

TruFocus LIO Premiere®
Laser Indirect Ophthalmoscope
Operator Manual



TruFocus LIO Premiere Operator Manual
87305 EN Rev F 2020 2

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1

Introduction

The IRIDEX TruFocus LIO Premiere® Laser Indirect Ophthalmoscope when connected to an IRIDEX laser, adds the therapeutic capability of transpupillary retinal photocoagulation to the wide angle diagnostic capabilities of a binocular indirect ophthalmoscope. It enables delivery of laser energy to the far periphery of the retina and to treat supine patients. Integrated eye safety filters protect user's eyes while providing a clear view of the target area. Fully enclosed optics prevent misalignment and contamination.

The TruFocus LIO Premiere is sold to medical doctors and intended to be used by trained medical professionals.

Indications for Use

The TruFocus LIO Premiere is indicated for transpupillary retinal photocoagulation.

Contraindications

The TruFocus LIO Premiere is indicated for transpupillary retinal photocoagulation.

Factors Affecting Spot Size

- The refractive index of media in the eye.
- Working distance. The smallest spot is obtained when the laser spot is at its focus point on the image plane.
- Refractive status of the eye. The laser spot size on the retina is smaller in a myopic eye and larger in a hyperopic eye.

$A \times (B/C)$ = spot size on the retina where:

- A = aerial spot size
- B = diopter power of handheld aspheric lens
- C = power of eye

Using this formula*:

- Emmetropic eye (60D): $1100 \mu\text{m} \times (20\text{D}/60\text{D}) = 360 \mu\text{m}$ spot size on retina
- Myopic eye (70D): $1100 \mu\text{m} \times (20\text{D}/70\text{D}) = 315 \mu\text{m}$ spot size on retina
- Hyperopic eye (50D): $1100 \mu\text{m} \times (20\text{D}/50\text{D}) = 440 \mu\text{m}$ spot size on retina

*Example only, power may vary by patient.

Positioning the 20D aspheric lens 55 mm from an emmetropic eye should produce a magnified aerial image of the fundus.

Warnings and Cautions



WARNINGS:

Lasers generate a highly concentrated beam of light that may cause injury if improperly used. To protect the patient and the operating personnel, the entire laser and the appropriate delivery system operator manuals should be carefully read and comprehended before operation.

Never look directly into the aiming or treatment beam apertures or the fiber-optic cables that deliver the laser beams, with or without laser safety eyewear.

Never look directly into the laser light source or at laser light scattered from bright reflective surfaces. Avoid directing the treatment beam at highly reflective surfaces such as metal instruments.

Carefully select your treatment room and location. Treatment locations should be free of uncovered windows and reflective surfaces that could inadvertently reflect the treatment beam.

Ensure that all personnel in the treatment room are wearing the appropriate laser safety eyewear. Never substitute prescription eyewear for laser safety eyewear.

Always inspect the fiber-optic cable before connecting it to the laser to ensure that it has not been damaged. A damaged fiber-optic cable could cause accidental laser exposure or injury to yourself, your patient, or others in the treatment room.

Always verify that the delivery device is properly connected to the laser. An improper connection may result in an inadvertent secondary laser beam. Severe eye or tissue damage could occur.

Do not use the delivery device with any laser system other than a compatible IRIDEX laser. Such use may void product warranties and threaten the safety of the patient, yourself, and others in the treatment room.



CAUTIONS:

US federal law restricts this device to sale by or on the order of a healthcare practitioner licensed by the law of the State in which he/she practices to use or order the use of the device.

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

Do not operate the equipment in the presence of flammables or explosives, such as volatile anesthetics, alcohol, and surgical preparation solutions.

Turn off the laser before inspecting any delivery device components.

Always handle the fiber-optic cables with extreme care. Do not kink, bend or coil the cable into a diameter less than 15 cm (6 in).

Do not use the cable retainers on the headset for fiber-optic cables.

Keep the protective cap over the fiber-optic connector when the delivery device is not in use.

Do not touch the bulb. Remove any fingerprints from the bulb with a cotton-tipped swab moistened with methanol.

