# User Guide

The Department of Materials Science and Engineering would like to measure changes in a material's microstructure during thermal treatment. This can be done by looking at the changes in conductivity in real-time as a sample undergoes thermal treatment. The changes can occur very quickly, and it is crucial to read real-time data at a sufficient acquisition rate. The equipment to be used in this project has been provided by the project supervisor, Dr. Hatem Zurob, and includes a current source, nanovoltmeter, and a Windows computer. The solution created is a GUI application that is compatible with the Windows computer provided. The computer is outfitted with a port which can be used to read data from the equipment. Should there be any concerns with this user guide or general concerns with the system, please contact Dr. Zurob: zurobh@mcmaster.ca.

Requirements

1. The system requires the provided nanovoltmeter, provided current supply, provided multimeter and a Windows PC with a monitor, mouse and keyboard (pictured).
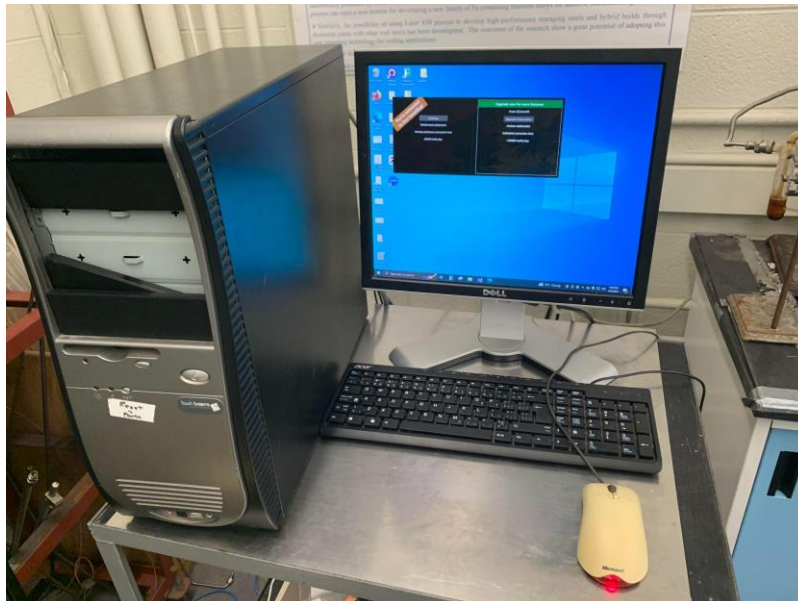
2. The Windows PC must have GPIB port(s) to connect to the equipment (pictured).

3. The system requires three GPIB cables to connect the three pieces of equipment to each other and to the PC. The PC in use should be running on windows 10 or 11 for compatibility with the solution. You can check your Windows version by going to Settings > System > About, bringing up the page in the image below.
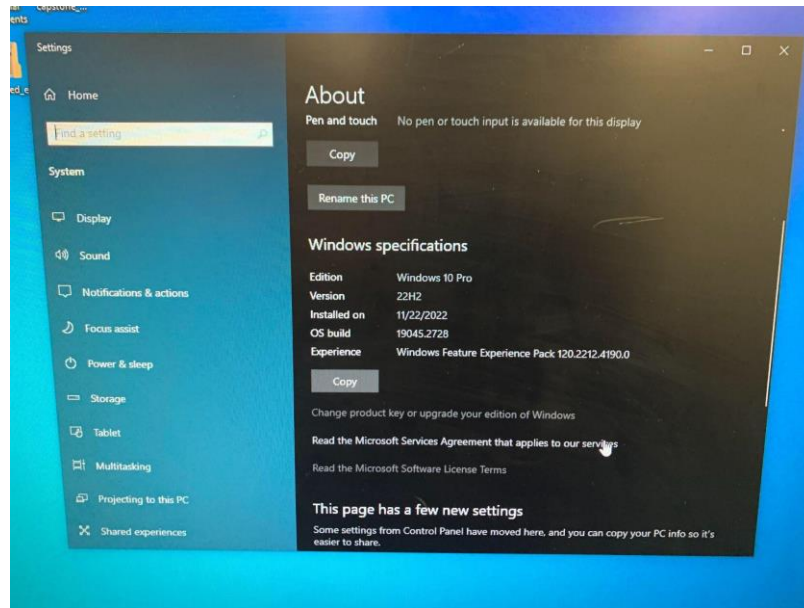

4. If the user wishes to utilize the built-in remote access features, it is important that the PC has network access in either a wireless or wired capacity.
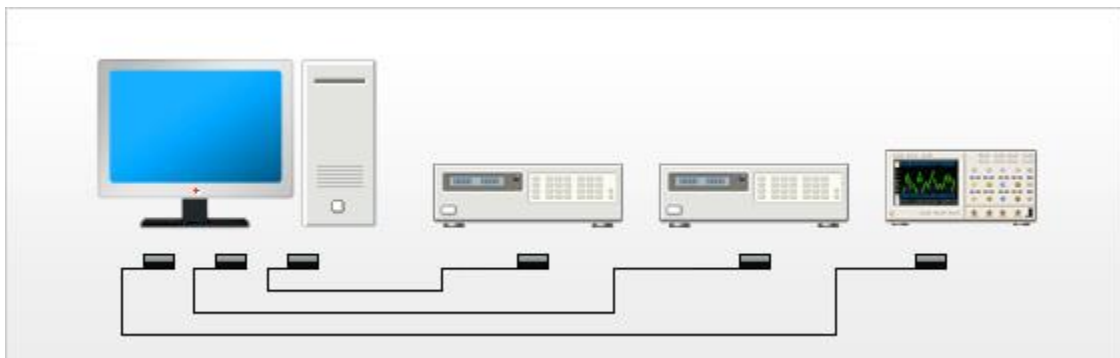
Starting an Experiment
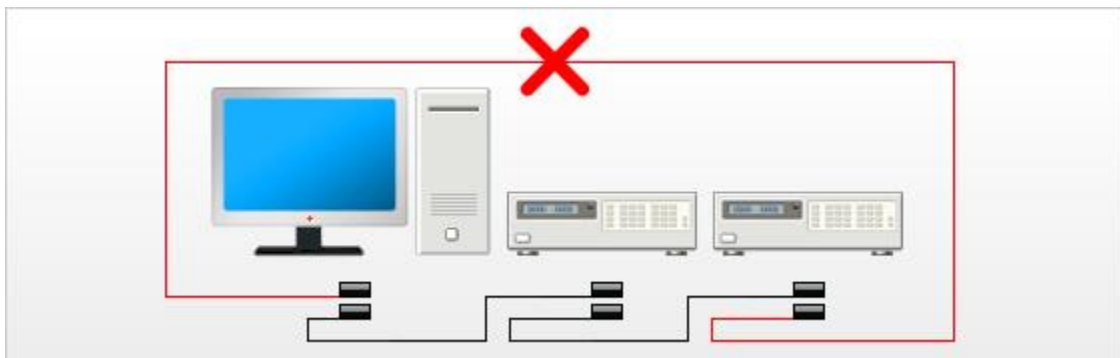
Setting up the hardware

