



PYROIS TECH

FJORD-series User Manual

Fiber coupled
SLED light source
NIR



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The specifications indicated in this manual are subject to change without prior notice.

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0. Introduction

Thank you for purchasing this FJORD light source from Pyroistech.SL. This document describes the FJORD light source and provides you with instructions for its correct operation. Please do not hesitate to contact us through **info@pyroistech.com** if you have any questions or doubts about this manual.

FJORD is the superluminescent diode (SLED) broadband light source that allows you to combine up to 8 high power SLED, with peak wavelengths that range from 830 nm to 1650 nm. Its compact, silent and sturdy design permits its integration in whatever type of application, covering a wide range of possibilities, from optical laboratories, fiber optics testing, Bragg grating interrogation, tomography, or industrial sensors among others.

The FJORD light source can include one or both of the following two extras: a touch screen to adjust the power of each SLED individually from 0 to 100% and a USB connection that enables to do the same through the computer, allowing the remote control of the source.

1. Technical Specifications

General characteristics

- Configurable spectral bandwidth with up to 8 SLEDs (see all the available SLED modules on the [next page](#))
- Max. optical power (fiber 8μm): -5dBm*
- Short stabilization time <1 min
- Temperature controlled $\pm 0.1^{\circ}\text{C}$
- Configurable output connector FC-PC/FC-APC
- Dimensions 18 x 5 x 12.7 cm*
- High quality materials for a durable product.
- Compact, light and silent

*These values may vary with the number and model of the chosen SLED modules. The dimensions correspond to a 2 SLED source.

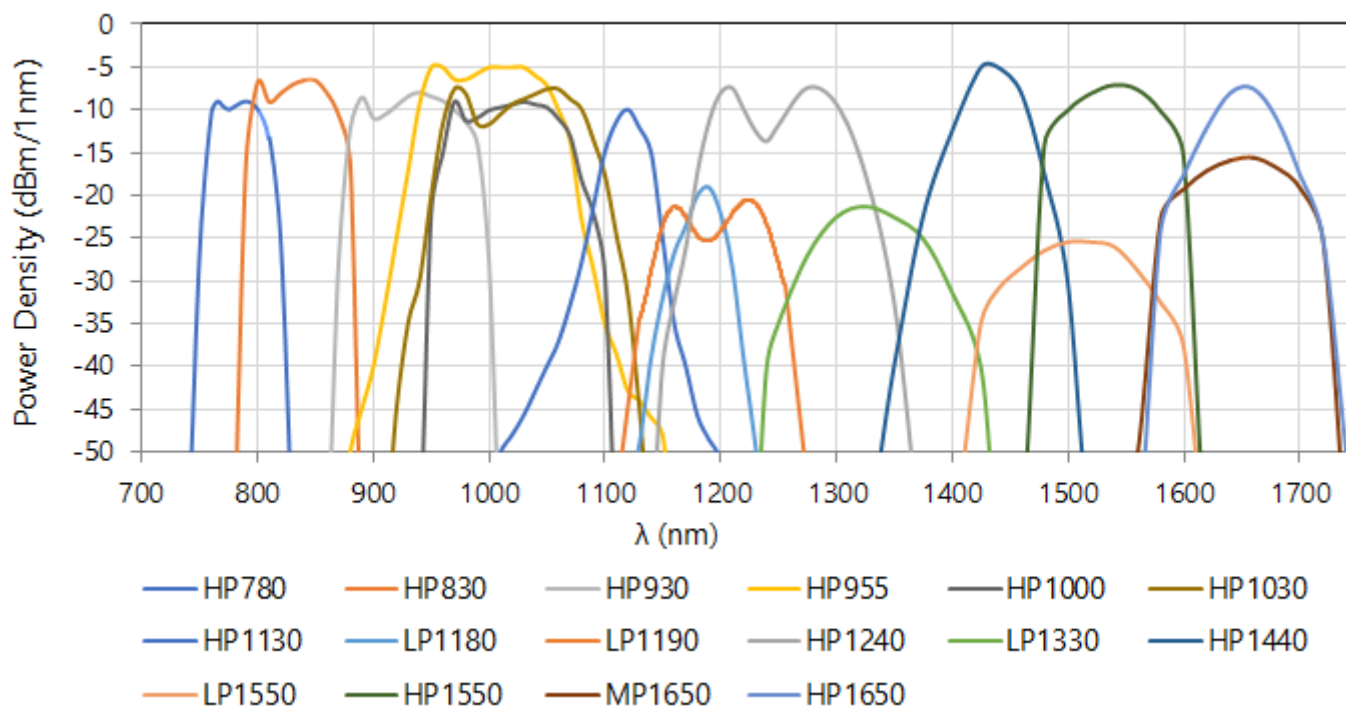
Available extras

- Individual control of the power of each SLED
- Touch screen option
- USB connection option



Optical characteristics

The available SLED for configuring your own FJORD source are the following:



The central wavelength of each SLED is included in its own name. For example, SLED HP1130 has a central wavelength of 1130 nm.