IRIDEX Corporation Contact Information



IRIDEX Corporation
1212 Terra Bella Avenue
Mountain View, California 94043-1824 USA

Telephone: (650) 940-4700
(800) 388-4747 (US only)
Fax: (650) 962-0486
Technical Support: (650) 962-8100
techsupport@iridex.com



Emergo Europe
Prinsessegracht 20
2514 AP The Hague
The Netherlands



Warranty and Service. This device carries a standard factory warranty. This warranty is void if service is attempted by anyone other than certified IRIDEX service personnel.

NOTE: This Warranty and Service statement is subject to the Disclaimer of Warranties, Limitation of Remedy, and Limitation of Liability contained in IRIDEX's Terms and Conditions.

Should you require assistance, please contact your local IRIDEX Technical Support representative or our corporate headquarters.



WEEE Guidance.

Dispose of equipment and accessories in compliance with local and regional regulations.
Contact IRIDEX or your distributor for disposal information.



2 Operation

Special Considerations

The TruFocus Premiere Laser Indirect Ophthalmoscope (LIO) is a modified Heine 500 Binocular Indirect Ophthalmoscope (BIO) with the addition of laser delivery optics. In this system there are two mirrors positioned off-axis with respect to the viewing optics (see **Figure 1** below).

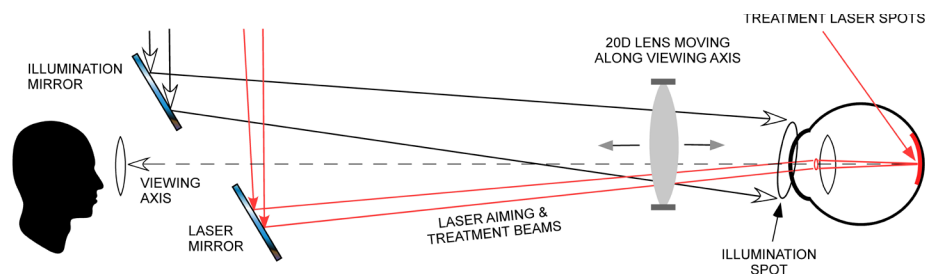


Figure 1. TruFocus LIO Premiere Optics

The illumination mirror is positioned above the viewing plane while the aiming beam and laser treatment beam mirror is positioned below the viewing axis. Unlike single mirror LIO optical systems where the illumination beam and aiming/treatment beams are coaxial, parfocal and are positioned together with a single vertical adjustment and manipulated as a single element, the TruFocus LIO Premiere has two independent mirror controls (see **Figure 2** below), one for illumination the other for the aiming and treatment laser beams.

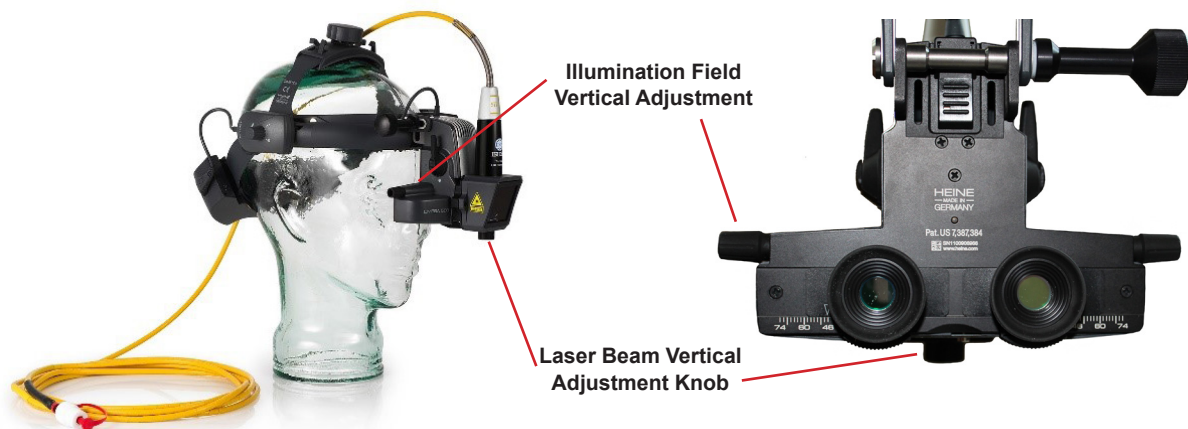


Figure 2. Adjustment Controls

The illumination field and aiming/treatment laser beams move independently and will tend to separate. To make them coaxial, adjust the vertical adjustment knob as desired. Concurrently, place the condenser lens and physician's head distance from the patient to obtain the smallest spot size and focus point on the image plane for the optimum working distance.

