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He-Cd Laser Instruction Manual

IK3, 4, 5 Series

Power Supply KP2014C

Read this instruction manual carefully before handling the laser. Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

KIMMON KOHA CO., LTD.

Introduction

Thank you very much for purchasing the Kimmon Koha Co., Ltd. He-Cd laser system. This system is a compact, light-weight and high-performance product that utilizes Kimmon's He-Cd laser technology which has been developed over many years. For your safety and to maintain long-lasting performance of this laser system, carefully read these instructions before attempting to handle the system. Always implement the correct method of operation by understanding the features offered in this laser system.

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1. Precautions for Safely Handling the Laser

This laser system adopts labeling that complies with International Electro-technical Commission (IEC), and the Center for Devices and Radiological Health (CDRH), which is based on the American National Standards Institute Inc. (ANSI). The CDRH standards are federal US law. Laser equipment exported from Japan to the United States of America must conform to these standards.

1-1 Safe Handling of the Laser Light

This laser system is classified as a "Class 3B" laser by IEC60825-1(Safety of laser product). Looking directly into Class 3B laser, or allowing laser beam reflected by the mirrors to enter the eyes is dangerous and can damage your eyes.

Setup the laser system at a height where laser beam will not enter the eyes. Also, always wear protective glasses when using the system. Use 325 nm or 442 nm protective glasses. Always follow the procedures defined in this manual to control or to adjust the system. Controls and adjustments using procedures other than those described in this manual will result in exposure to dangerous laser radiation.

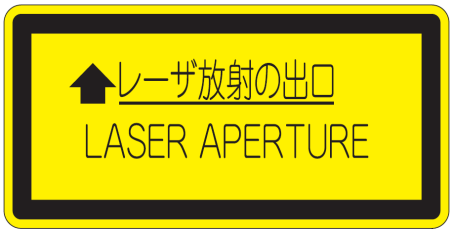
1-2 IEC-based Labeling



Explanatory Label 1



Explanatory Label 2



Aperture Label



Warning Label



Safety Interlock Release Warning Label

1-3 CDRH-based Labeling



Warning Logo Type Label 1



Warning Logo Type Label 2



Certification and Identification Label

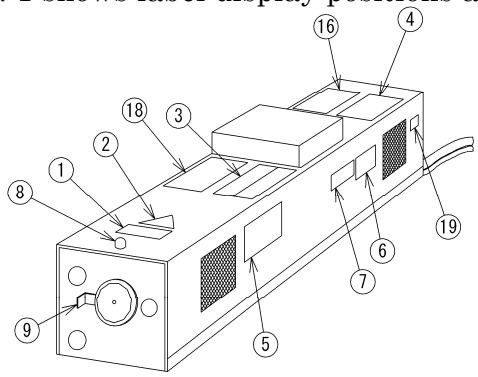


Aperture Label

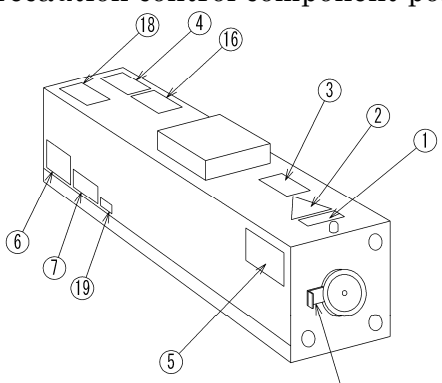


Safety Interlock Release Warning Label

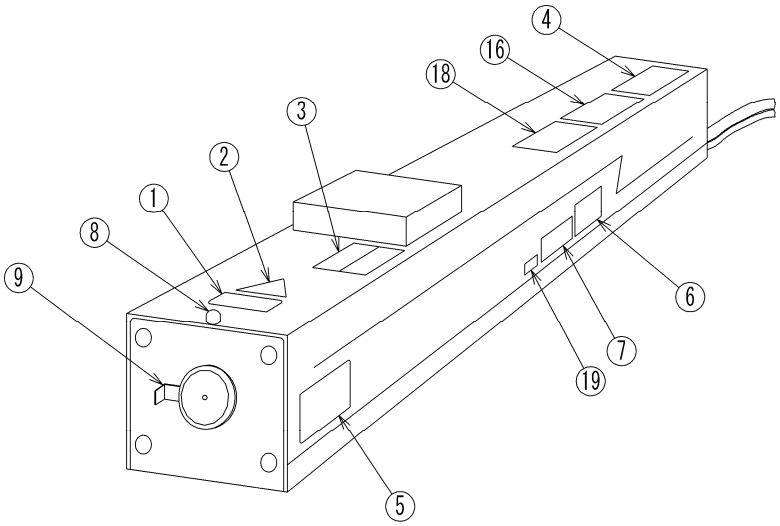
Fig. 1 shows label display positions and safety precaution control component positions.



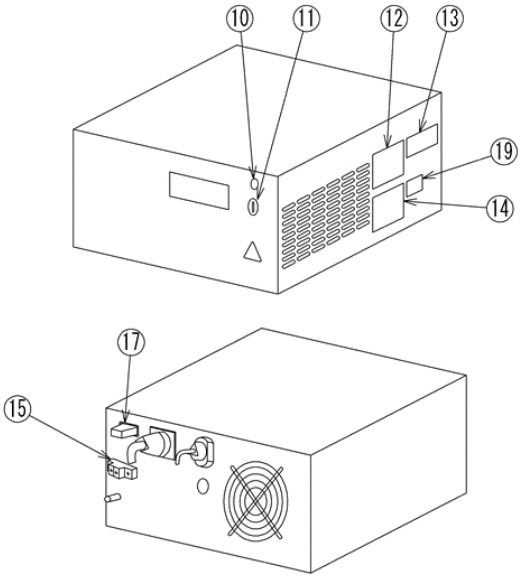
Laser Head
MODEL : IK****-B



Laser Head
MODEL : IK****-C



Laser Head
MODEL : IK****-D,E,F,G



Laser Power Supply
MODEL : KP2014C

Fig. 1 Label Display Positions and Safety Precaution Control Component Positions

1: Aperture Label (IEC, CDRH)
2: Warning Label (IEC)
3: Warning Logo Type Label (CDRH)
4: Safety Interlock Release Warning Label (IEC, CDRH)
5: Explanatory Label (IEC)
6: Certification and Identification Label (CDRH)
7: Revision Label
8: Laser Head Indicator
9: Shutter
10: Laser Power Supply Indicator
11: Key Switch
12: High Voltage Caution Label
13: Revision Label
14: Certification and Identification Label
15: Remote Interlock Connector
16: Power Supply Recognition Label
17: Input Voltage Display Label
18: This Side Up Label
19: CE Label

1-4 Caution for High Voltages

High voltage of approximately 8 kV, without a load, is supplied from the laser power supply to the laser head on this system. To prevent electric shocks from occurring after you connect the power supply cable (AC input power supply), absolutely never remove the laser power supply and laser head cover.

Also, when replacing the laser head or laser power supply, always turn the laser power supply key switch to the off position (turn the key in the counterclockwise direction so that it is vertical), and wait for 5 minutes or more before disconnecting the power supply cable.

1-5 Caution for Handling High Temperatures

The surface of the discharge tube will reach temperatures higher than approximately 200°C when the system is running. Therefore, this will remain hot for some time after discharging is stopped. There is the dangerous possibility of receiving a serious burn injury if you touch the discharge tube or components in the head. For that reason, absolutely never remove the head cover.

1-6 Cautions for System Transportation, Moving, Installation

The laser system is a precision instrument. Be particularly careful not to expose the laser head to excessive impacts or vibrations while conveying, moving or installing it. Also, when transporting, moving or installing the laser head, absolutely never stand it up, lean it, or turn it upside down because these can cause a malfunction. When transporting the laser, use our packing materials. Pack the laser in the normal direction.

Install the laser system in a level place. Avoid installation environments that will expose the system to high heat, humidity, and dust. Also, never place objects near the always ventilating holes in the laser system. Select a location where the laser head will not be directly exposed to wind and the like from air conditioning systems or other such equipment.

1-7 Protective Ground Terminal (Earth Terminal)

Always connect the system to a ground when in use. An earth terminal is incorporated into a 3P-type plug of the power supply cable. When the AC power supply side is a 3-pole outlet that has a grounded, protective ground outlet, the laser system will automatically be grounded by inserting this plug.

If the AC power supply side has only a two-pole outlet and does not have a grounding terminal, always ground the earth terminal to the ground by getting power through a 3P-2P adapter.

1-8 Heterogeneous Power Supplies and Heterogeneous Input Voltage Usage Cautions

The laser head has been adjusted with a stipulated type of laser power supply and input voltage. If a laser power supply or an input voltage that is a different type is mistakenly used, that can be a cause of system malfunction. Always use the stipulated type of laser power supply and input voltage. Check the “laser power supply recognition label” for the stipulated type of laser supply and the “input voltage display label” for the input voltage.

(See Fig. 1 Label Display Positions and Safety Precaution Control Component Positions)

1-9 Modification Prohibited

If the laser system is modified, not only will it no longer be covered by our warranty, but using a modified system is extremely dangerous. Never attempt to do so. Furthermore, removing the fixed feet on the laser head particularly affect laser characteristics in its structure. For that reason, absolutely never remove them.

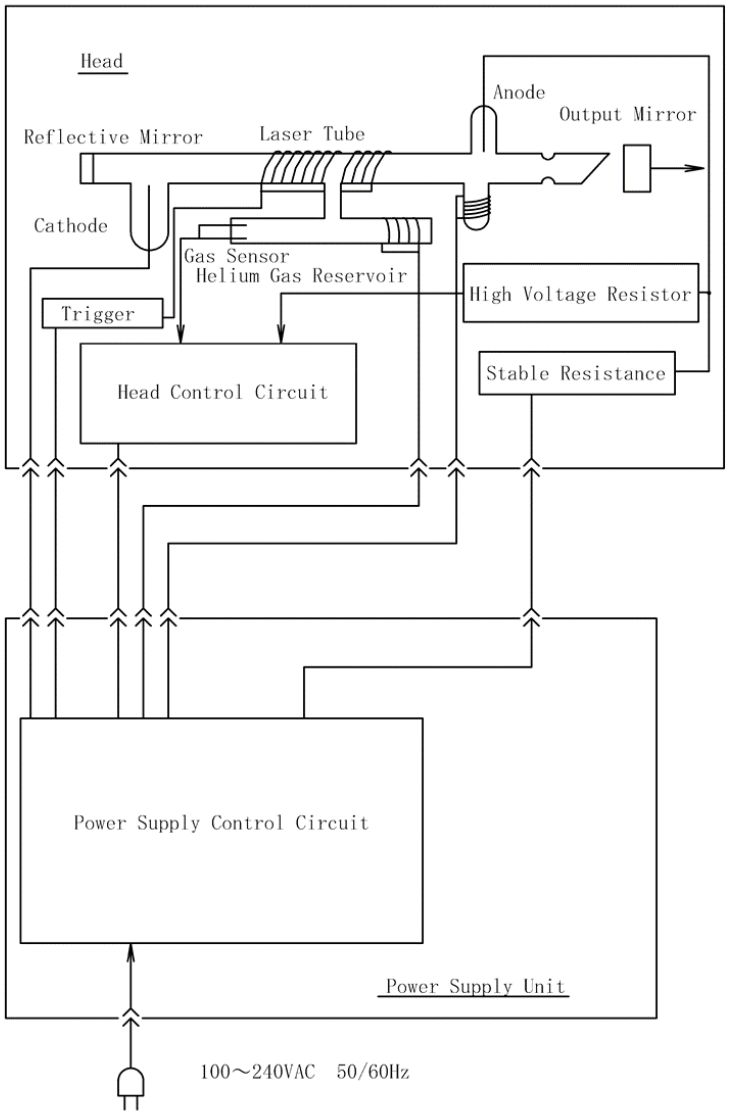
2. Overview of the Laser System

2-1 Overview

This system provides a laser that is classified as a metal vapor laser that uses He (helium) and Cd (cadmium) as laser active media. This system is composed of a discharge tube wherein He and Cd are sealed; a laser head composed of a resonator and a reflective mirror; a control circuit for tube voltage, tube current and He gas; and a laser power supply with an embedded interlock circuit. Also, the laser head and laser power supply are compatible because of a laser head control circuit board. For that reason, the laser head is easy to replace because of tube lifetimes or the like.

