ULN15TK
Ultra-Low-Noise Laser System

User Guide

Table of Contents

Chapter 1 Safety

Explosion Warning
This instrument must not be operated in an explosion endangered environment.

Laser Warning
Avoid Exposure – Radiation Emitted from apertures. Do not look into the laser aperture while the laser is on. Injury to the eye may result. Laser should not be turned on unless there is an optical fiber connected to the laser output port. Caution – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Caution
This instrument should be kept clear of environments where liquid spills or condensing moisture are likely. It is not water resistant. To avoid damage to the instrument, do not expose it to spray, liquids, or solvents.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, 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 antenna.—Increase the separation between the equipment and receiver.—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.—Consult the dealer or an experienced radio/TV technician for help.

Chapter 2 Description

Thorlabs' ULN15TK is a turnkey, ultra-low-noise (ULN) laser system. The device integrates Thorlabs' ULN15PC component in an extended butterfly package with a low-noise driver and temperature stabilization system inside a benchtop housing. The driver electronics are designed to minimize the current noise such that the specified narrow linewidth of the ULN15PC laser can be achieved. The drive electronics also includes two temperature stabilization circuits for the laser chip as well as the Fiber Bragg Grating (FBG). Additionally, the temperature of the laser case is stabilized through a third temperature stabilization circuit to provide long-term power and wavelength stability when the system is used in standard laboratory environments. A fiber isolator is integrated at the output of the laser in order to minimize the impact of any back-reflected light on the laser. The system is powered using Thorlabs' DS12 power supply (12 V, 4 A).

The single-frequency operation of the laser as well as its linewidth and noise properties are a function of the operating conditions (driver current and FBG temperature). Please see the ULN15PC product presentation and manual for additional details. The ULN15TK turnkey ULN laser system is pre-set to the optimal operating conditions that minimize the laser linewidth, while providing the highest output power and long-term stability. The laser is shipped with test data taken at those pre-set operating conditions. An enable push button switch can enable the laser at a pre-set current level. In applications where modifying the laser operating conditions might be desired, the laser operating set-points can be adjusted using a command-line interface via USB connection to the back panel of the instrument. The remote operation via the USB connection also allows turning the laser on and off, as well as reading the status indicators of the device.

The laser system includes three analog modulation inputs (SMA connectors on the front panel). Two modulation ports are included for changing the laser current by +/- 10 mA. One of these ports is AC-coupled and can provide a higher modulation frequency, and the other port is a DC-coupled port with lower modulation frequency. A third modulation port enables changing the FBG and the chip temperature using an analog voltage. This feature is turned off by default but can be switched on using a command sent through the USB interface. Please refer to Section 3.3 of this manual for additional details.

2.1 Shipping List

The ULN15TK laser system consists of the following components:

- Ultra-Low-Noise Laser System
- DS12 Power Supply (12 V, 4 A)
- USB-AB-72 USB 2.0 Type-A to Mini-B Cable, 72" (1.83 m) Long
- FBC250 Connector and Bulkhead Cleaner

Chapter 3 Setup

Caution

Prior to using the ULN systems, it is highly recommended to clean the output bulkhead as well as the connector facets to be connected to the bulkhead. Failure to clean the connectors can result in damage to the internal connector.

When cleaning the connectors, ensure that the laser is powered off by turning off the push-button switch. Never inspect optical connectors unless all light sources in your setup have been switched off.

