TeraXion

An indie Semiconductor Company

User's Guide

Rev 1.0

LXM – Narrow Linewidth DFB Laser Module

MKT-MANUEL-LXM

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LXM – Narrow Linewidth DFB Laser Module

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1/ Introduction

1.1. Purpose of Document

The purpose of this User's Guide is to facilitate the use of the LXM narrow linewidth DFB laser module manufactured by TeraXion. This document describes the functionality of the LXM and the operating conditions to obtain optimal optical performances.

1.2. Overview

This document provides all the necessary information to use and store the TeraXion LXM. This includes optical, mechanical and electrical details, as well as useful information about the control software.

1.3. Copyrights

1.4. Disclaimer

Failure to comply with the various operation limits and usage limitations listed in the present document may result in device malfunction or even device failure. TeraXion is not responsible for any misuse of the device.

1.5. Safety Precautions

This product is intended for use by qualified personnel that are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product.

There are no serviceable parts inside the module and the cover should not be opened by the customer. Opening of the casing will void warranty. There is a high risk of damaging internal parts if the cover is opened by someone other than a qualified TeraXion technician.

1.6. ESD Precautions

The LXM narrow linewidth DFB laser module is shipped in a ESD (electrostatic discharge) safe package. An ESD safe tape is installed on the connector to prevent ESD damage to the device. ESD can damage several components.

To avoid such damage, take the following precautions:

- Ground yourself using a grounding strap and verify effectiveness using a ground tester.
- Place the package onto an anti-static mat before removing the device from the package.

Remove the device from the package and inspect the device for loose components or any sign of damage. Notify TeraXion if the device appears damaged in any way. Do not install a damaged device. Store the device in the antistatic package when not in use.

1.7. Reference Documents

No	Reference	Title
[RD 1]	MKT-PS-COMM-001	PureSpectrum™ PS-COMM Protocol Description
[RD 2]	MKT-Manuel-ICD-LXM	LXM DFB Laser Module Interface Control Document (ICD)

2/ Safety Precautions

This product is intended for use by qualified personnel that are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product.

There is no serviceable part inside the module and the cover should not be opened by the customer. Opening of the casing will void warranty. There is a high risk of damaging internal parts if the cover is not opened by a qualified TeraXion technician.

2.1. Laser safety

2.1.1. USE OF INSTRUCTION

DANGER – Serious damage to health / risk to life
This symbol in conjunction with the signal word "DANGER" indicates an imminent electrical hazard. Failure to observe this safety information will result in death or severe injury.

WARNING – Bodily injury
This symbol in conjunction with the signal word "WARNING" indicates a potentially dangerous situation. Failure to observe this safety information may result in death or severe injury

CAUTION – Minor/Moderate Injuries
This symbol in conjunction with the signal word "CAUTION" indicates a potentially dangerous situation. Failure to observe this safety information may result in minor or moderate injury. This symbol may also be used for property damage warnings.

NOTICE – Property Damage
This symbol indicates a potentially damaging situation. Failure to observe this safety information may result in damage to or destruction of the product and / or other system components.

IMPORTANT (NOTE) – This symbol indicates operator tips, useful information or important information about the product or its further uses. The signal word "IMPORTANT (NOTE)" does not indicate a dangerous or harmful situation.

2.1.2. GENERAL SAFETY-RELATED LASER SPECIFICATIONS

Table 1. General Safety Related Specifications	
Parameter	Value
Wavelength	1000 nm – 2500 nm
Power	< 500 mW
Output Fiber	Polarization maintaining
Laser Class (IEC 60825-1)	Class 3B

WARNING – The light emitted by the laser is not visible to the human eye. The user should not look directly into the output connector or to the end of any optical cable attached to the optical output while the device is in operation as it may cause permanent damage.

WARNING – The performance of unauthorized procedures may result in hazardous optical radiation exposure.

LASER SAFETY – The auto-start mode is disabled during shipping. Even when first powered, the laser module will not emit radiation before the hardware and software interlock are first disabled (Sections 0 & 5.2.2).
Nevertheless, as soon as the laser module is removed from its packaging, proper care should be taken to reduce the risk of accidental exposure of eyes and skin to laser radiation.

This product complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019.

2.1.3. SAFETY LABEL ON THE PRODUCT

Warning logotype for class 3B laser product (located on top of FC/APC connector laser output)

2.2. Electrical Safety

DANGER – Use the recommended power supply only.
Always connect your devices to the same power outlet.
If the Laser module is plugged to a PC computer via its USB interface, they both should be plugged in the same power outlet (e.g. with a multi-outlet power strip). Failure to follow this recommendation may impair the laser module performance and even result in permanent damage.

WARNING – Operate under proper environmental conditions.
To avoid risks of injuries, among others, do not expose the instrument to excessive moisture, water, dust or flammable gases.

WARNING – Do not attempt to perform servicing or maintenance

3/ Product Description

3.1. Product Overview

The LXM is a compact, ultra-low noise and narrow linewidth laser module. This module offers a high spectral purity, together with excellent relative intensity noise (RIN) and frequency stability. The LXM is provided in a small form factor package suitable for embedding in an instrument or subsystem.

3.2. Principle of operation of LXM-S and LXM-U

The LXM narrow linewidth DFB laser module is based on a semiconductor distributed feedback (DFB) laser diode developed by TeraXion. The DFB laser diode is integrated into a sealed and temperature-controlled butterfly package (14 pins), and the LXM includes control electronics to drive the diode and tune its wavelength.

3.2.1. LXM-S

TeraXion's proprietary DFB laser diode is intrinsically narrow and has a high frequency modulation bandwidth. The LXM-S operates the diode under direct drive and features 15 kHz typical linewidth. A modulation circuit is included with the module, which translates analog voltage input at the modulation port into a current input at the laser electrode. The frequency modulation can reach few GHz(s) amplitude and is mainly limited by the maximum current allowed by the circuit. The LXM is a highly stable laser module, and the wavelength stabilization/tuning is obtained through state-of-the art laser thermal control. The wavelength tuning can reach ± 0.2 nm (± 25 GHz) with 20 MHz resolution.

3.2.2. LXM-U

The LXM-U ultra-narrow model features a frequency noise cancellation system to reach down to 0.08 kHz typical linewidth. The linewidth is reduced by stabilizing the laser frequency on a very narrowband optical reference. The optical reference converts the frequency fluctuations of the laser into intensity fluctuations, which are translated into an electrical signal using a photodetector. This electrical signal is then returned to the laser to correct these frequency fluctuations in an active feedback loop. The LXM-U includes a modulation circuit that translates analog voltage input at the modulation port into a frequency offset of the locking circuit. This approach limits the fast modulation amplitude to ± 100 MHz.

