ADVANCED PHOTONIC SCIENCES

APS-ILS-445nm-XXXW
Operating Manual & Datasheet

Version 1.2.1

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1 Introduction

APS' Integrated Laser System (APS-ILS-445) features the integration of multiple different components which together compose a simple and easy-to-use laser system. Enclosed in a standard 19" Rack Cabinet is a 445nm (Blue) fiber-coupled laser of your selected power, fueled by a high efficiency power supply, and cooled by a thermo-electric water chiller.

The ILS-445 product family consists of 4 models, offering 50W, 100W, 150W, and 200W of laser power levels (denoted by the number at the end of your model number). Most of the operation and assembly remains the same across models, regardless of selected power and wavelength. Any notable differences will be discussed, some of which are shown in Section 2. This document accounts for all ILS-445 models.

The system offers an array of controls and settings which with brief description provide a means for operation in any use case necessary. A full description of these can be found in Section 3. Monitoring signals and interlocking safety mechanisms provide a means to further integrate this laser system with any desired application.

The assembly, which includes a rack-mounted TEC chiller, driver, laser and other components, is further described in Section 4. Additionally, the arrangement of parts and the enclosure design vary slightly accross models and are also discussed, followed by dimensional drawings in Section 5.

This product is designed to be assembled and ready for use upon delivery. The assembly should not be taken apart as to avoid risking functionality and/or warranty. The fibers should be handled with care. This is expanded upon in Section 6.

This document should be read thoroughly before operating this device in order for the user to get the most of their new product.

Features

- High-Efficiency Power Supply
- Integrated Water-Cooling
- SMA Fiber Mating Sleeve
- Integrated Beam Collimation (Option)
- Standard 19" Rack Cabinet Enclosure
- Safety Interlocks and Stops
- Optional Wheels

Applications

- Material Processing/Softening
- Engraving and Cutting
- Additive Manufacturing
- Nuclear Research
- And More...

Contents

2 Specifications

Discipline	Parameter		Unit	50W	100W	150W	200W
Mechanical	Height		in.	19.4			
	Height (with Wheels)		in.	24.0			
	Width		in.	20.4			
	Depth		in.	20.0			
	Weight		lb.	45	55		
	Fiber Length		m	3	5.5		
	Fiber Connection		-	SMA 905			
Optical	Wavelength		nm	445±20			
	Fiber Core Diameter		um	200	105		
	Numerical Aperture		-	0.22			
	Max CW Output Power		W	50	100	150	200
	Min Bend Radius		mm	60	50		
Electrical	Max Operating Current		A	3.5			
	Operating Voltage		V	60	120	180	240
	Max Bandwidth		kHz	1			
	Modulation Voltage (typical)		V	0-5			
	RS232-Pins	Pin 1	-	Ground			
		Pin 2	-	Interlock			
		Pin 3	-	VILaser			
		Pin 4	-	Crowbar Status			
		Pin 5	-	Ground			
		Pin 6	-	N.C.			
		Pin 7	-	VMOD			
		Pin 8	-	Ground			
		Pin 9	-	N.C.			

3 Operation

This section goes through the various controls and auxiliary functions of the ILS-445 unit.

IMPORTANT: Before plugging in the system, the user must fill the TEC chiller with distilled water in the entry port on the lower front panel, shown in Figure 2 labeled as *Water Cap*. This is *required* in order to cool the laser using the chiller. It is *necessary* to use distilled water to avoid corrosion of internal components.

We recommend to fill the chiller tank with 1 quart, however, remaining between the "H" and "L" *Water Level* lines shown in Figure 2 will suffice. The level should not change drastically over time, aside from natural processes. If you notice your system losing any water, please contact info@apslasers.com for support. Otherwise, this portion of the system requires little maintenance.

3.1 Controls

There are various controls accessible to the user to change parameters of the laser during operation. Figures 1 , 2 and 3 represent the front panel of the device, and show the necessary components needed both turn on the laser, and change it's parameters.