3.1 Front and Back Panel Overview

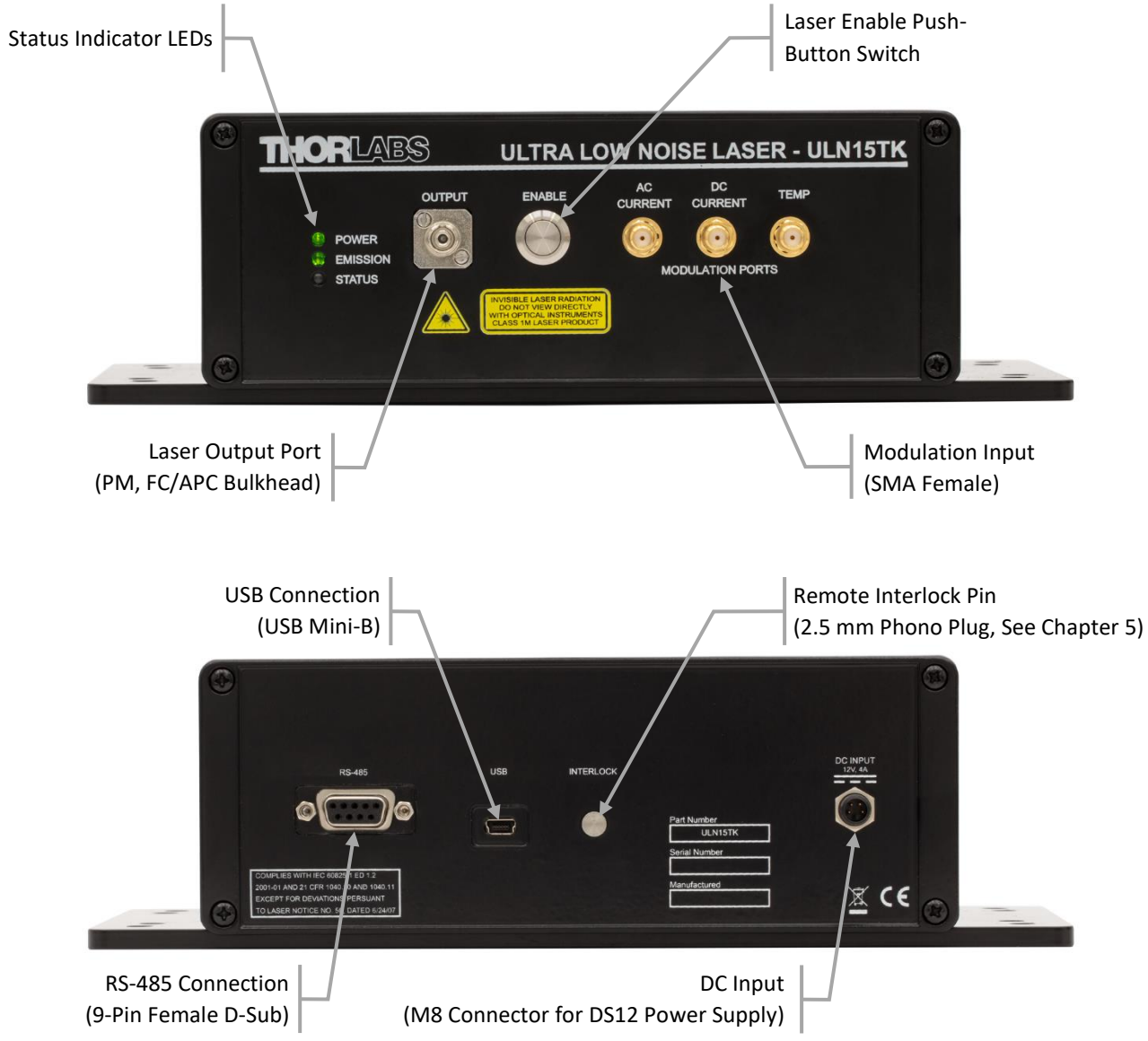


Figure 1 Front and Rear Panels of the ULN15TK Laser System

3.2 Operating the Laser

1. Please consult with your organization's laser safety officer regarding proper operation of the laser at your institution.
2. It is highly recommended to secure the laser to an optical table or metal breadboard. This improves heat dissipation from the laser housing and its long-term thermal stability. The laser housing includes two sets of mounting holes (4x) designed for Imperial and Metric breadboards.
3. Ensure the interlock pin is fully installed[a,b].
4. Connect the DC power supply (DS12) via the M8 connector on the back panel of the system. The Power indicator on the front panel should be illuminated.
5. With power supplied, the ULN15TK system will immediately begin stabilizing the laser case temperature. During laser case temperature stabilization, the Status indicator will blink. The system may require 1 - 2 minutes for basic thermal stability, during which time the laser cannot be turned on. When the laser case temperature is stabilized, the Status indicator will turn off.
6. Connect any applicable modulation signals to the appropriate SMA modulation ports.
7. Remove the output fiber connector bulkhead cap and connect to the desired instrument using an PM1550-XP FC/APC fiber patch cable.
8. The Laser is ready to be turned on and can be turned on by toggling the Enable push-button[c]. The Emission indicator will blink for 5 seconds then remain solid at which point the laser emission is on. The laser emission is not on during the blinking stage of the Emission indicator. Please note that the laser requires a 10 minute warm-up time after it has been enabled in order to reach its specified linewidth.
9. Laser emission can be turned off with another toggle of the Enable push-button.
10. At any time, if the ULN15TK system detects a fault, the status indicator will light up solid and the laser will be shut off.
11. To change the laser operating conditions, connect to the USB mini-B connector to configure settings for the system. A list of commands and parameters are listed in Chapter 4 Software Communications.

3.3 External Modulation Ports

There are three modulation ports located on the front panel of the ULN15TK. Two ports are allocated for modulating the current of the laser around the current set-point. The AC current modulation port is AC-coupled and supports modulation frequencies from 2 kHz to 20 MHz. The DC current modulation port is DC-coupled and supports frequencies from 0 Hz to 5 MHz. For both current modulation ports, an input voltage (-5 V to +5 V) modulates the current at a