NOTE: Reflections of the red aiming beam by various interfaces in the optical path are normal. However, it is good practice to minimize condenser lens tilt in order to minimize aiming beam reflections from the various optical surfaces by maintaining the condenser lens parallel to the pupil plane, making sure all optical surface are clean and free of finger marks and assuring the most convex surface of the condenser lens is facing the clinician.

Unpacking the LIO

Take care not to kink or tightly coil the fiberoptic cable to prevent fiberoptic damage.

Packing the LIO

Refer to the IRIDEX Carrying Case Packing Instructions included in the shipment box for instructions on correct packing of the LIO for storage and ground transportation. Contact IRIDEX for information before transporting the LIO battery by air.

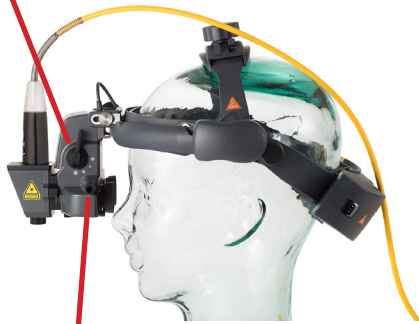
About the Components

Verify that you have received all of the components in the TruFocus LIO Premiere package, and check the components carefully before use to ensure that no damage occurred during transit. Along with this manual, you should have the TruFocus LIO Premiere, zero-diopter lenses, and either a wall-mounted charging cradle and battery or a plug-in transformer and battery. If there is a problem, contact your local IRIDEX Technical Support representative.



Appearance and type of components may vary based on the delivery device ordered.

Illuminated field size
adjustment with lock



Illumination Field
Vertical Adjustment



Headband size
adjustment knob

Battery



Cover for LED or
halogen bulb

One pair of zero-diopter lenses is included with the TruFocus LIO Premiere. If desired, you may replace these lenses with the two-diopter lenses that are factory-mounted in the binocular eye pieces. Unscrew the eye cups to access the lenses.

Installing the Rechargeable Battery on the Headband

For information on installing the rechargeable headband-mounted battery, see Heine instructions provided with the unit.

NOTE: *Ensure battery is fully charged prior to operation.*

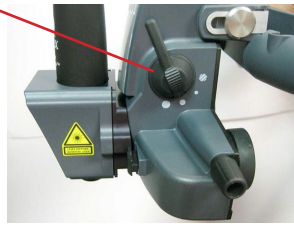
Setting Up and Operating the Headband-Mounted Rechargeable Battery and Wall-Mounted Cradle

The number of LEDs illuminated on the battery indicates the level of charge. The full operating period is achieved when at least 4 LEDs are lit. If LED is flashing, change or recharge the battery. If all the LEDs are unlit, the battery is fully discharged.

For additional information, reference instructions provided with the rechargeable battery and cradle, being sure to comply with all cautionary guidelines.

Pre-Procedure Set-Up

1. Select intermediate illumination spot using the Aperture Control Lever. Each control can be locked to prevent unintentional operation by sliding the lock.



2. Select desired filter setting using the Filter Control Lever. Available settings include no filter, interference red-free filter, a blue or yellow filter which can be introduced into the illumination beam.



3. Place the headset on head; adjust the top and rear Headset Knobs for a comfortable fit.



4. Adjust up/down and forward/backward location of the slots of LIO viewing assembly using thumbscrew and secure position with the thumbscrew.