Figure 1: Front Panel Top

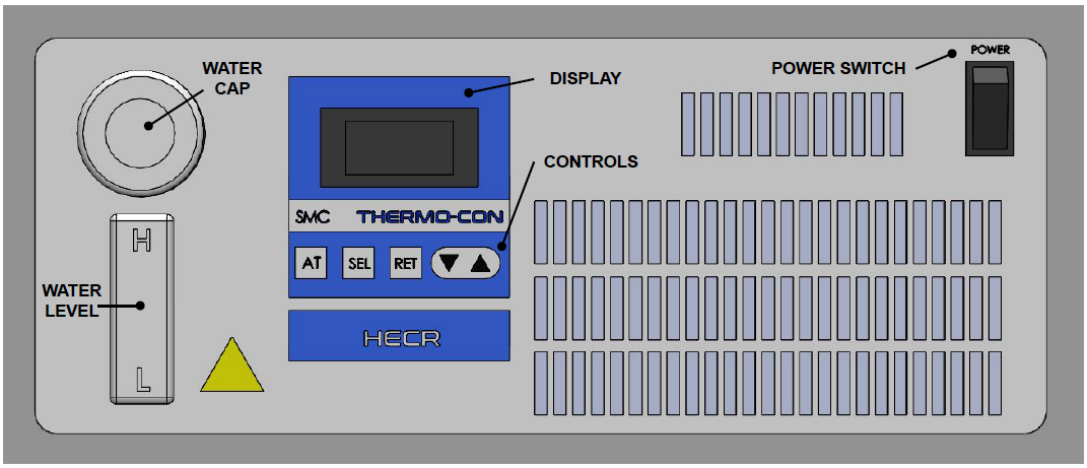

Figure 2: Front Panel Bottom

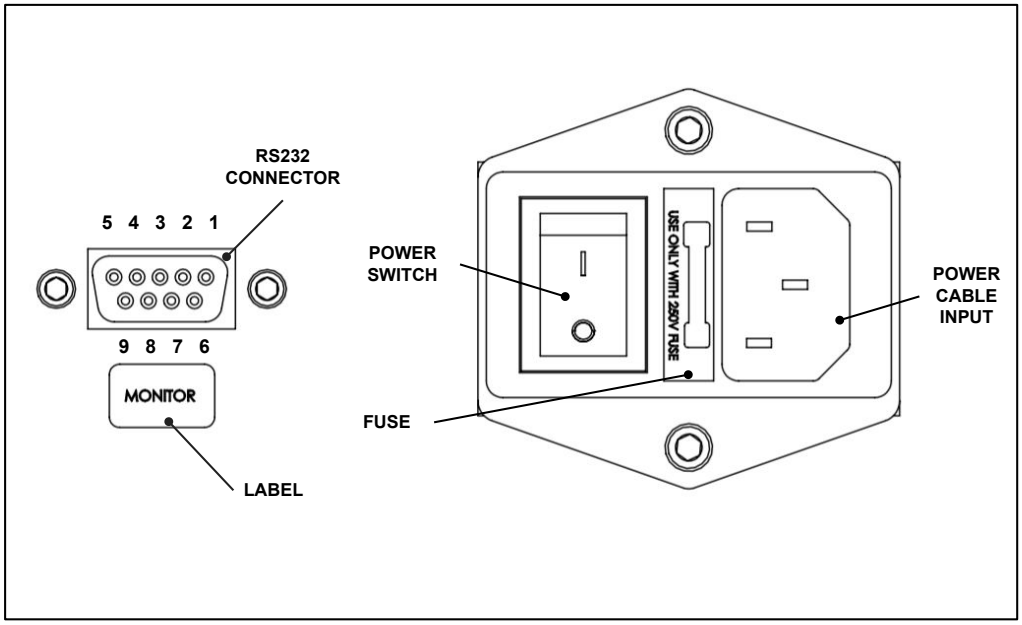

Figure 3: Rear Panel Controls

For immediate operation, it is required that (from Figure 1) the Emergency Stop button is in the **OFF** state (NOT PUSHED-IN), the Key Switch is turned to it's **ON** state (TO RIGHT), the Laser Power Ouput dial is turned all the way counter-clockwise until it reads **ZERO** on the tick mark, and the Power Switch in the rear of the system (Figure 3) is flipped **ON** (UP). Once all of these controls are in the correct orientation, pressing the RED *ENABLE* Button on the UPPER RIGHT of the Front Panel (Figure 1) will turn the laser **ON** and output the 445nm light through the SMA connector and/or external fiber or collimating lens.

CAUTION: DUST CAP MUST BE REMOVED FROM THE OUTPUT FIBER TIP BEFORE LASER IS TURNED ON!