The power measurements shown in the graph correspond to each individual SLED. The assembly of several SLED modules implies some power losses. Final power measurements will be provided for each FJORD SLED light source separately at the time of assembly.

Right now, we have available the FJORD configuration tool, that allows you to combine up to 8 SLED to preview your desired output spectrum. Contact us through info@pyroistech.com in order to get access to it or download it in our webpage.

Electrical characteristics

- Input voltage (V_{IN}): 5 V
- Input current (I_{IN}): 4 A max (typical value, it may vary depending on the model)
- Connector type: DC female 2.1 mm

Other characteristics

- Working Temperature: 15 - 25°C
- Relative Humidity: 20 - 80% HR

2. Operation

2.1 Package Content

- Requested FJORD light source
- Power source
- Power cord
- User's manual

Inspect carefully the devices and make sure there is no damage. On the contrary, do not employ the light source and please contact us through **info@pyroistech.com** for repair or replacement information.

2.2 Basic operation

Insert the plug of the power cord into the power supply and connect the power cord to the power outlet. Then, introduce the plug of the power supply into the light source power input (DC female type).

Unscrew the cap of the FC-PC/FC-APC connector on the front face of the light source and connect the fiber cable. Always do this step before turning on the light source. Now, the FJORD light source is ready to be used.

Press the ON/OFF button to turn on the light source. The button will be lit up in green while the source is working. Press again the button to turn off the light source.

USB connection

If your FJORD source has a USB connection (available extra) and you want to use it, physically connect the source to the computer through the USB cable. If your FJORD source has a touch screen (available extra), the message "USB Connected" will appear on it once you have done the connection.

In order to end the USB connection, just disconnect the USB cable. If you are using the app for the USB connection, it is recommended to click on "Disconnect" in the first place (more information on section **2.6.2**).

2.3 Maintenance

The output connector of the light source should be periodically cleaned employing compressed air to remove the dust. It is recommended to have the output connector with the cap on it whenever the light source is not being used. The connector of the fiber used with the light source also has to be clean to ensure the best possible performance.

2.4 FJORD-series diagrams

1	Switch (ON-OFF)
2	Power input
3	FC-PC/FC-APC output connector
4	Touch screen (available extra)
5	USB connector (available extra)

Front view



Rear view



Model with extras



Front view

*The size of the source may vary with the number of the SLED modules.

The standard FJORD on this page corresponds to a FJORD-X2-1330-1550 model.

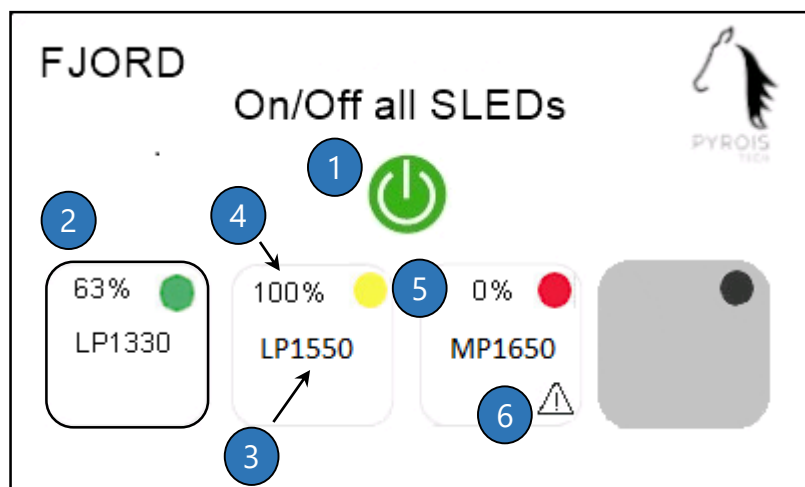
The FJORD with extras on this page corresponds to a FJORD-X3-1330-1550-1650 model.



