RESONANCE LTD
Optical Solutions & Technologies

RF-Powered Lyman-Alpha Line Source
Model: HHeLM-LOT

Hardware Manual

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1 - Hardware Description

The *Resonance* RF-powered Lyman-Alpha source is a reliable, compact, and maintenance free source of ultraviolet radiation centred at 121.6 nm. These line sources are sealed with a UV-transmitting window, packaged in an EMI-shielded enclosure, and have an operating life in excess of 2000 hours. Custom-designed mounting flanges are offered to adapt the source to the user's application. The integrated RF-exciter and power supply needs only a 28 VDC power supply which comes in the form of a small wall plug.

1.1 - Features

The Lyman-Alpha line 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 configurable heater 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.

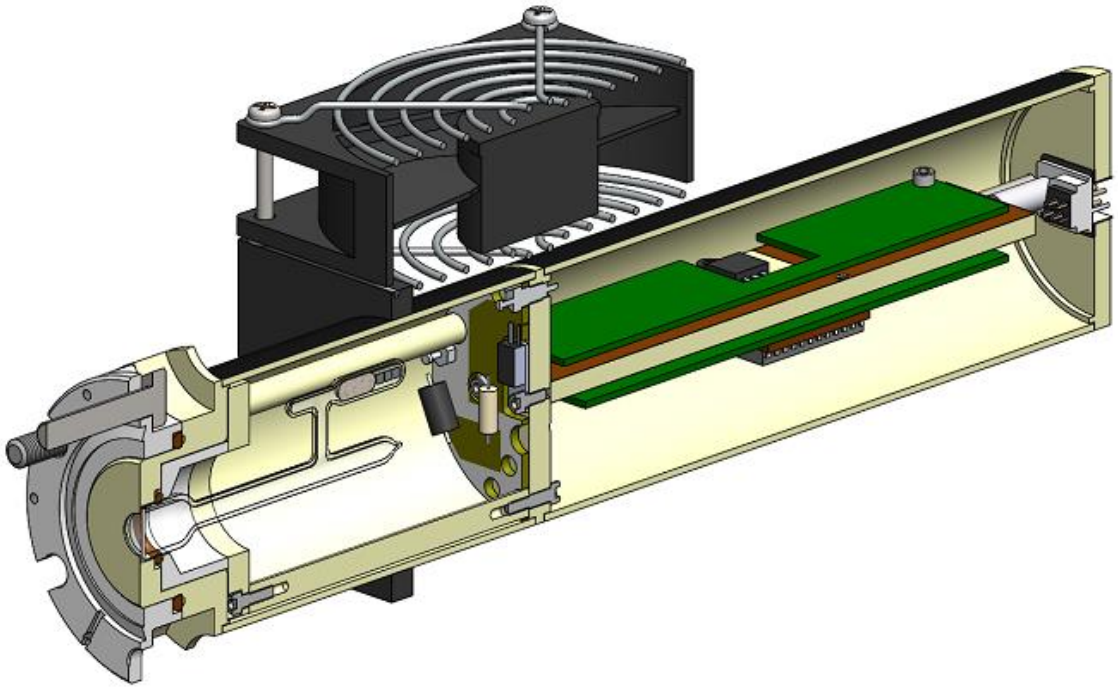
- Continuously variable heater temperature setting that allows:
  - "Optically thin" source of Lyman-Alpha radiation (121.6 nm)
  - Hydrogen spectrum from 110 to 300 nm
- Air-cooled, optically stable (Typically < 1% drift per hour)
- Longer lifetime than most available Lyman-Alpha sources owing to an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

2 - Specifications

- Typical output flux of > $1x10^{14}$ photons/s/sr for the 121.6 nm resonance line
- Lamp bulb plasma cavity dimensions: 15 mm x 9 mm ID
- Integrated units includes lamp bulb in housing with EMI shielded exciter / controller
- Input power to wall plug adapter 100 to 250 V, 50 or 60 Hz, 50 watts max.
- Lamp unit input power 28 V, 1.5 A maximum draw
- Case temperature range 0 to +55 °C
- Lifetime: 1500 hours ≥ 2000 hours typical
- Stability: Max. drift of +/- 2.5 % per hour (< +/- 1% per hour typical)
- Absolute intensity determined by photoionization or by traceable NBS standard

