LDI-7

Operating Manual

This manual contains important information necessary for the safe and efficient operation of the LDI light source system. Please read the manual in its entirety and heed all safety warnings before operating the light source.

Follow all safety precautions!

DANGER – LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

Prior to use, carefully unpack and inspect all components for any signs of damage which may have occurred during shipping. If shipping damage is suspected, notify 89 North or your authorized 89 North distributor immediately.

89 North customer service or your authorized 89 North distributor should be informed immediately in the event of any damage or malfunction in the equipment.

89 North®
20 Winter Sport Lane, Suite 135
Williston, VT 05495
U.S.A.
877-417-8313
+1-802-881-0302
www.89north.com

Contents

1 Document Symbols

Special instructions are emphasized as follows:

NOTE:	This term contains important information regarding set-up and operation to facilitate ease of use and obtain effective results

⚠	*This term contains critical information regarding safe handling and use of this system. Device malfunction or property damage could result if these instructions are not followed.*
WARNING:	*This term contains critical information by identifying conditions or practices that may result in injury or loss of life if these instructions are not followed.*

2 Equipment Symbol Definition

	Caution - Risk of electric shock *This symbol indicates there are hazardous electrical parts inside the equipment.*
	Caution - Risk of danger *This symbol indicates that safe handling and usage instructions must be followed to avoid injury and/or damage.*
	DANGER – LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT OF SCATTERED RADIATION CLASS 4 LASER PRODUCT IEC 60825-1:2014-05 Maximum Output: 2W Emitted Wavelengths: 405nm-640nm
	AVOID EXPOSURE – LASER RADIATION IS EMITTED FROM THIS APERTURE *This symbol indicates that Class 4 laser radiation emits from the aperture to which this label is closely affixed. Arrow points to location of the aperture.*
	CAUTION/DANGER – CLASS 4 VISIBLE AND INVISIBLE LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED. AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION. *This label indicates that removal of the panel to which this label is affixed will permit laser radiation in excess of Class 3B when interlocks are failed or defeated.*

DANGER	DANGER – OPTIONALLY INTERLOCKED PROTECTIVE HOUSING PANEL
DANGER VISIBLE and/or INVISIBLE LASER RADIATION WHEN OPEN AND INTERLOCK FAILED OR DEFEATED. AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION. RAYONNEMENT LASER VISIBLE ET INVISIBLE – EN CAS D'OUVERTURE ET LORSQUE LA SÉCURITÉ EST NEUTRALISÉE. EXPOSITION DANGEREUSE AU RAYONNEMENT DIRECT OU DIFFUS DES YEUX OU DE LA PEAU.	Visible and/or invisible laser radiation when open and interlock failed or defeated. Avoid eye or skin exposure to direct or scattered radiation. *This label indicates that removal of the panel to which this label is affixed will permit laser radiation in excess of Class 3B when interlocks are failed or defeated.*

3 Specifications

Table 1: LDI Specifications

Physical Specifications	
Dimensions	Length: 33cm (12.9 inches) Width: 15 cm (5.8 inches) Height: 24 cm (9.5 inches)
Weight	~9 lbs
Operating Conditions	
Required Clearance	15 cm (6 inches) around front and rear of unit
Safe Operating Temperature	15-30°C / 59-86°F; refer to TPD for performance specification
Operating Humidity	<80% relative humidity, non-condensing
Power Supply	
AC Input Power Requirements	100-240V AC, 50/60 Hz, 3.0 amps (maximum)
DC Input Power Requirements	24 VDC, 10.41A
Fuses	None
Optical	
Spectral Range	405nm-640nm
Internal Fiber, Laser Module	400µm, .39 NA
Internal Fiber, SHG	400µm, .22 NA
External Optical Cable Output (may be supplied with your unit)	As Tested: 400µm, 0.39NA Bifurcated Fiber Optional (may impact performance): 400µm, .22 NA
Control Options	
TTL	>2.3 V High
Analog	0-5V
USB-DSP	Virtual COM port – SDK available upon request

4 Introduction and Intended Use

WARNING: **DO NOT** look directly at the output from the LDI light source. The light source is capable of producing high intensity emission that could be damaging to the eyes or skin.

The LDI is a multi-wavelength laser-diode light source intended for use in fluorescence imaging applications. The LDI is a standalone unit, designed to operate on a desk or bench and connect to a microscopy instrument or other imaging equipment via optical cables.

The LDI-7 has seven discrete wavelength channel(s): 1-Violet, 2-Blue, 3-Green, 1-Red. The LDI-7 has two output connector(s) one corresponding to the multicolor laser module; one corresponding to the SHG laser. 89 North can supply an optional Bifurcated Fiber to combine the two LDI outputs into one fiber for light delivery.

Because of its intense brightness, the LDI includes several safety interlocks that, when tripped, will block the laser emission produced by the system. **Do not override these interlocks**. Doing so may result in injury to the user and/or the unit and will immediately void the warranty.

5 Certification Description

Regulatory model names are used to identify all certified and CE marked products. Regulatory model names are traceable to all regulatory documentation, third party reports, and certifications.

The model name "LDI-7" refers to the model described herein.

Emissions and Immunity
   EMC Directive 2014/30/EU:
      EN 55011/CISPR 11
      IEC/EN 61326-1
   FCC Part 15 Subpart B, Class A

Safety Certifications
   ETL CB Certification: IEC 61010-1:2010
   ETL US Certification: UL 61010-1:2012
   ETL CAN Certification: CSA C22.2 No. 61010-1-12:2012
Note: Compliance to IEC 60825-1 is validated per IEC 61010-1.

CE Marking
   Low Voltage Directive 2014/35/EU
   EMC Directive 2014/30/EU
   RoHS Directive 2011/65/EU (RoHS2), (EU) 2015/863 (RoHS3 Amendment)
   REACH Regulation (EC) No 1907/2006

Note: Refer to the Declaration of Conformity delivered with product

6 Safety

6.1 System

WARNING: The LDI contains Class 4 lasers. No field service or maintenance procedures are prescribed that present access to the Class 4 emission. Follow all procedures and heed all warnings provided in this manual to ensure access to Class 4 emission is prevented.

The LDI incorporates Class 4 lasers which produce heat as well as visible and UV light. Proper care must be taken in setup and operation to prevent injury.

The laser emission output aperture(s) are located on a connector panel in the 'fiber access area' of the LDI. The fiber access area is accessible by raising the interlocked fiber access cover (see section 7).

Locations of apertures where laser radiation exceeding Class 1 AEL specifications is emitted are shown in Figure 1:

Position 1: SMA: corresponding to the multicolor laser module

Position 2: SMA: corresponding to the SHG laser

Figure 1: Units shown with SMA and LLG connectors for reference. Single output units may have one SMA connector in position 2. Your device outputs may differ.

The LDI incorporates safety interlocks which prevent laser emission when optical cables are not installed in the unit.

NOTE: The LDI will not produce laser emission from an aperture unless an external output optical cable is installed.

Do not attempt to operate the LDI with the external output fiber distal end capped or not connected to an instrument or beam dump. Doing so could result in significant damage to the laser.

WARNING: Never operate the LDI with the optical fiber disconnected from the instrument or beam dump as visible and invisible laser radiation can be harmful to the unprotected eye and skin.

The LDI incorporates a remote safety interlock which prevents laser emission when the connected remote interlock is open, (Figure 4)

The LDI incorporates a safety interlock which prevents the unit from being powered with the protective cover removed.

Additionally, the LDI incorporates a safety interlock which prevents laser emission when the fiber access cover is removed, (Figure 5)

CAUTION – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

If the equipment is used in a manner not specified within this manual the protection provided by the equipment may be impaired.

The fiber access cover should be removed for optical cable installation or removal only. Removal of the fiber access cover will result in lasers turning off.

WARNING: Do not remove any covers except the fiber access cover. Removal of covers other than the fiber access cover could expose the user to electrical hazards and moving parts and will void the product warranty.

Do not operate the unit near any flammable materials including flammable gases or liquids.

WARNING: The LDI produces ultraviolet radiation. Never look directly at the output from the optical cable or at scattered laser light from any reflective surface.

WARNING: Use the laser in an enclosed room with restricted access.

WARNING: The LDI produces significant amounts of heat. Ensure sufficient clearance around the front and rear of the unit for proper cooling.

WARNING: Never attempt to override safety interlocks or operate the unit with interlocks overridden.

6.2 Laser Safety Guidance

The following information is provided as guidance to aid in safe usage of the LDI, per IEC 60825-1:2014. As a laser light source, the LDI emission presents hazard risks to the skin and eyes. Extreme caution is necessary when operating the light source to prevent injury. A Laser Hazard Assessment by your Laser Safety Officer is recommended.

WARNING: Even with protective eyewear, never look directly at the LDI output emission or allow skin to be exposed to the beam, as laser radiation can be harmful to the eyes and skin.

6.2.1 Maximum Permissible Exposure Limits

Maximum permissible exposure (MPE) limits represent the maximum level of laser radiation to which the eye or skin can be exposed without consequential injury. MPE is related to the wavelength of the laser emission, the exposure duration, the tissue at risk, and the size of the retinal image. MPE limits for an exposure time of 100 seconds for all LDI laser channels have been calculated and are tabulated below. These limits are calculated per IEC 60825-1:2014 and are intended to provide guidance <u>only</u>. The user is directed to IEC 60825-1:2014 for further detail to calculate safe exposure limits based on their application.

Table 2: Maximum Permissible Exposure Limits

Maximum Permissible Exposure		
Wavelength (nm)	Point Source MPE (W/m^2)	Extended Source Lowest MPE (W/m^2)
405	1.0	1.0
445	1.0	1.0
470	1.8	1.8
520	10.0	19.1
528	10.0	27.0
555	10.0	27.0
640	10.0	27.0
Extended Source MPE is evaluated at 100 mm viewing distance from 400 μm fiber		

Exposures from several wavelengths should be assumed to have an additive effect on a proportional basis of spectral effectiveness according to the MPE tables of IEC 60825-1.

6.2.2   Hazard Distance

Nominal Ocular Hazard Distance (NOHD) is the minimum distance from the laser output aperture beyond which the beam radiant exposure remains below the appropriate corneal maximum permissible exposure (MPE). In this case of NOHD determination for the LDI, the output aperture is taken to be the end of the output optical cable. The NOHD is based on the MPE and takes into consideration the power of each channel, the divergence of the beam, the diameter of the output, and the beam's intensity profile. The combined NOHD for the LDI is calculated to be **10.3 meters**.

6.2.3   Protective Eyewear

It is strongly recommended the user utilize protective eyewear when operating the LDI when viewing the laser emission at a range closer than the NOHD is possible. Eyewear meeting the following criteria is recommended: **OD 4+, 380 to 650nm**

7   System Overview

Values of the maximum output power of available laser lines in either pulsed or continuous operation are given in Table 3:

Table 3: Maximum output power values for each laser line.

	Center Wavelength (nm)	Max. Output Power (mW)
Laser Module	405	300
	445	1000
	470	1000
	520	500
	528	500
	640	400
SHG	555	1000

Output emission is delivered from the LDI through 400µm, 0.39NA Bifurcated Fiber cable(s) which are connected to optical connectors on the top of the LDI in the fiber access area. Typically, one output for the laser module and another output for the SHG laser.