After this point, both chiller temperature and laser current can now be set to the user's liking. These will be explained more in Sections 3.1.1 and 3.1.2, respectively.

3.1.1 Chiller Operation

The chiller operation is simple. Upon receipt of this system the chiller will already be *preset* to a determined value from Table 1. This value does not need to be set always, for example, when the user wishes to change wavelength and power based on the quantum-temperature relations.

Shown in Figure 4 are the buttons: "**AT**", "**SEL**", "**RET**", and the UP/DOWN keys underneath the screen and text. To set a desired temperature, press the "**SEL**" key and adjust the temperature setting using the up and down arrow keys. When finished choosing the desired temperature, press the "**RET**" key. The new temperature set point is now chosen. If an error code is displayed on the screen, reset the chiller by flipping the power switch off and then on, this is shut the laser off as well. Other operating controls and error codes can be found at https://www.smcworld.com/assets/manual/en-jp/files/HEC-OM-R008.pdf. Contact **APS** if an error code is launched or if further assistance/maintenance is required.

Figure 4: Chiller Display and Controls

Model Number	Recommended Operating Temperature
ILS-445-050W	20^{o}C
ILS-445-100W	20^{o}C
ILS-445-150W	18^{o}C
ILS-445-200W	18^{o}C

Table 1: Recommended Operating Temperatures for Each Model

3.1.2 Laser Current

Various monitoring can be done through the RS-232 pin connection at the rear panel, which will be discussed in Section 3.1.3. With some external wires and a voltmeter, the user can measure the current simply.

The current flowing through the laser is provided as a voltage from the electronics, and it can be converted using the following:

$$I_{Laser} = 0.4 * V_{I_{Laser}}, \tag{1}$$

where $V_{I_{Laser}}$ is the voltage reading of the laser current read from the voltmeter on the RS-232 connector, and I_{Laser} is the actually laser current. The maximum current allowed

is 2.5 Amps, which would read 6.25V on at the Current Monitoring Pin on the RS-232 connector.

For additional information or support, please contact **APS**.

3.1.3 Monitoring Signals

Besides measuring current, there are a couple of other interactions the user can perform when operating this device. Figure 5 and Table 2 offer some insight into the "ILS" monitor and control capabilities.

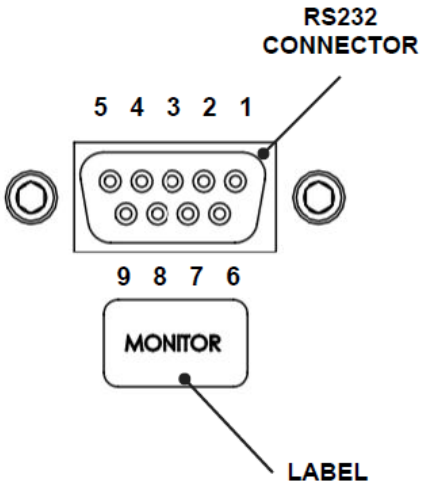

Figure 5: RS-232 Pin Out

Pin Number	Description
1	Ground
2	Interlock
3	$V_{I_{Laser}}$ (Laser Current)
4	Crowbar Status
5	Ground
6	N.C.
7	V_{MOD} (Modulation Input)
8	Ground
9	N.C.

Table 2: Pin Descriptions

Interlock Pin 2 (Input) This pin should be tied to ground. It is also connected to the front panel key switch. It can be used to interlock the system to external features such as a door or shutter.

$V_{I_{Laser}}$ (Laser Current) Monitor Pin 3 (Output) This pin provides a voltage from 0-6.25 V which is explained in Section 3.1.2. It is important that the system does not exceed the value of 6.25 V. This can be used in tandem with the front panel potentiometer to apply the desired laser power.

Crowbar Status Pin 4 (Output) This pin is an output from the system. If an error has occurred it will output low. If the system is running fine the crowbar will output high (5 V).

V_{MOD} (Modulation Input) Pin 7 (Input) This pin is an input to do external electrical modulation of the laser. Applying a signal from Pin 7 to ground will modulate the laser up to the bandwidth and voltage described in Section 2. Do not exceed the system bandwidth or maximum voltages for this pin.

3.2 Safety Features

The various safety parameters on this device are meant to prevent damage of the laser and it can be used in a way to prevent other users from operating the machine as well as providing human-based safety features.

