英诺激光 INNO LASER Advanced Optowave

This instruction is applicable to AMT

INNO LASER TECHNOLOGY CORPORATION LIMITED

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V2.0

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1 Laser safety instructions

1.1 Laser safety Level

The laser is a Class IV high-power laser. Extreme care should be taken when operating. The laser beam is a fire and safety hazard. Only personnel who are trained with the safety precautions listed in this manual should be allowed to operate the laser system. Precautions must be taken to prevent accidental exposures to direct or reflected laser beam. Both diffuse and specula reflections can cause severe skin or eye damages. Proper eye protection must be worn at all times. Direct eye contact with the output beam from the laser will cause serious damage and even blindness.

1.2 Laser Safety Responsibilities

Lasers are engineered industrially and undergo rigorous tests to ensure that they are safe and reliable under reasonable using conditions. If operators do not operate in accordance with the correct safety guidelines, it will be extremely dangerous to both their body and property. Especially when the output wavelength of the laser is in an invisible range, the danger also increases accordingly. If operators do not use the lasers in accordance with the normal use guidelines of our company, our company will not bear any legal liability for all personal injuries resulting therefrom.

1.3 Laser Safety Operation Guide

Danger!

Before using the laser, operators must read this manual and strictly follow the operating procedures in this user manual. Precautions must be taken to prevent accidental injuries caused by direct or reflected light beams. Non-operators must be evacuated outside the laser radiation hazard area.

The greatest danger is the direct exposure to the main laser beam when using a laser. In addition to the main beam, a few smaller weaker power beams may exit at different angles near the laser system. The weaker beams may still be sufficiently intense to cause eye damage.

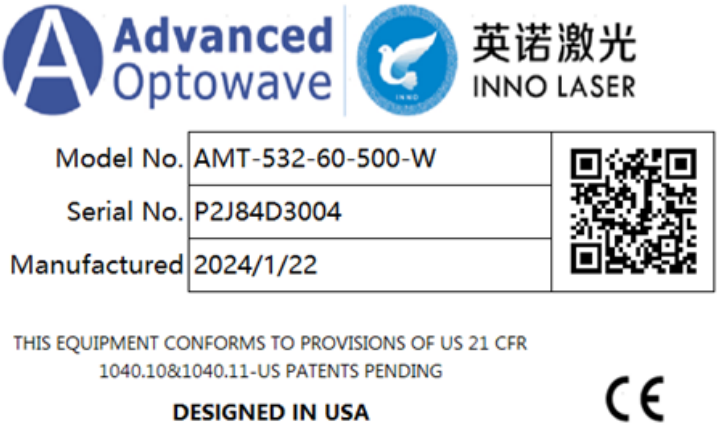
Laser light is powerful enough to burn skin, clothing or paint. They can ignite volatile substances such as solvents even at some distance. The laser beam can damage light sensors in video cameras and photo diodes. The user is advised to follow the precautions below and in this manual.

- Only qualified users who are familiar with standard laser safety practices and who are aware of the dangers involved should be allowed to have the access the laser.
- Don't look at the output beam directly. Specular and diffuse reflections are hazardous.
- Avoid wearing jewelry or any reflective items when operating the laser.
- Use protective eyewear that is suitable for the laser wavelength, that is, always use optical protective goggles during laser operations. Consult your organization's Laser Safety Officer in accordance with your laser safety procedures.
- Use a suitable wavelength fluorescence card to verify that the laser beam is off for safety.
- Be sure to use non-reflective beam stops to block the laser beam.
- Set up the laser beam so that it is not at eye level; the beam should be above or below eye level for both seated and standing positions.
- Post highly visible warning-signs near the laser operation area for Class IV laser products.
- Set up a dangerous zone around the laser, use safety interlocks to prevent non-experienced personnel from entering into the working area.
- Laser light is very bright and intense compared with conventional light sources. It poses a significant safety hazard. All laser users, and everyone near the laser system, should be aware of the dangers of using a class IV laser such as the laser system.
- Observe and follow all safety precautions in this manual.
- Extreme cautions should be taken when using volatile substances in the laser area.
- Never direct exposure to the laser beam. The intensity of the beam can easily cause flesh burns or ignite clothing.

Danger! Visible light, invisible light, and ultraviolet radiation.

AMT Laser produces both visible and invisible radiation. The invisible radiation has a wavelength of 1064nm which corresponds to the infrared (IR) optical region and 355-351nm which corresponds to the Ultra Violet (UV) optical region. The visible radiation is 532-527nm which corresponds to the Green (GR) optical region. All these radiations can easily cause permanent damage to the retina.

1.4 Warning and Safety Signs

LASER RADIATION WARNING LABEL		CLASS 4 LASER PRODUCT LABEL	
APERTURE LABEL			
MANUFACTURING IDENTIFICATION LABEL (Sample)			

1.5 Laser Safety Characteristics

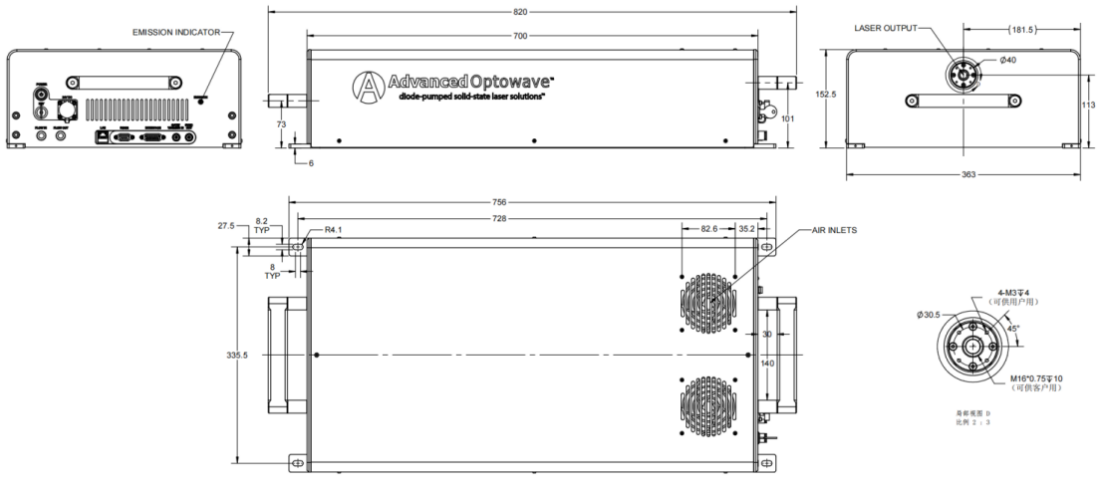
- External Interlock Connector: A detachable interlock connector is provided at the back of the laser control unit, which has two pins inside that can be connected to an external interlock switch. When the two pins are disconnected, the laser will stop working, displaying an alarm for the disconnection of the external interlock device. At the same time, the buzzer will sound an alarm sound. When the fault is resolved (e.g., the interlock switch is reconnected), clearing the fault alarm or powering off and restarting the laser will restore normal operation.
- Key switch control: The laser cannot be turned on when the key is turned off.
- Laser emission warning light: The on and off of the LED light on the laser can also indicate whether the laser is on or off. However, users cannot rely solely on this function to determine whether the laser is on or off. When using the laser, you need to be very careful at all times.

