Squidstat API User Manual

Generated by Admiral Instruments LLC

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Chapter 1

Squidstat API User Manual

The Admiral Instruments API provides you with more control of our potentiostats. Through asynchronous signals you can capture events such as experiments starting, stopping, and pausing to seamlessly integrate these controls into your pipeline and workflow automation.

Some common use cases include:

- Chaining multiple experiments together for long term testing.
- Manipulating experiment parameters based on the result of the previous experiment.
- Starting and stopping an experiment when an external device detects a specific temperature.

You can find it on our GitHub repository including examples for C++ and Python.

This documentation will guide you through how to install and set up our API as well as provide you with examples with explanations to help support your workflow.

If you have any difficulty using our API, please reach out to us through the discussions page on our GitHub.

1.0.0.1 Where to go from here

- Install and Setup C++
- Install and Setup Python
- Guided Examples
- API Objects

Chapter 2

Advanced Experiment Logic

This example demonstrates how to create a custom experiment using loops and subexperiments for added complexity.

2.0.1 Experiment Description

The API allows us to build experiments with multiple elements, which can loop individually or as a group. Let's consider building an experimental sequence with the following structure:

1. Open Circuit Potential (OCP) element
2. Constant Potential Element (loops 4 times, increasing the voltage by 100 mV each loop)
3. Galvanostatic EIS element and OCP element (loops 3 times)
4. Constant Current element that loops 2 times

- **C++**

```cpp
auto customExperiment = std::make_shared<AisExperiment>();

AisOpenCircuitElement ocpElement(1, 10);
success &= customExperiment->appendElement(ocpElement);

int voltage = 0;
for (int i = 0; i < 4; i++) {
    AisConstantPotElement cvElement(voltage, 0.1, 5);
    success &= customExperiment->appendElement(cvElement, 1);
    voltage += 0.1; // Adding 100 mV
}

AisExperiment eisSubExperiment;

AisEISGalvanostaticElement galvEISElement(10, 10000, 10, 0.01, 0.1);
AisOpenCircuitElement ocpElement2(1, 5);

success &= eisSubExperiment.appendElement(galvEISElement, 1);
success &= eisSubExperiment.appendElement(ocpElement2, 1);

success &= customExperiment->appendSubExperiment(eisSubExperiment, 3);

AisConstantCurrentElement ccElement(0.1, 1, 10);
success &= customExperiment->appendElement(ccElement, 2);

if (!success) {
    qDebug() « "Error building experiment";
    return 0;
}
```

- **Python**

```
customExperiment = AisExperiment()
# Step 1

ocpElement = AisOpenCircuitElement(1, 10)
success &= customExperiment.appendElement(ocpElement)

voltage = 0
for i in range(0, 4):
    cvElement = AisConstantPotElement(voltage, 0.1, 5)
    success &= customExperiment.appendElement(cvElement, 1)
    voltage = voltage + 0.1

eisSubExperiment = AisExperiment()

galvEISElement = AisEISGalvanostaticElement(10, 10000, 10, 0.01, 0.1)
ocpElement2 = AisOpenCircuitElement(1, 5)

success &= eisSubExperiment.appendElement(galvEISElement, 1)
success &= eisSubExperiment.appendElement(ocpElement2, 1)

success &= customExperiment.appendSubExperiment(eisSubExperiment, 3)

ccElement = AisConstantCurrentElement(0.1, 1, 10)
success &= customExperiment.appendElement(ccElement, 2)

if not success:
    print("Error building experiment")
    sys.exit()
```

Let's go over the code in more detail:

2.0.2 Building the Experiment

Here, we create the Open Circuit Element and add it to the experiment without specifying the number of loops, so it runs once.

- **C++**

```
    AisOpenCircuitElement ocpElement(1, 10);
    success &= customExperiment->appendElement(ocpElement);
```

- **Python**

```
ocpElement = AisOpenCircuitElement(1, 10)
success &= customExperiment.appendElement(ocpElement)
```

Next, we create the Constant Potential Elements, using a for loop to increment the voltage for each element, and then adding it to the created subExperiment.

- **C++**

```
    int voltage = 0;
    for (int i = 0; i < 4; i++) {
        AisConstantPotElement cvElement(voltage, 0.1, 5);
        success &= customExperiment->appendElement(cvElement, 1);
        voltage += 0.1; // Adding 100 mV
    }
```

- **Python**

```
voltage = 0
for i in range(0, 4):
    cvElement = AisConstantPotElement(voltage, 0.1, 5)
    success &= customExperiment.appendElement(cvElement, 1)
    voltage = voltage + 0.1
```

For the looped EIS and OCP elements, we create another AisExperiment (eisSubExperiment), add the elements, and use AisExperiment::appendSubExperiment with 3 passed as the loop argument. This makes the two elements loop consecutively 3 times.

- **C++**

```
AisExperiment eisSubExperiment;

AisEISGalvanostaticElement galvEISElement(10, 10000, 10, 0.01, 0.1);
AisOpenCircuitElement ocpElement2(1, 5);

success &= eisSubExperiment.appendElement(galvEISElement, 1);
success &= eisSubExperiment.appendElement(ocpElement2, 1);

success &= customExperiment->appendSubExperiment(eisSubExperiment, 3);
```

- **Python**

```
eisSubExperiment = AisExperiment()

galvEISElement = AisEISGalvanostaticElement(10, 10000, 10, 0.01, 0.1)
ocpElement2 = AisOpenCircuitElement(1, 5)

success &= eisSubExperiment.appendElement(galvEISElement, 1)
success &= eisSubExperiment.appendElement(ocpElement2, 1)

success &= customExperiment.appendSubExperiment(eisSubExperiment, 3)
```

Lastly, we create the Constant Current Element, adding it to the main experiment using AisExperiment::appendElement with the loop argument set to 2. This loops the element twice at the end.

- **C++**

```
AisExperiment eisSubExperiment;

AisEISGalvanostaticElement galvEISElement(10, 10000, 10, 0.01, 0.1);
AisOpenCircuitElement ocpElement2(1, 5);

success &= eisSubExperiment.appendElement(galvEISElement, 1);
success &= eisSubExperiment.appendElement(ocpElement2, 1);

success &= customExperiment->appendSubExperiment(eisSubExperiment, 3);
```

- **Python**

```
eisSubExperiment = AisExperiment()

galvEISElement = AisEISGalvanostaticElement(10, 10000, 10, 0.01, 0.1)
ocpElement2 = AisOpenCircuitElement(1, 5)

success &= eisSubExperiment.appendElement(galvEISElement, 1)
success &= eisSubExperiment.appendElement(ocpElement2, 1)

success &= customExperiment.appendSubExperiment(eisSubExperiment, 3)
```

2.0.3 Starting the Experiment

The experiment is now ready and can be started like any other experiment.

- **C++**

```
QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=](const QString& deviceName) {
    qDebug() « "New Device Connected: " « deviceName;
    auto& handler = tracker->getInstrumentHandler(INSTRUMENT_NAME);

    connectSignals(handler);

    AisErrorCode error = handler.uploadExperimentToChannel(CHANNEL, customExperiment);
    if (error) {
        qDebug() « error.message();
        return 0;
    }

    error = handler.startUploadedExperiment(CHANNEL);
    if (error) {
        qDebug() « error.message();
        return 0;
    }
});

AisErrorCode error = tracker->connectToDeviceOnComPort(COMPORT);
if (error != error.Success) {
    qDebug() « error.message();
    return 0;
}
```

- **Python**

```
def startExperiment():
    handler = tracker.getInstrumentHandler(INSTRUMENT_NAME)

    connectSignals(handler)

    error = handler.uploadExperimentToChannel(CHANNEL, customExperiment)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    error = handler.startUploadedExperiment(CHANNEL)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

tracker.newDeviceConnected.connect(startExperiment)

error = tracker.connectToDeviceOnComPort(COMPORT)
if error.value() != AisErrorCode.Success:
    print(error.message())
    sys.exit()
```

See the full example `here`

Now that we have seen how create complex custom experiments, lets move on to the next example, where we will utilize manual mode operations to provide real-time control of the Squidstat.

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Handling Signals	Manual Experiments

Chapter 3

Finding COM Ports

COM ports are used by the API to communicate with Squidstats. It is crucial to know which serial port the instrument is connected to in order to establish the correct communication pathway. Locate the serial port in the Squidstat User Interface (SUI) software in the "More Options" tab under "Device Information." If the SUI is not installed, you can determine the serial port using different methods based on your operating system

3.1 Windows

1. Connect the device via USB and power it on.
2. Open Device Manager using the search function (Windows key > then type "Device Manager") or through Control Panel via: Control Panel > Hardware and Sound > Devices and Printers > Device Manager
3. Expand 'Ports' to view the connected devices (e.g. `USB Serial Port(COM3)`). If multiple COM ports are listed, power cycle or disconnect the device to identify the correct one.
4. When referring to the serial port from the example above in the API, the format for the entry would be `COM3`.

3.2 Mac

1. Connect the device via USB and power it on.
2. Open Terminal via Applications > Utilities > Terminal or use Spotlight Search (Cmd + Space, then type "Terminal").
3. List serial devices by entering `ls /dev/cu.*` in Terminal.
4. Identify the USB serial port from the list.

   Example output:

   ```
   /dev/cu.Bluetooth-Incoming-Port
   /dev/cu.usbmodem14201
   /dev/cu.usbserial-Admiral_1409
   ```

   In this example, `/dev/cu.usbmodem14201` and `/dev/cu.usbserial-Admiral_1409` are the USB serial ports associated with the connected devices. If there are multiple entries, power cycle or disconnect the device and rerun the command.

5. When referring to a serial port from the example above in the API, the format for the entry would be `cu.usbmodem14201`.

3.3 Linux

1. Connect the device via USB and power it on.
2. Open Terminal (Ctrl + Alt + T).
3. Run `ls /dev | grep tty` in Terminal
4. Identify the USB serial port. Look for the lines that refer to USB devices (e.g., "`ttyACM0`" or "`ttyUSB1`"). For multiple entries, power cycle or disconnect the device and rerun the command.
5. When referring to the serial port from the example above in the API, the format for the entry would be `tty↩ ACM0`.

Chapter 4

Extra Examples

The previous examples cover all the API features required to run most experiments.

Below are additional examples showcasing specific features and use cases of the API.

	C++	Python
Writing Data to File	Link	Link
Nonblocking Experiment	Link	Link
Cycler Linked Channels	Link	Link
Handle Pulse Data	Link	Link
Advanced Control Flow	Link	
Async Example		Link
Remote Squidstat Operation		Client & Server

4.1 Discussions

If you have any other questions or requests regarding the API, please refer to the Admiral Instruments discussions page. Here you can ask questions, share your ongoing projects, and engage in discussions with other users and the Admiral Instruments team.

Chapter 5

Updating Firmware

5.0.1 Introduction

Each API version includes the necessary firmware for all supported Squidstats to connect properly. When a new API is released, it may include updated firmware with new features or fixes. However, firmware updates are not automatic. They must be initiated manually. A Squidstat won't connect to the API until its firmware is compatible. Once updated, the firmware stays on the device until another update is performed. No separate files or tools are needed, and updates are only required when the API version changes.
This page explains how to detect and handle outdated firmware.

Note

> The latest Squidstat API and Squidstat User Interface should always have matching firmware versions for all devices. If switching between them requires a firmware update, please verify that you have both the latest SUI and API.

5.0.2 Checking for and Updating Outdated Firmware

If AisDeviceTracker::connectToDeviceOnComPort returns the AisErrorCode::FirmwareNotSupported error code, a firmware update is required to use the device with the API. Here is an example of how to update the firmware in this scenario.

- **C++**

```
#include "AisInstrumentHandler.h"
#include "AisDeviceTracker.h"

#include <QCoreApplication>
#include <QThread>
#include <QDebug>

#define COMPORT "COM1"

int main()
{
    int args;
    QCoreApplication a(args, nullptr);

    auto tracker = AisDeviceTracker::Instance();

    QObject::connect(tracker, &AisDeviceTracker::firmwareUpdateNotification, [=](const QString&
message) {
        qDebug() « message;
        if (message.contains("firmware is updated.")) {
            // Now instrument is ready to go
        }
    });

    // Attempt to connect to the device
    auto error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error == AisErrorCode::FirmwareNotSupported) {
        error = tracker->updateFirmwareOnComPort(COMPORT);

        // Some other error occured
        if (error != AisErrorCode::Success) {
            qDebug() « "Error: " « error.message();
        }

    } else if (error != AisErrorCode::Success) {
        qDebug() « "Error: " « error.message();
    } else {
        qDebug() « "Device firmware is up to date";
    }

    return a.exec();
}
```

- **Python**

```
import sys
from PySide6.QtWidgets import QApplication

from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisErrorCode

# Define relavant device information, for easy access
COMPORT = "COM16"

app = QApplication()

tracker = AisDeviceTracker.Instance()

def onProgressMessage(message):
    print(message)
    if message.__contains__("firmware is updated"):
        app.quit()


tracker.firmwareUpdateNotification.connect(onProgressMessage)


# Attempt to connect to the device
error = tracker.connectToDeviceOnComPort(COMPORT)
if error.value() == AisErrorCode.FirmwareNotSupported:
    error = tracker.updateFirmwareOnComPort(COMPORT)

    # Some other error occured
    if error.value() != AisErrorCode.Success:
        print(f"Error: {error.message()}")
        sys.exit()
elif error.value() != AisErrorCode.Success:
    print(f"Error: {error.message()}")
    sys.exit()
else:
    print("Device is already up to date.")
    sys.exit()

sys.exit(app.exec())
```

The AisDeviceTracker::firmwareUpdateNotification signal will display the progress of the firmware update as a percentage while the instrument is updating. Once the update is complete, this notification will send the message "Firmware is updated", signaling that the instrument can now be connected to the API.

- **C++**

```
    QObject::connect(tracker, &AisDeviceTracker::firmwareUpdateNotification, [=](const QString&
message) {
        qDebug() « message;
        if (message.contains("firmware is updated.")) {
            // Now instrument is ready to go
        }
    });
```

- **Python**

```
tracker.firmwareUpdateNotification.connect(onProgressMessage)
```

See the full example here

Note that we check the AisErrorCode first before performing the firmware update. Alternatively, you can use AisDeviceTracker::updateFirmwareOnAllAvailableDevices all connected devices that require an update.

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Chapter 6

Guided Examples

In this section, we will walk through examples to demonstrate how to connect to instruments, build experiments, and handle data effectively. Each walkthrough references examples for Python and C++. Full versions of these can be found in the Raw Example Code tab of the Reference section. You can use these examples to test out code and explore the functionality of the API.

- Updating Firmware
- Running an Experiment
- Handling Signals
- Advanced Experiment Logic
- Manual Experiments

See the Reference section for more examples and documentation

6.1 About Qt

The SquidstatLibrary relies heavily on Qt's signals and slots mechanism for asynchronous communication between the API and Squidstats. This feature allows the API to operate in a non-blocking manner, enabling Squidstat control without blocking the main thread of your application. This ensures that the API can manage Squidstat operations seamlessly, without hindering the execution of other parts of your program or any additional applications running alongside it.

The SquidstatLibrary relies heavily on Qt's signal and slot mechanism for asynchronous communication between the API and Squidstats. This feature allows the API to operate in a non-blocking manner, enabling Squidstat control without interrupting the main thread of your application. This is essential for applications that need to control Squidstats via the API while keeping the main application responsive.

Here are some useful links to Qt documentation:

- `Signals and Slots`
- `Qt's Event Loop`

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Chapter 7

Manual Experiments

Here, we will cover how to operate a Squidstat in Manual Mode. The Squistat API provides a set of manual mode commands as functions, which allow the user to control the squidstat while an experiment is running. Which can be useful for for scenarios where the user needs to change parameters on the fly (i.e. in a GUI application). See the manual experiments tab in the Squidstat User Interface software for an example use case of this feature.

7.1 Manual Mode Commands

The following commands are provided by the AisInstrumentHandler to control the Squidstat.

```
AisErrorCode AisInstrumentHandler::setManualModeSamplingInterval(uint8_t channel, double value) const;

AisErrorCode AisInstrumentHandler::setManualModeOCP(uint8_t channel) const;

AisErrorCode AisInstrumentHandler::setManualModeConstantVoltage(uint8_t channel, double value) const;

AisErrorCode AisInstrumentHandler::setManualModeCurrentRange(uint8_t channel, int currentRangeIndex) const;

AisErrorCode AisInstrumentHandler::setManualModeCurrentAutorange(uint8_t channel) const;

AisErrorCode AisInstrumentHandler::setManualModeVoltageRange(uint8_t channel, int voltageRangeIndex) const;

AisErrorCode AisInstrumentHandler::setManualModeVoltageAutorange(uint8_t channel) const;

AisErrorCode AisInstrumentHandler::setManualModeConstantCurrent(uint8_t channel, double value) const;
```

7.1.1 Start the Experiment

Before calling any of the above commands, the manual experiment must be started.

- **C++**

```
//The default starting mode is always Open Circuit Potential
qDebug() « "Starting manual mode at open circuit potential";
AisErrorCode error = handler.startManualExperiment(CHANNEL);
if (error != AisErrorCode::Success) {
    qDebug() « error.message();
    QCoreApplication::quit();
}
```

- **Python**

```
# The default starting mode is always Open Circut Potential.

print("Starting manual mode at open circuit potential")
error = handler.startManualExperiment(CHANNEL)
if error.value() != AisErrorCode.Success:
    print(error.message())
    app.quit()
```

Now our experiment will run indefinitely, until AisInstrumentHandler::stopExperiment is called.

7.1.2 Manual Modes

The three main operational modes are OCP (Open Circuit Potential), Potentiostatic, and Galvanostatic, defined below:

- OCP: Measures the open circuit potential of the system.
- Potentiostatic: Maintains a constant potential while measuring current.
- Galvanostatic: Maintains a constant current while measuring potential.

Here is an example of how to set each at timed intervals after an experiment has started.

- **C++**

```
        // In this section we connect singleshot QTimers to lambda functions that call our mode changing functions.
        // These lambdas are called asynchronously when the QTimers expire.

        // 5 seconds after starting experiment, change to Constant Current at .1A
        QTimer::singleShot(5000, [=, &handler]() {
            qDebug() « "Switching to constant current at .1A";
            AisErrorCode error = handler.setManualModeConstantCurrent(CHANNEL, .1);
            if (error != AisErrorCode::Success) {
                qDebug() « error.message();
            }
        });

        // 15 seconds after starting experiment, change to Constant Voltage at 1V
        QTimer::singleShot(15000, [=, &handler]() {
            qDebug() « "Switching to constant voltage at 1V";
            AisErrorCode error = handler.setManualModeConstantVoltage(CHANNEL, 1);
            if (error != AisErrorCode::Success) {
                qDebug() « error.message();
            }
        });

        // 25 seconds after starting experiment, change back into Open Circuit Potential mode.
        QTimer::singleShot(25000, [=, &handler]() {
            qDebug() « "Switching to open circuit potential";
            AisErrorCode error = handler.setManualModeOCP(CHANNEL);
            if (error != AisErrorCode::Success) {
                qDebug() « error.message();
            }
        });
```

- **Python**

```
    # In this section we create wrapper functions for the manual mode changing functions.
    # These wrappers are called asynchronously when singleshot QTimers expire.

    # This function changes the instrument to Constant Current at .1A
    def setConstantCurrent(channel):
        print("Switching to constant current at .1A")
        error = handler.setManualModeConstantCurrent(channel, .1)
        if error.value() != AisErrorCode.Success:
            print(error.message())
    # It is called 5 seconds after the experiment starts
    QTimer.singleShot(5000, lambda:setConstantCurrent(CHANNEL))

    # This function changes the instrument to Constant Voltage at 1V
    def setConstantVoltage(channel):
        print("Switching to constant voltage at 1V")
        error = handler.setManualModeConstantVoltage(channel, 1)
        if error.value() != AisErrorCode.Success:
            print(error.message())
    # It is called 15 seconds after the experiment starts
    QTimer.singleShot(15000, lambda:setConstantVoltage(CHANNEL))

    # This function changes the instrument to Open Circuit Potential
    def setOpenCircuit(channel):
        print("Switching to open circuit potential")
        error = handler.setManualModeOCP(channel)
        if error.value() != AisErrorCode.Success:
            print(error.message())
    # It is called 25 seconds after the experiment starts
    QTimer.singleShot(25000, lambda:setOpenCircuit(CHANNEL))
```

Note: As a reminder, it is always a good idea to check the error code returned by each command to ensure successful execution. See AisErrorCode for more information.

7.1.3 Stop the Experiment

Stopping the manual experiment uses the same command as stopping a normal experiment (AisInstrumentHandler::stopExperiment). In this case, we use a SingleShot timer (C++ | Python) to stop the experiment after 30 seconds.

- **C++**

```
// Stop the experiment after 30 seconds
QTimer::singleShot(30000, [=, &handler]() {
    qDebug() « "Stopping experiment";
    if (handler.stopExperiment(CHANNEL) != AisErrorCode::Success) {
        qDebug() « error.message();
    }
});
```

- **Python**

```
# Stop experiment after 30 seconds
def stopExperiment(channel):
    print("Stopping experiment.")
    error = handler.stopExperiment(channel)
    if error.value() != AisErrorCode.Success:
        print(error.message())
QTimer.singleShot(30000, lambda:stopExperiment(CHANNEL))
```

See the full example here

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Chapter 8

Running an Experiment

The following example demonstrates how to set up and run a basic experiment using the API. This example simply outlines the steps needed to connect to a Squidstat, build an experiment, and start it. Notably, it does not cover handling and reporting data from the Squidstat, which will be addressed in the Example on handling signals.

8.0.1 Setup

To begin, we need to include all neccessary headers or libraries, and setup the Qt event loop. At this stage, you can also retrieve the AisDeviceTracker Instance.

- **C++**

```
#include "AisDeviceTracker.h"
#include "AisExperiment.h"
#include "AisInstrumentHandler.h"

#include "experiments/builder_elements/AisConstantPotElement.h"

#include <QCoreApplication>
#include <QDebug>

// Define relevant device information, for easy access
#define COMPORT "COM1"
#define CHANNEL 0

int main()
{
    char** test = nullptr;
    int args;

    QCoreApplication a(args, test);

    auto tracker = AisDeviceTracker::Instance();
```

- **Python**

```
import sys
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisExperiment, AisErrorCode
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisConstantPotElement

# Define relavant device information, for easy access
COMPORT = "COM16"
CHANNEL = 0

app = QApplication()

tracker = AisDeviceTracker.Instance()
```

Reference: https://doc.qt.io/qt-5/qcoreapplication.html

8.0.2 Building the experiment

Next, create an element (e.g. AisConstantPotElement) and pass in the required parameters. Then, we will create the experiment object AisExperiment and add the element to it using AisExperiment::appendElement.

- **C++**

```
//       Voltage = 1V, Sampling Interval = 1s, Duration = 30s
AisConstantPotElement cvElement(1, 1, 30);

auto customExperiment = std::make_shared<AisExperiment>();
// Append the constant potential element, and tell it to execute that element 1 time
customExperiment->appendElement(cvElement, 1);
```

- **Python**

```
cvElement = AisConstantPotElement(1, 1, 30)

# After this point, the experiment is empty, so we need to add some elements to it
experiment = AisExperiment()
# Append the constant potential element, and tell the experiment to execute that element 1 time
success = experiment.appendElement(cvElement, 1)

# Check if the element was added successfully
if not success:
    print("Error adding element to experiment")
    app.quit()
```

Reference: https://en.cppreference.com/w/cpp/memory/shared_ptr

8.0.3 Connecting to the Device

Connect to the instrument by calling AisDeviceTracker::connectToDeviceOnComPort with the desired COM port to link the AisDeviceTracker to the device Alternatively, use AisDeviceTracker::connectAllPluggedInDevices to connect to all available devices.

- **C++**

```
AisErrorCode error = tracker->connectToDeviceOnComPort(COMPORT);
if (error != error.Success) {
    qDebug() « error.message();
    return 0;
}
```

- **Python**

```
error = tracker.connectToDeviceOnComPort(COMPORT)
# Check if connection was successful
if error.value() != AisErrorCode.Success:
    print(error.message())
    sys.exit()
```

Note: Any command to the instrument should always be checked for errors via the returned AisErrorCode

8.0.4 Starting Experiment

Finally, to start the experiment:

1. Grab the instrument handler from the device tracker after establishing a connection to the instrument.
    - See Next Example for more details on establishing connections
2. Upload the experiment to the desired channel and check for errors
3. Start the experiment, again checking for any errors

4. Run the QApplication event loop to allow all relevant signals to be processed (see the next example "Handling Signals")

- **C++**

```
auto& handler = tracker->getInstrumentHandler(deviceName);

connectSignals(handler);

AisErrorCode error = handler.uploadExperimentToChannel(CHANNEL, customExperiment);
if (error) {
    qDebug() « error.message();
    return;
}

// Start the previously uploaded experiment on the same channel
error = handler.startUploadedExperiment(CHANNEL);

// Exit the application if there is any error starting the experiment
if (error) {
    qDebug() « error.message();
    return;
}
```

- **Python**

```
handler = tracker.getInstrumentHandler(deviceName)

connectSignals(handler)

error = handler.uploadExperimentToChannel(CHANNEL, experiment)
# Exit the application if there is any error uploading experiment
if error.value() != AisErrorCode.Success:
    print(error.message())
    app.quit()

error = handler.startUploadedExperiment(CHANNEL)
# Exit the application if there is any error starting experiment
if error.value() != AisErrorCode.Success:
    print(error.message())
    app.quit()
```

See the full example here

Now that we have covered the basics of connecting to a Squidstat, building an experiment, and starting it, we can proceed to the next example. It demonstrates how to combine these steps and handle the signals emitted by the Squidstat.

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Chapter 9

Installing with C++

You can download the C++ version of the Squidstat API from the Admiral Instruments GitHub page or clone the repository using Git on your machine.

9.1 Cloning the Repository

1. To clone the repository, you will need to install Git. Depending on your platform, you can download the Git tool from `this link`.
   - To verify if Git is properly installed, you can follow these steps:
     - Open the command prompt.
     - Type `git -v` and press Enter.
     - If Git is installed correctly, you should see the version information displayed in the terminal. ex: `git version 2.41.0.windows.1`
2. Open a command prompt and navigate to the directory where you want the API to be. **Note:** A new folder will be created automatically after the next step.
3. Clone the API from the `Git repository` by typing the following command in the command prompt and pressing Enter.

   git clone `https://github.com/Admiral-Instruments/AdmiralSquidstatAPI`

The result in the command prompt should look like this:

```
Cloning into 'AdmiralSquidstatAPI'...
remote: Enumerating objects: 1846, done.
remote: Counting objects: 100% (508/508), done.
remote: Compressing objects: 100% (159/159), done.
remote: Total 1846 (delta 440), reused 360 (delta 349), pack-reused 1338
Receiving objects: 100% (1846/1846), 79.18 MiB | 10.10 MiB/s, done.

Resolving deltas: 100% (1044/1044), done.
```

The `AdmiralSquidstatAPI` folder will now be created, and it contains all the files required to get started with the API using a compatible compiler. We will refer to this folder as the "Root Directory" of the API.

9.1.1 Mac ARM64 (Apple Silicon)

If you are using a newer Mac with an ARM64 processor (M1, M2, etc.), you must perform additional steps to set up the Squidstat API.

1. Open the cloned repository in a Finder window and navigate down a level to `./SquidstatLibrary`.
   - In this folder you should see `Linux`, `mac`, `windows`, and `mac.tar.gz`.
2. Delete the `mac` directory. It contains the library for Intel-based Mac processors.
3. Extract the tar file by double clicking `mac.tar.gz` in the Finder window.
   - You should see a new `mac/` directory get automatically created.
4. At this point, your build environment is set up, and you can proceed normally.

9.1.2 Linux

If you are on a device running Linux, before using the API, run `sudo ./SquidstatLibrary/↩ Linux/install_dependencies.sh` from the root directory of the SquidstatAPI. This will install all dependencies and configuration files needed to run the API.
Note: This will run `apt-get update && sudo apt-get upgrade -y` which will update all packages currently installed on your device.

9.1.3 CMake Installation

The API uses CMake natively to build the project. Provided is a CMakeLists.txt file which you can include in your project to build the API.

1. To utilize the CMakeLists.txt file, you need to install CMake. You can download CMake from `here`.
   Note: When installing, be sure to add the CMake executable to your environment variables.
2. To verify if CMake is installed correctly, type `cmake` in the command prompt and press Enter.

9.1.3.1 Building the project

1. To use the API on Windows you must install MSVC64 through Visual Studio. For Mac and Linux install Clang.
2. Open a command prompt or terminal in the root directory of the API.
3. Run the following command to generate the build files for the compiler installed in your environment.
   ```
   cmake -B ./build -S ./SquidstatLibrary/
   ```
   Note: If you want to use a different build generator, use the `-G` option.
4. Build the project using the following command. This will compile all examples present in the `Squidstat↩ Library` directory.
   ```
   cmake --build ./build
   ```
5. You can now run any of the examples through their compiled executable. ex: `./build/examples/↩ FirmwareUpdateDemo/Debug/FirmwareUpdateDemo.exe`

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Main	Finding Comports

Chapter 10

Installing the Python Wrapper

The Squidstat API provides a Python wrapper, which can be downloaded from the Admiral Instruments GitHub page. The Python wrapper gives access to all the functiosn of the Squidstat API in Python.

10.0.1 Mac ARM64 (Apple Silicon)

If you are using a newer Mac with an ARM64 processor (M1, M2, etc.), you must perform additional steps to set up the Squidstat API.

1. Open the cloned repository in a Finder window and navigate down a level to `./SquidstatLibrary`.
   - In this folder you should see `Linux`, `mac`, `windows`, and `mac.tar.gz`.
2. Delete the `mac` directory. It contains the library for Intel-based Mac processors.
3. Extract the tar file by double clicking `mac.tar.gz` in the Finder window.
   - You should see a new `mac/` directory get automatically created.
4. At this point, your build environment is set up, and you can proceed normally.

10.1 Linux

If you are on a device running Linux, before using the API, run `sudo ./SquidstatLibrary/↩ Linux/install_dependencies.sh` from the root directory of the SquidstatAPI. This will install all dependencies and configuration files needed to run the API.
Note: This will run `apt-get update && sudo apt-get upgrade -y` which will update all packages currently installed on your device.

10.2 How To Use The SquidstatLibrary with Python

1. To use the SquidstatPyLibrary, you need to install a Python version ≥ 3.9 and ≤ 3.12.
   - Visit the official Python website at `https://www.python.org/downloads/`.
   - Download the installer for the desired Python version (≥ 3.9 and ≤ 3.12).
   - Run the installer and follow the installation wizard's instructions.
   - Make sure to select the option to add Python to the system environment (PATH) variables during the installation process. This will enable you to run Python from any location on your computer.
2. Make sure you have installed Python correctly by checking the Python version using the `python -V` command.
3. Now you can choose to install the library in either the global environment or a virtual environment. If you want to install the library in the global environment, you can skip this step.
   - If you prefer using a `Python virtual environment`, you can create one by running the command: `python -m venv VIRTUAL_ENVIRONMENT_NAME`
   - Open the command prompt and activate the virtual environment by typing: `./VIRTUAL_↩ ENVIRONMENT_NAME/Scripts/activate.bat`
4. Now you can proceed to install the SquidstatPyLibrary. Download the .whl file from `here`. After downloading, you can install it using the command `pip install YOUR_DOWNLOADED_FILE.whl`
5. Now, let's run an example script. If you have an Experiment.py file that you created to run an experiment, you can execute it by using the command `python Experiment.py`.

The necessary Python library files are also located inside the `pythonWrapper` directory.

Check out the Guided Examples for help getting started.

Chapter 11

Handling Signals

This example reviews the basic signals emitted by the AisDeviceTracker and AisInstrumentHandler, which notify users of instrument events, errors, experiment data, and progress. For simplicity, all signals in this example are connected to lambda functions. However, they can be connected to any slot function compatible with the signal's signature.

11.0.1 Tracker Signals

The AisDeviceTracker emits signals regarding device connection, disconnection, and firmware update status. The following example demonstrates how these signals are connected. For details on firmware update signals, refer to the Firmware Update Example.

- **C++**

```
    QObject::connect(tracker, &AisDeviceTracker::deviceDisconnected, [=](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;
    });
    QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;
```

- **Python**

```
tracker.newDeviceConnected.connect(startExperiment)
tracker.deviceDisconnected.connect(lambda deviceName: print(f"Device Disconnected: {deviceName}"))
```

11.0.2 Experiment Data Signals

The AisInstrumentHandler emits signals containing experiment data and progress information during active experiments. The signals AisInstrumentHandler::activeDCDataReady and AisInstrumentHandler::activeACDataReady provide relevant DC and AC, respectively, and should be handled for each experiment.

- **C++**

```
        QObject::connect(&handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel,
const AisDCData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Current: " « data.current « " Voltage: " «
data.workingElectrodeVoltage « " CE Voltage : " « data.counterElectrodeVoltage;
        });
        QObject::connect(&handler, &AisInstrumentHandler::activeACDataReady, [=](uint8_t channel,
const AisACData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Frequency: " « data.frequency « "" «
data.absoluteImpedance;
        });
```

- **Python**

```
    handler.activeDCDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp}
Current: {data.current} Voltage: {data.workingElectrodeVoltage} CE Voltage :
{data.counterElectrodeVoltage}"))
    handler.activeACDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp}
Frequency: {data.frequency} Absolute Impedance: {data.absoluteImpedance}"))
```

11.0.3 Other Signals

The AisInstrumentHandler also emits other signals, such as notifications for the start of new elements, the end of an experiment, instrument errors, and more. Below are some examples:

- **C++**

```
        // Whenever a new node in the element starts, note: some Ais Elements contain multiple logical nodes
        // i.e AisCyclicVoltammatryElement contains 4 nodes for each linear segment of each cycle plus a quiet time node if enabled
        // So this lambda would be executed atleast 4 times for each cycle
        QObject::connect(&handler, &AisInstrumentHandler::experimentNewElementStarting, [=](uint8_t channel, const AisExperimentNode& info) {
            qDebug() « "New element starting: " « info.stepName;
        });
        // Whenever an experiment completes or is manually stopped, this will execute
        QObject::connect(&handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel, const QString& reason) {
            qDebug() « "Experiment Stopped Signal " « channel « "Reason : " « reason;
        });
        QObject::connect(&handler, &AisInstrumentHandler::deviceError, [=](uint8_t channel, const QString& error) {
            qDebug() « "Device Error: " « error;
        });
```

- **Python**

```
    # Whenever a new node in the element starts, note: some Ais Elements contain multiple logical nodes
    # i.e AisCyclicVoltammatryElement contains 4 nodes for each linear segment of each cycle plus a quiet time node if enabled
    # So this lambda would be executed atleast 4 times for each cycle
    handler.experimentNewElementStarting.connect(lambda channel, info: print(f"New element starting: {info.stepName}"))
    # Whenever an experiment completes or is manually stopped, this will execute
    handler.experimentStopped.connect(lambda channel, reason: (print(f"Experiment Stopped Signal {channel}, {reason}"), app.quit()))
    handler.deviceError.connect(lambda channel, error: print(f"Device Error: {error}"))
```

For othere signals emitted: `AisInstrumentHandler signals`

11.0.4 Connecting Signals

To connect data and handler signals to a valid AisInstrumentHandler object, ensure the connection to the instrument is fully established. This can be done by connecting signals when the AisDeviceTracker::newDeviceConnected signal is emitted.

Here, a lambda function is created to connect relevant signals to the handler when the device is connected:

- **C++**

```
    auto connectSignals = [=](const AisInstrumentHandler& handler) {
        QObject::connect(&handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel, const AisDCData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Current: " « data.current « " Voltage: " « data.workingElectrodeVoltage « " CE Voltage : " « data.counterElectrodeVoltage;
        });
        QObject::connect(&handler, &AisInstrumentHandler::activeACDataReady, [=](uint8_t channel, const AisACData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Frequency: " « data.frequency « "" « data.absoluteImpedance;
        });
        // Whenever a new node in the element starts, note: some Ais Elements contain multiple logical nodes
        // i.e AisCyclicVoltammatryElement contains 4 nodes for each linear segment of each cycle plus a quiet time node if enabled
        // So this lambda would be executed atleast 4 times for each cycle
        QObject::connect(&handler, &AisInstrumentHandler::experimentNewElementStarting, [=](uint8_t channel, const AisExperimentNode& info) {
            qDebug() « "New element starting: " « info.stepName;
        });
        // Whenever an experiment completes or is manually stopped, this will execute
        QObject::connect(&handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel,
const QString& reason) {
            qDebug() « "Experiment Stopped Signal " « channel « "Reason : " « reason;
        });
        QObject::connect(&handler, &AisInstrumentHandler::deviceError, [=](uint8_t channel, const
QString& error) {
            qDebug() « "Device Error: " « error;
        });
    };
```

- **Python**

```
def connectSignals(handler):

    handler.activeDCDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp}
Current: {data.current} Voltage: {data.workingElectrodeVoltage} CE Voltage :
{data.counterElectrodeVoltage}"))
    handler.activeACDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp}
Frequency: {data.frequency} Absolute Impedance: {data.absoluteImpedance}"))


    # Whenever a new node in the element starts, note: some Ais Elements contain multiple logical
nodes
    # i.e AisCyclicVoltammatryElement contains 4 nodes for each linear segment of each cycle plus a
quiet time node if enabled
    # So this lambda would be executed atleast 4 times for each cycle
    handler.experimentNewElementStarting.connect(lambda channel, info: print(f"New element starting:
{info.stepName}"))
    # Whenever an experiment completes or is manually stopped, this will execute
    handler.experimentStopped.connect(lambda channel, reason: (print(f"Experiment Stopped Signal
{channel}, {reason}"), app.quit()))
    handler.deviceError.connect(lambda channel, error: print(f"Device Error: {error}"))
```

Then, call this function after connecting to the device but before starting the experiment:

- **C++**

```
auto& handler = tracker->getInstrumentHandler(deviceName);

connectSignals(handler);

AisErrorCode error = handler.uploadExperimentToChannel(CHANNEL, customExperiment);
if (error) {
    qDebug() « error.message();
    return;
}

// Start the previously uploaded experiment on the same channel
error = handler.startUploadedExperiment(CHANNEL);

// Exit the application if there is any error starting the experiment
if (error) {
    qDebug() « error.message();
    return;
}
```

- **Python**

```
handler = tracker.getInstrumentHandler(deviceName)

connectSignals(handler)

error = handler.uploadExperimentToChannel(CHANNEL, experiment)
# Exit the application if there is any error uploading experiment
if error.value() != AisErrorCode.Success:
    print(error.message())
    app.quit()

error = handler.startUploadedExperiment(CHANNEL)
# Exit the application if there is any error starting experiment
if error.value() != AisErrorCode.Success:
    print(error.message())
    app.quit()
```

See the full example `here`

11.0.5 References

For information on syntax and related concepts used in this example, refer to the following documentation links:

- Signals and Slots: `C++` | `Python`
- Lambda Functions `C++` | `Python`

With all the relevant code to run an experiment in place, we can now explore how the API supports building more complex experiment logic.

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Running an Experiment	Advanced Experiment Logic

Chapter 12

Deprecated List

Member AisDiffPulseVoltammetryElement::isAutoRange () const

This function is deprecated and no longer supports auto range for this element. Specify the current using setApproxMaxCurrent(). The device will determine the appropriate range based on the current value.

Member AisDiffPulseVoltammetryElement::setAutoRange ()

This function is deprecated. Use setApproxMaxCurrent() to specify the current range instead.

Member AisNormalPulseVoltammetryElement::isAutoRange () const

This function is deprecated and no longer supports auto range for this element. Specify the current using setApproxMaxCurrent(). The device will determine the appropriate range based on the current value.

