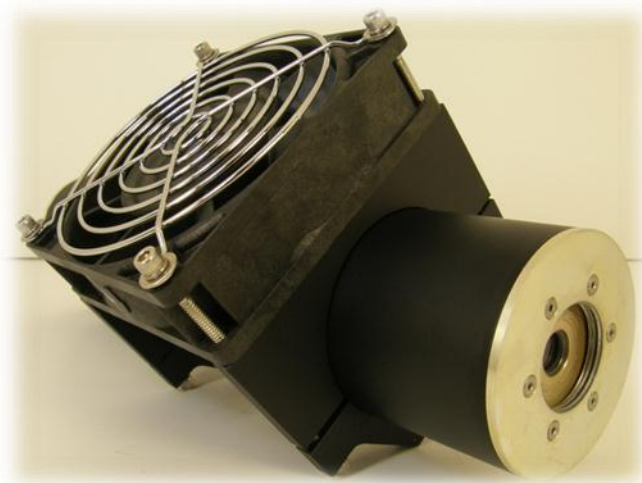




## **RF-Powered Lyman-alpha Light Source Operating Manual**

**Model HHeLM-L  
Rev. 4  
December 2011**



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## Description

The Resonance Ltd. RF-powered Lyman-alpha light source is a reliable, maintenance free, compact emitter of a 121.6 nm ultraviolet line with an operating life in excess of 2000 hours.

The light source is a sealed, RF excited source with a VUV transparent window packaged in an electro-magnetic interference (EMI) shielded enclosure. The light source comes standard with a 2.75" diameter *Conflat* (CF) type flange for easy mounting to most systems. The light source assembly has an integrated RF exciter powered by a small wall plug power supply.

Aside from providing a convenient power switch and allowing one standard serial-type cable to be used to screw and lock to the back of the light source, the included breakout box provides control capabilities such as temperature set-point and RF power monitoring - and also a means to externally modulate the light source. Telemetry output is available via the USB port and / or the RS-232 interface, depending on the user's preference. Paired with the LabVIEW control software, the light source's operation can be easily monitored and useful data can be saved using software features such as the digital chart recorder and .csv-file output.

## Features

The Lyman-alpha light source comes standard with everything needed to produce VUV radiation in the 110 to 200 nm region. The hydrogen in the light source is generated by a reversible heater-controlled source on the light source bulb. This allows the user to operate the light source at low hydrogen levels for an "optically thin" Lyman-alpha line or a multiple-lined hydrogen spectrum in the 110 to 170 nm region. In the latter mode, the light source also produces a continuum between 170 and 300 nm.

- Continuously variable heater set point allowing:
  - Optically thin source of Lyman-alpha radiation (121.6 nm) or
  - Hydrogen spectrum from 110 to 300 nm
- Air-cooled, optically stable – Typically < 1% drift per hour
- Longer lifetime than most available Lyman-alpha sources
- Breakout box for RS-232 telemetry, BNC modulation input (if equipped), power switch, and USB interface for light source interface software (see software manual)
- "Smart Light Source" software allows for precise control and monitoring of light source parameters (heater and RF power etc.)
- Temperature and RF power logging and graphing via graphical chart-recorder interface
- Excel-friendly .csv output formats for data saving

- Generalized data acquisition interface with software available as an option

## ***Options***

The following list details the various accessories available for the light source. Contact Resonance should you need more information:

### **1. Re-entrant Configuration & Wide Angle Output**

In this configuration the light source bulb is inside a tube which extends through the vacuum flange, into the vacuum chamber. This optimizes the irradiance on a given target within the vacuum chamber.

For applications that would benefit from a wider output cone Resonance offers a shortened flange.

### **2. Modulation**

The Resonance light sources can be very quickly modulated using a BNC-type connector on the breakout box. The circuitry to do this is an optional accessory. For more information about modulation, refer to the section titled “[Light Source Modulation](#)”.

