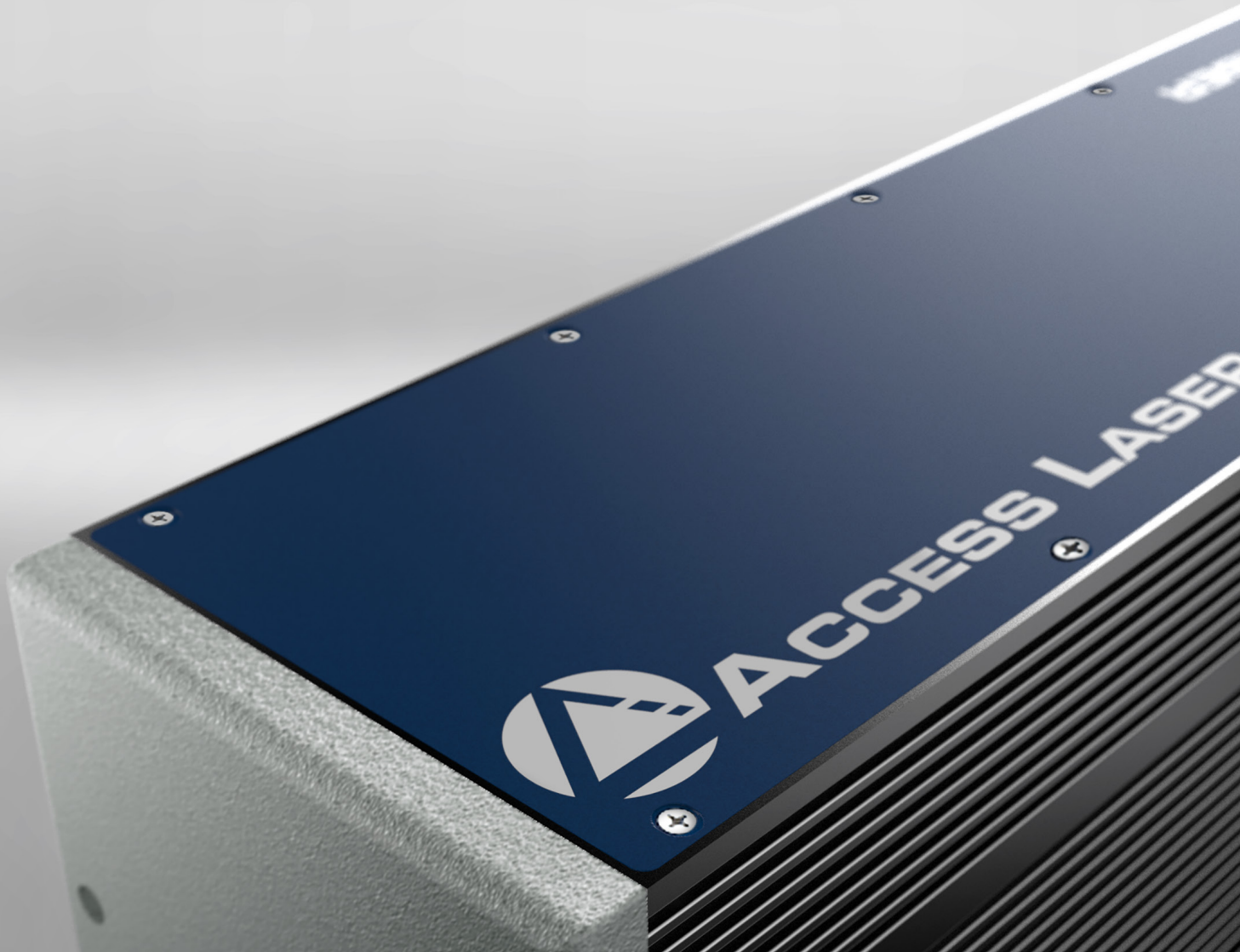
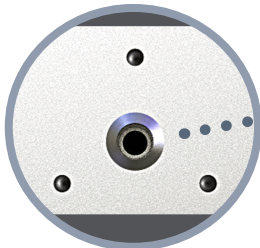