Emergency Stop

The Emergency Stop is connected to the AC line input on the rear panel shown in Figure 3. To operate the Emergency Stop button, simply push the button in order to shut off the entire system. When conditions are safe again, twist the cap counter-clockwise until it pops back up. The system will begin to run again.

Key Switch

The Key Switch is connected in-line with the interlock signal mentioned in Section 3.1.3. Turning the key to the left will shut the Laser aspects of the system off, and turning it right will allow the Laser to turn on. As a key, it can only be operated with the key put into the respective key switch receptacle. If the key is lost, this feature will not be controllable. Auxiliary interlocking can be done by using the back connection on the RS-232 as shown from Section 3.1.3. This interlocking signal connected to the RS-232 and the key switch is an active low, meaning, it needs to be tied to ground in order for the system to operate. **Make sure the key does not become lost or stolen.**

Enable Button

After everything is put into the proper "On" state, the user can use this button to apply power to the laser and operate. By pushing the button, the red light will indicate that the laser is ready and will run as long as all other logical functions are correct and the internal Crowbar status is set high (Refer to Section 3.1.3 for information on the Crowbar). **It is important to realize that the laser will operate at the previously set output current before or after the fault conditions are met! The user must be careful to avoid eye exposure when the system comes back to normalcy!**

Fiber Handling

The ILS-445-50 comes with a mounted cap for the SMA connector. This needs to be screwed off in order to apply external SMA fiber cabling. ***IT IS IMPERATIVE*** that when connecting the any external optics or fiber cable to this connector, the tips are **cleaned and cared for** with Isopropyl or Methanol Alcohol before insertion into the SMA connector. Care **must** be taken when attaching elements to the SMA adapter sleeve with **minimal force** applied and a **gentle** screw-in motion. If this is not followed, **damage** could occur on the fiber tips. If any issues occur, please contact **APS** for assistance.

3.3 Logic Operators

This section will explain some various peripherals that would assert the crowbar (Section 3.1.3) low and not allow the laser to turn on. It is important to realize that this system will not turn the laser on for any condition other than **every operator** shown in Table 3 being in the System On State. This can be considered similar to an "AND Gate" logic operator, where the output is only high when every input (i.e. these operators) is high. In this case, the output is the laser and the high state is emitted radiation.

Operator	Condition	System Status
Emergency Stop	Pushed In	Off
	Not Pushed In	On
Key Switch	Turned Left	Off
	Turned Right	On
Enable	Not Illuminated	Off
	Illuminated	On
Laser Temperature	>35 ^{o}C	Off
	<35 ^{o}C	On
Laser Actual Current	>10 V	Off
	<10 V	On
Laser Set Current	>10 V	Off
	<10 V	On
Chiller Water Flow	<1.5 L/min	Off
	>1.5 L/min	On

Table 3: ILS System Logic Operators. On represents Laser Radiation and Off represents no Radiation. **Every Operator has to be in the *On-State* in order for Laser Radiation!**

4 Mechanical

The assembly integrates three major components consisting of a rack-mounted TEC chiller, a driver and laser.

The rack-mounted TEC Chiller is featured on the lower section of the assembly. The necessary controls and apertures are accessible by the operator through the front panel. This includes power control, temperature setting and display, and the water port. The rear of the chiller is enclosed and integrated with hosing, a flow switch and accompanying electronics.

All models feature a fiber-coupled laser mounted on a rack shelf located above the TEC chiller. As stated, which laser is included depends on the power level selected. The laser fiber is extended to the exterior of the system through the front panel via an SMA-905 connector. This standard connector allows the user to extend longer fibers (patch cables) or additional optics for collimation and focusing per the users discretion. Refer to Section 3.2 for proper fiber handling.

A high-efficiency driver is mounted alongside the laser and is similarly enclosed, integrated and not to be disassembled. This component requires convective cooling, which is allowed through the front and rear panel air vents. During proper operation, heat is dissipated through these vents.

All components are enclosed in a standard 19" rack with custom aluminum panels on the front and rear. The control panel, explained in Section 3.1, is featured on the front of the system while the power input and monitor connector are accessible from the rear.

All necessary inputs, outputs and controls are exposed to the user eliminating any need for disassembly of the enclosure. The system allows for the optional addition of four wheels. An inside view of the assembly is shown in Figure 6.

