

User Manual

Diode Array Detector

2021.03

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Chapter I Diode Array Detector

The detector is one of the key components of the HPLC system. The detector, converting the physical or chemical characteristic information of the sample into electrical signals easy to measure, inputs it to the data processing system, thereby obtaining the chromatogram of the sample components. Diode array detector is the most widely used detector in HPLC, which can be used for qualitative and quantitative detection of most common organic substances with UV absorption and some inorganic substances. It is not very sensitive to the ambient temperature, composition changes of the mobile phase and the flow rate fluctuation, so it can be used for both isocratic and gradient elution.

The diode array detector is equipped with two light sources, deuterium lamp and tungsten lamp, which can generate ultraviolet light and visible light within the wavelength of 190nm – 800nm. The optimized optical system enables the instrument to have high signal-to-noise ratio, wide linear range, excellent wavelength accuracy, better repeatability, and easier maintenance of the flow cell. Diode array detector with powerful functions, which can provide operations such as automatic wavelength calibration, automatic zero calibration, multi-channel acquisition, multi-sampling rate selection, rapid sample spectral scanning, is an important part of the K2025 high performance liquid chromatography system.

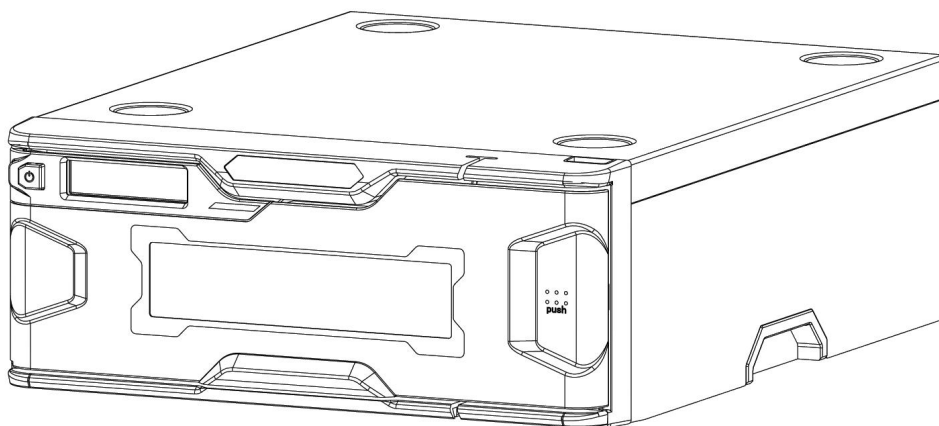


Figure 1-1 Profile of Diode Array Detector

Working flow

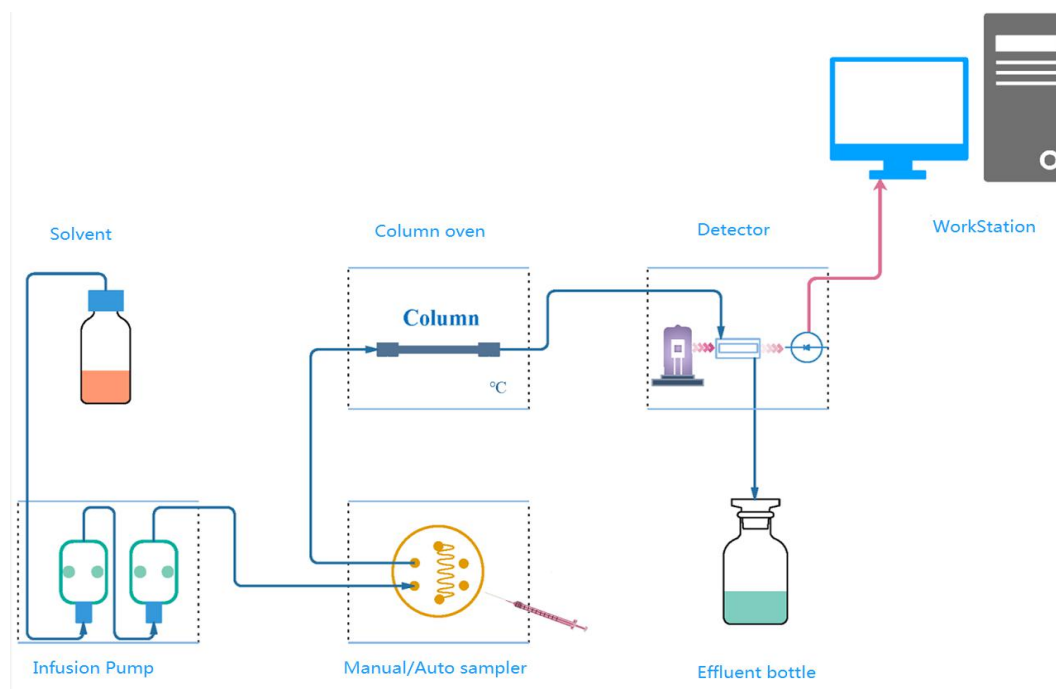


Figure 1-2 Working flow diagram of HPLC high performance liquid chromatography

The flowing phase and the sample solution flow through the components in the system in the directions indicated by the arrows respectively, and the functions of each component are specified as follows:

Flowing phase: The solvent carrying the sample to be tested moving forward.

Infusion Pump: providing a stable flow rate to keep the flowing phase flowing in the liquid system.

Vent valve: for the use of flushing the pump and the front section of the pipeline and venting the air bubbles.

Manual/ auto sampler: delivery of the sample to be separated into the system, and the flowing phase into the chromatographic column as the carrier of the sample.

Column oven: the sample flows through the chromatographic column with the flowing phase, and the separation of the sample components is completed with the principle that each component has specific retention capability on the stationary phase.

Detector: the separated components flow into the detector flow cell in turn, changes in component content are converted into electrical signals that can be detected, and PC completes qualitative, quantitative and separation analysis.

WorkStation: The signal converted by the detector is transmitted to the PC, and the WorkStation chromatography workstation performs qualitative and quantitative analysis on the sample.

Effluent bottle: Waste liquid from the system flows into the effluent bottle.

Except the diode array detector, the sampler, column ovens, detectors and workstations

required by the high performance liquid chromatography system are all retail products. Please contact with your regional distributor or office to purchase the necessary instrument according to the purpose of experimental analysis.

Working principle

The sample components separated in the chromatographic column enter the detector in turn, and the detector can convert the optical signals absorbed by the components into electrical signals with different intensities, as each component has different absorption ability of monochromatic light. The electrical signal is transmitted to a data processing system such as PC, and the chromatographic workstation is used to complete the sample qualitative, quantitative and separation analysis.