Member AisNormalPulseVoltammetryElement::setAutoRange ()

This function is deprecated. Use setApproxMaxCurrent() to specify the current range instead.

Member AisSquareWaveVoltammetryElement::AisSquareWaveVoltammetryElement (double startVoltage, double endVoltage, double voltageStep, double pulseAmp, double pulseFrequency)

Use the constructor with the approxMaxCurrent parameter instead.

Member AisSquareWaveVoltammetryElement::isAutoRange () const

This function is deprecated and no longer supports auto range for this element. Specify the current using setApproxMaxCurrent(). The device will determine the appropriate range based on the current value.

Member AisSquareWaveVoltammetryElement::setAutoRange ()

This function is deprecated. Use setApproxMaxCurrent() to specify the current range instead.

Chapter 13

Topic Index

13.1 API Objects by Category

Objects in the SquidstatAPI are grouped into categories to make it easier to find related items. Click any of the categories below to see the list of all included objects.

Chapter 14

Class Index

14.1 All Classes

All classes and structures in the SquidstatAPI in alphabetical order.

Chapter 15

Topic Documentation

15.1 Experiment Elements

Represents all elements used to create and configure experiments in the API.

Classes

- class AisConstantCurrentElement

  an experiment that simulates a constant current flow with more advance options for stopping the experiment.

- class AisConstantPotElement

  an experiment that simulates a constant applied voltage.

- class AisConstantPowerElement

  This experiment simulates a constant power, charge or discharge".

- class AisConstantResistanceElement

  This element/experiment simulates a constant resistance load.

- class AisCyclicVoltammetryElement

  *This experiment sweeps the potential of the working electrode back and forth between the **first voltage-limit** and the **second voltage-limit** at a constant **scan rate (dE/dt)** for a specified number of **cycles**.*

- class AisDCCurrentSweepElement

  *this experiment performs a DC current sweep from the **starting current** to the **ending current** which progresses linearly according to the **scan rate**.*

- class AisDCPotentialSweepElement

  *this experiment performs a DC potential sweep from the **starting current** to the **ending current** which progresses linearly according to the **scan rate**.*

- class AisDiffPulseVoltammetryElement

  *In this experiment, the working electrode holds at a **starting potential** during the **quiet time**. Then it applies a train of pulses superimposed on a staircase waveform, with a uniform **potential step** size. The potential continues to step until the **final potential** is reached.*

- class AisEISGalvanostaticElement

  *This experiment records the complex impedance of the experimental cell in galvanostatic mode, starting from the **start frequency** and sweeping through towards the **end frequency**, with a fixed number of frequency **steps per decade**.*

- class AisEISPotentiostaticElement

*This experiment records the complex impedance of the experimental cell in potentiostatic mode, starting from the **start frequency** and sweeping through towards the **end frequency**, with a fixed number of frequency **steps per decade**.*

- class AisNormalPulseVoltammetryElement

  *This experiment holds the working electrode at a **baseline potential** during the **quiet time**, then applies a train of pulses, which increase in amplitude until the **final potential** is reached.*
- class AisOpenCircuitElement

  *This experiment observes the **open circuit potential** of the working electrode for a specific period of time.*
- class AisSquareWaveVoltammetryElement

  *This experiment holds the working electrode at the **starting potential** during the **quiet time**. Then it applies a train of square pulses superimposed on a staircase waveform with a uniform **potential step** magnitude.*
- class AisStaircasePotentialVoltammetryElement

  AisStaircasePotentialVoltammetryElement class represents an element for staircase potential voltammetry experiments. It inherits from AisAbstractElement.
- class AisSteppedCurrentElement

  A class representing an experiment to apply the stepped current.
- class AisMottSchottkyElement

  This class performs Mott-Schottky analysis on the working electrode for a specified range of potentials.
- class AisSteppedVoltageElement

  A class representing an experiment to apply the stepped volatge.

15.2 Instrument Control

Classes used to communicate with and control connected devices.

Classes

- class AisDeviceTracker

  This class is used track device connections to the computer. It also provides instrument handlers specific to each connected device which provide control of the relevant device.
- class AisErrorCode

  This class contains the possible error codes returned to the user when working with the API. Error codes can help diagnose issues such as invalid parameters, communication failures, or device malfunctions. By handling errors properly, you can ensure reliable operation of your experiments.
- class AisExperiment

  this class is used to create custom experiments. A custom experiment contains one or more elements. Once you create elements and set their parameters, you can add them to the container.
- class AisInstrumentHandler

  this class provides control of the device including starting, pausing, resuming and stopping an experiment on a channel as well as reading the data and other controls of the device.

15.3 Helpers

Miscellaneous objects used to represent device configurations as well as manipulate and hold data.

Classes

- class AisCompRange

  This class has advanced options controlling the device stability including the bandwidth index and the stability factor.
- struct AisDCData

  A structure containing DC data collected from the instrument.
- struct AisACData

  A structure containing AC data collected from the instrument.
- struct AisExperimentNode

  A structure containing some information regarding the running element.
- class AisDataManipulator

  This class offers advanced control over pulse data collection and manipulation. It provides methods to manipulate AIS primary data for all three pulse voltammetry experiments types, namely Differential Pulse Voltammetry (DPV), Square Wave Voltammetry (SWV), and Normal Pulse Voltammetry (NPV).

Enumerations

- enum AisPulseType { **DifferentialPulse** = 0 , NormalPulse = 1 , SquarewavePulse = 2 }

  This enum represents different pulse types, it is intended to tell the AisDataManipulator class how to calculate various pulse experiment parameters.

15.3.1 Enumeration Type Documentation

15.3.1.1 AisPulseType

```
enum AisPulseType
```

Enumerator

NormalPulse	Corresponds to AisDiffPulseVoltammetryElement.
SquarewavePulse	Corresponds to AisNormPulseVoltammetryElement.

Chapter 16

Class Documentation

16.1 AisACData Struct Reference

A structure containing AC data collected from the instrument.

```
#include <AisDataPoints.h>
```

```
#include <AisDataPoints.h>
```

Public Attributes

- double **timestamp**

  the time at which the AC data arrived.
- double **frequency**

  the applied frequency in Hz.
- double **absoluteImpedance**

  the magnitude of the complex impedance.
- double **realImpedance**

  the real part of the complex impedance.
- double **imagImpedance**

  the imaginary part of the complex impedance.
- double **phaseAngle**

  the phase angle between the real and the imaginary parts of the impedance.
- double **totalHarmonicDistortion**

  the percentage of the total harmonic distortion in the AC signal.
- double numberOfCycles

  the number of cycles specific to the reported frequency.
- double **workingElectrodeDCVoltage**

  the DC working electrode voltage in volts.
- double **DCCurrent**

  the DC electric current value in Amps
- double **currentAmplitude**

  the amplitude of the AC current.
- double **voltageAmplitude**

  the amplitude of the AC voltage.

16.1.1 Member Data Documentation

16.1.1.1 numberOfCycles

```
double AisACData::numberOfCycles
```

Note

> In EIS, we run a range of frequencies. For each frequency, a specific number of cycles are run. The higher the frequency, the more number of cycles.

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

- AisDataPoints.h

16.2 AisCompRange Class Reference

This class has advanced options controlling the device stability including the bandwidth index and the stability factor.

```
#include <AisCompRange.h>
```

```
#include <AisCompRange.h>
```

Public Member Functions

- AisCompRange (const QString &compRangeName, uint8_t bandwidthIndex, uint8_t stabilityFactor)

  constructor for the compensation-range object.
- **AisCompRange** (const AisCompRange &)

  copy constructor for the compensation-range object.
- uint8_t getBandwidthIndex () const

  get the value set for the bandwidth index.
- void setBandwidthIndex (uint8_t index)

  set the index value for the bandwidth.
- uint8_t getStabilityFactor () const

  get the value set for the stability factor.
- void setStabilityFactor (uint8_t factor)

  set a value for the stability factor.
- void setCompRangeName (const QString &compRangeName)

  set a name for the compensation range for reference purposes.
- const QString & getCompRangeName () const

  get the name set for the compensation range.

16.2.1 Constructor & Destructor Documentation

16.2.1.1 AisCompRange()

```
AisCompRange::AisCompRange (
            const QString & compRangeName,
            uint8_t bandwidthIndex,
            uint8_t stabilityFactor)  [explicit]
```

Parameters

compRangeName	a name to set for the compensation range for reference purposes.
bandwidthIndex	the index value for the bandwidth.
stabilityFactor	the factor value for the stability.

See also

setBandwidthIndex
setStabilityFactor

16.2.2 Member Function Documentation

16.2.2.1 getBandwidthIndex()

```
uint8_t AisCompRange::getBandwidthIndex () const
```

Returns

the set value for the bandwidth index.

See also

setBandwidthIndex

16.2.2.2 getCompRangeName()

```
const QString & AisCompRange::getCompRangeName () const
```

Returns

the name set for the compensation range.

16.2.2.3 getStabilityFactor()

```
uint8_t AisCompRange::getStabilityFactor () const
```

Returns

the value set for the stability factor.

16.2.2.4 setBandwidthIndex()

```
void AisCompRange::setBandwidthIndex (
             uint8_t index)
```

Usually, the device's default index value is optimal for running experiments. You may still increase the index within the range 0-10 as you run higher frequency experiments to see what best fits.

Parameters

index	the index value for the bandwidth (0-10).

16.2.2.5 setCompRangeName()

```
void AisCompRange::setCompRangeName (
            const QString & compRangeName)
```

Parameters

compRangeName	the name to set for the compensation range.

16.2.2.6 setStabilityFactor()

```
void AisCompRange::setStabilityFactor (
            uint8_t factor)
```

Usually, the device's default factor value is optimal for running experiments. You may still increase the factor within the range 0-10 as you run experiments with more oscillations to see what best fits.

Parameters

factor	the stability-factor value (0-10)

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

- AisCompRange.h

16.3 AisConstantCurrentElement Class Reference

an experiment that simulates a constant current flow with more advance options for stopping the experiment.

```
#include <AisConstantCurrentElement.h>
```

```
#include <AisConstantCurrentElement.h>
```

Public Member Functions

- AisConstantCurrentElement (double current, double samplingInterval, double duration)

  the constant current element constructor.
- **AisConstantCurrentElement** (const AisConstantCurrentElement &)

  copy constructor for the AisConstantCurrentElement object.
- AisConstantCurrentElement & **operator=** (const AisConstantCurrentElement &)

  overload equal to operator for the AisConstantCurrentElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getCurrent () const

  get the value set for the current.
- void setCurrent (double current)

  set the value for the current.
- double getSamplingInterval () const

  get how frequently we are sampling the data.
- void setSamplingInterval (double samplingInterval)

  set how frequently we are sampling the data.
- double getMinSamplingVoltageDifference () const

  get the minimum sampling voltage difference for reporting the data.
- void setMinSamplingVoltageDifference (double minVoltageDifference)

  set a minimum sampling voltage difference for reporting the voltage.
- double getMaxVoltage () const

  get the value set for the maximum voltage. The experiment will end when it reaches this value.
- void setMaxVoltage (double maxVoltage)

  set a maximum voltage to stop the experiment.
- double getMinVoltage () const

  get the value set minimum for the voltage in volts.
- void setMinVoltage (double minVoltage)

  set a minimum voltage to stop the experiment.
- double getMaxDuration () const

  get the maximum duration set for the experiment. The experiment will end when the duration of the experiment reaches this value.
- void setMaxDuration (double maxDuration)

  set the maximum duration for the experiment.
- double getMaxCapacity () const

  get the value set for the maximum capacity / cumulative charge.
- void setMaxCapacity (double maxCapacity)

  set the value for the maximum capacity / cumulative charge in Coulomb.
- bool isAutoRange () const

  tells whether the current range is set to auto-select or not.
- void setAutoRange ()

  set to auto-select the current range.
- double getApproxMaxCurrent () const

  get the value set for the expected maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  set maximum current expected, for manual current range selection.
- bool isAutoVoltageRange () const

  tells whether the voltage range is set to auto-select or not.

- void setAutoVoltageRange ()

  set to auto-select the voltage range.
- double getApproxMaxVoltage () const

  get the value set for the expected maximum voltage.
- void setApproxMaxVoltage (double approxMaxVoltage)

  set maximum voltage expected, for manual voltage range selection.

16.3.1 Constructor & Destructor Documentation

16.3.1.1 AisConstantCurrentElement()

```
AisConstantCurrentElement::AisConstantCurrentElement (
            double current,
            double samplingInterval,
            double duration)  [explicit]
```

Parameters

current	the value for the current in Amps.
samplingInterval	the data sampling interval value in seconds.
duration	the maximum duration for the experiment in seconds.

16.3.2 Member Function Documentation

16.3.2.1 getApproxMaxCurrent()

```
double AisConstantCurrentElement::getApproxMaxCurrent () const
```

Returns

the value set for the expected maximum current in Amps.

Note

if nothing was manually set, the device will auto-select the current range and the return value will be positive infinity.

16.3.2.2 getApproxMaxVoltage()

```
double AisConstantCurrentElement::getApproxMaxVoltage () const
```

Returns

the value set for the expected maximum Voltage in volt.

Note

if nothing was manually set, the device will auto-select the voltage range and the return value will be positive infinity.

16.3.2.3 getCategory()

```
QStringList AisConstantCurrentElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Galvanostatic Control", "Basic Experiments").

16.3.2.4 getCurrent()

```
double AisConstantCurrentElement::getCurrent () const
```

Returns

the value for the current in Amps.

16.3.2.5 getMaxCapacity()

```
double AisConstantCurrentElement::getMaxCapacity () const
```

Returns

the value set for the maximum capacity in Coulomb.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.3.2.6 getMaxDuration()

```
double AisConstantCurrentElement::getMaxDuration () const
```

Returns

the maximum duration for the experiment in seconds.

16.3.2.7 getMaxVoltage()

```
double AisConstantCurrentElement::getMaxVoltage () const
```

Returns

the value set for the maximum voltage.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity

16.3.2.8 getMinSamplingVoltageDifference()

```
double AisConstantCurrentElement::getMinSamplingVoltageDifference () const
```

get the value set for the minimum sampling voltage difference.

Returns

the value set for the minimum sampling voltage difference.

See also

setMinSamplingVoltageDifference

Note

this is an optional parameter. If no value has been set, the default value is negative infinity.

16.3.2.9 getMinVoltage()

```
double AisConstantCurrentElement::getMinVoltage () const
```

Returns

the value set for the minimum voltage in volts.

Note

this is an optional parameter. If no value has been set, the default value is negative infinity

16.3.2.10 getName()

```
QString AisConstantCurrentElement::getName () const [override]
```

Returns

The name of the element: "Constant Current, Advanced".

16.3.2.11 getSamplingInterval()

```
double AisConstantCurrentElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.3.2.12 isAutoRange()

```
bool AisConstantCurrentElement::isAutoRange () const
```

Returns

true if the current range is set to auto-select and false if a range has been selected.

16.3.2.13 isAutoVoltageRange()

```
bool AisConstantCurrentElement::isAutoVoltageRange () const
```

Returns

true if the voltage range is set to auto-select and false if a range has been selected.

16.3.2.14 setApproxMaxCurrent()

```
void AisConstantCurrentElement::setApproxMaxCurrent (
            double approxMaxCurrent)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the current range.

Parameters

approxMaxCurrent	the value for the maximum current expected in Amps.

16.3.2.15 setApproxMaxVoltage()

```
void AisConstantCurrentElement::setApproxMaxVoltage (
            double approxMaxVoltage)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the voltage range.

Parameters

approxMaxVoltage	the value for the maximum current expected in V.

16.3.2.16 setAutoRange()

```
void AisConstantCurrentElement::setAutoRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

16.3.2.17 setAutoVoltageRange()

```
void AisConstantCurrentElement::setAutoVoltageRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

16.3.2.18 setCurrent()

```
void AisConstantCurrentElement::setCurrent (
            double current)
```

Parameters

current	the value for the current in Amps.

16.3.2.19 setMaxCapacity()

```
void AisConstantCurrentElement::setMaxCapacity (
            double maxCapacity)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit cumulative charge value. If a maximum capacity is set, the experiment will continue to run as long as the cumulative charge is below that value.

Parameters

maxCapacity	the value to set for the cell maximum capacity.

16.3.2.20 setMaxDuration()

```
void AisConstantCurrentElement::setMaxDuration (
            double maxDuration)
```

The experiment will continue to run as long as the time passed is less than the value to set.

Parameters

maxDuration	the maximum duration for the experiment in seconds.

16.3.2.21 setMaxVoltage()

```
void AisConstantCurrentElement::setMaxVoltage (
            double maxVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is below that value.

Parameters

maxVoltage	the maximum voltage value in volts at which the experiment will stop.

16.3.2.22 setMinSamplingVoltageDifference()

```
void AisConstantCurrentElement::setMinSamplingVoltageDifference (
            double minVoltageDifference)
```

This is an **optional** condition. If nothing is set, then the experiment will report the data at time sampling interval. When this is set, then the voltage is reported when there is a voltage difference of at least the given minimum sampling voltage difference. So, when one voltage data point is reported (at the minimum possible time sampling interval), the next data point is not reported unless the difference between the two voltage data points exceeds this given minimum sampling voltage difference value.

Note

when this is set, this overrides the set value for the sampling interval.

Parameters

minVoltageDifference	the minimum sampling voltage difference value in volts.

16.3.2.23 setMinVoltage()

```
void AisConstantCurrentElement::setMinVoltage (
            double minVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is above that value.

Parameters

minVoltage	the minimum voltage value in volts at which the experiment will stop.

16.3.2.24 setSamplingInterval()

```
void AisConstantCurrentElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

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

- AisConstantCurrentElement.h

16.4 AisConstantPotElement Class Reference

an experiment that simulates a constant applied voltage.

```
#include <AisConstantPotElement.h>
```

```
#include <AisConstantPotElement.h>
```

Public Member Functions

- AisConstantPotElement (double voltage, double samplingInterval, double duration)

    the constant potential element constructor.
- **AisConstantPotElement** (const AisConstantPotElement &)

    copy constructor for the AisConstantPotElement object.
- AisConstantPotElement & **operator=** (const AisConstantPotElement &)

    overload equal to operator for the AisConstantPotElement object.
- QString getName () const override

    get the name of the element.
- QStringList getCategory () const override

    get a list of applicable categories of the element.
- double getPotential () const

    get the value set for the potential in volts.
- void setPotential (double potential)

    set the value for the potential in volts.
- bool isVoltageVsOCP () const

    tells whether the specified voltage is set against the open-circuit voltage or the reference terminal.
- void setVoltageVsOCP (bool vsOCP)

    set whether to reference the specified voltage against the open-circuit voltage or the reference terminal.
- double getSamplingInterval () const

    get how frequently we are sampling the data.
- void setSamplingInterval (double samplingInterval)

    set how frequently we are sampling the data.
- double getMaxDuration () const

    get the maximum duration set for the experiment. The experiment will end when the duration of the experiment reaches this value.
- void setMaxDuration (double maxDuration)

    set the maximum duration for the experiment.
- double getMaxAbsoluteCurrent () const

    get the maximum value set for the absolute current in Amps. The experiment will end when the absolute current reaches this value.
- void setMaxAbsoluteCurrent (double maxCurrent)

    set the maximum value for the absolute current in Amps.
- double getMaxCurrent () const

    get the maximum value set for the absolute current in Amps. The experiment will end when the absolute current reaches this value.
- void setMaxCurrent (double maxCurrent)

    set the maximum value for the absolute current in Amps.
- double getMinAbsoluteCurrent () const

    get the minimum value set for the absolute current in Amps. The experiment will end when the absolute current falls down to this value.
- void setMinAbsoluteCurrent (double minCurrent)

    set the minimum value for the absolute current in Amps.
- double getMinCurrent () const

    get the minimum value set for the absolute current in Amps. The experiment will end when the absolute current falls down to this value.
- void setMinCurrent (double minCurrent)

    set the minimum value for the absolute current in Amps.
- double getMaxCapacity () const

    get the value set for the maximum capacity / cumulative charge.
- void setMaxCapacity (double maxCapacity)

set the value for the maximum capacity / cumulative charge in Coulomb.

- double getMindIdt () const

  get the value set for the minimum current rate of change with respect to time (minimum di/dt).
- void setMindIdt (double mindIdt)

  set the minimum value for the current rate of change with respect to time (minimum di/dt).
- bool isAutoRange () const

  tells whether the current range is set to auto-select or not.
- void setAutoRange ()

  set to auto-select the current range.
- double getApproxMaxCurrent () const

  get the value set for the expected maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  set maximum current expected, for manual current range selection.
- int getVoltageRange () const

  get the value set for the voltage range.
- void setVoltageRange (int idx)

  manually set the voltage control range.

16.4.1 Constructor & Destructor Documentation

16.4.1.1 AisConstantPotElement()

```
AisConstantPotElement::AisConstantPotElement (
             double voltage,
             double samplingInterval,
             double duration)  [explicit]
```

Parameters

voltage	the value set for the voltage/potential in volts.
samplingInterval	the data sampling interval value in seconds.
duration	the maximum duration for the experiment in seconds.

16.4.2 Member Function Documentation

16.4.2.1 getApproxMaxCurrent()

```
double AisConstantPotElement::getApproxMaxCurrent () const
```

Returns

the value set for the expected maximum current in Amps.

Note

if nothing was manually set, the device will auto-select the current range and the return value will be positive infinity.

16.4.2.2 getCategory()

```
QStringList AisConstantPotElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control", "Basic Experiments")

16.4.2.3 getMaxAbsoluteCurrent()

```
double AisConstantPotElement::getMaxAbsoluteCurrent () const
```

Returns

the maximum absolute current value in Amps.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.4.2.4 getMaxCapacity()

```
double AisConstantPotElement::getMaxCapacity () const
```

Returns

the value set for the maximum capacity in Coulomb.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.4.2.5 getMaxCurrent()

```
double AisConstantPotElement::getMaxCurrent () const
```

Returns

the maximum current value in Amps.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

Attention

Deprecation Warning: This function may be modified or changed in a future version. Use getMaxAbsoluteCurrent instead.

16.4.2.6 getMaxDuration()

```
double AisConstantPotElement::getMaxDuration () const
```

Returns

the maximum duration for the experiment in seconds.

16.4.2.7 getMinAbsoluteCurrent()

```
double AisConstantPotElement::getMinAbsoluteCurrent () const
```

Returns

the minimum absolute current value in Amps.

Note

this is an optional parameter. If no value has been set, the default value is zero.

16.4.2.8 getMinCurrent()

```
double AisConstantPotElement::getMinCurrent () const
```

Returns

the minimum absolute current value in Amps.

Note

this is an optional parameter. If no value has been set, the default value is zero.

Attention

Deprecation Warning: This function may be modified or changed in a future version. Use getMinAbsolute↩ Current instead.

16.4.2.9 getMindIdt()

```
double AisConstantPotElement::getMindIdt () const
```

Returns

the value set for the minimum current rate of change with respect to time (minimum di/dt).

Note

this is an optional parameter. If no value has been set, the default value is zero.

16.4.2.10 getName()

```
QString AisConstantPotElement::getName () const [override]
```

Returns

The name of the element: "Constant Potential, Advanced".

16.4.2.11 getPotential()

```
double AisConstantPotElement::getPotential () const
```

Returns

the value set for the potential in volts.

16.4.2.12 getSamplingInterval()

```
double AisConstantPotElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.4.2.13 getVoltageRange()

```
int AisConstantPotElement::getVoltageRange () const
```

Returns

the index set for the voltage range. (see AisInstrumentHandler::getManualModeVoltageRangeList())

16.4.2.14 isAutoRange()

```
bool AisConstantPotElement::isAutoRange () const
```

Returns

true if the current range is set to auto-select and false if a rage has been selected.

16.4.2.15 isVoltageVsOCP()

```
bool AisConstantPotElement::isVoltageVsOCP () const
```

Returns

true if the specified voltage is set against the open-circuit voltage and false if it is set against the reference terminal.

See also

setVsOcp

16.4.2.16 setApproxMaxCurrent()

```
void AisConstantPotElement::setApproxMaxCurrent (
            double approxMaxCurrent)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the current range.

Parameters

approxMaxCurrent	the value for the maximum current expected in Amps.

16.4.2.17 setAutoRange()

```
void AisConstantPotElement::setAutoRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

16.4.2.18 setMaxAbsoluteCurrent()

```
void AisConstantPotElement::setMaxAbsoluteCurrent (
            double maxCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit current value. If a maximum absolute current is set, the experiment will continue to run as long as the absolute measured current is below that value.

Parameters

maxCurrent	the maximum absolute current value in Amps.

16.4.2.19 setMaxCapacity()

```
void AisConstantPotElement::setMaxCapacity (
            double maxCapacity)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit cumulative charge value. If a maximum capacity is set, the experiment will continue to run as long as the cumulative charge is below that value.

Parameters

maxCapacity	the value to set for the cell maximum capacity.

16.4.2.20 setMaxCurrent()

```
void AisConstantPotElement::setMaxCurrent (
            double maxCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit current value. If a maximum current is set, the experiment will continue to run as long as the measured current is below that value.

Parameters

maxCurrent	the maximum current value in Amps.

Attention

> Deprecation Warning: This function may be modified or changed in a future version. Use setMaxAbsoluteCurrent instead.

16.4.2.21 setMaxDuration()

```
void AisConstantPotElement::setMaxDuration (
            double maxDuration)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an duration. If a maximum duration is set, the experiment will continue to run as long as the passed time is less than that value.

Parameters

maxDuration	the maximum duration for the experiment in seconds.

16.4.2.22 setMinAbsoluteCurrent()

```
void AisConstantPotElement::setMinAbsoluteCurrent (
            double minCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit current value. If a minimum absolute current is set, the experiment will continue to run as long as the measured absolute current is above that value.

Parameters

minCurrent	the value to set for the minimum absolute current.

16.4.2.23 setMinCurrent()

```
void AisConstantPotElement::setMinCurrent (
            double minCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit current value. If a minimum absolute current is set, the experiment will continue to run as long as the measured absolute current is above that value.

Parameters

minCurrent	the value to set for the minimum absolute current.

Attention

> Deprecation Warning: This function may be modified or changed in a future version. Use setMinAbsolute←Current instead.

16.4.2.24 setMindIdt()

```
void AisConstantPotElement::setMindIdt (
            double mindIdt)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit rate of change value. If a minimum value is set, the experiment will continue to run as long as the rage of change is above that value.

Parameters

mindIdt	the minimum value for the current rate of change with respect to time (minimum di/dt).

16.4.2.25 setPotential()

```
void AisConstantPotElement::setPotential (
            double potential)
```

Parameters

potential	the value to set for the potential in volts.

16.4.2.26 setSamplingInterval()

```
void AisConstantPotElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

16.4.2.27 setVoltageRange()

```
void AisConstantPotElement::setVoltageRange (
            int idx)
```

This is an **optional** parameter. If this function is not called, the device will auto-select the voltage range by default.

Parameters

idx	the corresponding voltage range index (see AisInstrumentHandler::getManualModeVoltageRangeList())

16.4.2.28 setVoltageVsOCP()

```
void AisConstantPotElement::setVoltageVsOCP (
            bool vsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

vsOCP	true to set the specified voltage to reference the open-circuit voltage and false to set against the reference terminal.

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

- AisConstantPotElement.h

16.5 AisConstantPowerElement Class Reference

This experiment simulates a constant power, charge or discharge".

```
#include <AisConstantPowerElement.h>
```

```
#include <AisConstantPowerElement.h>
```

Public Member Functions

- AisConstantPowerElement (double power, double duration, double samplingInterval)

    the constant power element constructor
- AisConstantPowerElement (bool isCharge, double power, double duration, double samplingInterval)

    the constant power element constructor that supports the isCharge parameter
- **AisConstantPowerElement** (const AisConstantPowerElement &)

    copy constructor for the AisConstantPowerElement object.
- AisConstantPowerElement & **operator=** (const AisConstantPowerElement &)

    overload equal to operator for the AisConstantPowerElement object.
- QString getName () const override

    get the name of the element.
- QStringList getCategory () const override

    get a list of applicable categories of the element.
- bool isCharge () const

    tells whether the experiment is set to simulate charge or discharge.
- void setCharge (bool isCharge)

    set whether the experiment is to simulate charge or discharge.
- double getPower () const

    get the value set for the power.
- void setPower (double power)

    set the value for the power.
- double getSamplingInterval () const

    get how frequently we are sampling the data.
- void setSamplingInterval (double samplingInterval)

    set how frequently we are sampling the data.
- double getMaxVoltage () const

    get the value set for the maximum voltage. The experiment will end when it reaches this value.
- void setMaxVoltage (double maxVoltage)

    set a maximum voltage to stop the experiment.
- bool isMaximumVoltageVsOCP () const

tells whether the specified maximum voltage is set against the open-circuit voltage or the reference terminal.

- void setMaximumVoltageVsOCP (bool vsOCP)

  set whether to reference the specified maximum voltage against the open-circuit voltage or the reference terminal.
- double getMinVoltage () const

  get the minimum value set for the voltage in volts. The experiment will end when it reaches down this value.
- void setMinVoltage (double minVoltage)

  set a minimum value for the voltage. The experiment will end when it reaches down this value.
- bool isMinimumVoltageVsOCP () const

  tells whether the specified minimum voltage is set against the open-circuit voltage or the reference terminal.
- void setMinimumVoltageVsOCP (bool vsOCP)

  set whether to reference the specified minimum voltage against the open-circuit voltage or the reference terminal.
- double getMaxCurrent () const

  get the value set maximum for the current in amps.
- void setMaxCurrent (double maxCurrent)

  set a maximum current to stop the experiment.
- double getMinCurrent () const

  get the value set minimum for the current in amps.
- void setMinCurrent (double maxCurrent)

  set a minimum current to stop the experiment.
- double getMaxDuration () const

  get the maximum duration set for the experiment. The experiment will end when the duration of the experiment reaches this value.
- void setMaxDuration (double maxDuration)

  set the maximum duration for the experiment.
- double getMaxCapacity () const

  get the value set for the maximum capacity / cumulative charge.
- void setMaxCapacity (double maxCapacity)

  set the value for the maximum capacity / cumulative charge in Coulomb.

16.5.1 Constructor & Destructor Documentation

16.5.1.1 AisConstantPowerElement() [1/2]

```
AisConstantPowerElement::AisConstantPowerElement (
            double power,
            double duration,
            double samplingInterval)  [explicit]
```

Parameters

power	the value set for the power in watts.
duration	the maximum duration for the experiment in seconds.
samplingInterval	the data sampling interval value in seconds.

16.5.1.2 AisConstantPowerElement() [2/2]

```
AisConstantPowerElement::AisConstantPowerElement (
            bool isCharge,
            double power,
            double duration,
            double samplingInterval)  [explicit]
```

Parameters

isCharge	true to set the experiment simulate charge and false to simulate discharge.
power	the value set for the power in watts.
duration	the maximum duration for the experiment in seconds.
samplingInterval	the data sampling interval value in seconds.

Attention

Deprecation Warning: the isCharge parameter will be deprecated in a future version. Using the alternative constructor is highly recommended to avoid compilation errors in a future version. If this constructor is used, the sign of the power will be ignored and isCharge state will be used to determine it instead.

16.5.2 Member Function Documentation

16.5.2.1 getCategory()

```
QStringList AisConstantPowerElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Energy Storage", "Charge/Discharge").

16.5.2.2 getMaxCapacity()

```
double AisConstantPowerElement::getMaxCapacity () const
```

Returns

the value set for the maximum capacity in Coulomb.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.5.2.3 getMaxCurrent()

```
double AisConstantPowerElement::getMaxCurrent () const
```

Returns

the value set for the maximum current in amps.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.5.2.4 getMaxDuration()

```
double AisConstantPowerElement::getMaxDuration () const
```

Returns

the maximum duration for the experiment in seconds.

16.5.2.5 getMaxVoltage()

```
double AisConstantPowerElement::getMaxVoltage () const
```

Returns

the value set for the maximum voltage.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity

16.5.2.6 getMinCurrent()

```
double AisConstantPowerElement::getMinCurrent () const
```

Returns

the value set for the minimum current in amps.

Note

this is an optional parameter. If no value has been set, the default value is 0.

16.5.2.7 getMinVoltage()

```
double AisConstantPowerElement::getMinVoltage () const
```

Returns

the minimum value set for the voltage in volts.

Note

this is an optional parameter. If no value has been set, the default value is negative infinity

16.5.2.8 getName()

```
QString AisConstantPowerElement::getName () const  [override]
```

Returns

The name of the element: "Constant Power Charge/Discharge".

16.5.2.9 getPower()

```
double AisConstantPowerElement::getPower () const
```

Returns

the value set for the power in watts.

16.5.2.10 getSamplingInterval()

```
double AisConstantPowerElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.5.2.11 isCharge()

```
bool AisConstantPowerElement::isCharge () const
```

Returns

true if the experiment is set to simulate charge and false if it is set to simulate discharge.

16.5.2.12 isMaximumVoltageVsOCP()

```
bool AisConstantPowerElement::isMaximumVoltageVsOCP () const
```

Returns

true if the specified maximum voltage is set against the open-circuit voltage and false if it is set against the reference terminal.

See also

setVsOcp

16.5.2.13 isMinimumVoltageVsOCP()

```
bool AisConstantPowerElement::isMinimumVoltageVsOCP () const
```

Returns

true if the specified voltage is set against the open-circuit minimum voltage and false if it is set against the reference terminal.

See also

setVsOcp

16.5.2.14 setCharge()

```
void AisConstantPowerElement::setCharge (
            bool isCharge)
```

Parameters

isCharge	if the given argument is true, the experiment will simulate charge and discharge if given false.

Attention

Deprecation Warning: setCharge will be deprecated in a future version. Avoid using this function, and instead set the power to a positive or negative value. If AisConstantPowerElement(bool, double, double, double) is used, you must use this function to set the charge/discharge state.

16.5.2.15 setMaxCapacity()

```
void AisConstantPowerElement::setMaxCapacity (
            double maxCapacity)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit cumulative charge value. If a maximum capacity is set, the experiment will continue to run as long as the cumulative charge is below that value.

Parameters

maxCapacity	the value to set for the cell maximum capacity.

16.5.2.16 setMaxCurrent()

```
void AisConstantPowerElement::setMaxCurrent (
            double maxCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an uper-limit Current value. If a maximum current is set, the experiment will continue to run as long as the measured current is above that value.

Parameters

maxCurrent	the maximum current value in amps at which the experiment will stop.

16.5.2.17 setMaxDuration()

```
void AisConstantPowerElement::setMaxDuration (
            double maxDuration)
```

The experiment will continue to run as long as the passed time is less than that the set duration value.

Parameters

maxDuration	the maximum duration for the experiment in seconds.

16.5.2.18 setMaximumVoltageVsOCP()

```
void AisConstantPowerElement::setMaximumVoltageVsOCP (
            bool vsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

vsOCP	true to set the specified maximum voltage to reference the open-circuit voltage and false to set against the reference terminal.

16.5.2.19 setMaxVoltage()

```
void AisConstantPowerElement::setMaxVoltage (
            double maxVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is below that value.

Parameters

maxVoltage	the maximum voltage value in volts at which the experiment will stop.

16.5.2.20 setMinCurrent()

```
void AisConstantPowerElement::setMinCurrent (
            double maxCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit Current value. If a minimum current is set, the experiment will continue to run as long as the measured current is below that value.

Parameters

maxCurrent	the minimum current value in amps at which the experiment will stop.

16.5.2.21 setMinimumVoltageVsOCP()

```
void AisConstantPowerElement::setMinimumVoltageVsOCP (
            bool vsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

vsOCP	true to set the specified minimum voltage to reference the open-circuit voltage and false to set against the reference terminal.

16.5.2.22 setMinVoltage()

```
void AisConstantPowerElement::setMinVoltage (
            double minVoltage)
```

Parameters

minVoltage	the value for the voltage in volts.

Note

this is an optional parameter. If no value has been set, the default value is negative infinity.

16.5.2.23 setPower()

```
void AisConstantPowerElement::setPower (
            double power)
```

Parameters

power	the value set for the power in watts.

16.5.2.24 setSamplingInterval()

```
void AisConstantPowerElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

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

- AisConstantPowerElement.h

16.6 AisConstantResistanceElement Class Reference

This element/experiment simulates a constant resistance load.

```
#include <AisConstantResistanceElement.h>
```

```
#include <AisConstantResistanceElement.h>
```

Public Member Functions

- AisConstantResistanceElement (double resistance, double duration, double samplingInterval)

  the constant resistance element constructor.
- **AisConstantResistanceElement** (const AisConstantResistanceElement &)

  copy constructor for the AisConstantResistanceElement object.
- AisConstantResistanceElement & **operator=** (const AisConstantResistanceElement &)

  overload equal to operator for the AisConstantResistanceElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getResistance () const

  get the value set for the resistance as a load.
- void setResistance (double resistance)

  set the value for the resistance as a load
- double getSamplingInterval () const

  get how frequently we are sampling the data.
- void setSamplingInterval (double samplingInterval)

  set how frequently we are sampling the data.
- double getMinVoltage () const

  get the value set minimum for the voltage in volts.
- void setMinVoltage (double minVoltage)

  set a minimum voltage to stop the experiment.
- bool isMinimumVoltageVsOCP () const

  tells whether the specified minimum voltage is set against the open-circuit voltage or the reference terminal.
- void setMinimumVoltageVsOCP (bool vsOCP)

  set whether to reference the specified minimum voltage against the open-circuit voltage or the reference terminal.
- double getMaxVoltage () const

  get the value set maximum for the voltage in volts.
- void setMaxVoltage (double maxVoltage)

set a maximum voltage to stop the experiment.

- bool isMaximumVoltageVsOCP () const

  tells whether the specified maximum voltage is set against the open-circuit voltage or the reference terminal.
- void setMaximumVoltageVsOCP (bool vsOCP)

  set whether to reference the specified maximum voltage against the open-circuit voltage or the reference terminal.
- double getMaxCurrent () const

  get the value set maximum for the current in amps.
- void setMaxCurrent (double maxCurrent)

  set a maximum current to stop the experiment.
- double getMinCurrent () const

  get the value set minimum for the current in amps.
- void setMinCurrent (double maxCurrent)

  set a minimum current to stop the experiment.
- double getMaxDuration () const

  get the maximum duration set for the experiment. The experiment will end when the duration of the experiment reaches this value.
- void setMaxDuration (double maxDuration)

  set the maximum duration for the experiment.
- double getMaxCapacity () const

  get the value set for the maximum capacity / cumulative charge.
- void setMaxCapacity (double maxCapacity)

  set the value for the maximum capacity / cumulative charge in Coulomb.

16.6.1 Constructor & Destructor Documentation

16.6.1.1 AisConstantResistanceElement()

```
AisConstantResistanceElement::AisConstantResistanceElement (
            double resistance,
            double duration,
            double samplingInterval)  [explicit]
```

Parameters

resistance	the value in ohm of the load resistance
duration	the maximum duration for the experiment in seconds.
samplingInterval	the data sampling interval value in seconds.