With regards to the linewidth and the wavelength, the LXM-U behaves like an LXM-S when unlocked. It can be tuned over ± 0.2 nm (± 25 GHz) with 20 MHz resolution through thermal control of the laser diode. After locking, the LXM-U stability is enhanced, and the device can be tuned over ± 0.016 nm (± 2 GHz) with 5 MHz resolution through thermal control of the optical reference.

The table below presents the main differences between the LXM-S and the LXM-U.

Table 2. Main Distinctions Between LXM-S and LXM-U

Parameter	LXM-S	LXM-U
Laser drive	Direct	Slaved on a frequency reference (built-in)
Linewidth	15 kHz typical	0.08 kHz typical
Frequency modulation method	Laser current modulation	Locking set-point modulation
Frequency modulation amplitude	> 4 GHz	200 MHz
Wavelength tuning method	Laser temperature	Laser temperature (unlocked) Frequency reference temperature (locked)
Wavelength tuning range	± 0.2 nm (± 25 GHz)	± 0.2 nm (± 25 GHz) (unlocked) ± 0.016 nm (± 2 GHz) (locked)
Wavelength tuning resolution	0.16 pm (20 MHz)	0.16 pm (20 MHz) (unlocked) 0.04 pm (5 MHz) (locked)

3.3. Physical Overview

The LXM is available with or without a communication interface unit. This communication unit is optional and stands on top of the laser, connecting directly to its 14 pins FTMH connector.

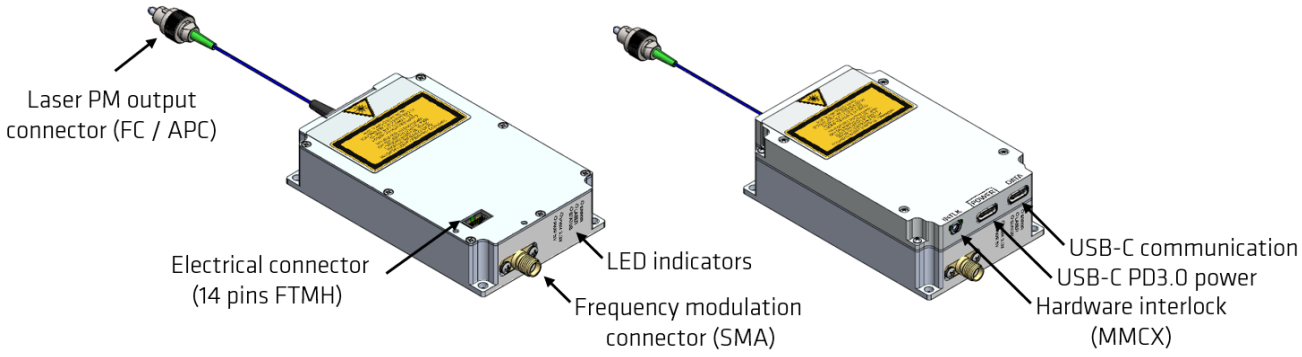


Figure 1. LXM Laser Module Overview with and without Communication Interface Unit

3.4. Mechanical Drawing

3.4.1. LASER ONLY

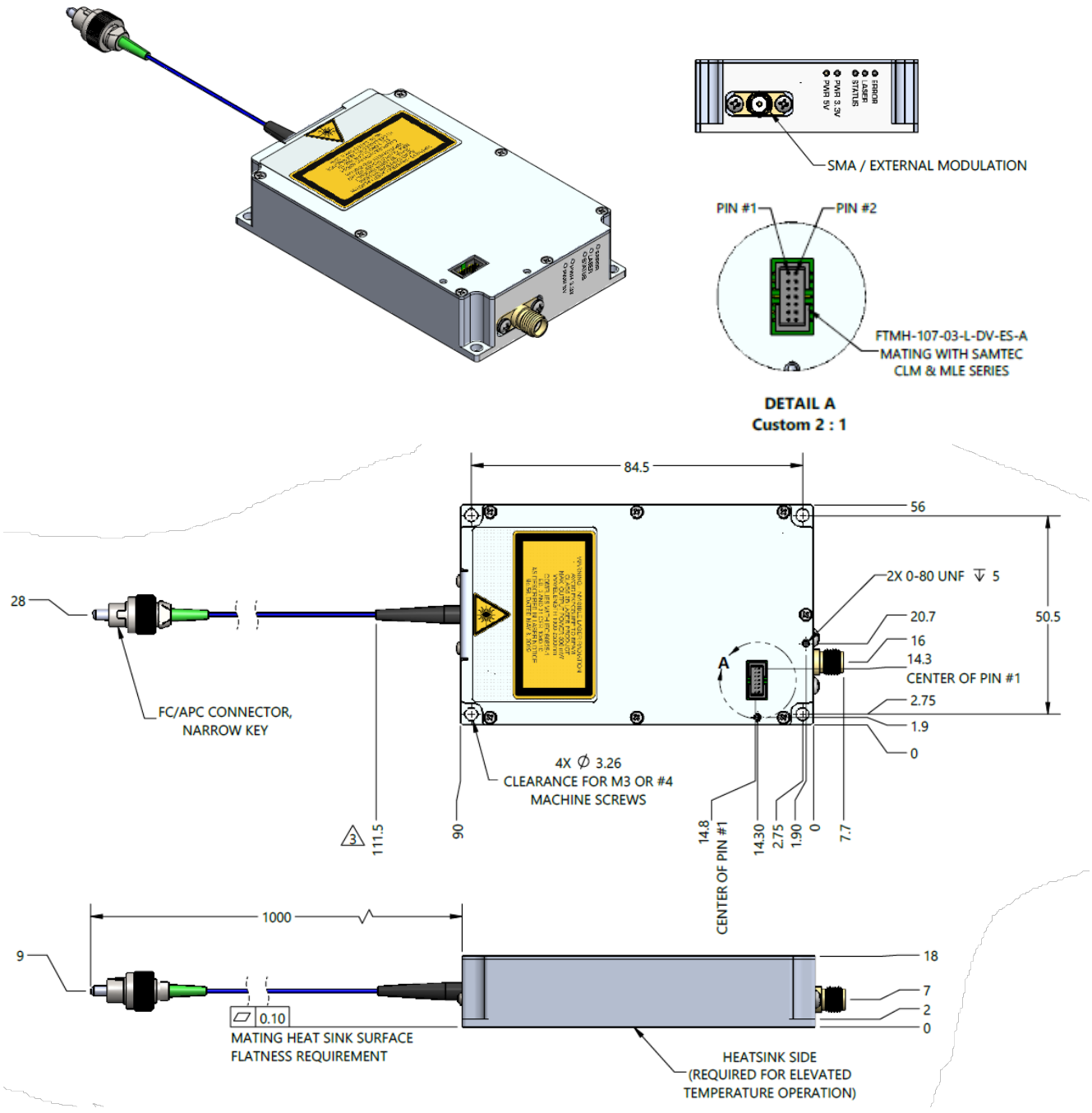


Figure 2. Mechanical Drawing of the LXM Laser Module (laser only)