DL500

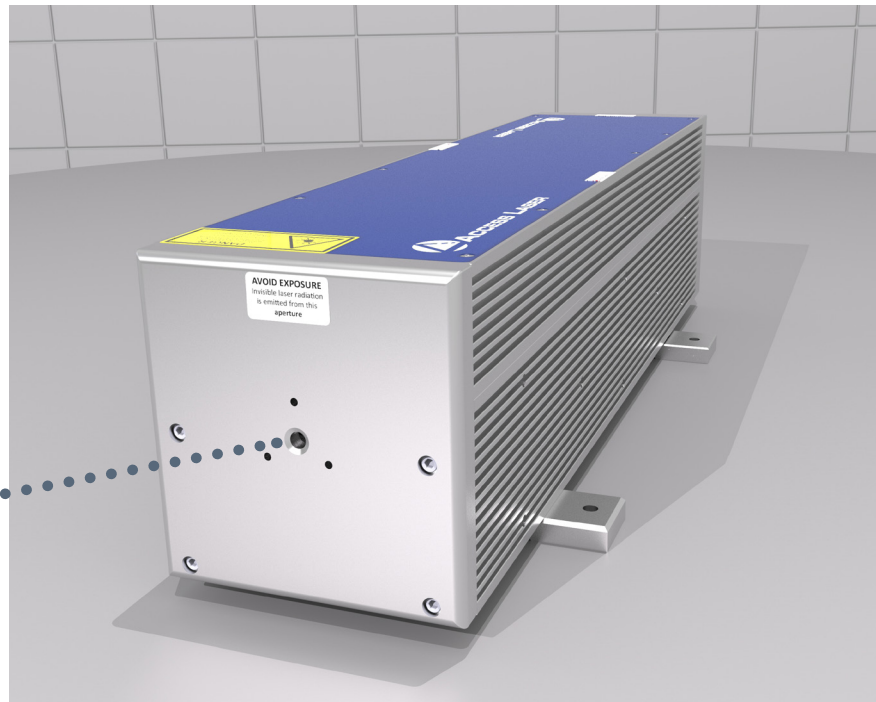
OPERATOR MANUAL



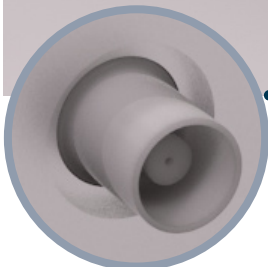
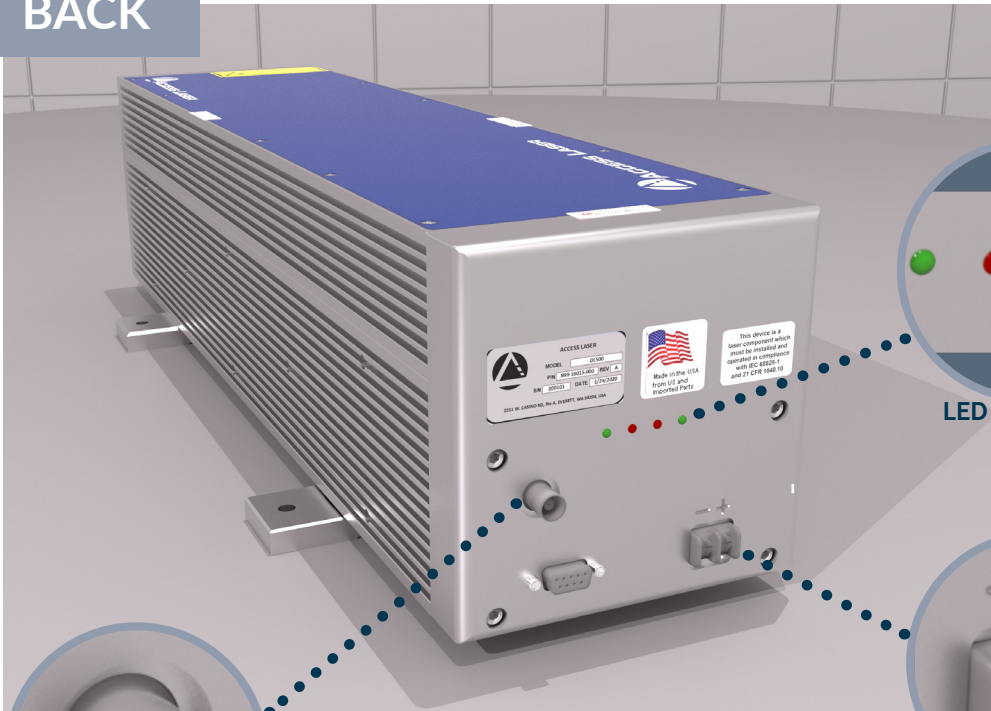
FRONT