Output beam divergence is dependent upon the external output optical cable installed.

The Laser Module lines can be pulsed up to 8000 Hz, 50% duty cycle at 100% intensity before performance degradation is evident (0.0625 msec pulse). The SHG Laser line can be pulsed up to 100Hz, 50% duty cycle at 100% intensity before performance degradation is evident (5 msec pulse)[1]. 'Performance degradation' could be laser line failing to achieve full set intensity or irregularity of pulse shapes, depending on the laser line and exact operating parameters. Laser diode lines cannot be overdriven for pulsed operation, i.e. the maximum output powers above hold for continuous wave and pulsed operation.

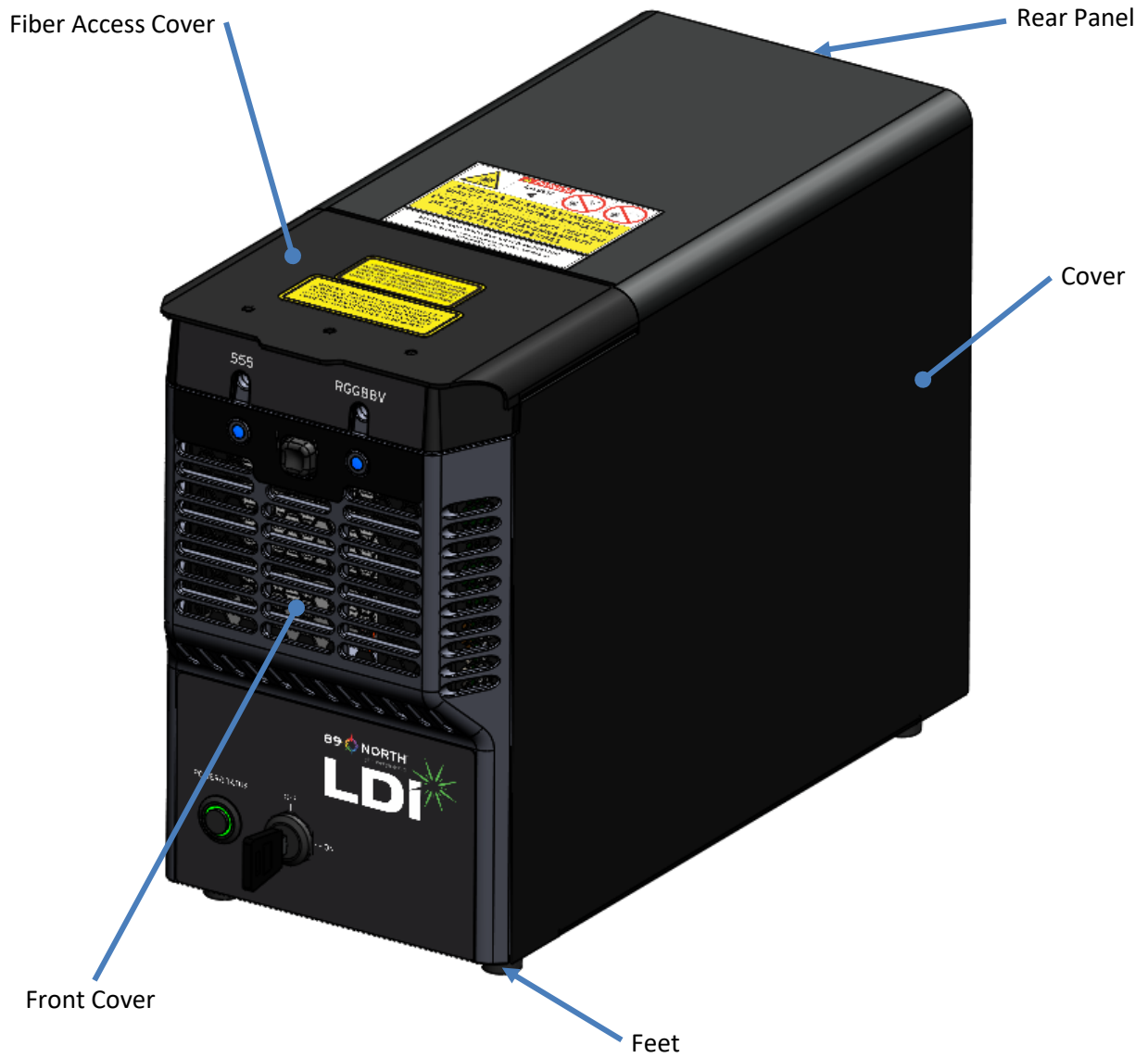[1] These specifications are subject to change.

LDI Overview Figures

LDI:

Figure 2: LDI-7 Model Shown

Front Panel Controls and Indicators:

Laser Enabled Indicators

Fiber Access Cover
Release Button

Master Key Switch

Status Indicator &
Soft Power Switch
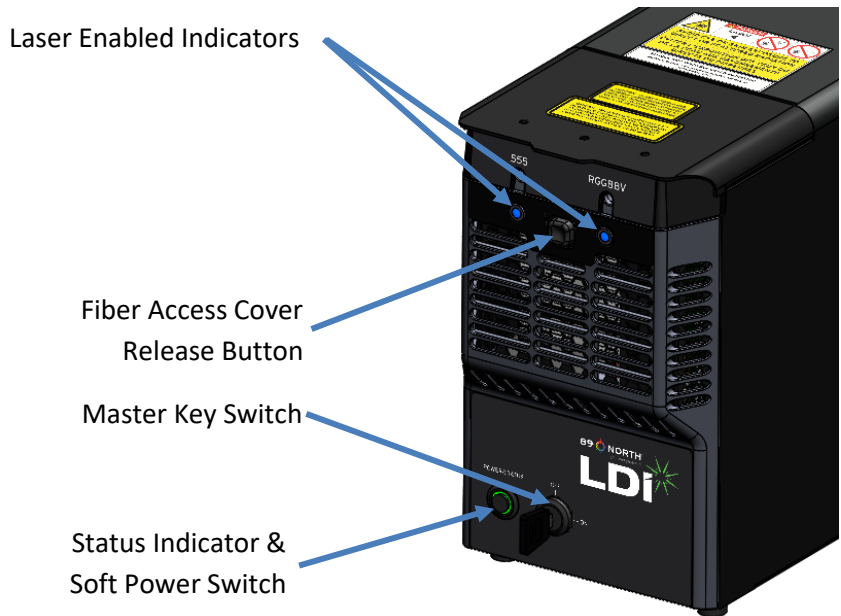
Figure 3: Front Panel (LDI-7 Model Shown)

Rear Panel Connections:

USB Connector:
Host Computer Interface

DB-25 System Connector:
Analog/TTL Interfaces

Remote Interlock

Power Input
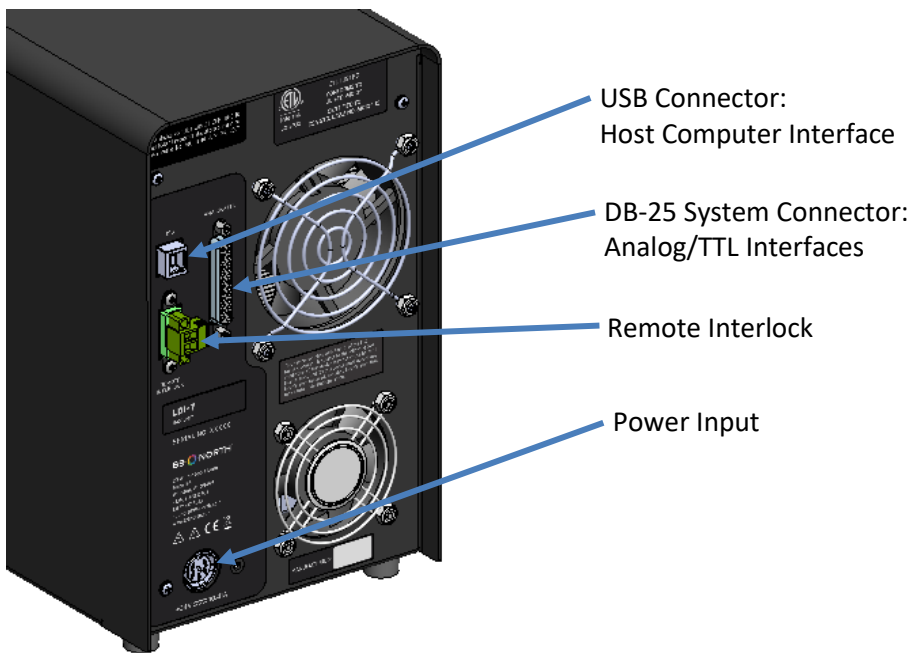
Figure 4: Rear Panel (LDI-7 Model Shown)

Laser Safety Label Locations:

Class 4 Explanatory Label
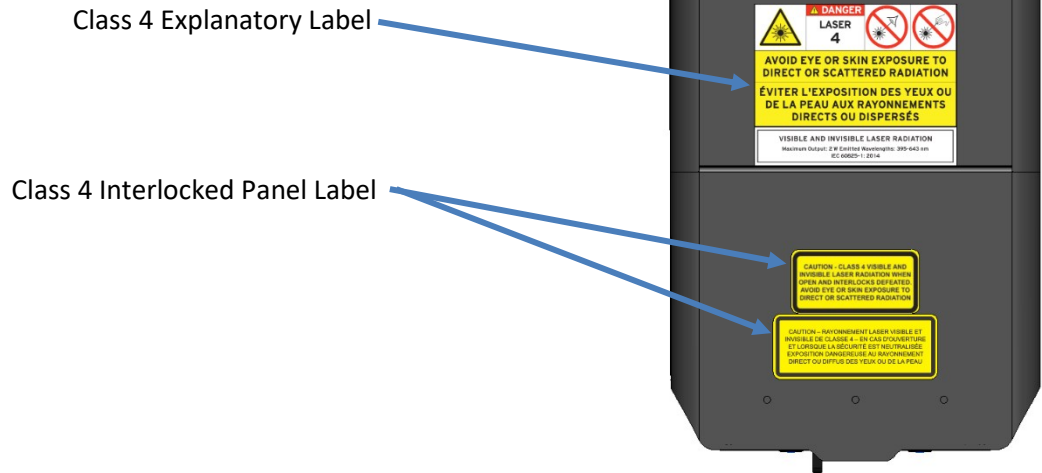
Figure 5: Laser Safety Labels, Interlocked Fiber Access Cover

Class 4 Interlocked Panel Label

Aperture Labels
(Fiber Access Cover Removed)