Rear view

2.5 Touch screen (available extra)

2.5.1 Initial screen



1	General ON/OFF button
2	SLED rectangle
3	SLED name
4	% of nominal P _{OUT}
5	Status circle
6	Warning

Figure 1. Initial screen

➤ General ON/OFF button (1)

- If all the SLEDs are **OFF**, the general ON/OFF button will be **OFF** (grey). By pressing it, the general button changes to the **ON** state (light green) and all the SLEDs will be turned **ON** with the 100% of its power.
- If one or more SLEDs are **ON**, whatever the output power, the general ON/OFF button will be **ON** (light green). By pressing it, the general button changes to the **OFF** state (grey) and all the SLEDs will be turned **OFF**.

➤ SLEDs section

Each SLED contained in the FJORD light source possesses a small rectangle (2) in the initial screen with its name (3), the percentage of the nominal output power (4) and a status circle (5) on the upper right corner of the rectangle. To access to more detailed information about the SLED (see **Figure 2** on the [next page](#)), please touch the rectangle.

The status circle can have the following colours:

- *Green*: the SLED is operating correctly and its temperature has achieved the value set as reference. See the first SLED on the left on **Figure 1**.
- *Yellow*: the SLED temperature hasn't achieved yet the value set as reference. Observe the second SLED starting from the left on **Figure 1**.
- *Red*: an error has occurred. In this case, a warning symbol (6) will appear in the rectangle of the corresponding SLED. The warning won't disappear until the error has been solved (green or yellow circle) and we have accessed to the screen of the corresponding SLED. See the third SLED starting from the left on **Figure 1**.

These colours will be lighter if the SLED is ON and darker if the SLED is OFF.

2.5.2 SLED screen

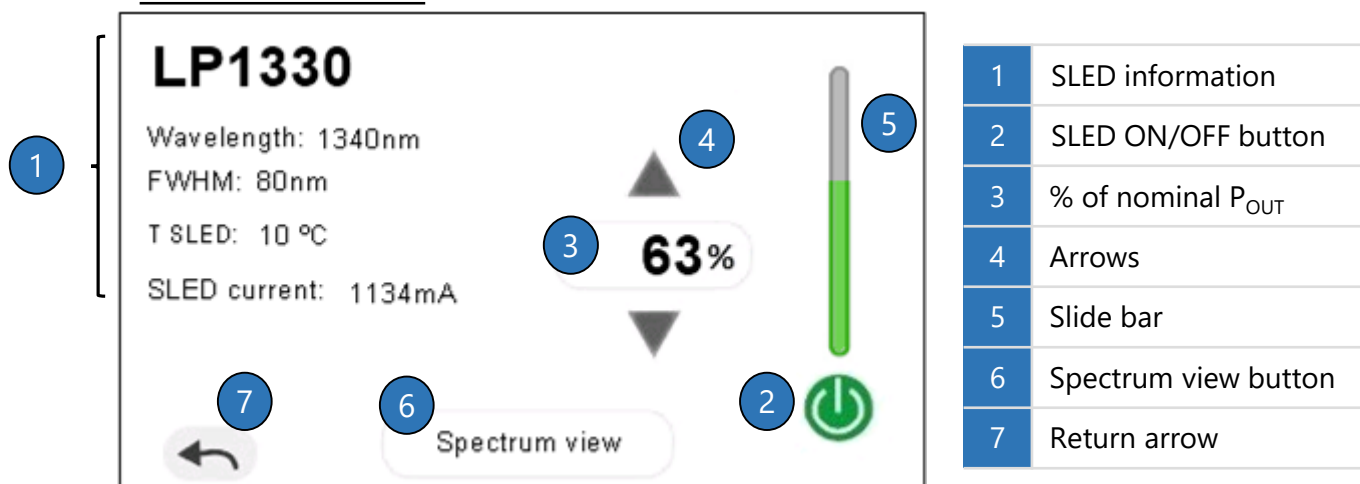


Figure 2. SLED screen

➤ SLED information (1)

On the left of the screen, the following information can be read:

- Name of the SLED
- Central wavelength of the SLED
- Full width at half maximum (FWHM)
- SLED Temperature (°C)
- SLED Current (mA)
- Type of error (only when an error has occurred, see **Figure 5** on [next page](#))