1. Connect the GPIB cables between the devices and to the back of the computer in the PCI-GPIB card port. For more details, refer to the [NI-488.2 User Manual](#). The following diagram shows an example of possible cable configurations:
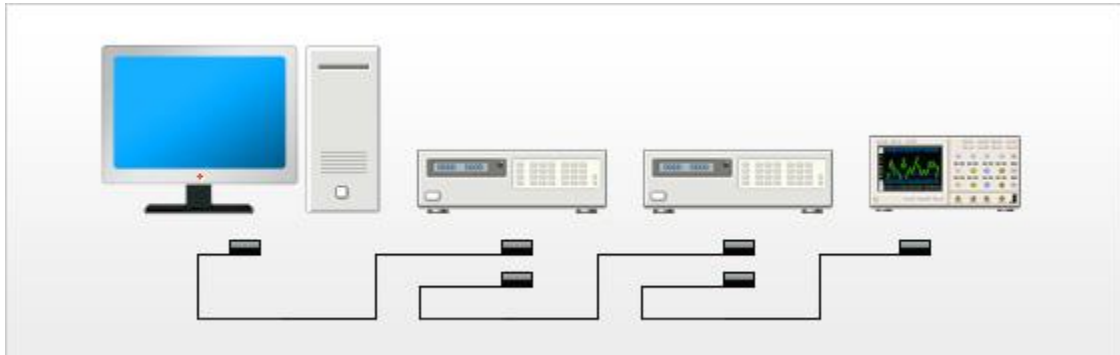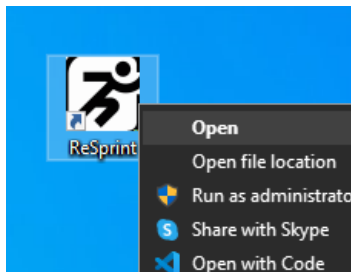

Daisy Chain Connection

Star Connection

Caution: Devices must not be connected in a loop arrangement

2. Power the equipment on. Make sure all the devices are running before launching the application.

3. Leave the equipment running for at least 2 and a half hours before running an experiment. The nanovoltmeter requires a warm-up period before producing accurate measurements. For more details, refer to the Nanovoltmeter User Manual. For additional information, refer to the Current Source User Manual.

4. Make sure to set the multimeter's display digits to 3.5 digits by pressing the blue button and then pressing the "Auto" button on the multimeter's front panel. This will set to the integration time of the multimeter to the fastest setting and will make sure that the application's performance is not limited by the multimeter. For more details, refer to the Multimeter User Manual. The diagram below demonstrates how the buttons look like:

Setting up the Application

1. Important: Make sure to follow the hardware setup steps before running the application. Otherwise, issues might arise including communication errors, inaccurate measurements, and performance issues.

2. Open the shortcut named "ReSprint" on the desktop. Or through the folder where the application is installed.

3. The application shall start up, the following window should appear:

4. Start by entering all the parameters in the "Experiment Details" section in the top-left corner:

5. Next, set up the parameters needed in the "Instrument Controls" section, make sure to click "Set" where needed, and turn the current supply output on if it was not already:

Current supply output was off in the left, then toggled on in the right-hand side.