### **3. Intensity Monitor**

This option works with the light source interface software to monitor and log the intensity in a selected spectral band of the light source.

### **4. RF Power Control**

This option works with the light source interface software to set the intensity of the light source’s output by controlling the RF power. This is a way of changing the light source’s intensity without changing its heater set point. Changing the RF power will have a smaller effect on the relative spectral irradiance than changing the heater set point.

### **5. NIST Traceable Calibration**

VUV / UV calibration of spectral irradiance is available upon request.

### **6. LED Spectral Extension**

An array of LEDs can be added to the light source to extend and increase its spectral output beyond ~350 nm. On special request LEDs for specific applications can be integrated into the light source.

## ***Accessories & Related Products***

### **1. High Power Light Source**

Resonance offers high power and ultra-high power light sources. These light sources are supplied with 100 – 500 Watt RF power supplies. Contact Resonance to discuss available power options for different light source configurations.

### **2. Low Power Consumption**

Resonance offers a lower power version of most of our light sources. These light sources are physically smaller, and are designed to use less power at the expense of some intensity. For applications where UV ion damage is a concern or higher fluxes aren't needed, the low flux model is an ideal choice.

### **3. Miniaturization**

Resonance has the ability to offer a smaller version of most of our light sources.

### **7. Focussing & Collector Optics**

In addition to our standard optical assemblies (ellipsoidal reflectors etc.) Resonance can also design and implement optics fitted to our light sources to meet customer requirements.

### **8. Phase-Sensitive Detection**

For applications that are sensitive to background signal or dark current drift, Resonance offers phase-sensitive detection (PSD) options. The light source is modulated anywhere from 30 – 5000 Hz, allowing the subtraction of dark current or scattered light from sensitive fluorescence or other signals generated by the light source emission.

### **9. Photon Counting / Fluorescence Decay Measurements**

Ideal for applications that result in extremely low light levels, Resonance offers a photon counting PMT assembly. This setup can detect individual photons striking the PMT and is best coupled with the PSD option or fluorescence decay software available from Resonance.

### **10. Detector Assemblies**

Resonance offers a wide range of detectors covering from the soft x-ray to the near-infrared. These detectors are designed to fit all Resonance products or can be easily adapted to fit most other systems as well.

## 11. McPherson, Acton or Custom Flanges

Resonance can offer flanges to adapt to most available systems. We can also accommodate non-standard or custom flanges.

## 12. Space Qualification

Many variations of our light sources have been flown in space missions (Gravity Probe B, Hubble, Wide-Field Planetary Camera, Space Telescope Imaging Spectrograph, International Space Station etc.). Contact us to discuss your needs.

