE = 0x01<br>TC_SET = 0x10<br>TC_CLEAR = 0x11<br>TC_RISING_EDGE = 0x12<br>TC_FALLING_EDGE = 0x13<br>TC_BIT_TOGGLE = 0x14<br>TC_GREATER = 0x15<br>TC_GREATER_OR_EQUAL = 0x16<br>TC_LESS = 0x17<br>TC_LESS_OR_EQUAL = 0x18<br>TC_EQUAL = 0x19<br>TC_NOT_EQUAL = 0x1A<br>TC_ONE_EDGE = 0x1B<br>TC_MULTI_EDGE = 0x1C |
| <i>OdIndex</i>                           | The trigger's <u>OdIndex</u> (address).  |
| <i>uin32_t value</i>                     | Condition value or bit number (starting from bit zero).  |

**8.40 Serial struct**

Find here your serial communication options and the following public attributes:

|                      |  |
|----------------------|--|
| const std::string    | BAUD_RATE_OPTIONS_NAME = "serial baud rate"    |
| const SerialBaudRate | <i>baudRate</i> = <u>SerialBaudRate struct</u> |



```
const std::string          PARITY_OPTIONS_NAME = "serial parity"
const SerialParity        parity = SerialParity struct
```

## 8.41 SerialBaudRate struct

Find here your serial communication baud rate and the following public attributes:

```
const std::string          BAUD_RATE_7200 = "7200"
const std::string          BAUD_RATE_9600 = "9600"
const std::string          BAUD_RATE_14400 = "14400"
const std::string          BAUD_RATE_19200 = "19200"
const std::string          BAUD_RATE_38400 = "38400"
const std::string          BAUD_RATE_56000 = "56000"
const std::string          BAUD_RATE_57600 = "57600"
const std::string          BAUD_RATE_115200 = "115200"
const std::string          BAUD_RATE_128000 = "128000"
const std::string          BAUD_RATE_256000 = "256000"
```

## 8.42 SerialParity struct

Find here your serial parity options and the following public attributes:

```
const std::string          NONE = "none"
const std::string          ODD = "odd"
const std::string          EVEN = "even"
const std::string          MARK = "mark"
const std::string          SPACE = "space"
```

## 9 Licenses

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## 10 Imprint, contact, versions

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| Document                 | + Added   > Changed   # Fixed  | Product         |
|--------------------------|--|-----------------|
| 1.4.0 <sup>2024.09</sup> | + NanoLib-CANopen: Support for <i>Peak</i> PCAN-USB adapter (IPEH-002021/002022).  | 1.2.0           |
| 1.3.3 <sup>2024.07</sup> | > NanoLib Core: Changed logging callback interface (LogLevel replaced by LogModule).<br># NanoLib Logger: Separation between core and modules has been corrected.<br># Modbus TCP: Fixed firmware update for FW4.<br># EtherCAT: Fixed NanoJ program upload for Core5.<br># EtherCAT: Fixed firmware update for Core5.   | 1.1.3           |
| 1.3.2 <sup>2024.05</sup> | # Modbus RTU: Fixed timing issues with low baud rates during firmware update.<br># RESTful: Fixed NanoJ program upload.  | 1.1.2           |
| 1.3.1 <sup>2024.04</sup> | # NanoLib Modules Sampler: Correct reading of sampled boolean values.  | 1.1.1           |
| 1.3.0 <sup>2024.02</sup> | + Java 11 support for all platforms.<br>+ Python 3.11 /3.12 support for all platforms.<br>+ New logging callback interface (see examples).<br>+ Callback sinks for NanoLib Logger.<br>> Update logger to version 1.12.0.<br>> NanoLib Modules Sampler: Support now for Nanotec controller firmware v24xx.<br>> NanoLib Modules Sampler: Change in structure used for sampler configuration.<br>> NanoLib Modules Sampler: Continuous mode is synonymous with <i>endless</i> ; the trigger condition is checked once; the number of samples must be 0.<br>> NanoLib Modules Sampler: Normal priority for the thread that collects data in firmware mode.<br>> NanoLib Modules Sampler: Rewritten algorithm to detect transition between <i>Ready &amp; Running state</i> .<br># NanoLib Core: No more <i>Access Violation (0xC0000005)</i> on closing 2 or more devices using the same bus hardware.<br># NanoLib Core: No more <i>Segmentation Fault</i> on attaching a PEAK adapter under Linux.<br># NanoLib Modules Sampler: Correct sampled-values reading in firmware mode.<br># NanoLib Modules Sampler: Correct configuration of 502X:04.<br># NanoLib Modules Sampler: Correct mixing of buffers with channels.<br># NanoLib-Canopen: Increased CAN timeouts for robustness and correct scanning at lower baudrates.<br># NanoLib-Modbus: VCP detection algorithm for special devices (USB-DA-IO). | 1.1.0           |
| 1.2.2 <sup>2022.09</sup> | + EtherCAT support.  | 1.0.1<br>(B349) |
| 1.2.1 <sup>2022.08</sup> | + Note on VS project settings in <a href="#">Configure your project</a> .  | 1.0.0<br>(B344) |
| 1.2.0 <sup>2022.08</sup> | + <a href="#">getDeviceHardwareGroup ()</a> .<br>+ <a href="#">getProfinetDCP (isServiceAvailable)</a> .<br>+ <a href="#">getProfinetDCP (validateProfinetDeviceIp)</a> .<br>+ <a href="#">autoAssignObjectDictionary ()</a> .<br>+ <a href="#">getXmlFileName ()</a> .<br>+ <code>const std::string &amp; xmlFilePath</code> in <a href="#">addObjectDictionary ()</a> .<br>+ <a href="#">getSamplerInterface ()</a> .<br>+ <a href="#">rebootDevice ()</a> .<br>+ Error code <i>ResourceUnavailable</i> for <a href="#">getDeviceBootloaderVersion ()</a> , <a href="#">~VendorId ()</a> , <a href="#">~HardwareVersion ()</a> , <a href="#">~SerialNumber</a> , and <a href="#">~Uid</a> .<br>> <a href="#">firmwareUploadFromFile</a> now <a href="#">uploadFirmwareFromFile ()</a> .<br>> <a href="#">firmwareUpload ()</a> now <a href="#">uploadFirmware ()</a> .   | 1.0.0<br>(B341) |