3.4.2. LASER WITH COMMUNICATION INTERFACE UNIT

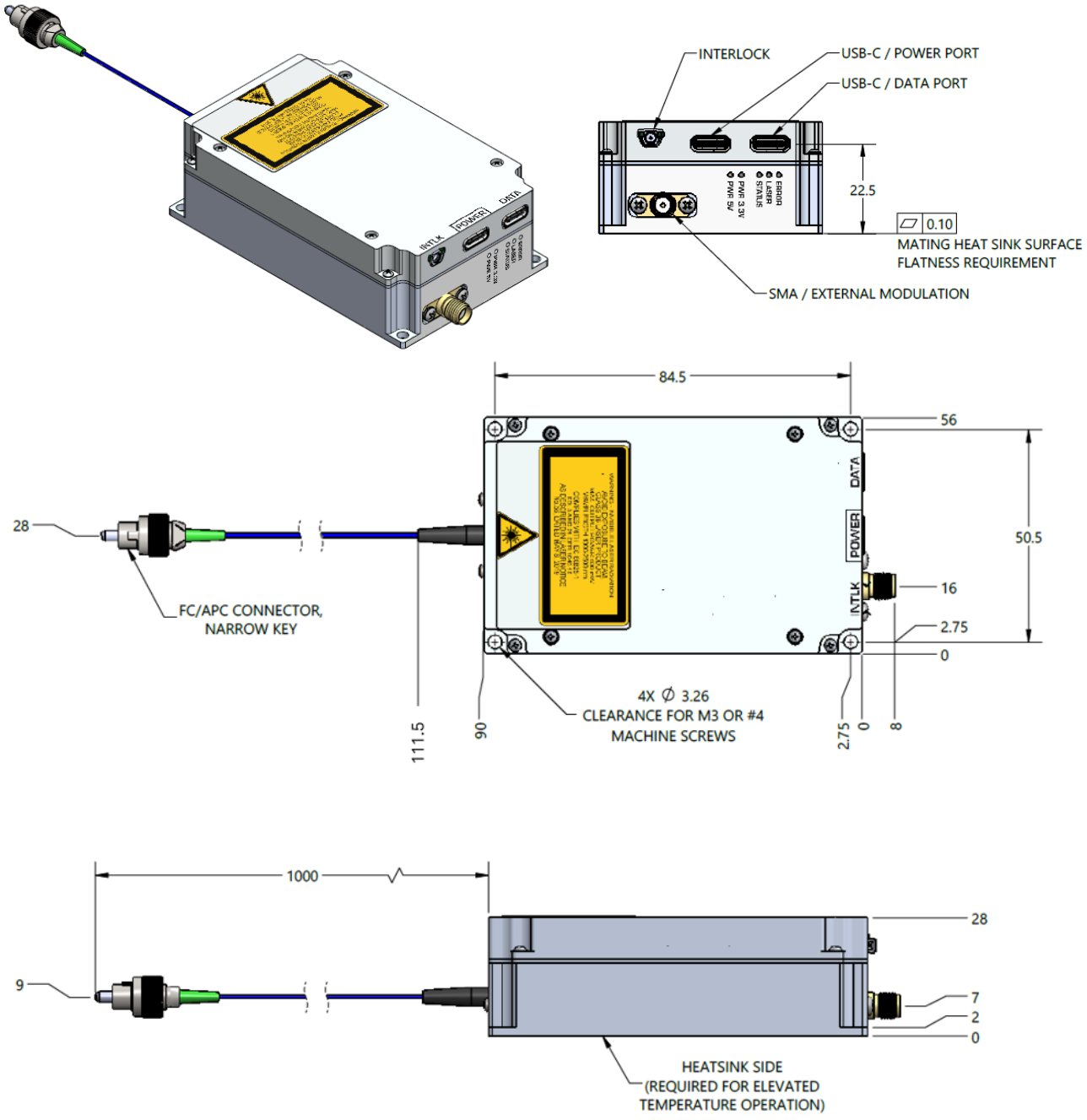


Figure 3. Mechanical drawing of the LXM Laser Module with Interface Communication Unit

4/ Getting Started

4.1. Unpacking

NOTICE – This unit is sensitive to electrostatic discharge (ESD).

The unit must remain in its original anti-static packaging until installation.

Handle the unit with care when the instrument is taken out of its anti static packaging. The use of a grounded anti-static wristband is required when handling the instrument or its power supply. The working surface must also be covered by a grounded conducting material (metal or anti static rug).

The LXM narrow linewidth DFB laser module is provided with the following:

- Conformance report;
- Password to download the user guide and the LXM Control and Monitoring Software.

When delivered with the communication interface unit, the package includes those additional items:

- USB-C PD3.0 power supply;
- USB-C cables for supply and communication (1 x USB-C to USB-C , 1 x USB-A to USB-C) ;
- MMCX hardware interlock plug.

4.2. Removing the laser from the box

Please follow those instructions to guarantee the integrity of the laser fiber output:

1. Remove the foam ring protecting the rolled fiber.
2. Delicately remove the FC/APC connector from its cutout position.
3. Inspect the fiber from the FC/APC connector to the strain-relief boot protruding from the laser module body. If any damage is noted, please contact TeraXion at support@teraxion.com.
4. Remove the module [Fig1-A] from the ESD foam.

IMPORTANT (NOTE) – Keep the box

If applicable, please safely store the empty box in a clean space. It may be used to ship the laser module safely back to TeraXion.

4.3. Physical Installation

To prevent overheating, the laser module must be fastened to a clean, flat metal surface using the four mounting holes. Pyrolytic graphite sheet (PGS) may be used to optimise heat transfer.

The recommended surface flatness is < 0.05 mm.