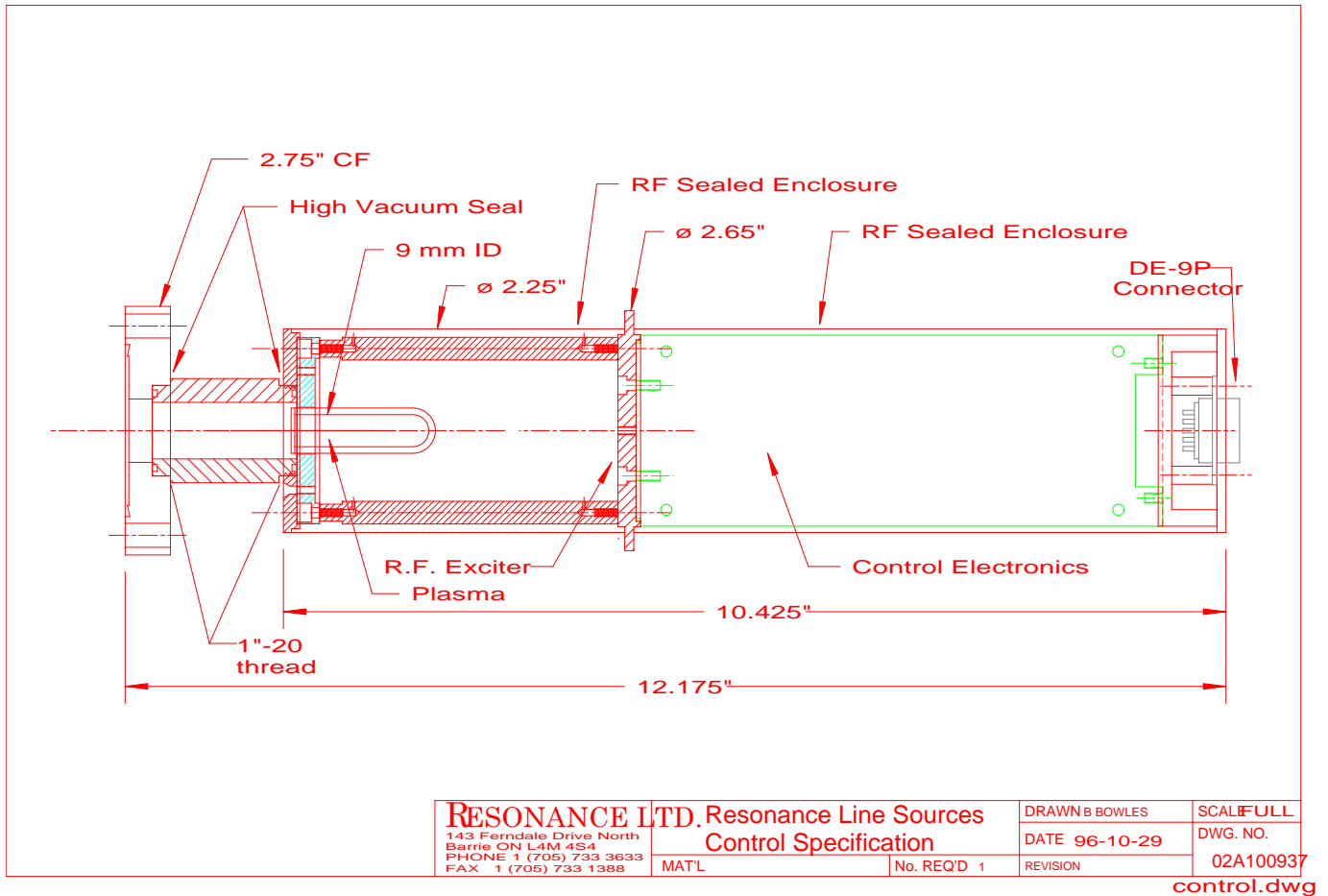
## Specifications

The table below contains the various specifications, with descriptions, pertaining to the light source:

Parameter	Value
Window Material	Magnesium Fluoride (MgF <sub>2</sub> )
Optical Flux (121.6 nm resonance line)	> 1x10 <sup>14</sup> photons / second / steradian
Light source bulb plasma cavity inner diameter	9 mm typical
Full angle output cone	28° ± 4
Running life	1500 hours minimum > 2000 hours typical
Stability	+/- 1% / hour typical drift
Modulation	Up to 5 kHz
Interface / vacuum flange	2.75" CF type standard
Power input (mains)	120 to 250 V, 50 to 60 Hz
Power input (DC)	28 V, 1 amp maximum draw
Case temperature	0 to 55° C
Mass (including power supply)	< 1500 g

## Dimensions:

Figure 1 below is a mechanical drawing with accurate dimensions of the light source.



**Fig. 1:** A mechanical drawing of the light source with dimensions.

## Installation / Mounting

The standard mounting configuration is with a 1”-20 thread adapted to a 2.75” CF type flange which can simply be mounted with the supplied bolts. The light source has been supplied with both *Viton*® and copper gaskets and has been vacuum tested down to  $10^{-7}$  Torr. The light source is not designed to be baked to more than 100° C therefore precautions should be taken to ensure the light source is not heated above this temperature during system bake-outs and should not be operated at all during any bake-outs.