Starting an Experiment

After setting up the parameters in the previous section, click "Start Capture" in the bottom-left corner. The application shall display values being added to the table and graph in real-time:
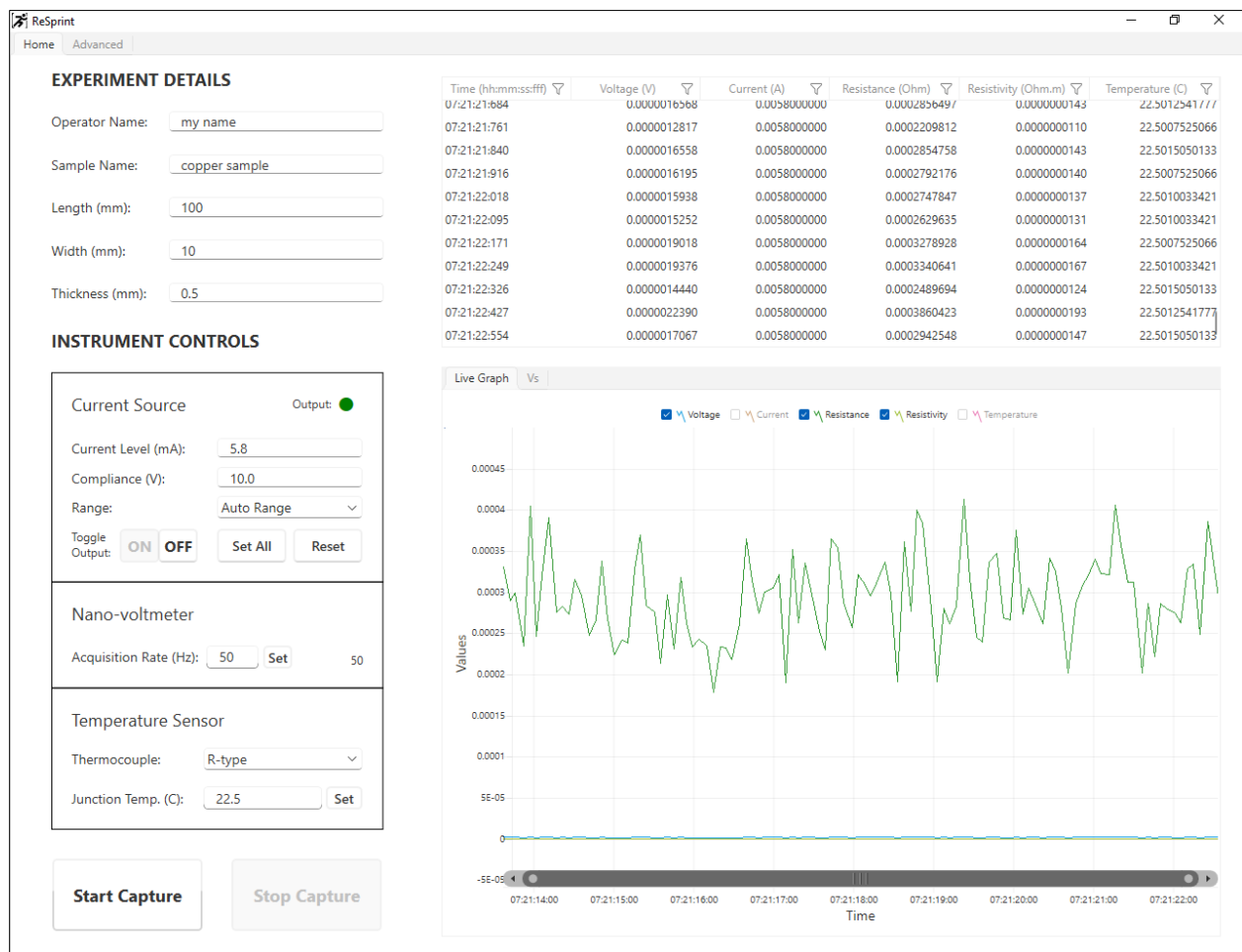
Advanced Control

In case there was a need to send customized SCPI commands to the instruments, this section of the guide will go through the steps to send the commands:

1. Select the "Advanced" tab from the top-left corner:
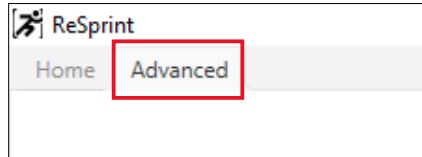
2. Click on one of the 3 buttons in the "SCPI Command Panel" section to select the desired device:
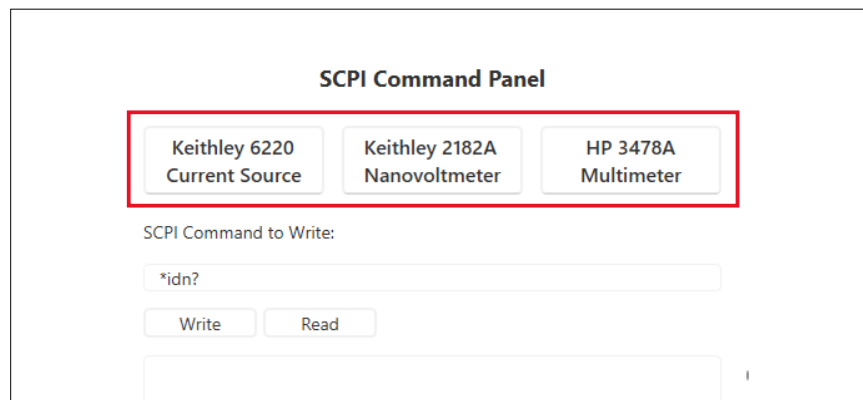
3. Type the desired command in the text box, and click "Write":
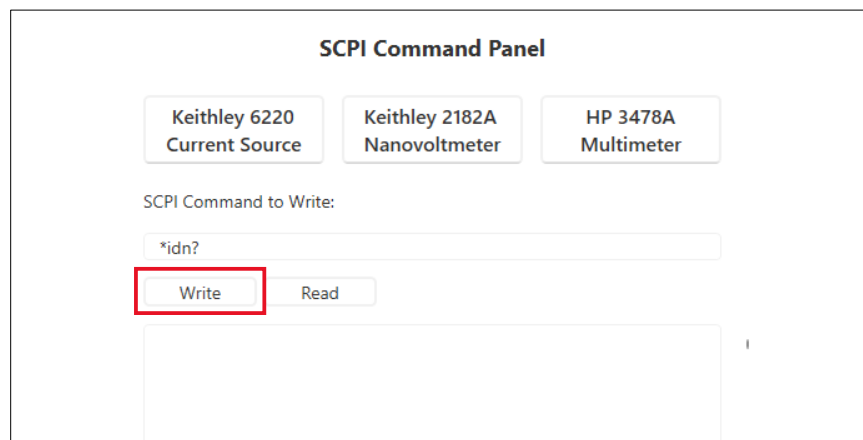
4. Click "Read" and observe the output text box:

During Experiment

Graph Controls
1. Live graph
   a. Time shown on y-axis
   b. Use cursor to select value(s) to display on x-axis: voltage, current, resistance, resistivity, temperature
   c. Use mouse wheel to zoom
   d. Click, hold, and drag mouse to select area for zoom
   e. Adjust the span of the y-axis by clicking and dragging the left or right edge of the scroll bar
   f. Use the bar at the bottom to scroll while capture is stopped

2. Vs. Graph
   a. Select values for x- and y-axis

Table Filters
NOTE: Only while capture is stopped.