5. Adjust and fine-tune the pupillary distance (PD) to obtain image fusion first by closing one eye, and then the other eye, and observing an object in the middle of the illumination spot while adjusting the appropriate eyepiece. Repeat until object is in the middle of the field of view, and a single image is obtained. Take off the instrument and check that the PD is symmetrically adjusted. If not, repeat the selection procedure. Correct adjustment of PD is particularly important when examining through a small pupil. While observing through both oculars, the user should be able to comfortably read printed material held at or near the retinal image/treatment plane (approximately 350 - 400 mm (13.8 - 15.7 inches) from the engraved surface of the LIO).



- Turn on illumination and adjust to an adequate viewing intensity. Adjust illumination brightness to provide sufficient illumination at the treatment site by turning the illumination brightness control knob located on the LIO headband. Do not use more illumination brightness than necessary to provide adequate visualization of the treatment site



- Connect the LIO fiber cable to compatible laser console of correct treatment wavelength. Turn on “aiming beam” and adjust the intensity at the laser control panel



Fiber-optic cable connection to family of OcuLight laser consoles



Fiber-optic cable connection to family of IQ laser consoles. Connect to either Port 1 or Port 2

Instructions to Treat a Patient

BEFORE TREATING A PATIENT:

- Inspect the LIO before use to confirm it is in good operating order. Verify aiming beam is present, uniform, round and not distorted prior to treatment.
- Ensure that the laser components and delivery device(s) are properly connected.
- Post the laser warning sign outside the treatment room door.
- Ensure that all ancillary personnel in the treatment room are wearing the appropriate laser safety eyewear.

NOTE: Refer to Chapter 6, “Safety and Compliance,” and your delivery device manual(s) for important information about laser safety eyewear and eye safety filters.

TO TREAT A PATIENT:

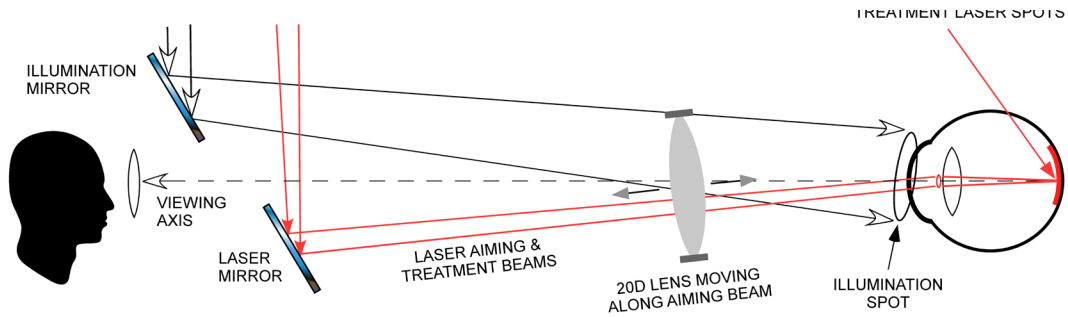
1. Turn on the laser.
2. Reset the counter.
3. Set the treatment parameters.
4. Position the patient.
5. Select an appropriate ophthalmoscopic examination lens.
6. Select **Treat** mode.
7. Project the round illumination beam on the patient’s forehead and adjust the illumination beam position with the vertical illumination control rotary knobs.



8. Using the condenser lens and vertical aiming beam knob located beneath the dust cover assembly, focus and position the aiming beam in the center of the illumination field already projected on the patient’s forehead.



9. Re-position the illumination and aiming beams through the condenser lens and through the patient’s dilated pupil. Move the condenser lens along the aiming beam path until the aiming beam is sharp and of the desired diameter. After a clear view of the retina is obtained, slowly move your head closer to or away from the patient until a focused aiming laser spot is simultaneously achieved. Be aware of potential iris clipping. The laser spot size diameter is approximately 360 μm at the retina for a standard spot size LIO or 1.4 mm for a large spot size LIO when treating an emmetropic eye with a 20 D condensing lens.



10. Press the footswitch to deliver the treatment beam. Release the footswitch to terminate the laser emission.

To CONCLUDE PATIENT TREATMENT:

1. Select Standby mode.
2. Record the number of exposures and any other treatment parameters.
3. Turn off the laser and remove the key.
4. Collect the safety eyewear.
5. Remove the warning sign from the treatment room door.
6. Disconnect the delivery device(s).
7. If an examination lens was used, handle the lens according to the manufacturer's instructions.
8. Keep the protective cap over the fiber-optic connector when the delivery device is not in use.

