RESONANCE LTD
Optical Solutions & Technologies

Standard Light Source

Software Manual

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Overview

The RF-powered lamps offered by Resonance Ltd. have built-in microprocessors for closed-loop temperature control of the source heater and RF output, and also supply temperature readings and power with telemetry output. The *Lamp Interface* software is a LabVIEW-based, fully-featured graphical application which allows easy setting and logging of all the lamps' parameters.

The *Lamp Interface* software provides a chart recorder on which all parameters can be displayed. The user can decide which telemetry data to display and even add. Data may be exported as Excel-friendly *.csv files. Annotations can be added to the chart, which are exported with the logged data, making the *Lamp Interface* a truly useful monitoring and data logging application.

Please Note:

Not every lamp will have the same hardware, owing to the type of spectral output. The software is designed to interface with all lamps, and therefore some features of the software will apply only to certain lamps. For example, if a given lamp does not have a heater module the software settings pertaining to the heater will not have any effect on the lamp; even though they may still be visible.

Features

- Setting and monitoring of lamps' heater and RF output
- Chart recorder with customizable plots
- Annotations can be added to chart recorder and logged data
- Excel-friendly *.csv file output
- Selective saving of data; can specify time range
- Supports cursors for analyzing chart record data
- Easy zooming and changing of graph scales
- Compatible with Windows XP, Vista and 7 (32 and 64 bit versions)

Installation & Requirements

The **Lamp Interface** software can be installed on any PC running Windows XP, Vista, or 7 in both 32-bit and 64-bit modes. The only driver required is also compatible with all these systems, and automatically detects the correct driver to install when launched. The software has very minimal requirements and can run on netbooks, laptops, and desktops with processors > 1 GHz. More than 2 GB of RAM is recommended if the software is to log data for a long time, on the order of days, otherwise any amount of memory will do as long as it is greater than 512 MB. In order to successfully install the lamp software, please follow these steps:

1. Make sure the lamp's breakout box is not plugged into the USB port of the computer you are installing the software on.

2. Obtain the correct installation package for your version of Windows and CPU architecture (32- or 64-bit). If you have any doubt please contact Resonance Ltd:
   http://www.resonance.on.ca/contact.htm

3. Each install package comes with its own custom set of installation instructions. This notepad file is called **Instructions.txt** and is found within the installation zip file. Unzip the package, read this file and follow it to install the **Lamp Interface** software. You should notice that shortcuts have been added to the desktop and start menu after installation. Do not start the software at this time.

4. Plug the USB cable of the breakout box into a USB port on the PC. Depending on the operating system you are running, Windows will find the hardware and look for a suitable driver. If it asks to look online, tell it not to. Windows will scan its driver directories, and automatically find and install the driver.

5. Plug the lamp and power supply into the breakout box and turn it on. The **Lamp Interface** software may now be run to start interfacing with the lamp.

Indicators

When the **Lamp Interface** software is run, it will automatically scan for a connected lamp breakout box. Refer to figure 1 below:
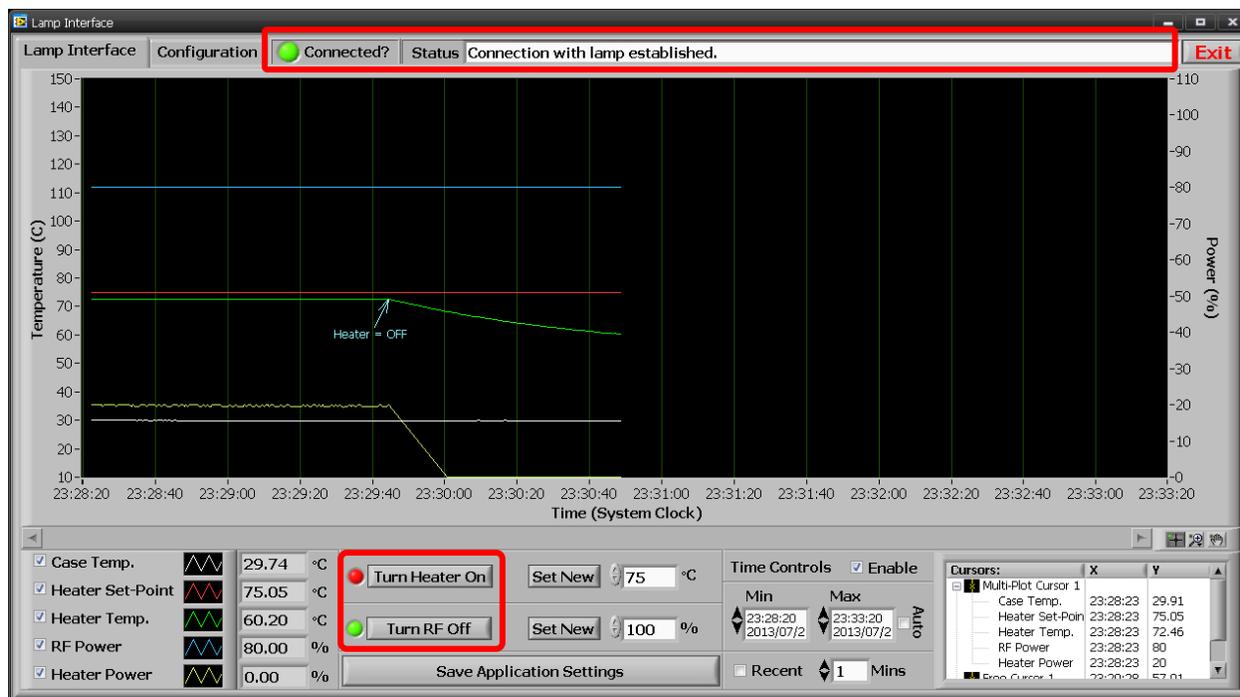
**Fig. 1: The Lamp Interface software just after connecting to a lamp.**