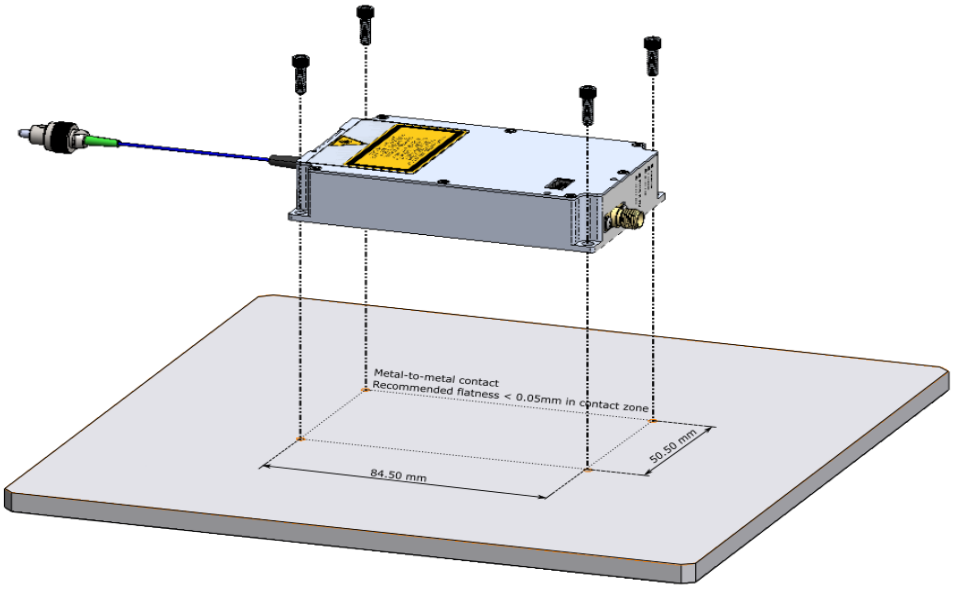


Figure 4. LXM Laser Thermal Sinking

The mounting fastener are not provided. It is recommended to use fasteners with a max head diameter of 5.80 mm, and a max body diameter of 3.26 mm.

To prevent bending the module during mounting:

- Install the four fasteners without applying any significant torque;
- Fasten the bolts in a pattern similar to what is shown in Figure 4.

The recommended torque for a #4-40 screw is 0.7Nm (Max 0.95Nm).

The recommended torque for a #M3x0.5 screw is 0.95Nm (Max 1.30Nm).

For maximum performance, it is better for the instrument not to be exposed to sudden temperature changes. Therefore, the instrument must not be near a ventilation access or should be protected from it.

4.4. Optical Connection

An external optical equipment can be connected to the LXM laser module via the FC/APC fiber pigtail. The output fiber is standard polarization maintaining Panda fiber and the slow axis is aligned to the connector narrow key.

CAUTION – Minor/Moderate Injuries
This symbol in conjunction with the signal word "CAUTION" indicates a potentially dangerous situation. Failure to observe this safety information may result in minor or moderate injury. This symbol may also be used for property damage warnings.

Optical connectors can produce back-reflections. Those back-reflections could reduce the stability performance of the instrument. In such a case, it is strongly recommended to add an optical isolator at the optical output of the LXM.

Before connecting the fiber of the LXM laser module, make sure connectors are clean to prevent loss of optical power or damage to the optical connectors. Refer to Appendix A, "Cleaning and Caring for Optical Connectors".

The standard output connector is a FC/APC type connector. Never connect another type of connector to the output pigtail. It is strongly recommended to turn the laser off before making any optical connection / disconnection.

Before proceeding to laser activation, the fiber optic connector of the module should be connected to a measuring device, the user's fiber optic sensor, or any other device ready to accept the emitted optical power.

4.5. Electrical Connection

4.5.1. LASER ONLY

The LXM laser module includes a 14 pins FTMH-107-03-L-DV-ES-A connector to supply power and achieve communication. The pinout is described in Table 3 and the electrical interface is detailed in Table 4 and Table 5.

4.5.1.1. ELECTRICAL INTERFACE

The recommended mating connector is CLM-107-02-F-D by SAMTEC. This connector is meant for surface mount integration and can be integrated with a custom-made flex PCB cable, for example. Two threaded holes are provided on the LXM and should be used to secure the connector with a proper immobilization adaptor (not included).

Table 3. FTMH Connector Pin Assignment

PIN Name	Pin #		Pin #	Pin Name
Power supply +5 VDC, 3 A	1		2	Laser interlock -
Power supply + 5 VDC, 3 A	3		4	Laser interlock +
Power RTN	5		6	Reserved
Power RTN	7		8	Comm Tx (LXM ➔)
Reserved	9		10	Comm Rx (LXM ➔)
Reserved	11		12	Reserved
Reserved	13		14	Reserved

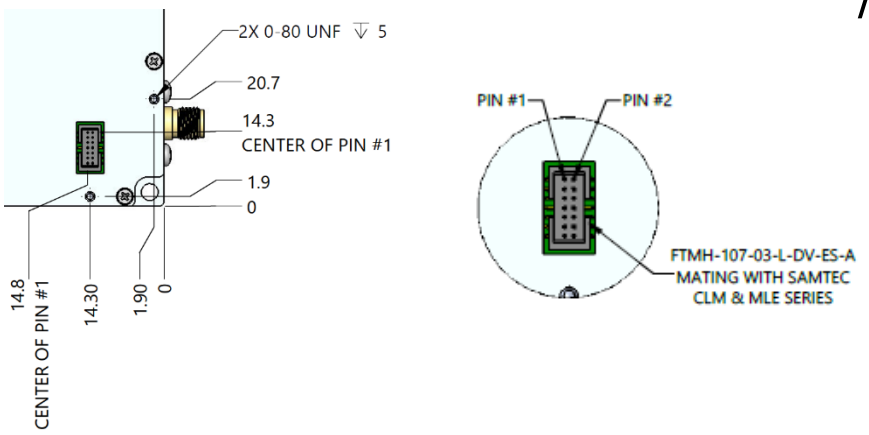


Figure 5. FTMH Connector Pin Numbering and 0-80 UNF Threaded Holes Positioning

Table 4. Electrical Interface			
PIN #	PIN NAME	Funtion	Note
1, 3	Power supply +5VDC, 3A	Input	5 V ± 5%. Typical 5 W consumption, up to 15 W during boot up.
5, 7	Power RTN	GND	0 V
2	Laser interlock - J	Switch only	8k Ω MAX to pin 4 for interlock detection (Not a GND). Max current on contact 330µA.
4	Laser interlock + J	Switch only	8kΩ MAX to pin 2 for interlock detection (Not a PWR+). Max current on contact 330µA.
8	Comm Tx (LXM ➔)	Output	From LXM to controller. LVTTL 3.3 V. See logic levels below. 10 pF parasitic capacitance.
10	Comm Rx (➔ LXM)	Input	From controller to LXM. LVTTL 3.3 V. See logic levels below. 10 pF parasitic capacitance.
6, 9, 11, 12, 13, 14	Reserved	Do not connect	***Leave unconnected***

Table 5. Comm Logic Levels (LVTTL 3.3 V)	
VOL	0.4 V (8 mA)
VOH	2.9 V (8 mA)
VIL	0.99 V
VIH	2.31 V

4.5.1.2. POWER SUPPLY REQUIREMENTS

The power supply used to provide the 5 V voltage rail should follow the guidelines below to guarantee the optimal performances of the LXM.