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Troubleshooting

General Problems

Problem	User Action(s)
No display	<ul style="list-style-type: none"> • Verify that the keyswitch is on. • Verify that the components are properly connected. • Verify that the electrical service is on. <p>If there is still no display, contact your local IRIDEX Technical Support representative.</p>
Inadequate or no aiming beam	<ul style="list-style-type: none"> • Verify that the delivery device is properly connected. • Verify that the console is in Treat mode. • Turn the aiming beam control fully clockwise. • Verify that the fiber-optic connector is not damaged. • If possible, connect another IRIDEX delivery device and place the console in Treat mode. <p>If the aiming beam is still not visible, contact your local IRIDEX Technical Support representative.</p>
No treatment beam	<ul style="list-style-type: none"> • Verify that the remote interlock has not been activated. • Verify that the aiming beam is visible. • Verify that the fiber switch is in the correct position for the laser system and wavelength you are using. • Verify that the eye safety filter is in the closed position. <p>If there is still no treatment beam, contact your local IRIDEX Technical Support representative.</p>
No illumination light	Reference instructions provided with the rechargeable battery and cradle. Check the bulb and replace it if necessary.
Illumination light is too dim	Reference instructions provided with the rechargeable battery and cradle.
The aiming beam is large or out of focus on the patient's retina	Readjust your working distance between the LIO headset and the examination lens. The aiming beam should be sharply defined and at its smallest diameter when in focus.
The treatment lesions are variable or intermittent	<ul style="list-style-type: none"> • The LIO may be slightly out of focus. This decreases power density. Readjust your working distance to obtain the smallest spot size. • A poorly centered laser beam may be clipping on the examination lens or on the patient's iris. Adjust the laser beam in the illumination field. • The laser treatment parameters may be too close to the tissue response threshold for consistent endpoint appearance. Increase the laser power and/or exposure duration, or select a different lens.

4

Maintenance

TO PROVIDE ROUTINE CARE:

- Do not kink or bend the fiber-optic cable.
- When the fiber-optic cable is connected to the console, ensure that the cable is located away from high traffic areas.
- Do not strike the fiber-optic connector against hard surfaces.
- Keep the optical components free of fingerprints.
- When not in use, cover the LIO to keep it free of dust, and store all accessories in suitable storage boxes.

Inspecting the LIO

Inspect the LIO for dirt, debris, and damage prior to each use.

Cleaning the Fiber-Optic Connector

Always inspect the fiber-optic connector for cleanliness prior to use; if needed, clean the connector using a cotton swab moistened with acetone. Inspect the fiber-optic connector using a minimum of 100X magnification to verify cleanliness. Inspect the lanyard for contamination before re-installing it onto the fiber-optic connector.

Cleaning the External Surfaces

Wipe the external surfaces of the LIO (except the optics) with a soft lint-free cloth dampened with a 70/30 Isopropyl Alcohol (IPA) solution.

Cleaning the Optical Components

TO CLEAN THE OPTICAL COMPONENTS:

1. Place 2-3 drops of high-grade acetone onto a cotton swab.
2. Wipe the optics gently in one direction with the swab to remove all dust and debris.
3. Repeat as needed with a fresh swab until all dust and debris have been removed from the optical surfaces.

Changing and Cleaning the Headband-Mounted Rechargeable Battery

Reference instructions provided with the rechargeable battery.



Headband-mounted rechargeable battery

Charging the Headband-Mounted Rechargeable Battery

Two battery chargers are available for use with the LIO:

1. Wall-Mounted Charging Cradle with plug in transformer:



2. Plug-in transformer:



The LIO battery can be charged with either battery charger. Refer to the Heine instructions provided with each battery charger for safe use and operation of the battery charger.