The theoretical basis of the diode array detector is the Lambert-Beer law: which is, when a beam of monochromatic light passes through the flow cell, if the flowing phase does not absorb light, the absorbance A is proportional to the concentration C of the light-absorbing component as well as the optical path length L of the flow cell:

$$A = \log(I_0/I) \quad (1)$$

Of which, I_0 is the incident intensity; I is the emergent intensity; ε is molar absorption coefficient, representing absorption properties of different substances ε and wavelength λ have the following functional relationship:

$$\varepsilon = \varepsilon(\lambda) \quad (2)$$

According to (1) and (2) the following can be known

$$A_\lambda = \log(I_{0\lambda}/I_\lambda) = \varepsilon_\lambda CL \quad (3)$$

In the above formula, I_0 、 I 、 L can be measured. To determine whether a substance exists, take (3) as the wavelength for scanning, it can be concluded:

$$A = f(\lambda) \quad (4)$$

Calculate the λ value and compare it with the peak position of the absorption peak of a substance to determine whether the substance exists. If a substance is known to exist (that is, $\varepsilon(\lambda)$ is known), its content needs to be calculated, use (3) for calculation

Product appearance

The front panel of Diode Array Detector has a simple design. upper left corner of the front panel is equipped with the display screen, which can display the running status of the instrument, and the operator can observe the relevant information of the instrument in real time.

The push logo is printed on the right side of the front door. For the switch-on, push the logo and the front door automatically pops open. For the switch-off, push the logo and the front door automatically closes and self-locks.

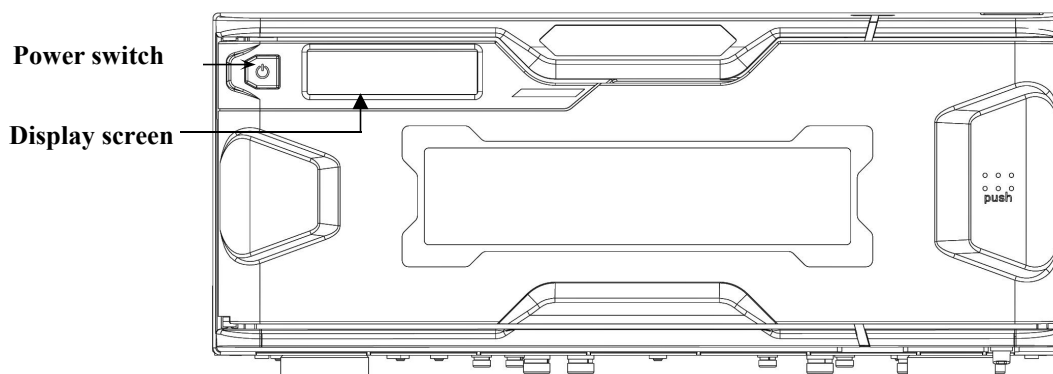


Figure 1-3 Diagram of front panel of Diode Array Detector

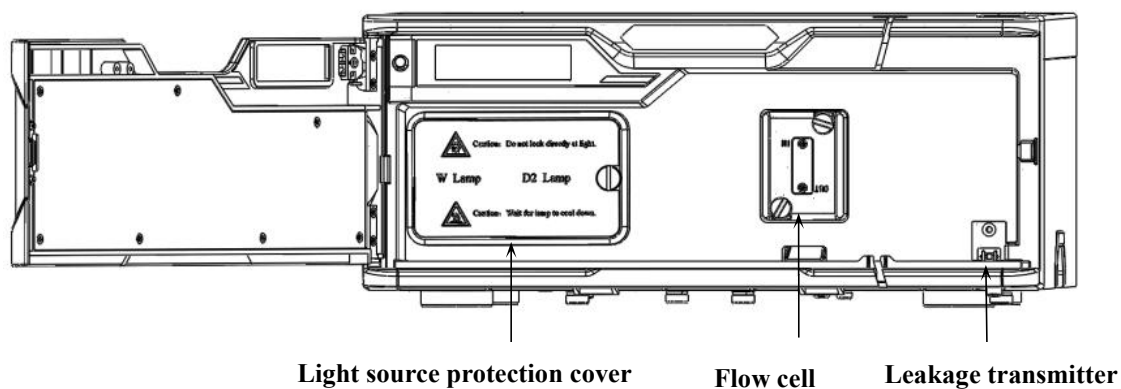


Figure 1-4 Internal schematic of Diode Array Detector

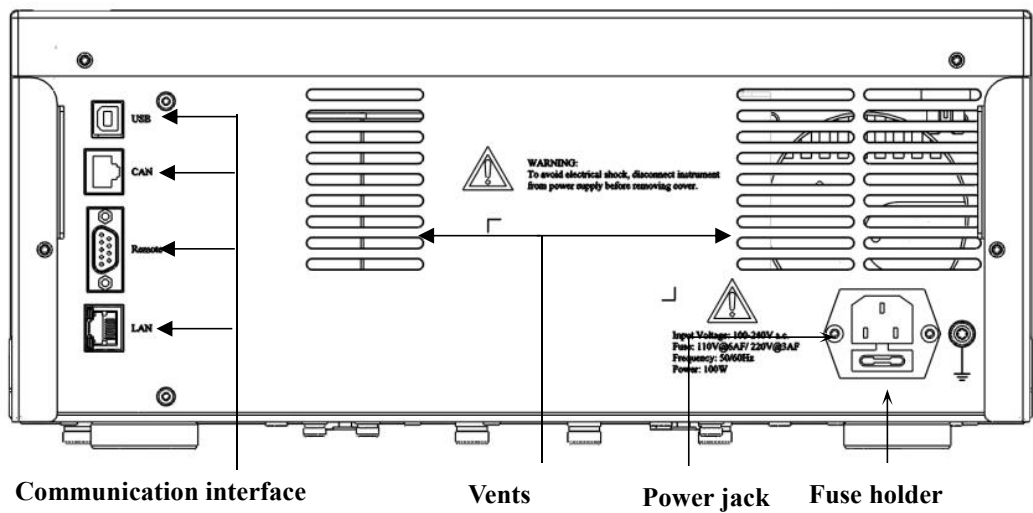


Figure 1-5 Diagram of rear panel of Diode Array Detector

Component introduction

Shown in Figure 1-6, Diode Array Detector is mainly composed of:

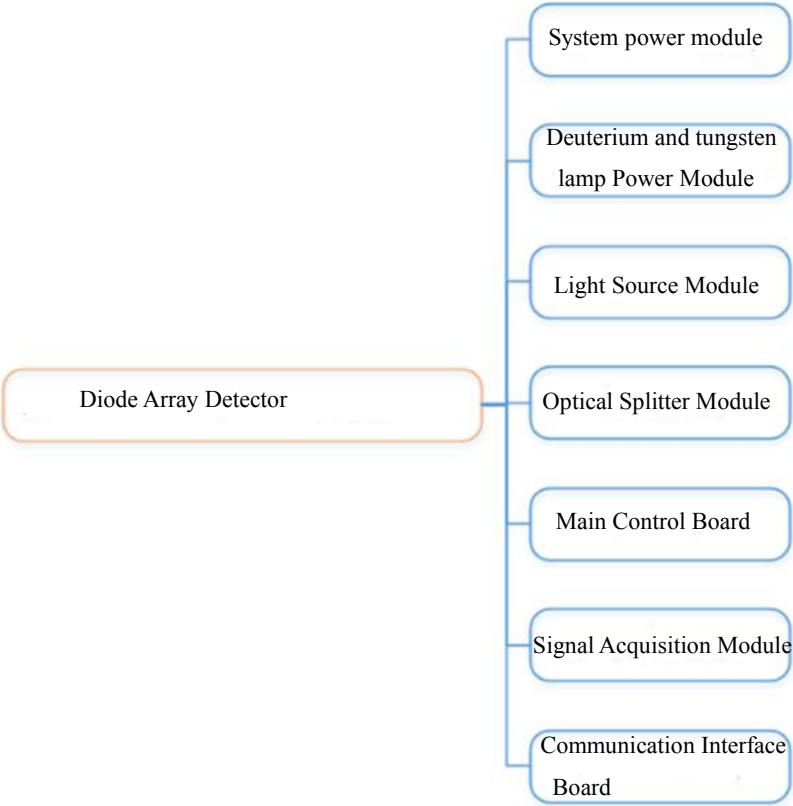


Figure 1-6 components of Diode Array Detector

Working principle of the main modules is introduced as follows:

1.System Power Module

Power supply to the main control board of the detector.