1. Time filter
   a. Sort by oldest to newest/ vice versa
   b. Search for specific value in measured values
   c. Select specific measured value(s)
   d. Date filters
      i. Filter by date

2. Voltage/Current/Resistance/Resistivity/Temperature filter
   a. Search for specific value in measured values

b. Select specific measured value(s)
c. Number filters
   i. Filter by value

Stopping an Experiment

Press the stop capture button to stop measuring values. The graph and table will stop moving.

Graphical Data Output

Introduction
The application GUI uses SyncFusion WPF controls to display data in a graphical format. The specific control used for the graph is the SfChart, which provides a wide variety of charting features that can be used to visualize large quantities of data, flexibility of binding data and user customization [1].

Live Graph
The Live Graph tab is selected by default. Once capture has been started, the graph will begin to display real-time values. While capture is ongoing, the graph will auto-scroll to display the latest data.

Basic Layout
The Live Graph displays various measurement values on the y-axis versus time on the x-axis. Y-axis scaling is set automatically such that all selected values are displayed on the chart at once. Time is displayed in the format hh:mm:ss.sss according to ISO 8601 [2].

Selecting Values for Display
The Live Graph can display any combination of the following values versus time:

- Voltage
- Current
- Resistance
- Resistivity
- Temperature

All values are selected for display by default. To deselect a value, use the cursor to click the check box next to the label of the value above the graph. This will remove the value from display and may adjust y-axis scaling. Click the check box again to re-select the value for display.

Other Features

1. <u>Zoom</u>:
   a. Use the mouse wheel to zoom in or out, focussed on the cursor point.
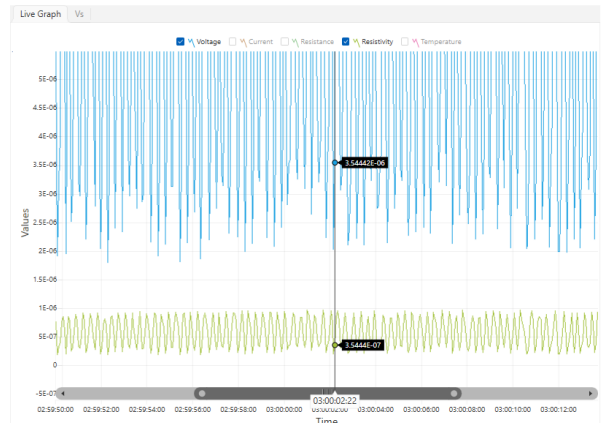
   b. Select an area of the graph to zoom into by clicking and dragging the cursor. The selected area will be highlighted. Once the cursor is released, the graph will zoom into the selected area.
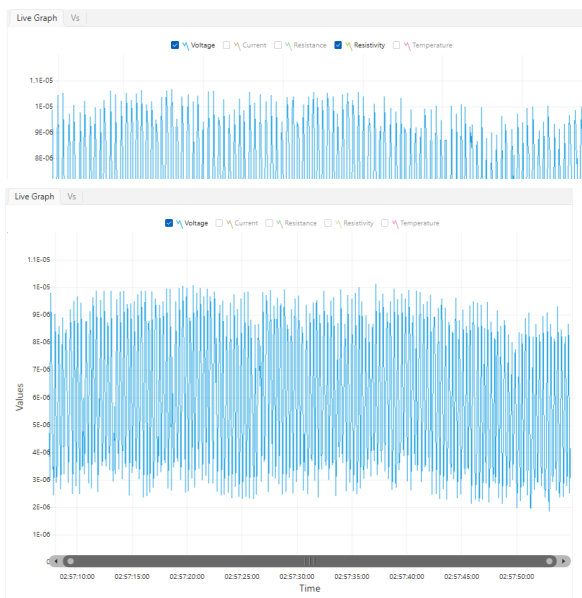
2. <u>Scroll</u>: Scroll left or right by clicking and dragging the scroll bar below the graph.
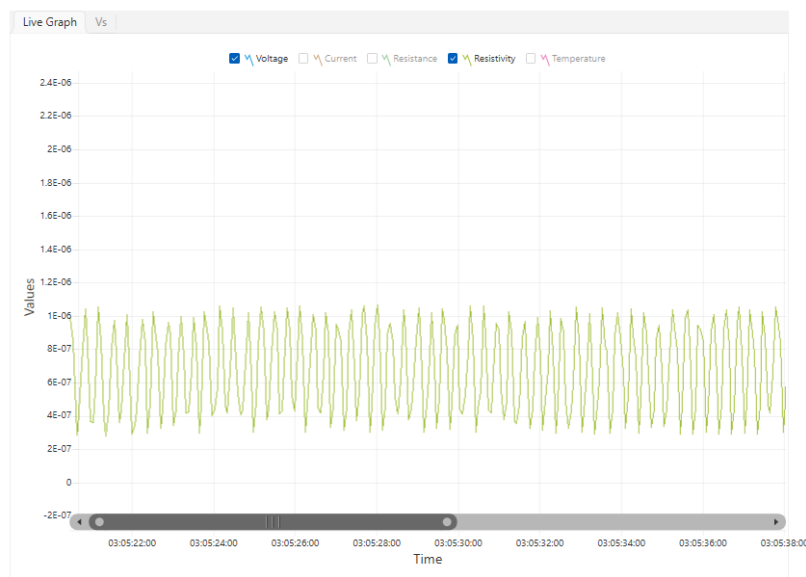
3. <u>Timespan</u>: Adjust the span of the x-axis (time) by clicking and dragging the left or right end of the scroll bar.
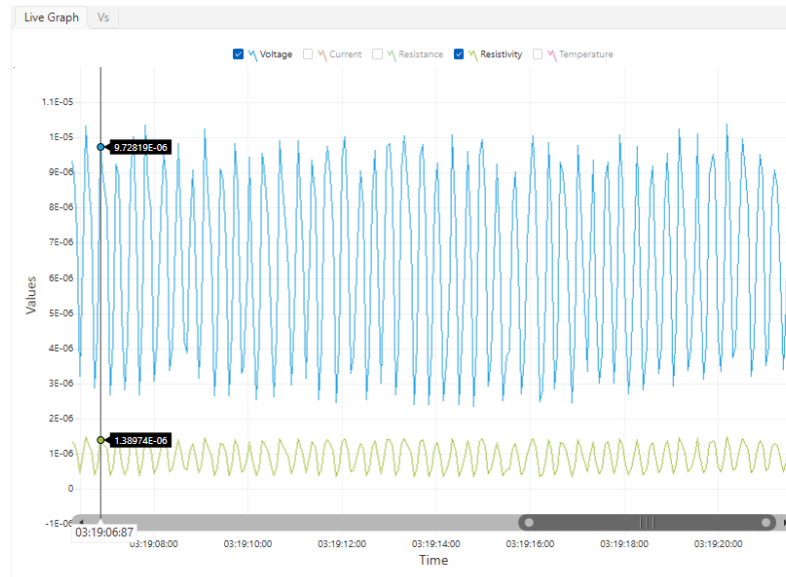
Versus Graph (?)
- Feature may be removed
- Display resistivity vs. temperature
- Display any value versus any other value