Figure 6: Laser Safety Labels, Apertures
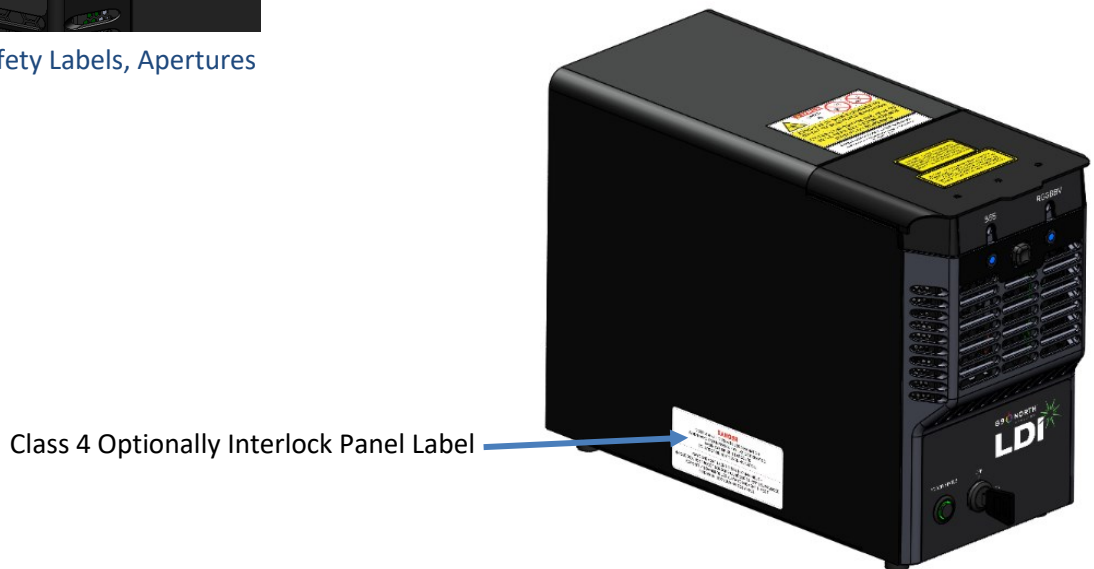
Class 4 Optionally Interlock Panel Label

Figure 7: Laser Safety Label, Interlocked Cover

8 I/O Connections

Serial I/O connection is made through the USB connector on the rear panel. Analog voltage and TTL signal connections for intensity and shutter control are made via the DB25 connector on the rear panel. When using Metamorph®, refer to the "Metamorph® Driver Installation zip file on the supplied thumb drive or contact 89 North customer support for assistance.

The DB25 system connector pinout is show below. Refer to Table 1 for analog and TTL signal levels.

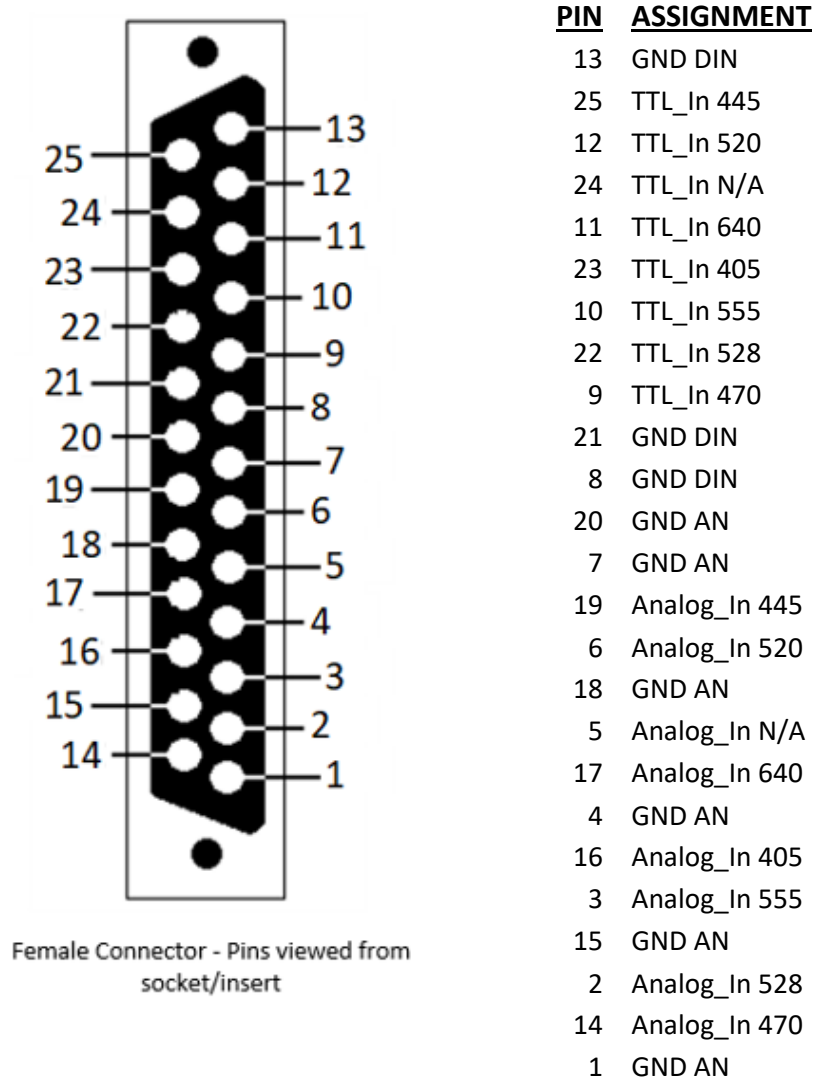| PIN	ASSIGNMENT
13	GND DIN
25	TTL_In 445
12	TTL_In 520
24	TTL_In N/A
11	TTL_In 640
23	TTL_In 405
10	TTL_In 555
22	TTL_In 528
9	TTL_In 470
21	GND DIN
8	GND DIN
20	GND AN
7	GND AN
19	Analog_In 445
6	Analog_In 520
18	GND AN
5	Analog_In N/A
17	Analog_In 640
4	GND AN
16	Analog_In 405
3	Analog_In 555
15	GND AN
2	Analog_In 528
14	Analog_In 470
1	GND AN

Female Connector - Pins viewed from socket/insert

Figure 8: DB25 Connector Pinout

9 Breakout Box (Optional)

The optional 'Breakout Box' provides external analog intensity control and TTL shutter control connections for each of the channels in the LDI and routes them to the appropriate pins of the LDI interface connector.

The Breakout Box connects to the LDI unit with the supplied DB25 male to male cable. BNC connections are provided to connect to the customer supplied equipment (BNC cables not included).

Currently available for LDI-7. Please contact 89 North for availability of a custom Breakout Box.

Figure 9: Breakout Box and Cable (LDI-7 Model Shown)

10 Initial Setup

System Components

The LDI illumination system is comprised of:

- Laser light engine
- External power supply: AC-DC adapter
- Electrical power cord
- USB cable
- External output optical cable(s) (89 North supplied or customer supplied)
- LDI.exe graphical user interface

Carefully unpack all components.

NOTE:	Use of a power supply other than that provided by 89 North may void the certifications listed in section 5 above, and it is not supported without prior agreement. It is the sole responsibility of the end user to verify regulatory compliance of operation with an alternate power supply.

Picking a Location

Place the LDI on a flat, level surface, with its feet on the surface in the orientation shown in Figure 2.

Set the external power supply on a flat surface that allows for adequate ventilation on all sides. Maintain 6" (15 cm) of clearance on the front and rear of the LDI. Note that the clearance between the LDI and other pieces of heat producing equipment should be increased to ensure that the heat from one unit does not contaminate the required cooling air stream for the other.

NOTE:	Maintain **at least 6" of clearance** around the front and rear or the LDI for adequate ventilation.

NOTE:	For proper temperature regulation, the LDI must be placed on a flat surface on its feet.

Installing Output Optical cables and Master Key

Remove the fiber access cover by pressing the fiber access cover release button and lifting the fiber access cover, (Figure 10). Remove the bag containing the master key, USB flash drive, remote interlock mating connector, and SMA-SMA adapter (if ordered).

Figure 10. LDI-7 shown with the fiber access cover.   LDI-7 shown without the fiber access

Install the output optical cables:

If applicable, remove the caps from the connector(s) installed in fiber access area. Connect output optical cables to the connector(s). Route the optical cable(s) or bifurcated fiber legs through the associated slot(s) in the LDI front panel, (Figure 11). Note: If an output channel is not intended to be used, i.e. the output fiber for this channel will not be installed, the connector cap for that channel should remain in place.

SMA Connectors
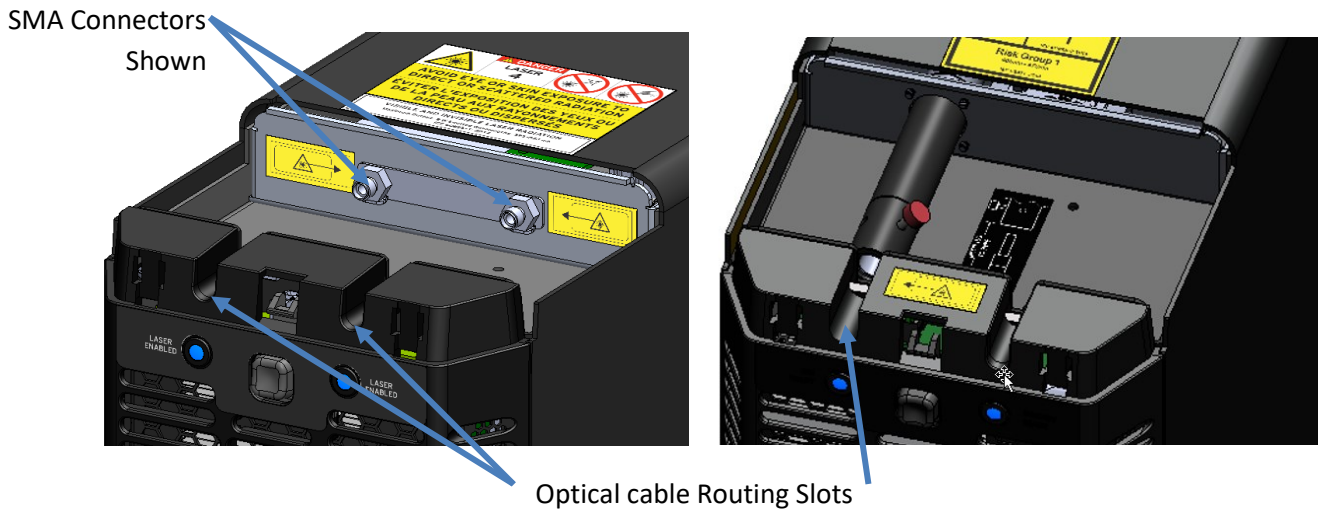Shown

Optical cable Routing Slots

Figure 11. Optical cable routing slots in the front panel of the LDI.
(LDI-7 and LDI-WF Shown)

Replace the fiber access cover by inserting the lip of the fiber access cover into the fiber access cover slot, as shown in Figure 12.