16.6.2 Member Function Documentation

16.6.2.1 getCategory()

```
QStringList AisConstantResistanceElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Energy Storage", "Charge/Discharge").

16.6.2.2 getMaxCapacity()

```
double AisConstantResistanceElement::getMaxCapacity () const
```

Returns

the value set for the maximum capacity in Coulomb.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.6.2.3 getMaxCurrent()

```
double AisConstantResistanceElement::getMaxCurrent () const
```

Returns

the value set for the maximum current in amps.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.6.2.4 getMaxDuration()

```
double AisConstantResistanceElement::getMaxDuration () const
```

Returns

the maximum duration for the experiment in seconds.

16.6.2.5 getMaxVoltage()

```
double AisConstantResistanceElement::getMaxVoltage () const
```

Returns

the value set for the maximum voltage in volts.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity

16.6.2.6 getMinCurrent()

```
double AisConstantResistanceElement::getMinCurrent () const
```

Returns

the value set for the minimum current in amps.

Note

this is an optional parameter. If no value has been set, the default value is 0.

16.6.2.7 getMinVoltage()

```
double AisConstantResistanceElement::getMinVoltage () const
```

Returns

the value set for the minimum voltage in volts.

Note

this is an optional parameter. If no value has been set, the default value is negative infinity

16.6.2.8 getName()

```
QString AisConstantResistanceElement::getName () const  [override]
```

Returns

The name of the element: "Constant Resistance".

16.6.2.9 getResistance()

```
double AisConstantResistanceElement::getResistance () const
```

Returns

the value in ohm of the load resistance.

16.6.2.10 getSamplingInterval()

```
double AisConstantResistanceElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.6.2.11 isMaximumVoltageVsOCP()

```
bool AisConstantResistanceElement::isMaximumVoltageVsOCP () const
```

Returns

true if the specified maximum voltage is set against the open-circuit voltage and false if it is set against the reference terminal.

See also

setVsOcp

16.6.2.12 isMinimumVoltageVsOCP()

```
bool AisConstantResistanceElement::isMinimumVoltageVsOCP () const
```

Returns

true if the specified voltage is set against the open-circuit minimum voltage and false if it is set against the reference terminal.

See also

setVsOcp

16.6.2.13 setMaxCapacity()

```
void AisConstantResistanceElement::setMaxCapacity (
             double maxCapacity)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit cumulative charge value. If a maximum capacity is set, the experiment will continue to run as long as the cumulative charge is below that value.

Parameters

maxCapacity	the value to set for the cell maximum capacity.

16.6.2.14 setMaxCurrent()

```
void AisConstantResistanceElement::setMaxCurrent (
             double maxCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an uper-limit Current value. If a maximum current is set, the experiment will continue to run as long as the measured current is above that value.

Parameters

maxCurrent	the maximum current value in amps at which the experiment will stop.

16.6.2.15 setMaxDuration()

```
void AisConstantResistanceElement::setMaxDuration (
            double maxDuration)
```

The experiment will continue to run as long as the passed time is less than that the set duration value.

Parameters

maxDuration	the maximum duration for the experiment in seconds.

16.6.2.16 setMaximumVoltageVsOCP()

```
void AisConstantResistanceElement::setMaximumVoltageVsOCP (
            bool vsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

vsOCP	true to set the specified maximum voltage to reference the open-circuit voltage and false to set against the reference terminal.

16.6.2.17 setMaxVoltage()

```
void AisConstantResistanceElement::setMaxVoltage (
            double maxVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is above that value.

Parameters

maxVoltage	the maximum voltage value in volts at which the experiment will stop.

16.6.2.18 setMinCurrent()

```
void AisConstantResistanceElement::setMinCurrent (
            double maxCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit Current value. If a minimum current is set, the experiment will continue to run as long as the measured current is below that value.

Parameters

maxCurrent	the minimum current value in amps at which the experiment will stop.

16.6.2.19 setMinimumVoltageVsOCP()

```
void AisConstantResistanceElement::setMinimumVoltageVsOCP (
             bool vsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

vsOCP	true to set the specified minimum voltage to reference the open-circuit voltage and false to set against the reference terminal.

16.6.2.20 setMinVoltage()

```
void AisConstantResistanceElement::setMinVoltage (
             double minVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is above that value.

Parameters

minVoltage	the minimum voltage value in volts at which the experiment will stop.

16.6.2.21 setResistance()

```
void AisConstantResistanceElement::setResistance (
             double resistance)
```

Parameters

resistance	the value in ohm of the load resistance.

16.6.2.22 setSamplingInterval()

```
void AisConstantResistanceElement::setSamplingInterval (
             double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

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

- AisConstantResistanceElement.h

16.7 AisCyclicVoltammetryElement Class Reference

This experiment sweeps the potential of the working electrode back and forth between the **first voltage-limit** and the **second voltage-limit** at a constant **scan rate (dE/dt)** for a specified number of **cycles**.

```
#include <AisCyclicVoltammetryElement.h>
```

```
#include <AisCyclicVoltammetryElement.h>
```

Public Member Functions

- AisCyclicVoltammetryElement (double startVoltage, double firstVoltageLimit, double secondVoltageLimit, double endVoltage, double dEdt, double samplingInterval)

  constructor of the cyclic voltammetry element.
- **AisCyclicVoltammetryElement** (const AisCyclicVoltammetryElement &)

  copy constructor for the AisCyclicVoltammetryElement object.
- AisCyclicVoltammetryElement & **operator=** (const AisCyclicVoltammetryElement &)

  overload equal to operator for the AisCyclicVoltammetryElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the potential sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartVoltage () const

  get the value set for the start voltage
- void setStartVoltage (double startVoltage)

  set the value for the start voltage.
- bool isStartVoltageVsOCP () const

  tells whether the start voltage is set with respect to the open circuit voltage or not.
- void setStartVoltageVsOCP (bool startVoltageVsOCP)

  set whether to reference the start voltage against the open-circuit voltage or the reference terminal.
- double getFirstVoltageLimit () const

  get the value set for the first voltage-limit.

- void setFirstVoltageLimit (double v1)

  set the first voltage-limit
- bool isFirstVoltageLimitVsOCP () const

  tells whether the first voltage-limit is set with respect to the open circuit voltage or not.
- void setFirstVoltageLimitVsOCP (bool firstVoltageLimitVsOCP)

  set whether to reference the first voltage-limit against the open-circuit voltage or not.
- double getSecondVoltageLimit () const

  get the value set for the second voltage-limit
- void setSecondVoltageLimit (double v2)

  set the second voltage-limit
- bool isSecondVoltageLimitVsOCP () const

  tells whether the second voltage-limit is set with respect to the open circuit voltage or not.
- void setSecondVoltageLimitVsOCP (bool secondVoltageLimitVsOCP)

  set whether to reference the second voltage-limit against the open-circuit voltage or not.
- unsigned int getNumberOfCycles ()

  get the value set for the number of cycles
- void setNumberOfCycles (unsigned int cycles)

  set the number of cycles to oscillate between the first voltage-limit and the second voltage-limit.
- double getEndVoltage () const

  get the value set for the ending potential value.
- void setEndVoltage (double endVoltage)

  set the ending potential value.
- bool isEndVoltageVsOCP () const

  tells whether the end voltage is set with respect to the open circuit voltage or the reference terminal.
- void setEndVoltageVsOCP (bool endVoltageVsOCP)

  set whether to reference the end voltage against the open-circuit voltage or the reference terminal.
- double getdEdt () const

  get the value set for the constant scan rate dE/dt.
- void setdEdt (double dEdt)

  set the value for the constant scan rate dE/dt.
- double getSamplingInterval () const

  get how frequently we are sampling the data.
- void setSamplingInterval (double sampInterval)

  set how frequently we are sampling the data.
- bool isAutoRange () const

  tells whether the current range is set to auto-select or not.
- void setAutoRange ()

  set to auto-select the current range.
- double getApproxMaxCurrent () const

  get the value set for the expected maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  set maximum current expected, for manual current range selection.
- double getAlphaFactor () const

  Get the value set for the alpha factor.
- void setAlphaFactor (double alphaFactor)

  alpha factor controls the percentage of data sampled during a given interval. Data will be averaged over the last n% of the sampling interval.

16.7.1 Constructor & Destructor Documentation

16.7.1.1 AisCyclicVoltammetryElement()

```
AisCyclicVoltammetryElement::AisCyclicVoltammetryElement (
            double startVoltage,
            double firstVoltageLimit,
            double secondVoltageLimit,
            double endVoltage,
            double dEdt,
            double samplingInterval)  [explicit]
```

Parameters

startVoltage	the value of the start voltage in volts
firstVoltageLimit	the value of the first voltage-limit in volts
secondVoltageLimit	the value of the second voltage-limit in volts
endVoltage	the value of the end voltage in volts
dEdt	the constant scan rate dE/dt in V/s.
samplingInterval	the data sampling interval value in seconds.

16.7.2 Member Function Documentation

16.7.2.1 getAlphaFactor()

```
double AisCyclicVoltammetryElement::getAlphaFactor () const
```

Returns

The value for the alpha factor is represented as a percent between 0 and 100.

Note

If nothing is set, this function will return a default value of 75.

16.7.2.2 getApproxMaxCurrent()

```
double AisCyclicVoltammetryElement::getApproxMaxCurrent () const
```

Returns

the value set for the expected maximum current in Amps.

Note

if nothing was manually set, the device will auto-select the current range and the return value will be positive infinity.

16.7.2.3 getCategory()

```
QStringList AisCyclicVoltammetryElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control", "Basic Experiments").

16.7.2.4 getdEdt()

```
double AisCyclicVoltammetryElement::getdEdt () const
```

Returns

the value set for the constant scan rate dE/dt in V/s.

16.7.2.5 getEndVoltage()

```
double AisCyclicVoltammetryElement::getEndVoltage () const
```

This is the value of the voltage at which the experiment will stop. After the last cycle, the experiment will do one last sweep towards this value.

Returns

the value set for the ending voltage in volts.

16.7.2.6 getFirstVoltageLimit()

```
double AisCyclicVoltammetryElement::getFirstVoltageLimit () const
```

After the starting voltage, the scan will go to the first voltage-limit. This could result in either upward scan first if the first voltage-limit is higher than the start voltage or downward scan first if the first voltage-limit is lower than the start voltage.

Returns

the first voltage-limit value in volts.

16.7.2.7 getName()

```
QString AisCyclicVoltammetryElement::getName () const  [override]
```

Returns

The name of the element: "Cyclic Voltammetry".

16.7.2.8 getNumberOfCycles()

```
unsigned int AisCyclicVoltammetryElement::getNumberOfCycles ()
```

Returns

the number of cycles set.

16.7.2.9 getQuietTime()

```
double AisCyclicVoltammetryElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.7.2.10 getQuietTimeSamplingInterval()

```
double AisCyclicVoltammetryElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.7.2.11 getSamplingInterval()

```
double AisCyclicVoltammetryElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.7.2.12 getSecondVoltageLimit()

```
double AisCyclicVoltammetryElement::getSecondVoltageLimit () const
```

After starting from the start-voltage and reaching the first voltage-limit, the scan will go to the second voltage limit. The scan will continue to oscillate between the first and second voltage-limits according to the number of cycles.

Returns

the second voltage-limit value in volts.

16.7.2.13 getStartVoltage()

```
double AisCyclicVoltammetryElement::getStartVoltage () const
```

Returns

the value of the start voltage in volts

16.7.2.14 isAutoRange()

```
bool AisCyclicVoltammetryElement::isAutoRange () const
```

Returns

true if the current range is set to auto-select and false if a rage has been selected.

16.7.2.15 isEndVoltageVsOCP()

```
bool AisCyclicVoltammetryElement::isEndVoltageVsOCP () const
```

Returns

true if the end voltage is set with respect to the open-circuit voltage and false if set against the reference terminal.

Note

if no value was set, the default is false

16.7.2.16 isFirstVoltageLimitVsOCP()

```
bool AisCyclicVoltammetryElement::isFirstVoltageLimitVsOCP () const
```

Returns

true if the first voltage-limit is set with respect to the open-circuit voltage and false if not.

Note

if no value was set, the default is false.

16.7.2.17 isSecondVoltageLimitVsOCP()

```
bool AisCyclicVoltammetryElement::isSecondVoltageLimitVsOCP () const
```

Returns

true if the second voltage-limit is set with respect to the open-circuit voltage and false if not.

Note

if no value was set, the default is false.

16.7.2.18 isStartVoltageVsOCP()

```
bool AisCyclicVoltammetryElement::isStartVoltageVsOCP () const
```

Returns

true if the start voltage is set with respect to the open-circuit voltage and false if not.

16.7.2.19 setAlphaFactor()

```
void AisCyclicVoltammetryElement::setAlphaFactor (
            double alphaFactor)
```

This is an **optional** parameter. If nothing is set, the device will use the default value of 75.

Parameters

alphaFactor	the value for the alphaFactor ranges from 0 to 100.

16.7.2.20 setApproxMaxCurrent()

```
void AisCyclicVoltammetryElement::setApproxMaxCurrent (
            double approxMaxCurrent)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the current range.

Parameters

approxMaxCurrent	the value for the maximum current expected in Amps.

16.7.2.21 setAutoRange()

```
void AisCyclicVoltammetryElement::setAutoRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

16.7.2.22 setdEdt()

```
void AisCyclicVoltammetryElement::setdEdt (
            double dEdt)
```

Parameters

dEdt	the value set for the constant scan rate dE/dt in V/s.

16.7.2.23 setEndVoltage()

```
void AisCyclicVoltammetryElement::setEndVoltage (
            double endVoltage)
```

This is the value of the voltage at which the experiment will stop. After the last cycle, the experiment will do one last sweep towards this value.

Parameters

endVoltage	the value to set for the ending potential in volts.

16.7.2.24 setEndVoltageVsOCP()

```
void AisCyclicVoltammetryElement::setEndVoltageVsOCP (
            bool endVoltageVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

endVoltageVsOCP	true to set the end voltage to be referenced against the open-circuit voltage and false if set against the reference terminal.

16.7.2.25 setFirstVoltageLimit()

```
void AisCyclicVoltammetryElement::setFirstVoltageLimit (
            double v1)
```

After the starting voltage, the scan will go to the first voltage-limit. This could result in either upward scan first if the first voltage-limit is higher than the start voltage or downward scan first if the first voltage-limit is lower than the start voltage.

Parameters

v1	first voltage-limit value in volts

16.7.2.26 setFirstVoltageLimitVsOCP()

```
void AisCyclicVoltammetryElement::setFirstVoltageLimitVsOCP (
            bool firstVoltageLimitVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

firstVoltageLimitVsOCP	true to set the upper voltage to be referenced against the open-circuit voltage and false otherwise.

16.7.2.27 setNumberOfCycles()

```
void AisCyclicVoltammetryElement::setNumberOfCycles (
             unsigned int cycles)
```

Parameters

cycles	the number of cycles to set

16.7.2.28 setQuietTime()

```
void AisCyclicVoltammetryElement::setQuietTime (
             double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.7.2.29 setQuietTimeSamplingInterval()

```
void AisCyclicVoltammetryElement::setQuietTimeSamplingInterval (
             double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.7.2.30 setSamplingInterval()

```
void AisCyclicVoltammetryElement::setSamplingInterval (
             double sampInterval)
```

Parameters

sampInterval	the data sampling interval value in seconds.

16.7.2.31 setSecondVoltageLimit()

```
void AisCyclicVoltammetryElement::setSecondVoltageLimit (
             double v2)
```

After starting from the start-voltage and reaching the first voltage-limit, the scan will go to the second voltage limit. The scan will continue to oscillate between the first and second voltage-limits according to the number of cycles.

Parameters

v2	the second voltage-limit value in volts

16.7.2.32 setSecondVoltageLimitVsOCP()

```
void AisCyclicVoltammetryElement::setSecondVoltageLimitVsOCP (
            bool secondVoltageLimitVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

secondVoltageLimitVsOCP	true to set the second voltage-limit to be referenced against the open-circuit voltage and false otherwise.

16.7.2.33 setStartVoltage()

```
void AisCyclicVoltammetryElement::setStartVoltage (
            double startVoltage)
```

Parameters

startVoltage	the value of the start voltage in volts

16.7.2.34 setStartVoltageVsOCP()

```
void AisCyclicVoltammetryElement::setStartVoltageVsOCP (
            bool startVoltageVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

startVoltageVsOCP	true to if the start voltage is set to reference the open-circuit voltage and false if set against the reference terminal.

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

- AisCyclicVoltammetryElement.h

16.8 AisDataManipulator Class Reference

This class offers advanced control over pulse data collection and manipulation. It provides methods to manipulate AIS primary data for all three pulse voltammetry experiments types, namely Differential Pulse Voltammetry (DPV), Square Wave Voltammetry (SWV), and Normal Pulse Voltammetry (NPV).

```
#include <AisDataManipulator.h>
```

```
#include <AisDataManipulator.h>
```

Public Member Functions

- **AisDataManipulator** ()

  Default constructor for AisDataManipulator class.
- AisErrorCode setPulseType (AisPulseType type, double pulseWidth, double pulsePeriod)

  Set pulse type with pulse width and pulse period.
- AisErrorCode setPulseType (AisPulseType type, double frequency)

  Set pulse type with frequency.
- double getPulseWidth () const

  Get the pulse width.
- double getPulsePeriod () const

  Get the pulse period.
- double getFrequency () const

  Get the pulse frequency.
- bool isPulseCompleted () const

  Check if the pulse is completed.
- double getBaseCurrent () const

  Get the base current.
- double getPulseCurrent () const

  Get the pulse current.
- double getBaseVoltage () const

  Get the base voltage.
- double getPulseVoltage () const

  Get the pulse voltage.
- void loadPrimaryData (const AisDCData &data)

  Load primary data from AisDCData object.

16.8.1 Member Function Documentation

16.8.1.1 getBaseCurrent()

```
double AisDataManipulator::getBaseCurrent () const
```

Returns

The base current.

16.8.1.2 getBaseVoltage()

```
double AisDataManipulator::getBaseVoltage () const
```

Returns

The base voltage.

16.8.1.3 getFrequency()

```
double AisDataManipulator::getFrequency () const
```

Returns

The pulse frequency.

16.8.1.4 getPulseCurrent()

```
double AisDataManipulator::getPulseCurrent () const
```

Returns

The pulse current.

16.8.1.5 getPulsePeriod()

```
double AisDataManipulator::getPulsePeriod () const
```

Returns

The pulse period.

16.8.1.6 getPulseVoltage()

```
double AisDataManipulator::getPulseVoltage () const
```

Returns

The pulse voltage.

16.8.1.7 getPulseWidth()

```
double AisDataManipulator::getPulseWidth () const
```

Returns

The pulse width.

16.8.1.8 isPulseCompleted()

```
bool AisDataManipulator::isPulseCompleted () const
```

Returns

True if the pulse is completed, false otherwise.

16.8.1.9 loadPrimaryData()

```
void AisDataManipulator::loadPrimaryData (
            const AisDCData & data)
```

Parameters

data	The AisDCData object containing primary data.

16.8.1.10 setPulseType() [1/2]

```
AisErrorCode AisDataManipulator::setPulseType (
            AisPulseType type,
            double frequency)
```

Note

This function is usefull only for SquarewavePulse.

Parameters

type	The type of pulse.
frequency	The frequency of the pulse.

Returns

AisErrorCode::Success if pulse setting was successful. If not successful, possible returned errors are:

- AisErrorCode::FailedRequest

16.8.1.11 setPulseType() [2/2]

```
AisErrorCode AisDataManipulator::setPulseType (
            AisPulseType type,
            double pulseWidth,
            double pulsePeriod)
```

Note

This function is usefull only for DifferentialPulse and NormalPulse.

Parameters

type	The type of pulse.
pulseWidth	The width of the pulse.
pulsePeriod	The period of the pulse.

Returns

AisErrorCode::Success if pulse setting was successful. If not successful, possible returned errors are:

- AisErrorCode::FailedRequest

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

- AisDataManipulator.h

16.9 AisDCCurrentSweepElement Class Reference

this experiment performs a DC current sweep from the **starting current** to the **ending current** which progresses linearly according to the **scan rate**.

```
#include <AisDCCurrentSweepElement.h>
```

```
#include <AisDCCurrentSweepElement.h>
```

Public Member Functions

- AisDCCurrentSweepElement (double startCurrent, double endCurrent, double scanRate, double sampling↩ Interval)

  the DC current sweep element.
- **AisDCCurrentSweepElement** (const AisDCCurrentSweepElement &)

  copy constructor for the AisDCCurrentSweepElement object.
- AisDCCurrentSweepElement & **operator=** (const AisDCCurrentSweepElement &)

  overload equal to operator for the AisDCCurrentSweepElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the quiet time sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartingCurrent () const

  get the value set for the starting current.
- void setStartingCurrent (double startingCurrent)

set the value for the starting current.

- double getEndingCurrent () const

  get the value set for the ending current.
- void setEndingCurrent (double endingCurrent)

  set the value for the ending current.
- double getScanRate () const

  get the value set for the scan rate.
- void setScanRate (double scanRate)

  set the value for the current scan rate.
- double getSamplingInterval () const

  get how frequently we are sampling the data.
- void setSamplingInterval (double samplingInterval)

  set how frequently we are sampling the data.
- double getMaxVoltage () const

  get the value set for the maximum voltage. The experiment will end when it reaches this value.
- void setMaxVoltage (double maxVoltage)

  set a maximum voltage to stop the experiment.
- double getMinVoltage () const

  get the value set minimum for the voltage in volts.
- void setMinVoltage (double minVoltage)

  set a minimum voltage to stop the experiment.
- double getAlphaFactor () const

  Get the value set for the alpha factor.
- void setAlphaFactor (double alphaFactor)

  alpha factor controls the percentage of data sampled during a given interval. Data will be averaged over the last n% of the sampling interval.

16.9.1 Constructor & Destructor Documentation

16.9.1.1 AisDCCurrentSweepElement()

```
AisDCCurrentSweepElement::AisDCCurrentSweepElement (
             double startCurrent,
             double endCurrent,
             double scanRate,
             double samplingInterval)  [explicit]
```

Parameters

startCurrent	the value for the starting current in Amps.
endCurrent	the value for the ending current in Amps.
scanRate	the value for the current scan rate in A/s.
samplingInterval	how frequently we are sampling the data.

16.9.2 Member Function Documentation

16.9.2.1 getAlphaFactor()

```
double AisDCCurrentSweepElement::getAlphaFactor () const
```

Returns

The value for the alpha factor is represented as a percent between 0 and 100.

Note

If nothing is set, this function will return a default value of 75.

16.9.2.2 getCategory()

```
QStringList AisDCCurrentSweepElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Galvanostatic Control", "Basic Voltammetry").

16.9.2.3 getEndingCurrent()

```
double AisDCCurrentSweepElement::getEndingCurrent () const
```

Returns

the value for the ending current in Amps.

16.9.2.4 getMaxVoltage()

```
double AisDCCurrentSweepElement::getMaxVoltage () const
```

Returns

the value set for the maximum voltage.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity

16.9.2.5 getMinVoltage()

```
double AisDCCurrentSweepElement::getMinVoltage () const
```

Returns

the value set for the minimum voltage in volts.

Note

this is an optional parameter. If no value has been set, the default value is negative infinity

16.9.2.6 getName()

```
QString AisDCCurrentSweepElement::getName () const  [override]
```

Returns

The name of the element: "DC Current Linear Sweep".

16.9.2.7 getQuietTime()

```
double AisDCCurrentSweepElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.9.2.8 getQuietTimeSamplingInterval()

```
double AisDCCurrentSweepElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.9.2.9 getSamplingInterval()

```
double AisDCCurrentSweepElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.9.2.10 getScanRate()

```
double AisDCCurrentSweepElement::getScanRate () const
```

Returns

the value set for the scan rate in A/s.

See also

setScanRate

16.9.2.11 getStartingCurrent()

```
double AisDCCurrentSweepElement::getStartingCurrent () const
```

Returns

the value set for the constant current in Amps.

16.9.2.12 setAlphaFactor()

```
void AisDCCurrentSweepElement::setAlphaFactor (
             double alphaFactor)
```

This is an **optional** parameter. If nothing is set, the device will use the default value of 75.

Parameters

alphaFactor	the value for the alphaFactor ranges from 0 to 100.

16.9.2.13 setEndingCurrent()

```
void AisDCCurrentSweepElement::setEndingCurrent (
             double endingCurrent)
```

Parameters

endingCurrent	the value for the ending current in Amps

16.9.2.14 setMaxVoltage()

```
void AisDCCurrentSweepElement::setMaxVoltage (
             double maxVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is below that value.

Parameters

maxVoltage	the maximum voltage value in volts at which the experiment will stop.

16.9.2.15 setMinVoltage()

```
void AisDCCurrentSweepElement::setMinVoltage (
            double minVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is above that value.

Parameters

minVoltage	the minimum voltage value in volts at which the experiment will stop.

16.9.2.16 setQuietTime()

```
void AisDCCurrentSweepElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.9.2.17 setQuietTimeSamplingInterval()

```
void AisDCCurrentSweepElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.9.2.18 setSamplingInterval()

```
void AisDCCurrentSweepElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

16.9.2.19 setScanRate()

```
void AisDCCurrentSweepElement::setScanRate (
            double scanRate)
```

The scan rate represents the value of the discrete current step size in one second in the linear sweep.

Parameters

scanRate	the value to set for the scan rate.

16.9.2.20 setStartingCurrent()

```
void AisDCCurrentSweepElement::setStartingCurrent (
             double startingCurrent)
```

Parameters

startingCurrent	the value to set for the starting current in Amps

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

- AisDCCurrentSweepElement.h

16.10 AisDCData Struct Reference

A structure containing DC data collected from the instrument.

```
#include <AisDataPoints.h>
```

```
#include <AisDataPoints.h>
```

Public Attributes

- double **timestamp**

  the time at which the DC data arrived.
- double **workingElectrodeVoltage**

  the measured working electrode voltage in volts.
- double **counterElectrodeVoltage**

  the measured counter electrode voltage in volts.
- double **current**

  the measured electric current value in Amps
- double **temperature**

  the measured temperature in Celsius.

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

- AisDataPoints.h

16.11 AisDCPotentialSweepElement Class Reference

this experiment performs a DC potential sweep from the **starting current** to the **ending current** which progresses linearly according to the **scan rate**.

```
#include <AisDCPotentialSweepElement.h>
```

```
#include <AisDCPotentialSweepElement.h>
```

Public Member Functions

- AisDCPotentialSweepElement (double startPotential, double endPotential, double scanRate, double samplingInterval)

  the potential sweep element constructor.
- **AisDCPotentialSweepElement** (const AisDCPotentialSweepElement &)

  copy constructor for the AisDCPotentialSweepElement object.
- AisDCPotentialSweepElement & **operator=** (const AisDCPotentialSweepElement &)

  overload equal to operator for the AisDCPotentialSweepElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the quiet time sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartingPot () const

  get the value set for the starting potential.
- void setStartingPot (double startingPotential)

  set the value for the starting potential.
- bool isStartVoltageVsOCP () const

  tells whether the starting potential is set against the open-circuit voltage or the reference terminal.
- void setStartVoltageVsOCP (bool startVoltageVsOCP)

  set whether to reference the starting potential against the open-circuit voltage or the reference terminal.
- double getEndingPot () const

  get the value set for the ending potential value.
- void setEndingPot (double endingPotential)

  set the ending potential value.
- bool isEndVoltageVsOCP () const

  tells whether the end voltage is set with respect to the open circuit voltage or the reference terminal.
- void setEndVoltageVsOCP (bool endVoltageVsOCP)

  set whether to reference the end voltage against the open-circuit voltage or the reference terminal.
- double getScanRate () const

  get the value set for the voltage scan rate.
- void setScanRate (double scanRate)

  set the value for the voltage scan rate.
- double getSamplingInterval () const

get how frequently we are sampling the data.

- void setSamplingInterval (double samplingInterval)

  set how frequently we are sampling the data.
- bool isAutoRange () const

  tells whether the current range is set to auto-select or not.
- void setAutoRange ()

  set to auto-select the current range.
- double getApproxMaxCurrent () const

  get the value set for the expected maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  set maximum current expected, for manual current range selection.
- double getMaxAbsoluteCurrent () const

  get the value set for the maximum Current. The experiment will end when it reaches this value.
- void setMaxAbsoluteCurrent (double maxCurrent)

  set a maximum Current to stop the experiment.
- double getMinAbsoluteCurrent () const

  get the value set minimum for the Current in amps.
- void setMinAbsoluteCurrent (double minCurrent)

  set a minimum Current to stop the experiment.
- double getAlphaFactor () const

  Get the value set for the alpha factor.
- void setAlphaFactor (double alphaFactor)

  alpha factor controls the percentage of data sampled during a given interval. Data will be averaged over the last n% of the sampling interval.

16.11.1 Constructor & Destructor Documentation

16.11.1.1 AisDCPotentialSweepElement()

```
AisDCPotentialSweepElement::AisDCPotentialSweepElement (
            double startPotential,
            double endPotential,
            double scanRate,
            double samplingInterval)  [explicit]
```

Parameters

startPotential	the value of the starting potential in volts
endPotential	the value of the ending potential in volts
scanRate	the voltage scan rate in V/s
samplingInterval	how frequently we are sampling the data.

16.11.2 Member Function Documentation

16.11.2.1 getAlphaFactor()

```
double AisDCPotentialSweepElement::getAlphaFactor () const
```

Returns

The value for the alpha factor is represented as a percent between 0 and 100.

Note

If nothing is set, this function will return a default value of 75.

16.11.2.2 getApproxMaxCurrent()

```
double AisDCPotentialSweepElement::getApproxMaxCurrent () const
```

Returns

the value set for the expected maximum current in Amps.

Note

if nothing was manually set, the device will auto-select the current range and the return value will be positive infinity.

16.11.2.3 getCategory()

```
QStringList AisDCPotentialSweepElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control", "Basic Experiments").

16.11.2.4 getEndingPot()

```
double AisDCPotentialSweepElement::getEndingPot () const
```

This is the value of the voltage at which the experiment will stop.

Returns

the value set for the ending voltage in volts.

16.11.2.5 getMaxAbsoluteCurrent()

```
double AisDCPotentialSweepElement::getMaxAbsoluteCurrent () const
```

Returns

the value set for the maximum Current.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity

16.11.2.6 getMinAbsoluteCurrent()

```
double AisDCPotentialSweepElement::getMinAbsoluteCurrent () const
```

Returns

the value set for the minimum Current in amps.

Note

this is an optional parameter. If no value has been set, the default value is negative infinity

16.11.2.7 getName()

```
QString AisDCPotentialSweepElement::getName () const  [override]
```

Returns

The name of the element: "DC Potential Linear Sweep".

16.11.2.8 getQuietTime()

```
double AisDCPotentialSweepElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.11.2.9 getQuietTimeSamplingInterval()

```
double AisDCPotentialSweepElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.11.2.10 getSamplingInterval()

```
double AisDCPotentialSweepElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.11.2.11 getScanRate()

```
double AisDCPotentialSweepElement::getScanRate () const
```

Returns

the value set for the voltage scan rate in V/s

See also

setScanRate

16.11.2.12 getStartingPot()

```
double AisDCPotentialSweepElement::getStartingPot () const
```

Returns

the value of the starting potential in volts.

16.11.2.13 isAutoRange()

```
bool AisDCPotentialSweepElement::isAutoRange () const
```

Returns

true if the current range is set to auto-select and false if a rage has been selected.

16.11.2.14 isEndVoltageVsOCP()

```
bool AisDCPotentialSweepElement::isEndVoltageVsOCP () const
```

Returns

true if the end voltage is set with respect to the open-circuit voltage and false if set against the reference terminal.

See also

setEndVoltageVsOCP

16.11.2.15 isStartVoltageVsOCP()

```
bool AisDCPotentialSweepElement::isStartVoltageVsOCP () const
```

Returns

true if the starting potential is set against the open-circuit voltage and false if it is set against the reference terminal.

See also

setStartVoltageVsOCP

16.11.2.16 setAlphaFactor()

```
void AisDCPotentialSweepElement::setAlphaFactor (
             double alphaFactor)
```

This is an **optional** parameter. If nothing is set, the device will use the default value of 75.

Parameters

alphaFactor	the value for the alphaFactor ranges from 0 to 100.

16.11.2.17 setApproxMaxCurrent()

```
void AisDCPotentialSweepElement::setApproxMaxCurrent (
             double approxMaxCurrent)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the current range.

Parameters

approxMaxCurrent	the value for the maximum current expected in Amps.

16.11.2.18 setAutoRange()

```
void AisDCPotentialSweepElement::setAutoRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

16.11.2.19 setEndingPot()

```
void AisDCPotentialSweepElement::setEndingPot (
             double endingPotential)
```

This is the value of the voltage at which the experiment will stop.

Parameters

endingPotential	the value to set for the ending potential in volts.

16.11.2.20 setEndVoltageVsOCP()

```
void AisDCPotentialSweepElement::setEndVoltageVsOCP (
             bool endVoltageVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

endVoltageVsOCP	true to set the end voltage to be referenced against the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

16.11.2.21 setMaxAbsoluteCurrent()

```
void AisDCPotentialSweepElement::setMaxAbsoluteCurrent (
            double maxCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit Current value. If a maximum Current is set, the experiment will continue to run as long as the measured Current is below that value with the harware current limitation.

Parameters

maxCurrent	the maximum Current value in volts at which the experiment will stop.

16.11.2.22 setMinAbsoluteCurrent()

```
void AisDCPotentialSweepElement::setMinAbsoluteCurrent (
            double minCurrent)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit Current value. If a maximum Current is set, the experiment will continue to run as long as the measured voltage is above that value.

Parameters

minCurrent	the minimum Current value in volts at which the experiment will stop.

16.11.2.23 setQuietTime()

```
void AisDCPotentialSweepElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.11.2.24 setQuietTimeSamplingInterval()

```
void AisDCPotentialSweepElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.11.2.25 setSamplingInterval()

```
void AisDCPotentialSweepElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

16.11.2.26 setScanRate()

```
void AisDCPotentialSweepElement::setScanRate (
            double scanRate)
```

The scan rate represents the value of the discrete voltage step size in one second in the linear sweep.

Parameters

scanRate	the value to set for the scan rate.

16.11.2.27 setStartingPot()

```
void AisDCPotentialSweepElement::setStartingPot (
            double startingPotential)
```

Parameters

startingPotential	the value of the starting potential in volts

16.11.2.28 setStartVoltageVsOCP()

```
void AisDCPotentialSweepElement::setStartVoltageVsOCP (
            bool startVoltageVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

startVoltageVsOCP	true to if the starting potential is set to reference the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

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

- AisDCPotentialSweepElement.h

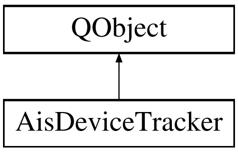
16.12 AisDeviceTracker Class Reference

This class is used track device connections to the computer. It also provides instrument handlers specific to each connected device which provide control of the relevant device.

```
#include <AisDeviceTracker.h>
```

```
#include <AisDeviceTracker.h>
```

Inheritance diagram for AisDeviceTracker:



Signals

- void newDeviceConnected (const QString &deviceName)

  a signal to be emitted whenever a new connection has been successfully established with a device.
- void deviceDisconnected (const QString &deviceName)

  a signal to be emitted whenever a device has been disconnected.
- void firmwareUpdateNotification (const QString &message)

  a signal which is emitted regularaly during a firmware update, providing information about the progress of the update.

Public Member Functions

- AisErrorCode connectToDeviceOnComPort (const QString &comPort)

  establish a connection with a device connected on a USB port.
- const AisInstrumentHandler & getInstrumentHandler (const QString &deviceName) const

  get an instrument handler to control a specific device.
- const std::list< QString > getConnectedDevices () const

  get a list of all the connected devices.
- int connectAllPluggedInDevices ()

  connect all devices physically plugged to the computer.
- AisErrorCode updateFirmwareOnComPort (const QString &comport) const

  update firmware on connected device at USB port.
- int updateFirmwareOnAllAvailableDevices ()

  request firmware update for all available devices.
- void saveLogToFile (bool save)

  Allow to collect device error message in file for debugging purpose.
- void setLogFilePath (const QString &path)

  This will help to change the log file directory.

Static Public Member Functions

- static AisDeviceTracker * Instance ()

  get the instance of the device tracker.

16.12.1 Member Function Documentation

16.12.1.1 connectAllPluggedInDevices()

```
int AisDeviceTracker::connectAllPluggedInDevices ()
```

This will automatically detect all the communication ports that have devices plugged in and establish a connection with each.

Returns

the number of *new* devices that have successfully established a connection with the computer. If a device has already been connected before calling this function, it will not be counted in the return value.

Note

emits newDeviceConnected() signal with the device name for each successful connection.

16.12.1.2 connectToDeviceOnComPort()

```
AisErrorCode AisDeviceTracker::connectToDeviceOnComPort (
             const QString & comPort)
```

Parameters

comPort	the communication port to connect through.

Returns

AisErrorCode::Success if a connection was established with the device through the given communication port. If not successful, possible returned errors are:

- AisErrorCode::Unknown
- AisErrorCode::FirmwareNotSupported
- AisErrorCode::ConnectionFailed

Note

emits newDeviceConnected() signal with the device name if establishing the connection was successful.

You need to specify the communication port specific to your computer. For example, on PC, you may find your port number through the 'device manager'. An example would be "COM15".

16.12.1.3 deviceDisconnected

```
void AisDeviceTracker::deviceDisconnected (
             const QString & deviceName)  [signal]
```

Parameters

deviceName	the name of the newly disconnected device.

Examples

advancedControlFlow.cpp, basicExperiment.cpp, and pulseData.cpp.

16.12.1.4 firmwareUpdateNotification

```
void AisDeviceTracker::firmwareUpdateNotification (
            const QString & message)  [signal]
```

Parameters

message	a string containing the progress percentage message.

Examples

firmwareUpdate.cpp.

16.12.1.5 getConnectedDevices()

```
const std::list< QString > AisDeviceTracker::getConnectedDevices () const
```

Returns

a list of all the connected devices.

16.12.1.6 getInstrumentHandler()

```
const AisInstrumentHandler & AisDeviceTracker::getInstrumentHandler (
            const QString & deviceName) const
```

Parameters

deviceName	the name of the connected device to get the instrument handler for (case sensitive).

Returns

the instrument handler that controls the specified device.

Note

You may get a list of the connected devices using getConnectedDevices(). Also, whenever a device has been connected by calling connectToDeviceOnComPort(), a signal is emitted with the device name.

See also

AisInstrumentHandler

AisdeviceTracker::connectToDeviceOnComPort()

AisdeviceTracker::getConnectedDevices()

16.12.1.7 Instance()

```
static AisDeviceTracker * AisDeviceTracker::Instance ()  [static]
```

Returns

the static instance of the AisDeviceTracker

Examples

advancedControlFlow.cpp, advancedExperiment.cpp, basicExperiment.cpp, dataOutput.cpp, firmwareUpdate.cpp, linkedChannels.cpp, manualExperiment.cpp, nonblockingExperiment.cpp, and pulseData.cpp.

16.12.1.8 newDeviceConnected

```
void AisDeviceTracker::newDeviceConnected (
            const QString & deviceName)  [signal]
```

Parameters

deviceName	the name of the newly connected device.

Note

this signal will be emitted for each newly connected device whenever either connectToDeviceOnComPort() or connectAllPluggedInDevices() successfully established connections.

Examples

advancedControlFlow.cpp, advancedExperiment.cpp, basicExperiment.cpp, dataOutput.cpp, linkedChannels.cpp, manualExperiment.cpp, nonblockingExperiment.cpp, and pulseData.cpp.

16.12.1.9 saveLogToFile()

```
void AisDeviceTracker::saveLogToFile (
            bool save)
```

Note

by default it will be true.

Parameters

save	When set to 'false,' it will not write logs to the file. When set to 'true,' it will begin writing device error logs to the file.

See also

setLogFilePath

16.12.1.10 setLogFilePath()

```
void AisDeviceTracker::setLogFilePath (
            const QString & path)
```

Note

by default it will be Document/Admiral Instrument/API

Parameters

path	Set the path value at which you want to save the log file.

Note

If you set 'false' for 'saveLogToFile,' it will not generate the log file. It is recommended to set it to 'true' or leave the permission as the default setting.

See also

saveLogToFile

16.12.1.11 updateFirmwareOnAllAvailableDevices()

```
int AisDeviceTracker::updateFirmwareOnAllAvailableDevices ()
```

This will automatically detect devices not currently in use and update firmware if necessary.