2.Deuterium and tungsten lamp Power Module

Power supply to deuterium and tungsten lamps.

3.Light Source Module

Provides UV/visible light in the wavelength of 190nm - 800nm.

4.Optical Splitter Module

Disperses the composite light of the light source module into the spectral band of 190nm to 800nm.

5.Main Control Board

Controls the operation of all the components inside the detector.

6.Signal Acquisition Module

Converts the optical signal into electrical signal and transmits it to the main control board.

7.Communication Interface Board

The board has many communication interfaces, providing the communication transfer function.

USB port: for USB communication between PC workstation and the instrument.

CAN port: for serial communication between devices in the liquid chromatography system.

REMOTE port: used to receive input trigger signals and output analog signals.

LAN port: network communication between PC workstation and the instrument.

Chapter II Indicator parameters of Diode Array Detector

Performance indicators

Parameter items of Diode Array Detector	Specifications
Wavelength range	190nm~800nm
Wavelength indication error	$\pm 1\text{nm}$
Wavelength repeatability	$\pm 0.1\text{nm}$
Noise	$1.2 \times 10^{-5}\text{AU}$ (ASTM) at 254nm/4nm
Drift	$\leq 5 \times 10^{-4}\text{AU/h}$
Maximum sample rate	100Hz (125Hz)
Linear range	$\geq 2.0\text{AU}$ (5%)
Flow cell	Optical path of 10mm, volume with 12uL, and maximum pressure resistance of 1500psi
Safety measures	Leakage alarm; over temperature alarm

Other parameters

Type	Specifications
Weight	15Kg
External dimensions (length ×width× height)	500mm×386mm×165mm
Power voltage	100-240V AC
Power frequency	50-60Hz
Power	100W
Operating ambient temperature	5°C-35°C, ambient temperature fluctuation is not more than 2°C/hour
Operating ambient humidity	20%-80% , non-condensing

Chapter III Installation instructions of Diode Array Detector

Safety requirements

Please use the product based on the requirement to avoid the possible danger. The following safety precautions shall be known to avoid any injury as well as the damage of the instrument or any other connected product with this instrument.

Use the right power cable	Please use the exclusive cable associated with the instrument, and no other cable is allowed. Please contact with the manufacturer when the cable is damaged
Ground connection	Connect the instrument with the ground through the grounding cable of the power outlet. Please do not use the outlet without ground connection to avoid shock. Please be sure that the instrument is grounded properly when it is to be connected.
Terminal rated value	Please check all the rated values and the sign information to avoid fire or the impact of excessive current. Please consult the user manual about the detailed information of the rated values before the connection of the instrument.
Do not disassemble the instrument for operation without authorization	The dismantlement shall be conducted by the installation engineer appointed by Chromatographic instrument company Instrument, and the user of the instrument shall not disassemble it without authorization. Apart from some components allowed to be replaced by the user, no other component inside the instrument is allowed to be disassembled or replaced
Do not adjust or maintain the instrument when it is energized.	Please make sure that the power is off before opening the outer case of the instrument, otherwise, injuries such as electric shock could be caused.
Do not operate the instrument when it is suspected to be in failure.	Please ask the maintenance personnel of Chromatographic instrument company Instrument for the inspection when you suspect the instrument to be in failure.
Maintain proper ventilation	As used solvents in the operation are mostly organic solvents having a certain degree of volatility and flammability, thus, the environment of the instrument shall be well ventilated (to avoid the air convection) and shall not have any flame. Routine

	inspection of the ventilation holes and fans shall be conducted.
Operate the instrument in proper environment conditions, and flammable and explosive conditions are not allowed.	Operate the instrument at the ambient temperature of 5°C- 35°C and the fluctuation shall be less than 2°C/h, as well as the relative humidity of 20% - 80%, and no direct air conditioning. Please do not operate the instrument in flammable and explosive conditions to avoid instrument damage or human injuries. Strong vibration or electromagnetic interference shall be avoided as well.
Conduct a proper electrostatic protection	Please note the electrostatic protection when the instrument is in operation, avoiding the inflammation of high-concentrate organic solvent fired by large amount of electrostatic charge or even the fire,
Possible harm caused by the solvent and the reagent	Please strictly comply with the operation instructions provided by the solvent supplier, and wear protection clothes, gloves, glasses to avoid the harm.
Note the transportation	Avoid the damage of the appearance, panel or the component of the instrument due to the drop-off during the transportation

Preparations

In order to make sure the instrument is safe and it can operate efficiently other than the danger, the working environment, field requirements, technical specifications, performance indicators and notes shall be known before the installation.

Before the installation, please be sure:

- The system is not in hot or cold air outlet.
- All the necessary component is ready.
- The package or the unpacked goods are in good condition.

Working environment

Attribute	Specifications
Working temperature	5°C-35°C, ambient temperature fluctuation is not more than 2°C/hour Note: for the optimum analysis performance, the working ambient temperature within 8 hours is suggested to be: 25±2°C
Relative humidity	20%-80% , non-condensing
Non-working ambient temperature	0-40°C

The working environment shall meet the above requirements about the ambient temperature and the relative humidity. The excessive fluctuation of the ambient temperature will impact the indicator performance of the instrument, and the optimum performance needs the constant room temperature and the direct air conditioning of the conditioner or other wind duct shall be avoided. Excessive relative humidity enables the surface and the interior of the instrument to be attached with moisture, resulting in corrosion of the metal parts, and the circuit damage. Do not store, use, or transport the instrument in an environment where condensation water is generated inside the instrument due to temperature fluctuations. Condensation water will damage the circuit of the instrument.



Warnings

The instrument shall be placed inside the room till it reaches to the room temperate before the unpacking to avoid the condensation water when it is transported during the cold weather.

Field requirements

1. Workbench

As the system needs to be operated in horizontal state, thus the instrument needs to be placed at the stable and horizontal workbench. The depth of the workbench shall be more than 75cm, and the width shall be more than 200cm, with the front and rear leaving 10cm gaps, and the two sides leaving 5cm gaps for the convenient operation. Adequate air flow is ensured to provide the cooling effect to avoid the overheat of the instrument.