To run the system, connect the laser head, direct coupling high voltage cable and the low voltage (signal) cable to the laser power supply. After allowing startup time of ten minutes with only the key switch turned on, the system will automatically shift to a steady state, and oscillate wavelengths of 325 nm or 442 nm, or dual wavelength simultaneous CW (continuous) laser light.

2-2 Basic Configuration Diagram



MODEL: KP2014C

Fig. 2 Laser System Basic Configuration Diagram

2-3 Description of Basic Operations

(1) Start Discharge

The laser power supply and laser head warning lights illuminate by turning on the key switch. This also supplies a current to the cathode heater in the laser head discharge tube. It is prohibited to supply high voltage to the anode for approximately 1 minute and 30 seconds, when starting up the cathode, and to cool the inside of the laser head or when restarting immediately after discharge is stopped. A startup direct current voltage of approximately 8 kV is charged to the anode after approximately 1 minute and 30 seconds. Electric discharge is started between an anode and cathode, tube voltage will fall in an instant. The tube voltage at that time is about 1.7～3.8 kV. The tube current becomes a constant electric current via the control circuit in the laser power supply, and behaves consistently at the 70～95 mA setting value.

(2) Cd Vapor Pressure (Tube Voltage) Control Mechanism

When a discharge is detected in the discharge tube, control of the tube voltage is started. Start laser oscillation when the Cd metal vaporizes thereby increasing vapor pressure a certain degree, and tube voltage decreases. The tube voltage and Cd vapor pressure have an inverse proportional relationship. When the Cd vapor pressure increases, the impedance (R) in the tube drops, but the tube current (It) is fixed, so the following equation is established.

$$\text{Vt (Tube Voltage)} = \text{It (Tube Current)} \times \frac{\text{R}}{\text{Pcd (Cd Vapor Pressure)}}$$

Control of Cd vapor pressure (tube voltage) is accomplished by controlling the temperature of the heater that sets the Cd vapor pressure by differential amplification of the tube voltage signal for the standard voltage. Fig. 3 shows the general relationship between tube voltage, laser power and noise. During the manufacturing process, characteristics for each laser tube are measured and adjusted to the optimum tube voltage for shipping.

(3) He Gas Pressure, Laser Output, and Noise Characteristics

Laser power and noise characteristics are affected by tube voltage as well as tube current and He gas pressure. Fluctuations in He gas pressure bring about the following general characteristics.

As shown in Fig. 4, the output characteristic for the tube voltage when there is He gas pressure P becomes the curved line that has the maximum value. Also, noise characteristics will fluctuate drastically with regard to the tube voltage. It will then become lower, and then stabilize.

The characteristic when the He gas pressure increases only ΔP is represented by the dashed line. The characteristic curved line shifts overall to the top right. Conversely, when lowered, it shifts to the bottom left. However, this is slightly different depending on the characteristics of each discharge tube.

When the output characteristic exceeds a certain value (different depending on the tube) for the initial He gas pressure, the characteristic specifications may not be satisfied, for the increase and decrease of the He gas pressure. For that reason, adopt the He gas refilling system described at (4) to suppress fluctuations in He gas pressure.

(4) He Gas Pressure Control

In order to maintain laser power and noise characteristics, a He gas automatic refilling system (patented) has been adopted.

When running the laser, Cd vapor coagulates in the discharge tube. When that occurs, there is an action to absorb He gas, and a phenomenon where He gas permeates from the discharge tube wall to the outside; He gas pressure drops. To offset the amount that is dropped, a sensor for measuring the pressure of the gas in the tube and a gas reservoir that is sealed with high-pressure He gas from the discharge tube are incorporated in the discharge tube.

This system amplifies the signal voltage of the gas pressure sensor, compares that to a standard voltage (initial setting value). If the He gas pressure is low, the He gas refilling circuit is activated to refill He gas into the discharge tube from the He gas reservoir.

If the He gas pressure is high, it is not refilled. The He gas pressure setting is adjusted using a volume on the control circuit board located on the side of the head. When you turn the He gas pressure adjustment volume (see Fig. 5(a)) in the clockwise direction, the display LED lights. When this lights, a current flows to the heater, and He gas is refilled. To increase the He gas pressure, turn this volume in the clockwise direction. To reduce the pressure, turn this volume in the counterclockwise direction. However, for approximately 30 minutes after turning on the switch, the pressure of the refilled He gas will fluctuate, so this is prohibited. Normally, this has been adjusted before shipping. He gas pressure adjustments are normally not necessary.

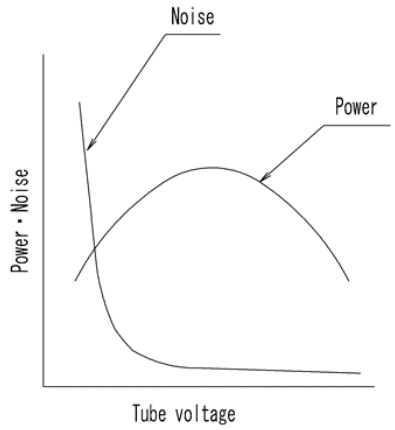


Fig. 3 Optical Noise Characteristics Versus Tube Voltage

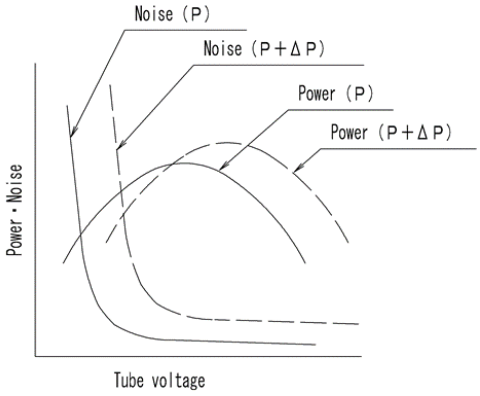


Fig. 4 Optical Noise Characteristics Versus Tube Voltage
(With Gas Pressure Fluctuation)

Head Control Circuit Board Adjustment Holes and Circuit Board Component Names

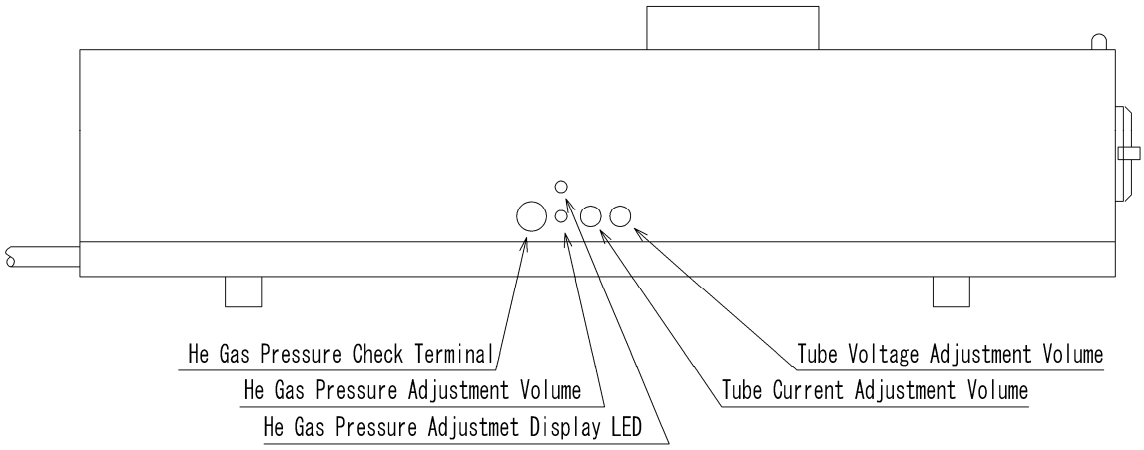


Fig. 5(a) Head Control Circuit Board Adjustment Holes
(Seal stamp for shipping)

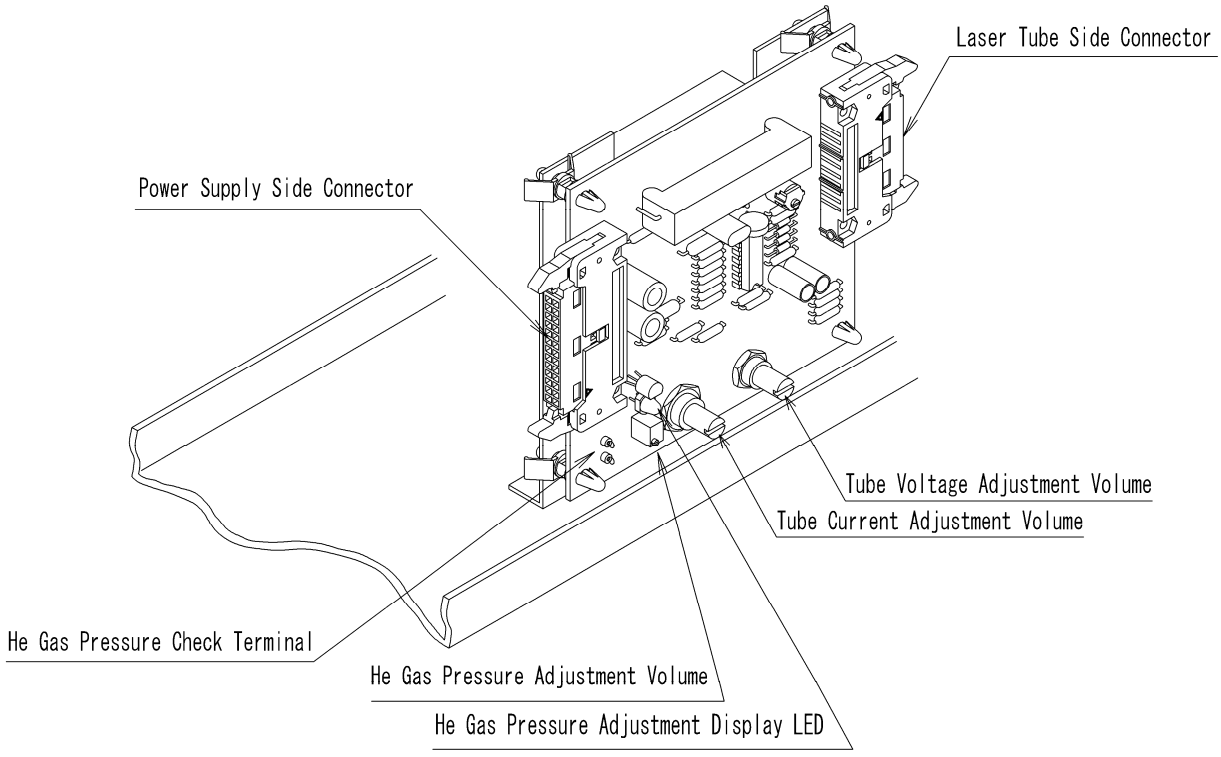


Fig. 5(b) Head Control Circuit Board Component Names

2-4 Specifications

2-4-1 Laser Head and Power Supply Combination

The laser power supply KP2014C supports the following lasers.