Returns

the number of devices that have successfully requested for firmware update. If a device has already been updated firmware before calling this function, it will not be counted in the return value. If any error is generated while requesting firmware update, it will not be counted in the return value.

Note

emits firmwareUpdateNotification() signal will provide notification regarding firmware update of all devices.

You can update firmware when you reset the device physically through reset button.

See also

updateFirmwareOnComPort

16.12.1.12 updateFirmwareOnComPort()

```
AisErrorCode AisDeviceTracker::updateFirmwareOnComPort (
              const QString & comport) const
```

Parameters

comport	the communication port to connect through.

Returns

AisErrorCode::Success if firmware update successfully initiated through the given communication port. If not successful, possible returned errors are:

- AisErrorCode::FirmwareUptodate
- AisErrorCode::ConnectionFailed

Note

emits firmwareUpdateNotification() signal to provide firmware update progress.

You need to specify the communication port specific to your computer. For example, on PC, you may find your port number through the 'device manager'. An example would be "COM15".

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

- AisDeviceTracker.h

16.13 AisDiffPulseVoltammetryElement Class Reference

In this experiment, the working electrode holds at a **starting potential** during the **quiet time**. Then it applies a train of pulses superimposed on a staircase waveform, with a uniform **potential step** size. The potential continues to step until the **final potential** is reached.

```
#include <AisDiffPulseVoltammetryElement.h>
```

```
#include <AisDiffPulseVoltammetryElement.h>
```

Public Member Functions

- AisDiffPulseVoltammetryElement (double startVoltage, double endVoltage, double voltageStep, double pulseHeight, double pulseWidth, double pulsePeriod, double approxMaxCurrent)

  the differential pulse element constructor.
- AisDiffPulseVoltammetryElement (double startVoltage, double endVoltage, double voltageStep, double pulseHeight, double pulseWidth, double pulsePeriod)

  the differential pulse element constructor.
- **AisDiffPulseVoltammetryElement** (const AisDiffPulseVoltammetryElement &)

  copy constructor for the AisDiffPulseVoltammetryElement object.
- AisDiffPulseVoltammetryElement & **operator=** (const AisDiffPulseVoltammetryElement &)

  overload equal to operator for the AisDiffPulseVoltammetryElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the quiet time sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartVoltage () const

  get the value set for the start voltage.
- void setStartVoltage (double startVoltage)

  set the value for the start voltage.
- bool isStartVoltageVsOCP () const

  tells whether the starting potential is set against the open-circuit voltage or the reference terminal.
- void setStartVoltageVsOCP (bool startVoltageVsOCP)

  set whether to reference the starting potential against the open-circuit voltage or the reference terminal.
- double getEndVoltage () const

  get the value set for the ending potential value.
- void setEndVoltage (double endVoltage)

  set the ending potential value.
- bool isEndVoltageVsOCP () const

  tells whether the end voltage is set with respect to the open circuit voltage or the reference terminal.
- void setEndVoltageVsOCP (bool endVoltageVsOCP)

  set whether to reference the end voltage against the open-circuit voltage or the reference terminal.
- double getVStep () const

get the value set for the potential step.
- void setVStep (double vStep)

  set the value for the potential step.
- double getPulseHeight () const

  get the value set for the pulse height.
- void setPulseHeight (double pulseHeight)

  set the value for the pulse height.
- double getPulseWidth () const

  get the value set for the pulse width.
- void setPulseWidth (double pulseWidth)

  set the value for the pulse width.
- double getPulsePeriod () const

  get the value set for the pulse period.
- void setPulsePeriod (double pulsePeriod)

  set the value for the pulse period.
- bool isAutoRange () const

  tells whether the current range is set to auto-select or not.
- void setAutoRange ()

  set to auto-select the current range.
- double getApproxMaxCurrent () const

  get the value set for the expected maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  set maximum current expected, for manual current range selection.
- double getAlphaFactor () const

  Get the value set for the alpha factor.
- void setAlphaFactor (double alphaFactor)

  alpha factor controls the percentage of data sampled during a given interval. Data will be averaged over the last n% of the sampling interval.

16.13.1 Constructor & Destructor Documentation

16.13.1.1 AisDiffPulseVoltammetryElement() [1/2]

```
AisDiffPulseVoltammetryElement::AisDiffPulseVoltammetryElement (
              double startVoltage,
              double endVoltage,
              double voltageStep,
              double pulseHeight,
              double pulseWidth,
              double pulsePeriod,
              double approxMaxCurrent)  [explicit]
```

Parameters

startVoltage	the value of the starting potential in volts
endVoltage	the value of the ending potential in volts
voltageStep	the value set for the voltage step in volts.
pulseHeight	the value for the pulse height in volts.
pulseWidth	the value for the pulse width in seconds.
pulsePeriod	the value for the pulse period in seconds.
approxMaxCurrent	the value for the approximate maximum current in amperes.

16.13.1.2 AisDiffPulseVoltammetryElement() [2/2]

```
AisDiffPulseVoltammetryElement::AisDiffPulseVoltammetryElement (
            double startVoltage,
            double endVoltage,
            double voltageStep,
            double pulseHeight,
            double pulseWidth,
            double pulsePeriod)  [explicit]
```

Parameters

startVoltage	the value of the starting potential in volts
endVoltage	the value of the ending potential in volts
voltageStep	the value set for the voltage step in volts.
pulseHeight	the value for the pulse height in volts.
pulseWidth	the value for the pulse width in seconds.
pulsePeriod	the value for the pulse period in seconds.

16.13.2 Member Function Documentation

16.13.2.1 getAlphaFactor()

```
double AisDiffPulseVoltammetryElement::getAlphaFactor () const
```

Returns

The value for the alpha factor is represented as a percent between 0 and 100.

Note

If nothing is set, this function will return a default value of 75.

16.13.2.2 getApproxMaxCurrent()

```
double AisDiffPulseVoltammetryElement::getApproxMaxCurrent () const
```

Returns

the value set for the expected maximum current in Amps.

Note

if nothing was manually set, the device will auto-select the current range and the return value will be positive infinity.

16.13.2.3 getCategory()

```
QStringList AisDiffPulseVoltammetryElement::getCategory () const [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control", "Basic Voltammetry", "Pulse Voltammetry").

16.13.2.4 getEndVoltage()

```
double AisDiffPulseVoltammetryElement::getEndVoltage () const
```

This is the value of the voltage at which the experiment will stop.

Returns

the value set for the ending voltage in volts.

16.13.2.5 getName()

```
QString AisDiffPulseVoltammetryElement::getName () const [override]
```

Returns

The name of the element: "Differential Pulse Potential Voltammetry".

16.13.2.6 getPulseHeight()

```
double AisDiffPulseVoltammetryElement::getPulseHeight () const
```

Returns

the value set for the pulse height in volts.

See also

setPulseHeight

16.13.2.7 getPulsePeriod()

```
double AisDiffPulseVoltammetryElement::getPulsePeriod () const
```

Returns

the value set for the pulse period in seconds.

See also

setPulsePeriod

Examples

pulseData.cpp.

16.13.2.8 getPulseWidth()

```
double AisDiffPulseVoltammetryElement::getPulseWidth () const
```

Returns

the value set for the pulse width in seconds.

See also

setPulseWidth

Examples

pulseData.cpp.

16.13.2.9 getQuietTime()

```
double AisDiffPulseVoltammetryElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.13.2.10 getQuietTimeSamplingInterval()

```
double AisDiffPulseVoltammetryElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.13.2.11 getStartVoltage()

```
double AisDiffPulseVoltammetryElement::getStartVoltage () const
```

Returns

the value of the start voltage in volts.

16.13.2.12 getVStep()

```
double AisDiffPulseVoltammetryElement::getVStep () const
```

Returns

the value set for the potential step in volts.

See also

setVStep

16.13.2.13 isAutoRange()

```
bool AisDiffPulseVoltammetryElement::isAutoRange () const
```

Returns

true if the current range is set to auto-select and false if a rage has been selected.

Deprecated This function is deprecated and no longer supports auto range for this element. Specify the current using setApproxMaxCurrent(). The device will determine the appropriate range based on the current value.

16.13.2.14 isEndVoltageVsOCP()

```
bool AisDiffPulseVoltammetryElement::isEndVoltageVsOCP () const
```

Returns

true if the end voltage is set with respect to the open-circuit voltage and false if set against the reference terminal.

See also

setEndVoltageVsOCP

16.13.2.15 isStartVoltageVsOCP()

```
bool AisDiffPulseVoltammetryElement::isStartVoltageVsOCP () const
```

Returns

true if the starting potential is set against the open-circuit voltage and false if it is set against the reference terminal.

See also

setStartVoltageVsOCP

16.13.2.16 setAlphaFactor()

```
void AisDiffPulseVoltammetryElement::setAlphaFactor (
             double alphaFactor)
```

This is an **optional** parameter. If nothing is set, the device will use the default value of 75.

Parameters

alphaFactor	the value for the alphaFactor ranges from 0 to 100.

16.13.2.17 setApproxMaxCurrent()

```
void AisDiffPulseVoltammetryElement::setApproxMaxCurrent (
             double approxMaxCurrent)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the current range.

Parameters

approxMaxCurrent	the value for the maximum current expected in Amps.

Examples

pulseData.cpp.

16.13.2.18 setAutoRange()

```
void AisDiffPulseVoltammetryElement::setAutoRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

Deprecated This function is deprecated. Use setApproxMaxCurrent() to specify the current range instead.

16.13.2.19 setEndVoltage()

```
void AisDiffPulseVoltammetryElement::setEndVoltage (
             double endVoltage)
```

This is the value of the voltage at which the experiment will stop.

Parameters

endVoltage	the value to set for the ending voltage in volts.

16.13.2.20 setEndVoltageVsOCP()

```
void AisDiffPulseVoltammetryElement::setEndVoltageVsOCP (
             bool endVoltageVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

endVoltageVsOCP	true to set the end voltage to be referenced against the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

Examples

pulseData.cpp.

16.13.2.21 setPulseHeight()

```
void AisDiffPulseVoltammetryElement::setPulseHeight (
            double pulseHeight)
```

For the first pulse, the pulse height is added to the starting potential. For the next pulse, the pulse height is added to the potential voltage and the potential step. In general, the pulse height is added to the potential step and the starting voltage of the last pulse.

Parameters

pulseHeight	the value to set for the pulse height in volts.

16.13.2.22 setPulsePeriod()

```
void AisDiffPulseVoltammetryElement::setPulsePeriod (
            double pulsePeriod)
```

The pulse period is the time spent between the starts of two consecutive pulses.

Parameters

pulsePeriod	the value to set for the pulse period in seconds.

16.13.2.23 setPulseWidth()

```
void AisDiffPulseVoltammetryElement::setPulseWidth (
            double pulseWidth)
```

The pulse width is the value in seconds for the time spent at the same voltage set for the pulse height.

Parameters

pulseWidth	the value to set for the pulse width in seconds.

See also

setPulseHeight

16.13.2.24 setQuietTime()

```
void AisDiffPulseVoltammetryElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.13.2.25 setQuietTimeSamplingInterval()

```
void AisDiffPulseVoltammetryElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.13.2.26 setStartVoltage()

```
void AisDiffPulseVoltammetryElement::setStartVoltage (
            double startVoltage)
```

Parameters

startVoltage	the value of the start voltage in volts

16.13.2.27 setStartVoltageVsOCP()

```
void AisDiffPulseVoltammetryElement::setStartVoltageVsOCP (
            bool startVoltageVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

startVoltageVsOCP	true to if the starting potential is set to reference the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

Examples

pulseData.cpp.

16.13.2.28 setVStep()

```
void AisDiffPulseVoltammetryElement::setVStep (
            double vStep)
```

The potential step is the difference between the starting potential of two consecutive pulses.

Parameters

vStep	the value to set for the potential step in volts.

Note

Regardless of vStep's sign, the device will determine the step direction based on the start and end voltage.

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

- AisDiffPulseVoltammetryElement.h

16.14 AisEISGalvanostaticElement Class Reference

This experiment records the complex impedance of the experimental cell in galvanostatic mode, starting from the **start frequency** and sweeping through towards the **end frequency**, with a fixed number of frequency **steps per decade**.

```
#include <AisEISGalvanostaticElement.h>
```

```
#include <AisEISGalvanostaticElement.h>
```

Public Member Functions

- AisEISGalvanostaticElement (double startFrequency, double endFrequency, double stepsPerDecade, double currentBias, double currentAmplitude)

  the EIS galvanostatic element constructor.
- **AisEISGalvanostaticElement** (const AisEISGalvanostaticElement &)

  copy constructor for the AisEISGalvanostaticElement object.
- AisEISGalvanostaticElement & **operator=** (const AisEISGalvanostaticElement &)

  overload equal to operator for the AisEISGalvanostaticElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the quiet time sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartFreq () const

  get the value set for the current starting frequency
- void setStartFreq (double startFreq)

  set the value for the current starting frequency.
- double getEndFreq () const

the value set for the current ending frequency.
- void setEndFreq (double endFreq)

  set the value for the current end frequency.
- double getStepsPerDecade () const

  get the value set for the current frequency steps per decade.
- void setStepsPerDecade (double stepsPerDecade)

  set the number of the current frequency steps per decade.
- double getBiasCurrent () const

  get the value set for the DC bias (DC offset).
- void setBiasCurrent (double biasCurrent)

  set the value for the DC bias (DC offset).
- double getAmplitude () const

  the value to set for the AC current amplitude.
- void setAmplitude (double amplitude)

  set the value for the AC current amplitude.
- unsigned int getMinimumCycles () const

  get the minimum number of periods of applied sinusoidal current to sample at each frequency.
- void setMinimumCycles (unsigned int numberOfCycle)

  set the minimum number of periods of applied sinusoidal current to sample at each frequency.

16.14.1 Constructor & Destructor Documentation

16.14.1.1 AisEISGalvanostaticElement()

```
AisEISGalvanostaticElement::AisEISGalvanostaticElement (
            double startFrequency,
            double endFrequency,
            double stepsPerDecade,
            double currentBias,
            double currentAmplitude)  [explicit]
```

Parameters

startFrequency	the value for the current starting frequency
endFrequency	the value for the current ending frequency
stepsPerDecade	the value for the current frequency steps per decade.
currentBias	the value for the DC bias (DC offset).
currentAmplitude	the AC current amplitude.

16.14.2 Member Function Documentation

16.14.2.1 getAmplitude()

```
double AisEISGalvanostaticElement::getAmplitude () const
```

Returns

the value set for the AC current amplitude in Amps.

16.14.2.2 getBiasCurrent()

```
double AisEISGalvanostaticElement::getBiasCurrent () const
```

Returns

the value set for the DC bias in Amps.

16.14.2.3 getCategory()

```
QStringList AisEISGalvanostaticElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Galvanostatic Control", "Impedance Methods", "Basic Experiments").

16.14.2.4 getEndFreq()

```
double AisEISGalvanostaticElement::getEndFreq () const
```

Returns

the value set for the current end frequency in Hz

16.14.2.5 getMinimumCycles()

```
unsigned int AisEISGalvanostaticElement::getMinimumCycles () const
```

Returns

get number of cycles to sample at each frequency.

16.14.2.6 getName()

```
QString AisEISGalvanostaticElement::getName () const  [override]
```

Returns

The name of the element: "Galvanostatic EIS".

16.14.2.7 getQuietTime()

```
double AisEISGalvanostaticElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.14.2.8 getQuietTimeSamplingInterval()

```
double AisEISGalvanostaticElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.14.2.9 getStartFreq()

```
double AisEISGalvanostaticElement::getStartFreq () const
```

Returns

the value set for the current start frequency in Hz?

16.14.2.10 getStepsPerDecade()

```
double AisEISGalvanostaticElement::getStepsPerDecade () const
```

Returns

the value set for the current frequency steps per decade. This is unit-less.

16.14.2.11 setAmplitude()

```
void AisEISGalvanostaticElement::setAmplitude (
             double amplitude)
```

Parameters

amplitude	the value to set for the AC current amplitude in Amps.

16.14.2.12 setBiasCurrent()

```
void AisEISGalvanostaticElement::setBiasCurrent (
             double biasCurrent)
```

Parameters

biasCurrent	the value to set for the DC bias in Amps.

16.14.2.13 setEndFreq()

```
void AisEISGalvanostaticElement::setEndFreq (
             double endFreq)
```

Parameters

endFreq	the value to set for the current end frequency in Hz

16.14.2.14 setMinimumCycles()

```
void AisEISGalvanostaticElement::setMinimumCycles (
            unsigned int numberOfCycle)
```

Parameters

numberOfCycle	number of cycles to sample at each frequency.

16.14.2.15 setQuietTime()

```
void AisEISGalvanostaticElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.14.2.16 setQuietTimeSamplingInterval()

```
void AisEISGalvanostaticElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.14.2.17 setStartFreq()

```
void AisEISGalvanostaticElement::setStartFreq (
            double startFreq)
```

Parameters

startFreq	the value to set the current starting frequency in Hz

16.14.2.18 setStepsPerDecade()

```
void AisEISGalvanostaticElement::setStepsPerDecade (
            double stepsPerDecade)
```

Parameters

stepsPerDecade	the value to set for the number of steps per decade.

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

- AisEISGalvanostaticElement.h

16.15 AisEISPotentiostaticElement Class Reference

This experiment records the complex impedance of the experimental cell in potentiostatic mode, starting from the **start frequency** and sweeping through towards the **end frequency**, with a fixed number of frequency **steps per decade**.

```
#include <AisEISPotentiostaticElement.h>
```

```
#include <AisEISPotentiostaticElement.h>
```

Public Member Functions

- AisEISPotentiostaticElement (double startFrequency, double endFrequency, double stepsPerDecade, double voltageBias, double voltageAmplitude)

  the EIS potentiostatic element
- **AisEISPotentiostaticElement** (const AisEISPotentiostaticElement &)

  copy constructor for the AisEISPotentiostaticElement object.
- AisEISPotentiostaticElement & **operator=** (const AisEISPotentiostaticElement &)

  overload equal to operator for the AisEISPotentiostaticElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the quiet time sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartFreq () const

  get the value set for the voltage starting frequency
- void setStartFreq (double startFreq)

  set the value for the voltage starting frequency.
- double getEndFreq () const

  the value set for the voltage ending frequency.
- void setEndFreq (double endFreq)

  set the value for the voltage end frequency.
- double getStepsPerDecade () const

get the value set for the voltage frequency steps per decade.

- void setStepsPerDecade (double stepsPerDecade)

  set the number of the voltage frequency steps per decade.
- double getBiasVoltage () const

  get the value set for the DC bias (DC offset).
- void setBiasVoltage (double biasVoltage)

  set the value for the DC bias (DC offset).
- bool isBiasVoltageVsOCP () const

  tells whether the DC-bias voltage is referenced against the open-circuit voltage or the reference cable.
- void setBiasVoltageVsOCP (bool biasVsOCP)

  set whether to reference the DC-bias voltage against the open-circuit voltage or the reference terminal.
- double getAmplitude () const

  the value to set for the AC voltage amplitude.
- void setAmplitude (double amplitude)

  set the value for the AC voltage amplitude.
- unsigned int getMinimumCycles () const

  get the minimum number of periods of applied sinusoidal voltage to sample at each frequency.
- void setMinimumCycles (unsigned int numberOfCycle)

  set the minimum number of periods of applied sinusoidal voltage to sample at each frequency.

16.15.1 Constructor & Destructor Documentation

16.15.1.1 AisEISPotentiostaticElement()

```
AisEISPotentiostaticElement::AisEISPotentiostaticElement (
                double startFrequency,
                double endFrequency,
                double stepsPerDecade,
                double voltageBias,
                double voltageAmplitude)  [explicit]
```

Parameters

startFrequency	the value for the voltage starting frequency
endFrequency	the value for the voltage ending frequency
stepsPerDecade	the value for the voltage frequency steps per decade.
voltageBias	the value for the DC bias (DC offset).
voltageAmplitude	the AC voltage amplitude.

16.15.2 Member Function Documentation

16.15.2.1 getAmplitude()

```
double AisEISPotentiostaticElement::getAmplitude () const
```

Returns

the value set for the AC voltage amplitude in volts.

16.15.2.2 getBiasVoltage()

```
double AisEISPotentiostaticElement::getBiasVoltage () const
```

Returns

the value set for the DC bias in volts.

16.15.2.3 getCategory()

```
QStringList AisEISPotentiostaticElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control", "Impedance Methods", "Basic Experiments").

16.15.2.4 getEndFreq()

```
double AisEISPotentiostaticElement::getEndFreq () const
```

Returns

the value set for the voltage end frequency in Hz

16.15.2.5 getMinimumCycles()

```
unsigned int AisEISPotentiostaticElement::getMinimumCycles () const
```

Returns

get number of cycles to sample at each frequency.

16.15.2.6 getName()

```
QString AisEISPotentiostaticElement::getName () const  [override]
```

Returns

The name of the element: "Potentiostatic EIS".

16.15.2.7 getQuietTime()

```
double AisEISPotentiostaticElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.15.2.8 getQuietTimeSamplingInterval()

```
double AisEISPotentiostaticElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.15.2.9 getStartFreq()

```
double AisEISPotentiostaticElement::getStartFreq () const
```

Returns

the value set for the start frequency in Hz

16.15.2.10 getStepsPerDecade()

```
double AisEISPotentiostaticElement::getStepsPerDecade () const
```

Returns

the value set for the frequency steps per decade. This is unit-less.

16.15.2.11 isBiasVoltageVsOCP()

```
bool AisEISPotentiostaticElement::isBiasVoltageVsOCP () const
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Returns

true if the DC-bias voltage is set against the open-circuit voltage and false if it is set against the reference terminal.

16.15.2.12 setAmplitude()

```
void AisEISPotentiostaticElement::setAmplitude (
            double amplitude)
```

Parameters

amplitude	the value to set for the AC voltage amplitude in volts.

16.15.2.13 setBiasVoltage()

```
void AisEISPotentiostaticElement::setBiasVoltage (
            double biasVoltage)
```

Parameters

biasVoltage	the value to set for the DC bias in volts.

16.15.2.14 setBiasVoltageVsOCP()

```
void AisEISPotentiostaticElement::setBiasVoltageVsOCP (
            bool biasVsOCP)
```

Parameters

biasVsOCP	true to if the DC-bias voltage is set to reference the open-circuit voltage and false if set against the reference terminal.

16.15.2.15 setEndFreq()

```
void AisEISPotentiostaticElement::setEndFreq (
            double endFreq)
```

Parameters

endFreq	the value to set for the voltage end frequency in Hz

16.15.2.16 setMinimumCycles()

```
void AisEISPotentiostaticElement::setMinimumCycles (
            unsigned int numberOfCycle)
```

Parameters

numberOfCycle	number of cycles to sample at each frequency.

16.15.2.17 setQuietTime()

```
void AisEISPotentiostaticElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.15.2.18 setQuietTimeSamplingInterval()

```
void AisEISPotentiostaticElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.15.2.19 setStartFreq()

```
void AisEISPotentiostaticElement::setStartFreq (
            double startFreq)
```

Parameters

startFreq	the value to set the starting frequency Hz

16.15.2.20 setStepsPerDecade()

```
void AisEISPotentiostaticElement::setStepsPerDecade (
            double stepsPerDecade)
```

Parameters

stepsPerDecade	the value to set for the number of steps per decade.

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

- AisEISPotentiostaticElement.h

16.16 AisErrorCode Class Reference

This class contains the possible error codes returned to the user when working with the API. Error codes can help diagnose issues such as invalid parameters, communication failures, or device malfunctions. By handling errors properly, you can ensure reliable operation of your experiments.

```
#include <AisErrorCode.h>
```

```
#include <AisErrorCode.h>
```

Public Types

- enum ErrorCode : uint8_t {
  Unknown = 255 , Success = 0 , ConnectionFailed = 1 , FirmwareNotSupported = 2 ,
  FirmwareFileNotFound = 3 , **FirmwareUptodate** = 4 , InvalidChannel = 10 , BusyChannel = 11 ,
  DeviceNotFound = 13 , FeatureNotSupported = 14 , ManualExperimentNotRunning = 51 , ExperimentNotUploaded = 52 ,
  ExperimentIsEmpty = 53 , InvalidParameters = 54 , ChannelNotBusy = 55 , ExperimentUploaded = 56 ,
  DeviceCommunicationFailed = 100 , FailedToSetManualModeCurrentRange = 101 , FailedToSetManualModeConstantVoltage = 102 , FailedToPauseExperiment = 103 ,
  FailedToResumeExperiment = 104 , FailedToStopExperiment = 105 , FailedToUploadExperiment = 106 , ExperimentAlreadyPaused = 107 ,
  ExperimentAlreadyRun = 108 , **FailedToSetManualModeVoltageRange** = 109 , FailedToSetManualModeConstantCurrent = 110 , FailedToSetManualModeInOCP = 111 ,
  FailedToSetManualModeSamplingInterval = 112 , FailedToSetIRComp = 113 , FailedToSetCompRange = 114 , FailedToSetChannelMaximumVoltage = 115 ,
  FailedToSetChannelMinimumVoltage = 116 , FailedToSetChannelMaximumCurrent = 117 , FailedToSetChannelMinimumCurren = 118 , FailedToSetChannelMinimumTemperature = 119 ,
  FailedRequest = 254 }

  The possible error codes that can be returned to the user.

Public Member Functions

- QString message () const

  a function to get a message explaining the error.
- int value () const

  a function to get the error code.

16.16.1 Member Enumeration Documentation

16.16.1.1 ErrorCode

```
enum AisErrorCode::ErrorCode : uint8_t
```

Enumerator

Unknown	indicates that the command failed for an unknown reason.
Success	indicates success.
ConnectionFailed	indicates failure connecting the plugged in device when calling AisDeviceTracker::connectToDeviceOnComPort.
FirmwareNotSupported	indicates failure connecting the plugged in device when calling AisDeviceTracker::connectToDeviceOnComPort because firmware update require.
InvalidChannel	indicates that the given channel number is not valid.
BusyChannel	indicates that the failure was due to the channel being busy.
DeviceNotFound	indicates that no device was detected to be connected.
FeatureNotSupported	indicates that the feature is not available on the device.
ManualExperimentNotRunning	indicates that the given command applies when there is a manual experiment running on the channel but there is none.
ExperimentNotUploaded	indicates that the given command applies when an experiment has already been uploaded to the channel but there is none.
ExperimentIsEmpty	indicates that the given experiment has no elements. It need to contain at least one.

Enumerator

InvalidParameters	indicates that a given parameter is invalid. For example, it is out of the allowed range.
ChannelNotBusy	indicates that the given command applies when there is an experiment running or paused on the channel but there is none.
ExperimentUploaded	indicates that the given command could not be completed because an experiment is already uploaded to the channel.
DeviceCommunicationFailed	indicates that there was failure in communication with the device.
FailedToSetManualModeCurrentRange	indicates failure to set manual mode current range due to a possible communication failure with the device.
FailedToSetManualModeConstantVoltage	indicates failure to set manual mode constant voltage due to a possible communication failure with the device
FailedToPauseExperiment	indicates that pausing the experiment failed because either there is no active experiment or due to a possible communication failure with the device.
FailedToResumeExperiment	indicates that resuming the experiment failed because either there is no paused experiment or due to a possible communication failure with the device.
FailedToStopExperiment	indicates that stopping the experiment failed because either there is no experiment running, the experiment is paused, or due to a possible communication failure with the device.
FailedToUploadExperiment	indicates failure to communicate with the device to upload the experiment.
ExperimentAlreadyPaused	indicates that pausing the experiment failed because the experiment is already paused.
ExperimentAlreadyRun	indicates that resuming the experiment failed because an experiment is already running.
FailedToSetManualModeConstantCurrent	indicates failure to set manual mode constant current due to a possible communication failure with the device.
FailedToSetManualModeInOCP	indicates failure of setting manual mode in open circuit mode for possible communication failure with the device.
FailedToSetManualModeSamplingInterval	indicates failure of setting manual mode sampling interval. possible communication failure with the device.
FailedToSetIRComp	indicates failure of setting IR Compensation. Possible communication failure with the device.
FailedToSetCompRange	indicates failure of setting Compensation Range. Possible communication failure with the device.
FailedToSetChannelMaximumVoltage	indicates failure of setting Channel Maximum Voltage. Possible communication failure with the device.
FailedToSetChannelMinimumVoltage	indicates failure of setting Channel Minimum Voltage. Possible communication failure with the device.
FailedToSetChannelMaximumCurrent	indicates failure of setting Channel Maximum Current. Possible communication failure with the device.
FailedToSetChannelMinimumCurrent	indicates failure of setting Channel Minimum Current. Possible communication failure with the device.
FailedToSetChannelMinimumTemperature	indicates failure of setting Channel Maximum Temperature. Possible communication failure with the device.

16.16.2 Member Function Documentation

16.16.2.1 message()

```
QString AisErrorCode::message () const
```

Returns

a message that explains the error.

16.16.2.2 value()

```
int AisErrorCode::value () const
```

Returns

the error code

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

- AisErrorCode.h

16.17 AisExperiment Class Reference

this class is used to create custom experiments. A custom experiment contains one or more elements. Once you create elements and set their parameters, you can add them to the container.

```
#include <AisExperiment.h>
```

```
#include <AisExperiment.h>
```

Public Member Functions

- **AisExperiment** ()

  this is the default constructor for the custom experiment.
- AisExperiment (const AisExperiment &exp)

  this is the copy constructor for the custom experiment.
- void operator= (const AisExperiment &exp)

  the assignment operator for the custom experiment.
- QString getExperimentName () const

  get the name of the custom experiment.
- QString getDescription () const

  get a brief description of the custom experiment.
- QStringList getCategory () const

  get the category for the custom experiment.
- void setExperimentName (QString name)

  set a name for the custom experiment.
- void setDescription (QString description)

  set a description for the experiment.
- bool appendElement (AisAbstractElement &element, unsigned int repeat=1)

  Append an element to this experiment.
- bool appendSubExperiment (const AisExperiment &subExp, unsigned int repeat=1)

  Append a sub experiment to this experiment.

Friends

- class **AisInstrumentHandler**

16.17.1 Constructor & Destructor Documentation

16.17.1.1 AisExperiment()

```
AisExperiment::AisExperiment (
            const AisExperiment & exp)  [explicit]
```

Parameters

exp	the custom experiment to copy from.

16.17.2 Member Function Documentation

16.17.2.1 appendElement()

```
bool AisExperiment::appendElement (
            AisAbstractElement & element,
            unsigned int repeat = 1)
```

Parameters

element	The experiment element to be appended to this experiment.
repeat	The number of times this element will be repeated. This is an optional parameter with a default value of 1. The minimum value is 1. If smaller the function will not append the node to the experiment. The maximum value is 65535. The function will clamp any value greater than this to 65535, and it will append the node to the experiment.

Returns

true if the element was appended to the experiment and **false** otherwise.

Note

Although an element is an experiment, in the context of custom experiments, it is referred to as an element to make a distinction between the two. In other contexts where such distinction is not needed, an element may still be referred to as an experiment.

16.17.2.2 appendSubExperiment()

```
bool AisExperiment::appendSubExperiment (
            const AisExperiment & subExp,
            unsigned int repeat = 1)
```

Parameters

subExp	A sub experiment to be appended to this experiment.
repeat	The number of times this sub experiment will be repeated. This is an optional parameter with a default value of 1. The minimum value is 1. If smaller, the function will not append the sub experiment to the experiment The maximum value is 65535. The function will clamp any value greater than this to 65535, and it will append the **sub experiment** to the experiment.

Returns

true if the sub experiment was appended to the experiment and **false** otherwise.

16.17.2.3 getCategory()

```
QStringList AisExperiment::getCategory () const
```

Returns

the category set for the custom experiment. If no category has been set, the default category returned is ("Custom").

16.17.2.4 getDescription()

```
QString AisExperiment::getDescription () const
```

Returns

the description set for the custom experiment. If no description has been set, the default description returned is "Not Defined".

16.17.2.5 getExperimentName()

```
QString AisExperiment::getExperimentName () const
```

Returns

the name set for the custom experiment. If no name has been set, the default name returned is "Custom Experiment"

16.17.2.6 operator=()

```
void AisExperiment::operator= (
            const AisExperiment & exp)
```

Parameters

exp	the custom experiment to copy from.

16.17.2.7 setDescription()

```
void AisExperiment::setDescription (
            QString description)
```

Parameters

description	the description to be set for the custom experiment.

16.17.2.8 setExperimentName()

```
void AisExperiment::setExperimentName (
            QString name)
```

Parameters

name	the name to be set for the custom experiment.

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

- AisExperiment.h

16.18 AisExperimentNode Struct Reference

A structure containing some information regarding the running element.

```
#include <AisDataPoints.h>
```

```
#include <AisDataPoints.h>
```

Public Attributes

- QString **stepName**

  This is the name of the current element running.
- int **stepNumber**

  this number is the order of the element within the custom experiment.
- int **substepNumber**

  this number is the order of the step within the element.
- int **cycle**

  this number is cycle within the element.

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

- AisDataPoints.h

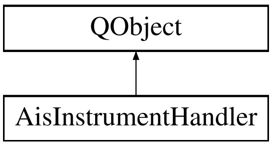
16.19 AisInstrumentHandler Class Reference

this class provides control of the device including starting, pausing, resuming and stopping an experiment on a channel as well as reading the data and other controls of the device.

```
#include <AisInstrumentHandler.h>
```

#include <AisInstrumentHandler.h>

Inheritance diagram for AisInstrumentHandler:



Signals

- void **deviceDisconnected** ()

  a signal that is emitted if the device associated with this handler has been disconnected.
- void groundFloatStateChanged (bool grounded)

  a signal that is emitted when the floating ground connection state has changed.
- void experimentNewElementStarting (uint8_t channel, const AisExperimentNode &stepInfo)

  a signal that is emitted whenever a new elemental experiment has started.
- void activeDCDataReady (uint8_t channel, const AisDCData &DCData)

  a signal that is emitted whenever new DC data for an active experiment are ready.
- void idleDCDataReady (uint8_t channel, const AisDCData &DCData)

  a signal that is emitted whenever new DC data are ready when the device is in an idle state.
- void recoveryDCDataReady (uint8_t channel, const AisDCData &DCData)

  a signal that is emitted whenever new DC recovery data are ready.
- void activeACDataReady (uint8_t channel, const AisACData &ACData)

  a signal that is emitted whenever new AC data for an active experiment are ready.
- void recoveryACDataReady (uint8_t channel, const AisACData &ACData)

  a signal that is emitted whenever new AC recovery data are ready.
- void experimentStopped (uint8_t channel, const QString &reason)

  a signal that is emitted whenever an experiment was stopped manually or has completed.
- void experimentPaused (uint8_t channel)

  a signal that is emitted whenever an experiment was paused.
- void experimentResumed (uint8_t channel)

  a signal that is emitted whenever an experiment was resumed.
- void recoverDataErased (bool successful)

  a signal that is emitted whenever data erase process is completed.
- void deviceError (uint8_t channel, const QString &error)

  a signal that is emitted whenever device send any critical error.

Public Member Functions

- AisErrorCode uploadExperimentToChannel (uint8_t channel, std::shared_ptr< AisExperiment > experiment) const

  upload an already created custom experiment to a specific channel on the device.
- AisErrorCode uploadExperimentToChannel (uint8_t channel, const AisExperiment &experiment) const

  upload an already created custom experiment to a specific channel on the device.
- AisErrorCode startUploadedExperiment (uint8_t channel) const

  start the previously uploaded experiment on the specific channel.
- AisErrorCode startIdleSampling (uint8_t channel) const

  start idle sampling when an experiment is neither uploaded nor running on the specified channel.
- AisErrorCode skipExperimentStep (uint8_t channel) const

  skip the current experiment step and proceed to the next.
- AisErrorCode pauseExperiment (uint8_t channel) const

  pause a running experiment on the channel.
- AisErrorCode resumeExperiment (uint8_t channel) const

  resume a paused experiment on the channel.
- AisErrorCode stopExperiment (uint8_t channel) const

  stop a running or a paused experiment on the channel.
- double getExperimentUTCStartTime (uint8_t channel) const

  get UTC time for the start of the experiment in seconds.
- AisErrorCode setIRComp (uint8_t channel, double uncompensatedResistance, double compensationLevel) const

  set IR compensation.
- AisErrorCode setCompRange (uint8_t channel, const AisCompRange &compRange) const

  set a compensation range with stability factor and bandwidth index.
- int8_t setLinkedChannels (std::vector< uint8_t > channels) const

  connect several channels together in parallel mode.
- int8_t setBipolarLinkedChannels (std::vector< uint8_t > channels) const

  connect two channels together in bipolar mode.
- bool hasBipolarMode (uint8_t channel) const

  tells whether the given channel is bipolar mode
- std::vector< uint8_t > getLinkedChannels (uint8_t channel) const

  get a list of channels linked to the given channel.
- AisErrorCode setFanSpeedMaximum () const

  Set the fan speed to maximum when an experiment is active. Only available on some devices.
- AisErrorCode setFanSpeedVariable () const

  Set the fan speed to always adjust automatically based on the internal temperature of the instrument. Only available on some devices.
- bool isChannelBusy (uint8_t channel) const

  tells whether the given channel is busy or not.
- bool isChannelPaused (uint8_t channel) const

  tells whether the given channel has a paused experiment or not.
- std::vector< uint8_t > getFreeChannels () const

  get a list of the currently free channels.
- int getNumberOfChannels () const

  get the number of all the channels on this device.
- AisErrorCode eraseRecoverData () const

  delete the recover data from device.
- AisErrorCode startManualExperiment (uint8_t channel) const

  start a manual experiment.

- AisErrorCode setManualModeSamplingInterval (uint8_t channel, double value) const

  set an interval for sampling the data.
- AisErrorCode setManualModeOCP (uint8_t channel) const

  set open-circuit potential mode.
- AisErrorCode setManualModeConstantVoltage (uint8_t channel, double value) const

  set constant voltage for the manual experiment.
- AisErrorCode setManualModeConstantVoltage (uint8_t channel, double value, int currentRangeIndex) const

  set constant voltage for the manual experiment and also set a manual current range.
- AisErrorCode setManualModeCurrentRange (uint8_t channel, int currentRangeIndex) const

  set the current range for the manual experiment. Once a range is set, autoranging capability is turned off. That means that during potentiostatic control, the current range may range up if necessary, but it will not drop below the user-set range. During galvanostatic control, the lowest current range that contains the designated setpoint will be chosen, provided it is not lower than the user-set range.
- AisErrorCode setManualModeCurrentAutorange (uint8_t channel) const

  enable current autoranging for the manual experiment.
- AisErrorCode setManualModeVoltageRange (uint8_t channel, int voltageRangeIndex) const

  set the voltage range for the manual experiment. Once a range is set, autoranging capability is turned off. That means that during galvanostatic control, the voltage range may range up if necessary, but it will not drop below the user-set range. During potentiostatic control, the lowest voltage range that contains the designated setpoint will be chosen, provided it is not lower than the user-set range.
- AisErrorCode setManualModeVoltageAutorange (uint8_t channel) const

  enable voltage autoranging for the manual experiment.
- AisErrorCode setManualModeConstantCurrent (uint8_t channel, double value) const

  set constant current for the manual experiment.
- std::vector< std::pair< double, double > > getManualModeCurrentRangeList (uint8_t channel) const

  get a list of the applicable current ranges to the given channel specific to your device.
- std::vector< std::pair< double, double > > getManualModeVoltageRangeList (uint8_t channel) const

  get a list of the applicable voltage ranges to the given channel specific to your device.
- AisErrorCode setChannelMaximumVoltage (uint8_t channel, double Vmax) const

  Sets the maximum allowable voltage for a channel. The experiment will stop if the measured voltage exceeds this limit.
- AisErrorCode setChannelMinimumVoltage (uint8_t channel, double Vmin) const

  Sets the minimum allowable voltage for a channel. The experiment will stop if the measured voltage falls below this limit.
- AisErrorCode setChannelMaximumCurrent (uint8_t channel, double Imax) const

  Sets the maximum allowable current for a channel. The experiment will stop if the measured current exceeds this limit.
- AisErrorCode setChannelMinimumCurrent (uint8_t channel, double Imin) const

  Sets the minimum allowable current for a channel. The experiment will stop if the measured current falls below this limit.
- AisErrorCode setChannelMaximumTemperature (uint8_t channel, double MaxTemperature) const

  Sets the maximum allowable temperature for a channel. The experiment will stop if the measured temperature exceeds this limit.
- AisErrorCode resetChannelLimits (uint8_t channel) const

  Resets all limits for the specified channel.