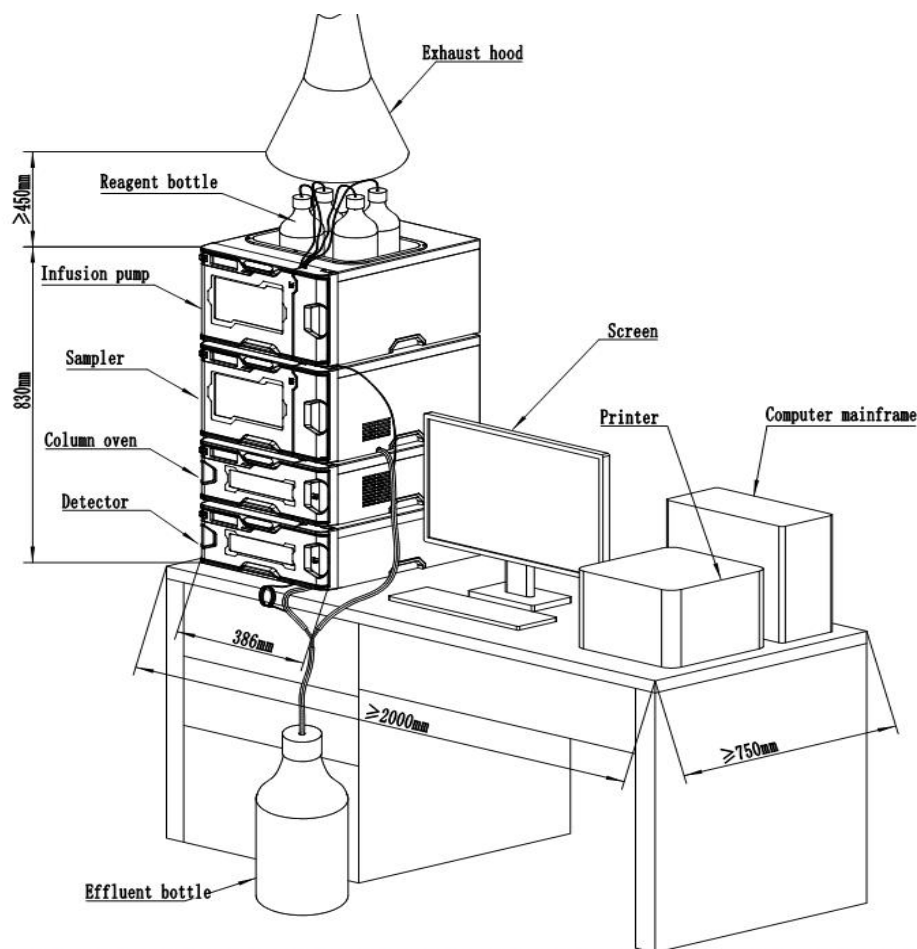


Figure 3- 1 Layout of HPLC liquid chromatography system

2. Power cable

Please use the associated cable to ensure the function and the safety of the power as well as the requirement of EMC.



Warnings

Connect the instrument with the ground through the grounding cable of the power outlet. Please do not use the outlet without ground connection to avoid shock. Please ground the instrument properly.

3. Power requirements

Attribute	Specifications
Power voltage	100-240V AC
Power frequency	50-60Hz



Warnings

Human shock or instrument damage could be caused when the used voltage is over rated value. Please comply with the requirement to use the power.



Warnings

Please unplug the cable jack when the instrument and the power needs to be unconnected, because even when the power switch of the instrument is off, the instrument is still in charge.

4. Reagent safety

As used solvents in the operation are mostly organic solvents having a certain degree of flammability, thus, the environment of the instrument shall be well ventilated (to avoid the air convection). No flame is allowed near to the instrument and no device that could trigger sparks in the room of the instrument is allowed to be installed. To ensure the normal operation and extend the service life of the instrument, flammable, explosive and strong corrosive gas shall be avoided, and the strong vibration or electromagnetic interference shall be avoided as well.

5. Electrostatic safety

Due to the tiny thin pipelines of the system, large amounts of electrostatic charge will be induced when the liquid flows through the tiny thin pipeline at a high speed and used solvents are mostly flammable and volatile organic solvents, thus, the electrostatic protection shall be conducted during the operation

Precautions

- Seal the crack between the inlet and outlet of the effluent bottle and pipelines with the lid or the sealing film, avoiding the outside electrostatic sparks to contact with the volatile solvents.
- Store the effluent with the metal (with conductivity) container and ground the container.
- Operators shall wear anti-static clothes and shoes.

Unpacking and checking

Check the instrument in the following procedures:

1. Check the instrument

Check the outside package of the instrument and preserve it if the package is in serious damage. Check the appearance of the instrument after the unpacking, if there is any damage please do not install it, and if the appearance is in good condition, ask the installation engineer appointed by Chromatographic instrument company Instrument to install it and have the further check of the working performance.

If there is any mechanical damage or missing, or the instrument fails the electrical and mechanical test, please contact with the reseller or the office responsible for the business.

The shipper shall contact with the carrier for the compensation due to the damage during the transportation. Chromatographic instrument company Instrument will not provide free repair or replacement.



Note

When the outside package is in good condition, the unpacking and installation of the instrument shall be conducted by the engineer appointed by Chromatographic instrument company Instrument. The user shall not unpack and install the instrument without the presence of the installation engineer.

Unpacking procedures:

- Cut the protection bandage of the outside package and open the packing box(preserve it well for the next transportation)
- Remove the protection foam around the instrument, take the instrument out carefully and place it on the workbench

2. Check the attachment

Take out all the associated attachments after the unpacking, and check the attachment to be complete and intact or not based on the packing list carefully. If there is any omission or damage, please contact with the reseller or the office responsible for the business.

Instrument installation

After the unpacking check, and when the field meets the requirement, the instrument is ready for installation.

Preparations

Diode Array Detector has four handling screws at the bottom for the fix of the instrument during the transportation, avoiding the component inside the instrument to be impacted.

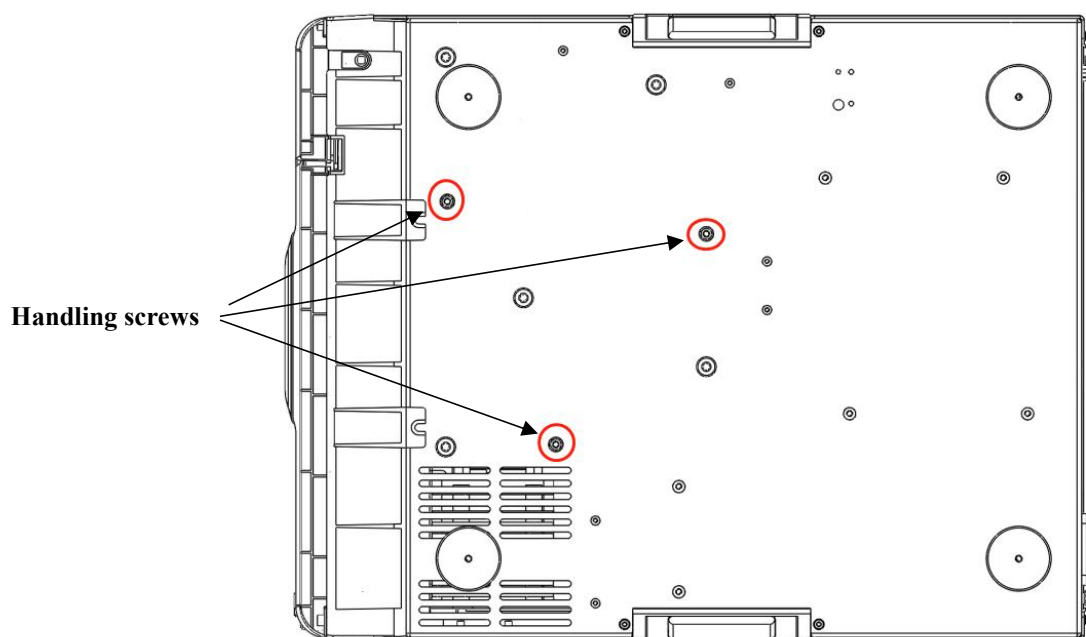


Figure 3-2 Bottom view of Diode Array Detector

1. Dismantle the screws before the installation and preserve them well for the further transportation.
2. Place the instrument on the horizontal workbench.
3. Make sure the power switch on the front panel is OFF.