## Operating Warnings

Be sure to read this section and thoroughly understand it before attempting to operate the light source – for both your own safety and that of the light source!

### **Warning: Eye Hazard**

Do not look directly at the light source plasma unless wearing glasses. Normal eyeglasses will block extreme UV of all light sources except Mercury and D2. For these light sources use special UV blocking glasses.

### **Warning: Avoid Damaging Window Seal**

Do not use chloroform, acetone, xylene or vinegar to clean the light source window. Use of these (or similar based solvents) might dissolve the window or the window seal.

## Operating Instructions

Follow these instructions to properly operate the light source. It is recommended that you read this section over carefully before applying power.

### **1. Inspect the Light Source Window**

Inspect the front of the window and clean it if contamination is suspected, according to the window cleaning instructions found in the section titled “[Window Cleaning Instructions](#)”.

### **2. Pre-Installation Test**

It is recommended that the light source be tested prior to installing into your system to verify it turns on properly. Plug the light source into the breakout box

using the supplied DE-9 cable. Then plug the power supply with its DE-9 connector into the breakout box, and flick the power switch on the box to “ON”. The light source should light almost immediately. If it does not, or its output differs from its specifications, refer to the troubleshooting guide found in the section titled “[Troubleshooting Guide](#)”.

### **3. Mount the Light Source**

Now that the light source has been successfully tested, it may be installed onto your system. Refer to the section titled “[Installation / Mounting](#)” for suggestions and guidelines.

### **4. Verify Installed Light Source Turns On**

Once the light source has been installed onto your system, it should again be immediately tested to verify it turns on. With power applied and the power switch on the breakout box flicked “ON”, look through the 1/16” hole in the front section near the bulb to ascertain whether it is emitting light. Again, if there are any problems please refer to the “[Troubleshooting Guide](#)” section.

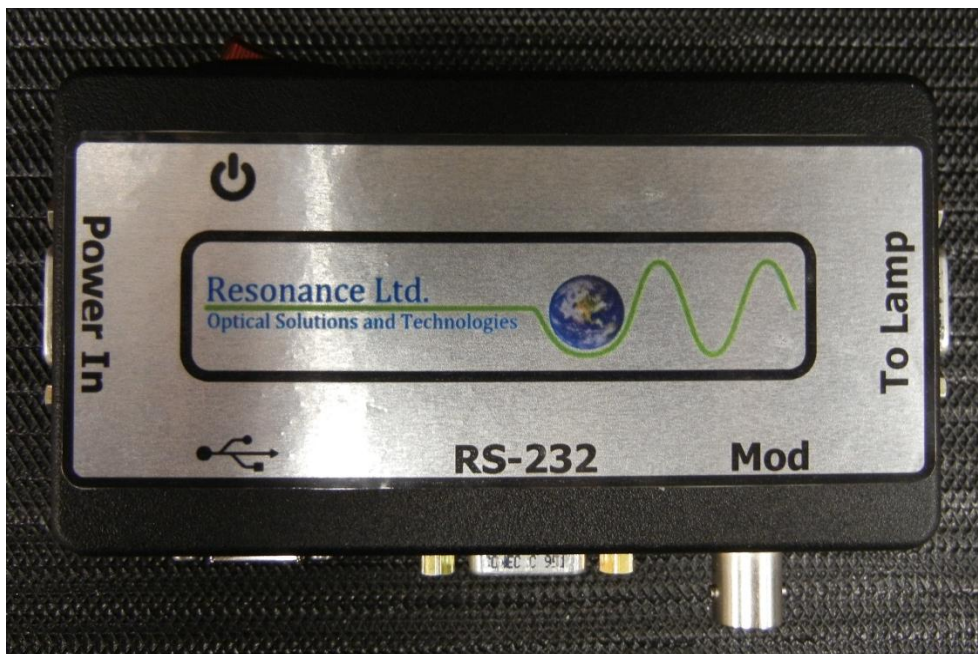
## ***Changing the Temperature Set-Point***