Laser Head	Laser Power Supply
IK3023R-BR IK3052R-BR	KP2014C
IK3031R-C IK3072R-C	
IK3101R-D IK3152R-D IK3202R-D IK3083R-D	
IK3151R-E IK3252R-E	
IK3201R-F IK3401R-F IK3452R-F	
IK3301R-G IK3501R-G IK3552R-G IK3802R-G IK3102R-G	
IK4123R-B	
IK4153R-C IK4151R-C	
IK4301R-D IK4401R-D	
IK4601R-E	
IK4101R-F	
IK4121R-G IK4131I-G IK4171I-G	
IK5351R-D IK5352R-D	
IK5451R-E IK5452R-E	
IK5551R-F IK5552R-F	
IK5651R-G IK5751I-G IK5652R-G IK5752I-G	

2-4-2 Laser System Specifications

UV IK Series Specifications (Wavelength 325nm)

Model	Power (mW)	Transverse Mode	Polarization	Beam Diameter $1/e^2$ (mm)*1	Beam Divergence (mrad)*2	Noise P-P, @30kHz ～ 2MHz (%)*2	Noise RMS, @30kHz ～ 10MHz (%)*2	Coherence Length (cm)
IK3023R-BR	2	TEM_{00}	Random	< 0.9	< 0.6	< 8	< 2.0	10
IK3052R-BR	5	TEM Multi-mode		< 1.5	< 0.8			
IK3031R-C	4	TEM_{00}	Linear	< 1.0	< 0.4			
IK3072R-C	7	TEM Multi-mode		< 1.8	< 1.0			
IK3083R-D	8	TEM_{00}		< 1.0	< 0.4	< 6		
IK3101R-D	10				< 0.5	< 10		
IK3152R-D	15	TEM Multi-mode		< 1.6	< 1.0			
IK3202R-D	25							
IK3151R-E	15	TEM_{00}		< 1.2	< 0.4		< 3.0	
IK3252R-E	30	TEM Multi-mode		< 1.8	< 1.0			
IK3201R-F	20	TEM_{00}		< 1.2	< 0.4	< 15	< 4.0	
IK3401R-F	40							30
IK3452R-F	45	TEM Multi-mode		< 1.8	< 1.0			10
IK3301R-G	30	TEM_{00}		< 1.2	< 0.5			
IK3501R-G	50							30
IK3552R-G	55	TEM Multi-mode		< 1.8	< 1.0			10
IK3802R-G	80							30
IK3102R-G	100							

Blue IK Series Specifications (Wavelength 442nm)

Model	Power (mW)	Transverse Mode	Polarization	Beam Diameter $1/e^2$ (mm)*1	Beam Divergence (mrad)*2	Noise P-P, @30kHz ～ 2MHz (%)*2	Noise RMS, @30kHz ～ 10MHz (%)*2	Coherence Length (cm)
IK4123R-B	14	TEM_{00}	Linear	< 0.9	< 0.5	< 5	< 2.0	10
IK4153R-C	20			< 1.0		< 10		
IK4151R-C	25							
IK4301R-D	30			< 1.1				
IK4401R-D	50							
IK4601R-E	70			< 1.2				
IK4101R-F	100				< 0.4	< 15	< 4.0	
IK4121R-G	125							
IK4131I-G	150							30
IK4171I-G	180			< 1.4	< 0.5	< 20	< 5.0	

Dual IK Series Specifications (Wavelength 325/442nm)

Model	Power (mW)	Transverse Mode	Polarization	Beam Diameter $1/e^2$ (mm)*1	Beam Divergence (mrad)*2	Noise P-P, @30kHz ～ 2MHz (%)*2	Noise RMS, @30kHz ～ 10MHz (%)*2	Coherence Length (cm)
IK5351R-D	5/35	TEM_{00}	Linear	< 0.9/1.0	< 0.5	< 10/10	< 2.0/2.0	10
IK5352R-D	10/50	TEM Multi-mode		< 1.3/1.3	< 1.0			
IK5451R-E	10/50	TEM_{00}		< 1.0/1.1	< 0.5		< 3.0/2.0	
IK5452R-E	15/65	TEM Multi-mode		< 1.3/1.3	< 1.0			
IK5551R-F	15/60	TEM_{00}		< 1.1/1.2	< 0.5	< 15/15	< 4.0/4.0	
IK5552R-F	25/100	TEM Multi-mode		< 1.5/1.5	< 1.0			
IK5651R-G	20/80	TEM_{00}		< 1.2/1.2	< 0.5			
IK5652R-G	30/120	TEM Multi-mode		< 1.8/1.8	< 1.0			10
IK5751I-G	30/110	TEM_{00}		< 1.2/1.2	< 0.5	< 15/20		30
IK5752I-G	40/150	TEM Multi-mode		< 1.8/1.8	< 1.0			10

Common Specifications

Model	Beam Pointing Stability (±rad)	Power Stability (%)*3	Warm Up Time (90% Output) (Min.)*3	Power Stability 10～40℃ (%)	Spectral Bandwidth (GHz)	Longitudinal Mode Spacing (MHz)	Laser Class	Weight (kg)
IK****R-B	25	≦±2.0 (4 hours)	15	2	3*4	280	3B / Ⅲb	8.5
IK****R-C						238		11.0
IK****R-D			20			194		16.0
IK****R-E						165		17.0
IK****R-F						129		19.0
IK****R(I)-G					1	113		23.5

*1 Measured at position 100 mm from beam window

*2 Pursuant to our measurement method

*3 Ambient temperature: Constant at 25°C

*4 However, IK3401R-F, IK3501R-G, IK3802R-G, and IK3102R-G are 1 GHz.

Laser Power Supply Specifications

Model	Applied Power Supply	Input Voltage (VAC)	Input Current (A)	Power Consumption (W)	Weight (kg)
IK****R-B	KP2014C	100～240 (50/60Hz) (±10%)	4.0	350	8.0
IK****R-C			4.2	480	
IK****R-D			5.5	500	
IK****R-E			7.0	610	
IK****R-F			7.5	660	
IK****R(I)-G			8.0	720	

2-4-3 Environmental Conditions

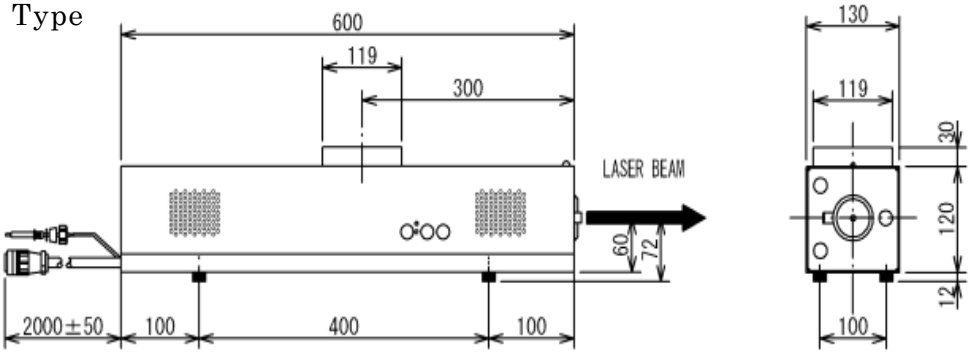
Use this laser system in an environment that satisfies the conditions below.
Table 3 Environmental Conditions

1. Environmental Conditions	When running: Operate 10℃～40℃ : Humidity ≧90%RH When not running: Storage −10℃～50℃ : Humidity ≧90%RH	Non Condensation
2. Vibration Resistance	When shipping: 20 G or less (in our packaging)	

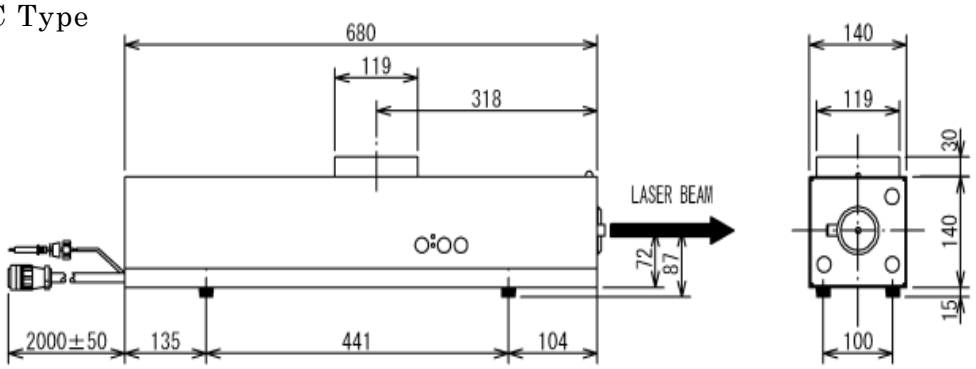
2-5 Dimensions

2-5-1 Laser Head Dimensions

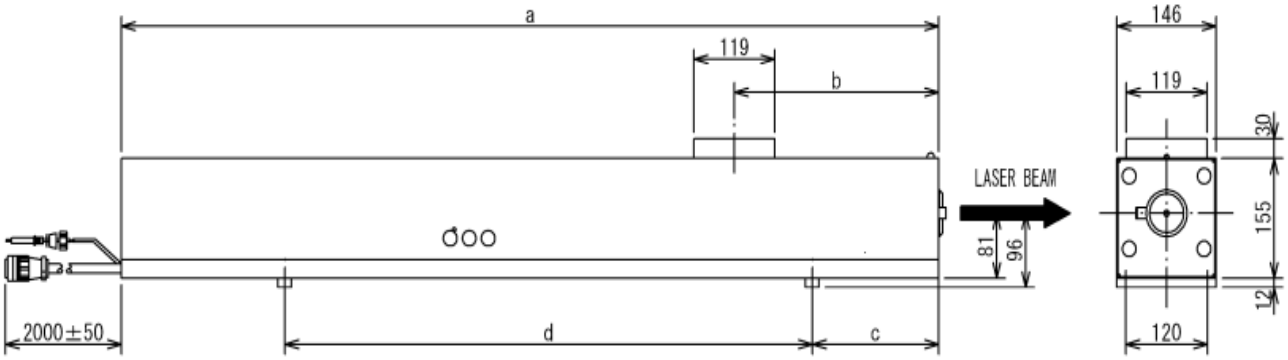
IK-B Type



IK-C Type



IK-D～G Type



	a	b	c	d
IK****R-D	850	380	128	605
IK****R-E	1020	300	128	775
IK****R-F	1200	300	353	440
IK****R(I)-G	1420	461	353	660

Fig. 6 Laser Head Dimensions(Units：mm)