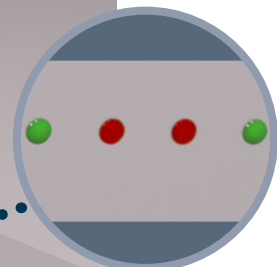
Beam Exit



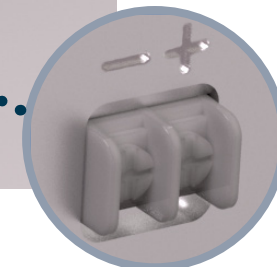
BACK



BNC Gate



LED Indicators



DC Input
RIGHT = +48V
LEFT = Ground

FDA and International Regulations

Access Laser Company (ALC) lasers are designed, tested, and certified to comply with United States (U.S.) and European Union (EU) regulations. For commerce within the U.S., laser safety requirements are governed by the Center for Devices and Radiological Health (CDRH) as set forth by United States' Radiation Control for Health and Safety Act of 1968. For International commerce outside the U.S., laser safety is governed by EU Directives and Standards.

Because the DL500 laser is an Original Equipment Manufacturer (OEM) laser product, ALC assumes no responsibility for the compliance of the system into which the DL500 is integrated. However, ALC has provided the means to implement an external keyswitch and an external interlock so the OEM integrator can easily comply with the appropriate laser safety standards.

Because the DL500 is considered an OEM product, it is not required to meet all standards for laser safety under 21CFR 1040.10 or IEC 60825-1. It is the responsibility of the OEM or system integrator to assure complete compliance with any and all applicable regulations when the DL500 is integrated into their system.

If you are an OEM that manufactures a laser product for selling or importing into the U.S. (that includes the DL500 laser), you are required to file a Product Report with the CDRH prior to entering commerce in the U.S. that demonstrates compliance to 21 CFR 1040.10. If you are an OEM that operates and sells outside of the U.S., use IEC 60825-1 for laser safety compliance.

Since ALC is a U.S. based company with international sales, ALC has filed an OEM Product Report with the CDRH for the DL500 laser; the Product Report shows our warning labels comply with IEC 60825-1. For labeling compliance within the U.S., ALC invokes Laser Note No. 50, Laser Products – Conformance with IEC 60825-1 and IEC 60601-2-22; Guidance for Industry and FDA Staff. Laser Note 50 lists sections of 21 CFR 1040 for which “the CDRH will not object to conformance with the comparable sections of IEC 60825-1”, including labeling requirements.

Both 21 CFR 1040 and IEC 60825-1 contain language regarding OEM lasers that are capable, without modification, of producing laser radiation when removed from the OEM system. In such cases the lasers must comply with all applicable requirements of 21 CFR 1040 or IEC 60825-1. Even though the DL500 includes an integrated RF power supply, it does not operate when removed from the OEM system since the keyswitch and interlock circuits become disabled when removed.

See Table 1 on the next page for a summary of safety requirements as an aid to integrating the DL500 into an OEM system.



FDA and International Regulations

Feature	Use case	Required by:		Available on the DL500?
		CDRH	IEC 60825-1	
Keyswitch	On/Off keyswitch controls power to laser electronics. The key cannot be removed when it is in the "ON" position.	Yes	Yes	Yes (Use DB9 to implement external keyswitch.)
Remote Interlock	Disables the RF power supply when protective equipment or panel door is open.	Yes	Yes	Yes (Use DB9 to implement external interlock circuit.)
Over Temperature Protection	Shuts down RF power supply when the temperature of the laser body exceeds 60°C.	No	No	Yes Thermal switch in RF driver is monitored by the control board. Disables RF if overtemp occurs.
Laser Shutter	User can close shutter when servicing unit.	Yes	Yes	No OEM must add external beam block.
Laser Ready Indicator	Indicates power is applied and laser is ready to operate.	Yes	Yes	Yes The green LED on back panel of the laser indicates enabled state.
Delay at Power Up	Laser is not enabled when powered up until approximately 5 seconds after the keyswitch is cycled.	Yes	Yes	Yes LED indicators on back panel of the laser flash left to right during 5 second delay.
Power Fail Lockout	The RF power supply is disabled when the power comes back on after an interruption.	Yes	Yes	Yes The keyswitch must be cycled (off to on) to restore operation after a power failure.
Warning Labels	Labels attached to various locations on laser housing to warn users of potential dangers.	Yes	Yes	Yes Labels are compliant to international standard (IEC 60825-1) and invoke CDRH "Laser Note 50" for compliance within U.S.