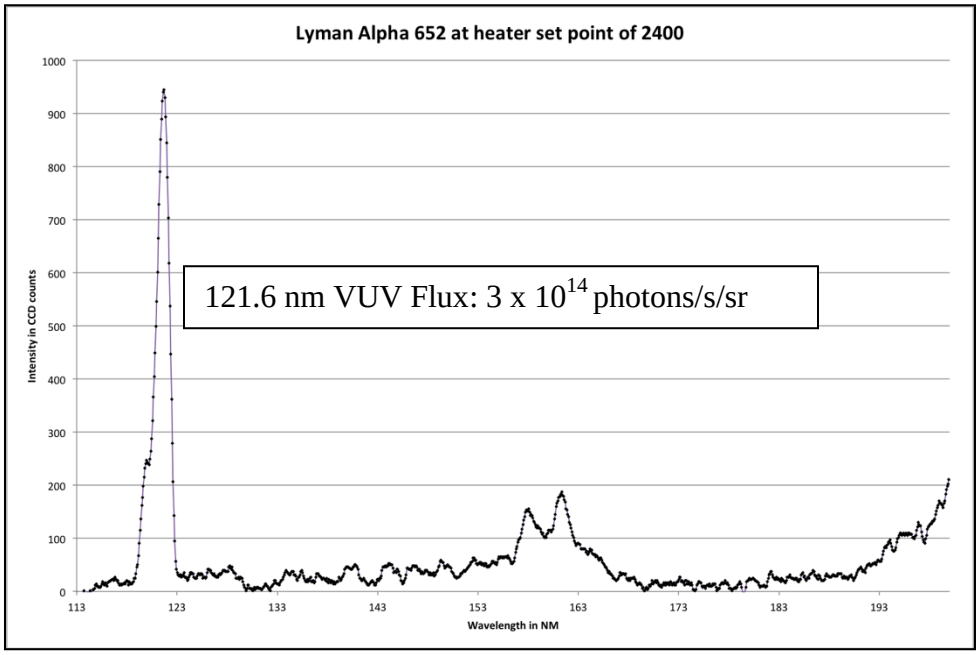
Specification	**Value**	**Units**
Peak Wavelengths Ly Alp	121.5	nm
Peak Wavelengths H2/D2 VUV	110 - 180	nm
Peak Wavelengths H2 UV	180 - 350	nm
VUV Flux H/D Ly Alp	3×10^{14}	Phot./s/sr
VUV Flux H2 or D2 UV	1×10^{15}	Phot./s/sr
Full angle output cone	45	Degrees
Bulb window location	1	mm
Window CA	0.8	cm
Modulation Range	1 - 1000	Hz
Standard flange	2.75	inches (CF)
Power Requirements	20-watt RF supply (Integral to lamp housing). Less than 0.51 amp at 28 VDC	
Power Supply	Power in: 100 to 240 volts AC (50-60 HZ) 0.5 amps at 110 V AC max. draw	
Mass of Line Source	500	g
Mass of Power supply	400	g