2-5-2 Laser Power Supply Dimensions

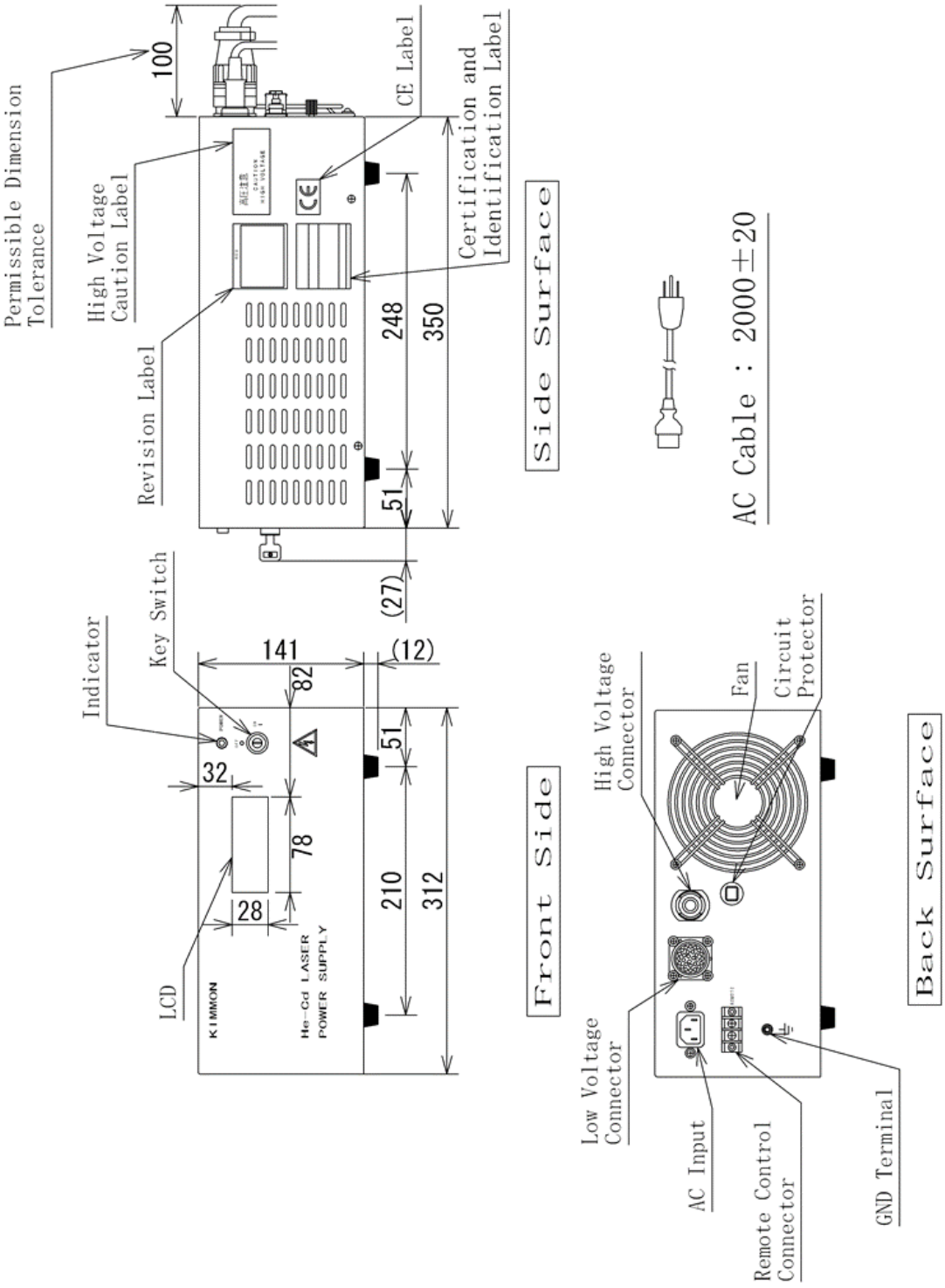


Fig. 7 Laser Power Supply Dimensions(Units:mm)

2-6 System Part Names

(Differs slightly according to model.)