Optimize the overlay

If the diode array detector is part of the high performance liquid chromatography system of the whole set of K2025 series, overlay the instrument modules in the method shown below to optimize the system performance.

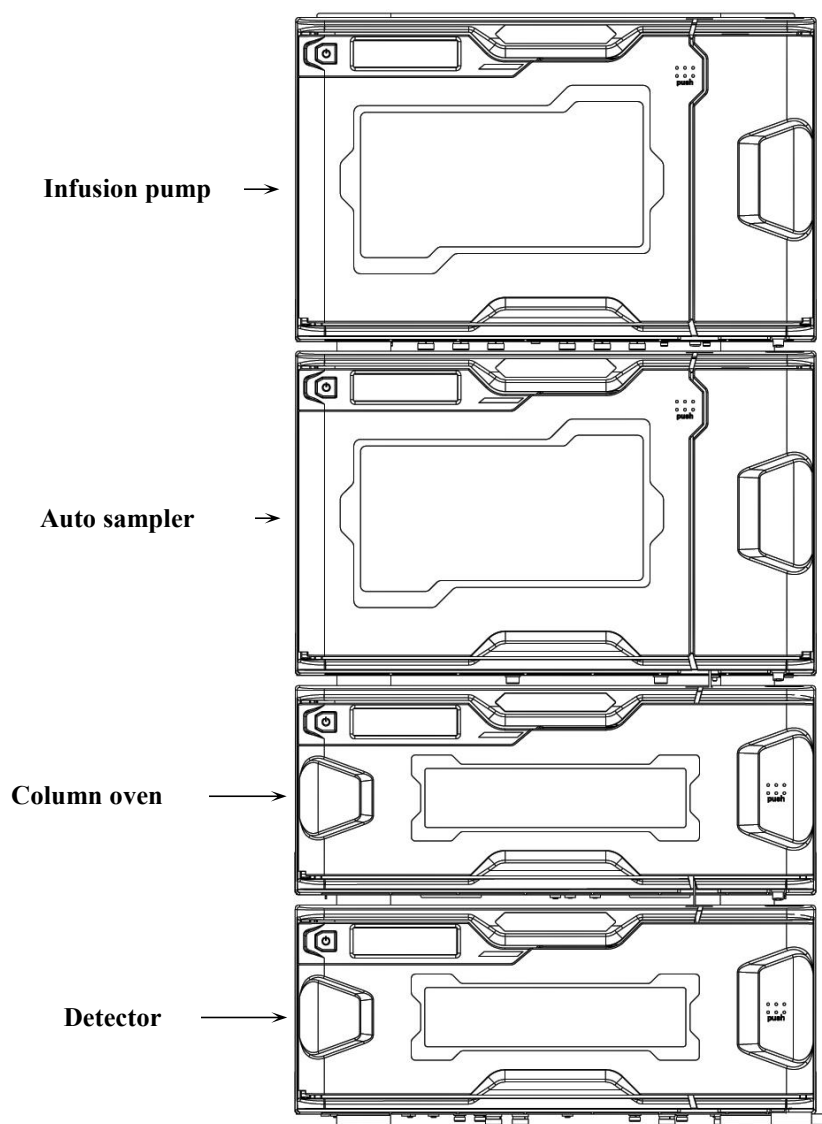


Figure 3-3 Sketch of HPLC optimized overlay

Liquid pipeline connection

The attachment box of diode array detector, is equipped with connectors, installation tools and the well-cut connecting pipelines for the liquid pipeline connection. You can also cut the pipelines based on the requirements.



Note

Make sure the power switch is off and cut off the power before the connection.

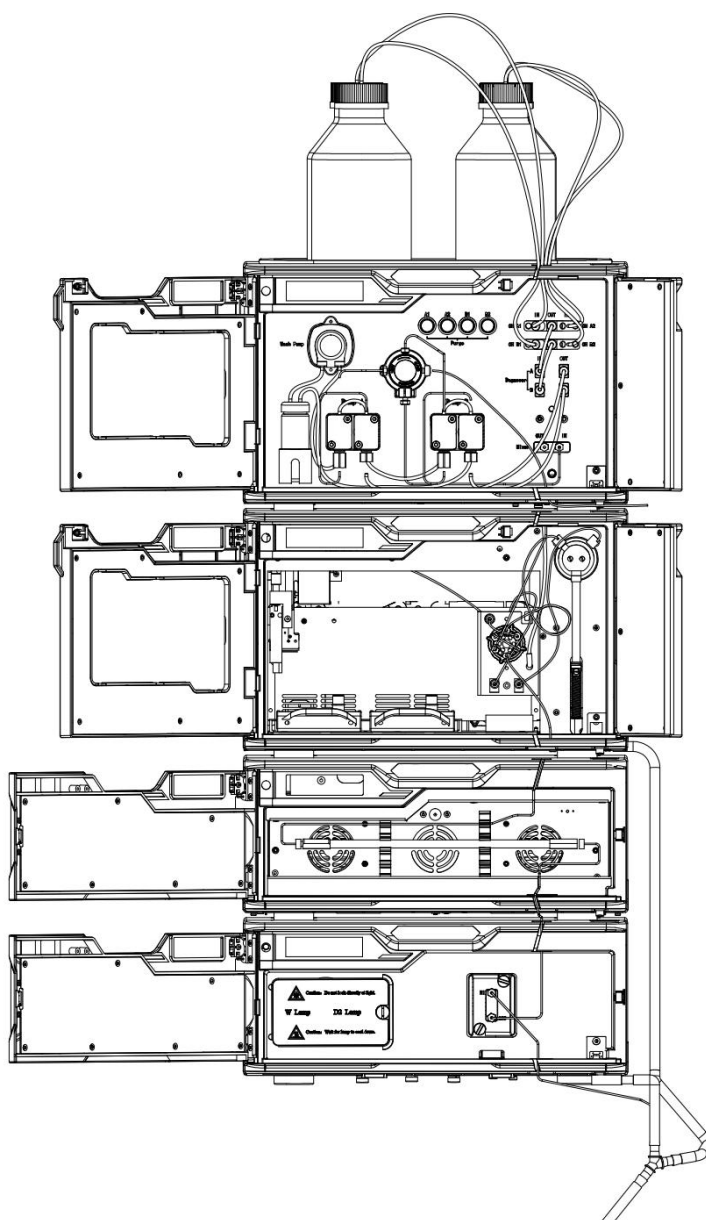


Figure 3-4 Diagram of HPLC liquid pipeline connection

The pipelines needed to be connected for the new installation are shown as follows:

1.Connection of the infusion pump

Refer to the *User Manual of K2025P1 unary isocratic pump*, *User Manual of K2025P2 binary high pressure gradient pump* and *User Manual of K2025P4 quaternary low-pressure gradient pump* for detailed connection methods.