By changing the temperature of the source heater, you can control the amount of hydrogen released by the source getters. This gives the user control over the intensity of the Lyman-alpha line and the purity of the spectrum. Higher temperatures will increase the intensity of the Lyman-alpha line but will also cause the getters to release any impurities they might have absorbed which will add features to the output and could eventually start to absorb the Lyman-alpha line. Lower temperatures will result in a lower Lyman-alpha intensity but a much cleaner spectrum.

The temperature can be changed using the light source control software. It is a very straight-forward process, and is accomplished by entering in a new value and clicking “Apply”. The temperature is not calibrated in a degree scale, and is represented by an arbitrary integer - where smaller numbers correspond to higher temperatures. The usable range is 0 to 5000, however the light source should only be operated in the range of 3000 to 5000. Numbers less than 3000 apply a great amount of heat to the bulb which could shock the glass and break the window or seal. Refer to the software manual for more information, which can be found on [Resonance Ltd.'s website](#).

## Breakout Box

Refer to figure 3 below for a detailed image of the light source's included breakout box. The box allows for a single 9-pin cable to be used to connect the light source to this box. The cable supplies power and provides I/O control of the light source. The box has a power input and a power switch for easy switching. There is a USB and an RS-232 port for communication with the light source using the control software. Both ports are active, so the software could control the light source via USB, and a microcontroller could be logging data using the RS-232 port simultaneously, for example. There is also a standard BNC-type connector for the modulation of the light source. All light sources come with a breakout box with this connector, however not all boxes have the modulation circuitry installed (this depends on the original order).



**Fig. 3:** The breakout box used to supply power, provide modulation abilities, and telemetry output from the light source.

### ***Light Source Modulation***

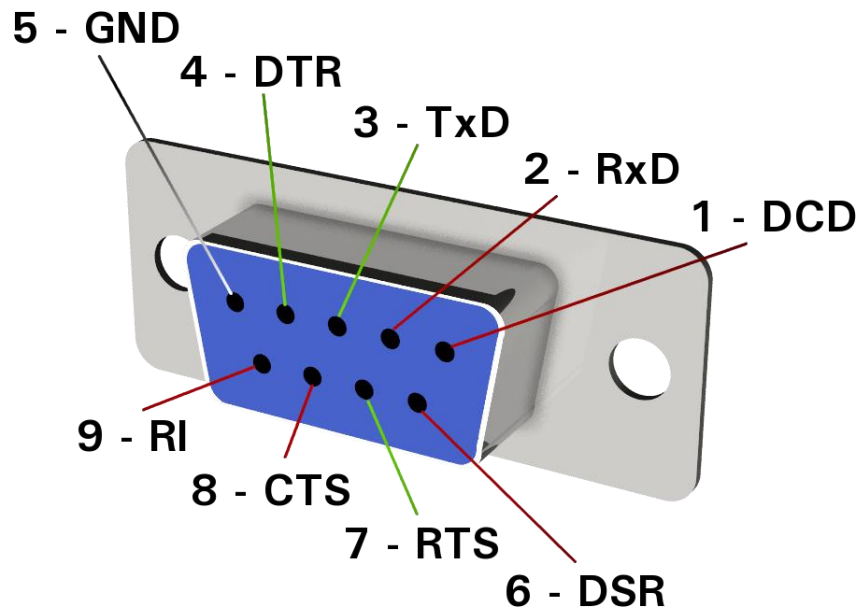
The BNC connector uses its centre pin for the signal line, and the housing for the signal ground. A standard signal would typically be 0 to +5 V. The turns off when the centre pin is at 0 V (pulled to ground). If left floating, the light source will remain on. The light source can be modulated at a rate of 1 kHz

## ***RS-232 Telemetry***

As previously stated, the RS-232 telemetry output remains active even when the USB interface is being used. This allows for low-level devices such as microcontrollers to interface with the light source and even control it if necessary. The syntax and baud rate etc. for the telemetry can be obtained by referring to the light source's software manual (available on the [Resonance Website](#)). The port uses standard RS-232 protocol logic levels so it should be compatible with any other RS-232 port. If directly interfacing to a microcontroller, a converter IC such as a MAX232 may be necessary to adjust the logic level voltages.