2-6-1 System Part Names IK-B and C Types

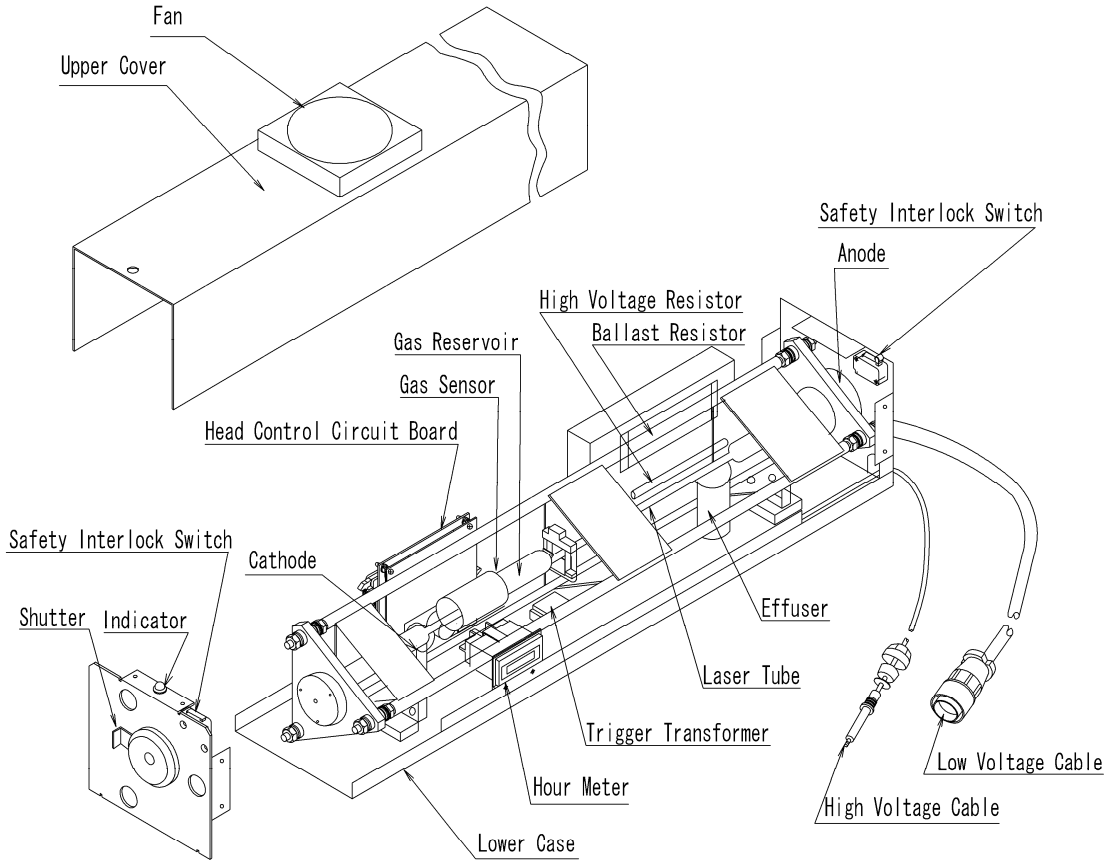


Fig. 8(a) IK-B Type Laser Head Main Constituent Part Names

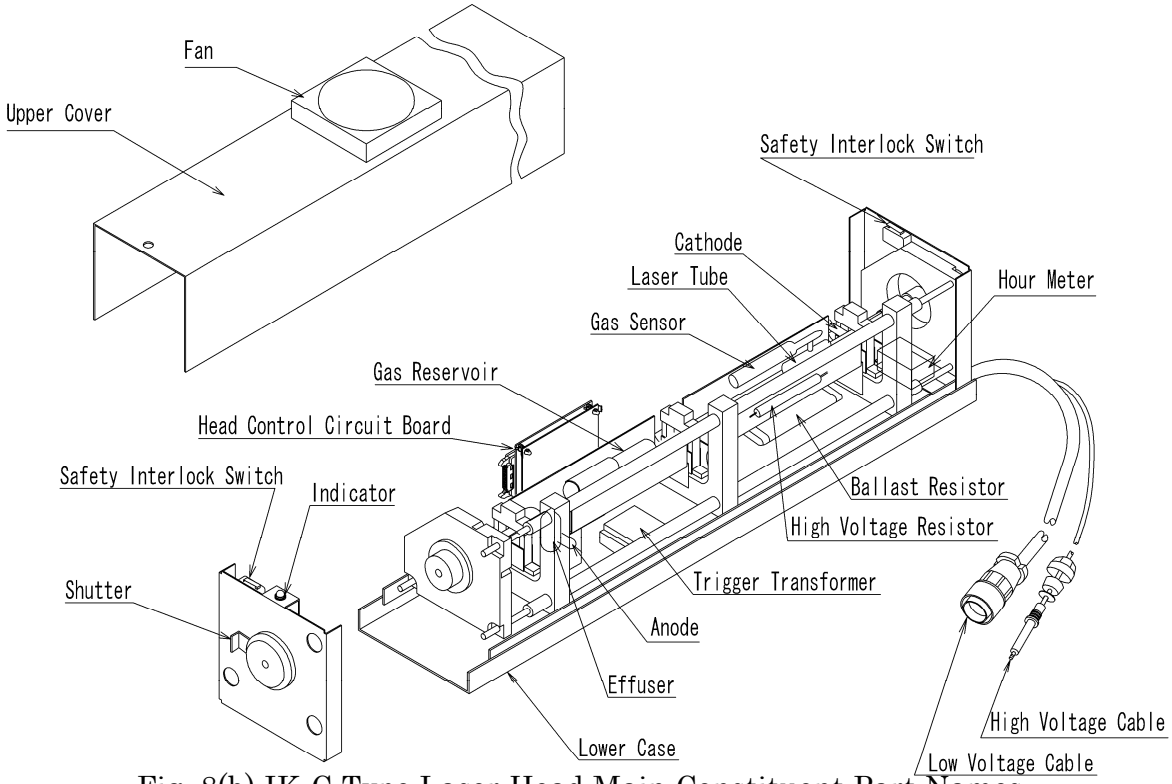


Fig. 8(b) IK-C Type Laser Head Main Constituent Part Names

2-6-2 System Part Names IK-D～G Type

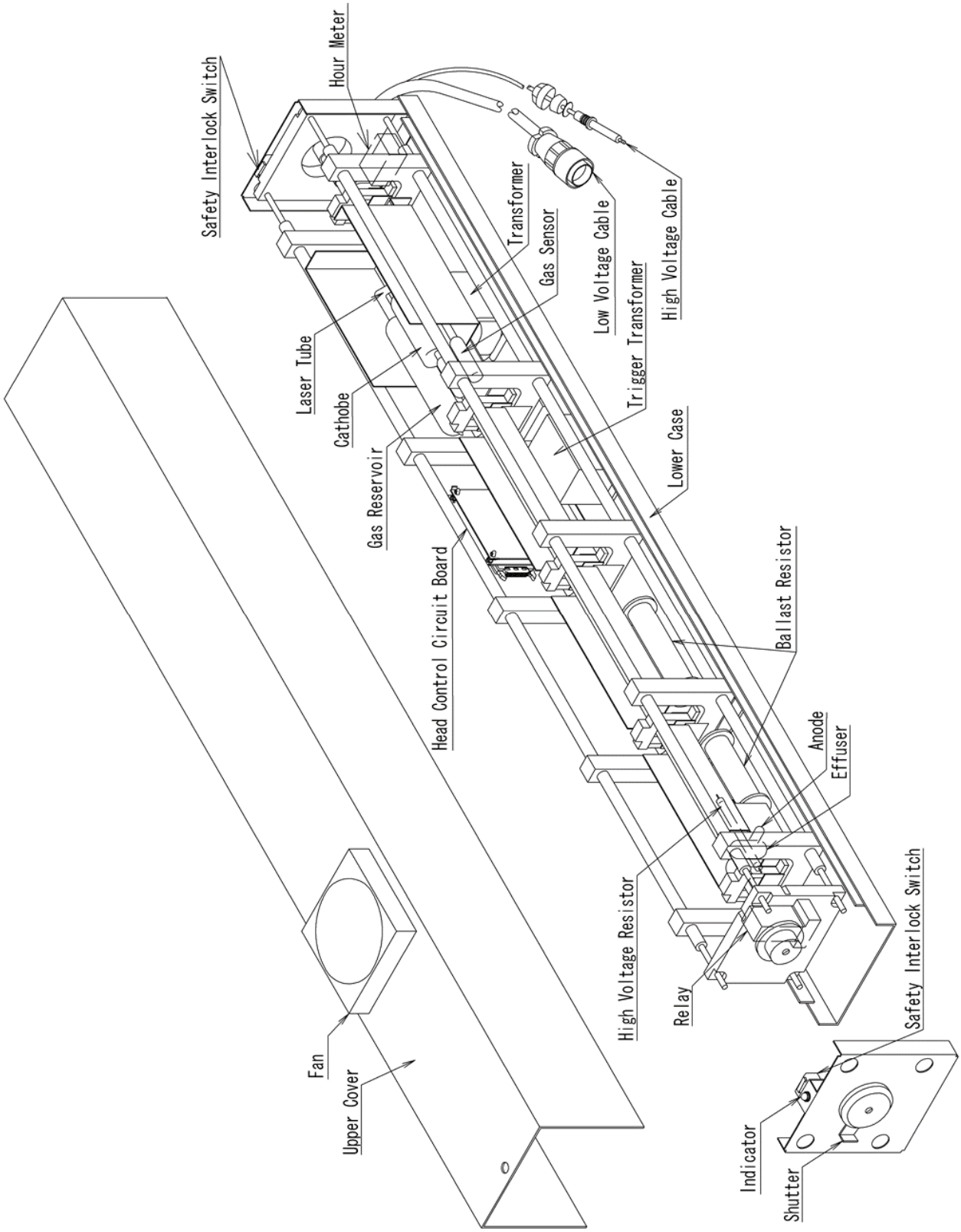


Fig. 8(c) IK-D～G Type Laser Head Main Constituent Part Names

2-7 Request for System Delivery Inspection

The laser head and laser power supply are carefully packed for delivery so that they are not damaged during shipping. Open the package when the product has arrived to check for any damage that may have occurred during shipping. Check whether there are any discrepancies to the system listed in the testing record documentation, and whether all of the parts are included.
Contact us if anything has been damaged or any parts are missing.
The contact information is listed at the end of this manual.

2-7-1 System Configuration

Laser Head → One Unit

High-voltage Cable (length 2.0 m; direct coupling)

Low-voltage Cable (length 2.0 m; direct coupling)

Laser Power Supply → One Unit

Power Supply Cable (length 2.0 m; with grounding terminal)

Power Supply Key → 2 pcs.

Testing Record → Two copies (One for each of the Head and the Power Supply)
User's Manual → One copy (However, excludes when replacing the tube.)

3. How to Use This System
3-1 Connecting the Cables
3-1-1 Connecting the Laser Head and the Laser Power Supply
If there are no abnormalities in the system inspection conducted at delivery (see section 2-7), check the safety of the laser radiating light (laser beam direction) to setup the laser head.
Connect the laser head direct coupling high voltage cable (1P) and the low voltage cable (28P) to each of the laser power supply connectors (see Fig. 6).
Particularly, insert the high voltage cable plug all the way until it stops. Insert the washer and rubber washer and screw in with an SC lock to fasten it. (See Fig. 9-1)

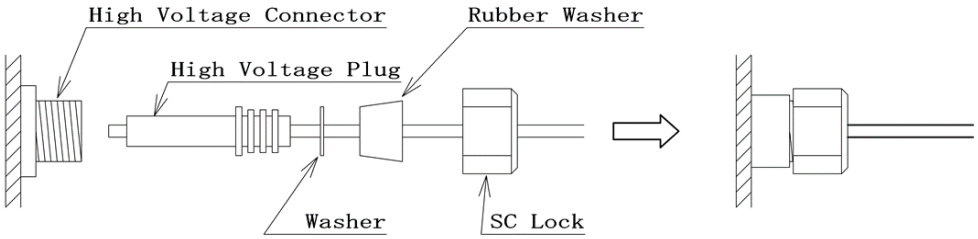


Fig. 9-1 High-voltage Cable Connection

3-1-2 Power Supply Cable Connection
After checking that the laser power supply key switch (see Fig. 7) is off, connect the power supply cable and plug the plug into the outlet.
3-1-3 Grounding the Grounding Terminal
A grounded 3P plug is an accessory to the power supply cable. For that reason, if the input power supply side is connected to a grounded 3P socket, the laser system will automatically be grounded. However, if the power supply side is 2P, always ground the power supply cable grounding terminal.
3-1-4 Connecting the Remote Interlock Connector
The remote interlock connector is used remotely to turn the laser on and off, or to stop the laser in times of emergency for safety reasons. Fig. 9-2 shows example connections. Connect from the terminal to the emergency switch or the remote switch and others. When the power supply switch is turned on, and the connectors are shorted, the laser will start running. When opened, the laser will stop.
When the power supply switch is turned off, the laser will not operate. The voltage between terminals is 5 VDC.
Use switches and contact capacity that support approximately 30 VDC 3 A.

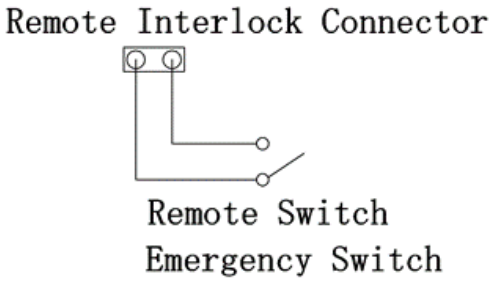


Fig. 9-2 Example Connection for the Remote Interlock Connector

3-2 Operating Procedures and System Behavior

3-2-1 Precautions for Operation

(1) Caution for exposure to laser beam

Always wear protective glasses (for 325 nm or 442 nm) to prevent the laser beam from directly or indirectly entering your eyes.

(2) Laser beam shutter

Before turning on the power supply to the laser system, check that the laser head shutter is closed before starting to operate the system. Check the safety of the direction of laser emission before opening the shutter.

(3) High voltage caution

High voltages are charged to the laser head and the laser power supply. Do not remove the cover of the laser head and the laser power supply.

(4) On/off operations over a short time are prohibited.

You can damage the laser tube by turning the system on and off over a short amount of time. For that reason, continue discharging for approximately 10 minutes after turning the light on.

3-2-2 Input Power Supply

Use with a power source capacity of AC single phase 100～240V, 50 Hz, or 60 Hz, and 1,500 W or higher.

3-2-3 Starting Operation

The laser automatically runs when the startup operation key switch is turned on.

3-2-4 Operation Displays and System Behavior

The tube is very hot immediately after discharging is stopped. In order to suppress restarting until the system has cooled to the predetermined temperature, and to preheat the cathode, start the discharge approximately 90 seconds after turning on the power supply key switch. (Table 4 shows the operation displays and system behavior.)

Table 4 Operation Displays and System Behavior

	Operation	Display	System Status
1	Key switch → On (Manual)	Power supply: Indicator (Green) Lights Head: Indicator (Red) Lights	(1) Start cathode preheating (2) Start cooling fan
2	Thereafter, operation is automatic. (90 seconds have passed.) Start discharge	Tube voltage, tube current, and Effuser	Start discharge (1) Vt: 1.7～3.8(kV) (2) It: Settings value (mA)
3	After starting discharge (Approx. 5 mins.)	LCD Indicator fluctuation (Effuser, Tube voltage)	(1) Vt: Settings value (kV) (2) It : Settings value (mA)
4	After starting oscillation (3～6 mins.)	LCD indicator stability	(1) Vt: Settings value (kV) (2) It : Settings value (mA)
5	After key switch → On (15～30 mins.)	LCD indicator stability	Rated power ≥ (90%)

3-2-5 Stopping

Stop the discharge and laser oscillation by turning the key switch to off.

3-2-6 System Operation and Alarm Displays

The operating status of this laser system is displayed on the LCD (see Fig. 7) in the power supply unit. The following outlines operating states.

Table 5 LCD Indicator Displays

LCD	Display Content	Assumed Cause
Please wait.	Displayed for ten minutes after turning thekey switch on.	
EFFUSER *.** TUBE CURRENT ***mA TUBE VOLTAGE ****V HOUR(S) *****	Normal operation	
REMOTE OPEN WARNING E: *.*** C: *.* V: ****.* T: *****.*	Remote open	Remote terminal is open
TUBE CURRENT ALARM E: *.*** C: *.* V: ****.* T: *****.*	Tube current alarm	High voltage cable is not connected Tube leak/not discharge
COVER OPEN ALARM E: *.*** C: *.* V: ****.* T: *****.*	Cover open	Low voltage cable is not connected. Head cover is not properly/ completely shut. Laser head fan has stopped or the like.
TUBE VOLT ALARM E: *.*** C: *.* V: ****.* T: *****.*	Tube voltage alarm	High voltage circuit has malfunctioned.
24V OUTPUT ALARM E: *.*** C: *.* V: ****.* T: *****.*	24 V power supply alarm	24 V circuit has malfunctioned.
CATHODE ALARM E: *.*** C: *.* V: ****.* T: *****.*	Cathode alarm	Cathode has malfunctioned.

LCD	Display Content	Assumed Cause
COOLER ALARM E: *.*** C: *.* V: ****.* T: *****.*	Cooling alarm	Ambient temperature has exceeded 40°C; power supply cooling fan error.
PS ALARM E: *.*** C: *.* V: ****.* T: *****.*	Power supply voltage alarm	Input voltage outside of rating/ power outage.
PFC ALARM E: *.*** C: *.* V: ****.* T: *****.*	PFC alarm	Circuit board has malfunctioned.
FAN ALARM E: *.*** C: *.* V: ****.* T: *****.*	Cooling fan alarm	Cooling fan has stopped running.

* If an alarm is lit, the high voltage power supply that is supplied to the laser head is automatically disconnected, and discharging is stopped. To reset the system, turn off the key switch once, and then turn it on again.

When an alarm is lit, check the content of the troubleshooting list to implement appropriate measures. If the system cannot be recovered, contact us.

4. Laser System Control and Adjusting Methods

4-1 Overview of Adjustments

Factors affecting laser power in this He-Cd laser system can broadly be classified into three areas. They are factors relating to electrical control; factors relating to fluctuations in mechanical alignments such as the mirrors, or the straightness and the like of fine tubes such as the discharge tube; and factors relating to deterioration or contamination of the optical components or the lifetime of the laser medium.