RIPPLES:

The LXM was tested using two switching power supplies models specifying ripples as such:

Table 6. Power Supply Ripple References		
ID	Ripple specifications	Note from the manufacturer
PSU #1 (Line)	< 1%	Peak to peak with 20 MHz bandwidth and 10 µF (Electrolytic capacitor) in parallel with a 0.1 µF capacitor at rated line voltage and load ranges.
PSU #2 (USB)	< 0.15 Vpp	Typical < 0.10 Vpp at rated line voltage and load ranges.

LARGE BANDWIDTH NOISE :

The electrical noise, measured on a 5 Ω load, should stay below -90 dBV/rt-Hz, from 0 to 300 MHz.

4.5.1.3. INTERLOCK AND COMMUNICATION

LASER SAFETY INTERLOCK :

The LXM laser module is a class 3B laser product equipped with a remote Interlock connection. The two pins of the laser interlock can be used to connect a remote interlock switch that can disable the laser source in case of an emergency. The interlock response time is < 10 msec.

If a remote interlock switch is not used, the two pins of the laser interlock need be connected to allow laser operation.

COMM PROTOCOL :

All information about the serial communication protocol can be found in the PureSpectrumTM PS-COMM Protocol Description document [RD 1].

All information about the serial communication commands and associated registers can be found in the LXM DFB Laser Module Interface Control Document (ICD) [RD 2].

4.5.2. LASER WITH COMMUNICATION INTERFACE UNIT

The LXM laser module may include a communication interface unit providing USB-C communication and power connectivity. This option is included in the product ordering code. When ordered with the interface unit, the laser package includes a wall plug USB-C power supply as well as a USB-C to USB-C cable for power and USB-C to USB-A cable for communication. A laser interlock male connector is also supplied and must be connected into the interlock MMCX port to allow the laser to operate. The connections are presented in the figure below.

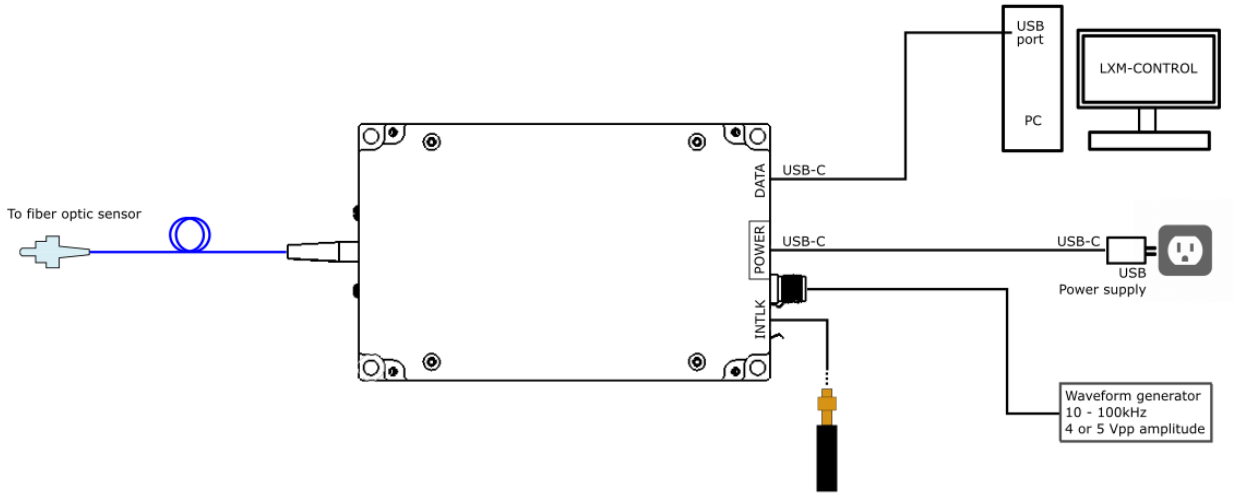


Figure 6. LXM Connections with the Communication Interface Unit

When connecting the device, please follow the procedure described below:

HARDWARE INTERLOCK:

1. Plug the MMCX interlock connector into the interlock port. The provided accessory is a jumper connecting the outer and inner portions of the coaxial interlock port. It cannot be used to connect the interlock port to your external laser safety interlock system. For this purpose, any MMCX cable can be used, as long as the total effective resistance in the interlock circuit remains below 8 kΩ.

Under TeraXion factory settings, there is also a password-protected software interlock that prevents lasing unless turned off (See Section 5.2.2). The interlock password is «1234». A «laser start» software function is also required to light up the device. Nevertheless, now that the hardware interlock is disabled, it is mandatory to consider all eye safety precautions introduced earlier in this manual prior to powering up the device.

POWER:

2. Plug the USB power supply in a type A (NEMA 1-15) or type B (NEMA 5-15) outlet providing 100 to 240 VAC at 50 – 60 kHz. The maximum rated input current is 0.5A RMS at 100 VAC.

For best results, consider using a conditioned power distribution system, commonly referred as a conditioned power bar.

3. Connect one end of the USB-C to USB-C cable to the POWER port of the LXM laser module.

4. Make sure the optical connector is safely connected to a device that can accept the emitted power and then connect the other end of the USB-C cable to the sole available connector of the USB power supply.

The PWR 5V and PWR 3.3V LEDs on the back of the laser module should light up with a bright green color.

COMMUNICATION:

5. Connect the USB-A end of the USB-A to USB-C cable to an available port of the control PC. If the computer doesn't have USB-A connector, you may have to supply your own USB-C to USB-C cable to achieve communication.

6. Connect the other end of the cable to the DATA port of the laser module. In the "Device Manager" windows of the control PC, a new COM port should become available. Take note of the COM port # as it will be useful in the following steps. If there is no COM port #, see section 4.6.1.

4.5.3. ANALOG MODULATION

To modulate the laser frequency, a waveform generator can be connected to the coaxial modulation port of the laser module. The connector must be torqued according to the specification below, using the appropriate tooling. RF performance may otherwise be affected.

- Connector type (module): Brass SMA jack, standard polarity;
- Mating connector (cable): Brass SMA plug, standard polarity;
- Recommend torque: 0.45 Nm;
- Max torque: 0.68 Nm.

The analog input signal must be within the following parameters:

- Input impedance: 50 ohm;

- DC coupled;
- Amplitude: 4 or 5 Vpp (please refer to the device test certificate to determine if your laser module accept ±2.5 V input or 0-4 V);
  ULTRA-NARROW MODEL ONLY: please refer to the device test certificate to determine the maximum modulation voltage amplitude that can be applied without unlocking the ultra-narrow linewidth mode. No modulation should be applied while locking the laser;
- Offset: 0 or 2 V (please refer to the device test sheet to determine if your laser module accept ±2.5 V input or 0-4 V).