Once connected, the **Connected?** LED will change from red to green and the status will indicate the software is now waiting for data. If the lamp is on and connected to the breakout box, telemetry data may then be received and the chart record will start plotting this data.

The heater and RF states are also indicated with LEDs. When the heater is off, its LED is red. When the heater is on, its LED is green. The text on the corresponding button to turn the heater on or off also changes depending on its current state. Similarly, the RF state has its own LED indicator and button to turn RF power on and off.

Lamp Control

There are 4 basic parameters that can be set with the **Lamp Interface** software:

1. Turn heater on or off
2. Change heater set-point temperature
3. Turn RF power on or off
4. Change RF power set-point %
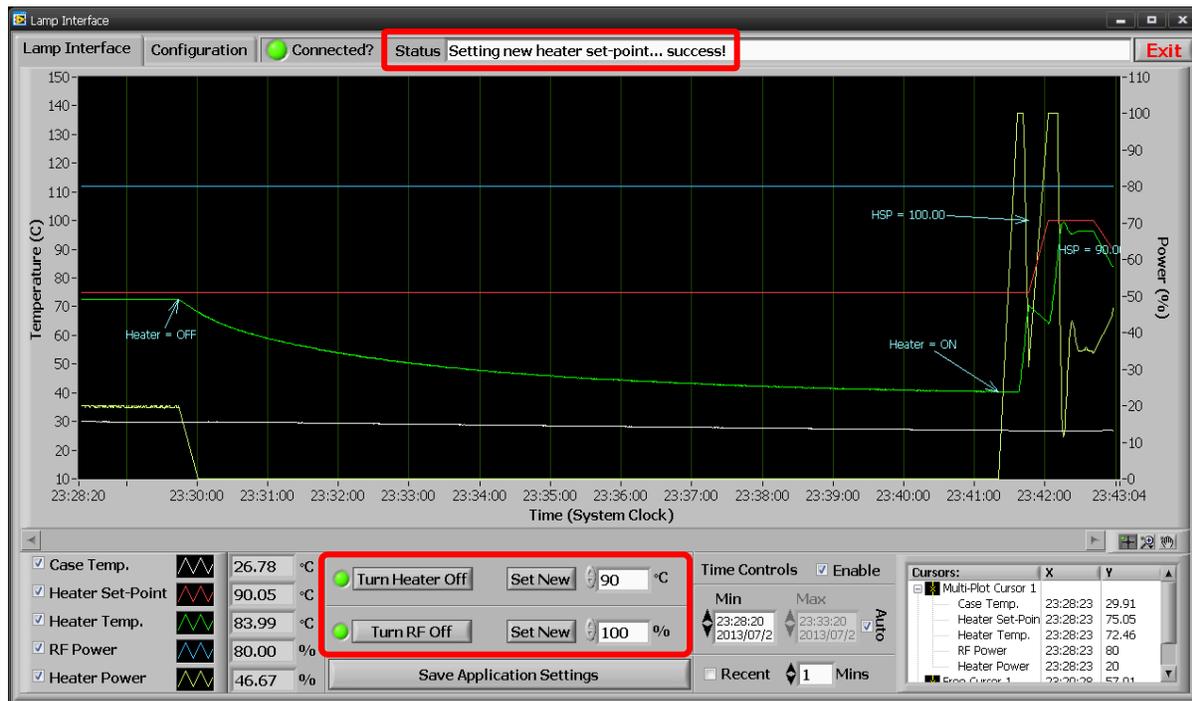
Fig. 2*: The Lamp Interface software with parameter settings highlighted.*

When a parameter is set using the highlighted buttons in figure 2, the **Status** indicator will provide feedback on whether the requested change was successful. During the "setting" process, the buttons will turn grey and won't become interactive again until the process completes.