Fiber Access Cover Lip

Chassis Cover

Fiber Access Cover Slot
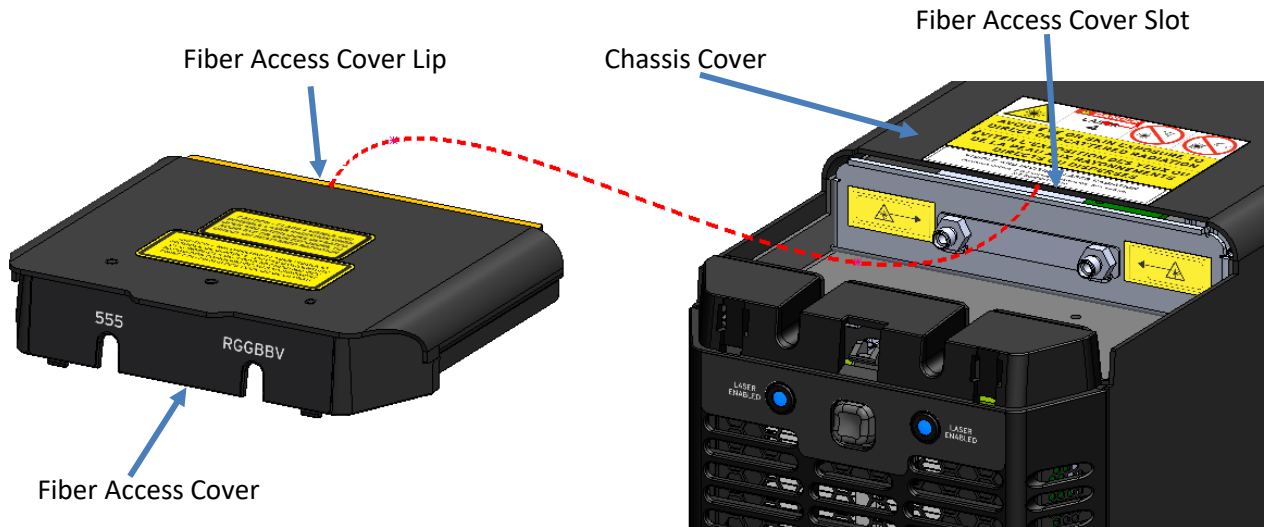
Fiber Access Cover

Figure 12: Fiber Access Cover Replacement (LDI-7 Model Shown)

Close the fiber access cover by pressing down on the cover until it latches. If the fiber access cover is not properly installed and closed, the LDI will not emit light.

Connect the distal end of the installed output optical cables to customer-supplied equipment.

WARNING: Output of optical cable connection from LDI must be installed into customer-supplied device before illuminating the LDI. Laser light exiting the optical cable presents a serious hazard and should be avoided. The LDI should never be operated with nothing connected to the output optical cable of the unit.

Connecting the AC-DC Power Supply and AC Power Cord

Insert the external power supply cord receptacle into the DC jack on the rear of the LDI, (Figure 13.) Insert the AC power cord plug receptacle end into the AC plug on the external power supply. Plug the AC power cord into a standard AC outlet. See the technical specifications in this manual for power requirement.

Input Power Connector

⚠ Only the power cord supplied with the unit should be used. The use of an inadequately rated power cord may impair safe operation of the equipment.

Figure 13. Power connection on the LDI rear panel.

Setting Up Control Interfaces

Run "LDI Setup.exe" supplied on the USB flash drive to install the LDI graphical user interface ("LDI.exe") and device drivers on the host PC. Follow the prompts to complete the installation. Note: The device drivers will install after the LDI.exe application install completes.

> **NOTE:** The LDI GUI supports Windows 10 and above operating systems. Prior Windows versions and Mac operating systems are not supported.

If external signals will be used for controlling intensities and/or shutters, connect the control cable to the DB25 system connector on the LDI rear panel, (Figure 14).

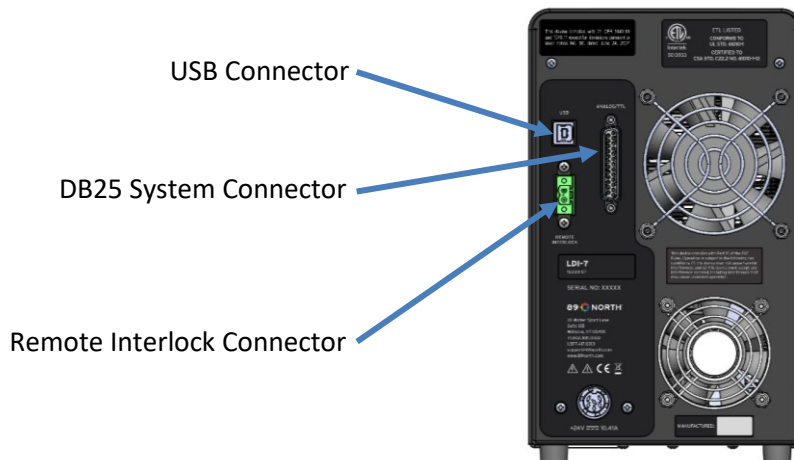Connect the USB port to the host PC with the cable provided, (Figure 14).

Figure 14. Communication connections on the LDI rear panel.

Installing Master Key and Remote Interlock

Install the master key in the LDI front panel. Leave the master key in the OFF position until the LDI is ready for use.

Terminate the leads of the customer-supplied equipment interlock to the remote interlock mating connector provided. Connect the resulting remote interlock cable to the remote interlock connector on the LDI, (Figure 14). The LDI will allow laser emission only if the remote interlock is closed, i.e. a short to ground across the remote interlock connector terminals as provided by the connected customer equipment.

The remote interlock ensures that laser emission is not accessible when the terminals of the interlock are open-circuited. Operating the LDI without the remote interlock properly connected to the customer-supplied equipment may impair safe operation of the equipment.

Turn the master key to the ON position. The LDI is now ready to be operated.

Additionally, cycling the master key ON-OFF-ON again will often clear a fault. See Troubleshooting for further information.

11 Operation

WARNING: Caution - use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

WARNING: Even with protective eyewear, **never look directly into the optical cable** or allow for skin to be exposed to the beam, as invisible laser radiation can be harmful to the eyes and skin.

Following initial setup, the LDI is ready to operate. The LDI can be controlled using the graphical user interface provided (LDI.exe), through serial commands sent to the LDI via USB, or through external analog and TTL signals to control intensity and shutter positions, respectively. To control the LDI via serial commands, refer to the LDI End-User Command Specification. The LDI GUI must be used to set control modes and perform firmware updates.

With the LDI connected via USB to the host PC, launch the LDI GUI (LDI.exe) on the host computer. Prior to powering the LDI on, the GUI should appear as seen in Figure 15. *Note*: Channel identifications will vary depending on the LDI model in use.
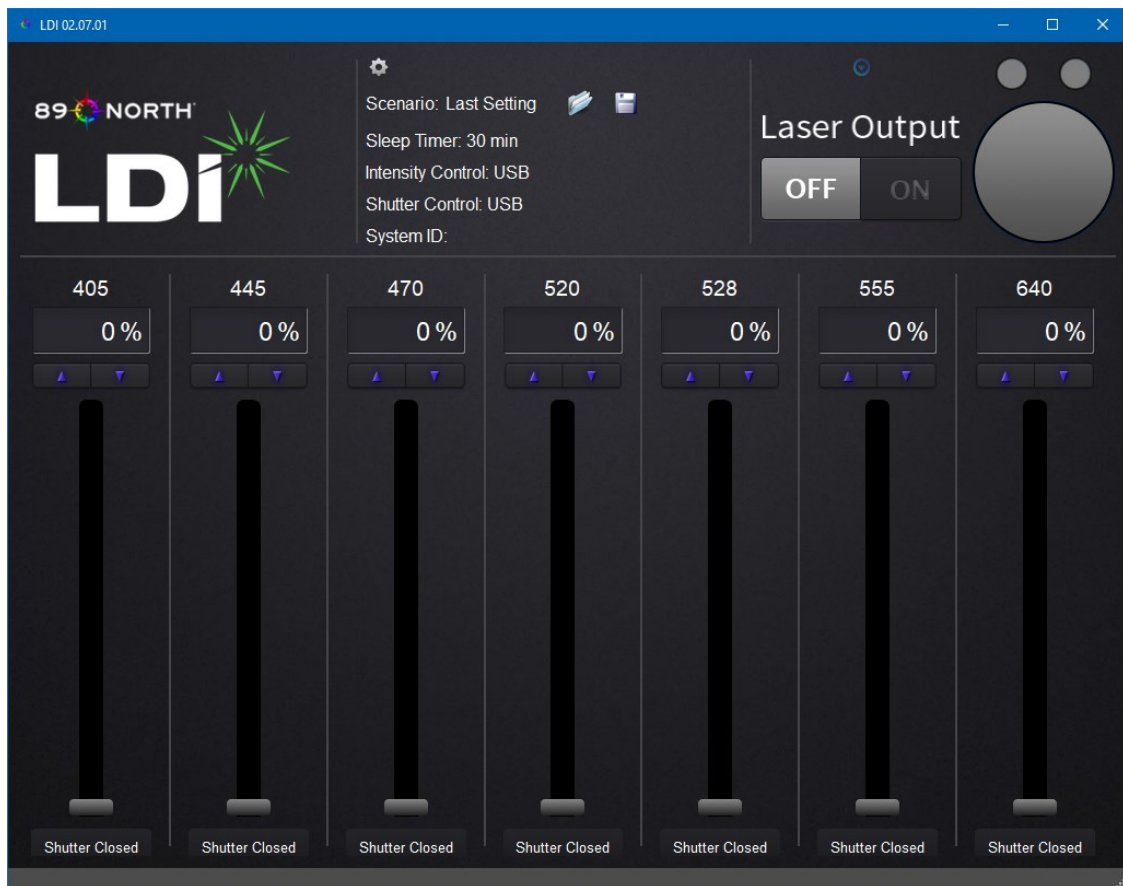

Figure 15. The GUI prior to powering on the LDI. (LDI-7 Wavelengths Shown)

Depress the power switch on the front panel to turn the LDI on. The unit will start in Warm-Up mode, as indicated by the yellow indication on the front panel status ring LED. The LDI is ready for operation when

Warm-Up is completed, which is indicated by the front panel status LED turning green. Front panel LED status color is also indicated in the upper right corner of the GUI; mode status and fault identification is indicated in status bar in the bottom left corner of the GUI, (Figure 16).