4.6. Software Installation

LXM-CONTROL is the dedicated user interface of the LXM laser module. It can be downloaded, together with the required driver, using the link below.

Cloudshare link : **https://cloudshare.teraxion.com/**

Username : **purespectrum**

Password : **terax1on223**

Folder : **LXM**

4.6.1. FTDI DRIVER

The FTDI driver enable communication between the host PC and the laser module.

1. Download the .zip file labelled "CDM212364_Setup.zip" from the link above.
2. Extract the files from the compressed file and execute the file **CDM212364_Setup.exe**. Complete the installation.

Disconnect the USB cable from the PC, wait a few second and reconnect it.

4.6.2. LXM-CONTROL SOFTWARE

1. Download the .zip file of the most recent version from the link above.
2. Copy the file in a local folder (e.g. C:\Program Files\TeraXion\LXM) and extract its contain.
3. Navigate to the extracted folder and launch the **setup.exe**.
4. Follow the instructions to install the user interface and all required libraries and drivers.
5. Restart the PC.

4.7. Warm-Up & Thermal Stability

As with any instrument, a warm-up time is required after cold starting of the unit to allow its internal temperature to stabilize and therefore ensure maximum performance. The minimum warm-up time required is 30 minutes to ensure a good wavelength and output power stability. The laser will be fully thermalized after 90 minutes.

5/ LXM-Control Software

5.1. Software Interface Overview

The LXM-Control software allows the user to control and monitor the laser using three interface menus: the **«Laser» menu**, the **«System» menu** and the **«Log» menu**. Those menus are presented on figures 6 to 8.