Lamp Control (continued)

Set New (Heater)

This applies a new heater set-point, entered in degrees Celsius. The Status indicator provides feedback messages. An annotation will automatically be added to the chart recorder if successfully set.

Set New (RF)

This applies a new RF power, entered in percentage. The Status indicator provides feedback messages. An annotation will automatically be added to the chart recorder if successfully set.

Turn Heater ON or OFF

This toggles the closed-loop heater circuit on or off. If the setting was successful, the button will change its label to reflect the current state of the heater. For example, if the button says "Turn Heater Off", it means the heater is currently on, and will change to "Turn Heater On" if it was successfully turned off. An annotation will automatically be added to the chart recorder if successfully set.

Turn RF ON or OFF

This toggles the RF circuit on or off. If the setting was successful, the button will change its label to reflect the current state of the RF output. For example, if the button says "Turn RF Off", it means that RF output is currently active, and will change to "Turn RF On" if it was successfully turned off. An annotation will automatically be added to the chart recorder if successfully set.

Chart Recorder

The chart recording function of the **Lamp Interface** software is one of its most useful features. All telemetry parameters are automatically stored with respect to absolute time (the PC's system clock). The chart recorder allows the user to graphically display any parameters simultaneously, and dynamically add annotations to the data which are included when data is exported. Cursors are also available to help in data analysis.
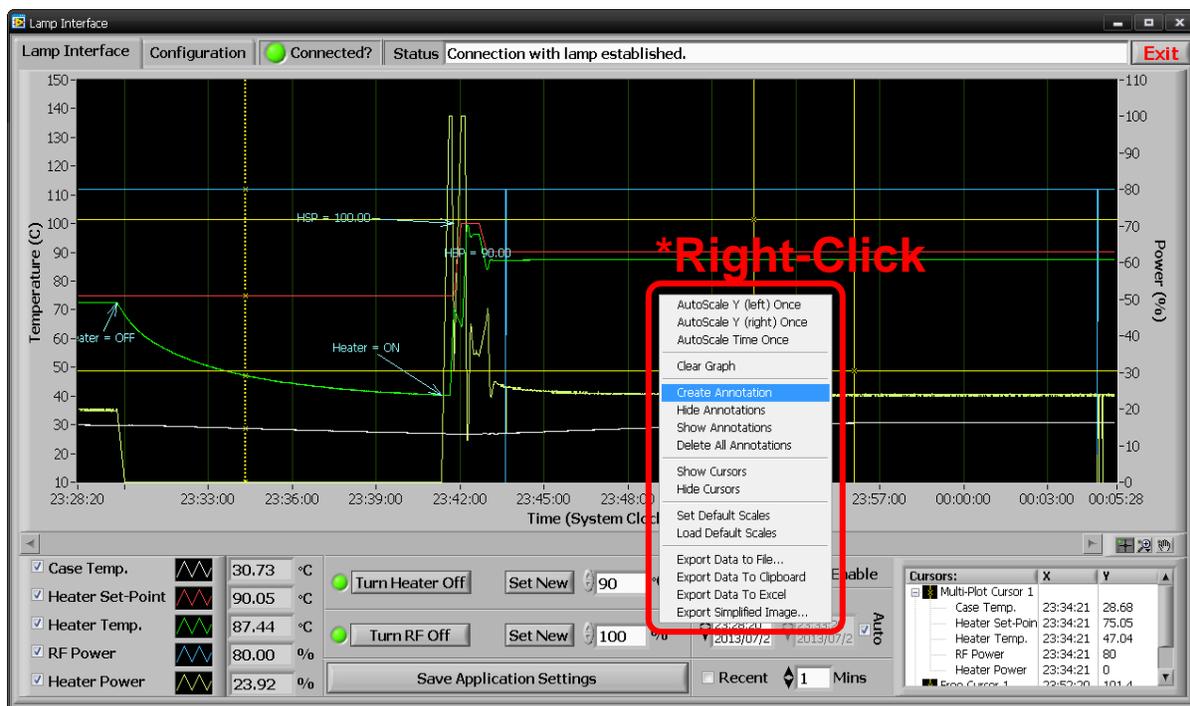
Fig. 3: The Lamp Interface software with the recorder right-click menu activated.