Wall-Mounted Battery Charging Cradle:

The wall-mounted battery charging cradle is installed on a wall at the user site using hardware and instructions included with the charging cradle. It provides a safe place to store the LIO and accommodates a spare battery. The batteries are automatically charged when placed in a functioning charging cradle. The wall-mounted battery charging cradle offers the following features:

- The battery can be charged in either charging cradle.
- The LIO illumination is automatically switched off as soon as the battery is parked in a functioning charging cradle.
- During charging, the LEDs blink sequentially; during use they remain lit.
- All 5 LEDs will light when the battery is fully charged. As the charge level falls, the LEDs go out in turn. When all LEDs are unlit, the battery is fully discharged.
- If the orange LED starts to flash, recharge the battery.

Plug-In Transformer:

The plug-in transformer allows the battery to be charged by connecting it directly to the plug-in transformer and plugging the transformer into an appropriate AC source.

For additional information, reference Heine instructions provided with the unit.

Changing the LED or Halogen Illumination Lamp

Reference Heine instructions to install or replace the LED or Halogen Illumination Lamp. Replacement lamps are available from IRIDEX, your IRIDEX distributor, or directly from Heine.

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Service

The LIO contains no user serviceable items.* LIO service must be performed by IRIDEX trained service personnel. Contact IRIDEX or your distributor for service information.

*Excluding light bulb replacement.

6

Safety and Compliance

To ensure safe operation and prevent hazards and unintended exposure to the laser beams, read and follow these instructions:

- Always review and observe the safety precautions outlined in the operator manuals before using the device to prevent exposure to laser energy, except as a therapeutic application from either direct or diffusely reflected laser beams.
- This device is intended for use only by a qualified physician or other medical professional. The suitability of the equipment and treatment techniques selected for clinical use is your sole responsibility.
- Do not use any device if you think it is not functioning properly.
- Laser beams reflected from specular surfaces can harm your eyes, the patient's eyes, or others' eyes. Any mirror or metal object that reflects the laser beam can constitute a reflection hazard. Be sure to remove all reflection hazards near the laser. Use non-reflecting instruments whenever possible. Be careful not to direct the laser beam at unintended objects.



CAUTION: *Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.*

Protection for the Physician

Eye safety filters protect the physician from backscattered treatment laser light. Integral eye safety filters are permanently installed in every compatible Slit Lamp Adapter (SLA) and Laser Indirect Ophthalmoscope (LIO). For endophotocoagulation or for Operating Microscope Adapter (OMA) use, a separate discrete eye safety filter assembly must be installed into each viewing path of the operating microscope. All eye safety filters have an optical density (OD) at the laser wavelength sufficient to permit long-term viewing of diffuse laser light at Class I levels.

Always wear appropriate laser safety eye wear when performing or observing laser treatments with the unaided eye. Refer to laser console Operator Manual for laser safety eye wear minimum OD, it is specific per each laser console wavelength and maximum power output.

Protection for All Treatment Room Personnel

The Laser Safety Officer should determine the need for safety eyewear based on the Maximum Permissible Exposure (MPE), Nominal Ocular Hazard Area (NOHA), and Nominal Ocular Hazard Distance (NOHD) for each of the delivery devices used with the laser system, as well as the configuration of the treatment room. These parameters are tabulated for each compatible IRIDEX laser console in the appropriate laser console User Manual for additional information, refer to ANSI Z136.1, ANSI Z136.3, or IEC 60825-1.

Safety Compliance

Complies with FDA performance standards for laser products, except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

The TruFocus Premiere LIO is compliant with EC directive 93/42/EEC and subsequent amendments.

Feature	Function
Eye safety filter	The eye safety filter ensures that all laser radiation returned to the physician and any co-observers is below Class I limits.
Laser emission indicator	Illumination of the green Treat light on the laser provides a visible warning that laser radiation may be emitted.
Safety interlock	The delivery device's protective housing and the laser fiber connector cannot be opened without the use of special tools. The delivery device is also safety-interlocked at the fiber-optic port on the laser.