1.6 Laser Safety Commitment

The laser itself is safe, but protection must be taken when using it. Both equipment manufacturers and end users should abide by the safety requirements of lasers. This is the basis for ensuring safe production. They should commit to installing laser protection devices that can isolate, block, and protect in the use scenario, even when the laser is not turned off. Laser safety requirements are included in IEC 60825-1:2014& CAN/CSA-E60825-1:15, GB 7247.1-2012.

2 Laser Description and Packing List

2.1 Laser size



net weight (KG)	gross weight (KG)	Box size（mm）
44.3	69.3	936*492*408

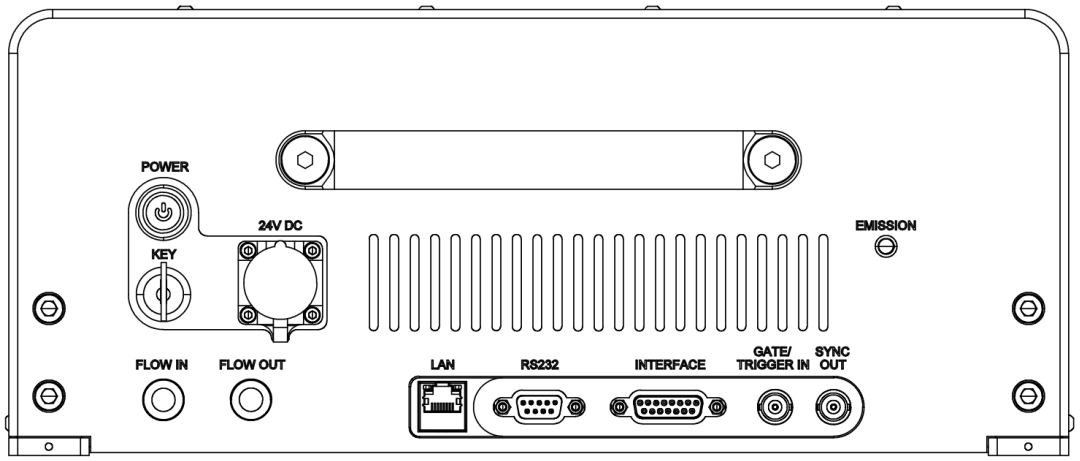
2.2 Packing list

Physical Objects	
Interlock Connector	1
Power Cord	1
Waterpipe	2
Key	2
Laser Test Report	1

Caution:

When installing the water pipe, it must be pressed inward firmly to prevent water leakage. The length of the water pipe connection is about 22mm.

2.3 Laser Interface Description



Identifier	Function
POWER	Power Button – used to energize the laser controller
KEY	Used to start the initialization process. Turn on the system.
24V DC	The 24 VDC Input connect is used to supply the power to the laser system. Input is 24 VDC
LAN	Network cable interface. Used to connect to the system to your computer
RS232	RS232 connector. Used to connect to the system to your computer
INTERFACE	DB 15 pin connector has a series of pins that can be used for various operational features. It also houses the two pins used for the Safety Interlock
GATE/TRIGGER IN	BNC connector where a 0-5 VDC TTL signal can be sent to GATE the laser output
SYNC OUT	BNC connector where a 0-5VDC TTL SYNC Single is available.
FLOW IN	Connector for cold coolant supply from the chiller to the laser.
FLOW OUT	Connector for the warm coolant return from the laser to the chiller.
EMISSION	Power indicator light

2.4 Interlock Pins

Pins	Signal Function	Comment
1	AIN1 0-10V	0-10V power external control
2	Reserve	
3	Interlock	Interlock, short with any GNDiso
4	Reserve	
5	Reserve	
6	Reserve	
7	Reserve	
8	Reserve	
9	GNDiso	
10	GNDiso	
11	Reserve	
12	Reserve	
13	Reserve	
14	Reserve	
15	Reserve	

2.5 RS232

Pins	Signal Function
1	Reserve
2	TX
3	RX
4	Reserve
5	GND
6	Reserve
7	Reserve
8	Reserve
9	Reserve

3 Laser System Environmental Requirements

3.1 Electrical Requirements

Parameter	Requirements
laser type	AMT-355-15-500-W AMT-355-30-1000-W AMT-532-60-1000-W AMT-1064-70-1000-W
power supply voltage	DC-24V
Suggested power supply	1000W

3.2 Environmental Requirements

Parameter	Requirements
Ambient Operating Temperature	15℃ to 35℃
Relative Humidity	20% to 80%(non-condensing)
Vibration	Keep away from Vibrations
Altitude	Sea level to 3000m

3.3 Chiller Requirements

Parameter	Requirements
Cooling Capacity	1000W
Water Flow	2L -5L/min
Pump Height	10m-20m(18-24psi)
Temperature Accuracy	±0.1°C
Set temperature	22°C