Tabular Data Output

Introduction
The application GUI uses Syncfusion WPF controls to display data in a tabular format. The specific control used for the table is the SfDataGrid control, which includes editing and data shaping features (sorting, grouping, filtering, etc.) that allows the end users to easily manage the data [3].

Basic Layout
The table displays the following values in order from left to right: time (Thh:mm:ss.sss), voltage (V), current (A), resistance (Ω), resistivity (Ω·m), and temperature (°C). Once capture has been started, the table will begin to auto-fill with real-time values. While capture is ongoing, the table will auto-scroll to display the latest data.

Filters
Time Filters
Available filters for the time values are as follows:

1. Sort oldest to newest / Sort newest to oldest.

2. Search bar: Search for a specific captured value.
3. Select values:
    a. Select all captured values for display.
    b. Choose to display specific captured values from the list of captured values.
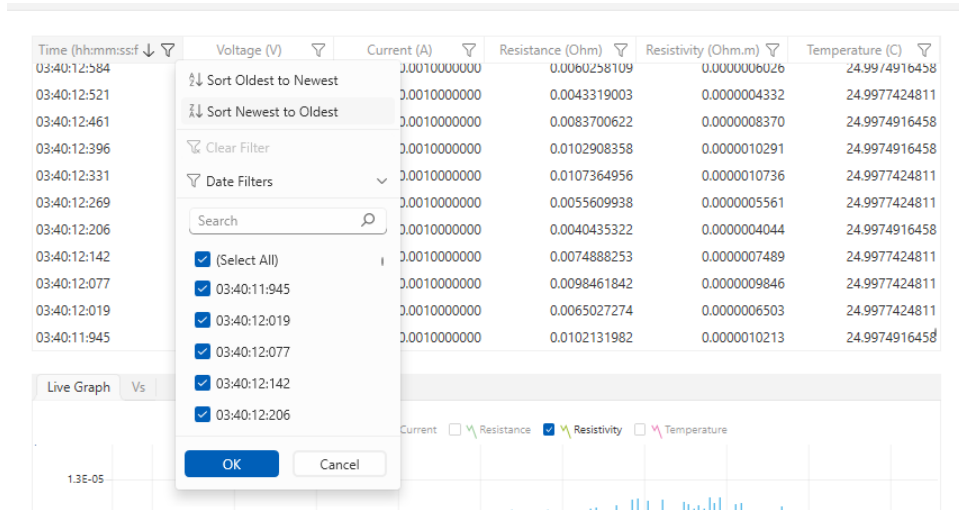
4. Date filters:
    a. Select operator from the drop-down menu; select date from calendar browser.
    b. Choose to add a second filter; select search for values satisfying both filter conditions (AND) or values satisfying one or the other filter condition (OR).
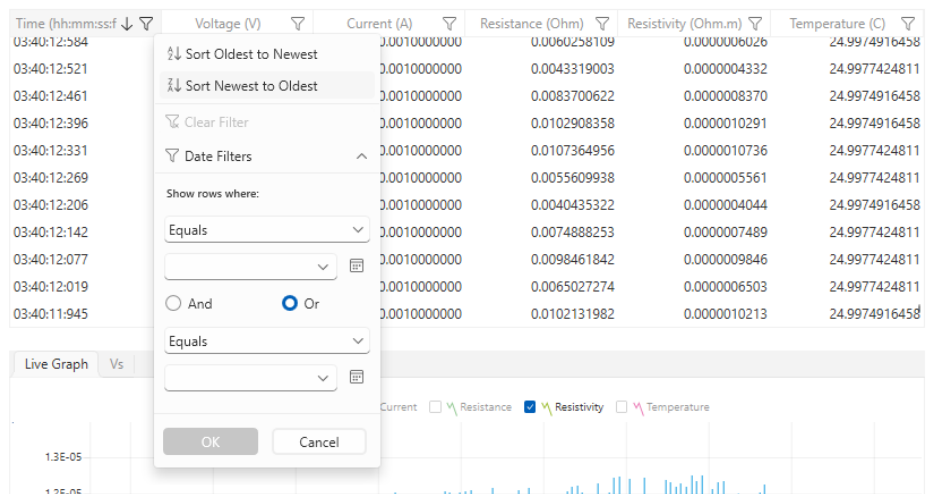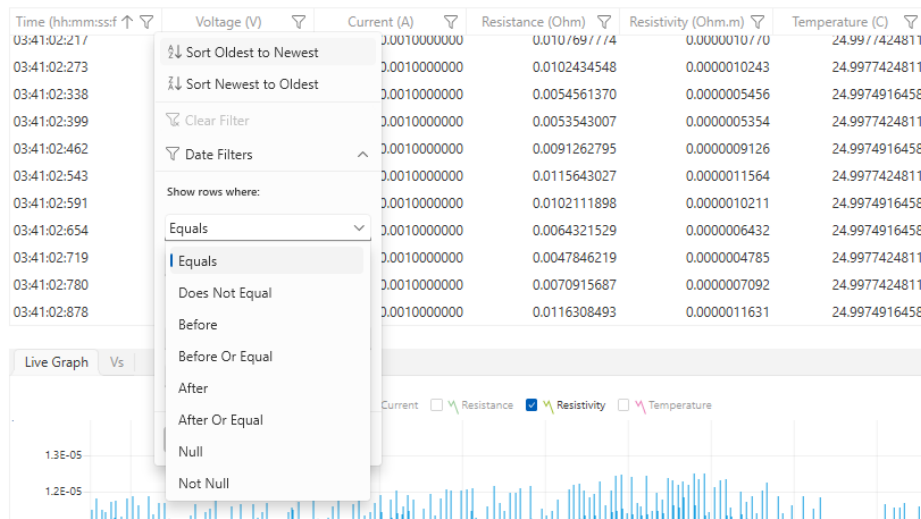
Value Filters