CAUTION: *The light emitted from this instrument is potentially hazardous. The longer the duration of exposure, the greater the risk of ocular damage. Exposure to light from this instrument when operated at maximum intensity should not exceed 21 minutes with the LED light and 15 minutes with the 5Watt XHL light.*

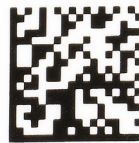
Labels



Laser Aperture Label



Product Labels



(01)00813125
015626(11)17
0106(21)0001
02
REF 87302
Rev A



IRIDEX Corporation
1212 Terra Bella Ave.
Mountain View, CA
94043 USA
www.irdex.com
Tel. 650-940-4700

Symbols



Caution



CE Mark



ETL mark



Authorized representative in the European Community



Manufacturer



Part number



Waste Electrical and Electronic Equipment (WEEE)



CSA Group Mark Health Canada



Color filter selector



Illumination field size selector



Aiming & treatment beam position range adjustment



Laser Aperture

TruFocus LIO Premiere Specifications

Specification	Standard Spot	Large Spot
IRIDEX Laser compatibility	OcuLight GL OcuLight GLx OcuLight TX OcuLight SLx OcuLight OR OcuLight SL IQ 532 IQ 577 IQ 810	OcuLight SLx IQ 810
Laser firmware compatibility (if applicable)	OcuLight GL version 3.2 and above OcuLight GLx version 3.3 and above OcuLight SLx version 4.1 and above	
Laser spot size on retina with 20D lens	360 µm*	1400 µm*
TruFocus LIO Premiere Models	532 nm and 810 nm 532 nm 810 nm 577 nm	810 nm
*May vary with refractive power.		

Operational and Storage Environmental Conditions	
Operational Environment	
Temperature Limits:	10° C (50° F) to 35° C (95° F)
Humidity Limits	20-80% Relative Humidity, Non-condensing
Storage Environment	
Temperature Limits:	-20° C (-4° F) to 60° C (140° F)
Humidity Limits	20 - 80% Relative Humidity, Non-condensing

EMC Safety Information

The laser system (console and accessories) needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided in this section. Portable and mobile RF communications equipment can affect this system.

This laser system has been tested and found to comply with the limits for medical devices in IEC 60601-1-2 according to the tables in this section. These limits are designed to provide reasonable protection against harmful interference in a typical medical installation.



CAUTION: *Changes or modifications to this laser system not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment and may result in increased emissions or decreased immunity of the laser system.*

EMC Requirements for Console and Accessories

Guidance and Manufacturer's Declaration - Electromagnetic Emissions		
This laser system (console and accessories) is intended for use in the electromagnetic environment specified below. The customer or the user of the laser system should assure that it is used in such an environment.		
Emissions Test	Compliance	
RF emissions CISPR 11	Group 1	The laser system uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ Flicker emissions	Complies	
The laser system is suitable for use in all establishments, other than domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.		

Guidance and Manufacturer's Declaration - Immunity			
This laser system (console and accessories) is intended for use in the electromagnetic environment specified below. The customer or the user of the laser system should assure that it is used in such an environment.			
Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment — Guidance
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	±2 kV for power supply lines Not Applicable	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	±1 kV differential mode ±2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T (30% dip in U_T) for 25 cycles <5% U_T (>95% dip in U_T) for 5 cycles	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T (30% dip in U_T) for 25 cycles <5% U_T (>95% dip in U_T) for 5 cycles	Mains power quality should be that of a typical commercial or hospital environment. If the user or the laser system requires continued operation during power mains interruptions, it is recommended that the laser system be powered from an uninterruptible power supply or a battery.
(50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE: U_T is the AC mains voltage prior to application of the test level.			

Recommended Separation Distances between Portable and Mobile RF Communications Equipment and the Device

The device is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the device as recommended below, according to the maximum output power of the communications equipment.

Rated Maximum Output Power of Transmitter (W)	Separation Distance According to Frequency of Transmitter (m)		
	150 kHz to 80 MHz $d = 1.2 * \text{SQRT}(P)$	80 MHz to 800 MHz $d = 1.2 * \text{SQRT}(P)$	800 MHz to 2.5 GHz $d = 2.3 * \text{SQRT}(P)$
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.74
1	1.2	1.2	2.3
10	3.7	3.7	7.4
100	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1: At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption from structures, objects, and people.