(1) Electrical control

Tube voltage, tube current, and He gas pressure

(2) Mechanical alignment

Mirror alignment, capillary straightness

(3) Deterioration, lifetime

Mirrors, BW deterioration, Cd metal deficiency

Also, factors that contribute to optical noise are considered to be the same as (1). For details, read laser system overview items.

These items include dangerous exposure to laser beam, and handling of high-temperature and high voltage components. The explanation of adjustment items is limited to setting adjustments for the tube voltage, tube current and He gas pressure, and mirror adjustments. Other adjustments involve dangerous exposure to laser radiation, and the danger of receiving an electric shock or burns. Do not attempt to make other adjustments.

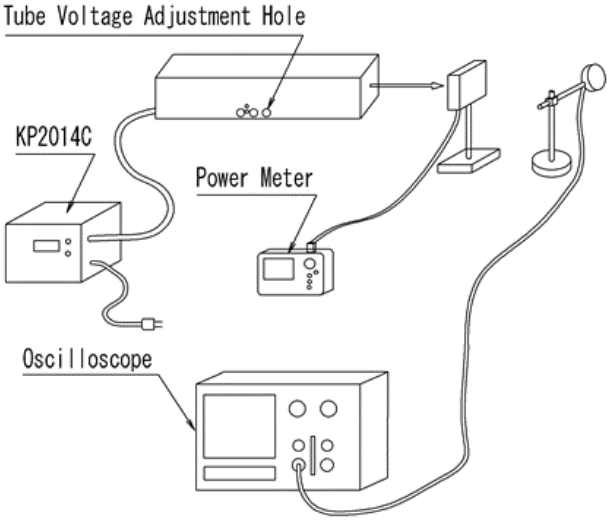
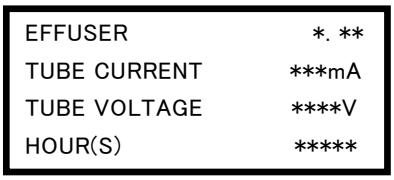
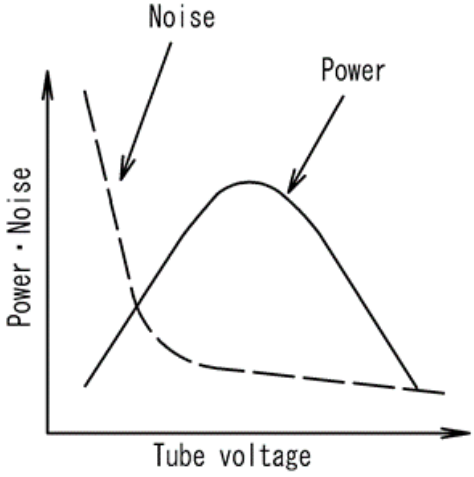
The following describes each method of adjustment.

4-2 Tube Voltage (Effuser) Adjustment

Implement the tube voltage adjustment when laser power is low, or power fluctuates.

Tools and measuring instruments
(1) Protective glasses
(2) Power meter
(3) Oscilloscope (for simple noise measurements)
(4) Regular screwdriver (for adjustments)
(5) Probe (BNC)

Implement adjustments with the following procedures.

Adjustment	Explanatory View
1. Set each laser measuring instrument. Close the shutter. 2. Turn on the measuring instrument. 3. Put on your protective glasses. 4. Turn on the laser power supply. 5. Approximately 20 minutes after turning on the key switch, read the tube voltage value (VOLT) on the LCD check whether it matches the tube voltage (setting value) listed in the test records. (If the tube voltage cyclically fluctuates, leave it for approximately five minutes before checking its status again. If it is not stable by then, implement the adjustment described at section 4-2-7.) 6. Record the tube voltage value (VOLT) and tube current value (CURR) when they are stable. Open the shutter and record the laser power. (As shown in the drawing at right, the horizontal axis represents tube voltage. The vertical axis represents power and noise. The optimum values can easily be found by plotting power and noise when you change the tube voltage.)	  

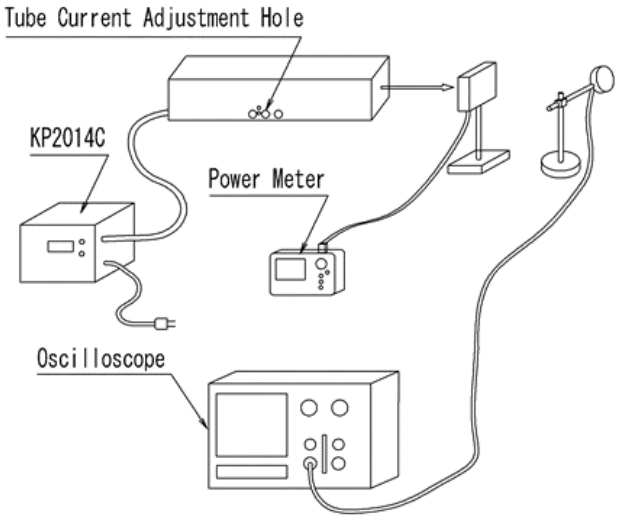
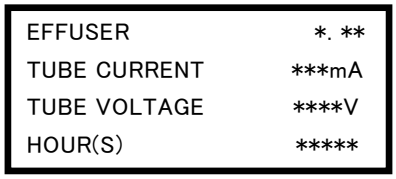
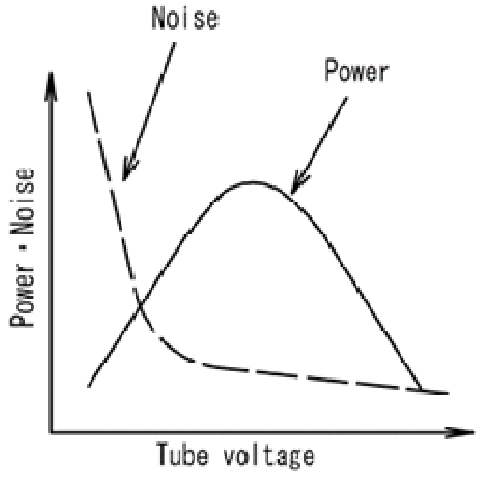
Adjustment	Explanatory View
7. Adjust the tube voltage. Read the effuser value (EFF) on the LCD. Use the regular screwdriver to turn the laser head tube voltage adjustment volume (see Figs. 5(a) and 5(b) on page 8). Clockwise: Increases the voltage. The effuser value (EFF) drops once, then gradually rises to return to its original indication. Angle for each single adjustment: Approximately 5°. If you turn it too far, the laser power will drop, or oscillation will stop, so be careful. Also, wait five to six minutes until it stabilizes. When the effuser value (EFF) on the LCD stabilizes, record the tube voltage value (VOLT) on the LCD. Also record the power and noise at that time. Set the tube voltage to the optimum value by repeating these procedures. (1) When output is unstable The effuser value (EFF) will fluctuate in the LCD and be unstable when power is unstable because the tube voltage is fluctuating. In such cases, adjust to lower the tube voltage and evaluate its status then. If the voltage does not stabilize then, check its status again after approximately five minutes, and adjust to lower the tube voltage again. (2) When the following states exist, adjust the tube voltage in the following way as a general guide. (1) High noise → Raise (2) Power is unstable → Lower 8. After setting to an optimum value, adjust the He gas in section 4-4.	

4-3 Tube Current Adjustment

Implement the tube current adjustment when laser power is high, or power fluctuates.

Tools and measuring instruments
(1) Protective glasses
(2) Power meter
(3) Oscilloscope (for simple noise measurements)
(4) Regular screwdriver (for adjustments)
(5) Probe (BNC)

Implement adjustments with the following procedures.

Adjustment	Explanatory View
1. Set each laser measuring instrument. Close the shutter. 2. Turn on the measuring instrument. 3. Put on your protective glasses. 4. Turn on the laser power supply. 5. Approximately 20 minutes after turning on the key switch, read the tube voltage value (VOLT) on the LCD check whether it matches the tube voltage (setting value) listed in the test records. (If the tube voltage cyclically fluctuates, leave it for approximately five minutes before checking its status again.) 6. Record the tube voltage value (VOLT) and tube current value (CURR) when they are stable. Open the shutter and record the laser power.	  

Adjustment	Explanatory View
7. Adjust the tube current. Read the tube current value (CURR) on the LCD. Use the regular screwdriver to turn the laser head tube current adjustment volume (see Figs. 5 (a) and 5 (b) on page 9). Clockwise: Increases the current. Amount to adjust each single time: Approximately 2～3 mA (1) When optical noise is high Adjust by raising the current. (2) When power fluctuates Adjust by lowering the current. 8. After setting to an optimum value, adjust the He gas in section 4-4.	

4-4 He Gas Pressure Setting Adjustment

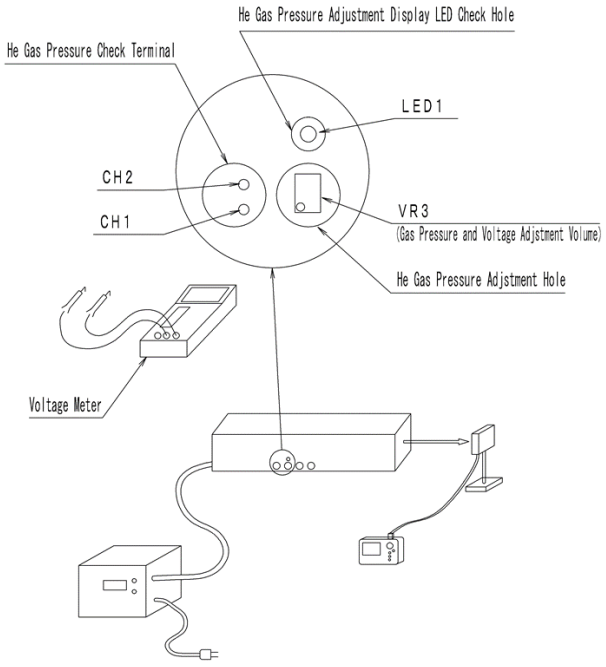
Normally, He gas pressure settings do not need to be adjusted. (See section 2-3 (4) He Gas Pressure Setting Adjustment.) However, when the tube voltage and tube current were adjusted before shipping, the temperature inside the discharge tube will change, as well as the optimum He gas pressure value. For that reason, always adjust the He gas pressure settings.

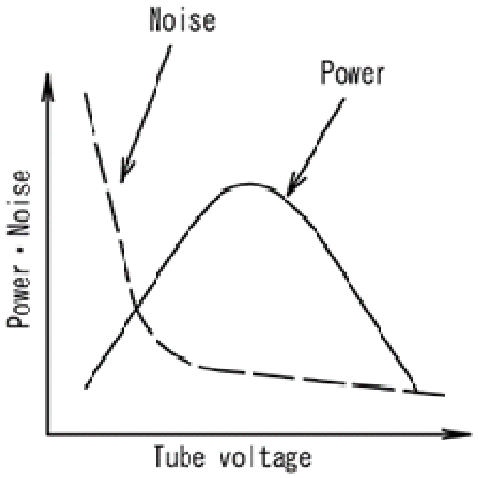
If the laser system will be stored unused for a long period (in increments of years), natural leaks will occur from the He gas reservoir. For that reason, a phenomenon will occur where the He gas pressure will increase in the discharge tube, increasing noise, thereby causing a drop in power. For that reason, conduct the following aging (continuous running) and adjustments.