Available filters for all other values are identical and as follows:

1. Search bar: Search for a specific captured value.
2. Select values:
   a. Select all captured values for display.
   b. Choose to display specific captured values from the list of captured values.

3. Number filters:
   a. Select operator from the drop-down menu; enter value for comparison or select a value from the drop-down menu.
   b. Choose to add a second filter; select search for values satisfying both filter conditions (AND) or values satisfying one or the other filter condition (OR).

Time (hh:mm:ss:f ↓ ▽	Voltage (V) ▽	Current (A) ▽	Resistance (Ohm) ▽	Resistivity (Ohm.m) ▽	Temperature (C) ▽
03:40:12:584	0.0000060258		0.0060258109	0.0000006026	24.9974916458
03:40:12:521	0.00004331⁹		0.0043319003	0.0000004332	24.9977424811
03:40:12:461	0.0000083701		0.0083700622	0.0000008370	24.9974916458
03:40:12:396	0.000010290⁸		0.0102908358	0.0000010291	24.9974916458
03:40:12:331	0.0000107365		0.0107364956	0.0000010736	24.9977424811
03:40:12:269	0.0000055610		0.0055609938	0.0000005561	24.9977424811
03:40:12:206	0.0000040435		0.0040435322	0.0000004044	24.9974916458
03:40:12:142	0.0000074888		0.0074888253	0.0000007489	24.9977424811
03:40:12:077	0.0000098462		0.0098461842	0.0000009846	24.9977424811
03:40:12:019	0.0000065027		0.0065027274	0.0000006503	24.9977424811
03:40:11:945	0.0000102132		0.0102131982	0.0000010213	24.9974916458

Filter popup:
↕ Sort Smallest to Largest
↕ Sort Largest to Smallest
▽ Clear Filter
▽ Number Filters ⌃
Show rows where:
[Equals ▽]
[▽]
○ And   ⦿ Or
[Equals ▽]
[▽]
[OK]   [Cancel]