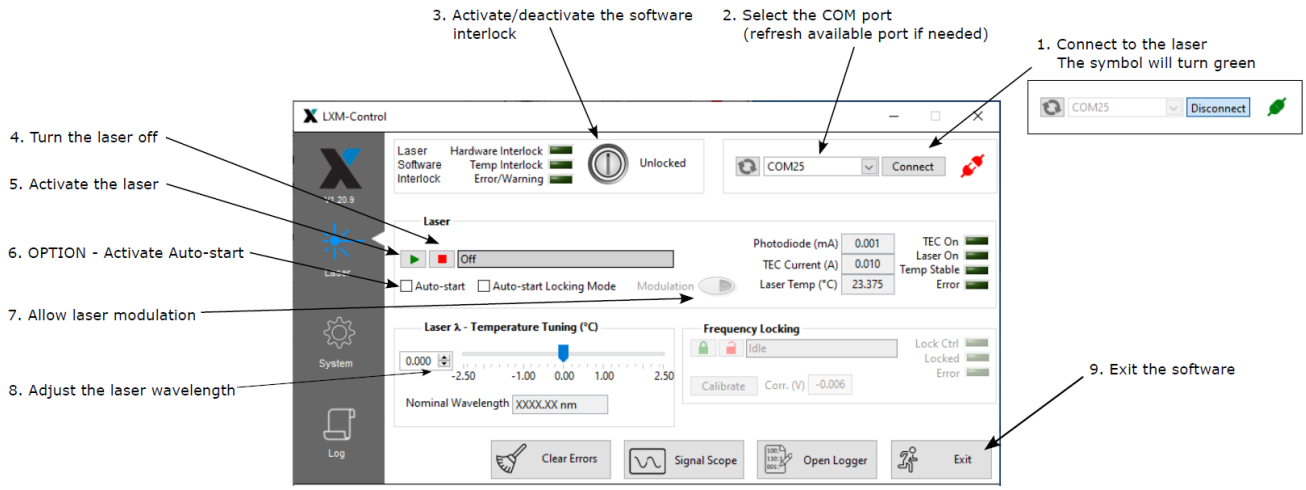


Figure 7. User Interface – Laser Menu & Instructions

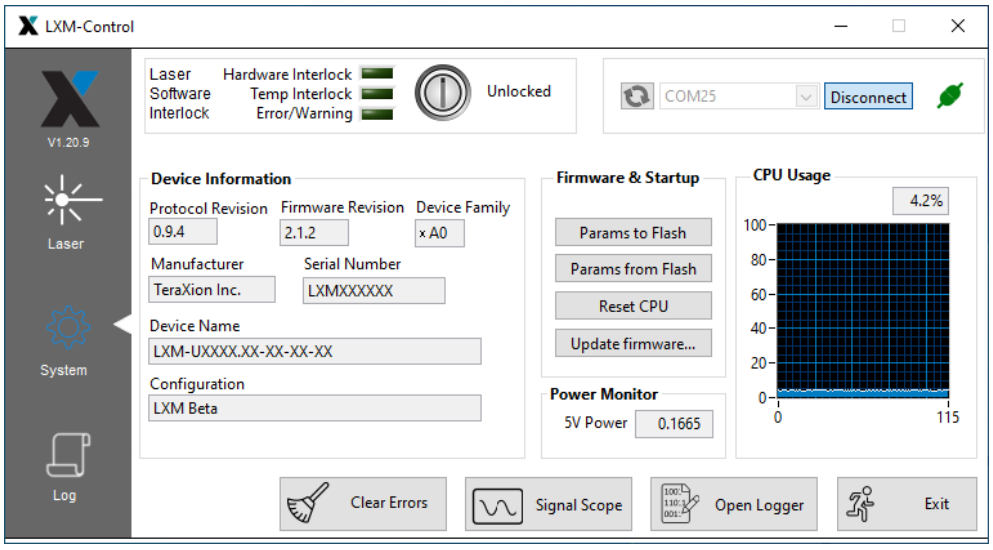


Figure 8. User interface – System Menu

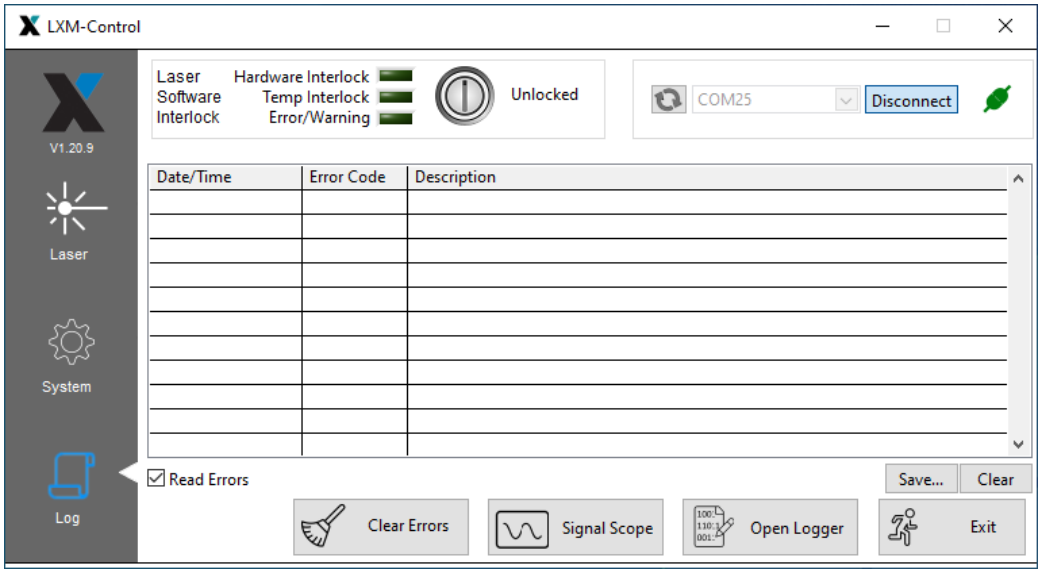


Figure 9. User Interface – Log Menu

5.2. Laser Control Parameters & First Light

The LXM laser control functions are available in the **«Laser» menu**.

To start the laser, please follow the software command sequence described below. All electrical connections must be performed as per section 0, including the unlocking of the hardware interlock.

5.2.1. LASER CONNECT

To achieve connection between the laser and the «LXM-Control» software, first refresh the list of available COM ports using the refresh button . Then, in the drop-down menu, select the COM port identified at step #7 of section 4.5.2. Finally, click on the «**Connect**» button. The symbol should turn green:

5.2.2. SOFTWARE INTERLOCK

To disable the software interlock, press on the software interlock button , enter «**1234**» in the password prompt message box and press «**Ok**». No password is required to lock the software interlock.

INTERLOCK STATE	SYMBOL
Activated Lasing is blocked.	**Locked**
Deactivated Lasing is possible.	**Unlocked**

IMPORTANT NOTE: The new software interlock status is automatically saved.

5.2.3. LASER START

Click on the **start button**  the to activate the «LASER ON» Sequence.

5.2.4. AUTO-START MODE

The auto-start function allows the laser to start automatically at device booth-up. To activate it, check the box labelled «**Auto-start**» on the **«Laser» menu**, then go to the **«System» menu** and click on the «**Params to Flash**» button under the «Firmware & Setup» section to save this new setting.

NOTE #1: If both the hardware and the software interlocks are deactivated, laser emission will occur automatically the next time the laser module is powered on, even without DATA connection.

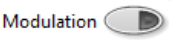
NOTE # 2 (only for LMX-U units): If the «Auto-lock at laser start» function is enabled, the laser will automatically lock itself after the «laser start». This takes typically few seconds, but it can take up to 10 minutes if the laser needs to proceed to a new locking calibration.

5.2.5. WAVELENGTH TUNING

The laser wavelength is tuned through thermal control of the laser diode. It can be done using the available slider under the «**Laser λ – Temperature Tuning (°C)**» section, or by inputting a numerical value directly. This value represents the offset from the factory temperature setpoint of the laser, in [°C]. Refer to the device test certificate to find the wavelength measurement associated to the factory temperature setpoint (offset=0°C). Laser wavelength is typically tuned by 0.1 nm/°C (red shift).

To make this new temperature setpoint the default value at the next startup, go to the **«System» menu** and click on the «**Params to Flash**» button under the «Firmware & Setup» section.

5.2.6. ENABLE MODULATION

The LXM-S modulation circuit includes an enabling switch controlled by software. This switch is disabled by default under factory settings. To enable the laser frequency modulation, click on the **modulation button** 

in the **«Laser» menu.**

If a waveform generator is connected to the SMA modulation port as described in section 4.5.3, the laser frequency can now be modulated.

To make this change permanent, go to the **«System» menu** and click on the «**Params to Flash**» button under the «Firmware & Setup» section.

ULTRA-NARROW MODEL ONLY – This step is not necessary for the LXM-U. The modulation button is then greyed out when this device type is connected.

5.2.7. LASER STOP

We recommend turning off the laser by using the software command «**laser stop**»  . For complete shut-down, please follow the procedure below:

1. Press the **stop button**  to stop the laser emission. You can validate that the laser stopped emitting light looking at the «Laser On» LED on the «Laser» menu.
2. Press the **disconnect button** to disconnect the LXM from the software. Please be aware that the disconnect function does not turn off the laser.

3. Disconnect the USB-C connector on the POWER port to turnoff the module.
4. Click «Exit» on the bottom right of the window.

NOTE: If the auto-start was previously selected, and that both the hardware and the software interlocks are deactivated, laser emission will occur automatically the next time the laser module is powered on, even without DATA connection.

5.3. Ultra Narrow Linewidth Mode (only on LXM-U units)

5.3.1. ACTIVATE/DEACTIVATE ULTRA NARROW LINEWIDTH MODE

The ultra-narrow linewidth mode is activated when the laser diode is locked on the module's built-in frequency discriminator. The Figure 10 presents the «Laser» menu when the laser is in the «Locked» state.

To start the locking sequence, click on the **lock button**  after the laser is turned on. Once the status of the «Frequency Locking» section shows «Locked», the ultra-narrow linewidth mode is operational.

To deactivate the Ultra Narrow Linewidth mode, click on the **unlock button**  .

NOTE: In some circumstances, the lock sequence may fail, which means that the laser needs a new locking calibration (see section 0 below). This can happen for example when the laser central wavelength is tuned to a new value compared to the wavelength of the previous calibration.