➤ Control of the output power

On the right of the screen, the percentage of the nominal output power of the SLED can be adjusted from 0% to 100% with the following controls:

- **SLED ON/OFF button (2):**
 - This button is **OFF** (grey) if the percentage is equal to 0%. By pressing it, it will change to the **ON** state (light green) and the output power will be set to 100%.
 - This button is **ON** (light green) if the percentage is higher than 0%. By pressing it, it will change to the **OFF** state (grey) and the output power will be set to 0%.
- **Keypad (3):** by clicking on the number, a keypad will appear (**Figure 3**). A percentage 0%-100% can be introduced by using it. You can erase a digit by pressing 'DEL'. Press 'OK' to confirm the percentage. If the value introduced is higher than 100%, it will be replaced by the previous valid percentage.

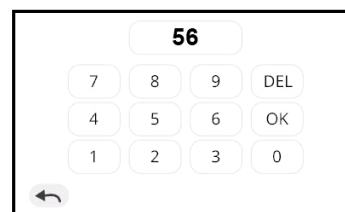


Figure 3. Keypad

The sequence '70925841' written on the keypad will restore all the source parameters to their Factory Mode values

- **Arrows (4):** using the up/down arrows will increase/decrease the current percentage of the nominal output power by 1%.
- **Slide bar (5):** it permits you to adjust the output power from 0% to 100%. While dragging the slide bar, it will be in yellow, and it will change to green once a value has been selected.

On the bottom of the screen, if we click on "Spectrum view" (6), we will see the spectral power distribution of the corresponding SLED (see **Figure 4** on [next page](#)). The arrow (7) enables to return to the initial screen.

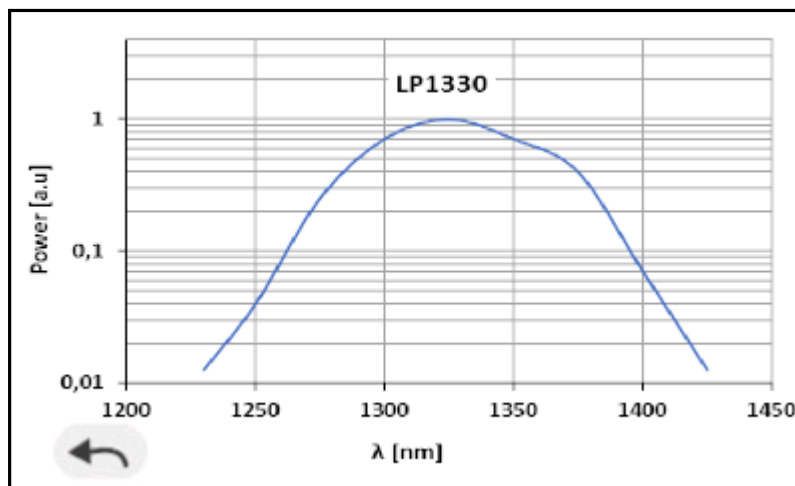


Figure 4. Spectrum view screen

2.5.3 Error management

When an error takes place, the user is automatically returned to the initial screen. The SLED where the error has occurred can be quickly identified by looking to the status circle of each SLED and observing which one is red. There will also be a warning symbol in the rectangle of the SLED (see again the third SLED starting from the left on **Figure 1** on [page 9](#)).

The SLED with the error is turned off and remains like this 10 s. Then it is turned on in the same conditions (power %) in which it was operating before the error happened. If the error persists, the SLED will be turned off again during 10 s. This cycle will be repeated until the error is solved.

The warning won't disappear until the error has been solved (circle green or yellow) and we have accessed to the screen of the corresponding SLED (see **Figure 5**, in this case, error 1 took place). This way we will be able to know which type of error happened. The error codes are given in **Table 1**:

Code	Type of error
1	T higher than maximum T
2	T lower than minimum T
3	Error in the driver of the SLED
4	T unexpectedly deviates from reference value after stabilizing
5	Error in the second driver of the SLED (only some SLEDs have a second driver)