rate of 2 mA/V around the current set-point. A third modulation port is included for modulating the temperature of the laser around its set-point. Either the chip or the FBG temperature can be controlled through the analog voltage input applied to this port (-5 V to +5 V). This port has a bandwidth of 1 Hz and is designed for slow modulation of the laser temperature for applications that require locking the laser frequency. The temperature modulation port is disabled by default and can be enabled to control either the chip or the FBG temperature through a command sent via the USB or RS-485 connection on the back panel of the laser. The rate of temperature change versus voltage can also be set through a command. Please see Chapter 5 for

[a] *An improperly installed interlock pin will not allow the laser to turn on, but will not be indicated as an error by the Error indicator.*

[b] *If the ULN system is powered on without the interlock pin, it must be power-cycled (unplugged from DC power supply and reconnected) before the laser can be turned on.*

[c] *For safety, a firm, deliberate button press is required.*

details on the commands for setting up the temperature modulation input. All modulation ports have an input impedance of approximately 1 kOhm.

Chapter 4 Software Communications

Each device is equipped with an USB mini-B style connector for USB communication with a host device. The device will enumerate as a Virtual COM port on the host device. For Windows PCs running Windows 10 or later, no special driver is required. For Windows PCs prior to Windows 10, the driver included as part of the firmware update utility is required.

All communication queries must be terminated by a single carriage return character (\r) or a combined carriage return and newline (\r\n). Communications originating from the device will be terminated by one or more combined carriage return, newline pairs (\r\n). A connected host should not attempt to send additional queries until a response has been received from the device. Most queries will result in a response within 10ms. Queries requesting the saving of configuration parameters will result in longer response times.

The commands sent from the USB interface enable the following functions:

- Turning the laser on or off
- Reading status of the laser, and values of the laser temperature set-points
- Adjusting the temperature set-points for the chip and the FBG
- Adjusting the drive current of the laser
- Setting the external temperature modulation port function. The default for this port is to be disabled, but it can be changed to adjust either the chip or the FBG temperature based on the analog voltage applied to this port.