16.19.1 Member Function Documentation

16.19.1.1 activeACDataReady

```
void AisInstrumentHandler::activeACDataReady (
            uint8_t channel,
            const AisACData & ACData)  [signal]
```

Parameters

channel	the channel number from which the AC data arrived.
ACData	the AC data that just arrived.

Examples

basicExperiment.cpp, dataOutput.cpp, nonblockingExperiment.cpp, and pulseData.cpp.

16.19.1.2 activeDCDataReady

```
void AisInstrumentHandler::activeDCDataReady (
            uint8_t channel,
            const AisDCData & DCData)  [signal]
```

Parameters

channel	the channel number from which the DC data arrived.
DCData	the DC data that just arrived.

Examples

advancedExperiment.cpp, basicExperiment.cpp, dataOutput.cpp, linkedChannels.cpp, manualExperiment.cpp, nonblockingExperiment.cpp, and pulseData.cpp.

16.19.1.3 deviceError

```
void AisInstrumentHandler::deviceError (
            uint8_t channel,
            const QString & error)  [signal]
```

Parameters

channel	the channel number at which error rise.
error	information about error message.

Note

stop experiment command will automatilcally send on channel.

Examples

advancedExperiment.cpp, basicExperiment.cpp, linkedChannels.cpp, and manualExperiment.cpp.

16.19.1.4 eraseRecoverData()

```
AisErrorCode AisInstrumentHandler::eraseRecoverData () const
```

Returns

AisErrorCode::Success if request is sucessfully send for delete the data. If not successful, possible returned errors are:

- AisErrorCode::DeviceNotFound
- AisErrorCode::DeviceCommunicationFailed

16.19.1.5 experimentNewElementStarting

```
void AisInstrumentHandler::experimentNewElementStarting (
            uint8_t channel,
            const AisExperimentNode & stepInfo)  [signal]
```

Parameters

channel	the channel number on which the experiment was started.
stepInfo	information regarding the current step.

See also

AisExperimentNode

Examples

advancedExperiment.cpp, basicExperiment.cpp, dataOutput.cpp, nonblockingExperiment.cpp, and pulseData.cpp.

16.19.1.6 experimentPaused

```
void AisInstrumentHandler::experimentPaused (
            uint8_t channel)  [signal]
```

Parameters

channel	the channel on which the experiment was paused.

Examples

pulseData.cpp.

16.19.1.7 experimentResumed

```
void AisInstrumentHandler::experimentResumed (
            uint8_t channel)  [signal]
```

Parameters

channel	the channel on which the experiment was resumed.

Examples

pulseData.cpp.

16.19.1.8 experimentStopped

```
void AisInstrumentHandler::experimentStopped (
            uint8_t channel,
            const QString & reason)  [signal]
```

Parameters

channel	the channel on which the experiment has stopped.
reason	the reason why the experiment has stopped.

Examples

advancedControlFlow.cpp, advancedExperiment.cpp, basicExperiment.cpp, dataOutput.cpp, manualExperiment.cpp, nonblockingExperiment.cpp, and pulseData.cpp.

16.19.1.9 getExperimentUTCStartTime()

```
double AisInstrumentHandler::getExperimentUTCStartTime (
            uint8_t channel) const
```

This will give the time in seconds between the origin of UTC time and the start of the experiment aka Unix Epoch.

Parameters

channel	the channel for which to get the start time of the experiment.

Returns

the Unix Epoch up to the start of the experiment in seconds.

16.19.1.10 getFreeChannels()

```
std::vector< uint8_t > AisInstrumentHandler::getFreeChannels () const
```

Returns

a list of the currently free channels. If all channels are busy, an empty list is returned.

16.19.1.11 getLinkedChannels()

```
std::vector< uint8_t > AisInstrumentHandler::getLinkedChannels (
            uint8_t channel) const
```

Parameters

channel	a valid channel number to find which other channels are linked to it.

Returns

a list of channels linked to the channel parameter.

16.19.1.12 getManualModeCurrentRangeList()

```
std::vector< std::pair< double, double > > AisInstrumentHandler::getManualModeCurrentRange←
List (
            uint8_t channel) const
```

The list is indexed, with each index containing a range with minimum and maximum current for the range. You can pass the index of the desired current range to setManualModeConstantVoltage or setManualModeConstantCurrent.

Parameters

channel	a valid channel number for which to check the current range.

Returns

a list of the of the applicable current ranges to the given channel specific to your device.

16.19.1.13 getManualModeVoltageRangeList()

```
std::vector< std::pair< double, double > > AisInstrumentHandler::getManualModeVoltageRange←
List (
            uint8_t channel) const
```

The list is indexed, with each index containing a range with minimum and maximum voltage for the range. You can pass the index of the desired current range to setManualModeConstantVoltage or setManualModeConstantCurrent.

Parameters

channel	a valid channel number for which to check the current range.

Returns

a list of the of the applicable current ranges to the given channel specific to your device.

16.19.1.14 getNumberOfChannels()

```
int AisInstrumentHandler::getNumberOfChannels () const
```

Returns

the number of channels on the connected device. If no device found, -1 will be returned.

16.19.1.15 groundFloatStateChanged

```
void AisInstrumentHandler::groundFloatStateChanged (
            bool grounded)  [signal]
```

Parameters

grounded	true if there is a connection to ground and false if the ground has disconnected.

16.19.1.16 hasBipolarMode()

```
bool AisInstrumentHandler::hasBipolarMode (
            uint8_t channel) const
```

Parameters

channel	the channel number to check if it is bipolar mode

Returns

true only if given a valid channel number that has bipolar mode.

16.19.1.17 idleDCDataReady

```
void AisInstrumentHandler::idleDCDataReady (
            uint8_t channel,
            const AisDCData & DCData)  [signal]
```

A manual experiment displays real time values. These values are displayed even if the channel does not have an experiment running on it.

Parameters

channel	the channel number from which the DC data arrived.
DCData	the DC data that just arrived.

16.19.1.18 isChannelBusy()

```
bool AisInstrumentHandler::isChannelBusy (
            uint8_t channel) const
```

Parameters

channel	the channel number to check if it is busy or not.

Returns

true only if given a valid channel number that has either a running or a paused experiment.

16.19.1.19 isChannelPaused()

```
bool AisInstrumentHandler::isChannelPaused (
            uint8_t channel) const
```

Parameters

channel	the channel number to check if it has a paused experiment.

Returns

true only if given a valid channel number that has an experiment that has been paused.

16.19.1.20 pauseExperiment()

```
AisErrorCode AisInstrumentHandler::pauseExperiment (
             uint8_t channel) const
```

Parameters

channel	the channel number to pause the experiment on.

Returns

true if an experiment was successfully paused on the channel and false otherwise. If not successful, possible returned errors are:

- AisErrorCode::FailedToPauseExperiment
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::ChannelNotBusy

This will return AisErrorCode::Success only if there is currently a running experiment on a valid channel on a connected device.

16.19.1.21 recoverDataErased

```
void AisInstrumentHandler::recoverDataErased (
             bool successful)  [signal]
```

Parameters

successful	is true on erased correctly, and false on data is not erased.

16.19.1.22 recoveryACDataReady

```
void AisInstrumentHandler::recoveryACDataReady (
             uint8_t channel,
             const AisACData & ACData)  [signal]
```

Parameters

channel	the channel number from which the AC data are recovered from.
ACData	the AC data that just arrived.

16.19.1.23 recoveryDCDataReady

```
void AisInstrumentHandler::recoveryDCDataReady (
             uint8_t channel,
             const AisDCData & DCData)  [signal]
```

Parameters

channel	the channel number from which the DC data are recovered from.
DCData	the DC data that just arrived.

16.19.1.24 resetChannelLimits()

```
AisErrorCode AisInstrumentHandler::resetChannelLimits (
             uint8_t channel) const
```

This function removes all configured voltage, current, and temperature limits for a specific channel, restoring it to its default state.

Parameters

channel	The channel number for which the limits are to be reset.

Returns

AisErrorCode indicating success or failure of the operation.

16.19.1.25 resumeExperiment()

```
AisErrorCode AisInstrumentHandler::resumeExperiment (
             uint8_t channel) const
```

Parameters

channel	the channel number to resume the experiment on.

Returns

AisErrorCode::Success if an experiment was successfully resumed on the channel. If not successful, possible returned errors are:

- AisErrorCode::FailedToResumeExperiment
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::ChannelNotBusy

This will return AisErrorCode::Success only if there is currently a paused experiment on a valid channel on a connected device.

16.19.1.26 setBipolarLinkedChannels()

```
int8_t AisInstrumentHandler::setBipolarLinkedChannels (
             std::vector< uint8_t > channels) const
```

You may combine two channels to expand the voltage range to include negative voltages. Note that this is only applicable to the cycler model. For 4 channel Cycler models, you can combine channels 1 and 2 or channels 3 and 4. You cannot use any other channel combinations.

Parameters

channels	a list of two channels to be oprate in bipolar mode.

Returns

the master channel out of the given list of two channels. The master channel is your interface to upload an experiment to and then control it. If not successful set in bipolar mode, possible returned errors as -1.

Note

this functionality is only applicable to the cycler model.

16.19.1.27 setChannelMaximumCurrent()

```
AisErrorCode AisInstrumentHandler::setChannelMaximumCurrent (
             uint8_t channel,
             double Imax) const
```

Sets the maximum allowable current for a channel. The experiment will stop if the measured current exceeds this limit.

Parameters

channel	The channel number for which the current limit is to be set.
Imax	The maximum allowable current in amperes.

Returns

AisErrorCode indicating success or failure of the operation.

Note

- For Squidstat Cyclers, this limit will not apply to AC elements.
- For all other devices, it is not recommended to use this for AC elements.

16.19.1.28 setChannelMaximumTemperature()

```
AisErrorCode AisInstrumentHandler::setChannelMaximumTemperature (
             uint8_t channel,
             double MaxTemperature) const
```

Sets the maximum allowable temperature for a channel. The experiment will stop if the measured temperature exceeds this limit.

Parameters

channel	The channel number for which the temperature limit is to be set.
MaxTemperature	The maximum allowable temperature in degrees Celsius.

Returns

AisErrorCode indicating success or failure of the operation.

Note

- For Squidstat Cyclers, this limit will not apply to AC elements.

16.19.1.29 setChannelMaximumVoltage()

```
AisErrorCode AisInstrumentHandler::setChannelMaximumVoltage (
              uint8_t channel,
              double Vmax) const
```

Sets the maximum allowable voltage for a channel. The experiment will stop if the measured voltage exceeds this limit.

Parameters

channel	The channel number for which the voltage limit is to be set.
Vmax	The maximum allowable voltage in volts.

Returns

AisErrorCode indicating success or failure of the operation.

Note

- For Squidstat Cyclers, this limit will not apply to AC elements.
- For all other devices, it is not recommended to use this for AC elements.

16.19.1.30 setChannelMinimumCurrent()

```
AisErrorCode AisInstrumentHandler::setChannelMinimumCurrent (
              uint8_t channel,
              double Imin) const
```

Sets the minimum allowable current for a channel. The experiment will stop if the measured current falls below this limit.

Parameters

channel	The channel number for which the current limit is to be set.
Imin	The minimum allowable current in amperes.

Returns

AisErrorCode indicating success or failure of the operation.

Note

- For Squidstat Cyclers, this limit will not apply to AC elements.
- For all other devices, it is not recommended to use this for AC elements.

16.19.1.31 setChannelMinimumVoltage()

```
AisErrorCode AisInstrumentHandler::setChannelMinimumVoltage (
             uint8_t channel,
             double Vmin) const
```

Sets the minimum allowable voltage for a channel. The experiment will stop if the measured voltage falls below this limit.

Parameters

channel	The channel number for which the voltage limit is to be set.
Vmin	The minimum allowable voltage in volts.

Returns

AisErrorCode indicating success or failure of the operation.

Note

- For Squidstat Cyclers, this limit will not apply to AC elements.
- For all other devices, it is not recommended to use this for AC elements.

16.19.1.32 setCompRange()

```
AisErrorCode AisInstrumentHandler::setCompRange (
             uint8_t channel,
             const AisCompRange & compRange) const
```

Parameters

channel	the channel for which to set the compensation range.
compRange	an object of type compRange that is initialized with a stability factor (0-10) and a bandwidth index (0-10).

Returns

AisErrorCode::Success if setting the IR compensation was successful. If not successful, possible returned errors are:

- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::InvalidParameters

See also

AisCompRange

16.19.1.33 setFanSpeedMaximum()

```
AisErrorCode AisInstrumentHandler::setFanSpeedMaximum () const
```

Note

Setting this mode may remove small variations in data caused by fan cycling in some electrochemical systems.

Set the fan speed to maximum when an experiment is active. Only available on some devices.
Model-specific fan behavior:

- Squidstat Cycler: Not available.
- Squidstat Ace, Prime, Solo, and Squidstat Plus (serial numbers below 1700): Always operate in this mode. Fans will turn off when no experiment is running.
- Squidstat Plus (serial numbers 1700 or higher), Squidstat Penta, Decka, and Venta: Default operating mode. Fans will adjust based on the internal temperature of the instrument when no experiment is running.

Return values

AisErrorCode::Success	
AisErrorCode::DeviceNotFound	
AisErrorCode::FeatureNotSupported	
AisErrorCode::DeviceCommunicationFailed	

See also

setFanSpeedVariable

16.19.1.34 setFanSpeedVariable()

```
AisErrorCode AisInstrumentHandler::setFanSpeedVariable () const
```

Set the fan speed to always adjust automatically based on the internal temperature of the instrument. Only available on some devices.
Model-specific fan behavior:

- Squidstat Cycler: Always operates in this mode; no data variances occur from fan cycling.
- Squidstat Ace, Prime, Solo, and Squidstat Plus (serial numbers below 1700): Not available.
- Squidstat Plus (serial numbers 1700 or higher), Squidstat Penta, Decka, and Venta: Available on these models.

Return values

AisErrorCode::Success	
AisErrorCode::DeviceNotFound	
AisErrorCode::FeatureNotSupported	
AisErrorCode::DeviceCommunicationFailed	

See also

setFanSpeedMaximum

16.19.1.35 setIRComp()

```
AisErrorCode AisInstrumentHandler::setIRComp (
             uint8_t channel,
             double uncompensatedResistance,
             double compensationLevel) const
```

Parameters

channel	the channel for which to set the IR compensation.
uncompensatedResistance	the value of the uncompensated resistance in Ohms.
compensationLevel	the compensation percentage (0%-100%). This is unit-less.

Returns

AisErrorCode::Success if setting the IR compensation was successful. If not successful, possible returned errors are:

- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::InvalidParameters

16.19.1.36 setLinkedChannels()

```
int8_t AisInstrumentHandler::setLinkedChannels (
             std::vector< uint8_t > channels) const
```

You may connect a list of channels so you can get a higher combined output current of all channels. Note that this is only applicable to the cycler model.

Parameters

channels	a list of channels to be linked.

Returns

the master channel out of the given list of channels. The master channel is your interface to upload an experiment to and then control it.

Note

this functionality is only applicable to the cycler model.

16.19.1.37 setManualModeConstantCurrent()

```
AisErrorCode AisInstrumentHandler::setManualModeConstantCurrent (
             uint8_t channel,
             double value) const
```

Parameters

channel	a valid channel number to set a constant voltage for.
value	the value to set the constant current in Amps.

Returns

AisErrorCode::Success if setting the constant current was successful. If not successful, possible returned errors are:

- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::DeviceCommunicationFailed
- AisErrorCode::FailedToSetManualModeConstantCurrent

16.19.1.38 setManualModeConstantVoltage() [1/2]

```
AisErrorCode AisInstrumentHandler::setManualModeConstantVoltage (
             uint8_t channel,
             double value) const
```

Parameters

channel	a valid channel number to set a constant voltage for.
value	the value to set the constant voltage in volts.

Returns

AisErrorCode::Success if setting the constant voltage was successful. If not successful, possible returned errors are:

- AisErrorCode::FailedToSetManualModeConstantVoltage
- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel

16.19.1.39 setManualModeConstantVoltage() [2/2]

```
AisErrorCode AisInstrumentHandler::setManualModeConstantVoltage (
             uint8_t channel,
             double value,
             int currentRangeIndex) const
```

Parameters

channel	a valid channel number to set a constant voltage for.
value	the value to set the constant voltage in volts.
currentRangeIndex	the index of the desired current range.

Returns

AisErrorCode::Success if setting the constant voltage was successful. You can get a list of the available ranges for your model by calling getManualModeCurrentRangeList. If not successful, possible returned errors are:

- AisErrorCode::FailedToSetManualModeConstantVoltage
- AisErrorCode::FailedToSetManualModeCurrentRange
- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel

16.19.1.40 setManualModeCurrentAutorange()

```
AisErrorCode AisInstrumentHandler::setManualModeCurrentAutorange (
              uint8_t channel) const
```

Parameters

channel	a valid channel number to enable current autoranging for.

Returns

AisErrorCode::Success if enabling current autoranging successful. If not successful, possible returned errors are:

- AisErrorCode::FailedToSetManualModeCurrentRange
- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel

16.19.1.41 setManualModeCurrentRange()

```
AisErrorCode AisInstrumentHandler::setManualModeCurrentRange (
              uint8_t channel,
              int currentRangeIndex) const
```

Parameters

channel	a valid channel number to set the current range for.
currentRangeIndex	the index of the desired current range.

Returns

AisErrorCode::Success if setting the current range was successful. You can get a list of the available ranges for your model by calling getManualModeCurrentRangeList. If not successful, possible returned errors are:

- AisErrorCode::FailedToSetManualModeCurrentRange
- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel

16.19.1.42 setManualModeOCP()

```
AisErrorCode AisInstrumentHandler::setManualModeOCP (
            uint8_t channel) const
```

To apply the set potential or current, leave the open circuit potential mode off. This operation is reversed automatically when calling either setManualModeConstantVoltage() or setManualModeConstantCurrent()

Parameters

channel	a valid channel number to set open circuit mode on.

Returns

AisErrorCode::Success if turning on the open circuit mode was successful. If not successful, possible returned errors are:

- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::DeviceCommunicationFailed

16.19.1.43 setManualModeSamplingInterval()

```
AisErrorCode AisInstrumentHandler::setManualModeSamplingInterval (
            uint8_t channel,
            double value) const
```

Parameters

channel	the channel to set the sampling interval for.
value	the value for the sampling interval in seconds.

Returns

AisErrorCode::Success if the operation was set successfully. If not successful, possible returned errors are:

- AisErrorCode::DeviceNotFound
- AisErrorCode::Unknown
- AisErrorCode::InvalidChannel

16.19.1.44 setManualModeVoltageAutorange()

```
AisErrorCode AisInstrumentHandler::setManualModeVoltageAutorange (
            uint8_t channel) const
```

Parameters

channel	a valid channel number to enable voltage autoranging for.

Returns

AisErrorCode::Success if enabling voltage autoranging successful. If not successful, possible returned errors are:

- AisErrorCode::FailedToSetManualModeVoltageRange
- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel

16.19.1.45 setManualModeVoltageRange()

```
AisErrorCode AisInstrumentHandler::setManualModeVoltageRange (
            uint8_t channel,
            int voltageRangeIndex) const
```

Parameters

channel	a valid channel number to set the voltage range for.
voltageRangeIndex	the index of the desired voltage range.

Returns

AisErrorCode::Success if setting the voltage rnage was successful. You can get a list of the available ranges for your model by calling getManualModeVoltageRangeList. If not successful, possible returned errors are:

- AisErrorCode::FailedToSetManualModeVoltageRange
- AisErrorCode::ManualExperimentNotRunning
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel

16.19.1.46 skipExperimentStep()

```
AisErrorCode AisInstrumentHandler::skipExperimentStep (
            uint8_t channel) const
```

When running an element that has several steps like going from CC to CV, then skipping the step goes to the next step within the element. When having several elements in the custom experiment and the current element has one step or we are at the last step within the element, then skipping the step results in going to the next element. If this is the final step of the final element, the experiment will stop.

Parameters

channel	a valid channel number with an experiment to skip the step.

Returns

AisErrorCode::Success the experiment step was successfully skipped If not successful, possible returned errors are:

- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::ChannelNotBusy
- AisErrorCode::DeviceCommunicationFailed

16.19.1.47 startIdleSampling()

```
AisErrorCode AisInstrumentHandler::startIdleSampling (
             uint8_t channel) const
```

Parameters

channel	the channel number to start collecting idle data on.

Returns

AisErrorCode::Success if the request to start idle data was sent. If not successful, possible returned errors are:

- AisErrorCode::ExperimentUploaded
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::BusyChannel

See also

isChannelBusy

16.19.1.48 startManualExperiment()

```
AisErrorCode AisInstrumentHandler::startManualExperiment (
             uint8_t channel) const
```

With manual experiments, users can turn on any connected channel and toggle between open circuit mode and voltage or current setpoints that can be changed in real-time and run for indefinite periods.

Parameters

channel	a valid channel number to run the manual experiment on.

Returns

AisErrorCode::Success if the manual experiment was successfully started. If not successful, possible returned errors are:

- AisErrorCode::FailedManualModeStartExperiment
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::BusyChannel

16.19.1.49 startUploadedExperiment()

```
AisErrorCode AisInstrumentHandler::startUploadedExperiment (
             uint8_t channel) const
```

Parameters

channel	the channel number to start the experiment on.

Returns

AisErrorCode::Success if the experiment was successfully started on the channel. If not successful, possible returned errors are:

- AisErrorCode::DeviceCommunicationFailed
- AisErrorCode::ExperimentNotUploaded
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel
- AisErrorCode::BusyChannel

See also

uploadExperimentToChannel
isChannelBusy

16.19.1.50 stopExperiment()

```
AisErrorCode AisInstrumentHandler::stopExperiment (
             uint8_t channel) const
```

Parameters

channel	the channel number to stop the experiment on.

Returns

AisErrorCode::Success if an experiment was successfully stopped on the channel. If not successful, possible returned errors are:

- AisErrorCode::FailedToStopExperiment
- AisErrorCode::DeviceNotFound
- AisErrorCode::InvalidChannel

This will only return AisErrorCode::Success if there is currently a running or a paused experiment on a valid channel on a connected device.

16.19.1.51 uploadExperimentToChannel() [1/2]

```
AisErrorCode AisInstrumentHandler::uploadExperimentToChannel (
             uint8_t channel,
             const AisExperiment & experiment) const
```

Any running experiment is run on a specific device on a specific channel. This function uploads an experiment to a channel so that you may start, pause, resume and stop the experiment. All of these four control functionalities and others require a channel number to control the experiment. Therefore, if we have several channels, we need to keep track of which experiment is on which channel.

Parameters

channel	the channel number to upload the experiment to.
experiment	the custom experiment to be uploaded to the channel.

Returns

> AisErrorCode::Success if the experiment was successfully uploaded to the channel. If not successful, possible returned errors are:
>
> - AisErrorCode::FailedToUploadExperiment
> - AisErrorCode::ExperimentIsEmpty
> - AisErrorCode::DeviceNotFound
> - AisErrorCode::InvalidChannel
> - AisErrorCode::BusyChannel
> - AisErrorCode::InvalidParameters

This returns AisErrorCode::Success only when given a valid channel number that is not busy on a connected device.

See also

> isChannelBusy

16.19.1.52 uploadExperimentToChannel() [2/2]

```
AisErrorCode AisInstrumentHandler::uploadExperimentToChannel (
             uint8_t channel,
             std::shared_ptr< AisExperiment > experiment) const
```

Any running experiment is run on a specific device on a specific channel. This function uploads an experiment to a channel so that you may start, pause, resume and stop the experiment. All of these four control functionalities and others require a channel number to control the experiment. Therefore, if we have several channels, we need to keep track of which experiment is on which channel.

Parameters

channel	the channel number to upload the experiment to.
experiment	the custom experiment to be uploaded to the channel.

Returns

> AisErrorCode::Success if the experiment was successfully uploaded to the channel. If not successful, possible returned errors are:
>
> - AisErrorCode::FailedToUploadExperiment
> - AisErrorCode::ExperimentIsEmpty
> - AisErrorCode::DeviceNotFound
> - AisErrorCode::InvalidChannel
> - AisErrorCode::BusyChannel
> - AisErrorCode::InvalidParameters

This returns AisErrorCode::Success only when given a valid channel number that is not busy on a connected device.

See also

> isChannelBusy

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

- AisInstrumentHandler.h

16.20 AisMottSchottkyElement Class Reference

This class performs Mott-Schottky analysis on the working electrode for a specified range of potentials.

```
#include <AisMottSchottkyElement.h>
```

```
#include <AisMottSchottkyElement.h>
```

Public Member Functions

- AisMottSchottkyElement (double startingPotential, double endingPotential, double voltageStep, double startFrequency, double endFrequency, double stepsPerDecade, double amplitude, unsigned int minCycles)

  Constructor for the Mott-Schottky experiment element.
- AisMottSchottkyElement (const AisMottSchottkyElement &other)

  Copy constructor for the AisMottSchottkyElement object.
- AisMottSchottkyElement & operator= (const AisMottSchottkyElement &other)

  Assignment operator for the AisMottSchottkyElement object.
- ∼**AisMottSchottkyElement** () override

  Destructor for the AisMottSchottkyElement object.
- QString getName () const override

  Get the name of the experiment element.
- QStringList getCategory () const override

  Get a list of applicable categories of the experiment element.
- double getStartingPotential () const

  Get the starting potential for the experiment.
- void setStartingPotential (double startingPotential)

  Set the starting potential for the experiment.
- double getEndingPotential () const

  Get the ending potential for the experiment.
- void setEndingPotential (double endingPotential)

  Set the ending potential for the experiment.
- double getVoltageStep () const

  Get the voltage step size between each potential.
- void setVoltageStep (double voltageStep)

  Set the voltage step size between each potential.
- double getStartFrequency () const

  Get the starting frequency for the EIS measurement.
- void setStartFrequency (double startFrequency)

  Set the starting frequency for the EIS measurement.
- double getEndFrequency () const

  Get the ending frequency for the EIS measurement.
- void setEndFrequency (double endFrequency)

  Set the ending frequency for the EIS measurement.
- double getStepsPerDecade () const

  Get the number of frequency steps per decade.
- void setStepsPerDecade (double stepsPerDecade)

  Set the number of frequency steps per decade.
- double getAmplitude () const

  Get the amplitude of the AC signal used in the EIS measurement.
- void setAmplitude (double amplitude)

Set the amplitude of the AC signal used in the EIS measurement.

- unsigned int getMinCycles () const

  Get the minimum number of cycles per frequency step.
- void setMinCycles (unsigned int minCycles)

  Set the minimum number of cycles per frequency step.
- double getQuietTime () const

  Get the quiet time before starting the EIS measurement.
- void setQuietTime (double quietTime)

  Set the quiet time before starting the EIS measurement.
- double getQuietTimeSampInterval () const

  Get the sampling interval during the quiet time.
- void setQuietTimeSampInterval (double quietTimeSampInterval)

  Set the sampling interval during the quiet time.
- double getStepQuietTime () const

  Get the quiet time after each potential step before starting the EIS measurement.
- void setStepQuietTime (double stepQuietTime)

  Set the quiet time after each potential step before starting the EIS measurement.
- double getStepQuietSampInterval () const

  Get the sampling interval during the quiet time after each potential step.
- void setStepQuietSampInterval (double stepQuietTimeSampInterval)

  Set the sampling interval during the quiet time after each potential step.
- bool isStartVoltageVsOCP () const

  Check if the starting voltage is measured versus the open circuit potential (OCP).
- void setStartVoltageVsOCP (bool startVsOCP)

  Set whether the starting voltage is measured versus the open circuit potential (OCP).
- bool isEndVoltageVsOCP () const

  Check if the ending voltage is measured versus the open circuit potential (OCP).
- void setEndVoltageVsOCP (bool endVsOCP)

  Set whether the ending voltage is measured versus the open circuit potential (OCP).

16.20.1 Constructor & Destructor Documentation

16.20.1.1 AisMottSchottkyElement() [1/2]

```
AisMottSchottkyElement::AisMottSchottkyElement (
              double startingPotential,
              double endingPotential,
              double voltageStep,
              double startFrequency,
              double endFrequency,
              double stepsPerDecade,
              double amplitude,
              unsigned int minCycles)  [explicit]
```

Parameters

startingPotential	The starting potential (voltage) for the experiment.
endingPotential	The ending potential (voltage) for the experiment.
voltageStep	The voltage step size between each potential during the experiment.
startFrequency	The starting frequency for the EIS measurement.
endFrequency	The ending frequency for the EIS measurement.

stepsPerDecade	The number of frequency steps per decade.
amplitude	The amplitude of the AC signal used in the EIS measurement.
minCycles	The minimum number of cycles per frequency step during the EIS measurement.

16.20.1.2 AisMottSchottkyElement() [2/2]

```
AisMottSchottkyElement::AisMottSchottkyElement (
            const AisMottSchottkyElement & other)  [explicit]
```

Parameters

other	The object to copy from.

16.20.2 Member Function Documentation

16.20.2.1 getAmplitude()

```
double AisMottSchottkyElement::getAmplitude () const
```

Returns

The AC amplitude in volts.

16.20.2.2 getCategory()

```
QStringList AisMottSchottkyElement::getCategory () const  [override]
```

Returns

A list of categories where the experiment is applicable, such as "Advanced Experiments".

16.20.2.3 getEndFrequency()

```
double AisMottSchottkyElement::getEndFrequency () const
```

Returns

The ending frequency in Hz.

16.20.2.4 getEndingPotential()

```
double AisMottSchottkyElement::getEndingPotential () const
```

Returns

The ending potential in volts.

16.20.2.5 getMinCycles()

```
unsigned int AisMottSchottkyElement::getMinCycles () const
```

Returns

The minimum number of cycles.

16.20.2.6 getName()

```
QString AisMottSchottkyElement::getName () const  [override]
```

Returns

The name of the element, "Mott-Schottky".

16.20.2.7 getQuietTime()

```
double AisMottSchottkyElement::getQuietTime () const
```

Returns

The quiet time in seconds.

16.20.2.8 getQuietTimeSampInterval()

```
double AisMottSchottkyElement::getQuietTimeSampInterval () const
```

Returns

The sampling interval in seconds.

16.20.2.9 getStartFrequency()

```
double AisMottSchottkyElement::getStartFrequency () const
```

Returns

The starting frequency in Hz.

16.20.2.10 getStartingPotential()

```
double AisMottSchottkyElement::getStartingPotential () const
```

Returns

The starting potential in volts.

16.20.2.11 getStepQuietSampInterval()

```
double AisMottSchottkyElement::getStepQuietSampInterval () const
```

Returns

The sampling interval in seconds.

16.20.2.12 getStepQuietTime()

```
double AisMottSchottkyElement::getStepQuietTime () const
```

Returns

The quiet time after each potential step in seconds.

16.20.2.13 getStepsPerDecade()

```
double AisMottSchottkyElement::getStepsPerDecade () const
```

Returns

The number of steps per decade.

16.20.2.14 getVoltageStep()

```
double AisMottSchottkyElement::getVoltageStep () const
```

Returns

The voltage step size in volts.

16.20.2.15 isEndVoltageVsOCP()

```
bool AisMottSchottkyElement::isEndVoltageVsOCP () const
```

Returns

True if the ending voltage is measured versus OCP, false otherwise.

16.20.2.16 isStartVoltageVsOCP()

```
bool AisMottSchottkyElement::isStartVoltageVsOCP () const
```

Returns

True if the starting voltage is measured versus OCP, false otherwise.

16.20.2.17 operator=()

```
AisMottSchottkyElement & AisMottSchottkyElement::operator= (
            const AisMottSchottkyElement & other)
```

Parameters

other	The object to assign from.

Returns

A reference to the assigned object.

16.20.2.18 setAmplitude()

```
void AisMottSchottkyElement::setAmplitude (
            double amplitude)
```

Parameters

amplitude	The AC amplitude in volts.

16.20.2.19 setEndFrequency()

```
void AisMottSchottkyElement::setEndFrequency (
            double endFrequency)
```

Parameters

endFrequency	The ending frequency in Hz.

16.20.2.20 setEndingPotential()

```
void AisMottSchottkyElement::setEndingPotential (
            double endingPotential)
```

Parameters

endingPotential	The ending potential in volts.

16.20.2.21 setEndVoltageVsOCP()

```
void AisMottSchottkyElement::setEndVoltageVsOCP (
            bool endVsOCP)
```

Parameters

endVsOCP	True if the ending voltage is measured versus OCP, false otherwise.

16.20.2.22 setMinCycles()

```
void AisMottSchottkyElement::setMinCycles (
            unsigned int minCycles)
```

Parameters

minCycles	The minimum number of cycles.

16.20.2.23 setQuietTime()

```
void AisMottSchottkyElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time in seconds.

16.20.2.24 setQuietTimeSampInterval()

```
void AisMottSchottkyElement::setQuietTimeSampInterval (
            double quietTimeSampInterval)
```

Parameters

quietTimeSampInterval	The sampling interval in seconds.

16.20.2.25 setStartFrequency()

```
void AisMottSchottkyElement::setStartFrequency (
            double startFrequency)
```

Parameters

startFrequency	The starting frequency in Hz.

16.20.2.26 setStartingPotential()

```
void AisMottSchottkyElement::setStartingPotential (
            double startingPotential)
```

Parameters

startingPotential	The starting potential in volts.

16.20.2.27 setStartVoltageVsOCP()

```
void AisMottSchottkyElement::setStartVoltageVsOCP (
            bool startVsOCP)
```

Parameters

startVsOCP	True if the starting voltage is measured versus OCP, false otherwise.

16.20.2.28 setStepQuietSampInterval()

```
void AisMottSchottkyElement::setStepQuietSampInterval (
            double stepQuietTimeSampInterval)
```

Parameters

stepQuietTimeSampInterval	The sampling interval in seconds.

16.20.2.29 setStepQuietTime()

```
void AisMottSchottkyElement::setStepQuietTime (
            double stepQuietTime)
```

Parameters

stepQuietTime	The quiet time after each potential step in seconds.

16.20.2.30 setStepsPerDecade()

```
void AisMottSchottkyElement::setStepsPerDecade (
            double stepsPerDecade)
```

Parameters

stepsPerDecade	The number of steps per decade.

16.20.2.31 setVoltageStep()

```
void AisMottSchottkyElement::setVoltageStep (
            double voltageStep)
```

Parameters

voltageStep	The voltage step size in volts.

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

- AisMottSchottkyElement.h

16.21 AisNormalPulseVoltammetryElement Class Reference

This experiment holds the working electrode at a **baseline potential** during the **quiet time**, then applies a train of pulses, which increase in amplitude until the **final potential** is reached.

```
#include <AisNormalPulseVoltammetryElement.h>
```

```
#include <AisNormalPulseVoltammetryElement.h>
```

Public Member Functions

- AisNormalPulseVoltammetryElement (double startVoltage, double endVoltage, double voltageStep, double pulseWidth, double pulsePeriod)

  the normal-pulse-voltammetry element constructor
- AisNormalPulseVoltammetryElement (double startVoltage, double endVoltage, double voltageStep, double pulseWidth, double pulsePeriod, double approxMaxCurrent)

  the normal-pulse-voltammetry element constructor
- **AisNormalPulseVoltammetryElement** (const AisNormalPulseVoltammetryElement &)

  copy constructor for the AisNormalPulseVoltammetryElement object.
- AisNormalPulseVoltammetryElement & **operator=** (const AisNormalPulseVoltammetryElement &)

  overload equal to operator for the AisNormalPulseVoltammetryElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

gets the quiet time sampling interval.

- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartVoltage () const

  get the value set for the start voltage.
- void setStartVoltage (double startVoltage)

  set the value for the start voltage.
- bool isStartVoltageVsOCP () const

  tells whether the start voltage is set against the open-circuit voltage or the reference terminal.
- void setStartVoltageVsOCP (bool startVoltageVsOCP)

  set whether to reference the start voltage against the open-circuit voltage or the reference terminal.
- double getEndVoltage () const

  get the value set for the ending potential value.
- void setEndVoltage (double endVoltage)

  set the ending potential value.
- bool isEndVoltageVsOCP () const

  tells whether the end voltage is set with respect to the open circuit voltage or the reference terminal.
- void setEndVoltageVsOCP (bool endVoltageVsOcp)

  set whether to reference the end voltage against the open-circuit voltage or the reference terminal.
- double getVStep () const

  get the value set for the voltage step.
- void setVStep (double vStep)

  set the value for the voltage step.
- double getPulseWidth () const

  get the value set for the pulse width
- void setPulseWidth (double pulseWidth)

  set the value in seconds for pulse width.
- double getPulsePeriod () const

  get the value set for the pulse period.
- void setPulsePeriod (double pulsePeriod)

  set the value for the pulse period.
- bool isAutoRange () const

  tells whether the current range is set to auto-select or not.
- void setAutoRange ()

  set to auto-select the current range.
- double getApproxMaxCurrent () const

  get the value set for the expected maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  set maximum current expected, for manual current range selection.
- double getAlphaFactor () const

  Get the value set for the alpha factor.
- void setAlphaFactor (double alphaFactor)

  alpha factor controls the percentage of data sampled during a given interval. Data will be averaged over the last n% of the sampling interval.

16.21.1 Constructor & Destructor Documentation

16.21.1.1 AisNormalPulseVoltammetryElement() [1/2]

```
AisNormalPulseVoltammetryElement::AisNormalPulseVoltammetryElement (
            double startVoltage,
            double endVoltage,
            double voltageStep,
            double pulseWidth,
            double pulsePeriod)  [explicit]
```

Parameters

startVoltage	the value of the starting potential in volts
endVoltage	the value of the ending potential in volts
voltageStep	the value set for the voltage step in volts.
pulseWidth	the value for the pulse width in seconds.
pulsePeriod	the value for the pulse period in seconds.

16.21.1.2 AisNormalPulseVoltammetryElement() [2/2]

```
AisNormalPulseVoltammetryElement::AisNormalPulseVoltammetryElement (
            double startVoltage,
            double endVoltage,
            double voltageStep,
            double pulseWidth,
            double pulsePeriod,
            double approxMaxCurrent)  [explicit]
```

Parameters

startVoltage	the value of the starting potential in volts
endVoltage	the value of the ending potential in volts
voltageStep	the value set for the voltage step in volts.
pulseWidth	the value for the pulse width in seconds.
pulsePeriod	the value for the pulse period in seconds.
approxMaxCurrent	the value for the approximate maximum current in amperes.

16.21.2 Member Function Documentation

16.21.2.1 getAlphaFactor()

```
double AisNormalPulseVoltammetryElement::getAlphaFactor () const
```

Returns

The value for the alpha factor is represented as a percent between 0 and 100.

Note

If nothing is set, this function will return a default value of 75.

16.21.2.2 getApproxMaxCurrent()

```
double AisNormalPulseVoltammetryElement::getApproxMaxCurrent () const
```

Returns

the value set for the expected maximum current in Amps.

Note

if nothing was manually set, the device will auto-select the current range and the return value will be positive infinity.

16.21.2.3 getCategory()

```
QStringList AisNormalPulseVoltammetryElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control", "Basic Voltammetry", "Pulse Voltammetry").