Table 1. Possible errors of the SLED

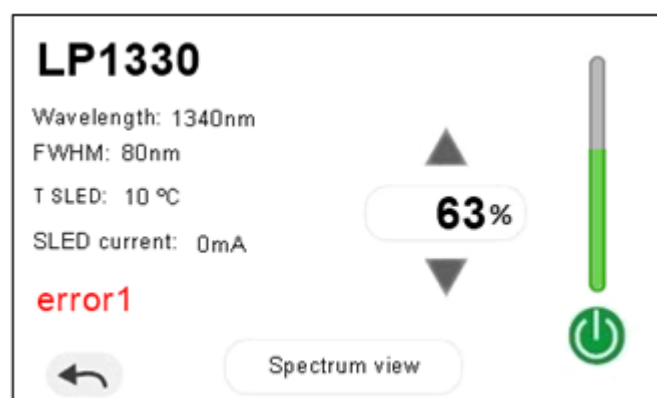


Figure 5. SLED screen when an error occurs

2.6 USB connection (available extra)

The aim of the USB connection is to allow the user to control the output power of each SLED and monitor its temperature through the computer. This option permits to remotely command the source through a VPN connection, for instance; avoiding the inconvenience of physically going to the laboratory to check or adjust the equipment.

An app is provided (contact us through info@pyroistech.com for more information) and commands can also be directly sent to the source to check and modify additional variables. Both are explained in detail in the following pages.

2.6.1 App: Connection

Initially, only the buttons "Port" and "Connect" are available. In order to effectively connect the FJORD light source to the computer, these steps must be followed:

- Click on the button "Port" (1) to update the list of ports used by the devices connected to the computer.
- Select on the drop-down menu (2) to the right of the button "Port" the port that corresponds to the FJORD light source.
- Choose the baud rate (3), on the right of the button "Connect". By default, the baud rate is 115200.
- Click on the button "Connect" (4).