3.4 Operating Precautions

- The laser controller power line has five reserved connectors: +24V×2, GND×2, and PE.
- Please correctly connect them to a switching power supply that meets the power requirements.
- The laser needs to be installed horizontally on the platform. If you need to install it in other directions, please consult Inno technical support personnel.
- The laser should be equipped with a chiller that meets the requirements. Excessive water pressure will squeeze the cavity and cause power attenuation.
- The water coolant should be replaced at least once every two months. It is recommended to use automotive antifreeze to prevent water blockage and extend the water replacement cycle.
- Install the chiller in a convenient and well-ventilated spot. The chiller will draw cool air in from the front of the unit and will exhaust warm air through the rear of the unit. Caution should be taken to ensure that the chiller can draw and expel air freely and that it will not recirculate its exhaust warm air as this will prevent the chiller from maintaining a stable water temperature.
- The optical path behind the laser window mirror needs to be sealed. It is recommended to use a beam expander directly installed on the window mirror, which can effectively extend the service life of the window mirror.
- It is necessary to switch on and off in accordance with the correct requirements.
- When moving the laser from a high-temperature environment to a low-temperature one (or vice versa), the warm-up time after power-on should be extended appropriately to more than 30 minutes.
- When the laser is in normal operation, it is strictly forbidden to adjust the water temperature for power optimization. otherwise, there is a risk of damaging the laser.

Note: The window mirror is a consumable and is not covered by the warranty.

4 AOC Ultrafast Laser Controller Software

4.1 Software List and System Requirements

The laser control software does not require installation. It can be downloaded directly from our official website or official account and opened by double-clicking.

- Software Name: MOPA_GUI
- Please install Microsoft .NET Framework 4.5.1 or a higher version software on the computer to support software operation.

4.2 Installation and Operating Problem Solutions

- Please use RS232 direct connection (2, 3, 5-pin direct connection), or use a USB to serial communication cable. If you choose a serial to USB data cable as the RS232 communication cable, please install the corresponding driver. Some systems may require a PC restart after installation.
- If the software is unable to start or error, please confirm whether the installation software version and the Microsoft .net framework software is correct. If there are multiple .NET Framework versions installed, please uninstall them all and reinstall one.
- When unable to find the serial port, please check if the serial port driver has been installed. You can open the device manager to check if the com port is not enabled.
- If the software interface displays 'Searching for laser……Please make sure the port connection is good', the COM port is incorrect; please switch to the correct COM port.
- The software running interface displays "Error! Unable to switch to remote state", please check if there is any alarm sound in the communication cable and laser. If there is an alarm, please first troubleshoot the laser problem and then restart the laser controller.

5 New Graphical User Interface - GUI

The AMT laser is operated directly by using the graphical user interface supplied with the laser. The GUI program operates on a standard computer running the latest version of Windows and communicates with the laser controller through the RS232 port on the computer. The GUI is designed to automatically configure the RS232 serial ports on the computer to ensure proper communication to the laser controller. The GUI will allow the users to do the following tasks:

- Open and close the system shutter
- Turn on and off the pump diodes
- Adjust the repetition rate
- Adjust the number of pulses contain in burst when running burst mode- Adjust the output power of the laser

5.1 Basic Page Introduction

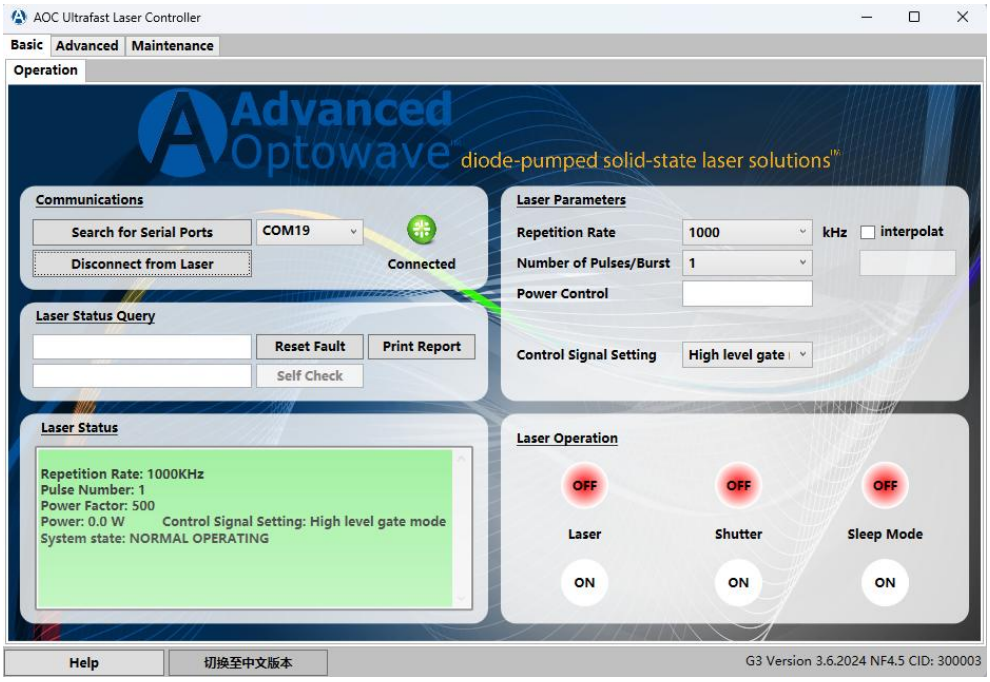


Figure 1: Basic Screen

The connectable serial port may not be displayed in the drop-down menu. Please click the "Search for Serial Ports" button. Then, the system will automatically search and display the connectable serial port. Then click "Connect to Laser", the system will be automatically connected and enter the initialization stage. (Note: It is necessary to select the correct serial port by yourself if multiple serials are connected in the computer, otherwise the system will display an error message.)