16.21.2.4 getEndVoltage()

```
double AisNormalPulseVoltammetryElement::getEndVoltage () const
```

This is the value of the voltage at which the experiment will stop.

Returns

the value set for the ending voltage in volts.

16.21.2.5 getName()

```
QString AisNormalPulseVoltammetryElement::getName () const  [override]
```

Returns

The name of the element: "Normal Pulse Potential Voltammetry".

16.21.2.6 getPulsePeriod()

```
double AisNormalPulseVoltammetryElement::getPulsePeriod () const
```

Returns

the value for the pulse period in seconds.

See also

setPulsePeriod

16.21.2.7 getPulseWidth()

```
double AisNormalPulseVoltammetryElement::getPulseWidth () const
```

Returns

the value of the pulse width in seconds.

See also

setPulseWidth

16.21.2.8 getQuietTime()

```
double AisNormalPulseVoltammetryElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.21.2.9 getQuietTimeSamplingInterval()

```
double AisNormalPulseVoltammetryElement::getQuietTimeSamplingInterval () const
```

Returns

quiet time The quiet time sampling interval to set in seconds.

16.21.2.10 getStartVoltage()

```
double AisNormalPulseVoltammetryElement::getStartVoltage () const
```

Returns

the value of the start voltage in volts.

16.21.2.11 getVStep()

```
double AisNormalPulseVoltammetryElement::getVStep () const
```

Returns

the value set for the voltage step in volts.

See also

setVStep

16.21.2.12 isAutoRange()

```
bool AisNormalPulseVoltammetryElement::isAutoRange () const
```

Returns

true if the current range is set to auto-select and false if a rage has been selected.

Deprecated This function is deprecated and no longer supports auto range for this element. Specify the current using setApproxMaxCurrent(). The device will determine the appropriate range based on the current value.

16.21.2.13 isEndVoltageVsOCP()

```
bool AisNormalPulseVoltammetryElement::isEndVoltageVsOCP () const
```

Returns

true if the end voltage is set with respect to the open-circuit voltage and false if set against the reference terminal.

Note

if nothing is set, the default is false.

16.21.2.14 isStartVoltageVsOCP()

```
bool AisNormalPulseVoltammetryElement::isStartVoltageVsOCP () const
```

Returns

true if the start voltage is set against the open-circuit voltage and false if it is set against the reference terminal.

Note

if nothing is set, the default is false.

See also

setStartVoltageVsOCP

16.21.2.15 setAlphaFactor()

```
void AisNormalPulseVoltammetryElement::setAlphaFactor (
            double alphaFactor)
```

This is an **optional** parameter. If nothing is set, the device will use the default value of 75.

Parameters

alphaFactor	the value for the alphaFactor ranges from 0 to 100.

16.21.2.16 setApproxMaxCurrent()

```
void AisNormalPulseVoltammetryElement::setApproxMaxCurrent (
            double approxMaxCurrent)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the current range.

Parameters

approxMaxCurrent	the value for the maximum current expected in Amps.

16.21.2.17 setAutoRange()

```
void AisNormalPulseVoltammetryElement::setAutoRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

Deprecated This function is deprecated. Use setApproxMaxCurrent() to specify the current range instead.

16.21.2.18 setEndVoltage()

```
void AisNormalPulseVoltammetryElement::setEndVoltage (
            double endVoltage)
```

This is the value of the voltage at which the experiment will stop.

Parameters

endVoltage	the value to set for the ending potential in volts.

16.21.2.19 setEndVoltageVsOCP()

```
void AisNormalPulseVoltammetryElement::setEndVoltageVsOCP (
            bool endVoltageVsOcp)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

endVoltageVsOcp	true to set the end voltage to be referenced against the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

16.21.2.20 setPulsePeriod()

```
void AisNormalPulseVoltammetryElement::setPulsePeriod (
            double pulsePeriod)
```

The pulse period is the time spent between the starts of two consecutive pulses.

Parameters

pulsePeriod	the value to set for the pulse period in seconds.

16.21.2.21 setPulseWidth()

```
void AisNormalPulseVoltammetryElement::setPulseWidth (
            double pulseWidth)
```

The pulse width is the value in seconds for the time spent at the same voltage set for the pulse height.

Parameters

pulseWidth	the value to set for the pulse width in seconds.

16.21.2.22 setQuietTime()

```
void AisNormalPulseVoltammetryElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.21.2.23 setQuietTimeSamplingInterval()

```
void AisNormalPulseVoltammetryElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.21.2.24 setStartVoltage()

```
void AisNormalPulseVoltammetryElement::setStartVoltage (
            double startVoltage)
```

Parameters

startVoltage	the value of the start voltage in volts

16.21.2.25 setStartVoltageVsOCP()

```
void AisNormalPulseVoltammetryElement::setStartVoltageVsOCP (
            bool startVoltageVsOCP)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

startVoltageVsOCP	true to if the start voltage is set to reference the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

16.21.2.26 setVStep()

```
void AisNormalPulseVoltammetryElement::setVStep (
            double vStep)
```

The voltage step is the voltage difference between the heights of two consecutive pulses.

Parameters

vStep	the value for the voltage step in volts.

Note

Regardless of vStep's sign, the device will determine the step direction based on the start and end voltage.

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

- AisNormalPulseVoltammetryElement.h

16.22 AisOpenCircuitElement Class Reference

This experiment observes the **open circuit potential** of the working electrode for a specific period of time.

```
#include <AisOpenCircuitElement.h>
```

```
#include <AisOpenCircuitElement.h>
```

Public Member Functions

- AisOpenCircuitElement (double duration, double samplingInterval)

  the open-circuit element constructor.
- **AisOpenCircuitElement** (const AisOpenCircuitElement &)

  copy constructor for the AisOpenCircuitElement object.
- AisOpenCircuitElement & **operator=** (const AisOpenCircuitElement &)

  overload equal to operator for the AisOpenCircuitElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getSamplingInterval () const

  get how frequently we are sampling the data.
- void setSamplingInterval (double samplingInterval)

  set how frequently we are sampling the data.
- double getMaxDuration () const

  get the value set for the duration of the experiment.
- void setMaxDuration (double maxDuration)

  set the value set for the duration of the experiment.
- double getMaxVoltage () const

  get the value set for the maximum voltage. The experiment will end when it reaches this value.
- void setMaxVoltage (double maxVoltage)

  set a maximum voltage to stop the experiment.
- double getMinVoltage () const

  get the value set minimum for the voltage in volts.
- void setMinVoltage (double minVoltage)

  set a minimum voltage to stop the experiment.
- double getMindVdt () const

  get the value set for the minimum voltage rate of change with respect to time (minimum dV/dt).
- void setMindVdt (double mindVdt)

  set the minimum value for the voltage rate of change with respect to time (minimum dV/dt).
- bool isAutoVoltageRange () const

  tells whether the voltage range is set to auto-select or not.
- void setAutoVoltageRange ()

  set to auto-select the voltage range.
- double getApproxMaxVoltage () const

  get the value set for the expected maximum voltage.
- void setApproxMaxVoltage (double approxMaxVoltage)

  set maximum voltage expected, for manual voltage range selection.

16.22.1 Constructor & Destructor Documentation

16.22.1.1 AisOpenCircuitElement()

```
AisOpenCircuitElement::AisOpenCircuitElement (
            double duration,
            double samplingInterval)  [explicit]
```

Parameters

duration	the maximum duration for the experiment in seconds.
samplingInterval	the data sampling interval value in seconds.

16.22.2 Member Function Documentation

16.22.2.1 getApproxMaxVoltage()

```
double AisOpenCircuitElement::getApproxMaxVoltage () const
```

Returns

the value set for the expected maximum Voltage in volt.

Note

if nothing was manually set, the device will auto-select the voltage range and the return value will be positive infinity.

16.22.2.2 getCategory()

```
QStringList AisOpenCircuitElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Basic Experiments").

16.22.2.3 getMaxDuration()

```
double AisOpenCircuitElement::getMaxDuration () const
```

Returns

the value set for the duration of the experiment in seconds.

16.22.2.4 getMaxVoltage()

```
double AisOpenCircuitElement::getMaxVoltage () const
```

Returns

the value set for the maximum voltage.

Note

this is an optional parameter. If no value has been set, the default value is positive infinity.

16.22.2.5 getMindVdt()

```
double AisOpenCircuitElement::getMindVdt () const
```

Returns

the value set for the minimum voltage rate of change with respect to time (minimum dV/dt).

Note

this is an optional parameter. If no value has been set, the default value is zero.

16.22.2.6 getMinVoltage()

```
double AisOpenCircuitElement::getMinVoltage () const
```

Returns

the value set for the minimum voltage in volts.

Note

this is an optional parameter. If no value has been set, the default value is negative infinity.

16.22.2.7 getName()

```
QString AisOpenCircuitElement::getName () const  [override]
```

Returns

The name of the element: "Open Circuit Potential".

16.22.2.8 getSamplingInterval()

```
double AisOpenCircuitElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.22.2.9 isAutoVoltageRange()

```
bool AisOpenCircuitElement::isAutoVoltageRange () const
```

Returns

true if the voltage range is set to auto-select and false if a range has been selected.

16.22.2.10 setApproxMaxVoltage()

```
void AisOpenCircuitElement::setApproxMaxVoltage (
            double approxMaxVoltage)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the voltage range.

Parameters

approxMaxVoltage	the value for the maximum voltage expected in V.

16.22.2.11 setAutoVoltageRange()

```
void AisOpenCircuitElement::setAutoVoltageRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

16.22.2.12 setMaxDuration()

```
void AisOpenCircuitElement::setMaxDuration (
            double maxDuration)
```

Parameters

maxDuration	the value to set for the duration of the experiment in seconds.

16.22.2.13 setMaxVoltage()

```
void AisOpenCircuitElement::setMaxVoltage (
            double maxVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an upper-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is below that value.

Parameters

maxVoltage	the maximum voltage value in volts at which the experiment will stop.

16.22.2.14 setMindVdt()

```
void AisOpenCircuitElement::setMindVdt (
            double mindVdt)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit rate of change value. If a minimum value is set, the experiment will continue to run as long as the rage of change is above that value.

Parameters

mindVdt	the minimum value for the voltage rate of change with respect to time (minimum dV/dt).

16.22.2.15 setMinVoltage()

```
void AisOpenCircuitElement::setMinVoltage (
            double minVoltage)
```

This is an **optional** condition. If nothing is set, then the experiment will not stop based on an lower-limit voltage value. If a maximum voltage is set, the experiment will continue to run as long as the measured voltage is above that value.

Parameters

minVoltage	the minimum voltage value in volts at which the experiment will stop.

16.22.2.16 setSamplingInterval()

```
void AisOpenCircuitElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

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

- AisOpenCircuitElement.h

16.23 AisSquareWaveVoltammetryElement Class Reference

This experiment holds the working electrode at the **starting potential** during the **quiet time**. Then it applies a train of square pulses superimposed on a staircase waveform with a uniform **potential step** magnitude.

```
#include <AisSquareWaveVoltammetryElement.h>
```

```
#include <AisSquareWaveVoltammetryElement.h>
```

Public Member Functions

- AisSquareWaveVoltammetryElement (double startVoltage, double endVoltage, double voltageStep, double pulseAmp, double pulseFrequency)

  the square wave element constructor
- AisSquareWaveVoltammetryElement (double startVoltage, double endVoltage, double voltageStep, double pulseAmp, double pulseFrequency, double approxMaxCurrent)

  the square wave element constructor
- **AisSquareWaveVoltammetryElement** (const AisSquareWaveVoltammetryElement &)

  copy constructor for the AisSquareWaveVoltammetryElement object.
- AisSquareWaveVoltammetryElement & **operator=** (const AisSquareWaveVoltammetryElement &)

  overload equal to operator for the AisSquareWaveVoltammetryElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the quiet time sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartVoltage () const

  get the value set for the start voltage.
- void setStartVoltage (double startVoltage)

  set the value for the start voltage.
- bool isStartVoltageVsOCP () const

  tells whether the start voltage is set against the open-circuit voltage or the reference terminal.
- void setStartVoltageVsOCP (bool startVoltageVsOcp)

  set whether to reference the start voltage against the open-circuit voltage or the reference terminal.
- double getEndVoltage () const

  get the value set for the ending potential value.
- void setEndVoltage (double endVoltage)

  set the ending potential value.
- bool isEndVoltageVsOCP () const

  tells whether the end voltage is set with respect to the open circuit voltage or the reference terminal.
- void setEndVoltageVsOCP (bool endVoltageVsOcp)

  set whether to reference the end voltage against the open-circuit voltage or the reference terminal.
- double getVStep () const

  get the value set for the voltage step.

- void setVStep (double vStep)

  set the value for the voltage step. The voltage step is added to the value of the starting potential of the previous pulse to start the new pulse.
- double getPulseAmp () const

  get the value set for the pulse amplitude.
- void setPulseAmp (double pulseAmp)

  set the value for the pulse amplitude.
- double getPulseFreq () const

  get the value set for the pulse frequency.
- void setPulseFreq (double pulseFreq)

  set the value for the pulse frequency.
- bool isAutoRange () const

  tells whether the current range is set to auto-select or not.
- void setAutoRange ()

  set to auto-select the current range.
- double getApproxMaxCurrent () const

  get the value set for the expected maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  set maximum current expected, for manual current range selection.
- double getAlphaFactor () const

  Get the value set for the alpha factor.
- void setAlphaFactor (double alphaFactor)

  alpha factor controls the percentage of data sampled during a given interval. Data will be averaged over the last n% of the sampling interval.

16.23.1 Constructor & Destructor Documentation

16.23.1.1 AisSquareWaveVoltammetryElement() [1/2]

```
AisSquareWaveVoltammetryElement::AisSquareWaveVoltammetryElement (
             double startVoltage,
             double endVoltage,
             double voltageStep,
             double pulseAmp,
             double pulseFrequency)  [explicit]
```

Parameters

startVoltage	the value of the starting potential in volts
endVoltage	the value of the ending potential in volts
voltageStep	the value set for the voltage step in volts.
pulseAmp	the value for the pulse amplitude in volts.
pulseFrequency	the value for the pulse frequency in Hz.

Deprecated Use the constructor with the approxMaxCurrent parameter instead.

16.23.1.2 AisSquareWaveVoltammetryElement() [2/2]

```
AisSquareWaveVoltammetryElement::AisSquareWaveVoltammetryElement (
            double startVoltage,
            double endVoltage,
            double voltageStep,
            double pulseAmp,
            double pulseFrequency,
            double approxMaxCurrent)  [explicit]
```

Parameters

startVoltage	the value of the starting potential in volts
endVoltage	the value of the ending potential in volts
voltageStep	the value set for the voltage step in volts.
pulseAmp	the value for the pulse amplitude in volts.
pulseFrequency	the value for the pulse frequency in Hz.
approxMaxCurrent	the value for the approximate maximum current in amperes.

16.23.2 Member Function Documentation

16.23.2.1 getAlphaFactor()

```
double AisSquareWaveVoltammetryElement::getAlphaFactor () const
```

Returns

The value for the alpha factor is represented as a percent between 0 and 100.

Note

If nothing is set, this function will return a default value of 75.

16.23.2.2 getApproxMaxCurrent()

```
double AisSquareWaveVoltammetryElement::getApproxMaxCurrent () const
```

Returns

the value set for the expected maximum current in Amps.

Note

if nothing was manually set, the device will auto-select the current range and the return value will be positive infinity.

16.23.2.3 getCategory()

```
QStringList AisSquareWaveVoltammetryElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control", "Pulse Voltammetry").

16.23.2.4 getEndVoltage()

```
double AisSquareWaveVoltammetryElement::getEndVoltage () const
```

This is the value of the voltage at which the experiment will stop.

Returns

the value set for the ending voltage in volts.

16.23.2.5 getName()

```
QString AisSquareWaveVoltammetryElement::getName () const  [override]
```

Returns

The name of the element: "Square Wave Potential Voltammetry".

16.23.2.6 getPulseAmp()

```
double AisSquareWaveVoltammetryElement::getPulseAmp () const
```

Returns

the value set for the pulse amplitude in volts.

See also

setPulseAmp

16.23.2.7 getPulseFreq()

```
double AisSquareWaveVoltammetryElement::getPulseFreq () const
```

Returns

the value set for the frequency in Hz.

16.23.2.8 getQuietTime()

```
double AisSquareWaveVoltammetryElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.23.2.9 getQuietTimeSamplingInterval()

```
double AisSquareWaveVoltammetryElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.23.2.10 getStartVoltage()

```
double AisSquareWaveVoltammetryElement::getStartVoltage () const
```

Returns

the value of the start voltage in volts.

16.23.2.11 getVStep()

```
double AisSquareWaveVoltammetryElement::getVStep () const
```

Returns

the value set for the voltage step in volts.

See also

setVStep

16.23.2.12 isAutoRange()

```
bool AisSquareWaveVoltammetryElement::isAutoRange () const
```

Returns

true if the current range is set to auto-select and false if a rage has been selected.

Deprecated This function is deprecated and no longer supports auto range for this element. Specify the current using setApproxMaxCurrent(). The device will determine the appropriate range based on the current value.

16.23.2.13 isEndVoltageVsOCP()

```
bool AisSquareWaveVoltammetryElement::isEndVoltageVsOCP () const
```

Returns

true if the end voltage is set with respect to the open-circuit voltage and false if set against the reference terminal.

Note

if nothing is set, the default is false.

16.23.2.14 isStartVoltageVsOCP()

```
bool AisSquareWaveVoltammetryElement::isStartVoltageVsOCP () const
```

Returns

true if the start voltage is set against the open-circuit voltage and false if it is set against the reference terminal.

Note

if nothing is set, the default is false.

See also

setStartVoltageVsOCP

16.23.2.15 setAlphaFactor()

```
void AisSquareWaveVoltammetryElement::setAlphaFactor (
            double alphaFactor)
```

This is an **optional** parameter. If nothing is set, the device will use the default value of 75.

Parameters

alphaFactor	the value for the alphaFactor ranges from 0 to 100.

16.23.2.16 setApproxMaxCurrent()

```
void AisSquareWaveVoltammetryElement::setApproxMaxCurrent (
            double approxMaxCurrent)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the current range.

Parameters

approxMaxCurrent	the value for the maximum current expected in Amps.

16.23.2.17 setAutoRange()

```
void AisSquareWaveVoltammetryElement::setAutoRange ()
```

This option is set by default. There is no need to call this function to auto-select if the range was not manually set.

Deprecated This function is deprecated. Use setApproxMaxCurrent() to specify the current range instead.

16.23.2.18 setEndVoltage()

```
void AisSquareWaveVoltammetryElement::setEndVoltage (
            double endVoltage)
```

This is the value of the voltage at which the experiment will stop.

Parameters

endVoltage	the value to set for the ending potential in volts.

16.23.2.19 setEndVoltageVsOCP()

```
void AisSquareWaveVoltammetryElement::setEndVoltageVsOCP (
            bool endVoltageVsOcp)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

endVoltageVsOcp	true to set the end voltage to be referenced against the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

16.23.2.20 setPulseAmp()

```
void AisSquareWaveVoltammetryElement::setPulseAmp (
            double pulseAmp)
```

The voltage pulse goes up in hight by the given amplitude in addition to the starting potential (of the previous pulse). It then goes back down twice the amplitude to end up one amplitude below the starting potential (of the previous pulse).

Parameters

pulseAmp	the value to set for the pulse amplitude in volts.

16.23.2.21 setPulseFreq()

```
void AisSquareWaveVoltammetryElement::setPulseFreq (
            double pulseFreq)
```

Parameters

pulseFreq	the value to set for the pulse frequency in Hz.

16.23.2.22 setQuietTime()

```
void AisSquareWaveVoltammetryElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.23.2.23 setQuietTimeSamplingInterval()

```
void AisSquareWaveVoltammetryElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.23.2.24 setStartVoltage()

```
void AisSquareWaveVoltammetryElement::setStartVoltage (
            double startVoltage)
```

Parameters

startVoltage	the value of the start voltage in volts

16.23.2.25 setStartVoltageVsOCP()

```
void AisSquareWaveVoltammetryElement::setStartVoltageVsOCP (
            bool startVoltageVsOcp)
```

The reference terminal is for you to connect to any reference point you like. Connect it to the working electrode to reference ground.

Parameters

startVoltageVsOcp	true to if the start voltage is set to reference the open-circuit voltage and false if set against the reference terminal.

Note

by default, this is set to false.

16.23.2.26 setVStep()

```
void AisSquareWaveVoltammetryElement::setVStep (
            double vStep)
```

Parameters

vStep	the value for the voltage step in volts.

Note

Regardless of vStep's sign, the device will determine the step direction based on the start and end voltage.

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

- AisSquareWaveVoltammetryElement.h

16.24 AisStaircasePotentialVoltammetryElement Class Reference

AisStaircasePotentialVoltammetryElement class represents an element for staircase potential voltammetry experiments. It inherits from AisAbstractElement.

```
#include <AisStaircasePotentialVoltammetryElement.h>
```

```
#include <AisStaircasePotentialVoltammetryElement.h>
```

Public Member Functions

- AisStaircasePotentialVoltammetryElement (double startVoltage, double firstVoltageLimit, double second↩ VoltageLimit, double endVoltage, double stepSize, double stepDuration, double samplingInterval)

  Constructs an AisStaircasePotentialVoltammetryElement with specified parameters.
- AisStaircasePotentialVoltammetryElement (const AisStaircasePotentialVoltammetryElement &other)

  Copy constructor for AisStaircasePotentialVoltammetryElement.
- AisStaircasePotentialVoltammetryElement & operator= (const AisStaircasePotentialVoltammetryElement &other)

  Assignment operator for AisStaircasePotentialVoltammetryElement.
- ∼**AisStaircasePotentialVoltammetryElement** () override

  Destructor for AisStaircasePotentialVoltammetryElement.

- QString getName () const override

  Gets the name of the element.
- QStringList getCategory () const override

  Gets the category of the element.
- double getQuietTime () const

  Gets the quiet time duration.
- void setQuietTime (double quietTime)

  Sets the quiet time duration.
- double getQuietTimeSamplingInterval () const

  gets the quiet time sampling interval.
- void setQuietTimeSamplingInterval (double quietTimeSamplingInterval)

  Sets the quiet time sampling interval.
- double getStartVoltage () const

  Gets the starting voltage.
- void setStartVoltage (double startVoltage)

  Sets the starting voltage.
- bool isStartVoltageVsOCP () const

  Checks if the starting voltage is with respect to the open circuit mode.
- void setStartVoltageVsOCP (bool startVsOCP)

  Sets whether the starting voltage is with respect to the open circuit mode.
- double getEndVoltage () const

  Gets the ending voltage.
- void setEndVoltage (double endVoltage)

  Sets the ending voltage.
- bool isEndVoltageVsOCP () const

  Checks if the ending voltage is with respect to the open circuit mode.
- void setEndVoltageVsOCP (bool endVsOCP)

  Sets whether the ending voltage is with respect to the open circuit mode.
- double getFirstVoltageLimit () const

  Gets the first voltage limit.
- void setFirstVoltageLimit (double firstVoltageLimit)

  Sets the first voltage limit.
- bool isFirstVoltageLimitVsOCP () const

  Checks if the first voltage limit is with respect to the open circuit mode.
- void setFirstVoltageLimitVsOCP (bool firstVoltageLimitVsOCP)

  Sets whether the first voltage limit is with respect to the open circuit mode.
- double getSecondVoltageLimit () const

  Gets the second voltage limit.
- void setSecondVoltageLimit (double secondVoltageLimit)

  Sets the second voltage limit.
- bool isSecondVoltageLimitVsOCP () const

  Checks if the second voltage limit is with respect to the open circuit mode.
- void setSecondVoltageLimitVsOCP (bool secondVoltageLimitVsOCP)

  Sets whether the second voltage limit is with respect to the open circuit mode.
- double getStepSize () const

  Gets the potential step size.
- void setStepSize (double stepSize)

  Sets the potential step size.
- double getStepDuration () const

  Gets the potential step duration.
- void setStepDuration (double stepDuration)

Sets the potential step duration.
- double getSamplingInterval () const

  Gets the potential sampling interval.
- void setSamplingInterval (double samplingInterval)

  Sets the potential sampling interval.
- bool isAutorange () const

  Checks if the experiment should autorange the current.
- void **setAutorange** ()

  Enables autorange for the experiment.
- double getApproxMaxCurrent () const

  Gets the approximate maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  Sets the approximate maximum current.
- unsigned int getNumberOfCycles ()

  get the value set for the number of cycles
- void setNumberOfCycles (unsigned int cycles)

  set the number of cycles to oscillate between the first voltage-limit and the second voltage-limit.

16.24.1 Constructor & Destructor Documentation

16.24.1.1 AisStaircasePotentialVoltammetryElement() [1/2]

```
AisStaircasePotentialVoltammetryElement::AisStaircasePotentialVoltammetryElement (
                double startVoltage,
                double firstVoltageLimit,
                double secondVoltageLimit,
                double endVoltage,
                double stepSize,
                double stepDuration,
                double samplingInterval)
```

Parameters

startVoltage	The starting voltage in volts.
firstVoltageLimit	The first voltage limit in volts.
secondVoltageLimit	The second voltage limit in volts.
endVoltage	The ending voltage in volts.
stepSize	The potential step size in volts.
stepDuration	The potential step duration in seconds.
samplingInterval	The potential sampling interval in seconds.

16.24.1.2 AisStaircasePotentialVoltammetryElement() [2/2]

```
AisStaircasePotentialVoltammetryElement::AisStaircasePotentialVoltammetryElement (
                const AisStaircasePotentialVoltammetryElement & other)
```

Parameters

other	The AisStaircasePotentialVoltammetryElement to copy.

16.24.2 Member Function Documentation

16.24.2.1 getApproxMaxCurrent()

```
double AisStaircasePotentialVoltammetryElement::getApproxMaxCurrent () const
```

Returns

The approximate maximum current.

16.24.2.2 getCategory()

```
QStringList AisStaircasePotentialVoltammetryElement::getCategory () const  [override]
```

Returns

The category of the element.

16.24.2.3 getEndVoltage()

```
double AisStaircasePotentialVoltammetryElement::getEndVoltage () const
```

Returns

The ending voltage in volts.

16.24.2.4 getFirstVoltageLimit()

```
double AisStaircasePotentialVoltammetryElement::getFirstVoltageLimit () const
```

Returns

The first voltage limit in volts.

16.24.2.5 getName()

```
QString AisStaircasePotentialVoltammetryElement::getName () const  [override]
```

Returns

The name of the element.

16.24.2.6 getNumberOfCycles()

```
unsigned int AisStaircasePotentialVoltammetryElement::getNumberOfCycles ()
```

Returns

the number of cycles set.

16.24.2.7 getQuietTime()

```
double AisStaircasePotentialVoltammetryElement::getQuietTime () const
```

Returns

The quiet time duration in seconds.

16.24.2.8 getQuietTimeSamplingInterval()

```
double AisStaircasePotentialVoltammetryElement::getQuietTimeSamplingInterval () const
```

Returns

samplingInterval The quiet time sampling interval to set in seconds.

16.24.2.9 getSamplingInterval()

```
double AisStaircasePotentialVoltammetryElement::getSamplingInterval () const
```

Returns

The potential sampling interval in seconds.

16.24.2.10 getSecondVoltageLimit()

```
double AisStaircasePotentialVoltammetryElement::getSecondVoltageLimit () const
```

Returns

The second voltage limit in volts.

16.24.2.11 getStartVoltage()

```
double AisStaircasePotentialVoltammetryElement::getStartVoltage () const
```

Returns

The starting voltage in volts.

16.24.2.12 getStepDuration()

```
double AisStaircasePotentialVoltammetryElement::getStepDuration () const
```

Returns

The potential step duration in seconds.

16.24.2.13 getStepSize()

```
double AisStaircasePotentialVoltammetryElement::getStepSize () const
```

Returns

The potential step size in volts.

16.24.2.14 isAutorange()

```
bool AisStaircasePotentialVoltammetryElement::isAutorange () const
```

Returns

True if autorange is enabled, false otherwise.

16.24.2.15 isEndVoltageVsOCP()

```
bool AisStaircasePotentialVoltammetryElement::isEndVoltageVsOCP () const
```

Returns

True if the ending voltage is with respect to the open circuit mode, false otherwise.

16.24.2.16 isFirstVoltageLimitVsOCP()

```
bool AisStaircasePotentialVoltammetryElement::isFirstVoltageLimitVsOCP () const
```

Returns

True if the first voltage limit is with respect to the open circuit mode, false otherwise.

16.24.2.17 isSecondVoltageLimitVsOCP()

```
bool AisStaircasePotentialVoltammetryElement::isSecondVoltageLimitVsOCP () const
```

Returns

True if the second voltage limit is with respect to the open circuit mode, false otherwise.

16.24.2.18 isStartVoltageVsOCP()

```
bool AisStaircasePotentialVoltammetryElement::isStartVoltageVsOCP () const
```

Returns

True if the starting voltage is with respect to the open circuit mode, false otherwise.

16.24.2.19 operator=()

```
AisStaircasePotentialVoltammetryElement & AisStaircasePotentialVoltammetryElement::operator= (
            const AisStaircasePotentialVoltammetryElement & other)
```

Parameters

other	The AisStaircasePotentialVoltammetryElement to assign.

Returns

Reference to this AisStaircasePotentialVoltammetryElement.

16.24.2.20 setApproxMaxCurrent()

```
void AisStaircasePotentialVoltammetryElement::setApproxMaxCurrent (
            double approxMaxCurrent)
```

Parameters

approxMaxCurrent	The approximate maximum current to set.

16.24.2.21 setEndVoltage()

```
void AisStaircasePotentialVoltammetryElement::setEndVoltage (
            double endVoltage)
```

Parameters

endVoltage	The ending voltage to set in volts.

16.24.2.22 setEndVoltageVsOCP()

```
void AisStaircasePotentialVoltammetryElement::setEndVoltageVsOCP (
            bool endVsOCP)
```

Parameters

endVsOCP	True to set the ending voltage with respect to the open circuit mode, false otherwise.

16.24.2.23 setFirstVoltageLimit()

```
void AisStaircasePotentialVoltammetryElement::setFirstVoltageLimit (
            double firstVoltageLimit)
```

Parameters

firstVoltageLimit	The first voltage limit to set in volts.

16.24.2.24 setFirstVoltageLimitVsOCP()

```
void AisStaircasePotentialVoltammetryElement::setFirstVoltageLimitVsOCP (
            bool firstVoltageLimitVsOCP)
```

Parameters

firstVoltageLimitVsOCP	True to set the first voltage limit with respect to the open circuit mode, false otherwise.

16.24.2.25 setNumberOfCycles()

```
void AisStaircasePotentialVoltammetryElement::setNumberOfCycles (
            unsigned int cycles)
```

Parameters

cycles	the number of cycles to set

16.24.2.26 setQuietTime()

```
void AisStaircasePotentialVoltammetryElement::setQuietTime (
            double quietTime)
```

Parameters

quietTime	The quiet time duration to set in seconds.

16.24.2.27 setQuietTimeSamplingInterval()

```
void AisStaircasePotentialVoltammetryElement::setQuietTimeSamplingInterval (
            double quietTimeSamplingInterval)
```

Parameters

quietTimeSamplingInterval	The quiet time sampling interval to set in seconds.

16.24.2.28 setSamplingInterval()

```
void AisStaircasePotentialVoltammetryElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	The potential sampling interval to set in seconds.

16.24.2.29 setSecondVoltageLimit()

```
void AisStaircasePotentialVoltammetryElement::setSecondVoltageLimit (
            double secondVoltageLimit)
```

Parameters

secondVoltageLimit	The second voltage limit to set in volts.

16.24.2.30 setSecondVoltageLimitVsOCP()

```
void AisStaircasePotentialVoltammetryElement::setSecondVoltageLimitVsOCP (
            bool secondVoltageLimitVsOCP)
```

Parameters

secondVoltageLimitVsOCP	True to set the second voltage limit with respect to the open circuit mode, false otherwise.

16.24.2.31 setStartVoltage()

```
void AisStaircasePotentialVoltammetryElement::setStartVoltage (
            double startVoltage)
```

Parameters

startVoltage	The starting voltage to set in volts.

16.24.2.32 setStartVoltageVsOCP()

```
void AisStaircasePotentialVoltammetryElement::setStartVoltageVsOCP (
            bool startVsOCP)
```

Parameters

startVsOCP	True to set the starting voltage with respect to the open circuit mode, false otherwise.

16.24.2.33 setStepDuration()

```
void AisStaircasePotentialVoltammetryElement::setStepDuration (
            double stepDuration)
```

Parameters

stepDuration	The potential step duration to set in seconds.

16.24.2.34 setStepSize()

```
void AisStaircasePotentialVoltammetryElement::setStepSize (
            double stepSize)
```

Parameters

stepSize	The potential step size to set in volts.

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

- AisStaircasePotentialVoltammetryElement.h

16.25 AisSteppedCurrentElement Class Reference

A class representing an experiment to apply the stepped current.

```
#include <AisSteppedCurrentElement.h>
```

```
#include <AisSteppedCurrentElement.h>
```

Public Member Functions

- AisSteppedCurrentElement (double startCurrent, double endCurrent, double stepSize, double stepDuration, double samplingInterval)

  Constructs a Stepped Current element.
- **AisSteppedCurrentElement** (const AisSteppedCurrentElement &)

  copy constructor for the AisSteppedCurrentElement object.
- AisSteppedCurrentElement & **operator=** (const AisSteppedCurrentElement &)

  overload equal to operator for the AisSteppedCurrentElement object.
- QString getName () const override

  get the name of the element.
- QStringList getCategory () const override

  get a list of applicable categories of the element.
- double getSamplingInterval () const

  get how frequently we are sampling the data.
- void setSamplingInterval (double samplingInterval)

  set how frequently we are sampling the data.
- double getEndCurrent () const

  Gets the ending current value for the stepped experiment.
- void setEndCurrent (double iEnd)

  Sets the ending current value for the stepped experiment.
- double getStepSize () const

  Gets the size of each current step in the stepped experiment.
- void setStepSize (double iStep)

  Sets the size of each current step in the stepped experiment.
- double getStartCurrent () const

  Gets the starting current value for the stepped experiment.
- void setStartCurrent (double iStart)

  Sets the starting current value for the stepped experiment.
- double getStepDuration () const

  Gets the duration of each current step in the stepped experiment.
- void setStepDuration (double tStep)

  Sets the duration of each current step in the stepped experiment.
- double getApproxMaxVoltage () const

  get the value set for the expected maximum voltage.
- void setApproxMaxVoltage (double approxMaxVoltage)

  set maximum voltage expected, for manual voltage range selection.
- double getApproxMinVoltage () const

  get the value set for the expected minimum voltage.
- void setApproxMinVoltage (double approxMinVoltage)

  set minimum voltage expected, for manual voltage range selection.

16.25.1 Constructor & Destructor Documentation

16.25.1.1 AisSteppedCurrentElement()

```
AisSteppedCurrentElement::AisSteppedCurrentElement (
             double startCurrent,
             double endCurrent,
             double stepSize,
             double stepDuration,
             double samplingInterval)  [explicit]
```

This constructor initializes the Stepped Current element with the specified parameters.

Parameters

startCurrent	The initial current value in amperes.
endCurrent	The final current value in amperes.
stepSize	The size of each current step in amperes.
stepDuration	The duration of each current step in seconds.
samplingInterval	The data sampling interval value in seconds.

16.25.2 Member Function Documentation

16.25.2.1 getApproxMaxVoltage()

```
double AisSteppedCurrentElement::getApproxMaxVoltage () const
```

Returns

the value set for the expected maximum Voltage in volt.

Note

if nothing was manually set, the device will auto-select the voltage range and the return value will be positive infinity.

16.25.2.2 getApproxMinVoltage()

```
double AisSteppedCurrentElement::getApproxMinVoltage () const
```

Returns

the value set for the expected maximum Voltage in volt.

Note

if nothing was manually set, the device will auto-select the voltage range and the return value will be positive infinity.

16.25.2.3 getCategory()

```
QStringList AisSteppedCurrentElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Galvanostatic Control").

16.25.2.4 getEndCurrent()

```
double AisSteppedCurrentElement::getEndCurrent () const
```

Returns

The ending current value in amperes.

16.25.2.5 getName()

```
QString AisSteppedCurrentElement::getName () const  [override]
```

Returns

The name of the element: "SteppedCurrent".

16.25.2.6 getSamplingInterval()

```
double AisSteppedCurrentElement::getSamplingInterval () const
```

Returns

the data sampling interval value in seconds.

16.25.2.7 getStartCurrent()

```
double AisSteppedCurrentElement::getStartCurrent () const
```

Returns

The starting current value in amperes.

16.25.2.8 getStepDuration()

```
double AisSteppedCurrentElement::getStepDuration () const
```

Returns

The duration of each current step in seconds.

16.25.2.9 getStepSize()

```
double AisSteppedCurrentElement::getStepSize () const
```

Returns

The size of each current step in amperes.

16.25.2.10 setApproxMaxVoltage()

```
void AisSteppedCurrentElement::setApproxMaxVoltage (
            double approxMaxVoltage)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the voltage range.

Parameters

approxMaxVoltage	the value for the maximum current expected in V.

16.25.2.11 setApproxMinVoltage()

```
void AisSteppedCurrentElement::setApproxMinVoltage (
            double approxMinVoltage)
```

This is an **optional** parameter. If nothing is set, the device will auto-select the voltage range.

Parameters

approxMinVoltage	the value for the minimum current expected in V.

16.25.2.12 setEndCurrent()

```
void AisSteppedCurrentElement::setEndCurrent (
            double iEnd)
```

Parameters

iEnd	The ending current value in amperes.

16.25.2.13 setSamplingInterval()

```
void AisSteppedCurrentElement::setSamplingInterval (
            double samplingInterval)
```

Parameters

samplingInterval	the data sampling interval value in seconds.

16.25.2.14 setStartCurrent()

```
void AisSteppedCurrentElement::setStartCurrent (
            double iStart)
```

Parameters

iStart	The starting current value in amperes.

16.25.2.15 setStepDuration()

```
void AisSteppedCurrentElement::setStepDuration (
            double tStep)
```

Parameters

tStep	The duration of each current step in seconds.

16.25.2.16 setStepSize()

```
void AisSteppedCurrentElement::setStepSize (
            double iStep)
```

Parameters

iStep	The size of each current step in amperes.

Note

Regardless of iStep's sign, the device will determine the step direction based on the start and end current.

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

- AisSteppedCurrentElement.h

16.26 AisSteppedVoltageElement Class Reference

A class representing an experiment to apply the stepped volatge.

```
#include <AisSteppedVoltageElement.h>
```

```
#include <AisSteppedVoltageElement.h>
```

Public Member Functions

- AisSteppedVoltageElement (double startVoltage, double endVoltage, double voltageStep, double voltageStepDuration, double samplingInterval)

  Constructor for the AisSteppedVoltageElement element.
- AisSteppedVoltageElement (const AisSteppedVoltageElement &other)

  Copy constructor for the AisSteppedVoltageElement object.
- AisSteppedVoltageElement & operator= (const AisSteppedVoltageElement &other)

  Overloaded assignment operator for the AisSteppedVoltageElement object.
- ∼**AisSteppedVoltageElement** () override

  Destructor for the AisSteppedVoltageElement object.
- QString getName () const override

  Get the name of the element.
- QStringList getCategory () const override

  Get a list of applicable categories of the element.
- double getStartVoltage () const

  Get the starting voltage for the experiment.
- void setStartVoltage (double vStart)

Set the starting voltage for the experiment.
- double getEndVoltage () const

  Get the ending voltage for the experiment.
- void setEndVoltage (double vEnd)

  Set the ending voltage for the experiment.
- double getStepSize () const

  Get the voltage step for each iteration.
- void setStepSize (double vStep)

  Set the voltage step for each iteration.
- double getStepDuration () const

  Get the time step for each iteration.
- void setStepDuration (double duration)

  Set the duration of each step.
- double getSamplingInterval () const

  Get the data sampling interval.
- void setSamplingInterval (double samplingInterval)

  Set the data sampling interval.
- double getApproxMaxCurrent () const

  Get the approximate maximum current.
- void setApproxMaxCurrent (double approxMaxCurrent)

  Set the approximate maximum current.
- bool isStartVoltageVsOCP () const

  Check if the experiment starts with the open circuit potential.
- void setStartVoltageVsOCP (bool startVsOCP)

  Set whether the experiment starts with the open circuit potential.
- bool isEndVoltageVsOCP () const

  Check if the experiment ends with the open circuit potential.
- void setEndVoltageVsOCP (bool endVsOCP)

  Set whether the experiment ends with the open circuit potential.
- bool isAutoRange () const

  Check if current autoranging is enabled.
- void **setCurrentAutorange** ()

  Enable current autoranging for the experiment.