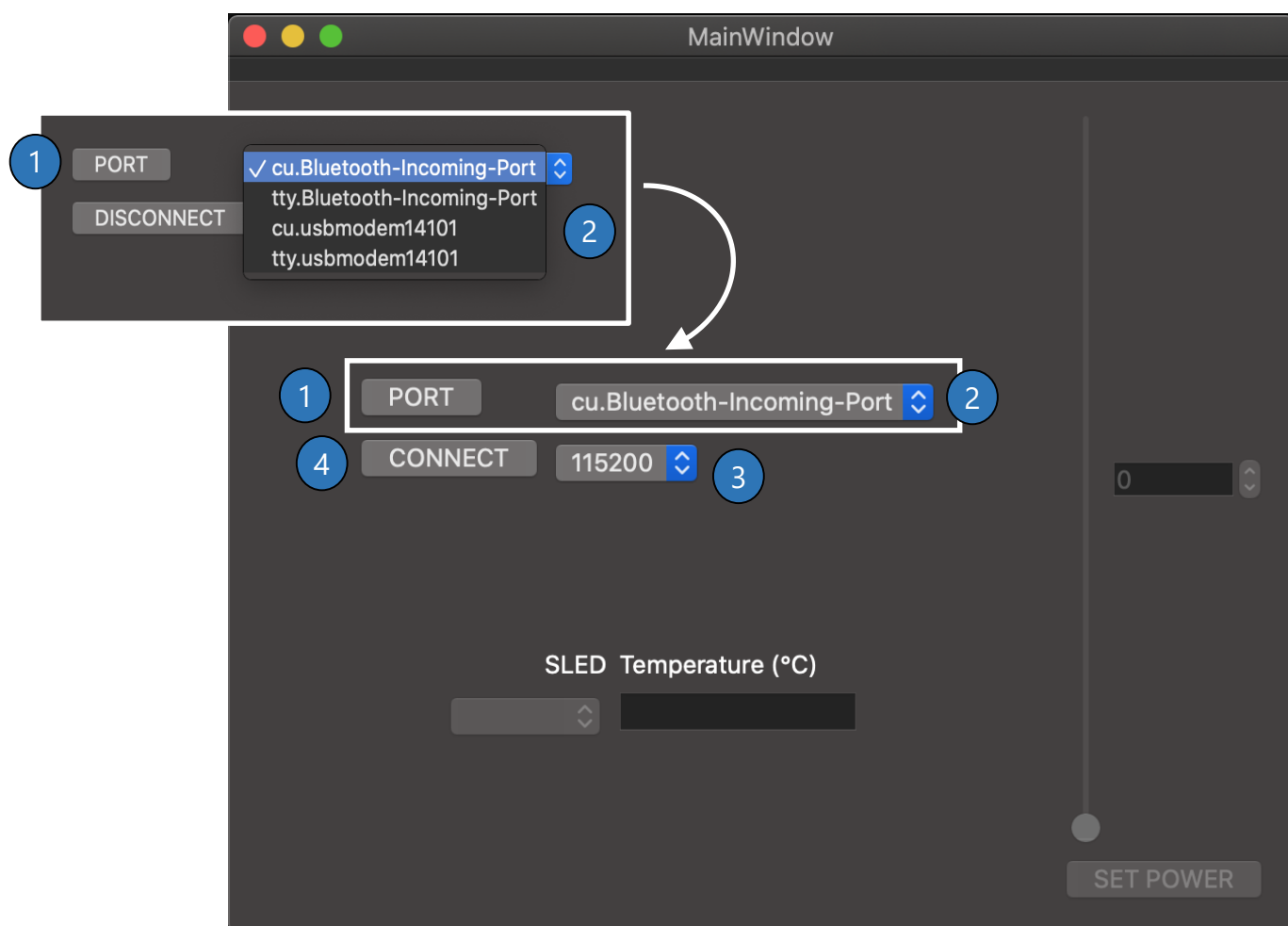


Figure 6. Main window of the FJORD app. Connection

2.6.2 App: Control and monitoring

Once the connection has been made, the drop-down menu that allows you to choose the desired SLED and the widgets that let you control the output power will be active. The connection between the computer and the FJORD light source can be closed at any time by clicking on "Disconnect" (5).

- In the drop-down menu (6) we can select each SLED that is in the light source.
- For the selected SLED, the temperature in °C is shown (7). This value is updated every second.
- The output power of the selected SLED can be varied from 0 to 100 % by using the slide bar (8) or by directly introducing the desired value in the regulator (9). The arrows permit to increase/decrease this value by 1% (10).
- After each change, the button "SET POWER" (11) has to be pressed to update the new value of the output power of the corresponding SLED in the FJORD light source.

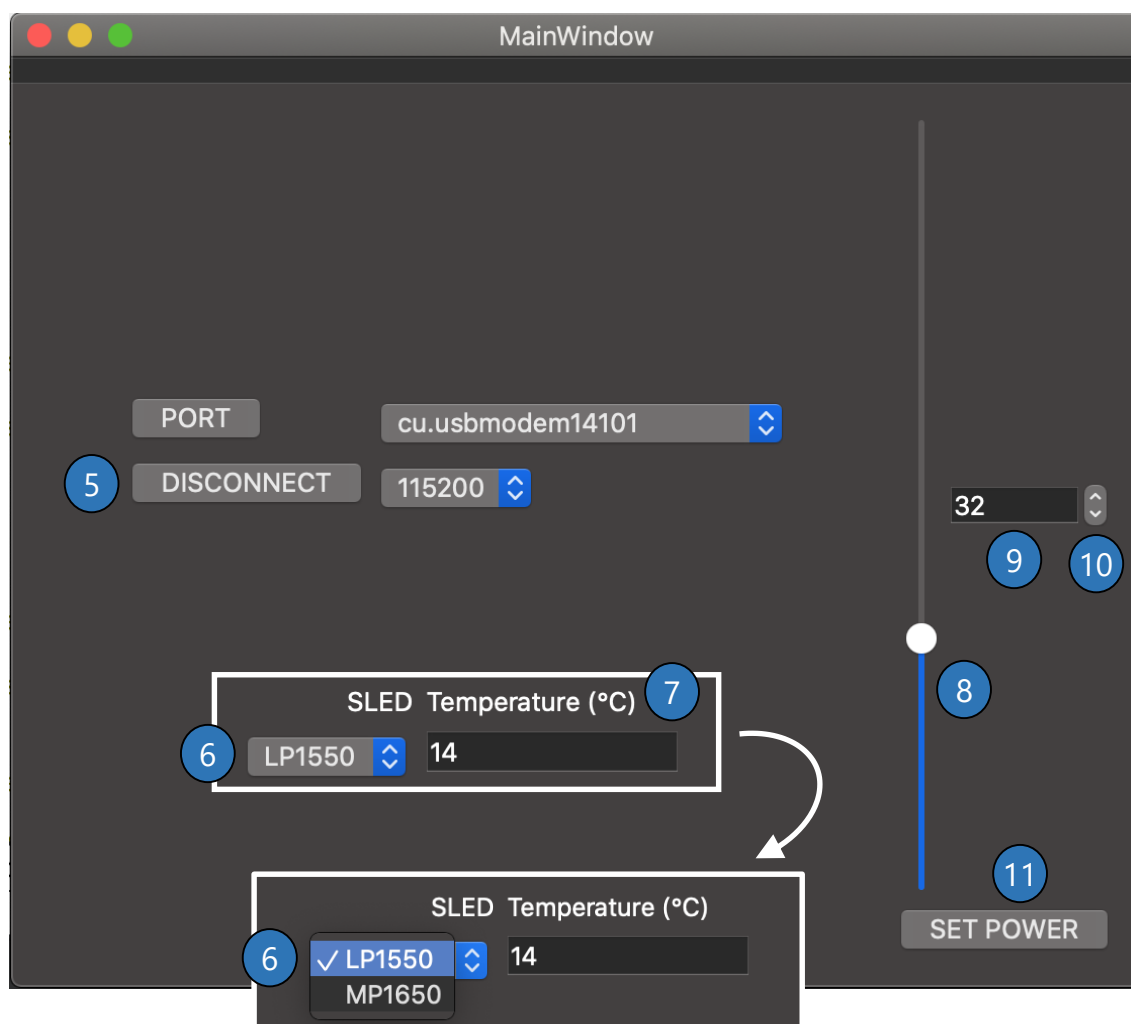
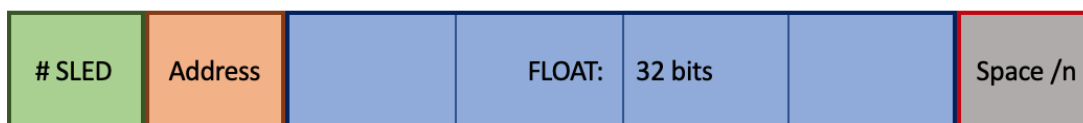