- Laser Parameters area
  - ✧ Repetition Rate: Selection of the operating frequency of the laser.
  - ✧ Number of Pulse/Burst: This allows the user to determine the number of pulses they would like in each burst. The spacing between the pulses in the burst will be spaced at 50 ns and the bursts will be delivered at the selected repetition rate
  - ✧ Power Control: This allows the user to set the laser's output power. The is a value from 0 to 1000, with zero being no output and 1000 being maximum power. Each laser ships with a calibrate lock-up sheet that can be used to set the desired output power.
  - ✧ Control signal setting: Setting of the laser control mode.
- Laser Operation area
  - ✧ Laser OFF/ON: Laser on/off button. When the 'Laser ON' button is pressed, the system will undergo a 5-minute warm-up/initialization process. The laser diodes will turn on and the system will warm up. The system will be ready to be used after the systems has completed its Initialization process.
  - ✧ SHUTTER OFF/ON: To open the shutter press the Shutter ON button. To Close the shutter, press the Shutter OFF button. The shutter ON feature will be available 5 minutes after the Laser button is pressed.
  - ✧ Sleep Mode OFF/ON: Sleep mode is used in cases where the laser will not be used for more than one hour. Sleep mode will safely turn off the laser's diodes. Sleep mode is designed to help prolong the life time of the systems diodes and optics. To exit Sleep Mode, press the Sleep Mode OFF button. The laser diodes will ramp up to their previous current sent points.
- Laser Status Query area
  - ✧ The blank box above is the input field for laser commands.
  - ✧ The blank box below is the feedback field for laser commands.
  - ✧ Reset Fault: The button to eliminate alarms. The alarm can be eliminated by pressing this button when the malfunction is resolved.
  - ✧ Print Report: The button is used to record the systems operating parameters into a text file. This text file will be saved to the same location where the GUI is saved to.
- Laser Status area

This section of the GUI is a system status window that will display the last setting for the Shutter Status, Pump Diode Status, Repetition Rate(PRF), Output Power Setting(MCS) and the Number of Pulses/Burst(PSN).

5.2 Advanced Page Introduction

Click the "Advanced" and enter the password "AOC" (in capital letters), shown in Figure 2.

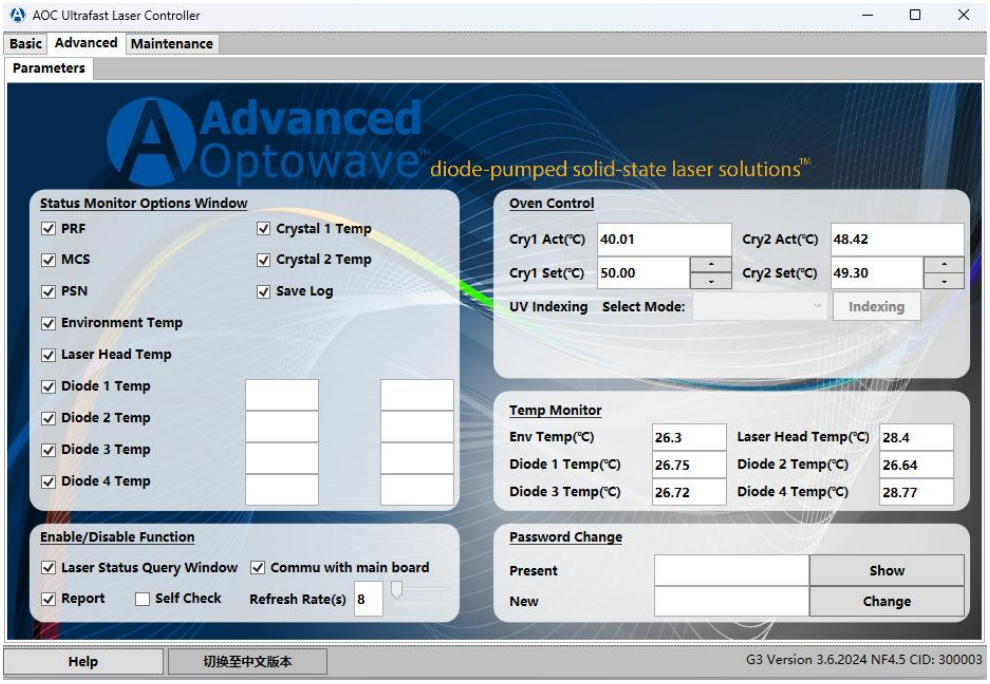


Figure 2: Advanced screen

- Status Monitor Options Window Area

Only by checking the box corresponding to the function, you can enter the corresponding command in the Laser Status Query of the Basic interface.

- Oven Control Area

Crystal temperature control area: UV lasers have two crystals, GR lasers have only one crystal (crystal1), and IR lasers have no crystals.

- Temp Monitor Area

Display the various temperatures of the laser.

- Password Change Area

Change login password.

6 Laser Basic Operations

6.1 Laser Start-up Procedure

- Connect the laser to the computer with RS232, turn on the laser power, and turn on the laser key switch. Warm up the machine for 5–8 minutes until the cooling system reaches the set temperature and stabilizes.
- Launch the AOC GUI on your computer. Click “Search for serial ports” button, select the serial port you are using. On the GUI click “Connect to laser” button to connect the computer to the laser controller. The status showing in the system.