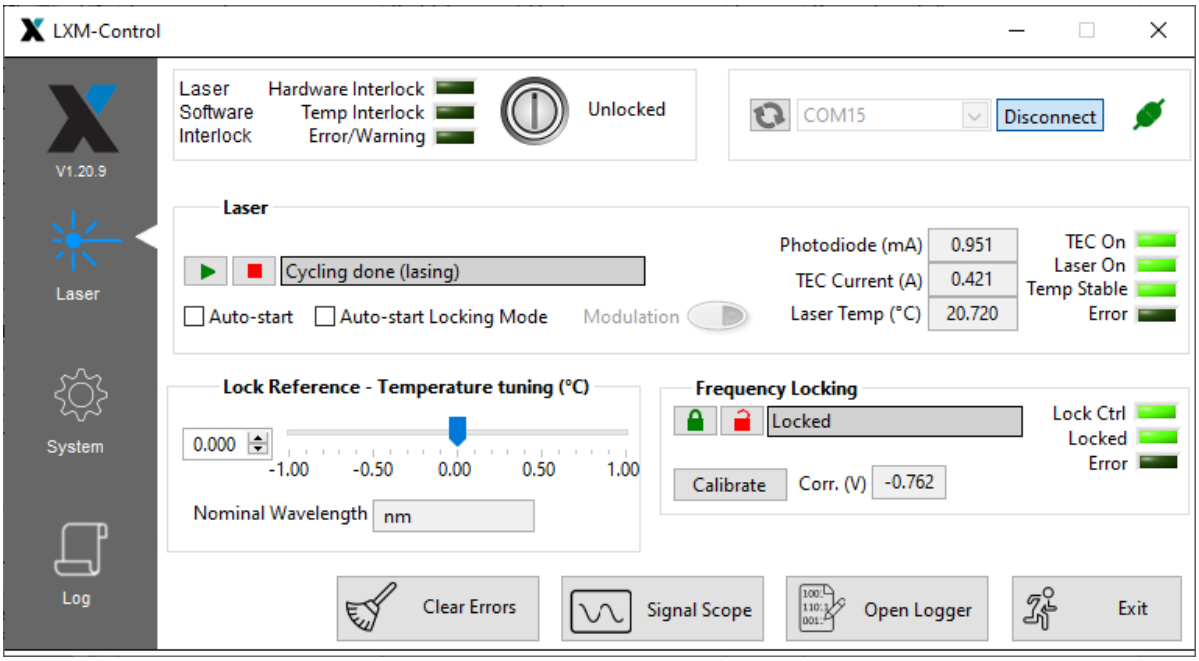
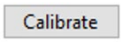


Figure 10 User Interface - Laser Menu under Frequency Locked State

5.3.2. FREQUENCY LOCKING CALIBRATION SEQUENCE

The locking calibration sequence ends in a locked mode. When launched, it ensures achieving locking, but it implies a longer delay compared to the lock function described above.

To start the sequence, click on the **calibrate button** 

. This will start the calibration sequence of the frequency lock. It can take up to 10 minutes for the entire process to be done. Note that this sequence depends on the temperature of the laser. Be sure to adjust it for your need before launching the calibration.

In some cases, the calibration sequence might proceed to an automatic slight adjustment of the laser temperature to achieve locking, thus affecting the central wavelength. Once locked, you can retrieve the desired wavelength using the fine wavelength tuning function described in the section 0.

To make this new calibration the default value at the next startup. Go to the **«System»** menu and click «**Params to Flash**» under «Firmware & Setup».

5.3.3. SETTING THE AUTO-LOCKING MODE

The laser can automatically lock itself on the frequency discriminator after «Laser Start». To activate this function, check the box labelled «**Auto-lock at Laser Start**» on the **«Laser» menu**, then go to the **«System» menu** and click «**Params to Flash**» under the «Firmware & Setup» section to save this new setting.

NOTE: The locking step typically takes few seconds, but it can take up to 10 minutes if the laser needs to proceed to a new locking calibration.

5.3.4. LOCK REFERENCE TEMPERATURE TUNING

Once the laser is locked on the frequency discriminator, the temperature tuning window will switch from «Laser **λ** – Temperature Tuning (°C)» to «**Lock Reference Temperature Tuning (°C)**» (see Figure 10 at the beginning of this section). This corresponds to the fine wavelength tuning mechanism. To adjust the wavelength, you can use the slider or input a numerical value directly. This value represents a temperature offset compared to the calibration temperature setpoint of the lock reference, in [°C]. The module wavelength is typically tuned by 0.01 nm/°C (red shift).

6/ Troubleshooting

6.1. Hardware LEDs

Table 7. Hardware LEDs Description			
Label	**Color**	**State**	**Description**
PWR 5V	Green	ON	Module is powered.
		OFF	Module is not powered.
PWR 3.3V	Green	ON	Module is powered.
		OFF	Module is not powered.
STATUS	Green	BLINK	Start of the LASER ON sequence.
		ON	Sequence completed.
		OFF	Sequence is in Idle.
LASER	Green	ON	The laser diode is powered. Laser light is emitted.
		OFF	The laser diode is not powered.
ERR	Red	BLINK	An error occurred. See Error Log.
		ON	Fatal error. The system will not boot to prevent loops. Contact TeraXion.
		OFF	No error.

6.2. Software LEDs

Table 8. Software LEDs Description			
Section	**Label**	**Color (on state)**	**Condition**
System	Hardware Interlock	Red	Hardware interlock activated. See section 0
	Temp. Interlock	Red	Temperature error on Laser or TEC. See Error Log.
	Error/Warning	Red	Laser or frequency lock error active. See Error Log.
Laser	TEC On	Green	The TEC module is active.
	Laser On	Green	The laser diode is powered.
	Temp Stable	Green	The temperature setpoint is reached and stable.
	Error	Red	Any error on laser or TEC. See Error Log.
Frequency Locking (if applicable)	Lock Control	Green	The discriminator temperature is actively controlled.
	Locked	Green	The frequency locking loop is locked to its setpoint.
	Error	Red	Any error on frequency locking sequence. See Error Log.

6.3. Clearing the errors

Clicking the **Clear Errors** button in the main toolbar (bottom of the «LXM Control» software window) will clear errors and turn off the Error LED.

Clicking the **Clear** button in the «**Log**» menu will clear the log and turn off the Error/Warnings indicator.

Clicking the **Save** button in the «**Log**» menu will allow you to export the log table to an external file.

Appendix A. Cleaning and Caring for Optical Connectors

For prolonged life and maximum performance operation, care must be taken to keep optical connectors free of outside contaminants.

CAUTION!

Before connecting the LXM laser module optical output, make sure connectors are clean to prevent loss of optical power or any damage. To reduce the need for frequent cleaning, place a dust cap immediately on the connector when not in use.

CAUTION!

Ensure the power is off when connecting or disconnecting the LXM laser module optical connector.

Please find below a suggested procedure to clean a male optical connector:

Materials:

- Clean compressed air (oil free)
- Fiber-optic wipes
- Isopropyl alcohol (99%)

Procedure:

- Hold the can of compressed air upright and spray the gas into the air to purge any propellant;
- Spray the clean compressed air on the connector to remove any loose particles or moisture;
- Moisten a clean optical wipe with isopropyl alcohol, then lightly wipe the optical connectors using a slow rotating movement;
- Use a dry section of the optical wipe and repeat the movement to remove any residue dissolved by the alcohol.

Please find below a suggested procedure to clean a female optical connector:

Materials:

- Clean compressed air (oil free)
- Fiber-optic cleaning swab
- Isopropyl alcohol (99%)

Procedure:

- Hold the can of compressed air upright and spray the gas into the air to purge any propellant;
- Spray the clean compressed air on the connector to remove any loose particles or moisture;
- Moisten a clean optical swab with isopropyl alcohol, then lightly swab the optical connectors using a slow rotating movement while pushing and pulling the swab;
- Use another clean and dry optical swab and repeat the movement to remove any residue dissolved by the alcohol.

– END –

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