In addition to the USB port, a RS-485 port has also been included on the back panel of the system. This port, a 9-pin D-Sub, can be used with the same command set outlined in this chapter through the RS-485 communication protocol. Please refer to the last sub-section in this chapter to see the pin-out of the D-Sub connector.

4.1 Command/Response Structure

All commands are text based with the basic format as follows:

command [param1 [param2..[paramN]]]

Proper syntax will be specified for each command in the following subsections. Each command will be followed by a corresponding response with the following format:

Response_code:Response_Text[command_response]

Note that all commands and parameters are lower-case letters.

4.2 List of Commands

See corresponding subsections for details.

Command	Descriptions
laser ***[state]***	Set the user requested state of the laser.
write_param ***[tag] [value]***	Write a parameter to the device
read_param ***[tag]***	Read a parameter from the device
save_param ***[tag]***	Immediately write a parameter to EEPROM.
read_string ***[name]***	Read a string value from the device
savecfg	Save all parameters on the main and optics boards to non-volatile memory.
get_clock	Gets the currently set time and date.
update	Places the system into a mode where it can accept firmware updates from the PC.
reset	Reset the system. Note that this will drop the USB connection.
firmware_version	Read the current firmware version number.

4.2.1 List of States

Corresponding to the 'laser' command

Command	Descriptions
on	Set the requested state to on. When system failures are cleared and interlock indicates OK, the laser till turn on. When system errors occur or when interlock is lost, the laser is tuned off.
off	Laser is turned off.

4.2.2 List of Tags

Corresponding to the 'write_param,' 'read_param,' and 'save_param' commands

Name	Type	Default Value	Access	Descriptions
Laser Configuration				
laser_state	Int.	N/A	R	60 = Laser on 61 = Laser off (Normal) 62 = Laser off because of interlock 63 = Laser off because of one of the following faults: • Laser TEC in error mode • FBG TEC in error mode • AUX TEC timeout 64 = Laser state is unknown 65 = Laser is starting (flashing LED)
laser.current	Float	0	R/W	Nominal open-loop laser current (A)
laser.case.temperature	Float	N/A	R	Laser case temperature reading in Celsius.
Laser TEC Control System				
laser_tec_ctrl.temperature	Float	N/A	R	Laser temperature reading in Celsius.
laser_tec_ctrl.setpoint	Float	25	R/W	Set point for the laser TEC control system. (deg C)
FBG TEC Control System				
fbg_tec_ctrl.temperature	Float	N/A	R	FBG temperature reading in Celsius.
fbg_tec_ctrl.setpoint	Float	25	R/W	Set point for the FBG TEC control system. (deg C)
External TEC Setpoint Adjustment				
tec_adj.select	Int	120	R/W	The selected TEC control on which tec_adj acts: 120: None 121: Laser TEC 122: FBG TEC
tec_adj.range	Float	1	R/W	The full-scale range of the TEC setpoint adjustment +/- (deg C)
tec_adj	Float	N/A	R	The active tec setpoint adjustment applied to the selected TEC (deg C)

4.2.3 List of Names

Corresponding to the 'read_string' command

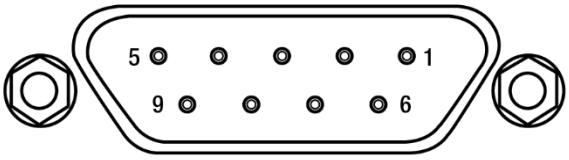
Name	Descriptions
oem	OEM string
module_sn	Module serial number
main_board_sn	Main board serial number
laser_sn	Laser serial number

4.3 List of Responses

Value	Descriptions
000: OK	Command executed successfully
100: Unknown command	Executed command is unknown
101: Syntax error	Incorrect number of parameters or the formatting of the parameters is incorrect.
102: Invalid parameter	One of the specified parameters is out of range of allowable values.
103: Unknown Tag	A command that takes a tag as a parameter was given a string that it could not find in the system.
104: Not Writeable	An attempt was made to write a tag value that cannot be modified either because it is read only or the user does not have the appropriate permission.
105: Unknown Response	This is an internal failure of the device. This should generally only be returned if there is a software defect.
106: Device Error	An error was encountered in the hardware while attempting to execute the command. NOTE: When this failure happens, the unit may be in an undefined state. For example, tag values that are written by a command may not reflect actual hardware settings when the tag is read.
111: Response Too Large	Occurs when a command has a variable length response, and that response is too large to be sent back to the host.