| Document                 | + Added   > Changed   # Fixed   | Product |
|--------------------------|---|---------|
|                          | <ul style="list-style-type: none"> <li>&gt; <i>bootloaderUploadFromFile ()</i> now <i>uploadBootloaderFromFile ()</i>.</li> <li>&gt; <i>bootloaderUpload ()</i> now <i>uploadBootloader ()</i>.</li> <li>&gt; <i>bootloaderFirmwareUploadFromFile ()</i> to <i>uploadBootloaderFirmwareFromFile ()</i>.</li> <li>&gt; <i>bootloaderFirmwareUpload ()</i> now <i>uploadBootloaderFirmware ()</i>.</li> <li>&gt; <i>nanojUploadFromFile ()</i> now <i>uploadNanoJFromFile ()</i>.</li> <li>&gt; <i>nanojUpload ()</i> now <i>uploadNanoJ ()</i>.</li> <li>&gt; <i>objectDictionaryLibrary ()</i> now <i>getObjectDictionaryLibrary ()</i>.</li> <li>&gt; <i>String_String_Map</i> now <i>StringStringMap</i>.</li> <li>&gt; NanoLib-Common: faster execution of <i>listAvailableBusHardware</i> and <i>openBusHardwareWithProtocol</i> with Ixxat adapter.</li> <li>&gt; NanoLib-CANopen: default settings used (1000k baudrate, Ixxat bus number 0) if bus hardware options empty.</li> <li>&gt; NanoLib-RESTful: admin permission obsolete for communication with Ethernet bootloaders under Windows if <i>npcap / winpcap</i> driver is available.</li> <li># NanoLib-CANopen: bus hardware now opens crashless with empty options.</li> <li># NanoLib-Common: <i>openBusHardwareWithProtocol ()</i> with no memory leak now.</li> </ul> |         |
| 1.1.2 <sup>2022.03</sup> | <ul style="list-style-type: none"> <li>+ Linux ARM64 support.</li> <li>+ USB mass storage / REST / Profinet DCP support.</li> <li>+ <i>checkConnectionState ()</i>.</li> <li>+ <i>getDeviceBootloaderVersion ()</i>.</li> <li>+ <i>ResultProfinetDevices</i>.</li> <li>+ <i>NlcErrorCode</i> (replaced <i>NanotecExceptions</i>).</li> <li>+ NanoLib Modbus: VCP / USB hub unified to USB.</li> <li>&gt; Modbus TCP scanning returns results.</li> <li>&lt; Modbus TCP communication latency remains constant.</li> </ul>   | 0.8.0   |
| 1.1.1 <sup>2021.11</sup> | <ul style="list-style-type: none"> <li>+ More <i>ObjectEntryDataType</i> (complex and profile-specific).</li> <li>+ <i>IOError</i> return if <i>connectDevice ()</i> and <i>scanDevices ()</i> find none.</li> <li>+ Only 100 ms nominal timeout for CanOpen / Modbus.</li> </ul>   | 0.7.1   |
| 1.1.0 <sup>2021.06</sup> | <ul style="list-style-type: none"> <li>+ Modbus support (plus USB Hub via VCP).</li> <li>+ Chapter <i>Creating your own Linux project</i>.</li> <li>+ <i>extraHardwareSpecifier</i> to <i>BusHardwareId ()</i>.</li> <li>+ <i>extraId_</i> and <i>extraStringId_</i> to <i>DeviceId ()</i>.</li> </ul>  | 0.7.0   |
| 1.0.1 <sup>2021.06</sup> | <ul style="list-style-type: none"> <li>+ <i>setBusState ()</i>.</li> <li>+ <i>getDeviceBootloaderBuildId ()</i>.</li> <li>+ <i>getDeviceFirmwareBuildId ()</i>.</li> <li>+ <i>getDeviceHardwareVersion ()</i>.</li> <li># Bugfixes.</li> </ul>  | 0.5.1   |
| 1.0.0 <sup>2021.05</sup> | Edition.  | 0.5.1   |