Figure 7. Main window of the FJORD app. Control and monitoring

2.6.3 Commands through USB connection

The sequence that has to be sent in order to read or write the value of a variable must have the following structure:



1. #SLED (1 byte): number of the SLED whose parameters we want to read or write. The first SLED contained in the source is assigned number 1 and so on.
2. ADDRESS (1 byte): the address of the variable we want to read or write. The addresses of the different parameters are given in **Table 2**.
3. FLOAT 32bits: in case of a writing command, the new value for the variable we want to modify has to be introduced here with this format. In case of a reading command, nothing has to be sent.
4. SPACE /n: end of the message, where a space " " has to be included. In case of a reading command, directly introduce the space after the address.

Variable	Address	Variable	Address
Reference T (°C)	0	Maximum I through TEC (A)	28
Minimum allowable T (°C)	4	Minimum I through TEC (A)	32
Maximum allowable T (°C)	8	Reference I through the SLED (mA)	36
Proportional gain KP	12	Instantaneous T of the SLED	40
Integral gain KI	16	Measured T of the SLED	44

Table 2. Variables and their corresponding addresses

Comments

- It is not recommended to overwrite the values of the variables that are shadowed (minimum and maximum allowable T, KP and KI).
- Reference T is the target temperature for the temperature control. The default value is 20 °C and it is not recommended to introduce a lower one.
- Addresses 0x20 and 0x24 are not used.
- Modifying the maximum and minimum allowable currents through the TEC will affect the velocity of the temperature control.
- Instantaneous T of the SLED is the real temperature of the SLED while measured T of the SLED is its value after applying a filter. Both values can only be read, not written.

Sending 0xFFFFFFFF (6 bytes) followed by /n will restore all the source parameters to their Factory Mode values

Not following the recommendations on this page can result in undesired behaviour that can cause damage to the light source, which is NOT covered by Pyroistech's warranty

3. Important Notes

Before operation

- Please read the rest of this manual carefully if this is your first time using this equipment.
- Do not remove or alter any labels or safety features on this equipment or open the equipment. Doing so will void your warranty and create an unsafe operating environment.
- There are no parts inside the equipment that the user must manipulate. There are dangerous currents inside the equipment. You should only allow the technical staff of Pyroistech S.L. to repair or work with this equipment. SLEDs are very sensitive to electrostatic discharge and working with them without the appropriate measures can damage them.
- Inspect this unit and its power before using it for the first time. Do not use this device if it is damaged in any way. Contact us to inquire about repair or replacement possibilities.

During operation

There are 2 aspects that affect the operation and performance of a SLED source in a very relevant way: optical feedback and temperature.