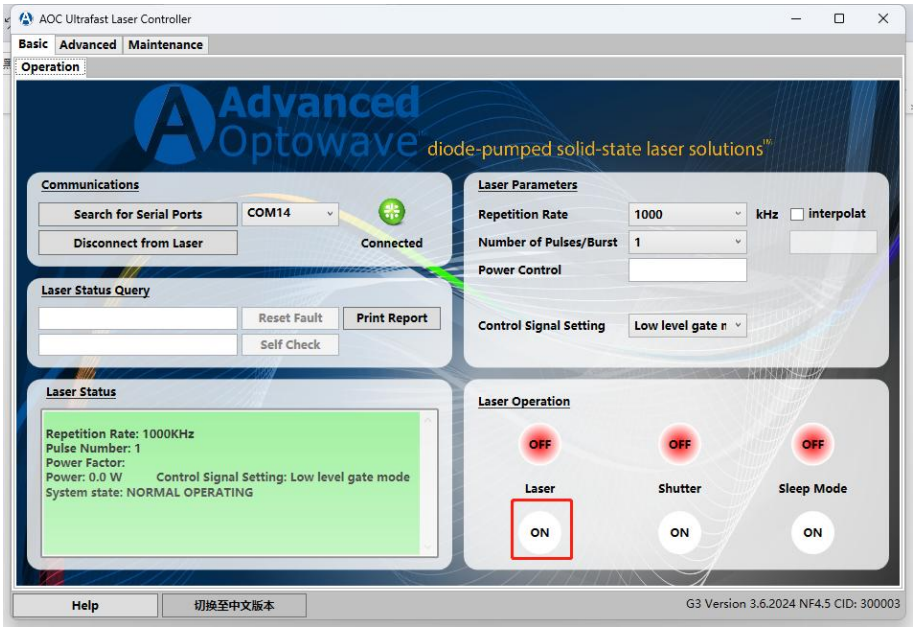


Figure 3: Laser initializing

- After 2 minutes, the following interface appears, indicating that the software has been correctly connected.
- Click the “Laser ON” button in the GUI. After approximately 7 minutes, the laser finishes starting up, and the "laser on" button changes from red to green. The Laser Status interface displays system statuses of the laser such as frequency, Power Factor, and PSN.
- Now that this system is fully operational, open the shutter by clicking the “Shutter ON” button in the GUI. Please make sure the output beam is contained in the external power meter and laser safety glasses are being used. Allow the system to warm-up and thermal stabilize for another 20 minutes before using the laser for your given application.

Note: It is important that the system is allowed to thermally stabilize for 20 minutes when power is first applied to the system. The system will maintain a stable harmonic temperature.

6.2 Laser Shutdown Procedure

- Using the AOC GUI close the shutter by clicking the "OFF" button located in Laser Operation Window section of the AOC GUI.
- Using the AOC GUI turn the laser off by clicking the laser "Off" button located in Laser Operation Window section of the AOC GUI.
- Press the Disconnect button in the Communications Window of the AOC GUI.
- On the front panel of the laser controller rotate the Key counter-clockwise to turn the Key Switch to the off position.

Note: After shutting down the laser system, it is recommended to keep the main power switch of the controller turned on to ensure the power supply of the controller, because the crystal temperature control module of the laser controller is still in working condition at this time, which can reduce the warm-up time when the laser system is restarted and extend the working lifetime of the crystal.

6.3 Power Control – MCS

The Power Control or MCS allows for fast control of the out power of the laser without causing stability or beam quality related issues. The command operates by using a MCS value to determine the different output powers the laser will operate at. During the final test process, INNO will calibrate the MCS values and provide a lookup chart showing the different laser output power for different MCS values. Maximum output power is achieved at an MCS Value of 1000. Conversely the minimum output power is achieved at an MCS Value of 0. These values can be inputted into the Power Control(MCS) window in the Laser Parameter Window section of the AOC GUI.

6.4 Burst Mode – PSN

The Burst Mode function allows a user defined number of pulses to come out as a burst. Each pulse is separated by 50 ns and each burst is at the repetition rate of the laser. In Figure 4, we show a diagram as an example of burst mode operation. To define the number of pulses in the burst use the Number of Pulses/Burst – PSN window in the Laser Parameter section of the GUI. The acceptable numbers in this window are 1 to 10, while the maximum number of pulses in a burst is 10 however this maximum value is dependent on the operating Frequency. If the user wants to operate the laser in standard, non-burst mode the value should be set to one(1).

Note: Before changing the PSN value the diode working current must be adjusted. After the

PSN value is changed the diode current will again need to be adjusted to prevent damage to the system. Please reference the laser test report for the system as it will contain a table which will provide the current value for each PSN value.

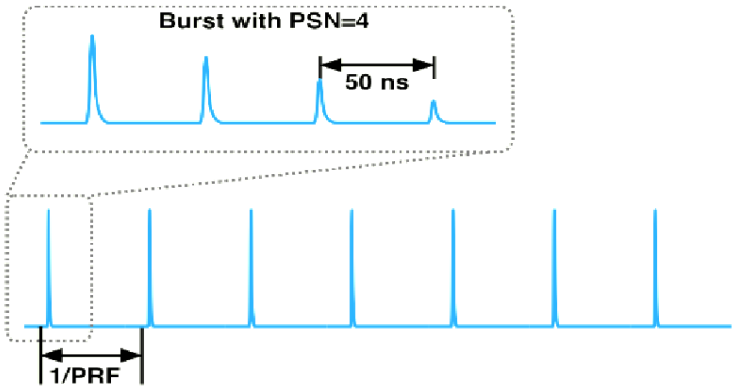
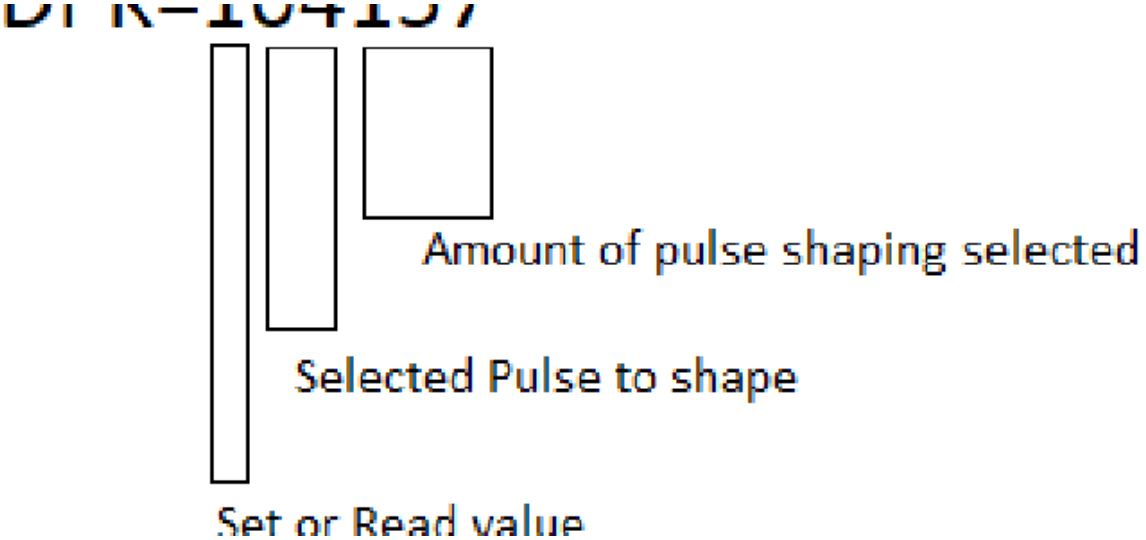