2.1 - Configuration Drawings and Photos

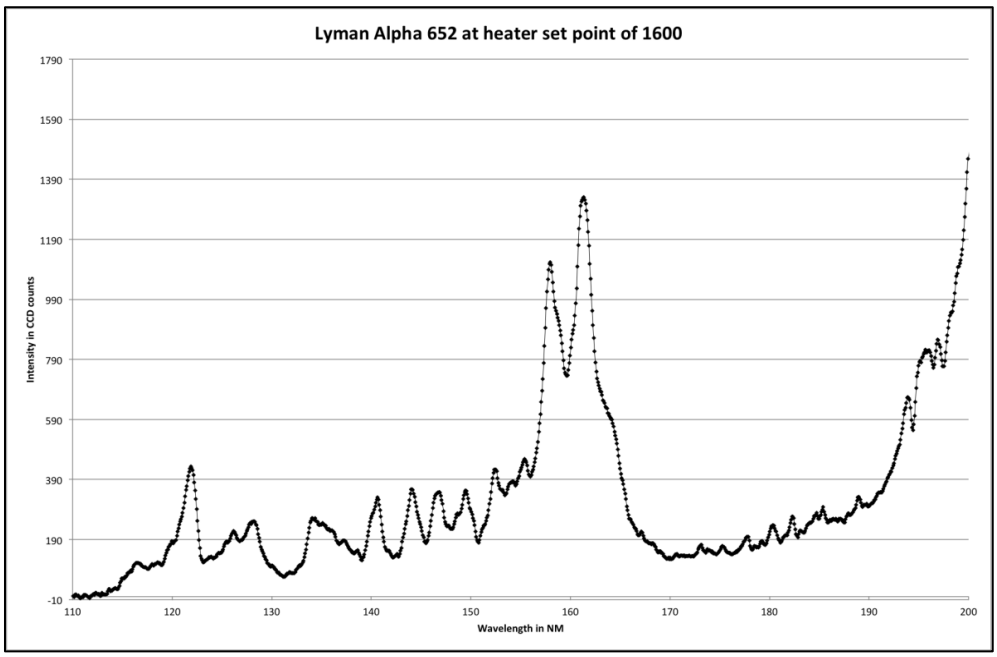


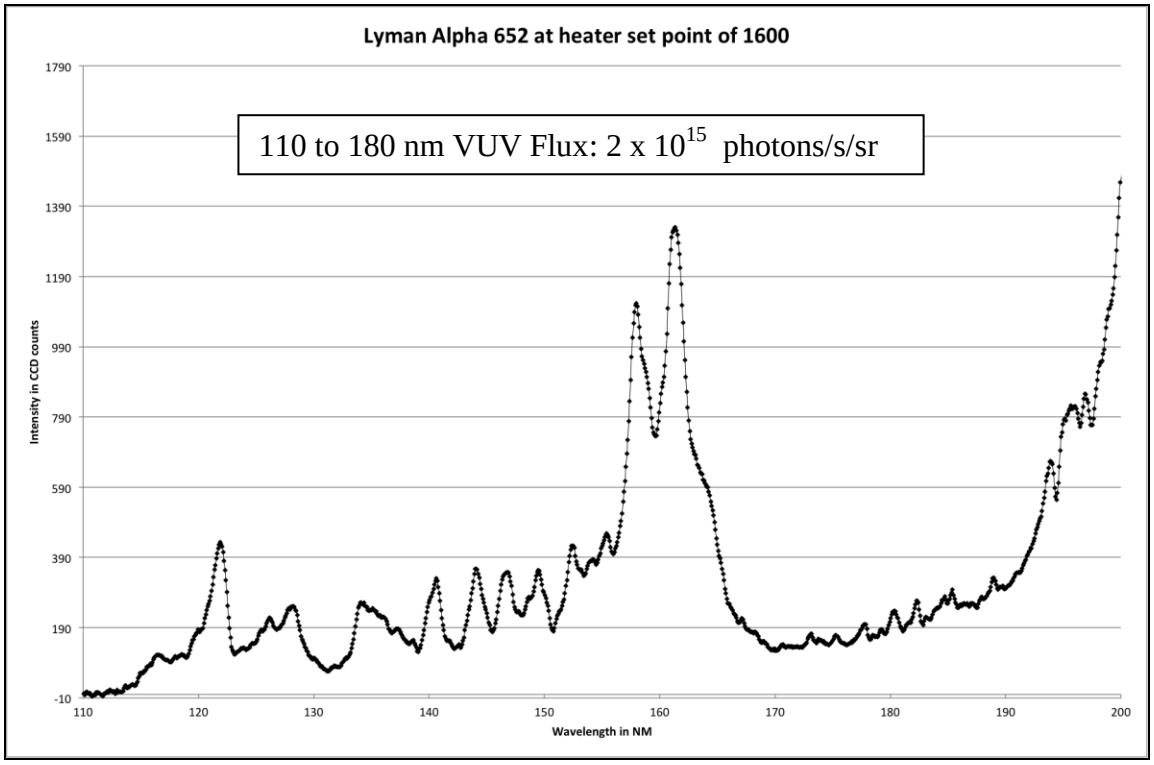
2.2 – Typical VUV and UV Output Spectra

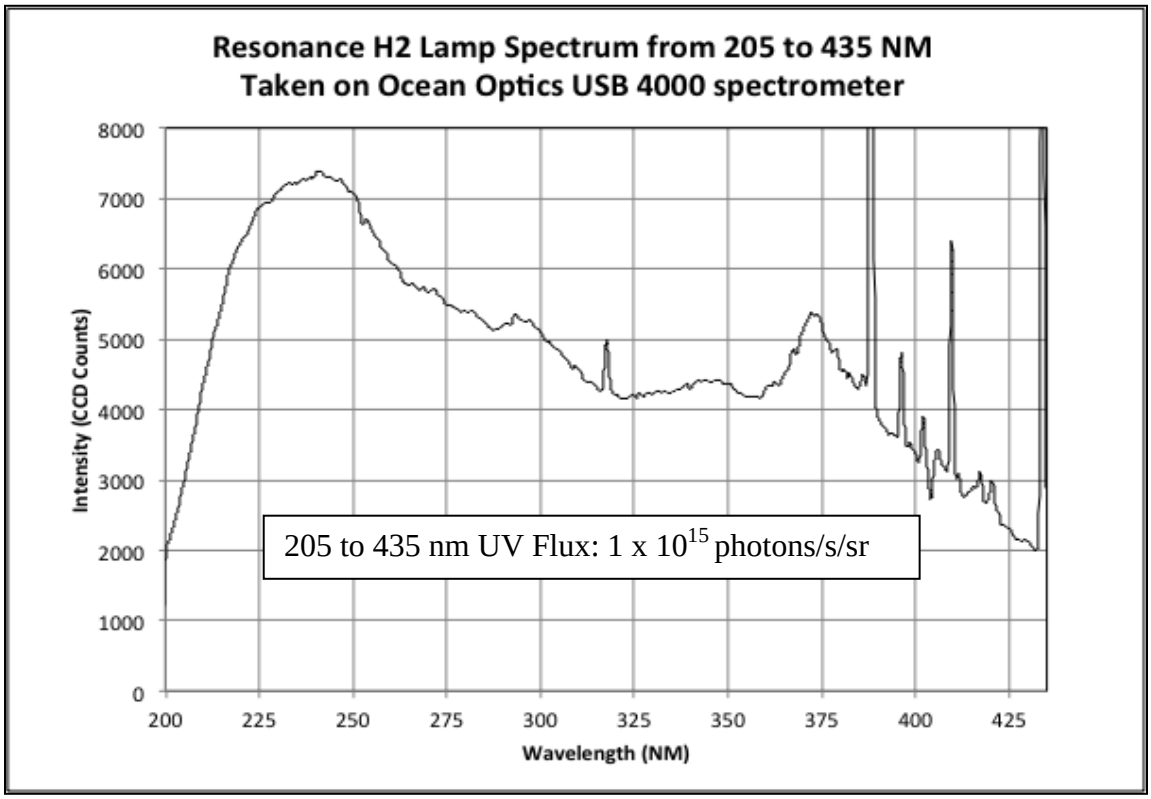
Emission with the heater optimized for Lyman-Alpha.



The spectra shown below are with the hydrogen source heater set. Emission at wavelengths longer than 180 nm is significantly less when the heater is optimized for Lyman-Alpha.




Lyman Alpha 652 at heater set point of 1600
110 to 180 nm VUV Flux: 2 x 10^15 photons/s/sr
Intensity in CCD counts
Wavelength in NM


Resonance H2 Lamp Spectrum from 205 to 435 NM
Taken on Ocean Optics USB 4000 spectrometer
205 to 435 nm UV Flux: 1 x 10^15 photons/s/sr
Intensity (CCD Counts)
Wavelength (NM)

3 - Operating Instructions

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 deuterium. 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.