NOTE: This equipment has been successfully tested for EMI/RFI radiation and susceptibility; however, if not installed and used in accordance with these instructions, interference with other devices in the near vicinity may occur. If this equipment does cause harmful interference to other devices, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving device.
- Increase the separation between the equipment.
- Connect the equipment into an outlet on a circuit different from that to which the other device(s) are connected.
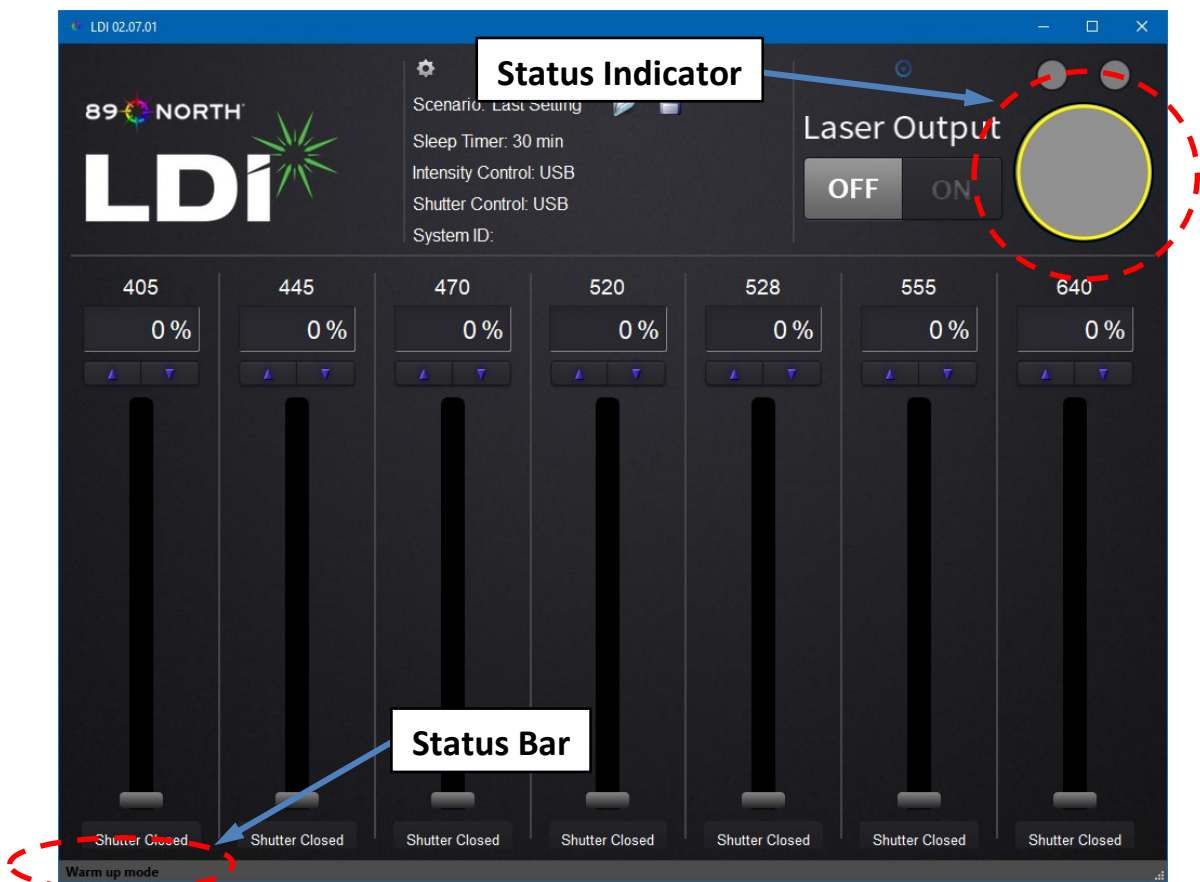- Consult the manufacturer or field service technician for help.

Figure 16. Status Indicator and Status Bar (LDI-7 Wavelengths Shown)

Here, the ring in the upper right corner of the GUI is yellow, indicating that the LDI is in Warm-up mode. The operating mode is indicated in the status bar in the lower left corner.

11.1 Setting the Control Mode

After the unit completes Warm-up, configure the desired shutter and intensity control modes from 'Control Modes' tab in the 'System Info & Settings' window. The 'System Info & Settings' window is accessed by gear icon in the LDI GUI, (Figure 17).
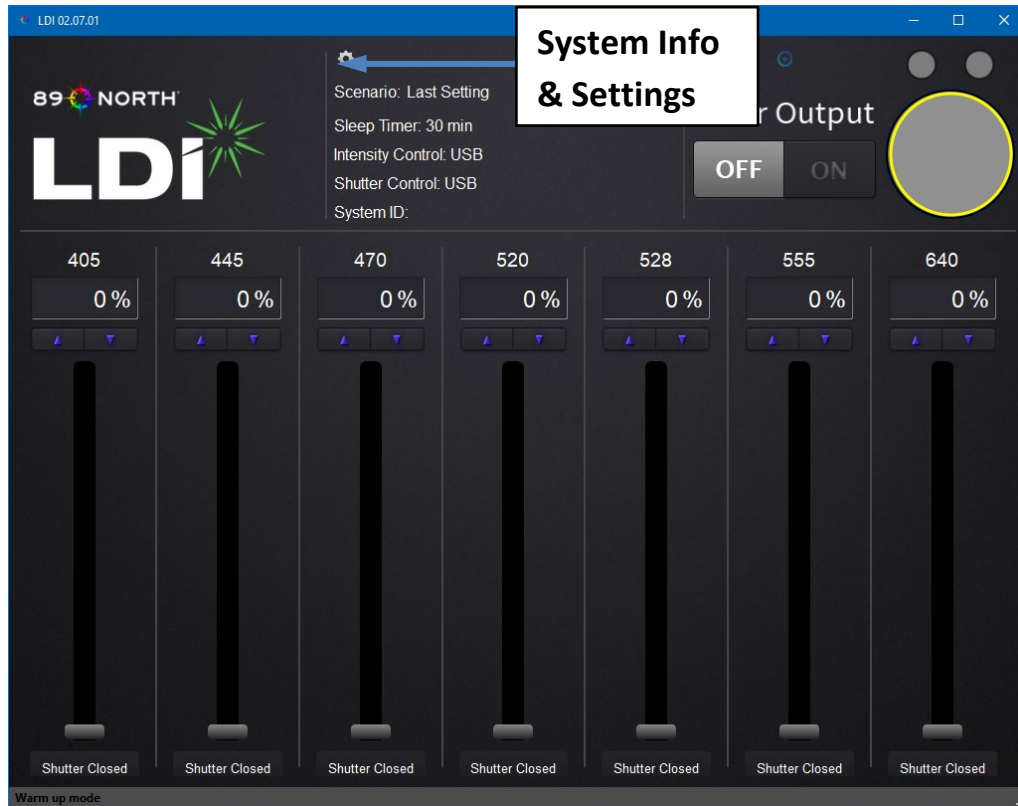

Figure 17. System Info and Settings. (LDI-7 Wavelengths Shown)

System Info & Settings can be accessed by pressing the gear icon. Also note that the ring indicator is now green, indicating that the LDI is no longer in Warm-up mode

The **'Control Mode'** tab lists options for controlling laser intensity and shutter control, (Figure 18).

When the 'Sleep Timer' is checked, the LDI will operate in Run Mode for the desired time and then enter Idle Mode when the time has elapsed. If a command or a state change is sent to the LDI during the sleep timers' cycle, the sleep timer resets its count.

'Intensity Control' mode options are 'Host USB' or 'External Analog'; 'Shutter Control' mode options are 'Host USB' or 'External Digital'.

If 'External Digital' shutter control mode is selected, configure the TTL shutter positions in the **'TTL Configuration'** tab of the 'System Info & Settings' window, (Figure 18). Options are active (shutter open) high or active (shutter open) low (see Section 8).

The "Despeckler" can be turned On or Off. When the Despeckler is turned On, the Despeckler device will turn on following Warm-Up and remain on. When turning the Despeckler On from Off, allow a minimum of one second for the Despeckler to stabilize.

> **NOTE:** **Despeckler Mode:** Turn the Despeckler "Off" when not in use to extend the life of the device.

When control modes have been set, select OK to close the 'System Info & Settings' window. Control mode settings will be retained between LDI power cycles.
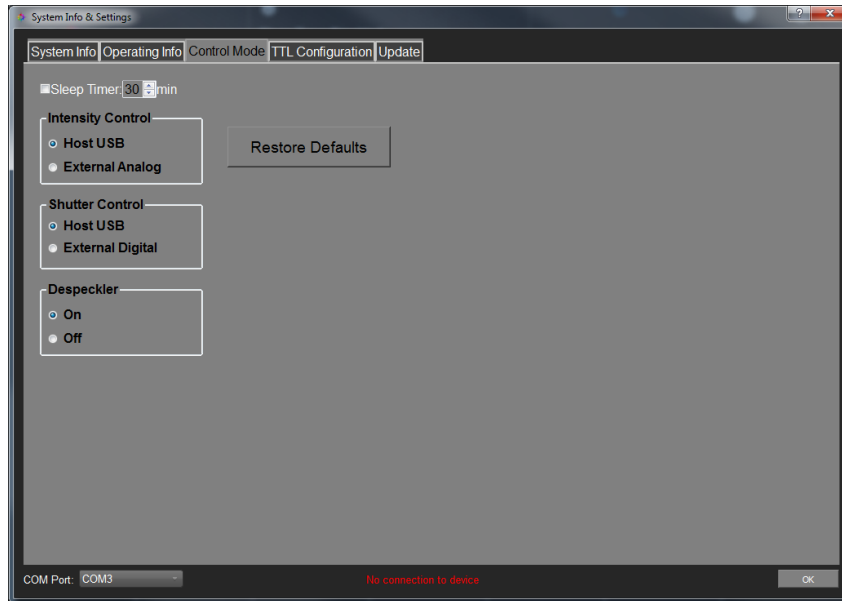

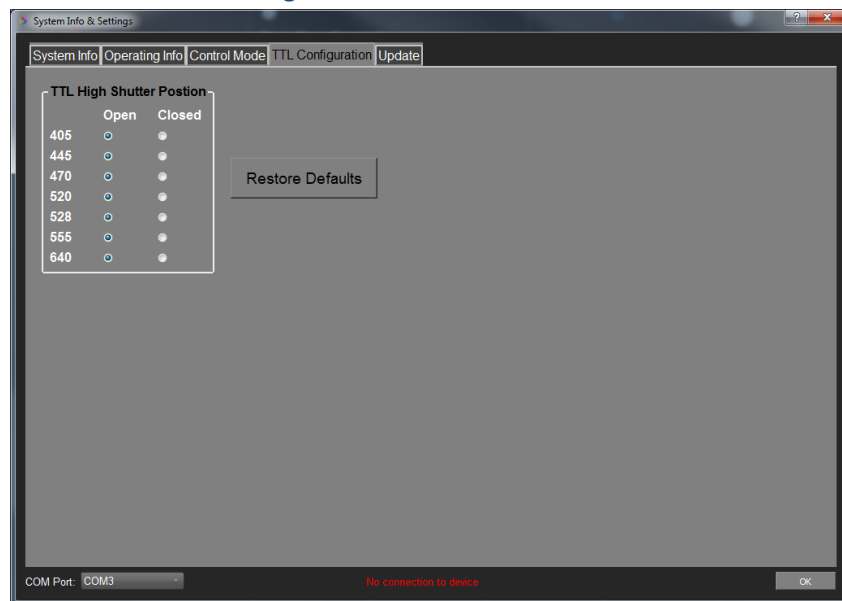Figure 18. Control Mode Tab

Figure 19. TTL Configuration Tab. (LDI-7 Wavelengths Shown)

If 'Host USB' mode is selected for intensity control, set channel intensities to the desired levels (0-100%) via the slider, arrows (incrementing by 1%), or text controls in the GUI, (Figure 20). Additionally, clicking in the intensity bar space for a given channel will increment the intensity setting by 10%.