Figure 4: Example of Burst Mode Operation

6.5 Pulse shaping adjustments – DKP

DPK mode allows the user to adjust the pulse height of each individual optical pulse in a Burst train. The command used is DPK=xxxxxx and below is an explanation of the values used in the command



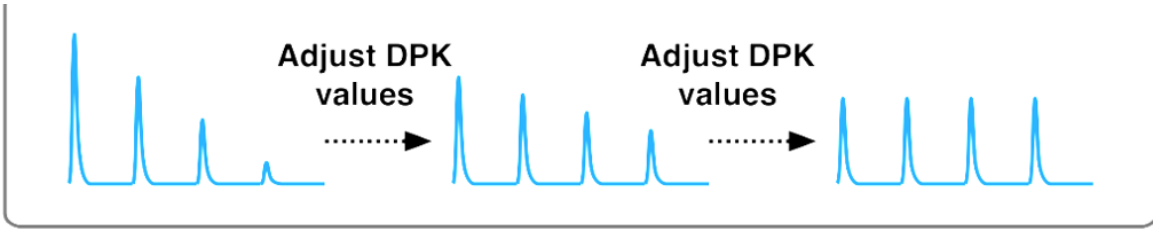
- The first digit sets the Set or Read value. 1 is to Set, 2 is to read.
- The next 2 digits selects the pulse number to be adjusted, value can be between 01 to 10. The above diagram shows pulse number 4 as being selected.
- The last 3 digits are the amount of pulse shaping to apply, value can be between 0 and 255 where 0 is minimum pulse shaping and 255 is maximum pulse shaping

To adjust the optical pulse height, you will need to enter the command DPK= followed by the value to set the command logic(read or set), then select the optical pulse to be selected followed

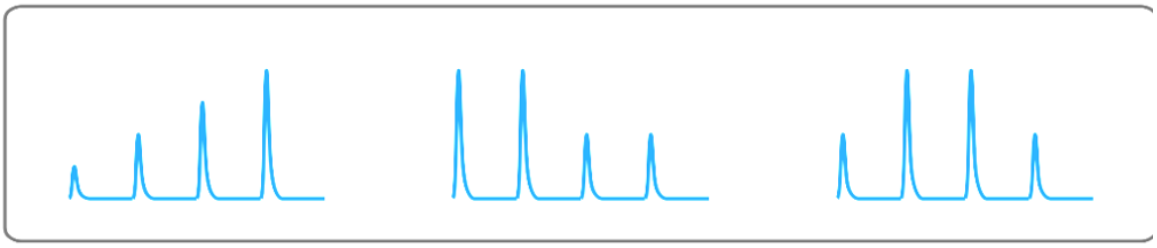
by the amount of pulse shaping adjustment. Press enter to that your command will take effect.

Now view your pulse height on your oscilloscope and continue to enter the command with a higher or lower pulse shaping value to meet your pulse height requirement. When this is achieved, you can then move on to the next optical pulse in the train to adjust its height. View the pulse train on your oscilloscope and make your pulse shaping adjustment as necessary for the second pulse to meet your requirement. Please note when you have completed the adjustment of the second pulse height, the pulse height of the first optical pulse may have changed. You will now need to readjust the pulse height of the first optical pulse to the level of your specification. After you have optimized the first and second optical pulse in the burst you can then adjust the third optical pulse in the same fashion as the previous two pulses. Note that by adjusting the third optical pulse height, the height of the first and second optical pulse may have changed. You will then need to readjust all three optical pulses until all three meet you're your optical pulse height requirement. Continue to adjust the next optical pulse to meet your requirement followed by the re-optimization of the previous optical pulses so that they meet your requirement. Please note that the pulse height within a single burst will be duplicated in all the bursts in the burst train.

Adjust DPK value to change pulses shape within a burst



Other examples



The DPK command can be used to adjust the pulse heights within a burst to be of the same height. DPK can also be used to customize each optical pulse height to meet your requirement. Please see the above diagram for reference.

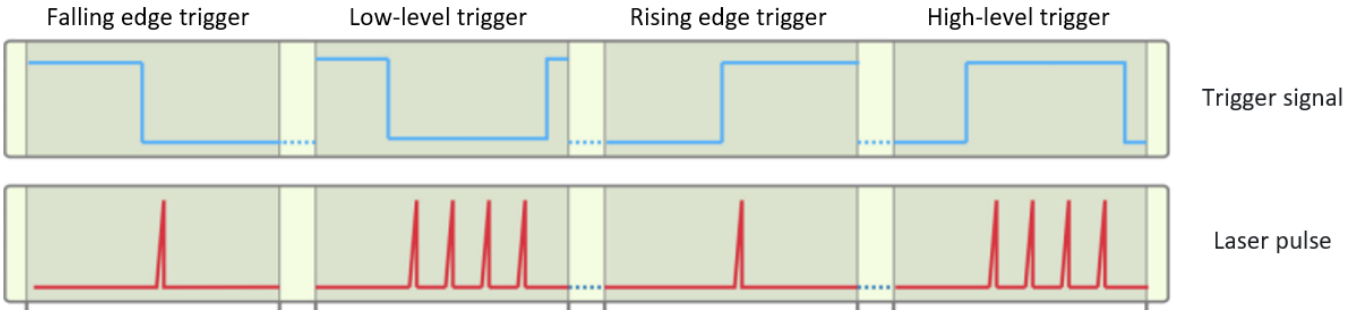
7 Laser Triggering Methods

7.1 Requirements for Control Signals

- The signal line needs to use coaxial cable.
- The high - level threshold of the TTL signal voltage is between 4V - 5.5V, the low - level threshold is less than 1.2V, and the rise and fall times should be less than 20% of the pulse width.
- The signals triggered by the level, the time interval between two signals must be greater than the period of one laser pulse (1/PRF)
- The width of the triggered signal must be > 600ns, and the interval between two trigger signals must be greater than the period of one laser pulse (1/PRF).

7.2 Introduction to Control Methods

The laser can be controlled to emit light or not through a TTL signal. AMT laser supports four trigger modes: falling edge trigger, low-level trigger, rising edge trigger and high-level trigger. You can refer to the following figure to set the working mode of the laser.