SAFETY INFORMATION

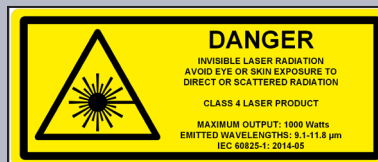
- Safety labels identify some potential risks while operating the laser.
- Please familiarize yourself with the labels.

Safety Label Location and Definition

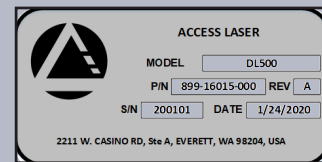


AVOID EXPOSURE
Invisible laser radiation
is emitted from this
aperture

Aperture Label
Indicates location
of laser beam exit (ap-
erture)



Laser Danger/IEC 60825-1 Label
Indicates output laser beam specifications
per standardized safety requirements, laser
class, and associated warnings



Product Identification Label
Indicates Model, Series, and
Date of Manufacture

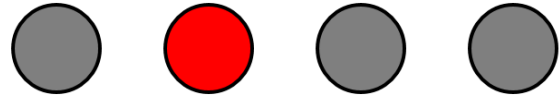
* All non-OEM lasers comply with 21 CFR sub-chapter J at the time of manufacture (If they enter inter-state commerce).

If your laser is a custom order (OEM), it is your responsibility to assure compliance with the CFR in your final application.

LED INDICATORS

Power On

When DC power is applied to the laser, the control system will perform a quick self-test to check for error conditions. (See the description of fault States below.) If the self-test is successful, the red LED on the left will be lit, indicating power is applied.

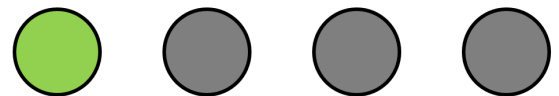
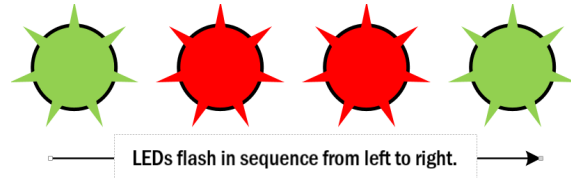


Laser Ready

When the keyswitch is cycled from OFF to ON, the four LEDs will cycle for a five second safety delay. After cycling the keyswitch the green LED on the left will stay lit, indicating the laser ready state.

The laser ready state means that the laser is ready to accept input signals through the BNC connector, and will output laser power matching the input signal.

Once in the ready state, the laser will remain in the ready state until (1) the keyswitch is cycled off (2), the DC power is removed from the laser or (3), a fault occurs.



Control Input

The BNC Gate is optoisolated. Input signals applied to the BNC connector must be 0 V to 5 V (± 1 V) rectangular pulses and be able to source at least 3 mA.

Input signal pulses must be $\leq 25 \mu\text{s}$ in length and have a frequency of ≤ 500 Hz.

When the input signal is applied, the green LED on the right will be latched on, indicating a signal is applied and the laser is active; the LED goes off when the signal is removed.

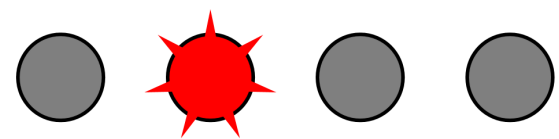


Fault States for Left Red LED

The red LED on the left will flash between 1 and 4 times, before staying off for approximately 2 seconds, to indicate the following fault states:

- One flash if the remote interlock is triggered.
- Two flashes if the keyswitch is open.
- Three flashes if the input signal pulse width is too long.
- Four flashes if the input signal frequency is too high.