Tools and measuring instruments

(1) Protective glasses
(2) Power meter
(3) Oscilloscope (for simple noise measurements)
(4) Regular screwdriver (for adjustments)
(5) Voltage meter (that includes mV range)

Implement adjustments with the following procedures.

Adjustment	Explanatory View
1. Set each laser measuring instrument. Close the shutter. 2. Turn on the measuring instrument. 3. Put on your protective glasses. 4. Turn on the laser power supply. 5. Approximately 20 minutes after turning on the key switch, read the tube voltage value (VOLT) on the LCD check whether it matches the tube voltage (setting value) listed in the test records. (If the tube voltage cyclically fluctuates, leave it for approximately five minutes before checking its status again.) 6. Record the tube voltage value (VOLT) and tube current value (CURR) when they are stable. Open the shutter and record the laser power.	

Adjustment	Explanatory View
7. Adjusting the He gas pressure setting after adjusting tube voltage and tube current. Check that the laser power has stabilized after adjusting tube voltage and tube current. After checking, check the He gas pressure status. Check the status of the He gas pressure with the status of the LED that shows He gas pressure. Then adjust the Gas ADJ. If the He gas pressure adjustment display (see Figs. 5 (a) and 5 (b) on page 9) is lit, turn this in the counterclockwise direction until the LED blinks or turn to the boundary where it either is extinguished or blinks. When these adjustments are made, this He gas pressure will be maintained thereafter. 8. First turn on the switch of the laser to set the He gas pressure setting when storing the laser system for a long period. When power is stabilized, connect the probe to the voltage meter. Connect + to CH1 and – to CH2 on the He gas pressure check terminals (see Figs. 5 (a) and 5 (b) on page 9). Approximately 0.1 torr is equivalent to 40 mV. Default setting value: -5 to -20 mV (He gas pressure signal voltage). If the measurement voltage minus default setting value equal X (mV), the gas pressure fluctuation amount Y (torr) can be found using the following equation. X(mV)÷400=Y(torr) If, the default setting value is -5 mV and the measurement voltage is 75 mV: 75mV-(-5mV)=80mV 80(mV) ÷400=0.2(torr) Therefore, at present, the He gas pressure will increase only 0.2 torr. Normally, if there are no problems in power or noise in such a case, the LED will blink.	

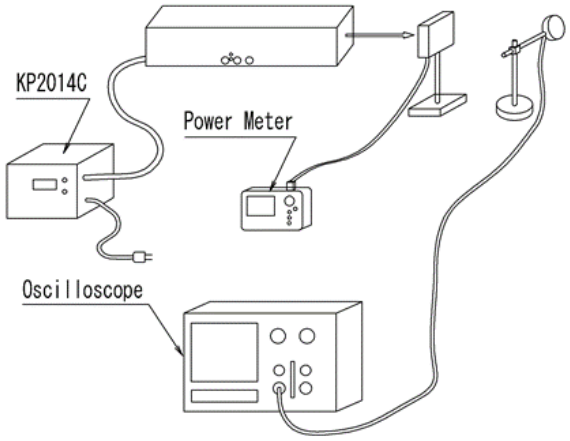
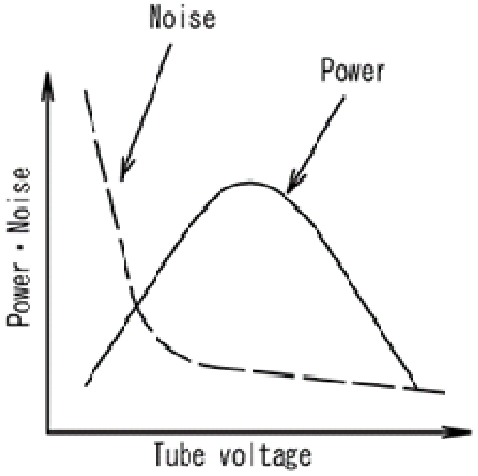
Adjustment	Explanatory View
If there is a problem in power or noise, do either (1) or (2). (1) Turn on the switch of the laser, and leave it until the He gas pressure signal voltage is -5 to -20 mV. The characteristics will return substantially to the default value. (2) Adjust the tube voltage and tube current. Lastly, adjust the He gas.	

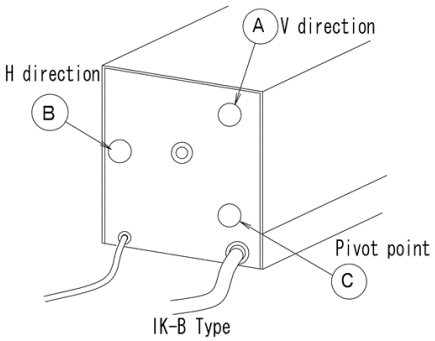
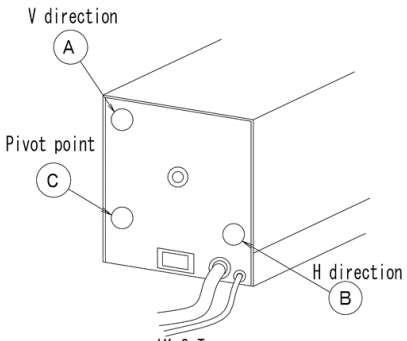
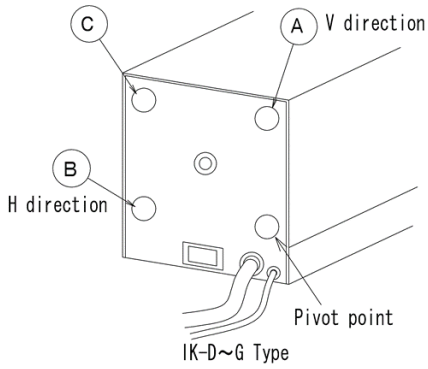
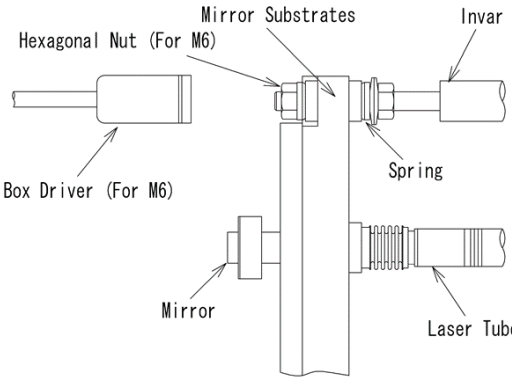
4-5 Mirror Adjustment

Implement the mirror adjustment when the laser power is low.

Tools and measuring instruments
(1) Protective glasses
(2) Power meter
(3) Box driver (For M6)

Implement adjustments with the following procedures.

Adjustment	Explanatory View
1. Set each laser measuring instrument. Close the shutter. 2. Turn on the measuring instrument. 3. Put on your protective glasses. 4. Turn on the laser power supply.	
5. Approximately 20 minutes after turning on the key switch, read the tube voltage value (VOLT) on the LCD check whether it matches the tube voltage (setting value) listed in the test records. (If the tube voltage cyclically fluctuates, leave it for approximately five minutes before checking its status again.)	EFFUSER *. ** TUBE CURRENT ***mA TUBE VOLTAGE ****V HOUR(S) *****
6. Record the tube voltage value (VOLT) and tube current value (CURR) when they are stable. Open the shutter and record the laser power.	

Adjustment	Explanatory View
7. Mirror Adjustment Adjust only the rear panel of the laser head. (1) Absolutely do not turn the pivot point at the bottom right of the drawing. (2) First, insert the box driver into the adjustment hole A for V direction adjustment. Adjust so that the indicator is at its maximum value, while watching the power meter. The turning angle is very small. (3) Next, adjust the H direction adjustment hole B in the same way as with (1). (4) Next, adjust adjustment hole C. (The pivot point for the IK-B・C types is adjustment hole C.) Hypothetically, if the laser power becomes 0, and oscillation stops, turn the screwdriver in the opposite direction to return it to its original position. Oscillation will recover. 8. When there is no problem in laser power, do not make any adjustment.	 IK-B Type Rear Panel of Laser Head (Opposite Side to Beam Emission Side)  IK-C Type Rear Panel of Laser Head (Opposite Side to Beam Emission Side)  IK-D～G Type Rear Panel of Laser Head (Opposite Side to Beam Emission Side)  Mirror Alignment Adjustment Mechanism (Shape is slightly different according to model.)

5. Precautions for Saving the Laser System

The main elements that affect laser power and noise characteristics are tube voltage (Cd vapor pressure), tube current, and He gas pressure.
Among these, He gas pressure control is a system that controls the temperature of the glass transmissive wall from the glass He gas reservoir tank, to refill the discharge tube with He passing through the glass wall. With this system, there is a phenomenon that He gas penetrates through the glass (albeit a minute amount) when it is stored at room temperature. For that reason, the final He gas pressure in the discharge tube increases when stored for a long time, and this can affect power and noise characteristics. When storing unused for a long period of time, implement aging (idle running) for 48 hours once every two months, at least. Aging consumes He gas, and maintains laser characteristics close to the default values.

6. The disposal the Laser System

The heavy metal cadmium is sealed in the discharge tube. To discard of the system, contact an industrial waste handler that possesses the appropriate government certification. Also, our company can discard the system (for a fee) if you require this. In such a case, please contact us.

7. Troubleshooting

7-1 System Does Not Operate Even With Key Switch Turned On (Indicator Does Not Light)

Status	Items to Check	Measures
Key switch on ↓ Indicator is extinguished ↓ Does not run ↓ YES	(1)Is input voltage(from100～240VAC) being supplied to the outlet? (2)Is the power supply cable correctly connected to the outlet and the power supply?	(1)Use an outlet with 100～240 VAC being supplied. (2)Correctly connect the cable.
Is input voltage correctly supplied? ↓ YES　NO	Is the circuit protector on the laser power supply tripped? (Has the power supply voltage value display unit popped out?)	Press the push button (voltage value display unit) that projected on the circuit protector to recover. However, check the following before turning the power on again. (1)Supply voltage:100～240VAC (2)Ambient temperature:10 ≤ T ≤ 40°C If the same phenomenon (trip) occurs when the power is turned on again, the device could be malfunctioning. In such cases, contact us.
Is the circuit protector behaving normally? ↓ YES　NO		
Contact us.		

7-2 System Does Not Operate Even With Key Switch Turned On (Indicator Lights)

Status	Items to Check	Measures
Key switch on ↓ Indicator Lights ↓ Approximately 90 seconds after being turned on	Approximately 90 seconds after being turned on	The system will warm up for approximately 90 seconds after turning the power on. Wait 90 seconds.
↓ Does not run YES ↓ Interlock alarm NO YES	(1)Is low voltage cable correctly connected? (2)Is the power supply fan running (rotating)? (3)Is the laser head cover correctly attached?	(1)Correctly connect the cable. (2)The power supply fan is malfunctioning. Contact us. (3)Attach it correctly. (4)If the system still does not run after the power is turned on again, contact us.
↓ Cathode alarm NO YES	(1)Is low voltage cable correctly connected?	(1)Correctly connect the cable. (2)If the system still does not run after the power is turned on again, contact us.
↓ Tube current error alarm NO YES	(1)Is high voltage cable correctly connected? (2)Is the supplied voltage 100～240VAC?	(1)Correctly connect the cable. (2)The system will not discharge if the power supply is 90 VAC or less. (3)If the system still does not run after the power is turned on again, contact us.
↓ Tube overcurrent alarm NO YES	(1)Is the tube current 100 mA or lower?	(1)Turn the tube current adjustment volume in the counterclockwise direction five times, then turn the switch on again.
↓ Contact us.		