Live Graph | Vs
☑ ⩘ V ... ⦿ Resistivity ☐ ⩘ Temperature
1.3E-05
1.2E-05

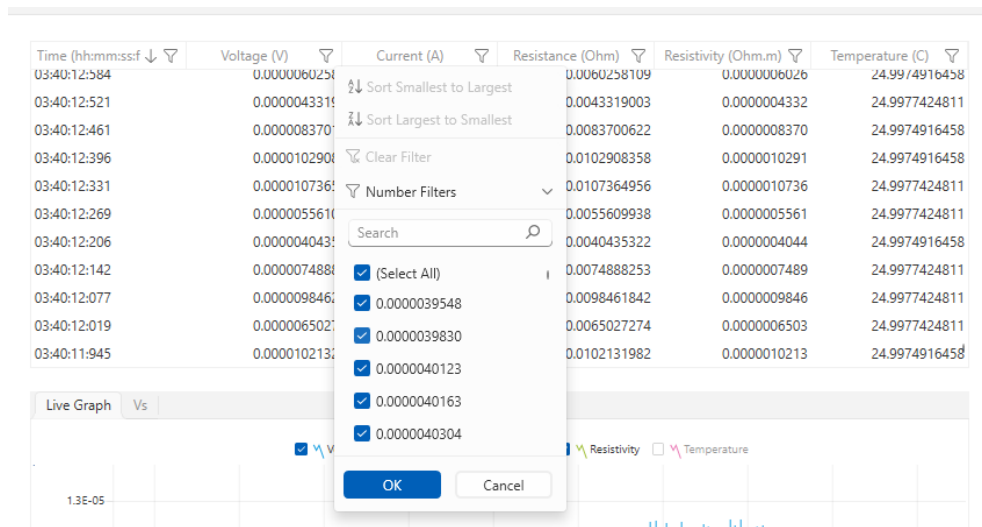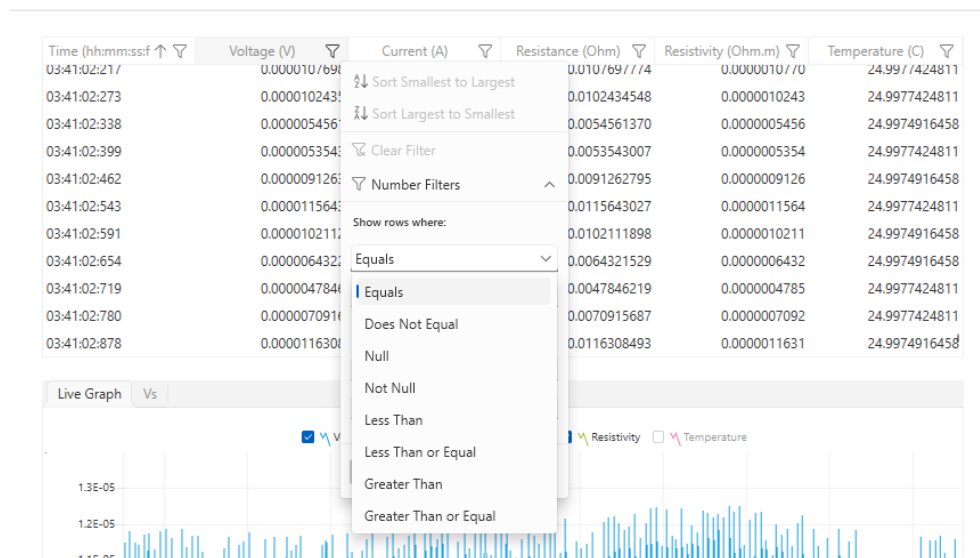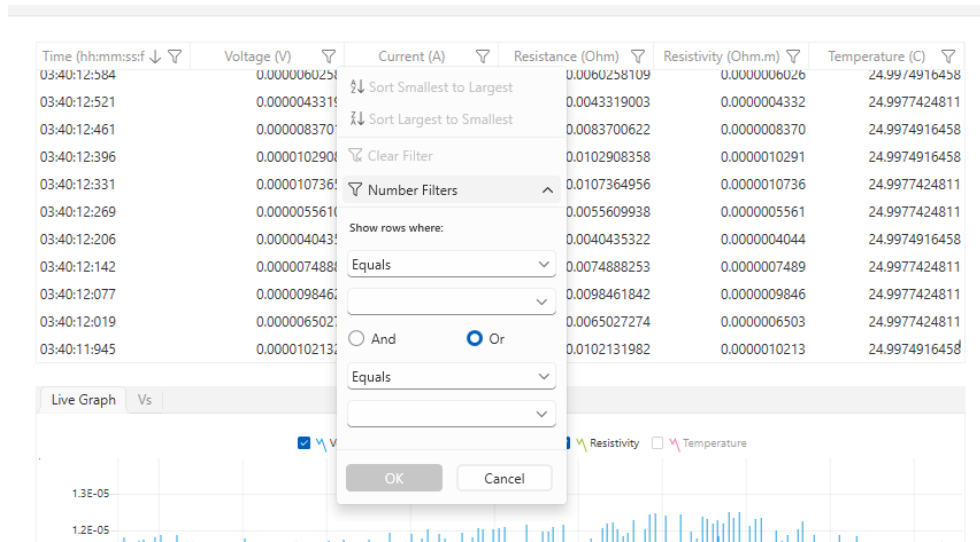| Time (hh:mm:ss:f ↑ ▽	Voltage (V) ▽	Current (A) ▽	Resistance (Ohm) ▽	Resistivity (Ohm.m) ▽	Temperature (C) ▽
03:41:02:217	0.0000107690		0.0107697774	0.0000010770	24.9977424811
03:41:02:273	0.0000102435		0.0102434548	0.0000010243	24.9977424811
03:41:02:338	0.0000054561		0.0054561370	0.0000005456	24.9974916458
03:41:02:399	0.0000053543		0.0053543007	0.0000005354	24.9977424811
03:41:02:462	0.0000091262		0.0091262795	0.0000009126	24.9974916458
03:41:02:543	0.0000115643		0.0115643027	0.0000011564	24.9977424811
03:41:02:591	0.0000102112		0.0102111898	0.0000010211	24.9974916458
03:41:02:654	0.0000064322		0.0064321529	0.0000006432	24.9974916458
03:41:02:719	0.0000047846		0.0047846219	0.0000004785	24.9977424811
03:41:02:780	0.0000070916		0.0070915687	0.0000007092	24.9977424811
03:41:02:878	0.0000116308		0.0116308493	0.0000011631	24.9974916458

Filter popup:
↕ Sort Smallest to Largest
↕ Sort Largest to Smallest
▽ Clear Filter
▽ Number Filters ⌃
Show rows where:
[Equals ▽]
| Equals
Does Not Equal
Null
Not Null
Less Than
Less Than or Equal
Greater Than
Greater Than or Equal

Live Graph | Vs
☑ ⩘ V ... ⦿ Resistivity ☐ ⩘ Temperature
1.3E-05
1.2E-05
1.1E-05

Stopping an Experiment

To stop displaying real-time data output, click the "Stop Capture" button in the lower left corner of the GUI. Once capture has ended, the graph and table output will freeze. The user can scroll through the graph or table to view past values.

References

[1] https://help.syncfusion.com/wpf/charts/overview
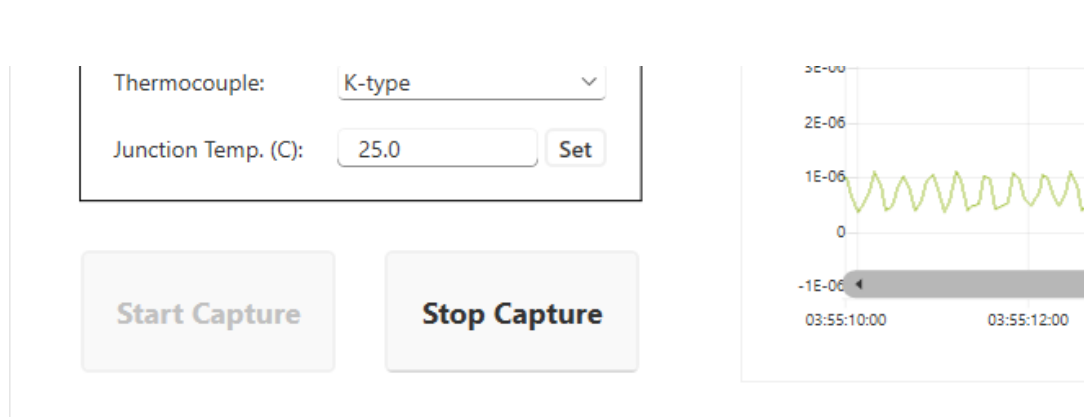
[2] https://en.wikipedia.org/wiki/ISO_8601

[3] https://help.syncfusion.com/windowsforms/datagrid/overview

Connecting to ReSprint via Remote Web Client User Guide

Introduction
The purpose of the ReSprint Remote Client is to allow the user to be able to monitor the experiment status and control the current output for preventive measures. The client is accessible on both desktop and mobile devices through the internet at resprint.netlify.app.