### ***DE9 Connector Pinout***

Figure 4 below is a standard RS-232 interface pinout, which is exactly the same as the breakout box's RS-232 port. The serial telemetry is simpler than an "official" port in that only the RxD (receive), TxD (transmit), and GND (ground) pins are connected (as these are the only necessary pins). All other pins may be ignored.



**Fig. 4:** The RS-232 pinout for the light source's breakout box.

## Window Cleaning Instructions

The light source window is polished magnesium fluoride and its vacuum ultraviolet transmission will be degraded if it is touched or otherwise contaminated. In all but the best vacuum systems a slow loss of window transmission will result from photo-polymerization of organic materials on the outside window surface. These problems may be overcome by proper cleaning of the window. A small bottle of polishing powder (1 micron aluminum oxide powder) and cotton-tipped applicators along with polishing instructions are included with the light source unit.

Before using the light source, inspect the window for any signs of gross contamination, such as fingerprints. If there are or if, after operating the light source, you notice a drop in output then clean the window with polishing powder (aluminum oxide) following these instructions. All cleaning operations are carried out with cotton-tipped applicators or with lint-free tissues.

1. Apply the polishing powder to an applicator tip.
2. Polish the window by firmly pressing the applicator against the center of the window and, in a circular motion, work your way outwards to the edge of the window. You should notice a frictional resistance as you slide across the window.
3. Repeat, using a new applicator, until there is no evidence of a film on the window when it is viewed with reflected light and there has been a noticeable decrease in the frictional resistance.
4. Wipe away excess powder with a dry applicator. A few specks of powder on the window will have a negligible effect on the optical transmission.
5. Remove the final bits of powder by directing a stream of ultra-high purity helium, nitrogen or argon across the window. ***Never use a lab source of air for this process because it may contain compressor oil.***

For quick cleaning, it is acceptable to wipe the window with isopropanol or methanol using a cotton-tipped applicator. This will only work for light cleaning (light finger prints, dust, light smudges) and not more serious window contaminants.

# Troubleshooting Guide

The following is a quick guide meant for diagnosing problems and offers possible solutions which will hopefully rectify any unwanted behavior.

## Light Source Does Not Start

The first thing to check for in this case is whether all cables are securely connected. Make sure the light source's DE9 cable is securely fastened to its rear panel and also the breakout box, the power cable is securely plugged into the breakout box, and the power switch is positioned to the "ON" state. You can check if the main power is active by checking if the red LED indicator on the power switch of the breakout box is lit, and also whether the green LED on the power supply transformer is lit.

It is often observed that after sitting for extended periods of time the light source may be hard to start. Refer to the section titled "[Operating Instructions](#)" and follow the starting procedure for further advice.

As a last resort you can start the light source by holding a Tesla coil in the vicinity of the light source window. **BE VERY CAREFUL** that the coil does not arc to the window or light source body as this can damage the window, the light source electronics, and even the power supply.

## Light Source Intensity Appears to Drop

This is most often caused by contamination of the outside of the light source window, and can occur in vacuum systems with  $10^{-7}$  Torr total pressure and  $10^{-9}$  Torr partial pressure of organic materials. The light source window should be cleaned according to the instructions found in the section titled "[Window Cleaning Instructions](#)".

## There is a Problem with the Software / Telemetry / RS-232 Port

Please refer to the software manual which can be found on the [Resonance Website](#).