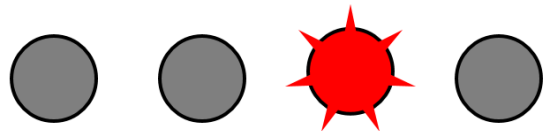
Note: The left red LED will also stay on continuously when DC power is first applied to the laser.



Fault States for Right Red LED

The red LED on the right will flash between 1 and 4 times, before staying off for approximately 2 seconds, to indicate the following fault states:

- One flash if the DC voltage is too high or low.
- Two flashes if an over temp fault is detected.
- Three or four flashes indicates an internal hardware fault. Contact ALC Customer Support if these faults occur.



OPERATION INSTRUCTIONS

1. Direct the laser toward an appropriate target, such as a power meter or a beam block.



This laser can cause mild to severe burns if skin or eyes are exposed to the beam or scattered radiation. Protective eye-wear should be worn at all times.

2. Secure the laser to a bench top.



The feet of the laser can be used on both a metric or imperial breadboard. Do not torque, twist or bend the laser body during the mounting process. Applying uneven pressure to the laser body may distort the laser body, causing poor performance and possible damage.

3. Remove the protective tab from the aperture (if present).
4. Connect the Cooling System.
 - a. For air cooled lasers (where cooling is provided by the end user), no cooling is built into the laser system; the user is responsible for providing sufficient cooling to maintain the laser specifications.
 - b. Laser Model DL500:
 - 1) Operating at frequencies below 250 Hz at the maximum 25 μ s pulse length requires no cooling.
 - 2) Operating at frequencies above 250 Hz at the maximum 25 μ s pulse length requires cooling when operating continuously for more than 5 minutes.
 - 3) For typical intermittent dental use no cooling is expected to be required.
 - 4) A thermal fault will shut down the laser if the temperature reaches 60 °C.
5. Connect a dongle or other control system to the DB9 Connector which enables the Keyswitch and Interlock functions as described in the DB9 Port Definition (Page 9).
6. Set the control source parameters.
 - a. Set Input amplitude to 5 V (0 V = OFF; 5 V = ON).
 - b. Set Input pulse length (Max pulse length \leq 25 μ s; Min pulse length is 5 μ s).
 - c. Set Input frequency (Max frequency \leq 500 Hz).
7. Verify control source is off. Connect your 5 V control source to the laser via the BNC connector.

8. Connect the appropriate DC Power Supply to the Laser.
 - a. Laser Model DL500: 48 V-DC 500 W (Max 50 V-DC, Min 43 V-DC).
 - b. A powered off DC power supply should be connected to the back of the laser with ring or spade terminals. When looking at the back of the laser the terminal to the right is to be connected to the (+) 48 V output of the DC supply, and the terminal to the left is to be connected to the (-) ground output of the DC supply.
 - c. Plug in or turn on the DC power supply. When DC power is applied to the laser, after 1-2 seconds, the left red LED will come on and stay lit. If the LEDs do not light, turn off the DC power supply and verify the connections to be certain the DC power isn't reversed.

9. Open the laser shutter (if present).



If your laser is configured with a shutter, be cautious whenever opening it. Always ensure that the laser is off, and the beam path is clear before opening the shutter. If the laser is accidentally activated with the shutter closed, it could be heated and dangerous to touch. Additionally, the beam path would be active immediately after opening.

10. Enable Laser Ready:

When the user-implemented Keyswitch is turned from OFF to ON, the 4 LEDs will cycle several times over a period of 5 seconds. After cycling the left green LED will remain on.

- a. This means that the laser is in the ready state and will accept input signals through the BNC connector, and will output laser power accordingly. Input signal pulses must be $\leq 25 \mu\text{s}$ in length and have a frequency of $\leq 500 \text{ Hz}$. The amplitude for the pulses is 5 V = HIGH (ON), and 0 V = LOW (OFF).
 - b. Once in the ready state, the Laser and LEDs will remain in the ready state until the key switch is turned to the off position, the DC power is removed from the laser, or a fault occurs. There are faults for the remote interlock, laser body temperature, for the DC power voltage, and for the input signal pulse width and frequency.
11. To activate the laser beam, apply input signal to the BNC connector; 5 V = HIGH (ON); 0 V = LOW (OFF).