4.4 RS-485 Connector Pin Information

The ULN can be interfaced via RS485 half-duplex (2-wire) according to the below pinout table. Pins 8 and 9 are for factory configuration use only. Do not connect to pins 8 and 9. Pins 3, 4, and 6 have no internal connections and should not be used.



D8-9/RS485 Pin Assignment	
Pin	**Output Signal**
1	RS-485 half-duplex T/R+
2	RS-485 half-duplex T/R-
3	NC
4	NC
5	GND
6	NC
7	GND
8	DO NOT CONNECT
9	DO NOT CONNECT

Chapter 5 Making Safety Interlock Connections

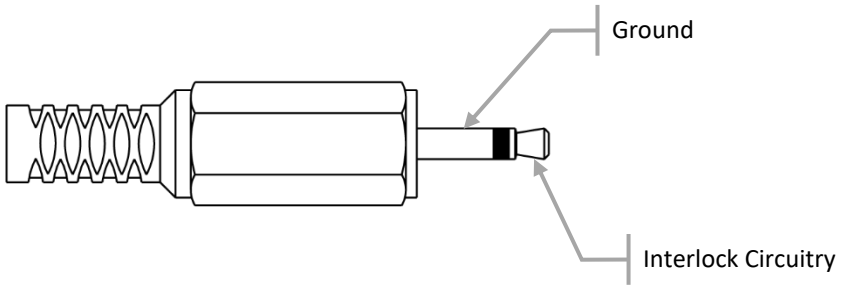
The ULN15TK is equipped with a remote interlock connector located on the rear panel. In order to enable the laser, a short circuit must be applied across the terminals of the Remote Interlock connector. This connection is made available to allow the user to connect a remotely actuated switch to the connector (i.e. an open door indicator).

The switch that is connected to this interlock must be normally open (N.O.), meaning that it has to be closed in order for the unit to be enabled. If the switch is changed to an open state, the amplifier will automatically shut down.

All units shipped from Thorlabs are configured with a shorting device installed in the interlock connector. If you are not going to use this feature then you can leave the shorting device installed and the unit will operate normally, as described throughout this manual. If you wish to make use of the interlock feature you will need to acquire the appropriate mating connector (e.g., a 2.5 mm mono jack, available at most electronics stores) and wire it your remote interlock switch.

The electrical specifications for the interlock input are shown in the following table.

Specification	Value
Mating Connector	2.5 mm Mono Phono Jack
Open Circuit Voltage	Internal Pull Up to 5 VDC
Short Circuit Requirements	1.0 mA DC
Interlock Switch Requirements	Must be N.O. Dry Contacts Under No Circumstances Should Any External Voltages be Applied to the Interlock Input



Chapter 6 General Maintenance

Always clean fiber optic connectors that will be inserted into the system and install the dust cap whenever the source is not being used. Allowing dust and dirt onto the fiber end faces will degrade coupling efficiency and possibly damage the fiber patch cables, both inside and outside.

6.1 Connector Cleaning

Always clean the ferrule end of your fiber patch cables as well as the input and output FC bulkheads prior to inserting the fiber patch cables into the FC bulkhead. Thorlabs offers the FCC-7020 Fiber Cleaning Cloth Spool, which can be used for cleaning the ferrule ends of the patch cables.

Additionally, each unit is shipped with an FBC250 Bulkhead and Connector Cleaner for cleaning the output bulkhead.