Adjusting X & Y Scales

X and Y scale adjustments are made simply by highlighting the maximum or minimum value on either scale and entering a new value. The graph instantly snaps to the new value when you press "Enter" or leave its focus. The application even supports letters as shortcuts to powers of 10. For example, typing 10k would be the equivalent of typing 10000 before "Enter" is pressed.
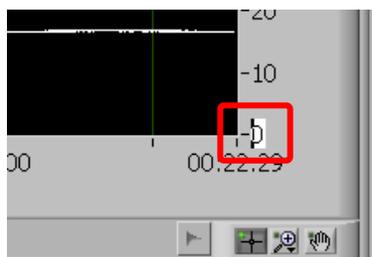
Fig. 4: Changing the recorder graph's minimum Y-scale value.

For the time (x) scale, however, there is extra functionality.
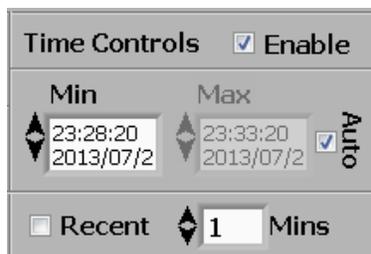
Fig. 5: The recorder graph's enhanced time (X-scale) controls.

When the **Enable** toggle is selected, the x-scale will not be adjustable manually by simply editing the maximum and minimum anymore. Instead, the max and min can be set by the controls shown in figure 5. This enables the **Auto** and **Recent** options. When **Auto** is checked, the software will use the specified minimum value for the x-scale, but will automatically choose a maximum value such that all future data is always on-scale. When **Recent** is checked, the software automatically adjusts the X-scale such that the last x minutes worth of data is always displayed, where x is specified in minutes by the **Mins** control.

Both Y-scale max and min values can be saved as default by simply right-clicking on the graph to obtain the context menu. Select **Set Default Scales** to save the current scales as default, or **Load Default Scales** to revert back to the saved limits.

Annotations

Annotations are automatically added to the recorder by the software to mark events such as the heater turning on or off, or the RF set-point being changed. Because annotations are saved with respect to the X-axis in the exported data file, they are suitable for marking important regions of data. Annotations can also be dynamically added to any region of the recorder to mark interesting events etc. Simply right-click anywhere on the recorder graph to bring up a context menu. There are 4 commands that are related to annotations:

Create Annotation

Opens a window that allows an annotation to be pinned to the graph. Annotations are saved with respect to the X axes in the exported data file, making them suitable for marking important regions of data.
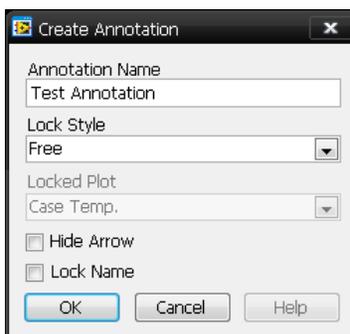
Fig. 6: The annotation pop-up.

Each annotation features an arrow which points directly to the point it is tied to. The text itself can be clicked and dragged around the graph to any location for aesthetic purposes. Only these dynamic annotations can be edited once they have been created. Simply right-click on the annotation's data point to invoke a menu of options for colour, arrow style, and of course its text.

Hide Annotations

Renders all displayed annotations invisible; except for their crosshairs.

Show Annotations

Displays all annotations; including hidden ones.

Delete All Annotations

Removes all annotations from the graph permanently; including hidden ones.

Cursors

Cursors are used to report the X and Y values of any plot on any graph at a specific location. The chart recorder features dynamic cursors, which means they can be created, deleted, or modified from their default state. All cursor configuration is done by a contextual right-click menu in the cursor area.
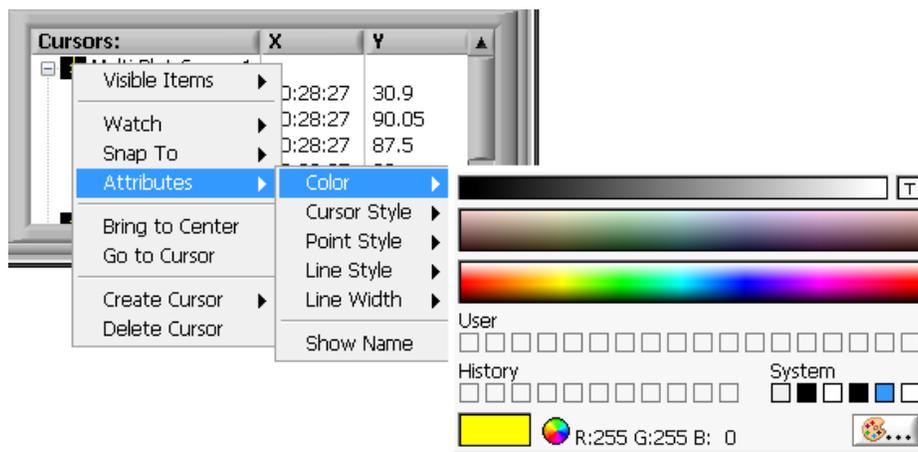
**Fig. 7: The cursor configuration menu accessed via right-click.**