If 'External Analog' control mode is selected for intensity control, verify the applied voltage levels (0-5V) correspond to the desired intensity settings as reported in the GUI (see Sections 8 and 9).
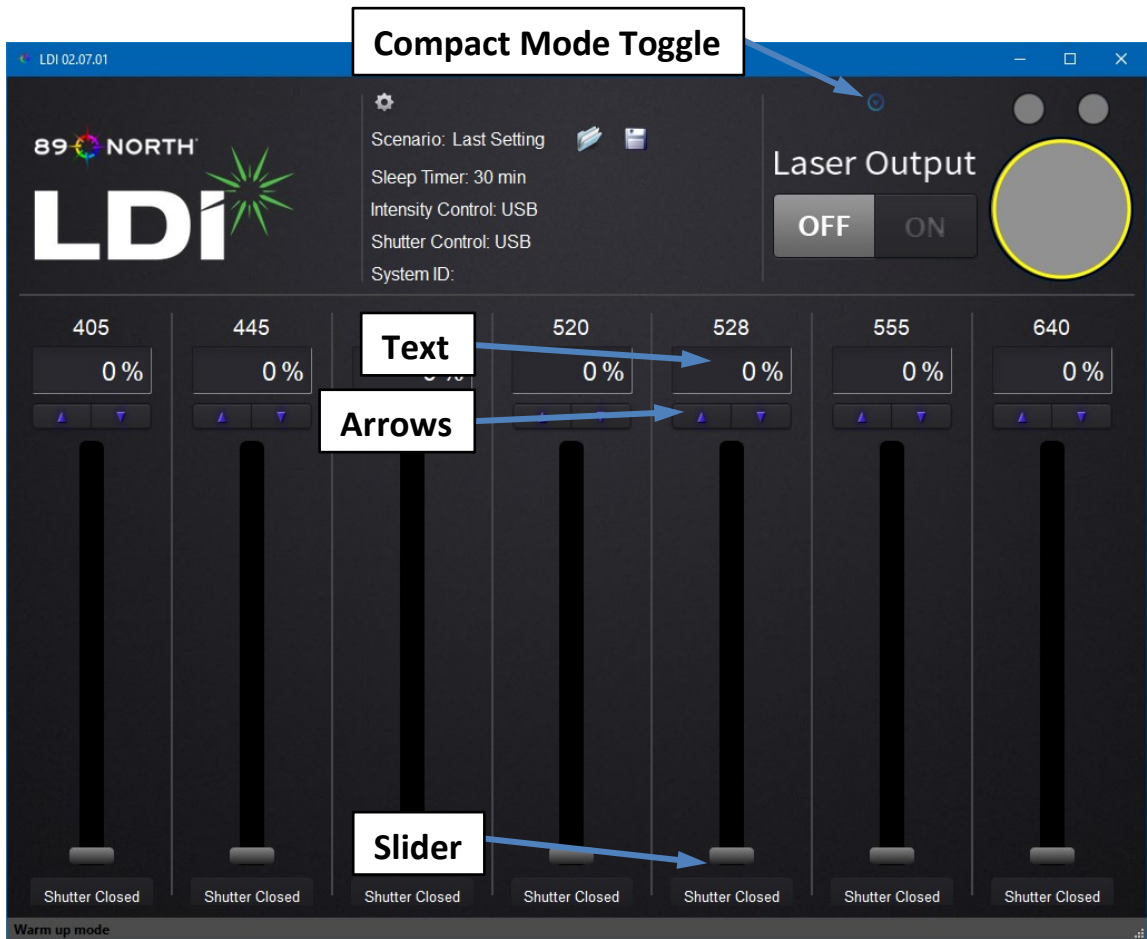

Figure 20. GUI Intensity Controls. (LDI-7 Wavelengths Shown)

Controls of the LDI can be changed on the home screen of the GUI using the slider, arrows, text boxes, or by clicking in the intensity bar space.

If 'Host USB' mode is selected for shutter control, open the shutters of the desired channels by clicking the shutter buttons of the corresponding channels. The buttons will toggle between "Shutter Open" and "Shutter Closed" when clicked.

Alternatively, to save display space on the host computer, the LDI GUI can be switched to 'Compact Mode', (Figure 21). Click on the blue Compact Mode Toggle icon to switch from Normal Mode to Compact Mode. The shutter open/closed buttons and sliders will be hidden. Click on the icon again to restore the display to Normal Mode.

Additionally, if you manually resize the GUI window by dragging the sides of the window, you can toggle the Compact Mode icon to restore the GUI interface to the default size.
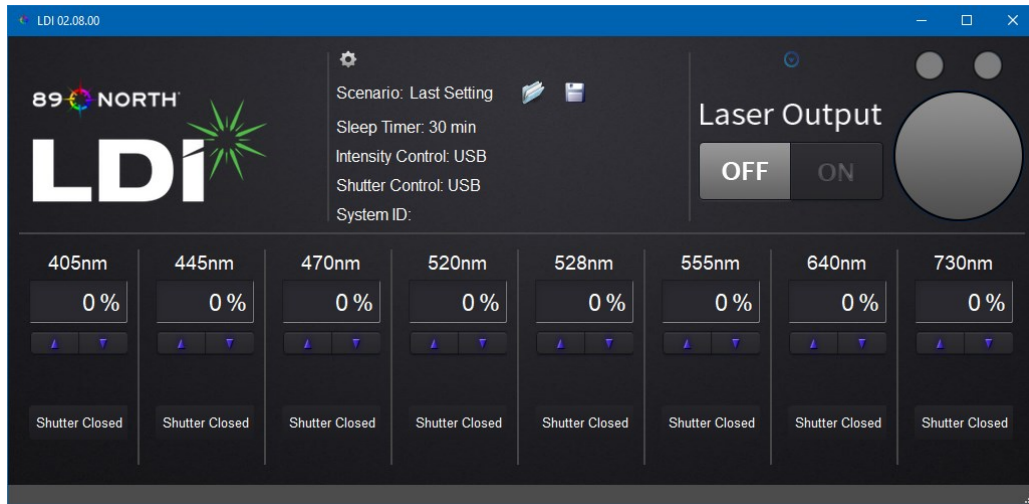
Figure 21. Compact Mode GUI. (LDI-7 Wavelengths Shown)

11.2 Turning Lasers On (Run Mode)

The LDI supports the concurrent operation of up to 4 laser lines. In 'Host USB' control mode, the system limits the number of concurrently open shutters to 4. In 'External Digital' shutter mode, the number of concurrently open shutters is not constrained by the LDI firmware. Attempting to operate more than 4 channels simultaneously could lead to performance degradation or fault conditions. Operation of more than 4 laser line channels simultaneously is not recommended.

⚠️ Attempting to operate more than 4 channels simultaneously could lead to performance degradation and/or over-temperature conditions. Operation of more than 4 laser lines simultaneously is not a supported operating mode.

Light will not emit from the system until Run mode is selected. If 'External Digital' mode is selected for shutter control, verify that the shutters indicated as Open correspond to the desired channels.

Click the ON button in the upper right corner of the GUI to put the system in Run mode. When the system is in Run mode, laser light will emit from channels with Open shutters and intensities greater than 0%.

NOTE: The LDI will not produce light until commanded into the Run mode. The System Indicator icon in the upper right corner of the GUI will display the IEC laser radiation warning symbol when the system is in Run mode.

If 'Host USB' mode is selected for shutter control, to turn a channel off, click the corresponding shutter button to turn it to "Shutter Closed". If 'External Digital' mode is selected for shutter control, to turn a channel off, set the corresponding TTL input voltage to the Shutter Closed TTL level.

To turn all channels off, click the OFF button in the upper right corner of the GUI to put the system in Idle mode.

At any point, depressing and releasing the soft power button on the LDI front panel will remove power from all lasers. Alternatively, selecting 'System Reset' from the 'System Info' tab of the 'System Info &

Settings' window will also remove power from all lasers and restart the system, as if the soft power button was toggled, (Figure 22).
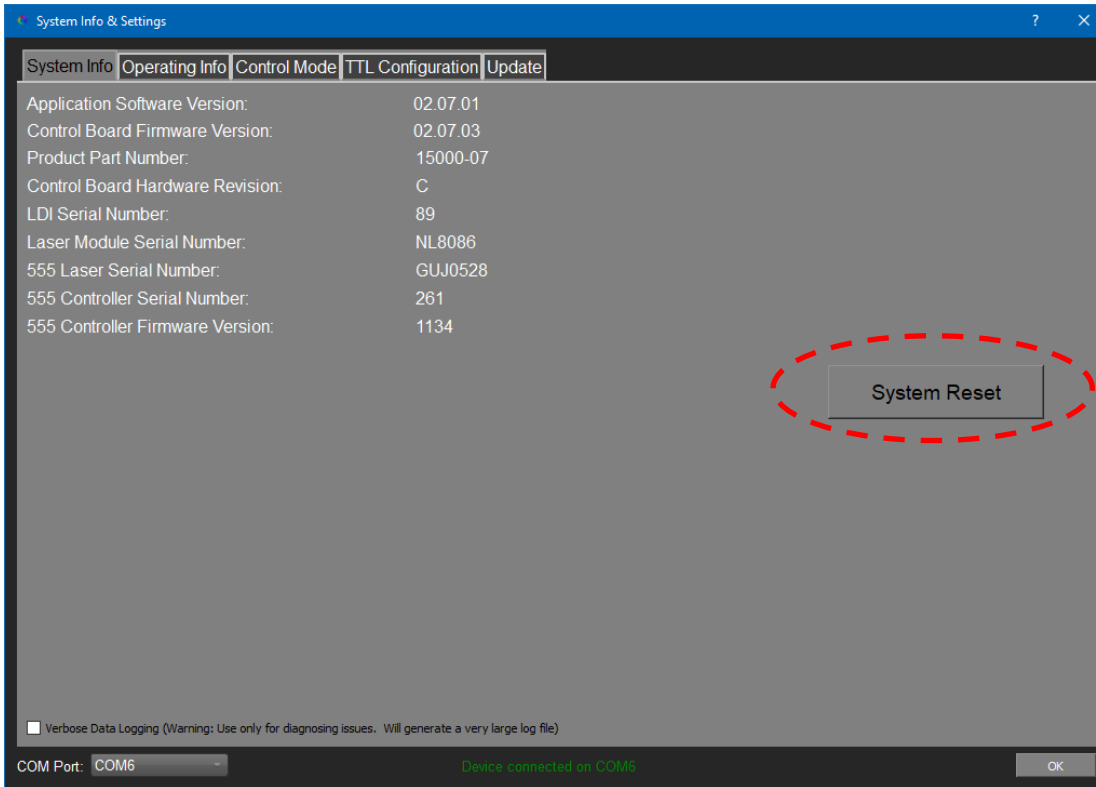

Figure 22: System Reset Button

11.3 System Status Indicators

A multi-color System Status indicator ring LED is located on the front panel soft power switch. The System Status Indicator LED has 3 possible states in normal operation:

- Yellow, solid: Indicates the system is in Warm-Up mode

- Green, solid: Indicates the system is in Idle or Run mode, ready to be operated and produce laser emission

- Red, solid: Indicates the system is has a fault

- Green, Flashing: Immediately shutdown the unit and contact 89 North Technical Service

Other indications are utilized for factory service modes. If the Status Indicator LED displays a color or blink rate other than described above, contact 89 North Technical Service. See section 18, "Troubleshooting".