Optical feedback

Optical feedback occurs when part of the optical power is reflected by one of the elements of the experimental setup and returns to the SLED cavity. This phenomenon occurs in any type of assembly, but in the case of SLEDs it is especially critical, because its internal operation is based on NO optical feedback (or at least very reduced compared to that which occurs in a laser).

- The warranty does not cover problems associated with optical feedback, simply because it is a problem that may be caused by an experimental end-user assembly, and it is not possible to test and ensure that optical feedback will not cause problems for all types of assembly.
- As a safety threshold, it is recommended to ensure that the optical feedback at each wavelength is at least 40 dB lower than the direct power emitted by the source at that wavelength. Higher values do not necessarily have to be dangerous, but they do increase the risk of critical failure. REALIZE that the threshold is a reference value that does not imply any guarantee.
- The following phenomena may be indicative of optical feedback: sudden drops in power, alterations in the shape of the spectrum or the appearance of narrow peaks in the emission spectrum. In extreme cases, a serious optical feedback problem, even if momentary, can lead to an SLED breaking immediately.
- The presence of an optical feedback problem may be due to a specific error or to the continued incorrect use of the equipment, which may appear immediately or take time to manifest. Therefore, it is very difficult to identify the real cause of the problem once it manifests itself.

- Improper mounting connections can lead to optical feedback problems. Therefore, it is advisable to pay attention to them. Additionally, it is recommended to use FC/APC connectors instead of FC/PC because the reflection losses of the first type of connectors are lower.
- The mentioned problems may have other causes that are easy to solve. For example, an unexpected sudden drop in power of a few dB over the entire spectrum of the source may be due to the accumulation of dust on a connector. But it is recommended not to ignore these details because they can be an indicator of an optical feedback problem, much more serious for the source and with potentially serious consequences.

Temperature

Temperature is always an important factor in light sources. The worse the temperature regulation of a source, the longer its stabilization time will be. But temperature control is especially critical in the case of a SLED, considered more sensitive to temperature than other technologies (LED, laser).

Every FJORD source has a temperature control of each SLED with $\pm 0.1^{\circ}\text{C}$ precision. This temperature control is implemented with several security mechanisms. This does not mean that the recommendations indicated in this manual should not be followed.

- It is recommended to ensure that the ambient temperature is in the $15\text{-}25^{\circ}\text{C}$ range, to avoid direct exposure to sunlight and to check that the equipment is not immediately adjacent to others that impede natural convection cooling to achieve optimal operation.
- Failure to follow the above recommendations may not affect the output power of the source, slightly affect it, but in some cases, it will shorten the life of the SLEDs, depending on how good or bad the cooling is. In any case, the correct operation of the source and the consequences derived from it in case of not following the above recommendations are not guaranteed.

Eye Safety

- Optical radiation can damage your eyes. DO NOT look directly at the source output.



CAUTION !

Do NOT stare directly
at the light beam

- FJORD sources emit infrared light, not visible to the human eye, which can be dangerous depending on the mounting configuration (including, but not limited to, optics, current, and temperature). Follow the safety recommendations given in IEC 62471 when working with these light sources.

Electromagnetic compatibility

- Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm (12 inches) to any part of this equipment. Otherwise, degradation of the performance of this equipment could result.
- The use of cables, power supplies, transformers and accessories other than those specified by Pyroistech S.L., in addition to not being covered by the warranty, may lead to increased emissions and/or decreased electromagnetic compatibility.

4. Warranty

Pyroistech's general warranty for a product has a 1 year duration.

This warranty includes repairs and replacement of damaged parts due to a malfunction of the source, as long as said malfunction can be attributed to errors made in the manufacture of it by Pyroistech SL, not to a punctual misuse of the source or to a continued incorrect employment of it by the user, whether conscious or unconscious, due to not having followed the operation recommendations indicated by Pyroistech SL

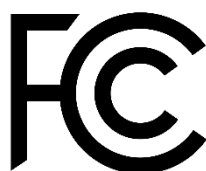
There is the possibility of extending this guarantee. For more information, contact Pyroistech S.L.

5. Compliance

This device complies the following standards:



EMC 2014/30/EU
RoHS-compliant



Federal
Communications
Commision

Contact Pyroistech S.L. if you require more information about the electromagnetic compatibility of the product.



WEEE
Compliance

If you consider that the product has reached the end of its useful life and you want to dispose of it, you can contact Pyroistech S.L. so that it is in charge of its management.

Version	Date	Description
1.0	3 May 2020	First Document