- Falling Edge Trigger

In falling edge trigger, the laser will emit one and only one pulse (pulse or pulse burst). When the laser receives an external trigger signal, the laser will start to output a laser pulse within a very short time (<1 us).

- Low-level Trigger

When the laser detects that the trigger signal provided by the user changes from high level (5 V) to low level (0 V), the laser will continuously emit light according to the set repetition frequency. The laser will only stop emitting light when the trigger signal provided by the user changes from low to high.

- Rising Edge Trigger

In rising edge trigger, the laser will emit one and only one pulse (pulse or pulse burst). When the laser receives an external trigger signal, the laser will start to output a laser pulse within a very short time (<1 us).

- High-level Trigger

When the laser detects that the trigger signal provided by the user changes from low level (0 V) to high level (5 V), the laser will continuously emit light according to the set repetition frequency. The laser will only stop emitting light when the trigger signal provided by the user changes from high to low.

7.3 POD and PWM

The PWM mode has two main characteristics. First, like the POD mode, it is only controlled by edges (rising edge or falling edge). When the laser receives an external edge trigger signal, the laser will start to output a laser pulse (or a burst of laser pulses in burst mode) within a very short time (<1 microsecond). Second, unlike the POD mode, the energy of the output pulse changes with the trigger frequency. When customers want to adjust the power at different frequencies, they need to control it through MCS commands or externally controlled analog voltage.

7.4 The Simulated External Control Power Mode

In order to meet the different needs of customers, we have added the external control power mode for the laser. Connect the external DC voltage (0 - 10V) through pin 1 and pin 9 of the DB15 Interface. In the ACA external control mode, control the laser's light output.

The DB15 Interlock connector in the random accessories has led out the two pins required for the external control mode, which are red and black wires. The red wire is connected to the + pole of the external DC voltage, and the black wire is connected to the - pole of the external DC voltage. The allowable external control voltage is DC voltage (DC) 0 - 10V.

Please turn off the laser before wiring. After the correct wiring is completed, first turn on the laser. After turning on, enter “ACA=1” in the command box under Laser status Query to turn on the external control mode. At this time, the laser does not emit light. After turning on the external DC voltage input, the laser emits light normally. When the voltage is 10V, the maximum power is output.

8 Maintenance

8.1 Maintenance Schedule

Frequency	Detail
Monthly	Check and optimize the maximum power of the laser
Every 2 Months	Check the laser output window for damage
Every 3 Months	Check the chiller coolant level
Every 6 Months	Replace the chiller coolant
Every 12 Months	Clean the chiller and the controller's fans of dust

- Optimize the maximum power of the laser

Regular measurement and optimization of laser power can improve the stability and reliability of product usage, and it is also beneficial to the lifespan of the laser.

The UV laser is equipped with two (2) harmonic crystals. GR laser only has crystal 1. Below are the steps to optimizing Crystal 2's temperature. The same steps are also applicable to optimizing crystal 1.

- ✧ While in Basic screen please hit the Advanced page, the password is AOC. Once the Advanced page is opened located the Crystal 2 Temperature Adjustment Section, see figure 5.

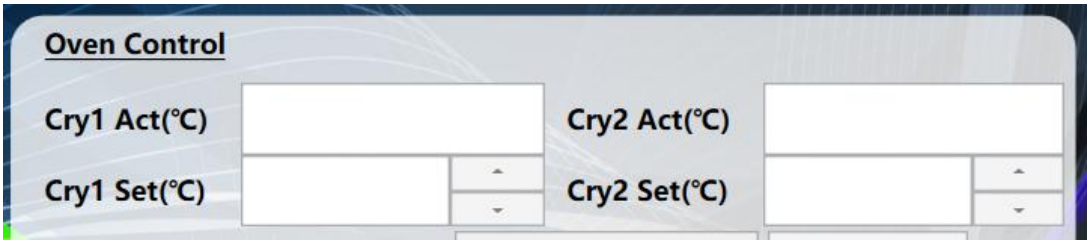


Figure 5: Temperature of crystal

- ✧ During this procedure, please make sure that there is a power meter in front of the laser and that you are monitoring the power as you make the following adjustments.
- ✧ Using the 'UP' arrow located to the right of the set temperature, make small 0.5°C adjustments to the set temperature (this can be done by checking the 0.1 box). It will take a few seconds for the crystal to respond to the change.
- ✧ If the power shown on the power meter increases, continue making 0.5°C adjustments until the output power decreases; at this point, you have passed the optimal crystal temperature.
- ✧ Once the maxima temperature has passed, please start lowering the set temperature in 0.2°C steps, until the laser has reached its peak performance.

- Check the laser output window for damage

The AMT laser is equipped with a replaceable output window. This window should be inspected every 2 months depending on the laser usage. This test requires the user to wear safety laser glasses. To inspect for damage, please setup a beam block capable of handling the full output of the laser. The beam should look round and free of scatter. If you see a large amount of scatter around the beam the output window should be replaced.

To replace the output window, execute the following steps

- ✧ Shut down the laser using the steps shown in Section 5 Laser Operation, subsection5.4 – Laser Shut Down Procedure.
- ✧ Remove the four screws holding the output window into the laser housing.
- ✧ Remove the window from the housing. The output window is a Brewster window. In order to minimize downstream alignment issues, please note the orientation of the window when removing it from the laser housing.
- ✧ Insert the new output window into the laser housing – noting to insert the window with the same orientation as the old window. Using the four original screws secure the laser window in the laser head.
- ✧ Restart the laser using the steps shown in Section 5 Laser Operation, subsection5.2.4 – Start Laser Procedure
- ✧ Plug the chiller back into the power source located on the rear panel of the laser controller and turn the power switch on the chiller to the "On" position.
- ✧ Using the Key Switch on the laser controller turn on the main power and energize the chiller to circulate the new coolant in the system – you may have to add new coolant.
- ✧ Replace the black filler cap.

- Check the chiller coolant level

Some laser models require the use of an external chiller unit. This chiller unit provides chiller liquid coolant to the laser head and the controller to regulate their temperatures to a set level. The coolant level of the chiller unit should be checked every 3 months to ensure that it is at its maximum capacity.