2.Connection between the infusion pump and the sampler

Refer to *User Manual of K2025AS auto sampler* for detailed connection methods.

3.Connection between the sampler and the chromatographic columns

Refer to *User Manual of K2025CO column oven* for detailed connection methods.

4.Connection between the chromatographic column and the detector

Connect one end of the PEEK pipe and connector with the outlet of the chromatographic column and the other end with the flow cell inlet of the detector.

5.Connection between the flow cell and the effluent bottle

Connect one end of the ETFE pipe and connector with the flow cell outlet of the detector and the other end with the effluent bottle.



Note

Lines or equipment which can induce the back pressure of the flow cell to exceed 1000 psi are not allowed to be connected to avoid damage to the flow cell.



Note

Make sure all the pipelines, connectors and all the parts are tightly connected during the pipeline connection to avoid the leakage.

Line connection

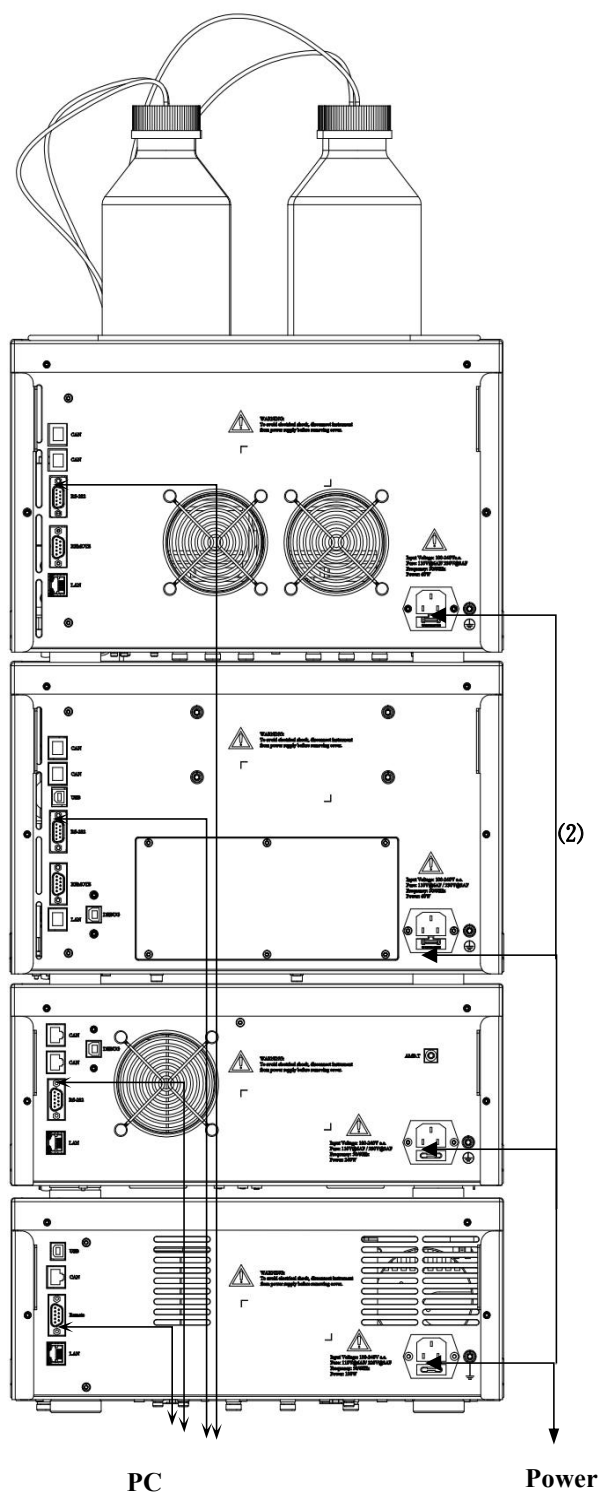


Figure 3-5 Diagram of HPLC line connection

Connect the communication line

(1)

1. Use USB serial data line (1) to connect the interface of the infusion pump RS232 and the USB interface of PC terminal;
2. Use USB serial data line to connect the interface of the auto sampler RS232 and the USB interface of PC terminal.

3. Use USB serial data line to connect the interface of the column oven RS232 and the USB interface of PC terminal.
4. Use network line to connect the interface of the detector and the network interface of PC terminal or the router, ensuring the detector and PC are in the same network.

Connect the power cable

1. Ensure all the power switches of the module are off.
2. Connect one end of the power cable (2) to the power outlet at the rear panel of the instrument, and connect the other end to the AC within the required range.



Note

Please read the notifications of “working environment and field requirement” before the connection to avoid any danger.

Power-on self-test

Press the power button at the upper left of the instrument and the power is on, the screen will be lit and display the self-test information. It will enter in idle display after the self-test.

Chapter IV Instructions for use of Diode Array Detector

Please confirm the following considerations to ensure the proper operation before the use of diode array detector.

Considerations

- All the functions of the instrument need to be realized in the **WorkStation** chromatography workstation, please make sure that the connected PC has installed the liquid chromatography workstation properly before the operation, (all the installation and use methods shall be referred to “**user manual of WorkStation** chromatography workstation”).
- Please make sure that the instrument is connected with the liquid pipeline system properly, check the connection pipelines and connectors to avoid the solvent leakage before the instrument is powered on.
- Do not open or close the front door repentantly, or touch and shake the liquid pipelines, otherwise, the normal data acquisition of the baseline will be interfaced.
- For excellent performance indicators, it is recommended to turn on the instrument and run it stably for more than half an hour.
- When the instrument is in operation, if the flowing phase is buffer salt, please use the transitional flowing phase (flowing phase at the same rate without salt or 10% methanol aqueous solution) to rinse the whole liquid phase system and then the flowing phase of the buffer salt can be used for the experiment.

Use of instruments

System preparation

Connect one end of the power jack with AC, and the other end with the power outlet at the rear panel of the instrument (note the power switch shall be off), press the upper left switch button at the front panel, and the screen is lit showing the instrument model and the self-test information. After the self-test, the screen will enter in idle display, showing the instrument start up normally.

When the self-test has a failure, the screen will switch to alarm display interface with the bee alarming sound. Refer to the instructions of “alarm prompt” for the alarm display.

Operation of instruments

Functions to be implemented of diode array detector with the help of WorkStation chromatography workstation include:

●Connection function

When the instrument is start-up, the chromatography workstation cannot conduct the communication connection with the instrument, which needs the operator to enter in the configuration interface to distribute the proper port of the detector, and then the instrument can be controlled by the chromatography workstation.

●Sampling channel setting function

Set the sampling channel according to the test sample within the wavelength range of the detector.