3.1 - Installation

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 included power/data splitter into the light source. Then plug the power supply into the power/data splitter's other free end labeled "P". When power is applied, the light source should produce VUV 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. This procedure will vary depending on the type of flange included.

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

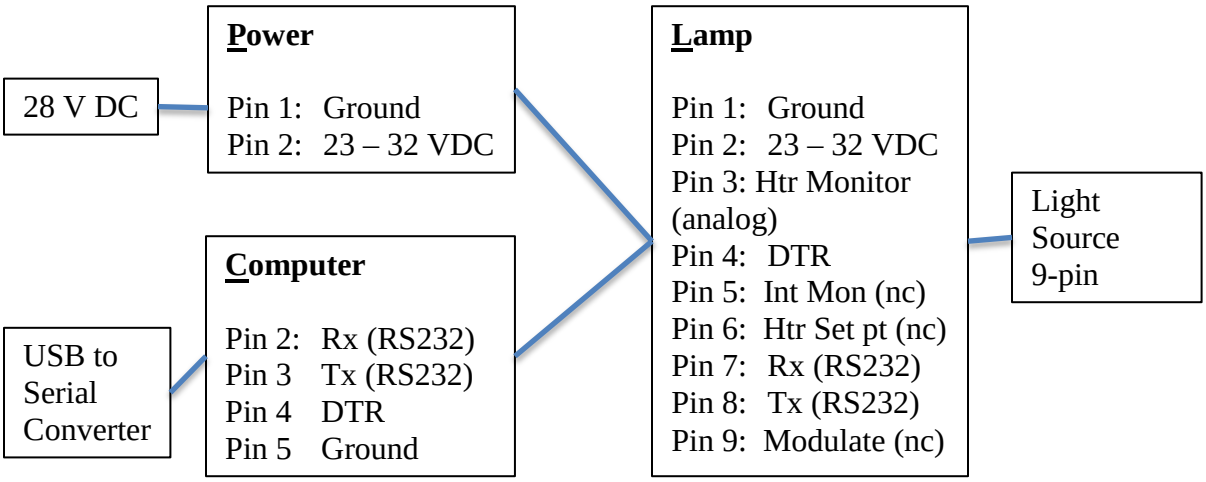
the breakout box flicked “ON”, look through the 1/16” hole in the front section near the bulb to ascertain whether it is emitting light. Again, if there are any problems please refer to the “Troubleshooting Guide” section.

3.2 - Power/Data Splitter:

The splitter for the lamp breaks out its 9 pins and provides a connector for power and telemetry via USB separately. Included is a modulation BNC connector.

Above: The power/data Break-out box, with 28 V input, RS-232 telemetry, and Lamp connector.

3.2.1 – Power/Data Splitter Pinout



3.3 - Changing the Heater Temperature

By changing the temperature of the source heater, you can control the amount of H_2 released by the solid hydrogen source. This gives the user control over the intensity of the Lyman-Alpha line and the purity of the spectrum (Lyman-Alpha results from the dissociation of H_2 into H atoms and subsequent excitation by electron impact). Higher temperatures will increase the intensity of the Lyman-Alpha line but also increase the amount of H_2 lamp emissions. In addition, more H_2 in the lamp results in higher hydrogen atom concentration causing the Lyman-Alpha line to be "self-absorbed". Thus, as the source temperature is increased there will be a point where the Lyman-Alpha intensity stops increasing.

The temperature of the source heater can be changed using the light source software. The concentration of hydrogen in the lamp is controlled by the heater temperature. The thermal control circuit in the lamp will apply power which forces the heater to be nearly equal to the chosen set-point. To prevent damage to the source the heater should never exceed 205 °C (the software, by default, will not accept temperatures higher). Refer to the software manual for more information.

4 - RS-232 Telemetry

The USB telemetry output remains active even when the USB interface is being used. This allows for low-level devices such as microcontrollers interfacing with the light source and even controlling 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.

5 - 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.

6 - Troubleshooting Guide

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

6.1 - 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 green 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.

6.2 - 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".

6.3 - Problem with the Software / Telemetry / RS-232 Port

Please refer to the software manual, which can be found on the Resonance Website

7 – Contact Resonance Ltd.

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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