11.4 Laser Enabled Indicators

As shown in Figure 3, the front panel of the LDI includes two Laser Enabled Indicators. These indicators illuminate blue when laser emission through the corresponding aperture can occur. Both Laser Enabled Indicators will remain extinguished while the system is in Warm Up mode since laser emission is prevented in this mode. Once the system has completed warm up, the Laser Enabled Indicator will illuminate blue for any aperture which can produce laser emission and has an optical fiber or cable installed.

> **WARNING:** Laser Enabled Indicators will illuminate blue whenever the system can produce laser emission. Illumination of either Laser Enabled Indicator signals that laser radiation can be emitted from either aperture.

12 User Interface Files Location

User Interface Files such as the system calibration configuration file, log files, and scenario files, are located in the "C:\Users\<<username>>\Documents\89 North\LDI\" folder. These files are important but not critical to the operation of the LDI unit and are not deleted nor overwritten when the LDI GUI software version is updated.

The CalibrationConfig<<machine specific>>.json is automatically created when a firmware update is performed on an LDI. It contains backup information for that specific LDI.

The log files contain important information about the status of the LDI and is used by technical support for troubleshooting potential issues. The most current log file is "LDI_Log.txt" and is updated each time the GUI is closed. Previous versions of the log file are saved. with a ".1, .2, etc." extension. Log files are only generated when using the LDI.exe GUI.

The "<<filename>>.ini" files are configuration "Scenario" files that are created by the user. See "Saving/Restoring Configuration Settings".

13 Saving/Restoring Configuration Settings

Configuration Scenarios

User defined parameters such as Intensity and Shutter Control as well as System Info & Settings on the Control Mode and TTL Configuration tabs can be saved to a configuration "Scenario" to be recalled for later use. Laser Output (On/Off) cannot be saved in the Scenario file.

After configuring the LDI, select the save icon to the far right of the Scenario field, (Figure 25). This will open a dialog box where the current scenario can be named and saved. Additionally, once the LDI GUI has been opened and closed, the software will automatically create the "Last Saved State" scenario and will update it with the current settings each time the GUI is closed, (Figure 23).
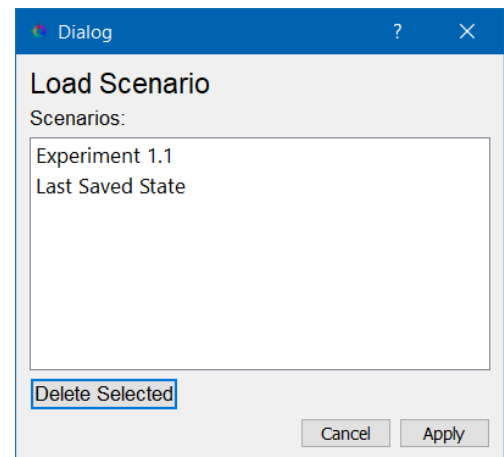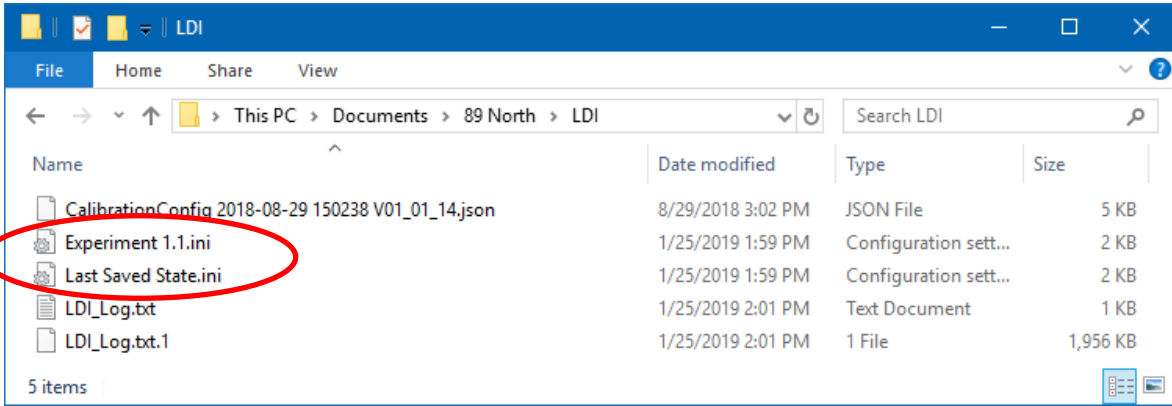

Figure 23: Saved Scenarios

Figure 24: Saved Scenarios Location

Saved scenarios may be transferred from one host computer/LDI to another but the ".ini" file should not be edited outside of the LDI GUI.

To restore or 'Load' a Saved Scenario, select the file open icon to the left of the save icon. This will open a dialog box where the Saved Scenario can be selected and applied. Saved Shutter Control settings may not take effect unless the LDI is powered on. Saved Scenarios can be deleted in the dialog box as well as in the save scenario dialog box. Scenarios cannot be applied while the LDI is in Run Mode.

The currently applied Scenario name is displayed in Scenario field on the GUI. When the GUI is first opened, the "Last Saved State" scenario is applied and the Scenario field will say "Last Saved State". It is recommended to reload your Saved Scenario upon opening the GUI to ensure you have the desired settings, (Figure 25).
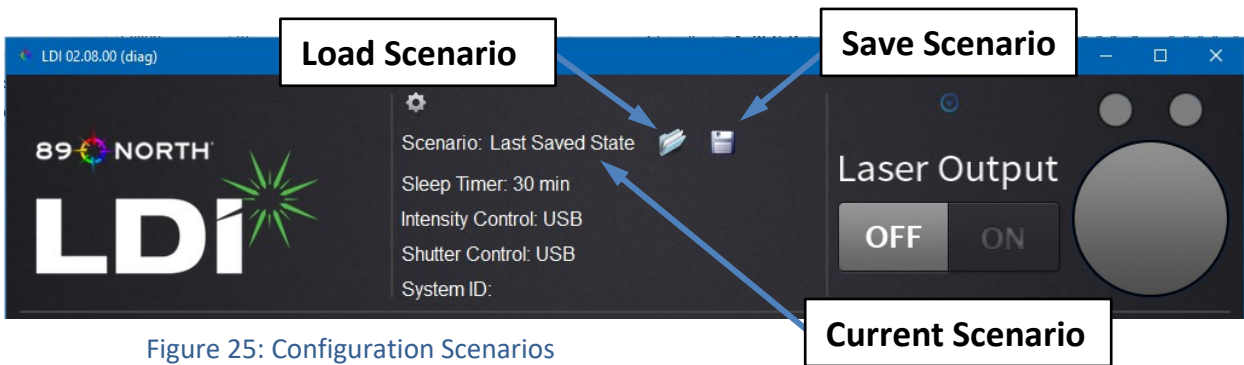

Figure 25: Configuration Scenarios

Restore After Loss of Communication

If the Host USB cable is unplugged from the LDI, or If the LDI GUI is closed, or if there is a loss of communication with the host computer during Run Mode, laser output will remain ON. When the Host USB cable is plugged back in or the GUI restarted and communications are reestablished, the LDI will enter Idle Mode and laser output is turned OFF

When the GUI is launched, the "Last Saved State" settings are restored.

When the LDI unit is powered down, the only settings saved to internal memory are Shutter Control Mode and Intensity Control Mode settings as well as accumulated hours metrics. The other settings will be restored when the unit is powered on or until changed by the GUI or third-party application.

14 Operating LDIs Simultaneously

To run multiple LDIs, connect each LDI unit to the host computer and power them on. This will allow the computer to recognize the LDI and which port it is connected to. To determine which COM port(s) the LDI(s) is connected to, open the "Device Manager" on the host computer. Select "View" and "Show hidden devices". Find the "Ports (COM & LPT)" section and expand it to see the various ports and connected devices. Make note of to which ports the LDI(s) is connected.

Open an instance of the LDI GUI and select the "System Info & Settings" gear icon. In the lower left status bar, uncheck "Auto Select" next to the COM Port field and select the COM Port from the drop-down list that the first LDI Unit is connected to. (Figure 26).
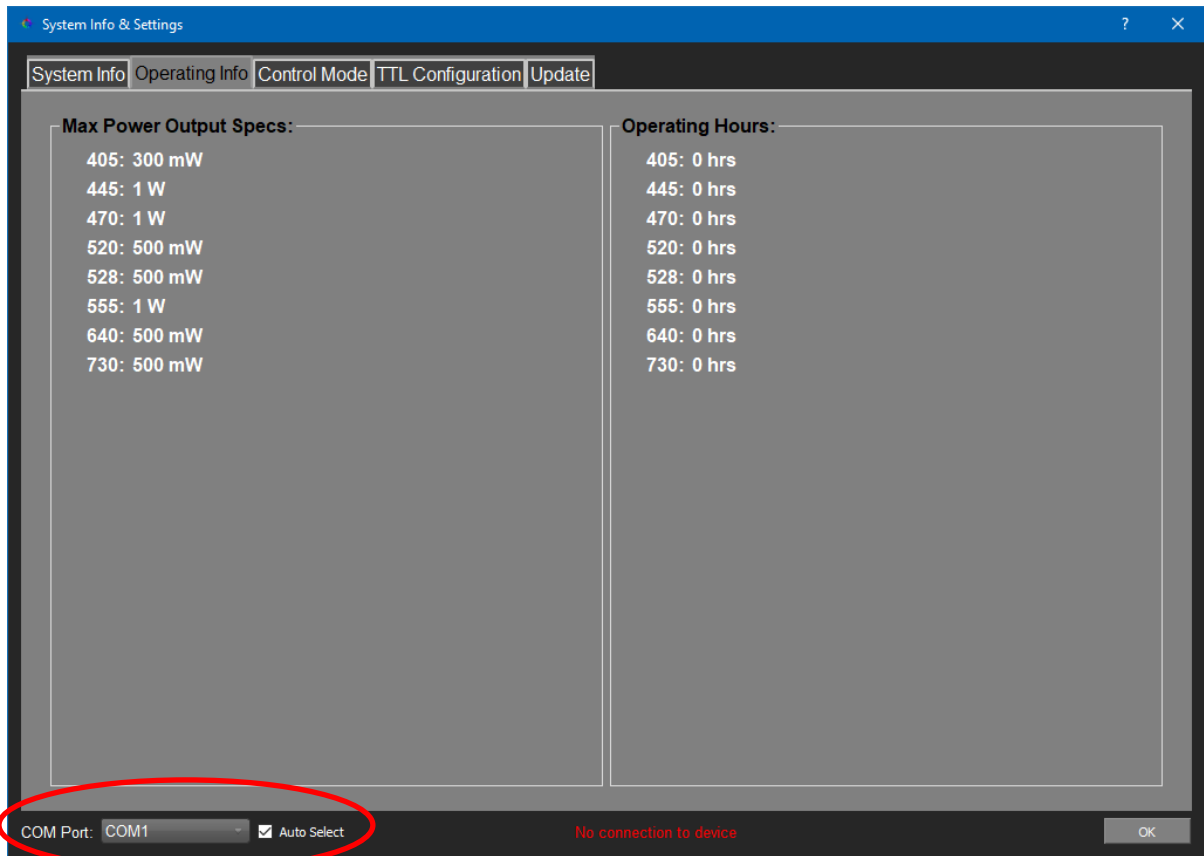

Figure 26: System Info & Settings "Auto Select" Checkbox. (LDI-7 Wavelengths Shown)

Open another instance of the LDI GUI and repeat the above steps, selecting the COM Port that the additional LDI Unit is connect to. Do this for each LDI you wish to control. Now each LDI can be operated independently, with its own GUI on the same host computer.