●3D spectrum function

Set The 3D spectrum function to be on or off. The 3D spectrum function can provide data information of the whole band within the sampling time.

●Sample rate selection function

Select the appropriate sampling rate according to the half peak width of the target. Sharp peaks may be detected due to the increased sample rate, while more noise may be detected as well.

Sampling rate setting

Half peak width	Sampling rate
0.1 s	100 Hz
0.2 s	50 Hz
0.4 s	25 Hz
1 s	10 Hz
2 s	5 Hz
5 s	2 Hz
10 s	1 Hz
20 s	0.5 Hz

●Spectral scan function

The detector can be used as a spectrophotometer and the flow cell replaced with a cuvette, which can be used for the spectrum acquisition to determine the optimal absorption wavelength of a substance.



Note

During the spectral scanning process, the pump needs to be stopped to ensure the still test sample in the flow cell.

●Deuterium lamp and tungsten lamp control function

Control the deuterium lamp and tungsten lamp to be on and off.

Chapter V Failure and maintenance instructions of diode array detector

This chapter lists possible failures during the use, and provides the corresponding methods to help the user to analyze and deal with the common problems. Please contact with our office if the problem is still unsolved after the corresponding measures are taken or the problem is unlisted in the following chart.

Common failures

Common failures	Possible causes	Measures
The instrument is not start-up after the power button is pressed.	Power jack is not well plugged.	Plug out and in the jack again
	Power cable is damaged.	Replace the cable of the same type.
	Power supply does not meet the requirement.	Use the power supply in accordance with the requirement.
	Fuse is melt.	Replace the fuse of the same specification.
Excessive noise	Flow cell is contaminated.	Rinse the flow cell sequentially with water and isopropanol.
	flow cell has air bubbles.	Increase the flow rapidly to dislodge air bubbles.
	Liquid leakage	Check and tighten the connectors of the pipelines.
	Tiny particles flow through the flow cell.	Check the outlet frit of the chromatographic column.
	Low light source energy of the detector	Check the status and energy of the deuterium lamp and tungsten lamp, and replace the lamp with a new one if necessary.
Excessive drift	Temperature change of the detector	Ensure the constant ambient temperature.
	Chromatographic column is contaminated.	Replace the chromatographic column.
	The flowing phase of the chromatographic column is not	Extend the rinsing time of the chromatographic column.

	replaced completely.	
	Flow cell is contaminated.	Rinse the flow cell sequentially with water and isopropanol.
	Light source failure of the detector	Replace the new deuterium lamp and tungsten lamp.
Big peak	Air bubbles flow through the flow cell.	Degas the flowing phase and flush the system, check the pipeline connections for leakage.
	Poor detector grounding	Ensure the proper grounding
Negative peaks	Sampling failure	Use the sampling valve to verify that there are no air bubbles during the sampling.
	Impure flowing phase	Use the chromatographic-pure flowing phase or purify the solvent.

Alarm prompt

diode array detector has the diagnostic function. The instrument will give an alarm prompt if it diagnoses the problem during the operation with a bee sound. Possible alarm prompts, causes and corresponding measures are listed below.

1.Warning: Leak

Implication: leakage alarm

Cause: leakage is detected.

Measures: clean the leaked solvent, check and repair the pipeline.

2.Warning: Above temperature

Implication: over temperature alarm of the light source room

Cause: the light source room is detected to be of excessive temperature, higher than 65°C.

Measures: check the fans for normal work and replace with a new one if necessary.

3.Error: FM01

Implication: memory error

Cause: memory read and write abnormal

Measures: restart the detector and conduct the new self-test, and contact the engineer if necessary.

4.Error: DE01

Implication: deuterium lamp failure alarm

Cause: deuterium lamp failure

Measures: check the deuterium lamp whether it is damaged and contact the engineer if necessary.

5.Error: DE02

Implication: deuterium lamp has low energy

Cause: deuterium lamp has decreased energy

Measures: check the deuterium lamp whether it uses for more than 2000 hours and contact the engineer if necessary.

6.Error: TU01

Implication: tungsten lamp failure alarm

Cause: tungsten lamp failure

Measures: check the tungsten lamp whether it is damaged and contact the engineer if necessary.

7.Error: TU02

Implication: tungsten lamp has low energy

Cause: tungsten lamp has decreased energy

Measures: check the tungsten lamp whether it uses for more than 2000 hours and contact the engineer if necessary.

8.Error: PK01

Implication: abnormal positioning of 656.1nm characteristic peak alarm

Cause: failure of wavelength positioning.

Measures: check whether the deuterium lamp has the proper energy, rinse the flow cell, restart the detector and conduct the new self-test and contact the engineer if necessary.

9.Error: PK02

Implication: abnormal positioning of 486nm characteristic peak alarm

Cause: failure of wavelength positioning.

Measures: check whether the deuterium lamp has the proper energy, rinse the flow cell, restart the detector and conduct the new self-test and contact the engineer if necessary.

10.Error: WL01

Implication: wavelength calibration alarm.

Cause: failure of wavelength calibration.

Measures: restart the detector and conduct the new self-test, and contact the engineer if necessary.

11.Error: FT01

Implication: filter motor alarm.

Cause: initial position searching error of motor

Measures: restart the detector and conduct the new self-test. Contact the engineer if necessary.

12.Error: SL01

Implication: slit motor alarm.

Cause: initial position searching error of motor

Measures: restart the detector and conduct the new self-test. Contact the engineer if necessary.

13.Error: FP01

Implication: front board program loading alarm

Cause: front board program loading in failure

Measures: check the line connection of the front board, restart the detector and conduct the new self-test. Contact the engineer if necessary.

14.Error: FP02

Implication: front board program communication alarm

Cause: communication failure between main board and the front board

Measures: check the line connection of the front board, restart the detector and conduct the new self-test. Contact the engineer if necessary.

Routine maintenance

For a good measurement result of diode array detector, please have a regular inspection and maintenance of the instrument, mainly includes,

System rinsing

- Rinse the system with the pure methanol before the switch-off. If the flowing phase of the buffer salt has been used, please use the transitional flowing phase (flowing phase at the same rate without salt or 10% methanol aqueous solution) to rinse the system and then rinse the system with the pure methanol.



Note

Instrument system can only be conserved in the methanol, other than the ethanol, pure water or the flowing phase containing buffer salt

Repair and maintenance

- Solvents such as methanol and ethanol should be chromatography-level pure, and water should be super-pure water. The associated flowing phase should go through the filter film of 0.45 μ m or 0.22 μ m for filtering with the ultrasonic degassing for 20 min, and the standard sample and the sample should go through the filter film of 0.45 μ m or 0.22 μ m for filtering.
- Rinse the system and the flow cell with 10% methanol aqueous solution, and rinse and preserve with the pure methanol or solution with high proportion of methanol then if the flowing phase applied containing acid or inorganic salt.

Routine maintenance of Diode Array Detector

Maintenance items	Maintenance cycle*
Replace the deuterium lamp	2000 hours
Replace the tungsten lamp	2000 hours

Note *: The maintenance cycle of this chart is the suggested inspection cycle other than the warranty period, and the maintenance shall be conducted based on the specific usage conditions.