16.26.1 Constructor & Destructor Documentation

16.26.1.1 AisSteppedVoltageElement() [1/2]

```
AisSteppedVoltageElement::AisSteppedVoltageElement (
             double startVoltage,
             double endVoltage,
             double voltageStep,
             double voltageStepDuration,
             double samplingInterval)  [explicit]
```

This constructor initializes the AisSteppedVoltageElement element with the specified parameters.

Parameters

startVoltage	The initial voltage value in volts.
endVoltage	The final voltage value in volts.
voltageStep	The size of each voltage step in volts.
voltageStepDuration	The duration of each voltage step in seconds.
samplingInterval	The data sampling interval value in seconds.

16.26.1.2 AisSteppedVoltageElement() [2/2]

```
AisSteppedVoltageElement::AisSteppedVoltageElement (
             const AisSteppedVoltageElement & other)  [explicit]
```

Parameters

other	The AisSteppedVoltageElement object to be copied.

16.26.2 Member Function Documentation

16.26.2.1 getApproxMaxCurrent()

```
double AisSteppedVoltageElement::getApproxMaxCurrent () const
```

Returns

The approximate maximum current in Amps.

16.26.2.2 getCategory()

```
QStringList AisSteppedVoltageElement::getCategory () const  [override]
```

Returns

A list of applicable categories: ("Potentiostatic Control").

16.26.2.3 getEndVoltage()

```
double AisSteppedVoltageElement::getEndVoltage () const
```

Returns

The ending voltage in volts.

16.26.2.4 getName()

```
QString AisSteppedVoltageElement::getName () const  [override]
```

Returns

The name of the element: "Stepped Voltage".

16.26.2.5 getSamplingInterval()

```
double AisSteppedVoltageElement::getSamplingInterval () const
```

Returns

The data sampling interval in seconds.

16.26.2.6 getStartVoltage()

```
double AisSteppedVoltageElement::getStartVoltage () const
```

Returns

The starting voltage in volts.

16.26.2.7 getStepDuration()

```
double AisSteppedVoltageElement::getStepDuration () const
```

Returns

The time step in seconds.

16.26.2.8 getStepSize()

```
double AisSteppedVoltageElement::getStepSize () const
```

Returns

The voltage step in volts.

16.26.2.9 isAutoRange()

```
bool AisSteppedVoltageElement::isAutoRange () const
```

Returns

True if current autoranging is enabled, false otherwise.

16.26.2.10 isEndVoltageVsOCP()

```
bool AisSteppedVoltageElement::isEndVoltageVsOCP () const
```

Returns

True if the experiment ends with open circuit potential, false otherwise.

16.26.2.11 isStartVoltageVsOCP()

```
bool AisSteppedVoltageElement::isStartVoltageVsOCP () const
```

Returns

True if the experiment starts with open circuit potential, false otherwise.

16.26.2.12 operator=()

```
AisSteppedVoltageElement & AisSteppedVoltageElement::operator= (
            const AisSteppedVoltageElement & other)
```

Parameters

other	The AisSteppedVoltageElement object to be assigned.

Returns

A reference to the assigned AisSteppedVoltageElement object.

16.26.2.13 setApproxMaxCurrent()

```
void AisSteppedVoltageElement::setApproxMaxCurrent (
            double approxMaxCurrent)
```

Parameters

approxMaxCurrent	The approximate maximum current in Amps.

16.26.2.14 setEndVoltage()

```
void AisSteppedVoltageElement::setEndVoltage (
            double vEnd)
```

Parameters

vEnd	The ending voltage in volts.

16.26.2.15 setEndVoltageVsOCP()

```
void AisSteppedVoltageElement::setEndVoltageVsOCP (
            bool endVsOCP)
```

Parameters

endVsOCP	True to end with open circuit potential, false otherwise.

16.26.2.16 setSamplingInterval()

```
void AisSteppedVoltageElement::setSamplingInterval (
             double samplingInterval)
```

Parameters

samplingInterval	The data sampling interval in seconds.

16.26.2.17 setStartVoltage()

```
void AisSteppedVoltageElement::setStartVoltage (
             double vStart)
```

Parameters

vStart	The starting voltage in volts.

16.26.2.18 setStartVoltageVsOCP()

```
void AisSteppedVoltageElement::setStartVoltageVsOCP (
             bool startVsOCP)
```

Parameters

startVsOCP	True to start with open circuit potential, false otherwise.

16.26.2.19 setStepDuration()

```
void AisSteppedVoltageElement::setStepDuration (
             double duration)
```

Parameters

duration	The step duration in seconds.

16.26.2.20 setStepSize()

```
void AisSteppedVoltageElement::setStepSize (
             double vStep)
```

Parameters

vStep	The voltage step in volts.

Note

Regardless of vStep's sign, the device will determine the step direction based on the start and end voltage.

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

- AisSteppedVoltageElement.h

Chapter 17

Examples

17.1 advancedControlFlow.cpp

This example shows how we can setup an advanced control flow for a sequence of experiments. For simplicity we will be using an incremented integer as an external condition to control the workflow. This logic can be replaced with any sort of logic pertaining to external instruments, sensors, or any other conditions.

```
#include "AisExperiment.h"
#include "AisDeviceTracker.h"
#include "AisInstrumentHandler.h"
#include "experiments/builder_elements/AisConstantCurrentElement.h"
#include "experiments/builder_elements/AisConstantPotElement.h"
#include <QCoreApplication>
#include <QTimer>
#include <qdebug.h>

int main()
{
    // Environment Setup
    char** test = nullptr;
    int args;
    QCoreApplication a(args, test); // this creates a non-GUI Qt application

    // constructing a constant potential element with required arguments
    AisConstantPotElement cvElement(
        5, // voltage: 1v
        1, // sampling interval: 1s
        10 // duration: 10s
    );

    // constructing a constant current element with required arguments
    AisConstantCurrentElement ccElement(
        0.002,  // current: 2mA
        1,      // sampling interval: 1s
        10      // duration: 10s
    );

    auto experimentA = std::make_shared<AisExperiment>(); // create a custom experiment
    experimentA->appendElement(cvElement, 1); // append to experimentA, the created CV element and set it to
      run 1 time

    auto experimentB = std::make_shared<AisExperiment>(); // create a second experiment
    experimentB->appendElement(ccElement, 1); // append to experimentB, the created CC element and set it to
      run 1 time

    auto experimentC = std::make_shared<AisExperiment>(); // create a third experiment
    experimentC->appendElement(cvElement, 2); // append to experimentC, the created CV element and set it to
      run 2 times

    /*
    * Now we have the experiments set up. Next we will create the logic for the sequence of experiments.
    * We will be using timers as external conditions to control the workflow. You may substitute that with
      your own conditions.
    *
    * The following lambda function creates a logic and assigns it to the given handler.
    * We will call this function after a newDeviceConnected signal has been emitted and a handler has been
      created.
    * The logic controls the workflow as follows:
```

```
* # Start the first timer
* # once the timer times out, start Experiment A
* # once Experiment A completes, start the second timer
* # once the second timer times out, start Experiment B
* # start a third timer to stop Experiment B early
* # once the third timer out, stop Experiment B
* # start a fourth timer
* # once the fourth timer times out, start Experiment C
* # once Experiment C completes, start Experiment B
*/

// Lambda function
auto createLogic = [&](const AisInstrumentHandler* handler) {
    QTimer* timer1 = new QTimer(); // the first timer is used in lieu of the first external condition
    timer1->setSingleShot(true);
    timer1->start(1000);

    QObject::connect(timer1, &QTimer::timeout, [=]() {
        qDebug() « "Initial condition met. Starting Experiment A ";
        handler->uploadExperimentToChannel(0, experimentA);
        handler->startUploadedExperiment(0);

        // once the first experiment is completed (Experiment A), start the next experiment (Experiment
  B).
        // this signal will be emitted for any experiment not just A so, we will track of the sequence
  with experimentStep
        // once an experiment has completed or has been stopped, continue to the next experimentStep
        QObject::connect(handler, &AisInstrumentHandler::experimentStopped, [&](uint8_t channel) {
            static int experimentStep = 0;
            qDebug() « "Experiment Step " « experimentStep « " Completed";

            experimentStep++; //increment the experiment step
            if (experimentStep == 1) {
                // Wait for external start condition
                QTimer* timer = new QTimer(); // the timer is used in lieu of an external condition
                timer->setSingleShot(true);
                timer->start(10000); // when this timer times out, the next experiment (Experiment B)
  will start

                // Create an external condition that will stop the upcoming experiment early
                QTimer* StopEarlyTimer = new QTimer();
                StopEarlyTimer->setSingleShot(true);
                QObject::connect(StopEarlyTimer, &QTimer::timeout, [&]() {
                    qDebug() « "External early stop condition met";
                    handler->stopExperiment(0); // Once the external condition is met, experiment B will
  stop, and the experimentCompleted signal will be emitted
                });

                QObject::connect(timer, &QTimer::timeout, [&, StopEarlyTimer]() {
                    qDebug() « "External condition met, starting experiment B";
                    handler->uploadExperimentToChannel(0, experimentB); // start Experiment B
                    handler->startUploadedExperiment(0);
                    StopEarlyTimer->start(2000);
                });
            } else if (experimentStep == 2) {
                QTimer* timer = new QTimer(); // the timer is used in lieu of an external condition
                timer->setSingleShot(true);
                timer->start(10000); // when this timer times out, the next experiment (Experiment C)
  will start

                QObject::connect(timer, &QTimer::timeout, [&]() {
                    qDebug() « "External condition met, starting Experiment C ";
                    handler->uploadExperimentToChannel(0, experimentC); // start Experiment C
                    handler->startUploadedExperiment(0);
                });
            } else if (experimentStep == 3) {
                QTimer* timer = new QTimer(); // the timer is used in lieu of an external condition
                timer->setSingleShot(true);
                timer->start(10000); // when this timer times out, the next experiment (Experiment B)
  will start

                QObject::connect(timer, &QTimer::timeout, [&]() {
                    qDebug() « "External condition met, starting Experiment B ";
                    handler->uploadExperimentToChannel(0, experimentB); // start Experiment B
                    handler->startUploadedExperiment(0);
                });
            }
        });
    });
};

// this is a signal-slot connection where the slot assigns the logic to the device handler when
  newDeviceConnected signal is emitted.
auto tracker = AisDeviceTracker::Instance(); // create a tracker that tracks connected devices
QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, &a, [&](const QString& deviceName) {
    auto& handler = tracker->getInstrumentHandler(deviceName);
    createLogic(&handler); // controlling experiments is to be done only after a device handler has been
```

```
      assigned. That is why it is placed inside this slot.
    });

    // here we have a signal and slot for when a device has been disconnected
    QObject::connect(tracker, &AisDeviceTracker::deviceDisconnected, &a, [=](const QString& deviceName) {
        qDebug() « deviceName « "is disconnected ";
    });

    AisErrorCode error = tracker->connectToDeviceOnComPort("COM18"); // change the port number to your
      device. For example, in windows, you can find it from the device manager
    if (error != error.Success) {
        qDebug() « error.message();
    }
    a.exec();
}
```

17.2 advancedExperiment.cpp

```
#include "AisDeviceTracker.h"
#include "AisExperiment.h"
#include "AisInstrumentHandler.h"

#include "experiments/builder_elements/AisOpenCircuitElement.h"
#include "experiments/builder_elements/AisConstantPotElement.h"
#include "experiments/builder_elements/AisEISGalvanostaticElement.h"
#include "experiments/builder_elements/AisConstantCurrentElement.h"

#include <QCoreApplication>
#include <QDebug>

// Define relevant device information, for easy access
#define COMPORT "COM5"
#define CHANNEL 0
#define INSTRUMENT_NAME "PLus1366"

int main()
{
    char** test = nullptr;
    int args;

    QCoreApplication a(args, test);

    auto tracker = AisDeviceTracker::Instance();

    bool success = true;
    auto customExperiment = std::make_shared<AisExperiment>();

    AisOpenCircuitElement ocpElement(1, 10);
    success &= customExperiment->appendElement(ocpElement);

    int voltage = 0;
    for (int i = 0; i < 4; i++) {
        AisConstantPotElement cvElement(voltage, 0.1, 5);
        success &= customExperiment->appendElement(cvElement, 1);
        voltage += 0.1; // Adding 100 mV
    }

    AisExperiment eisSubExperiment;

    AisEISGalvanostaticElement galvEISElement(10, 10000, 10, 0.01, 0.1);
    AisOpenCircuitElement ocpElement2(1, 5);

    success &= eisSubExperiment.appendElement(galvEISElement, 1);
    success &= eisSubExperiment.appendElement(ocpElement2, 1);

    success &= customExperiment->appendSubExperiment(eisSubExperiment, 3);

    AisConstantCurrentElement ccElement(0.1, 1, 10);
    success &= customExperiment->appendElement(ccElement, 2);

    if (!success) {
        qDebug() « "Error building experiment";
        return 0;
    }

    auto connectSignals = [=](const AisInstrumentHandler& handler) {
        QObject::connect(&handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel, const
      AisDCData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Current: " « data.current « " Voltage: " «
      data.workingElectrodeVoltage « " CE Voltage : " « data.counterElectrodeVoltage;
        });
        QObject::connect(&handler, &AisInstrumentHandler::experimentNewElementStarting, [=](uint8_t channel,
      const AisExperimentNode& info) {
            qDebug() « "New element starting: " « info.stepName;
        });
        QObject::connect(&handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel, const
      QString& reason) {
            qDebug() « "Experiment Stopped Signal " « channel « "Reason : " « reason;
        });
        QObject::connect(&handler, &AisInstrumentHandler::deviceError, [=](uint8_t channel, const QString&
      error) {
            qDebug() « "Device Error: " « error;
        });
    };

    // When device is connected, setup connections, and upload/start the experiment
    QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;
        auto& handler = tracker->getInstrumentHandler(INSTRUMENT_NAME);

        connectSignals(handler);

        AisErrorCode error = handler.uploadExperimentToChannel(CHANNEL, customExperiment);
        if (error) {
            qDebug() « error.message();
            return 0;
        }

        error = handler.startUploadedExperiment(CHANNEL);
        if (error) {
            qDebug() « error.message();
            return 0;
        }
    });

    AisErrorCode error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error != error.Success) {
        qDebug() « error.message();
        return 0;
    }

    return a.exec();
}
```

17.3 basicExperiment.cpp

```
#include "AisDeviceTracker.h"
#include "AisExperiment.h"
#include "AisInstrumentHandler.h"

#include "experiments/builder_elements/AisConstantPotElement.h"

#include <QCoreApplication>
#include <QDebug>

// Define relevant device information, for easy access
#define COMPORT "COM1"
#define CHANNEL 0

int main()
{
    char** test = nullptr;
    int args;

    QCoreApplication a(args, test);

    auto tracker = AisDeviceTracker::Instance();

    //       Voltage = 1V, Sampling Interval = 1s, Duration = 30s
    AisConstantPotElement cvElement(1, 1, 30);

    auto customExperiment = std::make_shared<AisExperiment>();
    // Append the constant potential element, and tell it to execute that element 1 time
    customExperiment->appendElement(cvElement, 1);
    auto connectSignals = [=](const AisInstrumentHandler& handler) {
        QObject::connect(&handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel, const
      AisDCData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Current: " « data.current « " Voltage: " «
      data.workingElectrodeVoltage « " CE Voltage : " « data.counterElectrodeVoltage;
        });
        QObject::connect(&handler, &AisInstrumentHandler::activeACDataReady, [=](uint8_t channel, const
      AisACData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Frequency: " « data.frequency « "" «
      data.absoluteImpedance;
        });
        // Whenever a new node in the element starts, note: some Ais Elements contain multiple logical nodes
        // i.e AisCyclicVoltammatryElement contains 4 nodes for each linear segment of each cycle plus a
      quiet time node if enabled
        // So this lambda would be executed atleast 4 times for each cycle
        QObject::connect(&handler, &AisInstrumentHandler::experimentNewElementStarting, [=](uint8_t channel,
      const AisExperimentNode& info) {
            qDebug() « "New element starting: " « info.stepName;
        });
        // Whenever an experiment completes or is manually stopped, this will execute
        QObject::connect(&handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel, const
      QString& reason) {
            qDebug() « "Experiment Stopped Signal " « channel « "Reason : " « reason;
        });
        QObject::connect(&handler, &AisInstrumentHandler::deviceError, [=](uint8_t channel, const QString&
      error) {
            qDebug() « "Device Error: " « error;
        });
    };
    QObject::connect(tracker, &AisDeviceTracker::deviceDisconnected, [=](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;
    });
    QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;
        auto& handler = tracker->getInstrumentHandler(deviceName);

        connectSignals(handler);

        AisErrorCode error = handler.uploadExperimentToChannel(CHANNEL, customExperiment);
        if (error) {
            qDebug() « error.message();
            return;
        }

        // Start the previously uploaded experiment on the same channel
        error = handler.startUploadedExperiment(CHANNEL);

        // Exit the application if there is any error starting the experiment
        if (error) {
            qDebug() « error.message();
            return;
        }
    });
    AisErrorCode error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error != error.Success) {
        qDebug() « error.message();
        return 0;
    }

    // Returning a.axec() executes the event loop, which continues running until the application is exited
    return a.exec();
}
```

17.4 dataOutput.cpp

This example shows how to capture data from the device, and write it to a CSV file using Qt's QFile and QTextStream classes.

```
#include "AisExperiment.h"
#include "AisDeviceTracker.h"
#include "AisInstrumentHandler.h"
#include "experiments/builder_elements/AisConstantCurrentElement.h"
#include "experiments/builder_elements/AisConstantPotElement.h"

#include <QCoreApplication>
#include <QTimer>
#include <QDebug>
#include <QFile>
#include <QStandardPaths>

// Define relevant device information, for easy access
#define COMPORT "COM1"
#define CHANNEL 0

int main()
{
    char** test = nullptr;
    int args;
    QCoreApplication a(args, test);

    auto tracker = AisDeviceTracker::Instance();

    // Build the experiment
```

```
AisConstantPotElement cvElement(
    1,      // voltage: 1v
    1,      // sampling interval: 1s
    30      // duration: 30s
);
AisConstantCurrentElement ccElement(
    0.001,  // current: 1mA
    1,      // sampling interval: 1s
    60      // duration: 60s
);
auto customExperiment = std::make_shared<AisExperiment>();
customExperiment->appendElement(ccElement, 1);
customExperiment->appendElement(cvElement, 1);

// Static QString variable to store the current elements file path
static QString filePath;

// Create a lambda funnction to connect signals to the handler
auto connectSignals = [=](const AisInstrumentHandler& handler) {
    QObject::connect(&handler, &AisInstrumentHandler::experimentNewElementStarting, [=](uint8_t channel,
  const AisExperimentNode& node) {
        // Create a unique file name for each element, with the format
  "stepNumber_stepName_expStartTime.csv"
        static int fileNum = 1;
        auto name = "/" + QString::number(fileNum) + "_" + QString::number(node.stepNumber) + "_" +
  node.stepName + ".csv";
        filePath = QString(QStandardPaths::writableLocation(QStandardPaths::DesktopLocation)) + name;

        QFile file(filePath);
        if (!file.open(QIODevice::WriteOnly | QIODevice::Text))
            return;

        // Writing headers to file
        QTextStream out(&file);
        out « "Time Stamp,"
            « "Counter Electrode Voltage,"
            « "Working Electrode Voltage,"
            « "Current"
            « "\n";
        file.close();

        qDebug() « "New element beginning: " « node.stepName « "step: " « node.stepNumber;
    });

    QObject::connect(&handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel, const
  AisDCData& data) {
        qDebug() « "current :" « data.current « "   voltage: " « data.workingElectrodeVoltage « "
  counter electrode : " « data.counterElectrodeVoltage « "  timestamp : " « data.timestamp;

        // Save the DC data to the file created at element beginning
        QFile file(filePath);
        if (!file.open(QIODevice::Append | QIODevice::WriteOnly | QIODevice::Text))
            return;
        QTextStream out(&file);
        out « data.timestamp « ","
            « data.counterElectrodeVoltage « ","
            « data.workingElectrodeVoltage « ","
            « data.current
            « "\n";
        file.close();
    });

    // The experiment created only uses DC elements, so this will not be executed.
    // However, ac data can be handled and written to a csv like seen above with dc data
    QObject::connect(&handler, &AisInstrumentHandler::activeACDataReady, [=](uint8_t channel, const
  AisACData& data) {
        qDebug() « data.frequency « "         " « data.absoluteImpedance « "        " « data.phaseAngle;
    });

    QObject::connect(&handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel, const
  QString& reason) {
        qDebug() « "Experiment Completed Signal " « channel « "Reason : " « reason;
    });
};

// When device is connected, setup connections, and upload/start the experiment
QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=](const QString& deviceName) {
    auto& handler = tracker->getInstrumentHandler(deviceName);

    connectSignals(handler);

    AisErrorCode error = handler.uploadExperimentToChannel(0, customExperiment);
    if (error) {
        qDebug() « error.message();
        return 0;
        }

        error = handler.startUploadedExperiment(CHANNEL);
        if (error) {
            qDebug() « error.message();
            return 0;
        }
    });

    AisErrorCode error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error != error.Success) {
        qDebug() « error.message();
        return 0;
    }

    return a.exec();
}
```

17.5 firmwareUpdate.cpp

```
#include "AisInstrumentHandler.h"
#include "AisDeviceTracker.h"

#include <QCoreApplication>
#include <QThread>
#include <QDebug>

#define COMPORT "COM1"

int main()
{
    int args;
    QCoreApplication a(args, nullptr);

    auto tracker = AisDeviceTracker::Instance();

    QObject::connect(tracker, &AisDeviceTracker::firmwareUpdateNotification, [=](const QString& message) {
        qDebug() « message;
        if (message.contains("firmware is updated.")) {
            // Now instrument is ready to go
        }
    });

    // Attempt to connect to the device
    auto error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error == AisErrorCode::FirmwareNotSupported) {
        error = tracker->updateFirmwareOnComPort(COMPORT);

        // Some other error occured
        if (error != AisErrorCode::Success) {
            qDebug() « "Error: " « error.message();
        }

    } else if (error != AisErrorCode::Success) {
        qDebug() « "Error: " « error.message();
    } else {
        qDebug() « "Device firmware is up to date";
    }

    return a.exec();
}
```

17.6 linkedChannels.cpp

This example will show you how linked channels can be used to combine the multiple channels on a device, in order to amplify the output for a single experiment. AisInstrumentHandler::setLinkedChannels MUST be called before each experiment that uses paralleled channels. Once linked, these channels must be controlled by ONLY the master channel, which is returned by the AIsInstrumentHandler::setLinkedChannels function.

Note

This feature is only available on Cycler models.

```
#include "AisDeviceTracker.h"
#include "AisExperiment.h"
#include "AisInstrumentHandler.h"

#include "experiments/builder_elements/AisConstantCurrentElement.h"

#include <QCoreApplication>
#include <QDebug>

// Define relevant device information, for easy access
#define COMPORT "COM1"

int main()
{
    char** test = nullptr;
    int args;

    QCoreApplication a(args, test);

    auto tracker = AisDeviceTracker::Instance();

    // Create an experiment
    AisConstantCurrentElement ccElement(10, 1, 30);
    auto customExperiment = std::make_shared<AisExperiment>();
    customExperiment->appendElement(ccElement, 1);

    auto connectSignals = [=](const AisInstrumentHandler& handler) {
        QObject::connect(&handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel, const
      AisDCData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Current: " « data.current « " Voltage: " «
      data.workingElectrodeVoltage « " CE Voltage : " « data.counterElectrodeVoltage;
        });
        QObject::connect(&handler, &AisInstrumentHandler::deviceError, [=](uint8_t channel, const QString&
      error) {
            qDebug() « "Device Error: " « error;
        });
    };

    QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;

        auto& handler = tracker->getInstrumentHandler(deviceName);

        // Here we want to link channels 0 and 1 together, so we pass in a vector of the channels to link
        // It will return which of the channels is the master channel, this should be used to control the
      experiment
        int8_t masterChannel = handler.setLinkedChannels({ 0, 1 });

        connectSignals(handler);

        AisErrorCode error = handler.uploadExperimentToChannel(masterChannel, customExperiment);
        if (error) {
            qDebug() « error.message();
        }

        // Start the previously uploaded experiment on the master channel
        error = handler.startUploadedExperiment(masterChannel);
        if (error) {
            qDebug() « error.message();
            return 0;
        }
    });

    AisErrorCode error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error != error.Success) {
        qDebug() « error.message();
        return 0;
    }
    return a.exec();
}
```

17.7 manualExperiment.cpp

```
#include "AisDeviceTracker.h"
#include "AisInstrumentHandler.h"

#include <QCoreApplication>
```

```
#include <QDebug>

#include <QTimer> // For QTimer::singleShot

// Define relevant device information, for easy access
#define COMPORT "COM1"
#define CHANNEL 0

int main()
{
    char** test = nullptr;
    int args;

    QCoreApplication a(args, test);

    auto tracker = AisDeviceTracker::Instance();

    // Create a lambda function to connect signals to the handler
    auto connectSignals = [=](const AisInstrumentHandler& handler) {
        QObject::connect(&handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel, const
      AisDCData& data) {
            qDebug() « "Timestamp: " « data.timestamp « " Current: " « data.current « " Voltage: " «
      data.workingElectrodeVoltage « " CE Voltage : " « data.counterElectrodeVoltage;
        });
        QObject::connect(&handler, &AisInstrumentHandler::deviceError, [=](uint8_t channel, const QString&
      error) {
            qDebug() « "Device Error: " « error;
        });
        QObject::connect(&handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel, const
      QString& reason) {
            qDebug() « reason;
            qDebug() « "Experiment has ended. Closing application.";
            QCoreApplication::quit();
        });
    };

    // Create a lambda function to run the experiment
    auto runExperiment = [=](const AisInstrumentHandler& handler) {
        //The default starting mode is always Open Circuit Potential
        qDebug() « "Starting manual mode at open circuit potential";
        AisErrorCode error = handler.startManualExperiment(CHANNEL);
        if (error != AisErrorCode::Success) {
            qDebug() « error.message();
            QCoreApplication::quit();
        }

        // In this section we connect singleshot QTimers to lambda functions that call our mode changing
      functions.
        // These lambdas are called asynchronously when the QTimers expire.

        // 5 seconds after starting experiment, change to Constant Current at .1A
        QTimer::singleShot(5000, [=, &handler]() {
            qDebug() « "Switching to constant current at .1A";
            AisErrorCode error = handler.setManualModeConstantCurrent(CHANNEL, .1);
            if (error != AisErrorCode::Success) {
                qDebug() « error.message();
            }
        });

        // 15 seconds after starting experiment, change to Constant Voltage at 1V
        QTimer::singleShot(15000, [=, &handler]() {
            qDebug() « "Switching to constant voltage at 1V";
            AisErrorCode error = handler.setManualModeConstantVoltage(CHANNEL, 1);
            if (error != AisErrorCode::Success) {
                qDebug() « error.message();
            }
        });

        // 25 seconds after starting experiment, change back into Open Circuit Potential mode.
        QTimer::singleShot(25000, [=, &handler]() {
            qDebug() « "Switching to open circuit potential";
            AisErrorCode error = handler.setManualModeOCP(CHANNEL);
            if (error != AisErrorCode::Success) {
                qDebug() « error.message();
            }
        });

        // Stop the experiment after 30 seconds
        QTimer::singleShot(30000, [=, &handler]() {
            qDebug() « "Stopping experiment";
            if (handler.stopExperiment(CHANNEL) != AisErrorCode::Success) {
                qDebug() « error.message();
            }
        });
    };

    QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;

        // When instrument is connected, grab the handler and setup/start the experiment
        auto& handler = tracker->getInstrumentHandler(deviceName);

        connectSignals(handler);
        runExperiment(handler);
    });

    AisErrorCode error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error != error.Success) {
        qDebug() « error.message();
        return 0;
    }

    return a.exec();
}
```

17.8 nonblockingExperiment.cpp

This non blocking example show how we can start and run an experiment, while still being able to process other events. Say there is other logic that needs to be processed while an experiment is running, this example shows how we can continue to process events while our experiment and relavant logic is running. The Admiral Instruments API gives more control of the device and gives you the tools to integrate running our experiments in your pipeline and automating your workflow. Our API lets you programmatically start an experiment, pause an experiment and stop an experiment. For example, you may want to start an experiment, and stop after certain time, and exit the program.

Below is an example for start a manual experiment, stop after 25 s, and exit the program after.

```
#include "AisExperiment.h"
#include "AisDeviceTracker.h"
#include "AisInstrumentHandler.h"
#include "experiments/builder_elements/AisConstantCurrentElement.h"
#include "experiments/builder_elements/AisConstantPotElement.h"
#include <QCoreApplication>
#include <QDebug>
#include <QTimer>

// Define relevant device information, for easy access
#define COMPORT "COM1"
#define CHANNEL 0
#define INSTRUMENT_NAME "Plus2001"

int main()
{
    char** test = nullptr;
    int args;
    QCoreApplication a(args, test);

    auto tracker = AisDeviceTracker::Instance();

    auto createLogic = [=] (const AisInstrumentHandler* handler) {
        QObject::connect(handler, &AisInstrumentHandler::activeDCDataReady,  [=](uint8_t channel, const
      AisDCData& data) {
            qDebug() « "Timestamp : " « data.timestamp « "  Current :" « data.current « "  Voltage: " «
      data.workingElectrodeVoltage « "  CE Voltage: " « data.counterElectrodeVoltage ;
        });

        QObject::connect(handler, &AisInstrumentHandler::activeACDataReady, [=](uint8_t channel, const
      AisACData& data) {
            qDebug() « "Frequency: " « data.frequency « "  Absolute Impedance:" « data.absoluteImpedance « "
      Phase Angle" « data.phaseAngle;
        });

        QObject::connect(handler, &AisInstrumentHandler::experimentNewElementStarting, [=](uint8_t channel,
      const AisExperimentNode& nodeInfo) {
            qDebug() « "New Node beging ";
        });

        QObject::connect(handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel, const
      QString& reason) {
            qDebug() « "Experiment Completd Signal " « channel « "Reason: " « reason;
        });
    };

    QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, [=, &a](const QString& deviceName) {
        qDebug() « "New Device Connected: " « deviceName;

        auto& handler = tracker->getInstrumentHandler(INSTRUMENT_NAME);

        createLogic(&handler);

        auto error = handler.startManualExperiment(CHANNEL);
        if (error) {
            qDebug() « error.message();
            return;
        }
        error = handler.setManualModeSamplingInterval(CHANNEL, 2);
        if (error) {
            qDebug() « error.message();
            return;
        }

        error = handler.setManualModeConstantVoltage(CHANNEL, 2);
        if (error) {
            qDebug() « error.message();
            return;
        }
        QTimer::singleShot(25000, [=, &handler]() {
            auto error = handler.stopExperiment(CHANNEL);
            if (error) {
                qDebug() « error.message();
                return;
            }
        });

        // Allow the event loop to process other events while the current experiment is running
        // isChannelBusy will return true while the channel is running an experiment
        while (handler.isChannelBusy(CHANNEL)) {
            a.processEvents();
        }

        // Process any remaining events
        a.processEvents();
    });

    auto connectdevices = tracker->connectAllPluggedInDevices();
    if (connectdevices == 0)
    {
        qDebug() « "No devices connected";
        return 0;
    }

    return 0;
}
```

17.9 pulseData.cpp

This example demonstrates how to use the AisDataManipulator class to calculate advanced parameters from raw DC data recieved from pulse experiments.

```
#include "AisDeviceTracker.h"
#include "AisInstrumentHandler.h"
#include "AisExperiment.h"
#include "AisDataManipulator.h"

#include "experiments/builder_elements/AisDiffPulseVoltammetryElement.h"

#include <QCoreApplication>
#include <QTimer>
#include <QDebug>

// Define relevant device information, for easy access
#define COMPORT "COM1"
#define CHANNEL 0

int main()
{
    char** test = nullptr;
    int args;
    QCoreApplication a(args, test);
    auto tracker = AisDeviceTracker::Instance();

    // Create the AisDiffPulseVoltammetryElement element and add it to the experiment
    std::shared_ptr<AisExperiment> experiment = nullptr;
    AisDiffPulseVoltammetryElement dpv_element(-0.4, 0.5, 0.01, 0.1, 0.1, 0.45);
    dpv_element.setStartVoltageVsOCP(false);
    dpv_element.setEndVoltageVsOCP(false);
    dpv_element.setApproxMaxCurrent(0.001);
    experiment = std::make_shared<AisExperiment>();
    experiment->appendElement(dpv_element, 1);

     // Create an `AisDataManipulator` class for calculating advance parameters.
    std::shared_ptr<AisDataManipulator> dataManipulator = std::make_shared<AisDataManipulator>();
    dataManipulator->setPulseType(AisPulseType::DifferentialPulse, dpv_element.getPulseWidth(),
      dpv_element.getPulsePeriod());

    auto connectSignals = [=](const AisInstrumentHandler* handler) {
        QObject::connect(handler, &AisInstrumentHandler::activeDCDataReady, [=](uint8_t channel, const
      AisDCData& data) {
            auto utcTime = handler->getExperimentUTCStartTime(0);

            dataManipulator->loadPrimaryData(data);

            if (dataManipulator->isPulseCompleted()) {
                static bool writeheader = true;

                if (writeheader) {

                    qDebug() « "time"
                             « ", Pulse_current"
                             « ", base_current"
                             « ", diff_current"
                             « ", base_voltage"
                             « ", pulse_volatge";
                    writeheader = false;
                }
                qDebug() « data.timestamp « ", " « dataManipulator->getPulseCurrent() « ", " «
      dataManipulator->getBaseCurrent() « ", " « dataManipulator->getPulseCurrent() -
      dataManipulator->getBaseCurrent() « ", " « dataManipulator->getBaseVoltage() « "," «
      dataManipulator->getPulseVoltage();
            }
        });

        QObject::connect(handler, &AisInstrumentHandler::activeACDataReady, [=](uint8_t channel, const
      AisACData& data) {
            qDebug() « "channel: " « (int)channel « "frequency :" « data.frequency « "   absoluteImpedance:
      " « data.absoluteImpedance « "   phaseAngle : " « data.phaseAngle « "  timestamp : " « data.timestamp;
        });

        QObject::connect(handler, &AisInstrumentHandler::experimentNewElementStarting, [=](uint8_t channel,
      const AisExperimentNode& data) {
            qDebug() « "New Node beginning " « data.stepName « " step number  " « data.stepNumber « " step
      sub : " « data.substepNumber;
        });

        QObject::connect(handler, &AisInstrumentHandler::experimentStopped, [=](uint8_t channel, const
      QString& reason) {
            qDebug() « "Experiment Completed Signal " « channel « "Reason : " « reason;
        });
        QObject::connect(handler, &AisInstrumentHandler::experimentPaused, [=](uint8_t channel) {
            qDebug() « "Experiment Paused " « channel;
        });
        QObject::connect(handler, &AisInstrumentHandler::experimentResumed, [=](uint8_t channel) {
            qDebug() « "Experiment Resume " « channel;
        });
    };

    QObject::connect(tracker, &AisDeviceTracker::newDeviceConnected, &a, [=](const QString& deviceName) {
        auto& handler = tracker->getInstrumentHandler(deviceName);
        connectSignals(&handler);
        {
            std::shared_ptr<AisExperiment> deleteExp = std::make_shared<AisExperiment>(*experiment);
            auto error = handler.uploadExperimentToChannel(CHANNEL, deleteExp);
            if (error) {
                qDebug() « "Error: " « error.message();
            }
        }
        auto error = handler.startUploadedExperiment(0);
        if (error) {
            qDebug() « "Error: " « error.message();
        }
    });

    QObject::connect(tracker, &AisDeviceTracker::deviceDisconnected, &a, [=](const QString& deviceName) {
        qDebug() « deviceName « "is disconnected ";
    });

    auto error = tracker->connectToDeviceOnComPort(COMPORT);
    if (error) {
        qDebug() « "Error: " « error.message();
    }

    a.exec();
```

```
}
```

17.10 advancedExperiment.py

```
"""! @example advancedExperiment.py """
#! [Setup]
import sys
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker, AisExperiment, AisInstrumentHandler, AisErrorCode, AisOpenCircuitElement, AisConstantPotElement, AisConstantCurrentElement, AisEISGalvanostaticElement

#Define relavant device information, for easy access
COMPORT = "COM1"
CHANNEL = 0
INSTRUMENT_NAME = "Plus2000"

app = QApplication()

tracker = AisDeviceTracker.Instance()

success = True

customExperiment = AisExperiment()
# Step 1

ocpElement = AisOpenCircuitElement(1, 10)
success &= customExperiment.appendElement(ocpElement)

voltage = 0
for i in range(0, 4):
    cvElement = AisConstantPotElement(voltage, 0.1, 5)
    success &= customExperiment.appendElement(cvElement, 1)
    voltage = voltage + 0.1

eisSubExperiment = AisExperiment()

galvEISElement = AisEISGalvanostaticElement(10, 10000, 10, 0.01, 0.1)
ocpElement2 = AisOpenCircuitElement(1, 5)

success &= eisSubExperiment.appendElement(galvEISElement, 1)
success &= eisSubExperiment.appendElement(ocpElement2, 1)

success &= customExperiment.appendSubExperiment(eisSubExperiment, 3)

ccElement = AisConstantCurrentElement(0.1, 1, 10)
success &= customExperiment.appendElement(ccElement, 2)

if not success:
    print("Error building experiment")
    sys.exit()


# When device is connected, setup connections, and upload/start the experiment
def connectSignals(handler):
    handler.activeDCDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Current: {data.current} Voltage: {data.workingElectrodeVoltage} CE Voltage : {data.counterElectrodeVoltage}"))
    handler.activeACDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Frequency: {data.frequency} Absolute Impedance: {data.absoluteImpedance}"))
    handler.experimentNewElementStarting.connect(lambda channel, info: print(f"New element starting: {info.stepName}"))
    handler.experimentStopped.connect(lambda channel, reason: (print(f"Experiment Stopped Signal {channel}, {reason}"), app.quit()))
    handler.deviceError.connect(lambda channel, error: print(f"Device Error: {error}"))


def startExperiment():
    handler = tracker.getInstrumentHandler(INSTRUMENT_NAME)

    connectSignals(handler)

    error = handler.uploadExperimentToChannel(CHANNEL, customExperiment)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    error = handler.startUploadedExperiment(CHANNEL)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

tracker.newDeviceConnected.connect(startExperiment)

```

```
error = tracker.connectToDeviceOnComPort(COMPORT)
if error.value() != AisErrorCode.Success:
    print(error.message())
    sys.exit()


sys.exit(app.exec())
```