15 Software/Firmware Update Instructions

Software and Firmware updates are released when important or significant changes and improvements are made to the software. Contact 89 North customer support if you feel an update is required for your LDI unit. When updating the LDI firmware, be sure to update the LDI control software (GUI) first.

Software Update

1. Uninstall any currently installed GUI software versions by going to Control Panel > Programs and Features > select "LDI" and "Uninstall".

2. Locate the software update executable, "LDI Setup.exe", that was provided to you by technical support.

3. Double-click "LDI Setup.exe" to run the setup file and follow the prompts.

4. InstallShield will indicate when the setup is complete.

5. LDI drivers will automatically install after InstallShield completes.

6. "LDI.exe" will be installed in C:\Program Files (x86)\89 North\LDI

Firmware Update

1. Locate the firmware update file provided to you. It will have the extension ".7z".

2. Save the file to a folder on the host computer.

3. Launch the LDI GUI (LDI.exe)

4. If the LDI is not already connected and powered up, connect and turn on the LDI unit.

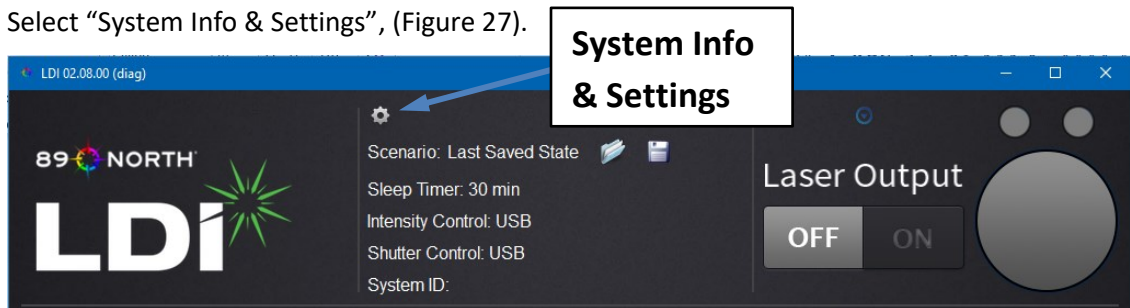5. Select "System Info & Settings", (Figure 27).

Figure 27: System Info & Settings

6. Before beginning the firmware update, note the current version as shown on the "System Info" tab.

7. In the "System Info & Settings" window, select the "Update" tab and select "Update Control Board Firmware", (Figure 28).
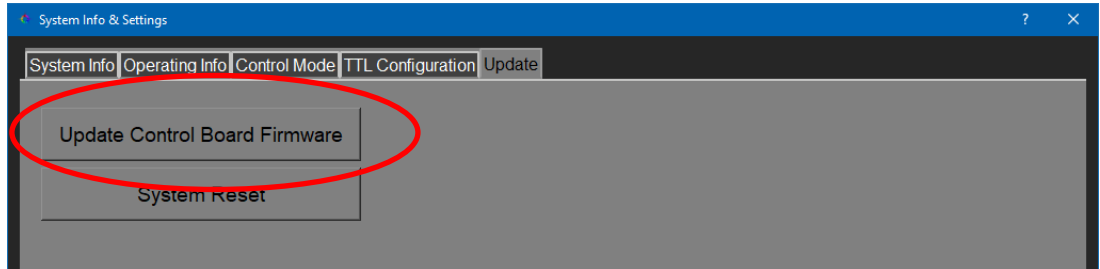
Figure 28: Update Control Board Firmware

8. Navigate to the firmware update file "LDI_VXX_XX_XX.7z" that you saved to the host computer and select the file and click "Open". The firmware update will begin.

9. **DO NOT** turn off or unplug the unit while the firmware update is in progress.

10. The update GUI will notify you when the update is complete and click "OK".

11. The system should automatically restart. If it does not restart, click "System Reset" on the "Update" tab.

12. Click on the "System Info" tab and confirm that the firmware version has been updated.

16 Maintenance

No scheduled user or factory maintenance is required for the LDI.

⚠️ **All maintenance and/or repair is to be performed by qualified personnel only.** Under no circumstances should any cover other than the fiber access cover be removed as electrical, mechanical, and radiation hazards exists.

Keep housing vents dust free.

If the unit should malfunction, please contact 89 North or you authorized 89 North distributor.

17 Warranty

The LDI light engine is under warranty for two years from the date of delivery provided it is operated as described in this manual.

89 North reserves the right to deny replacement of LDI units that appear to have been damaged by improper use.

89 North's liability to the customer is limited to the replacement cost of the LDI unit. Separate warranties cover accessories such as fiber optic cables, liquid light guides, collimators, and other equipment.

18 Troubleshooting

During normal operation, the Status Bar at the bottom of the LDI GUI screen will indicate which operation mode the LDI is in and the Status Indicator will be yellow or green, (see Figure 16). The Status Indicator should reflect the status of the front panel LED. Should a problem or fault occur, the Status Indicator and front panel Status Indicator LED may change color, and/or the status bar may display an error message.

Clearing a Fault

Some faults will clear automatically when the fault condition is removed. Others require clearing manually. Faults can be cleared manually (if the fault has been removed) by clicking the GUI status indicator (see Figure 16) and/or cycling the master key on-off-on. **Attempt to remove the fault condition and clear the fault before cycling the power (unplug-plugin) in all cases.**

Below is a list of more common fault messages. Should the recommended actions not correct the problem, please contact 89 North Technical Support.

Fault or Error Message	Error Code	Source of Fault or Error	Corrective Action
Status Indicator LED is solid RED		The system is in fault	Check the status bar for fault information. Note the status message displayed. Cycle the system power.
SYSTEM_FAULT_UNKNOWN		Unknown fault	Please contact a technical representative if this error persists.
SYSTEM_FAULT_COVER_REMOVED		Interlock - Cover Removed	Please contact a technical representative if this error persists.
SYSTEM_FAULT_INTERLOCK_USER_OPEN		Interlock - Remote Open	Verify that the eyepiece interlock on the back of the LDI is properly installed and in the proper state.
WARNING:_FIBER_INTERLOCK_1_OPEN		Interlock - LASER_MODULE Fiber Open	Verify that the interlock switch in the MULTICOLOR MODULE fiber routing slot on the front of the LDI is completely

			depressed and the "Laser Ready" light is blue.
WARNING:_FIBER_INTERLOCK_2_OPEN		Interlock - SHG Fiber Open	Verify that the interlock switch in the SHG fiber routing slot on the front of the LDI is completely depressed and the "Laser Ready" light is blue.
SYSTEM_FAULT_OVER_CURRENT		Over current	Please contact a technical representative if this error persists.
SYSTEM_FAULT_SHG_LASER_OVER_TEMP		SHG_LASER Over Temp	Close all shutters and let the system cool down. If the error persists, verify that the unit is operating within the specified ambient temperature range and nothing is blocking the air inlet or exhaust.
SYSTEM_FAULT_SHG_LASER_UNDER_TEMP		SHG_LASER Under Temp	Verify that the unit is operating within the specified ambient temperature range. Please contact a technical representative if this error persists.
SYSTEM_FAULT_ LASER_MODULE_OVER_TEMP		LASER_MODULE Over Temp	Close all shutters and let the system cool down. If the error persists, verify that the unit is operating within the specified ambient temperature range and nothing is blocking the air inlet or exhaust.
SYSTEM_FAULT_LASER_MODULE_UNDER_TEMP		LASER_MODULE Under Temp	Verify that the unit is operating within the specified ambient temperature range. Please contact a technical representative if this error persists.
SYSTEM_FAULT_COM_ERROR		Communications Error	Check USB cable connection to the host PC. Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.

SYSTEM_FAULT_SYSTEM_ERROR		System Error	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
SYSTEM_FAULT_CHANNEL_ERROR		Channel Error	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
SYSTEM_FAULT_LASER_MODULE_HAL_ERROR		LASER_MODULE HAL Error	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
SYSTEM_FAULT_SYSCOM_HAL_ERROR		Interlock HAL Error	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
SYSTEM_FAULT_INTERLOCK_CVR_REED_OPEN		The Fiber Access Cover is open	Verify that the fiber access cover is completely closed, and nothing is in-between the cover and the LDI.
SYSTEM_FAULT_OVER_FREQUENCY		Over-Frequency	Decrease the frequency at which the laser is being pulsed.
SYSTEM_FAULT_I2C_TIMEOUT		I2C Timeout	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
T_COM_HAL_COM_ERR	-20035	HAL/low level communications failure	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
FIRMWARE_SYSTEM_IN_WARMUP	-20100	Attempted to go to RUN mode when system still in WARMUP	Wait for the system to exit WARM-UP mode and transition to RUN mode.

FIRMWARE_MAX_SHUTTERS_OPEN	-20103	Attempted to open a shutter when maximum number already open	Only 4 shutters can be open at one time. If this fault persists while less than four shutters are open, unplug the unit and wait 10 seconds before reapplying power to the system.
FIRMWARE_SHG_LASER_CONTROLLER_TEMP_SERVO	-20259	SHG_LASER Controller temperature servo error	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
FIRMWARE_SHG_LASER_CONTROLLER_LASER_UNDER_TEMP	-20262	SHG_LASER Controller laser under temp error	Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
FIRMWARE_SHG_LASER_CONTROLLER_LASER_OVER_TEMP	-20263	SHG_LASER Controller laser over temp error	Close all shutter and let the system cool down. If the error persists, verify that the unit is operating within the specified ambient temperature range and nothing is blocking the air inlet or exhaust.
FIRMWARE_SHG_LASER_CONTROLLER_CURRENT_AT_RAIL	-20265	SHG_LASER Controller current at rail error	Please contact a technical representative if this error persists.
PC_APP_WRITE_COMMAND_ERR	-40006	LDI UI - communication error with LDI	Make sure the LDI is powered on. Check USB cable connection to the host PC and the LDI. Disconnect the LDI from the PC, wait 10 seconds and reconnect the LDI to the PC. Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.
PC_APP_WRITE_TIMEOUT_ERR	-40007	LDI UI - communication timeout with LDI Usually during a firmware update	If you were trying to update your unit's firmware, try updating the firmware again. If the error persists, place the unit in boot loader mode by holding down the

			soft power button until it starts blinking blue, then try updating the firmware again. If the error persists, please contact a technical representative.
PC_APP_WRITE_FLASH_ERR	-40008	LDI UI - error updating firmware	If you were trying to update your unit's firmware, Try updating the firmware again. If the error persists, place the unit in boot loader mode by holding down the soft power button until it starts blinking blue, then try updating the firmware again. If the error persists, please contact a technical representative.
PC_APP_INVALID_RESPONSE	-40009	LDI UI - received invalid response from LDI	Check USB cable connection to the host PC. Unplug the unit and wait 10 seconds before reapplying power to the system. If the error persists, please contact a technical representative.