Right-clicking on a cursor brings up a menu that allows you to set various options. The **Attributes** subsection allows you to change the visual style of the cursor, including color and line width and style etc. There are three main types of cursors; "free", "single-plot", and "multi-plot". Free cursors simply report their exact position on the graph, and not necessarily a data point. They can be handy when you don't need them to be tied to a specific plot. Single- and Multi-plot cursors adhere to specific plots. A Single-plot cursor will follow and snap to only one plot that is specified when it is created. A Multi-plot cursor is similar, but instead of snapping to one plot, it simultaneously snaps to them all, giving simultaneous y-values at any x-value.

Depending if the cursor is of the type "free" the **Snap To** option appears in the right-click menu. This option lets you specify which plot the cursor will follow, or snap-to. **All Plots** (under the sub-menu **Snap To**) means the cursor will snap to the nearest plot on the graph to its crosshair, otherwise the cursor will only specify X and Y values for its respective "snapped-to" plot. It should be noted that cursor settings are not saved and only last as long as the application's session.

There are also options in the chart recorder's right-click context menu to hide or show the cursors.

Chart Recorder Right-Click Menu

The user can access useful functions by means of a right-click context menu that can be activated by right-clicking anywhere on the chart recorder.
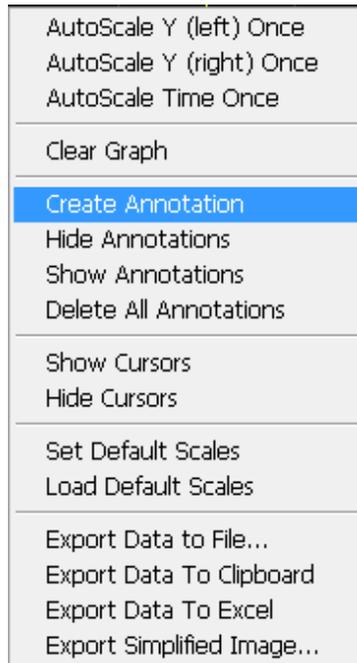
Fig. 8: The chart recorder's right-click context menu.

Chart Recorder Right-Click Menu (continued)

Refer to the table below for a description of each menu item:

| Menu Item	Description
AutoScale Y (left) Once	Adjusts the graph's Y-scale (**temperature**) minimum and maximum to the min and max points of the currently displayed data. This is only done once, so subsequent spectra may be off-scale.
AutoScale Y (right) Once	Adjusts the graph's Y-scale (**power**) minimum and maximum to the min and max points of the currently displayed data. This is only done once, so subsequent spectra may be off-scale.
AutoScale Time Once	Adjusts the graph's X-scale minimum and maximum to the min and max time of the acquired data. This is only done once.
Clear Graph	Clears and deletes all recorded data thus far, and starts over - akin to a new application instance.
Create Annotation	Please refer to the section titled Annotations
Hide Annotations	Please refer to the section titled Annotations
Show Annotations	Please refer to the section titled Annotations
Delete All Annotations	Please refer to the section titled Annotations
Show Cursors	Shows all cursors on the recorder graph.
Hide Cursors	Hides all cursors on the recorder graph.
Set Default Scales	Please refer to the section titled Adjusting X & Y Scales
Load Default Scales	Please refer to the section titled Adjusting X & Y Scales
Export Data to Clipboard	Please refer to the section titled Exporting Data
Export Data to Excel	Please refer to the section titled Exporting Data
Export Simplified Image…	Please refer to the section titled Exporting Data

Exporting Data

All telemetry parameters are automatically logged in program memory for a pre-determined amount of time set by a static first-in, first-out (FIFO) buffer. This buffer, by default, is configured to hold 25,000 data points, which is equivalent to approximately 2 hours' worth of data at the default lamp telemetry rate. This buffer is fixed to avoid memory overflow conditions that would eventually occur with continuous operation. Changing the buffer length can be done by manually editing the program's settings file; however consulting Resonance Ltd. first is recommended.