Figure 2 FBC250 Bulkhead and Connector Cleaner

To use the FBC250 Bulkhead and Connector Cleaner, please refer to the instructions shipped with the FBC250.

Chapter 7 Specifications

Item #	ULN15TK
Laser Specifications (Taken at Factory Preset Operating Conditions)	
Center Wavelength	1550 nm ± 15 nm
Output Power[a]	>90 mW (Typ. 120 mW)
Linewidth[b]	<250 Hz (Typ. 100 Hz)
Relative Intensity Noise (RIN)[c]	-160 dBc/Hz
Side-Mode Suppression Ratio (SMSR)	>60 dB (Typ. 70 dB)
Polarization Extinction Ratio (PER)	>18 dB
Output Isolation	>25 dB
Laser Class	1M
Fiber Specifications	
Output Fiber Type[d]	Corning® PM15-U25D
Output Fiber Connectors	FC/APC Compatible, 2.0 Narrow Key
External Modulation Specifications	
Voltage to Current Conversion Rate (AC and DC)	2 mA/V
Voltage to Temperature Conversion Rate	Firmware Adjustable (Default = 0.2 °C/V)
Input Voltage Range (All Ports)	-5 V to 5 V
Input Impedance (All Ports)	1 kOhm
AC Current Modulation Frequency Range[e]	2 kHz to 20 MHz
DC Current Modulation Frequency Range[e]	DC to 5 MHz
Temperature Modulation Frequency Range	DC to 1 Hz

a. Measured at the bulkhead.
b. Measured based on the Lorentzian definition. Please refer to the ULN15PC laser manual for details.
c. Represents the typical value at 10 MHz frequency.
d. Compatible for mating with Thorlabs' PM1550-XP cables.
e. Specified bandwidth refers to the 3 dB electrical bandwidth of the modulation circuits. Laser response has a slow roll-off for frequencies above 1 MHz.

Absolute Maximum Ratings	
Absolute Maximum Output Power	145 mW
Operating Temperature	15 to 30 °C
Storage Temperature	-10 to 40 °C

General Specifications	
Input Voltage	12 V (from DS12 Power Supply)
Input Power	20 W (Max)
Dimensions (W x D x H)	10.00" x 5.31" x 2.93" (254.0 mm x 135.0 mm x 74.4 mm)
Weight	4.7 lbs (2.1 kg)