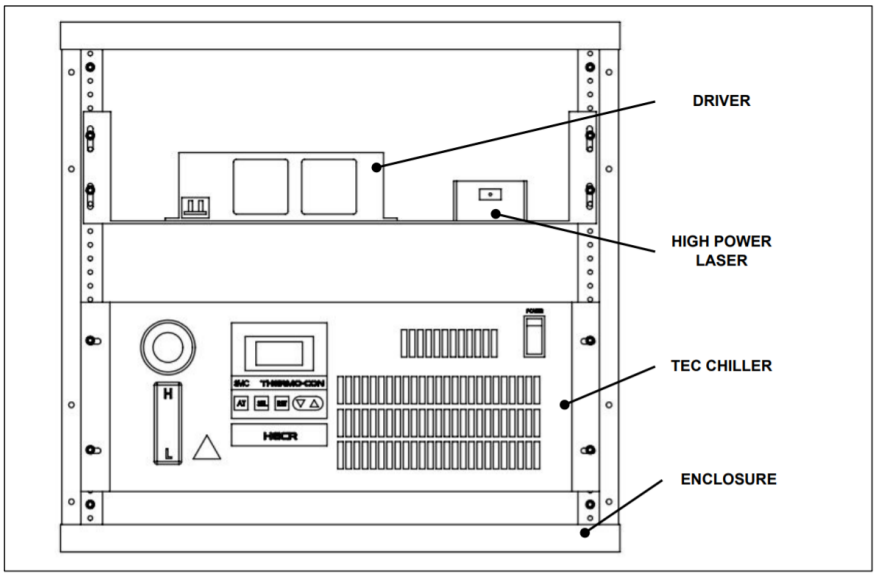

Figure 6: System Assembly

5 Drawings/Dimensions

5.1 Unit Dimensions

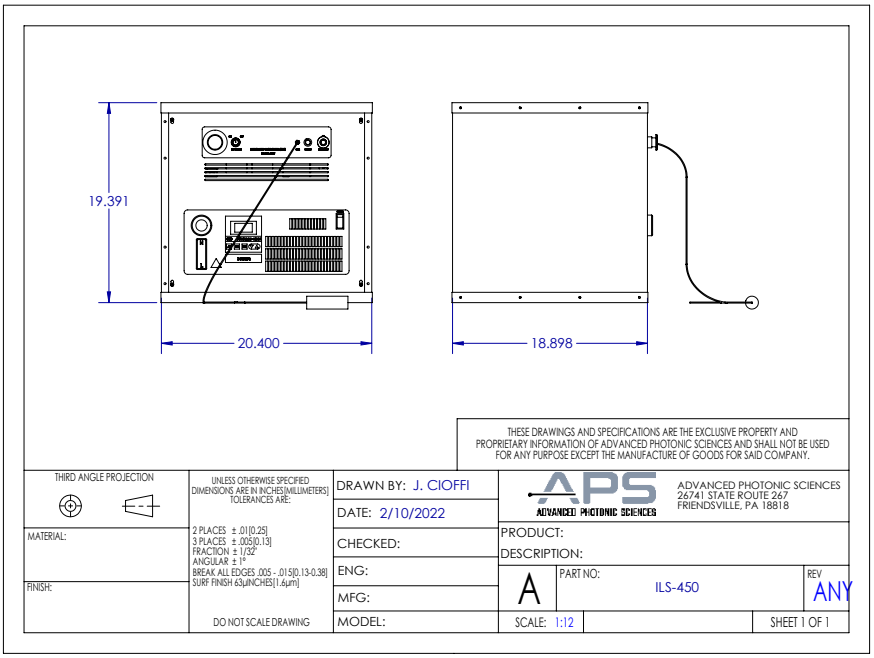

Figure 7: Dimensional Drawing

6 Packaging and Handling

This product is assembled before packaging and shipping. If optional focusing optics are requested, the lens apparatus will be assembled by the user.

System Weight: Approx. 55-60 lbs

Revisions

Revision -	Initial Documentation
Revision 1	Documentation Release. Addition of Extra Safety Features and Handling.
Revision 2	Expansion of Document to Encompass 4 Models of Varying Power Levels.

Support

Please contact Advanced Photonic Sciences for technical support: www.apslasers.com

Figure 8: apslasers.com

Advanced Photonic Sciences
26741 State Route 267
Friendsville, PA 18818
(570) 553-1120
info@apslasers.com