The data can be output in a number of formats by invoking the chart recorder's right-click menu. Each of these options are described below:

Export Data to File…

Opens a file dialog with save options for exporting the graph's data to an Excel-compatible file featuring a header with application settings.
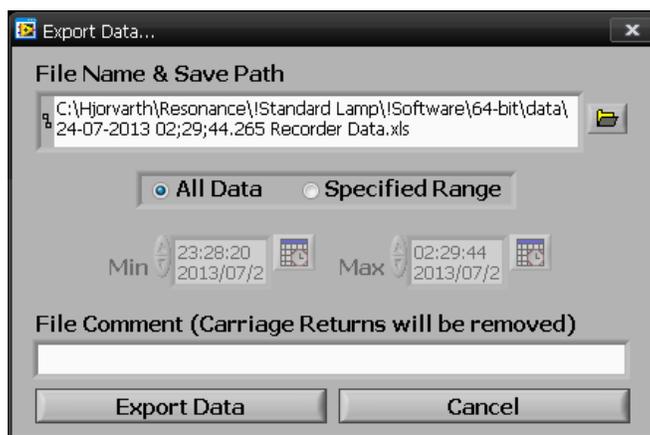
Fig. 9: The "Export Data" dialog for the chart recorder data.

The default filename is presented with the current date and time prepended to the filename - which is recommended to keep directory structures chronologically organized for PC file browsers. A file comment can also be added which will appear within the file's header. When the **Specified Range** option is selected, the **Min** and **Max** time controls will un-grey, allowing you to specify a custom range for output – otherwise all data will be exported by default. Note that the saved files are truly *.csv files that have been renamed to a *.xls file extension in order to allow the files to be opened directly in *Excel* by simply double-clicking them, and also has the added benefit that re-saving is by default set to a more desirable *.xls file type.

Exporting Data (continued)

Export Data to Clipboard

When this option is selected, only the portion of data currently displayed within the graph's limits is exported to the PC's "clipboard". This temporary buffer can be pasted into compatible programs such as Microsoft *Excel* or *Notepad* for manipulation and saving. This feature is built-in to the graph itself and as a result does not include the same (very informative and useful) file header as the ***Export Data to File…*** option.

Export Data to Excel

Similar to the ***Export Data To Clipboard*** option, except *Excel* will automatically be launched and loaded with the data automatically – ready for manipulation and saving.

Export Simplified Image…

This option will invoke a file dialog asking where to place an image of the graph and its file format.
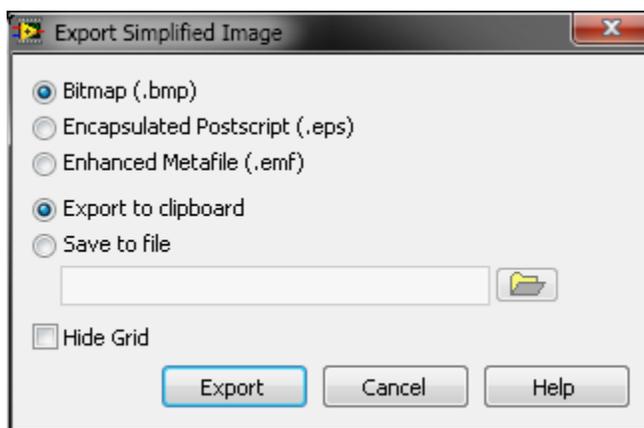

Fig. 10: The "Export Simplified Image" dialog.

Note that the image is referred to as "simplified" because it has been modified to be printer-friendly, which means the graph's background colour was changed from black to white. The ***Hide Grid*** option can also be used to remove the X and Y axes grids from the image.