DB9 Port Definition

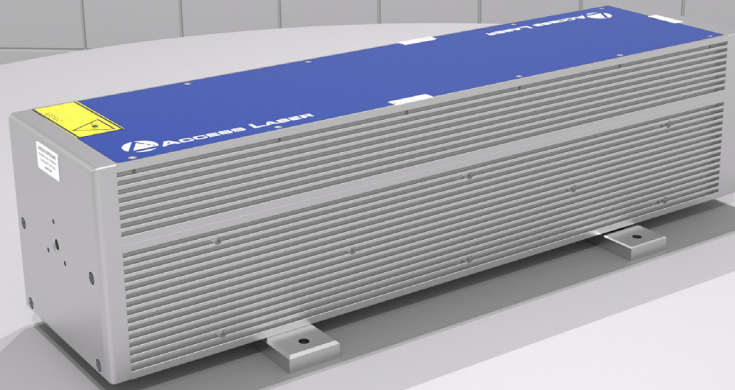
The DB9 Connector on the DL500 is intended to be used to monitor the status of the laser while it is on and to implement a remote keyswitch and a remote interlock circuit.

Pin #	Description	Comments
1	MSG3	Laser status message in combination with pin 7 and 9.
2	Safety Keyswitch	Connect other side of key switch to Pin 6 Ground. Laser will be enabled when keyswitch is closed pulling Pin 2 LOW. Laser will be disabled when key switch is open leaving Pin 2 HIGH.
3	Safety Interlock	Connect other side of interlock circuit to Pin 5 Ground. Laser will remain enabled as long as interlock circuit is uninterrupted pulling Pin 3 LOW. Laser will be disabled when interlock circuit is open making Pin 3 HIGH.
4	Input Signal Feedback	Outputs a 0 V - 3.6 V square wave matching the frequency and pulse width of the input signal applied to the BNC.
5	GND	Ground pin.
6	GND	Ground pin.
7	MSG2	Laser status message in combination with pin 1 and 9.
8	GND	Ground pin.
9	MSG1	Laser status message in combination with pin 1 and 7.

The 3 laser status message (MSG) pins on the DB9 will output a combination of TTL HIGH and LOW signals to be interpreted by a remote system. They indicate the same ready/fault states shown by the LEDs on the laser back panel. The table below defines the various message states.

Laser Status	MSG3	MSG2	MSG1
Laser Ready	HIGH	HIGH	HIGH
DC Voltage Over/Under	HIGH	HIGH	LOW
Over Temperature	HIGH	LOW	HIGH
Internal Hardware Fault	HIGH	LOW	LOW
Remote Interlock Triggered	LOW	HIGH	HIGH
Keyswitch Open/Power Up	LOW	HIGH	LOW
Pulse Width Too Long	LOW	LOW	HIGH
Pulse Frequency Too High	LOW	LOW	LOW

DL500



Laser Power

Wavelength	9.3 μm
Average Power	5 W
Peak Power	500 W
Power Stability	± 10 %

Pulse Width Modulation Parameters

Pulse Width	(5 - 25) μs
Pulse Repetition Frequency	(0 - 500) Hz

Dimensions & Weight

Laser Weight	14.8 kg
Dimensions L x W x H	(57.6 x 20.3 x 15.4) cm

Beam Characteristics

Beam Waist Diameter	2.2 mm
Waist Location	Output Coupler
Mode Quality	M ² ≤ 1.1
Full Divergence Angle	6.2 mrad
Rise Time	≤ 10 μs
Fall Time	≤ 15 μs
Polarization	Random

DC Power Requirements

RF Driver Input	48 V; 200 W Min
-----------------	-----------------

Heat & Cooling

Heat Dissipation	≤ 200 W
Cooling Requirement	Air Cooled
Working Temperature	(5 - 40) °C

Notes

Power Stability calculated with average power from cold start:

$$\pm \frac{P_{max}-P_{min}}{P_{max}+P_{min}} \frac{1}{e^2}$$

Beam specifications measured at:

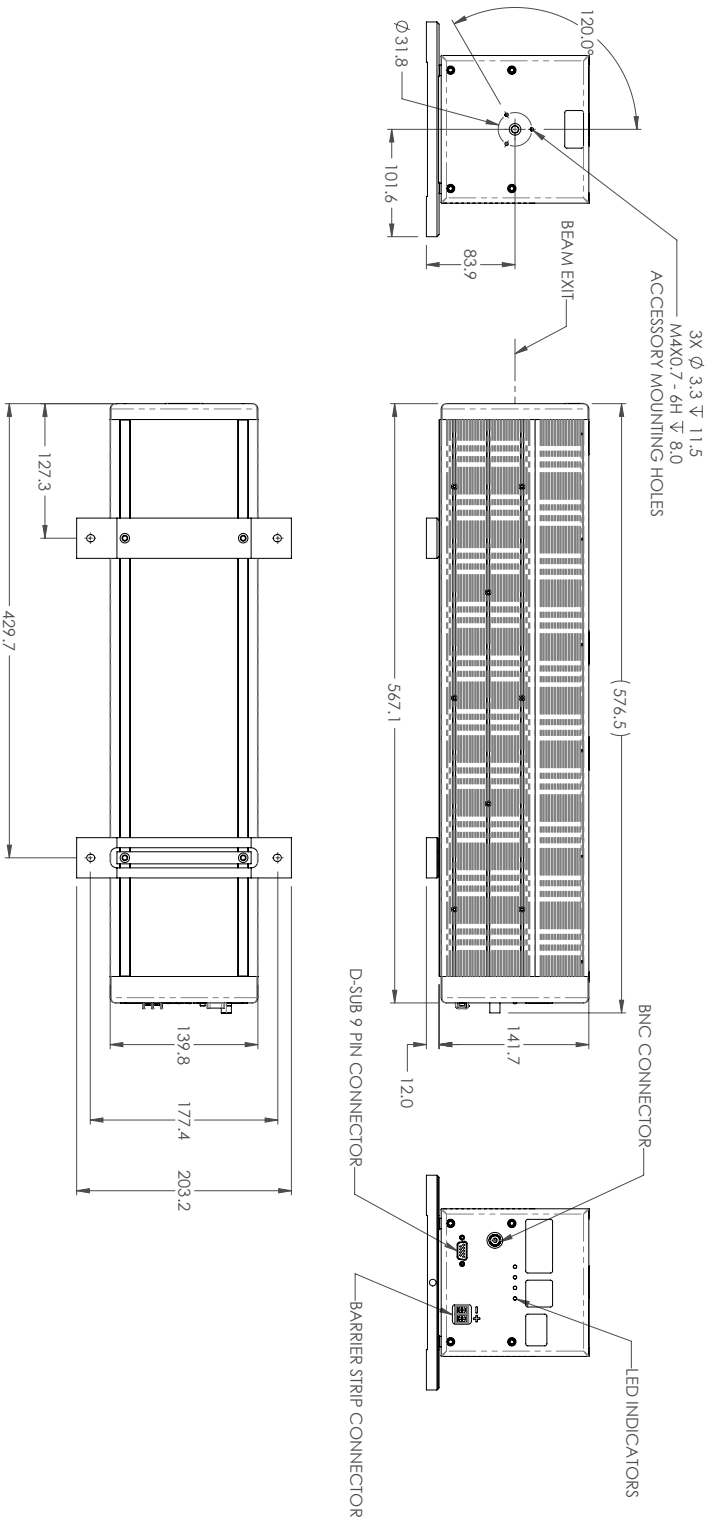
All specifications are subject to change without notice.




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REVISION HISTORY				DATE	APPROVED
ECO	ZONE	REV	DESCRIPTION		
967		A	INITIAL RELEASE	9/25/2020	AD

NOTES UNLESS OTHERWISE SPECIFIED:
1. DRAWING IS FOR REFERENCE ONLY



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ISO 2768 TOLERANCE / UNIT FRACTIONAL DECIMAL ANGULAR: MACH ± 0.2°		DRAWN BY AD 9/25/2020 CHECKED BY CD 9/25/2020 APPROVED BY SW 9/25/2020		PART NO. 898-16015-000 DESCRIPTION: DL500 Laser, Integrated RF, AC 48V OEM	
THIRD ANGLE PROJECTION SURFACE FINISH FINISH MATERIAL		DRAWING SHALL BE IN ACCORDANCE WITH ASME Y14.5-2009 DO NOT SCALE DRAWING		SCALE 1:4 SHEET 1 OF 1 SIZE B	