Installing SSL Certificate
(Mandatory for a device to be configured to use the remote client)
- Refer to this link for your corresponding device to set up the certificates:
  - https://conveyor.cloud/Help/SSL
  - The remote URL is: 130.113.3.225:45457

Requirements:
Ensure the following conditions/requirements are met to connect to ReSprint via the remote web client:

- Device is connected to Mac-Wifi or McMaster VPN services (This will require MacID credentials)
- Device has installed custom SSL certificate (see "Installing SSL certificate")
- If the device is using MacOS, please use Firefox. Other browsers are not yet supported.
- Device has a working internet connection.
- The computer that is running ReSprint is on and actively hosting through Conveyor.

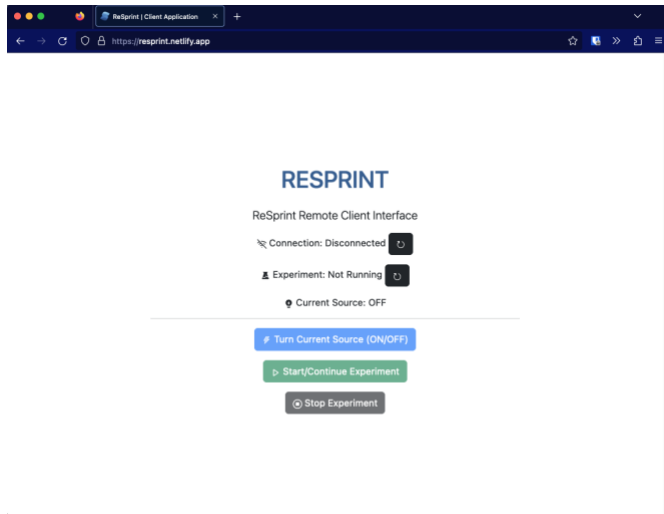## Section 1: Accessing the Remote Web Client

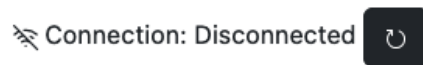1. Open the any browser on your device. (MacOS – please use Firefox)

2. Enter "resprint.netlify.app" in the address bar

3. You should see the following interface: (See image below)

4. Wait a few seconds to allow a connection to be made. If connection is not made, try refreshing the page or clicking on the "Refresh button" next to "Connection Status" (See image below)
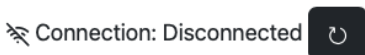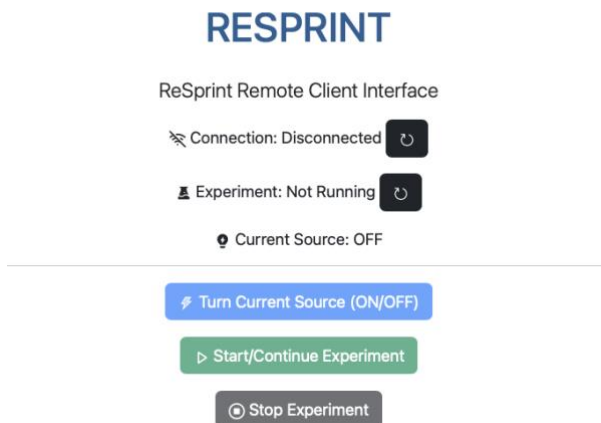

5. Once the connection status is updated to "Connected", you are good to go! (See image below)
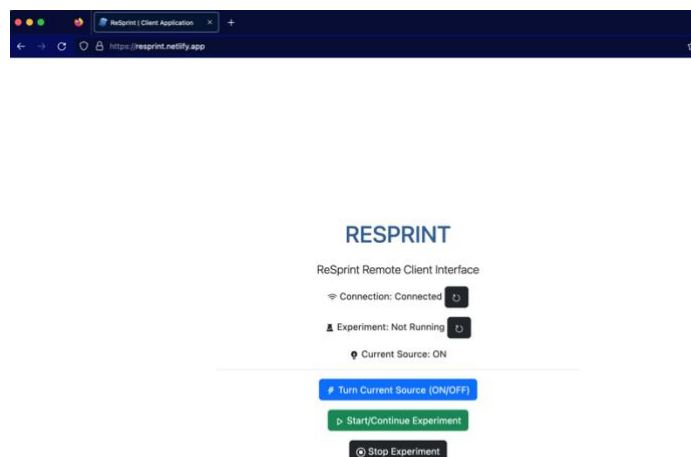
Section 2: Navigating the Remote Web Client

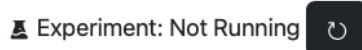Here is an overview of the interface and a description of each component.

Connection Status:

This displays the current connection status to ReSprint. ReSprint must be online for the remote client to be connected. Using the "Refresh" button, the user can manually trigger an update to the connection status.

Experiment Status:

This displays the current experiment status to ReSprint. Using the "Refresh" button, the user can manually trigger an update to the experiment status.

Turning Current Output ON/OFF:

This button can toggle the current output that is connected to ReSprint on and off. When the button is pressed, it will send a request to the application to toggle the current output. The state of the current will be updated upon receiving confirmation of ReSprint.

Start/Stop Experiment:

These buttons can be used to start and stop the experiment that is set up on ReSprint. Please note that all necessary parameters must be in place to start the experiment initially from the remote client.

Disclaimer:

- The remote web client is provided "as is" without warranty of any kind, either express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose.
- The use of the remote web client is at the user's own risk. The owner of the application shall not be liable for any damages or losses arising out of or in connection with the use of the remote web client, including but not limited to direct, indirect, incidental, consequential, special, or punitive damages, loss of profits, data, or use.
- The owner of the application reserves the right to modify or discontinue the remote web client at any time without notice.
- The user is solely responsible for maintaining the security and confidentiality of their login credentials, and the owner of the application shall not be liable for any unauthorized access to or use of the user's account.
- By using the remote web client, the user agrees to comply with all applicable laws, regulations, and policies, and to use the remote web client only for lawful purposes.