- Replace the chiller coolant

The regular coolant replacement ensures that the system is free of contamination and that the coolants anti corrosive properties are not depleted. To drain the system the chiller must be in the OFF position and the AC cord unplugged. Remove the VENT plug and remove the rubber fill plug. Locate the female water connecter that is next to the coolant. Remove one of the water

hoses from the system. Insert one end into the plug labeled DRAIN. Press in the male connector of the other end of the water hose and coolant should flow out. The reason why you must press the tip of the male water connector is because the water fittings are self-sealing, and they are designed to prevent unwanted coolant leakages. Pressing the tip of the fitting will open the seal and allow coolant to flow. When the coolant stops flowing disconnect the water hoes from the DRAIN fitting and fill the clear plastic tube with fresh coolant so that it reached the MAX fill line. Turn on the system and allow the coolant to circulate. The coolant level will drop as the coolant fills the cavity of the laser and the coolant lines. Add coolant as necessary.

- Clean the chiller and the laser's fans of dust

During the long-term use of the cooling fan of the laser, dust will accumulate on it, resulting in a decline in heat dissipation performance. Compressed gas can be used to clean the fan and the heat sink. Pay attention to protecting the window mirror and other lenses during the cleaning process.

8.2 Special Response from Laser

Special case	Response from laser is always 6 digits (each digit is between 0-9)	Comments
Any error message: wrong message, wrong message ending (0xD, 0xA), or incorrect value range.	ERROR	Need to check the message, the ending and value. If it is caused by RS232 bit error rate, PC needs to resend message
PC tries to send message to laser driver when it is busy with other high priority task.	BUSY	Wait for laser driver to finish its task
When laser alarms any command sent to laser driver will be ignored and get a return of "ALARM", followed by the alarm condition code.	Example: ALARM 000007	Indicates laser is alarming because of interlock open
When alarm condition cleared, laser will require user to press RESET button by GUI. Before the button is pressed any commands to laser will be ignored and get a return "RESET"	RESET	RESET by user required

8.3 Laser alarm promotion and solutions

Code	Malfunction Description	Solutions
000001	Diode Temperature High	Check whether the chiller is working, whether the water temperature and pressure are normal, and whether the water hose is blocked.
000002	Diode Temperature Low	Check whether the temperature sensor is loose. Check whether the environment temperature is too low. Turn on the air conditional if the indoor temperature is too low.
000003	Laser Head Temperature High	Check whether the chiller is working, whether the water temperature and pressure are normal, and whether the water hose is blocked.
000004	Laser Head Temperature Low	Check whether the temperature sensor connector is loose. Check whether the environment temperature is too low. Turn on the air conditional if the indoor temperature is too low.
000005	Environment Temperature High	Check the indoor temperature, please turn on the air conditional if it's too high. Check whether the air inlet and outlet of the laser controller are blocked.
000006	Environment Temperature Low	Check if the temperature sensor plus is loose. Check whether the indoor temperature is too low (15C or below), Turn on the air conditional if it is too low.
000007	Interlock Open	Check whether the interlock connector is loose. Check whether the connections is shorted
000009	Crystal 1 Temperature High	Restart the laser by cutting off the power and then turning it on again. Ensure that the ambient temperature is within the operating range.
000010	Crystal 1 Temperature Low	
000011	Crystal 2 Temperature High	
000012	Crystal 2 Temperature Low	

8.4 Laser common malfunction troubleshooting

Malfunction Description	Solutions
Beam quality degrades	Check whether the laser current value is consistent with the factory report Check whether external optical components (e.g., the f-theta lens, beam expander, reflector, and laser window) are dirty or damaged.
No beam output	1. Check whether the laser alarms. 2. Select the low-level light output mode, unplug the light output signal cable, and check if the laser emits light. 3. If the light can be emitted when the signal is unplugged, but the light emission cannot be controlled when the light-emitting signal is plugged in, please check whether the light-emitting signal is normal. 4. If the light cannot be emitted, please check the parameters of the laser. Click "Print Report" to check if there are any abnormalities in the laser parameters. 5. Check whether the voltage of the external power supply switching power supply changes to meet the requirements.
Power attenuation	1. Check whether the parameters in the laser's Report are consistent with those in the factory report. 2. Confirm whether the control signal voltage is normal. 3. Check whether the laser window is broken. 4. Check whether the temperature of the laser is abnormal. If all the above items are correct and the power is still weak, then the crystal temperature needs to be optimized. Crystal optimization method: 1. Switch the laser working mode to 01 internal control mode. 2. Put the power meter in front of the laser window. 3. Click Enable on the Engineer interface of the laser control software. 4. Refer to the power meter, adjust the temperature of crystal 2 first, just click the arrow icon below Crystal 2. If the power rises when the temperature of crystal 2 is increased, continue to increase the temperature, otherwise reduce it until the crystal temperature does not change or decay any more. 5. Adjust the temperature of Crystal 1 with same method and optimize the temperature of Crystal 2 again after completion

Wherever you are, the instant service will be provided for you.

- **ADVANCED OPTOWAVE CORPORATION**

Advanced Optowave Corporation USA
40 Fleetwood Ct, Ronkonkoma, NY 11779,USA
Tel: : 001-631-750-6035
FAX: 001-631-803-4445
Email: info@a-optowave.com
http://www.a-optowave.com

- **Shenzhen Inno Laser Technology Co.,ltd.**

11F, A1, 1st phase, Creative City Building, Nanshan District, Shenzhen, China
Tel:+86-755-8635 0999
Fax:+86-755-8635 5000

Floor 6, Building 3, Xinlun Science and Technology Industrial Park,
Zhangwu Crossing, Tangjia Community, Guangming, Shenzhen
Tel: +86-755-2340 5158

Room 16, Floor 5, 99 Commons Building, Pui To Road, Tuen Mun, NT, HK

Email:info@inno-laser.com
http://www.inno-laser.com

- **Changzhou Inno Machining Co.,ltd.**

Yingnuo Laser Building, 18-69 Changwu Middle Road,
Wujin District, Changzhou City, Jiangsu Province, China
Tel: +86-519-86339051 / 86339052
Fax: +86-519-86339050
Email:info@inno-laser.com
http://www.inno-laser.com