7-3 Laser Power Decrease

Status	Items to Check	Measures
Laser power decrease		
Shutter is open	Is the shutter at the correct opening position?	Set the shutter at the open position.
Laser head fan is running	Is the laser head fan running?	Contact us.
NO / YES		
Head intake, exhaust ports	Are the laser head intake, and exhaust ports blocked?	If the laser head intake and exhaust ports are blocked, affecting the internal cooling, there is a possibility that the mirror is misaligned. Allow for adequate space outside of the intake and exhaust ports.
NO / YES		
Ambient temperature	Is the ambient temperature $10 \leq T \leq 40°C$?	Use the system with an ambient temperature of $10 \leq T \leq 40°C$.
NO / YES		
Tube voltage setting value	(1) Does the tube voltage value (VOLT) match the test record value? (2) Can the tube voltage be adjusted?	(1) If they do not match, contact us. (2) If the usage time is 3,500 to 5,000 hours or more, there is a possibility that the Cd has been consumed and reached its lifetime.
NO / YES		
Tube current setting value	Does the tube current value (CURR) match the test record value?	Contact us.
NO / YES		
Contact us.		

7-4 Laser Noise Increase

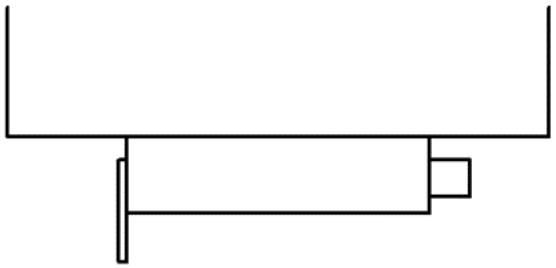
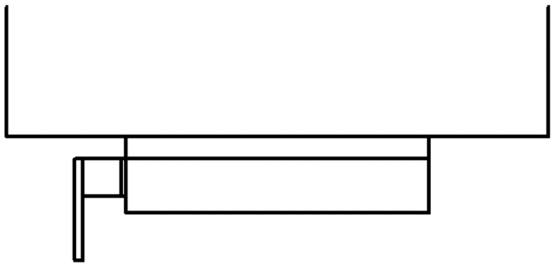
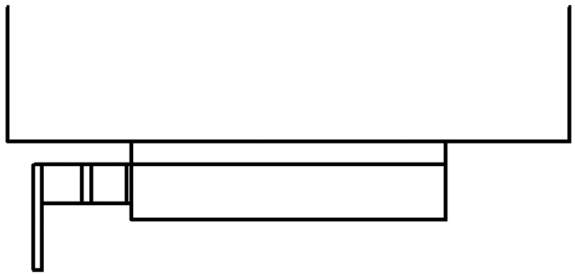
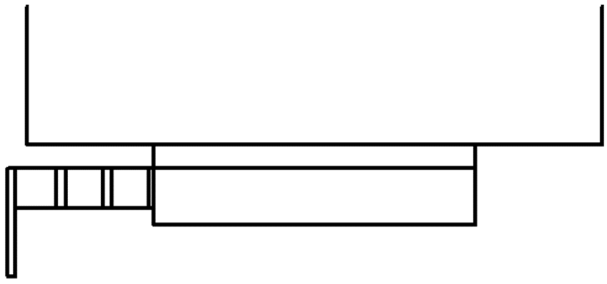
Status	Items to Check	Measures
The laser noise has increased.		
Ambient temperature	Is the ambient temperature 10 ≤ T ≤ 40°C?	Use the system with an ambient temperature of 10 ≤ T ≤ 40°C.
NO / YES		
Long-term storage	Has the He gas pressure in the laser tube risen?	Contact us.
NO / YES		
Tube voltage setting value	Does the tube voltage value (VOLT) match the test record value? (See section 4-2)	Contact us.
NO / YES		
Tube current setting value	Does the tube current value (CURR) match the test record value? (See section 4-3)	Contact us.
NO / YES		
Contact us.		

7-5 Power Stability

Status	Items to Check	Measures
Laser power fluctuates		
Fluctuation in comparatively short amount of time (cycle within one minute)	(1)Look at the effuser value (EFF). Normally, this fluctuates within 0.05 A. When fluctuation exceeds this, the tube voltage will fluctuate. Is there any fluctuation over 0.05 A?	(1)Allow to run for approximately one hour. Then check the status. (2)Adjust the tube voltage and tube current. (3)If not improvement is seen, contact us.
NO / YES		
Fluctuation in long period of time (time order cycle)	(1)Is there fluctuation with comparatively high ambient temperature (10°C or more)? (2)Is wind from the temperature controller in the ambient environment of the laser directly hitting the laser?	(1)Avoid running the system in locations where there are notable fluctuations in the ambient environment temperature of the laser, whenever possible. (2)If not improvement is seen, contact us.
NO / YES		
Contact us.		

8. Dual Wavelength Selection Filter

This section describes the wavelength selection filter in the dual wavelength laser system.

Laser Beam	Shutter Position
Closed No laser power	
442 nm Emits only 442 nm	
325 nm Emits only 325 nm	
DUAL Emits 442 nm and 325 nm simultaneously.	

Shutter Diagram

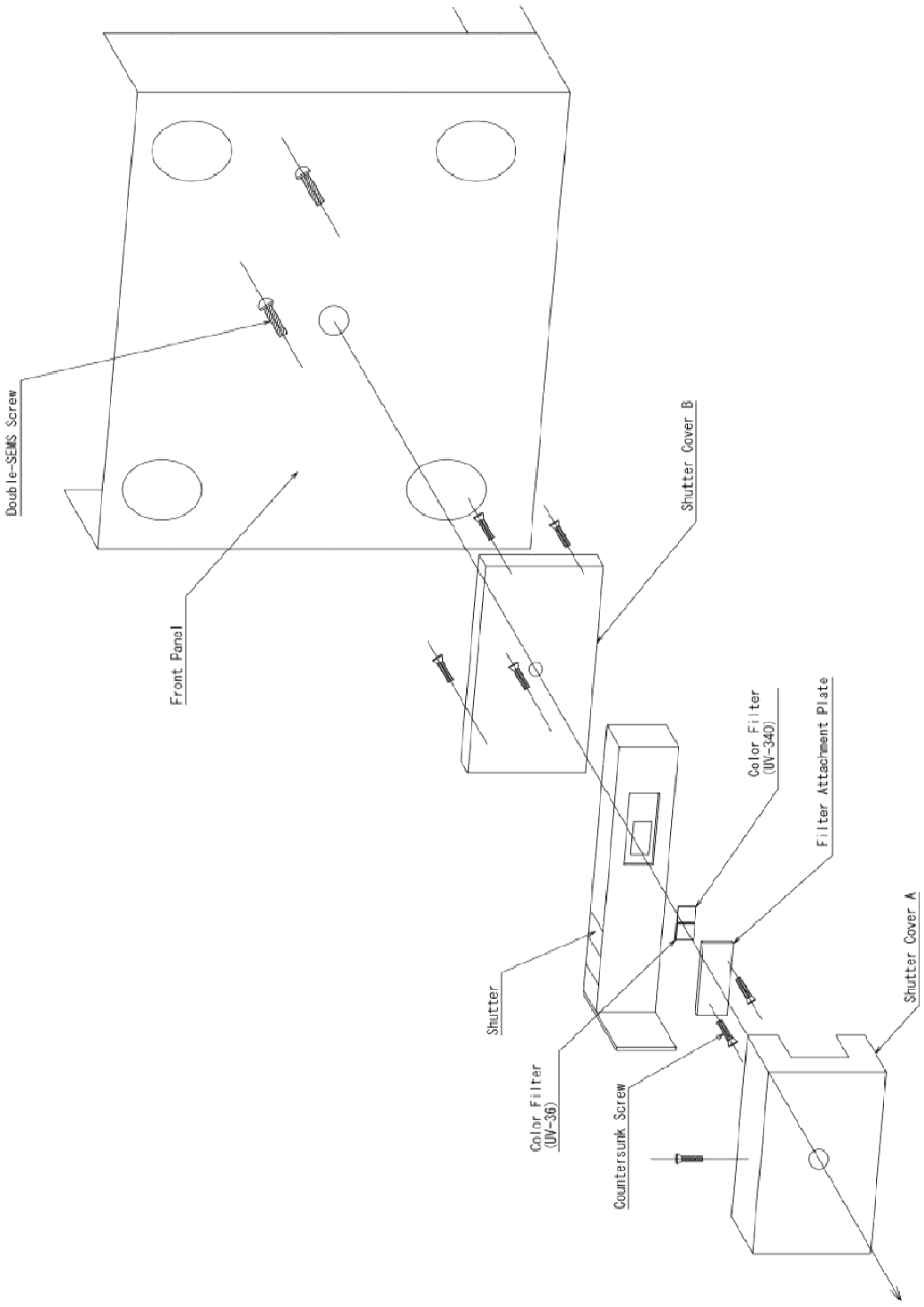


Fig. 11　Dual Wavelength Selection Filter (Shutter) Configuration Diagram

9. Warranty

The following outlines the warranty period for our laser system. Problems attributed to our company will be repaired, or parts will substituted or replaced free of charge during the warranty period.

・ Laser head: Within one year from the day of purchase; 70% or less of rated power during the warranty period for each model (using our standard power meter).

・ Laser power supply: Within one year from the day of purchase.

However, any one of the problems described below is considered to be outside of the scope of our warranty.

(1) When the system is used under conditions, environments or handling outside of the description in the catalog or the User's Manual;
(2) When handled with a method not described in the User's Manual, or when a problem occurs because of the customer's use, by being dropped or being jarred;
(3) When stored using a method other than that described in the User's Manual;
(4) When a problem occurs because of a system other than our product;
(5) When the system is modified or repaired by someone other than us;
(6) When there has been a natural disaster including earthquakes, water damage, and lightning, or fires, or accidents outside of our responsibility, are a cause;
(7) When the timer built into the system malfunctions, and it is judged that the system has been used for longer than the stipulated time with clearly little cadmium remaining in the laser tube;
(8) We accept no responsibility for any damages to the customer caused by a problem in our product.

10. Product Repairs

(1) We will receive normal repairs and maintenance within seven years of purchase. If seven or more years have passed since the purchase of the laser system, we will conduct repairs and maintenance. However, in the event that we judge that we cannot offer a warranty after repairs because electronic components in the product will degrade over time, we will replace those components as a precautionary measure. This will differ from ordinary repair and maintenance costs. For that reason, we will offer you a separate quote. Also, malfunctions that were caused by things other than replaced components when repairing systems after the seventh year or later will be charged. Product maintenance period is for three years after manufacturing of the product is terminated. However, if manufacturing is terminated for repair parts or spare parts, we may refuse maintenance or repairs within that three-year period.
(2) If it is necessary to return the product because of a bug, please bring or send the system to our plant. Shipping costs are the responsibility of the customer.

11. Contact

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