Configuration Tab

The **Configuration** tab contains a running log of the lamp's raw telemetry output. This is the data which is parsed and presented in the main **Lamp Interface** tab. This window is useful to debug any serial communication problems. For example, if the connection to the lamp is acting unreliably, it may be an issue with a broken or noisy serial cable from the breakout box to the lamp, or a USB cable from the breakout box to the PC. If the sentences appear garbled or display funny characters in this window, it indicates that many errors are present in the serial data, which would prevent proper parsing of the sentences.
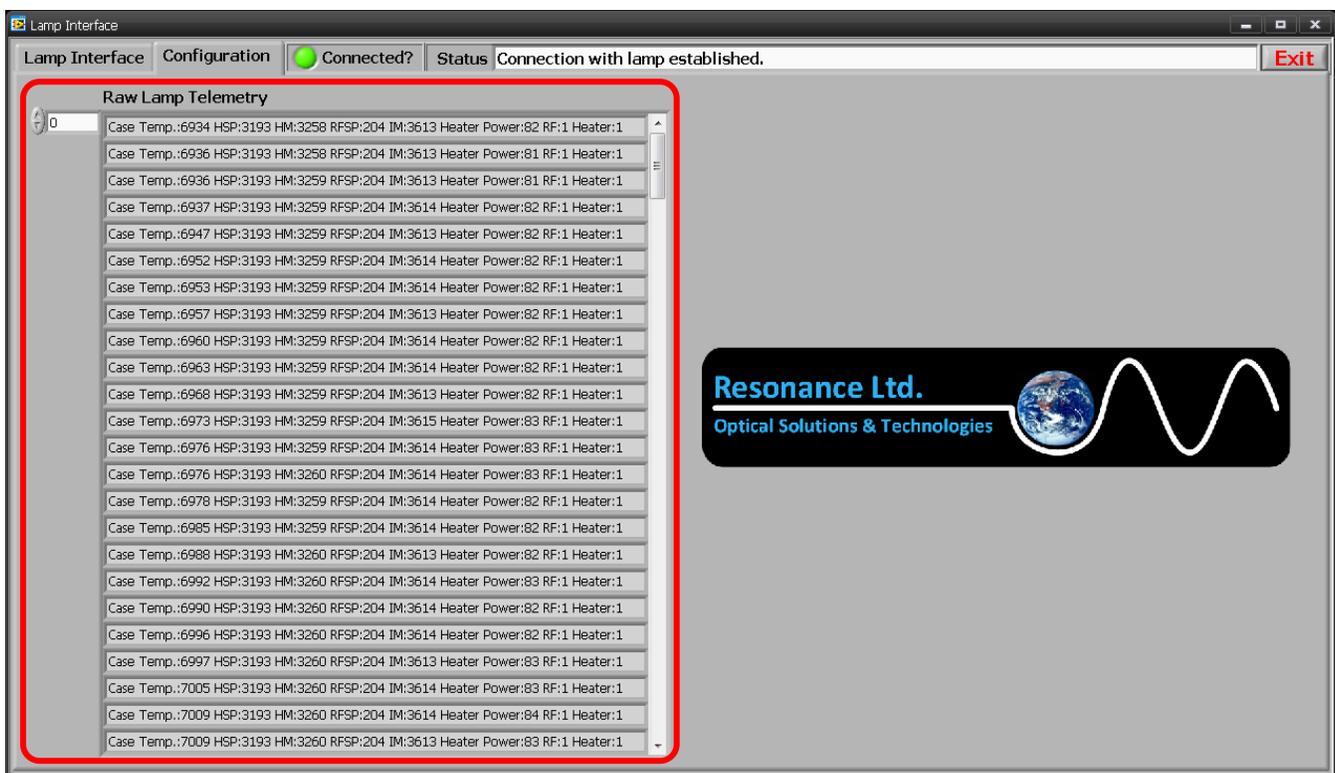
Fig. 11: The Configuration tab of the software showing raw lamp telemetry.

Another use for this tab is add-in modules or experimental features such as data acquisition devices or mechanical motor control etc. Because these new modules often need tweaking, the **Configuration** tab provides a good place for them without interfering with the main lamp user interface.

Telemetry Format

The telemetry from a lamp consists of ASCII strings with parameters delimited by spaces. The output from the lamp to its breakout box is actually serial data (RS-232 protocol). The breakout box contains a Serial-to-USB board to present this data on a virtual COM port on the PC. The **Lamp Interface** software can then read data and set parameters via this 2-way serial link. Other applications may also control the lamp if the RS-232 syntax is followed.

RS-232 Syntax

The telemetry sentences are ASCII characters delimited by spaces and terminated with carriage returns (<CR>). Parsing the sentence is easy if the programmer simply looks for these spaces to separate the data fields. Here is an example sentence:

 Case Temp.: 6934   HSP: 3000 HM: 3100   RFSP: 115   IM: 0   Heater Power: 0   RF: 1   Heater: 1

From this sentence we can extract the following information:

Case Temp.	6934 (arb)
Heater Set-Point (HSP):	3000 / 4095
Heater Temp. (HM)	3100 / 4095
RF Set-Point (RFSP):	115 / 255
Intensity Monitor (IM):	0 / 255 (not used)
Heater Power:	0 / 255
RF ON or OFF? (1 or 0):	ON
Heater ON or OFF? (1 or 0):	ON

The sentences are not fixed-width so it is very important to search the string for spaces, and not rely on offsets from the beginning of the sentence for parsing. This information is output at approximately 2-3 Hz. The following section describes each parameter.

Case Temperature (reported as an integer)

This is simply the temperature of the lamp's forward- cylindrical case covering its bulb. It is very useful for monitoring the lamp's thermal stability over time. The temperature is approximate and is primarily present to detect major hardware problems that may occur with the lamp (overheating etc.). To convert the reported integer to a temperature in degrees Celsius, refer to the following equation:

$$\textbf{Case Temp.}(\textbf{C}) = \textbf{Case Temp.}(\textbf{integer}) * -0.0078 + 65.904$$

RS-232 Syntax (continued)