Chapter 8 Mechanical Drawings

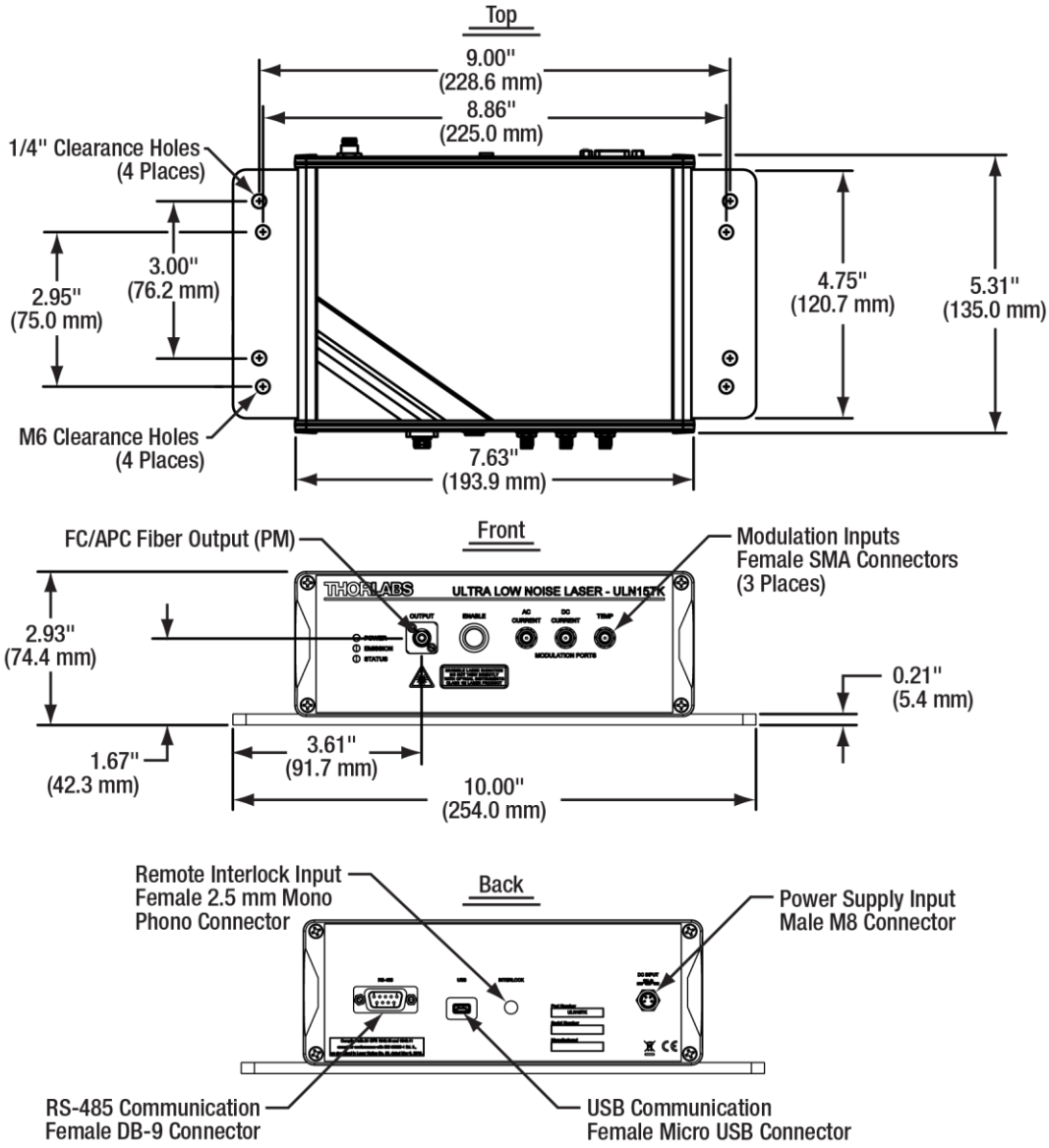


Figure 3 ULN15TK Laser System Mechanical Drawing

Chapter 9 Certifications and Compliance

in accordance with EN ISO 17050-1:2010

We: Thorlabs Inc.

Of: 56 Sparta Avenue, Newton, New Jersey, 07860, USA

in accordance with the following Directive(s):

2014/35/EU	Low Voltage Directive (LVD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: ***ULN15TK***

Equipment:

Ultra Noise Noise Laser System

is/are in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Labor...	2010 + A1:2019 + ...
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN 60825-1	Safety of Laser Products	2014 3rd ...

and which, issued under the sole responsibility of Thorlabs, is/are in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

contains no substances in excess of the maximum concentration values tolerated by weight in homogenous ...

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed: *On:* 28 July 2022

Name: Danielle Strong

Position: Director of Quality and Complia...

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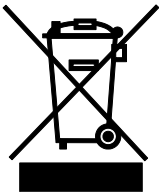
Chapter 10 Warranty and RMA Information



Annex I

Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return "end of life" Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out "wheelie bin" logo (see right), were sold to and are currently owned by a company or institute within the EC and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. "End of life" units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site. It is the user's responsibility to delete all private data stored on the device prior to disposal.

10.1 Return of Devices

This precision device is only serviceable if returned and properly packed into the complete original packaging including the complete shipment plus the cardboard insert that holds the enclosed devices. If necessary, ask for replacement packaging. Refer servicing to qualified personnel.

Chapter 11 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at **www.thorlabs.com/contact** for our most up-to-date contact information.

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