17.11 async.py

```
"""! @example async.py """
import sys
import struct
import asyncio
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisCompRange
from SquidstatPyLibrary import AisDCData
from SquidstatPyLibrary import AisACData
from SquidstatPyLibrary import AisExperimentNode
from SquidstatPyLibrary import AisErrorCode
from SquidstatPyLibrary import AisExperiment
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisConstantPotElement
from SquidstatPyLibrary import AisEISPotentiostaticElement
from SquidstatPyLibrary import AisConstantCurrentElement

# initialize the application
app = QApplication([])

# Add delay before quitting
async def delayed_quit():
    await asyncio.sleep(5)
    app.quit()

# function to print when experiment has completed
def experiment_complete_handler(channel, reason):
    print(f"Experiment Completed on channel {channel} , {reason}")
    asyncio.run(delayed_quit())


# main function setup as async
async def main():
    # initialize a device tracker
    tracker = AisDeviceTracker.Instance()
    # connect to device associated with the tracker
    # print device serial number
    tracker.newDeviceConnected.connect(lambda deviceName: print(f"Connected Device: {deviceName}"))
    # connect to device on com port 4
    error = tracker.connectToDeviceOnComPort("COM4")
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    # Add initial delay before asking for hanlder (5 s)
    await asyncio.sleep(5)

    # use serial number to get handler for instrument
    handler = tracker.getInstrumentHandler("Cycler1518")
    # manages DC data input and output
    # add more variables if you want to print more data to the console
    handler.activeDCDataReady.connect(lambda channel, data: print("timestamp:",
"{:.9f}".format(data.timestamp), "workingElectrodeVoltage: ",
"{:.9f}".format(data.workingElectrodeVoltage)))
    # manages AC data input and output
    # add more variables if you want to print more data to the console
    handler.activeACDataReady.connect(lambda channel, data: print("frequency:",
"{:.9f}".format(data.frequency), "absoluteImpedance: ", "{:.9f}".format(data.absoluteImpedance),
"phaseAngle: ", "{:.9f}".format(data.phaseAngle)))
    # print when a new node starts to the console
    handler.experimentNewElementStarting.connect(lambda channel, data: print("New Node beginning:",
data.stepName, "step number: ", data.stepNumber, " step sub : ", data.substepNumber))
    # called when an experiment has completed
    handler.experimentStopped.connect(experiment_complete_handler)

    # initialize an experiment
    experiment = AisExperiment()
    # define a constant potential experiment at 0.2 V, with 1 s sampling time, and a duration of 10 s
    cvElement = AisConstantPotElement(0.2, 1, 10)
    # define a constant current experiment at 0.1 A, with 0.1 s sampling time, and a duration of 5 s
    ccElement = AisConstantCurrentElement(0.1, 0.1, 5)

    success = True

    # initialize a sub experiment
    subExperiment = AisExperiment()
    # add constant current experiment to position 1 of the sub experiment
    # this experiment will run 1 time
    success &= subExperiment.appendElement(ccElement, 1)
    # add constant potential experiment to positions 2 and 3 of the sub experiment
    # this experiment will run 2 times
    success &= subExperiment.appendElement(cvElement, 2)

    # add constant current experiment to position 1 and 2 of the main experiment
    # this experiment will run 2 times
    success &= experiment.appendElement(ccElement, 2)
    # add constant potential experiment to position 3 of the main experiment
    # this experiment will run 1 time
    success &= experiment.appendElement(cvElement, 1)

    # add the sub experiment to the main experiment
    # the sub experiment will run 2 times
    success &= experiment.appendSubExperiment(subExperiment, 2)

    if not success:
        print("Error building experiment")
        app.quit()

    # upload experiment list to the given channel
    error = handler.uploadExperimentToChannel(0, experiment)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    # start the expiment on channel
    error = handler.startUploadedExperiment(0)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    # Add initial delay (5 s)
    await asyncio.sleep(5)

# setup main to be ran as async
startFunc = main()
asyncio.run(startFunc)

# exit application
sys.exit(app.exec())  # Start the event loop

```

17.12 basicExperiment.py

```
"""! @example basicExperiment.py """

import sys
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisExperiment, AisErrorCode
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisConstantPotElement

# Define relavant device information, for easy access
COMPORT = "COM16"
CHANNEL = 0

app = QApplication()

tracker = AisDeviceTracker.Instance()



cvElement = AisConstantPotElement(1, 1, 30)

# After this point, the experiment is empty, so we need to add some elements to it
experiment = AisExperiment()
# Append the constant potential element, and tell the experiment to execute that element 1 time
success = experiment.appendElement(cvElement, 1)

# Check if the element was added successfully
if not success:
    print("Error adding element to experiment")
    app.quit()



```

```python
def connectSignals(handler):

    handler.activeDCDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Current: {data.current} Voltage: {data.workingElectrodeVoltage} CE Voltage : {data.counterElectrodeVoltage}"))
    handler.activeACDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Frequency: {data.frequency} Absolute Impedance: {data.absoluteImpedance}"))


    # Whenever a new node in the element starts, note: some Ais Elements contain multiple logical nodes
    # i.e AisCyclicVoltammatryElement contains 4 nodes for each linear segment of each cycle plus a quiet time node if enabled
    # So this lambda would be executed atleast 4 times for each cycle
    handler.experimentNewElementStarting.connect(lambda channel, info: print(f"New element starting: {info.stepName}"))
    # Whenever an experiment completes or is manually stopped, this will execute
    handler.experimentStopped.connect(lambda channel, reason: (print(f"Experiment Stopped Signal {channel}, {reason}"), app.quit()))
    handler.deviceError.connect(lambda channel, error: print(f"Device Error: {error}"))


def startExperiment(deviceName):
    print(f"New Device Connected: {deviceName}")

    handler = tracker.getInstrumentHandler(deviceName)

    connectSignals(handler)

    error = handler.uploadExperimentToChannel(CHANNEL, experiment)
    # Exit the application if there is any error uploading experiment
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    error = handler.startUploadedExperiment(CHANNEL)
    # Exit the application if there is any error starting experiment
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()



tracker.newDeviceConnected.connect(startExperiment)
tracker.deviceDisconnected.connect(lambda deviceName: print(f"Device Disconnected: {deviceName}"))



error = tracker.connectToDeviceOnComPort(COMPORT)
# Check if connection was successful
if error.value() != AisErrorCode.Success:
    print(error.message())
    sys.exit()


# Calling sys.exit(app.exec()) will keep the program running until the application is exited
sys.exit(app.exec())
```

17.13 dataOutput.py

```python
"""! @example dataOutput.py """
import sys
from PySide6.QtWidgets import QApplication
from PySide6.QtCore import  QTextStream, QFile, QStandardPaths, QIODevice
from SquidstatPyLibrary import AisDeviceTracker, AisErrorCode
from SquidstatPyLibrary import AisExperiment
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisConstantPotElement
from SquidstatPyLibrary import AisConstantCurrentElement

# Define relavant device information, for easy access
COMPORT = "COM1"
CHANNEL = 0

app = QApplication()

tracker = AisDeviceTracker.Instance()

cvElement = AisConstantPotElement(1, 1, 30)
ccElement = AisConstantCurrentElement(0.001, 1, 60)

experiment = AisExperiment()

```

```
success = True

success &= experiment.appendElement(cvElement, 1)
success &= experiment.appendElement(ccElement, 1)

if not success:
    print("Error building experiment")
    sys.exit()

filePath = ""
fileNum = 1

def onNewElementStarting(channel, info):
    name = f"/{fileNum}_{info.stepNumber}_{info.stepName}.csv"
    filePath = QStandardPaths.writableLocation(QStandardPaths.DesktopLocation) + name

    file = QFile(filePath)
    if not file.open(QIODevice.WriteOnly | QIODevice.Text):
        return

    # Writing headers to file
    out = QTextStream(file)
    out « "Time Stamp, Counter Electrode Voltage, Working Electrode Voltage, Current \n"
    file.close()

    print(f"New element beginning: {info.stepName} step: {info.stepNumber}")

def onActiveDCDataReady(channel, data):
    print(f"current: {data.current}  voltage: {data.workingElectrodeVoltage}  counter electrode: {data.counterElectrodeVoltage}  timestamp: {data.timestamp}")

    # Save the DC data to the file created at element beginning
    file = QFile(filePath)
    if not file.open(QIODevice.Append | QIODevice.WriteOnly | QIODevice.Text):
        return

    out = QTextStream(file)
    out « data.timestamp « ","« data.counterElectrodeVoltage « "," « data.workingElectrodeVoltage « "," « data.current « "\n"
    file.close()

def connectSignals(handler):
    handler.activeDCDataReady.connect(onActiveDCDataReady)
    handler.activeACDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Frequency: {data.frequency} Absolute Impedance: {data.absoluteImpedance}"))
    handler.experimentNewElementStarting.connect(onNewElementStarting)
    handler.experimentStopped.connect(lambda channel, reason: (print(f"Experiment Stopped Signal {channel}, {reason}"), app.quit()))
    handler.deviceError.connect(lambda channel, error: print(f"Device Error: {error}"))

def runExperiment(deviceName):
    handler = tracker.getInstrumentHandler(deviceName)

    connectSignals(handler)

    error = handler.uploadExperimentToChannel(CHANNEL, experiment)
    # Exit the application if there is any error uploading experiment
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    error = handler.startUploadedExperiment(CHANNEL)
    # Exit the application if there is any error starting experiment
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

tracker.newDeviceConnected.connect(runExperiment)
tracker.deviceDisconnected.connect(lambda deviceName: print(f"Device Disconnected: {deviceName}"))

error = tracker.connectToDeviceOnComPort(COMPORT)
# Check if connection was successful
if error.value() != AisErrorCode.Success:
    print(error.message())
    sys.exit()

# Calling sys.exit(app.exec()) will keep the program running until the application is exited
sys.exit(app.exec())
```

17.14 firmwareUpdate.py

```
"""! @example firmwareUpdate.py """

```

```python
import sys
from PySide6.QtWidgets import QApplication

from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisErrorCode

# Define relavant device information, for easy access
COMPORT = "COM16"

app = QApplication()

tracker = AisDeviceTracker.Instance()

def onProgressMessage(message):
    print(message)
    if message.__contains__("firmware is updated"):
        app.quit()


tracker.firmwareUpdateNotification.connect(onProgressMessage)


# Attempt to connect to the device
error = tracker.connectToDeviceOnComPort(COMPORT)
if error.value() == AisErrorCode.FirmwareNotSupported:
    error = tracker.updateFirmwareOnComPort(COMPORT)

    # Some other error occured
    if error.value() != AisErrorCode.Success:
        print(f"Error: {error.message()}")
        sys.exit()
elif error.value() != AisErrorCode.Success:
    print(f"Error: {error.message()}")
    sys.exit()
else:
    print("Device is already up to date.")
    sys.exit()

sys.exit(app.exec())

```

17.15 linkedChannels.py

This example will show you how linked channels can be used to combine the multiple channels on a device, in order to amplify the output for a single experiment.

This example will show you how linked channels can be used to combine the multiple channels on a device, in order to amplify the output for a single experiment. AisInstrumentHandler.setLinkedChannels MUST be called before each experiment that uses paralleled channels. Once linked, these channels must be controlled by ONLY the master channel, which is returned by the AIsInstrumentHandler::setLinkedChannels function.

Note

This feature is only available on Cycler models.

```python
"""! @example linkedChannels.py
    This example will show you how linked channels can be used to combine the multiple channels on a device, in order to amplify the output for a single experiment.
    AisInstrumentHandler::setLinkedChannels MUST be called before each experiment that uses paralleled channels.
    Once linked, these channels must be controlled by ONLY the master channel, which is returned by the AIsInstrumentHandler::setLinkedChannels function.

    @note This feature is only available on Cycler models.
"""
import sys
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker, AisInstrumentHandler, AisErrorCode, AisConstantCurrentElement, AisExperiment

# Define relavant device information, for easy access
COMPORT = "COM1"

app = QApplication()

```

```
tracker = AisDeviceTracker.Instance()

# Build an experiment
ccElement = AisConstantCurrentElement(10, 1, 30)
experiment = AisExperiment()
success = experiment.appendElement(ccElement)

if not success:
    print("Error adding element to experiment")
    app.quit()

def connectSignals(handler):
    handler.activeDCDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Current: {data.current} Voltage: {data.workingElectrodeVoltage} CE Voltage : {data.counterElectrodeVoltage}"))
    handler.deviceError.connect(lambda channel, error: print(f"Device Error: {error}"))
    handler.experimentStopped.connect(lambda channel, reason: (print(f"Experiment Stopped Signal {channel}, {reason}"), app.quit()))

def startExperiment(deviceName):
    handler = tracker.getInstrumentHandler(deviceName)

    # Here we want to link channels 0 and 1 together, so we pass in a vector of the channels to link
    # It will return which of the channels is the master channel, this should be used to control the experiment
    masterChannel = handler.setLinkedChannels([ 0, 1 ])

    connectSignals(handler)

    error = handler.uploadExperimentToChannel(masterChannel, experiment)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    # Start the previously uploaded experiment on the master channel
    error = handler.startUploadedExperiment(masterChannel)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()


tracker.newDeviceConnected.connect(startExperiment)
tracker.deviceDisconnected.connect(lambda deviceName: print(f"Device Disconnected: {deviceName}"))

error = tracker.connectToDeviceOnComPort(COMPORT)
if error.value() != AisErrorCode.Success:
    print(error.message())
    sys.exit()
# Calling sys.exit(app.exec()) will keep the program running until the application is exited
sys.exit(app.exec())
```

17.16 manualExperiment.py

```
"""! @example manualExperiment.py """
import sys
from PySide6.QtWidgets import QApplication
from PySide6.QtCore import QTimer
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisErrorCode


# Define relavant device information, for easy access
COMPORT = "COM1"
CHANNEL = 0

app = QApplication()

tracker = AisDeviceTracker.Instance()

def handleStopExperiment(handler, reason):
    print(reason)
    print("Experiment has ended. Closing application.")
    app.quit()


def connectSignal(handler):
    handler.activeDCDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Current: {data.current} Voltage: {data.workingElectrodeVoltage} CE Voltage : {data.counterElectrodeVoltage}"))
    handler.deviceError.connect(lambda channel, error: print(f"Device Error: {error}"))
    handler.experimentStopped.connect(handleStopExperiment)

```

```
def startExperiment(deviceName):
    handler = tracker.getInstrumentHandler(deviceName)

    connectSignal(handler)



    # The default starting mode is always Open Circut Potential.

    print("Starting manual mode at open circuit potential")
    error = handler.startManualExperiment(CHANNEL)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()




    # In this section we create wrapper functions for the manual mode changing functions.
    # These wrappers are called asynchronously when singleshot QTimers expire.

    # This function changes the instrument to Constant Current at .1A
    def setConstantCurrent(channel):
        print("Switching to constant current at .1A")
        error = handler.setManualModeConstantCurrent(channel, .1)
        if error.value() != AisErrorCode.Success:
            print(error.message())
    # It is called 5 seconds after the experiment starts
    QTimer.singleShot(5000, lambda:setConstantCurrent(CHANNEL))

    # This function changes the instrument to Constant Voltage at 1V
    def setConstantVoltage(channel):
        print("Switching to constant voltage at 1V")
        error = handler.setManualModeConstantVoltage(channel, 1)
        if error.value() != AisErrorCode.Success:
            print(error.message())
    # It is called 15 seconds after the experiment starts
    QTimer.singleShot(15000, lambda:setConstantVoltage(CHANNEL))

    # This function changes the instrument to Open Circuit Potential
    def setOpenCircuit(channel):
        print("Switching to open circuit potential")
        error = handler.setManualModeOCP(channel)
        if error.value() != AisErrorCode.Success:
            print(error.message())
    # It is called 25 seconds after the experiment starts
    QTimer.singleShot(25000, lambda:setOpenCircuit(CHANNEL))





    # Stop experiment after 30 seconds
    def stopExperiment(channel):
        print("Stopping experiment.")
        error = handler.stopExperiment(channel)
        if error.value() != AisErrorCode.Success:
            print(error.message())
    QTimer.singleShot(30000, lambda:stopExperiment(CHANNEL))



tracker.newDeviceConnected.connect(startExperiment)
tracker.deviceDisconnected.connect(lambda deviceName: print(f"Device Disconnected: {deviceName}"))

error = tracker.connectToDeviceOnComPort(COMPORT)
if error.value() != AisErrorCode.Success:
    print(error.message())
    sys.exit()
# Calling sys.exit(app.exec()) will keep the program running until the application is exited
sys.exit(app.exec())
```

17.17 nonblockingExperiment.py

```
"""! @example nonblockingExperiment.py """
import sys
from PySide6.QtWidgets import QApplication
from PySide6.QtCore import QTimer
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisErrorCode


```

```
# Define relavant device information, for easy access

CHANNEL = 0

app = QApplication()

tracker = AisDeviceTracker.Instance()

def connectSignals(handler):
    handler.activeDCDataReady.connect(lambda channel, data: print(f"Timestamp: {data.timestamp} Current: {data.current} Voltage: {data.workingElectrodeVoltage} CE Voltage : {data.counterElectrodeVoltage}"))
    handler.activeACDataReady.connect(lambda channel, data: print(f"Frequency: {data.frequency} Absolute Impedance: {data.absoluteImpedance} Phase Angle: {data.phaseAngle}"))
    handler.experimentNewElementStarting.connect(lambda channel, nodeInfo: print(f"New Node Beginning"))
    handler.experimentStopped.connect(lambda channel, reason: print(f"Experiment Stopped Signal {channel}, {reason}"))

def startExperiment(deviceName):
    handler = tracker.getInstrumentHandler(deviceName)

    connectSignals(handler)

    error = handler.startManualExperiment(CHANNEL)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    error = handler.setManualModeSamplingInterval(CHANNEL, 2)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    error = handler.setManualModeConstantVoltage(CHANNEL, 2)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    error = handler.setManualModeOCP(CHANNEL)
    if error.value() != AisErrorCode.Success:
        print(error.message())
        app.quit()

    def stopExperiment():
        error = handler.stopExperiment(CHANNEL)
        if error.value() != AisErrorCode.Success:
            print(error.message())
            app.quit()

    QTimer.singleShot(25000, stopExperiment)

    # Allow the recent loop to process other events while the current experiment is running
    while handler.isChannelBusy(CHANNEL):
        app.processEvents()

    # Process any remaining events
    app.processEvents()

tracker.newDeviceConnected.connect(startExperiment)

numDevices = tracker.connectAllPluggedInDevices()
if numDevices == 0:
    print("No devices connected")
    sys.exit()

# Calling sys.exit(app.exec()) will keep the program running until the application is exited
sys.exit(app.exec())
```

17.18 pulseData.py

```
"""! @example pulseData.py """

import sys
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisCompRange
from SquidstatPyLibrary import AisDCData
from SquidstatPyLibrary import AisACData
from SquidstatPyLibrary import AisExperimentNode
from SquidstatPyLibrary import AisErrorCode
from SquidstatPyLibrary import AisExperiment
from SquidstatPyLibrary import AisInstrumentHandler
from SquidstatPyLibrary import AisCyclicVoltammetryElement
from SquidstatPyLibrary import AisDiffPulseVoltammetryElement
from SquidstatPyLibrary import AisDataManipulator
from SquidstatPyLibrary import AisPulseType

# do you want headers in your file?
write_header = True
# instantiate the data manipulator
data_manipulator = AisDataManipulator()
# setup COM port
COMPORT = "COM5"
CHANNEL = 0

def create_logic(handler):
    def on_active_dc_data_ready(channel, data):
        # define global parameters
        global write_header, data_manipulator

        # convert time to UTC
        # utc_time = handler.getExperimentUTCStartTime(0)
        # read data via data manipulator
        data_manipulator.loadPrimaryData(data)

        # upon completed pulse, write data with header
        if data_manipulator.isPulseCompleted():

            # if write_header = true
            # prints header for every pulse data point
            if write_header:
                print("time, Pulse_current, base_current, diff_current, base_voltage, pulse_voltage")
                write_header = False

            # will print data as defined by the header print statement above
            print(f"{data.timestamp}, {data_manipulator.getPulseCurrent()}, {data_manipulator.getBaseCurrent()}, "
                f"{data_manipulator.getPulseCurrent() - data_manipulator.getBaseCurrent()}, "
                f"{data_manipulator.getBaseVoltage()}, {data_manipulator.getPulseVoltage()}")

    # function for printing ac data when it is received
    def on_active_ac_data_ready(channel, data):
        print(f"channel: {channel}, frequency: {data.frequency}, absoluteImpedance: {data.absoluteImpedance}, "
            f"phaseAngle: {data.phaseAngle}, timestamp: {data.timestamp}")

    # function for printing a new node when it begins
    def on_experiment_new_element_starting(channel, data):
        print(f"New Node beginning {data.stepName}, step number {data.stepNumber}, step sub: {data.substepNumber}")

    # fucntion for printing an experiment has stopped
    def on_experiment_stopped(channel, reason):
        print(f"Experiment has completed on channel {channel}, {reason}")
        QApplication.quit()

    # function to print an experiment has paused
    def on_experiment_paused(channel):
        print(f"Experiment on channel {channel} has been paused")

    # function to print an experiment has resumed
    def on_experiment_resumed(channel):
        print(f"Experiment resumed on channel {channel}")

    # pass dc data to data manipulator function
    handler.activeDCDataReady.connect(on_active_dc_data_ready)

    # pass ac data to print function
    handler.activeACDataReady.connect(on_active_ac_data_ready)

    # pass new node starting to print function
    handler.experimentNewElementStarting.connect(on_experiment_new_element_starting)

    # pass experiment stopped to print function
    handler.experimentStopped.connect(on_experiment_stopped)

    # pass experiment puased to print function
    handler.experimentPaused.connect(on_experiment_paused)
    handler.experimentResumed.connect(on_experiment_resumed)

# setup experiment
def main():
    # initialize the application
    app = QApplication()

    # get a device tracker
    tracker = AisDeviceTracker.Instance()

    # Create the AisDiffPulseVoltammetryElement pulse experiment.
    # startPotential (V), endPotential (V), potentialStep (V), pulseHeight (V), pulseWidth (s), pulsePeriod (s)
    dpv_element = AisDiffPulseVoltammetryElement(-0.115, 0.115, 0.005, 0.01, 0.02, 0.2)

    # set start voltage VS reference
    dpv_element.setStartVoltageVsOCP(False)

    # set end voltage VS reference
    dpv_element.setEndVoltageVsOCP(False)

    # set current range
    # will range up, but will not range down
    dpv_element.setApproxMaxCurrent(0.2)

    # initialize an experiment
    experiment = AisExperiment()

    # append differential pulse element to the experiment list
    # will run 1 time
    success = experiment.appendElement(dpv_element, 1)
    if not success:
        print("Error building experiment")
        sys.exit()

    # Create an `AisDataManipulator` class for calculating advance parameters.
    data_manipulator.setPulseType(AisPulseType.DifferentialPulse, dpv_element.getPulseWidth(), dpv_element.getPulsePeriod())

    # if device is connected, get name and use logic function to handle events
    def on_new_device_connected(device_name):

        # get instrument handler using device name
        handler = tracker.getInstrumentHandler(device_name)

        # create the required connections for the handler.
        create_logic(handler)

        # uplaod experiment to device.
        error = handler.uploadExperimentToChannel(CHANNEL, experiment)
        if error.value() != AisErrorCode.ErrorCode.Success:
            print(f"Error: {error.message()}")
            app.quit()

        # start experiment on device on defined channel
        error = handler.startUploadedExperiment(CHANNEL)
        if error.value() != AisErrorCode.ErrorCode.Success:
            print(f"Error: {error.message()}")
            app.quit()

    # connect call back handler which is called on connection of device.
    tracker.newDeviceConnected.connect(on_new_device_connected)

    # print which device has disconnected to terminal
    tracker.deviceDisconnected.connect(lambda device_name: print(f"{device_name} has been disconnected"))

    # if error is encountered, print to terminal
    error = tracker.connectToDeviceOnComPort(COMPORT)
    if error.value() != AisErrorCode.ErrorCode.Success:
        print(f"Error: {error.message()}")
        sys.exit()

    # exit application
    sys.exit(app.exec())

# run main
if __name__ == "__main__":
    main()
```

17.19 tcpClient.py

This example file shows how to create a TCP client which can send commands to a server that is connected to a Squidstat.

This example file shows how to create a TCP client which can send commands to a server that is connected to a Squidstat.You can build experiments and recieve data from the server without having to interact with the instrument directly.

```
"""! @example tcpClient.py This example file shows how to create a TCP client which can send commands to a server that is connected to a Squidstat.
```

```

You can build experiments and recieve data from the server without having to interact with the instrument directly.
"""

import os
import socket
import threading
import time

# Create a TCP/IP socket
client_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
activeSockets = [client_socket]

# Define the server address and port
SERVER_HOST = "localhost"
SERVER_PORT = 12345

# Function to send a command to the server
def send_command(command):
    # Send the command to the server
    try:
        client_socket.send(command.encode())
    except:
        print("Connection was closed by host")
        os._exit(1)

    # Receive and print the response from the server
    response = client_socket.recv(1024).decode()
    print("Server response:", response)

# listens for <CTRL>+c to stop the client script
def interupt_listener():
    print("Press <CTRL>+c to stop the program at any time.")
    try:
        while True:
            input()
    except (EOFError, KeyboardInterrupt):
        pass
    for socket in activeSockets:
        socket.close()
    os._exit(1)

# Try and open a socket to the server
try:
    client_socket.connect((SERVER_HOST, SERVER_PORT))
except Exception as ex:
    print("Unable to establish connection to server:\n%s" % ex)
    exit()

print("Connected to the server.")

# Get a duration from the user
duration = 0
while duration == 0:
    try:
        duration = int(input("Enter a duration for Open Circuit Potential: "))
    except ValueError:
        duration = 0
    if(duration < 1):
        print("Invalid entry.")
        duration = 0

# Send the start command to the server with the duration
send_command(f'startExperiment {duration}')

interupt_thread = threading.Thread(target=interupt_listener)
interupt_thread.start()

# Listen for information from the server, which at this point will be data and the experiment stop message
while True:
    try:
        data = client_socket.recv(1024).decode()
    except (ConnectionAbortedError, BrokenPipeError):
        # This exception will be raised when the user presses <ENTER>
        print("Finishing connection")
        break
    except ConnectionResetError:
        print("The server closed the connection suddenly.")
        break

    if not data:
        break

    # Handle the data that was received.
    print(data)

    if("Experiment Completed: " in data):
        break

os._exit(1)
```

17.20 tcpServer.py

This example file shows how to create a server that connects to an instrument.

This example file shows how to create a server that connects to an instrument.It can recieve TCP commands from a client to trigger experiments and send data back to the client.

```
"""! @example tcpServer.py
@brief This example file shows how to create a server that connects to an instrument.

It can recieve TCP commands from a client to trigger experiments and send data back to the client.
"""
import os
import socket
import threading
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisExperiment
from SquidstatPyLibrary import AisOpenCircuitElement
from SquidstatPyLibrary import AisErrorCode

# Define the server address and port
HOST = ’localhost’
PORT = 12345

# The COM port the Squidstat is connected to
SQUIDCOMPORT = "COM1"
SQUIDNAME = "Plus2000"

# Create the QT application
app = QApplication([])
activeSockets = []

# This will build and start the Open Circuit Potential experiment
def start_ocp_experiment(handler, durationSec=60):
    # Create an experiment with elements
    experiment = AisExperiment()
    ocpElement = AisOpenCircuitElement(durationSec, 1)

    success = experiment.appendElement(ocpElement, 1)
    if not success:
        print("Error adding element to experiment")
        return error.ExperimentNotUploaded

    # Upload the experiment to channel 0
    error = handler.uploadExperimentToChannel(0, experiment)
    if error.value() != AisErrorCode.ErrorCode.Success:
        return error

    # Start the experiment
    return(handler.startUploadedExperiment(0))

# Send a specified command to our Squidstat
def command_to_device(command, handler):
    #Check if we had an argument associated with the command
    splitCommand = command.split(" ")
    action = splitCommand[0]
    actionArg = 0
    if(len(splitCommand) > 1):
        try:
            actionArg = int(splitCommand[1])
        except:
            actionArg = 0

    # Here you can add various commands which can be send from the tcpClient to directly interact with the Squidstat
    response = None
    if action == ’startExperiment’:
        response = start_ocp_experiment(handler, actionArg)
    elif action == ’stopExperiment’:
        response = handler.stopExperiment(0)
    else:
        #print("Invalid command:", command)
        pass
    return response
```

```python
# Handle commands from the client
def handle_command(command, handler, client_socket):
    # Send a response back to the client
    responseMsg = "Unknown Command"
    response = command_to_device(command, handler)
    if(response != None):
        responseMsg = response.message()
    response = "{}".format(responseMsg)
    client_socket.send(response.encode())

# Listen for the client’s messages, and disconnect signals and terminate program when finished
def handle_client(handler, client_socket):
    print("Client connected")

    while True:
        # Receive data from the client
        try:
            data = client_socket.recv(1024).decode()
        except ConnectionResetError:
            break

        # Check if the client has closed the connection
        if not data:
            break

        # Handle the command
        handle_command(data, handler, client_socket)


    handler.activeDCDataReady.disconnect()
    handler.activeACDataReady.disconnect()
    handler.experimentNewElementStarting.disconnect()
    handler.experimentStopped.disconnect()
    command_to_device("stopExperiment", handler)
    # Close the client socket
    client_socket.close()
    print("Client disconnected")
    os._exit(1)

# Send data the the client based on the type of event (Hooked up to signals)
def send_data_to_client(client_socket, event_type, data):
    if event_type == "DCData":
        message = "timestamp: {:.9f}, workingElectrodeVoltage: {:.9f}".format(data.timestamp,
data.workingElectrodeVoltage)
    elif event_type == "ACData":
        message = "frequency: {:.9f}, absoluteImpedance: {:.9f}, phaseAngle:
{:.9f}".format(data.frequency, data.absoluteImpedance, data.phaseAngle)
    elif event_type == "NewElement":
        message = "New Node beginning: {}, step number: {}, step sub: {}".format(data.stepName,
data.stepNumber, data.substepNumber)
    elif event_type == "ExperimentCompleted":
        message = "Experiment Completed: {}".format(data)
    else:
        return

    client_socket.send(message.encode())

def terminate_program():
    print("Press <CTRL>+c to close the server")
    try:
        while True:
            input()
    except (EOFError, KeyboardInterrupt):
        pass
    for socket in activeSockets:
        socket.close()
    app.quit()
    os._exit(1)


# Create the device tracker and connect to the Squidstat we will be using
print(f"Attempting to connect to the Squidstat {SQUIDNAME} on {SQUIDCOMPORT}...")
tracker = AisDeviceTracker.Instance()
tracker.newDeviceConnected.connect(lambda deviceName: print("Device is Connected: %s" % deviceName))
error = tracker.connectToDeviceOnComPort(SQUIDCOMPORT)

if error.value() != AisErrorCode.ErrorCode.Success:
    print(error.message())
    exit()

# Create the instrument handler
handler = tracker.getInstrumentHandler(SQUIDNAME)
print("Connection successful\n")

# Create the TCP/IP socket and bind it to our host
print("Starting server...")
```

```
server_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
activeSockets.append(server_socket)
server_socket.bind((HOST, PORT))

# Listen for incoming connections
server_socket.listen(1)

print("Server started successfully. Waiting for client connection...")

terminal_thread = threading.Thread(target=terminate_program)
terminal_thread.start()

# Accept a client connection
client_socket, client_address = server_socket.accept()
activeSockets.append(client_socket)

# Connect the signals to send data to the client
handler.activeDCDataReady.connect(lambda channel, data: send_data_to_client(client_socket, "DCData", data))
handler.activeACDataReady.connect(lambda channel, data: send_data_to_client(client_socket, "ACData", data))
handler.experimentNewElementStarting.connect(lambda channel, data: send_data_to_client(client_socket, "NewElement", data))
handler.experimentStopped.connect(lambda channel: send_data_to_client(client_socket, "ExperimentCompleted", channel))

# Start the listening process in a separate thread
listening_thread = threading.Thread(target=handle_client, args=(handler, client_socket))
listening_thread.start()

# Start the QT event loop
app.exec()
```

17.21 writeinCSV.py

This is an example of the writeinCSV.py file, which helps control Squidstat in parallel with other devices.

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The Squidstat data is also written to a CSV file.

In detail:

1. The `SerialPortReader` class handles reading from and writing to a serial port of other device.
2. The `WriteCSV` class is responsible for writing data to a CSV file which is received from Squidstat.
3. The `writingThread` class is used to manage the data writing in csv file process in a separate thread.

```
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inside Squidstat, and also print the data received from the other device using the SerialPortReader::dataReceived signal.
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In detail:
1. The `SerialPortReader` class handles reading from and writing to a serial port of other device.
2. The `WriteCSV` class is responsible for writing data to a CSV file which is received from Squidstat.
3. The `writingThread` class is used to manage the data writing in csv file process in a separate thread.
"""

import sys
from PySide6.QtCore import QIODevice, QThread, QObject, Signal
from PySide6.QtSerialPort import QSerialPort
```

```python
from PySide6.QtWidgets import QApplication
from SquidstatPyLibrary import AisDeviceTracker
from SquidstatPyLibrary import AisErrorCode
from SquidstatPyLibrary import AisExperiment
from SquidstatPyLibrary import AisConstantCurrentElement
from SquidstatPyLibrary import AisOpenCircuitElement

# initialize the application
app = QApplication([])

# convert incoming data to string with single line
def convert_to_csv_line(data_list):
    return ’,’.join(str(item) for item in data_list)

# \cond EXCLUDE_FROM_DOX
# class for reading and writing data from serial port of other device.
class SerialPortReader(QObject):
    # define the Qt signal.
    dataReceived = Signal(str)

    # initialize self and port
    def __init__(self, port):
        super().__init__()
        self.port = port

    # open port if closed
    # get data and decode
    # emit data
    def run(self):
        if not self.port.isOpen():
            self.port.open(QIODevice.ReadOnly)
        while self.port.isOpen():
            if self.port.waitForReadyRead():
                data = self.port.readAll().data().decode()
                self.dataReceived.emit(data)

    # open port if closed
    # write data and encode
    def writeData(self, data):
        if not self.port.isOpen():
            successfullyOpen = self.port.open(QIODevice.WriteOnly)
            if not successfullyOpen:
                print("USB port is not open.")
        self.port.write(data.encode())

    # check if port is open, close port if open
    def closePort(self):
        if self.port.isOpen():
            self.port.close()


# class for writing data to a csv file. data received from Squidstat.
class WriteCSV:
    # init filename and file
    def __init__(self, filename):
        self.filename = filename
        self.file = None

    # open file and write headers
    def write_header(self, header):
        if self.file is None:
            self.file = open(self.filename, ’w’)
        self.file.write(convert_to_csv_line(header) + ’\n’)

    # write data to file
    def write_data(self, data):
        if self.file is not None:
            self.file.write(convert_to_csv_line(data) + ’\n’)

    # close file when we are done
    def close(self):
        if self.file is not None:
            self.file.close()


# class to handle the write funcationality on seprate thread in pareller operation of Squidstat and other device.
class writingThread(QThread):
    # define the signal.
    writeData = Signal(float, float)
    stopTowrite = Signal()

   # init self with values to be written
    def __init__(self, csv_writer):
        super().__init__()
        self.timestamps = []
        self.voltages = []
        self.csv_writer = csv_writer

    # setup data file with headers and connect the call back function on emitting of Qt signal.
    def run(self):
        self.csv_writer.write_header(['Timestamp', 'Working Electrode Voltage'])
        self.writeData.connect(self.add_data)
        self.stopTowrite.connect(self.close)

    # add data into list as well as call back handler you can use to write the data in csv file.
    def add_data(self, timestamp, voltage):
        self.timestamps.append(timestamp)
        self.voltages.append(voltage)
        self.csv_writer.write_data([timestamp, voltage])

    # close writer for a channel
    def close(self):
        self.csv_writer.close()
# \endcond

# setup serial port of other device.
serialPort = QSerialPort("COM3")
# setup baud rate of other device.
serialPort.setBaudRate(QSerialPort.Baud9600)
# set up communication data type of other device.
serialPort.setDataBits(QSerialPort.Data8)
# define a serial port reader thread.
serialPortReader = SerialPortReader(serialPort)


# function to write data from the serial port of other device.
def writeDataToPort(data):
    serialPortReader.writeData(data)

# instantiate a Squidstat device tracker
tracker = AisDeviceTracker.Instance()

# interact with data and send experiments to Squidstat device
def onNewDeviceConnected(deviceName):
    # print which device has been connected
    print(f"Connected to: {deviceName}")
    # get handler using device name.
    handler = tracker.getInstrumentHandler(deviceName)
    # if handler is present for the particular device then we can interact with the data and upload/start/stop/puase/resume experiments
    if handler:
        # setup file name
        csv_writer = WriteCSV('dataFile.csv')
        # add csv file to writing thread.
        writingThread = writingThread(csv_writer)
        # start sub thread for write funcationality.
        writingThread.start()

        # manages DC data input and output
        # add more variables if you want to print more data to the console
        # send the signal to writing thread to write the information in csv file.
        handler.activeDCDataReady.connect(lambda channel, data: (
            print("timestamp:", "{:.9f}".format(data.timestamp), "workingElectrodeVoltage: ",
                  "{:.9f}".format(data.workingElectrodeVoltage)),
            writingThread.writeData.emit(data.timestamp, data.workingElectrodeVoltage)
        ))

        # manages AC data input and output
        # add more variables if you want to print more data to the console
        handler.activeACDataReady.connect(lambda channel, data: print("frequency:", "{:.9f}".format(data.frequency),
                                                                      "absoluteImpedance: ", "{:.9f}".format(
                                                                          data.absoluteImpedance), "phaseAngle: ",
                                                                      "{:.9f}".format(data.phaseAngle)))
        # write when new node is starting
        handler.experimentNewElementStarting.connect(lambda channel, data: writeDataToPort(data.stepName))
        # print when experiment has stopped, stop writeting thread
        # send the signal to writing thread experiment is completed, which will close the csv file.
        handler.experimentStopped.connect(lambda channel: (print(f"Experiment completed on channel {channel}"), writingThread.stopTowrite.emit(), app.quit()))

        # initialize an experiment
        experiment = AisExperiment()

        # define a constant current experiment at 0.1 A, with 1 s sampling time, and a duration of 10 s
        ccElement = AisConstantCurrentElement(0.1, 1, 10)
        # define an open circuit experiment with a duration of 10 s and a sampling time of 2 s
        opencircuitElement = AisOpenCircuitElement(10, 2)

        # add constant current as the first element in the list
        # element runs 1 time
        successfullyadd = experiment.appendElement(ccElement, 1)
        # add open circuit as the second and thirds elements in the list
        # element runs 2 times
        successfullyadd |= experiment.appendElement(opencircuitElement, 2)

        if not successfullyadd:
            print("Error adding element to experiment")
            app.quit()

        # upload experiment to channel 1
        error = handler.uploadExperimentToChannel(0, experiment)
        if error.value() != AisErrorCode.Success:
            print(error.message())
            app.quit()

        # start experiment on channel 1
        error = handler.startUploadedExperiment(0)
        if error.value() != AisErrorCode.Success:
            print(error.message())
            app.quit()

# connect to device associated with the tracker
tracker.newDeviceConnected.connect(onNewDeviceConnected)

# Request the device to connect using com port 4
error = tracker.connectToDeviceOnComPort("COM4")
if error:
    print(error.message())
    sys.exit()

# print the data which is received from another device (other then Squidstat)
serialPortReader.dataReceived.connect(lambda data: print("Received data from COM port 3:", data))
# setup a sub thread for read and write the information from the other device.
serialPortThread = QThread()
# pushes object to another thread
serialPortReader.moveToThread(serialPortThread)
# start the sub thread of other device.
serialPortThread.start()
# exit program
sys.exit(app.exec())
```

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