Heater Set-Point

An integer ranging from 0 – 4095 which sets the temperature the lamp will heat its bulb to. The lower this number the higher the set temperature will be. The integer is actually reporting the resistance of a thermistor. The thermistor has 3 Steinhart-Hart coefficients that allow the reading to be converted to degrees Celsius. The **Lamp Interface** software uses the following equations to convert a temperature in degrees Celsius to an integer for the lamp:

Steinhart **A** = 0.00053022645

Steinhart **B** = 0.00024012105

Steinhart **C** = 0.000000030210536

*Note: Each lamp may have different Steinhart-Hart coefficients. Contact Resonance Ltd. to ensure the correct coefficients are used.

$$X = \frac{A - \dfrac{1}{T}}{C}, \qquad Y = \sqrt{\left(\frac{B}{3C}\right)^3 + \left(\frac{X^2}{4}\right)}, \qquad T = Temperature \ (^{\circ}C)$$

$$Rth = \exp\left[\left(\sqrt[3]{Y - \frac{X}{2}}\right) - \left(\sqrt[3]{Y + \frac{X}{2}}\right)\right]$$

$$Heater \ Temp. (integer) = \frac{Rth * 4096}{Rth + 2000}$$

Please note that values below 3000 (temperatures > 150 ºC) can be dangerously hot for the lamp bulb and may induce cracking of its window, or loss of its seal to the bulb body.

RS-232 Syntax (continued)

Heater Monitor

Using the same Steinhart-Hart coefficients as the set-point, the Heater Monitor reports the actual temperature of the heater. Monitoring this parameter can let the user know whether the lamp is successfully heating the bulb to its set point. The **Lamp Interface** software uses the following equation to convert the integer to a temperature in ºC:

$$Rth = \frac{HM * 2000}{4095 - HM}, \qquad HM = Heater\ Temp.(integer)$$

$$Heater\ Temp\ (^{O}C) = \frac{1}{A + B * \ln(Rth) + C * \ln(Rth)^3}$$

RF Set-Point

Using a different arbitrary integer scale, the RF set point has a useable range of 0 to 255, where 255 is the maximum RF power (100%).

Heater Power

This parameter reports the output of the lamp's heater, in a scale of 0 to 255, where 255 is the heater's maximum setting (100%).

RS-232 Command Set

The RS-232 interface is 2-way, and all these parameters can be set with a set of serial commands. Because the internal firmware of the lamp is continually improved. Please obtain an up-to-date set of instructions by requesting them from Resonance Ltd.. Contact information can be found on the Resonance Ltd. website:

http://www.resonance.on.ca/contact.htm

Software Settings

The **Lamp Interface** software saves settings to an *ini configuration file found in the same directory as the executable. This file can be opened in a text editor such as *Notepad* if certain advanced parameters need to be changed; such as the FIFO buffer length. The file is titled **Settings.ini** and is written to when the **Save Application Settings** button is pressed on the main **Lamp Interface** tab of the software.

When settings are saved, a backup of the existing settings is automatically saved to an **Old Settings** folder in the software's **data** directory, which can be found in the same path as the executable itself. A date and time stamp are prepended to the settings file for convenience. In order to revert to these settings, simply copy them to the main directory and rename them to **Settings.ini** - replacing the existing file. The next time the software is loaded these settings will be used.

Troubleshooting

The following is a quick guide meant for diagnosing problems and offers possible solutions which will hopefully rectify any unwanted behavior. You are encouraged to contact Resonance Ltd. with any problems, and can contact us via our website at

http://www.resonance.on.ca/contact.htm

Telemetry is not Received

This issue can be caused by a number of things. First, make sure the breakout box is connected to the PC with a USB cable, and that the lamp is receiving power (the breakout box power switch is ON). Check *Device Manager* and make sure the lamp's breakout box shows up under the section titled "Ports (COM an LPT). If it does not appear here there may be a driver installation problem. Contact Resonance Ltd. for further advise.

Telemetry is Sporadic and Unreliable

If telemetry data is observed in the "Raw Telemetry" section, but the **Connected?** indicator LED is often red, serial data may have a high error rate which is preventing the proper parsing of data. This could be caused by a bad cable connecting the breakout box to the lamp, or even a shoddy USB cable from the box to the PC. It could also be caused by intense interference from electro-magnetic sources that may be present in the room. Make sure the cables are secured and unbroken.

The Software Reports No Settings File Could Be Found

When the software is started it attempts to read an INI file that contains program settings. If this file is missing or corrupt, the software will inform the user and offer to either load default settings or ask for a suitable settings file. To create or overwrite a corrupt file, simply click **Save Application Settings** on the main tab.

To revert to an older settings file, please see the section titled Software Settings.

Contact

Resonance Ltd. stands behind every product we sell. We welcome feedback and encourage any of our customers to contact us with questions, or concerns. You may contact us through e-mail, our website, telephone, or fax!

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