Warnings

Please refer to the safety instructions provided by the solvent supplier for details and take protection measures (such as wearing protective clothes, glasses and gloves) before the maintenance in order to avoid the injuries to the operator due to the solvent (especially the poisonous or harmful solvent) leakage during the opening of the pipelines or the connectors.

Maintenance of consumables

Deuterium lamp

Replacement criteria: when the deuterium lamp uses for 2000 hours, and the energy decreases significantly and the noise increases, the replacement is to be considered.

Tools needed : flat-blade screwdriver, T10 Torx screwdriver, and white cloth gloves

Considerations:

- Switch off the detector and unplug the power cord to avoid the electric shock before opening the light source protection cover; ensure that the deuterium lamp cools down for more than 30 minutes to avoid burns of high temperature.
- Never touch the glass parts with your bare hands during the replacement of the deuterium lamp. If the deuterium lamp is stained, wipe it off with the lens tissue with small amount of alcohol.
- Please wrap the deuterium lamp with a veil when you need to take it and handle it with care.

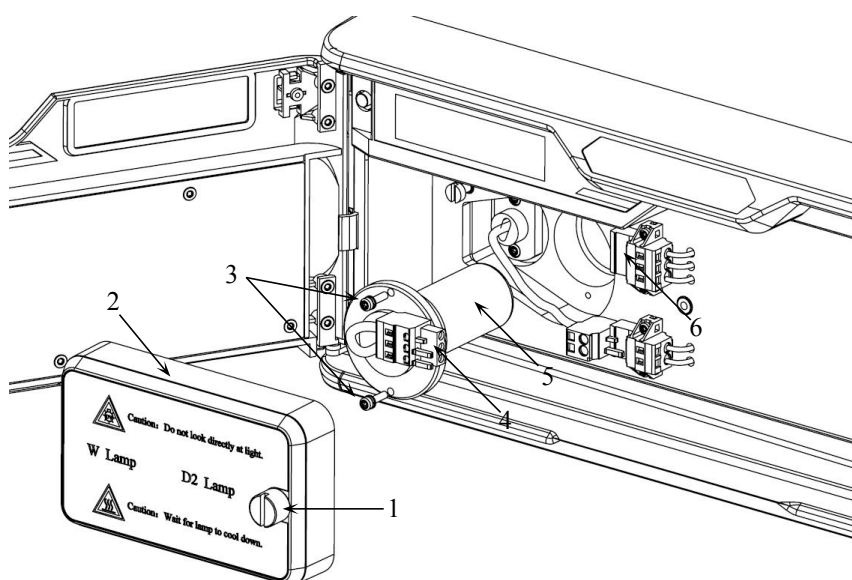


Figure 5-1 Replacement diagram of deuterium lamp

Replacement procedures:

- a. Switch off the instrument and plug out the power cord and ensure that the deuterium lamp cools down for more than 30 minutes.
- b. Open the front door of the detector, use a flat-blade screwdriver to loosen the fastening screws (1) of the light source protection cover, and pull it to the right to remove the protection cover (2).
- c. Disconnect the deuterium lamp plug (4) and socket (6), loosen the two fastening screws (3) of the deuterium lamp carefully and evenly with the use of a T10 Torx screwdriver, and carefully remove the deuterium lamp (5).
- d. Install the new deuterium lamp back into the lamp holder, match the limit hole of the

deuterium lamp and the limit pin of the lamp holder to adjust the direction, tighten the fastening screws alternately, and connect the deuterium lamp plug and socket.

- e. Reinstall the light source protection cover and tighten the fastening screws.
- f. Close the front door of the detector.
- g. Connect the power cord, turn on the detector, and if the self-check is normal, it means that the deuterium lamp has been replaced successfully.
- h. Connect the chromatography workstation, and the use time of the detector's deuterium lamp can be reset during diagnostic maintenance.

Tungsten lamp

Replacement criteria: when the tungsten lamp uses for 2000 hours, and the energy decreases significantly and the noise increases, the replacement is to be considered.

Tools needed: flat-blade screwdriver, T10 Torx screwdriver, and white cloth gloves.

Considerations

- Switch off the detector and unplug the power cord to avoid the electric shock before opening the light source protection cover; ensure that the tungsten lamp cools down for more than 30 minutes to avoid burns of high temperature.
- Never touch the glass parts with your bare hands during the replacement of the tungsten lamp. If the tungsten lamp is stained, wipe it off with the lens tissue with small amount of alcohol.
- Please wrap the tungsten lamp with a veil when you need to take it and handle it with care.

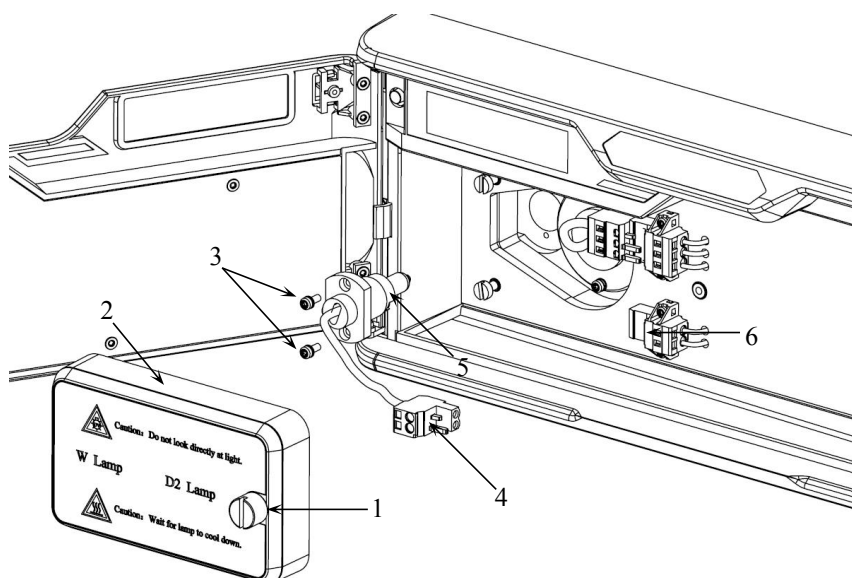


Figure 5-2 Replacement diagram of tungsten lamp

Replacement procedures:

- Switch off the instrument and plug out the power cord and ensure that the tungsten lamp cools down for more than 30 minutes.
- Open the front door of the detector, use a flat-blade screwdriver to loosen the fastening screws (1) of the light source protection cover, and pull it to the right to remove the protection cover (2).
- Disconnect the tungsten lamp plug (4) and socket (6), loosen the two fastening screws (3) of the tungsten lamp carefully and evenly with the use of a T10 Torx screwdriver, and carefully remove the tungsten lamp (5).
- Install the new tungsten lamp back into the lamp holder, match the limit hole of the tungsten lamp and the limit pin of the lamp holder to adjust the direction, tighten the fastening screws, and connect the tungsten lamp plug and socket.
- Reinstall the light source protection cover and tighten the fastening screws.
- Close the front door of the detector.
- Connect the power cord, turn on the detector, and if the self-check is normal, it means that the

tungsten lamp has been replaced successfully.

- h. Connect the chromatography workstation, and the use time of the detector's tungsten lamp can be reset during diagnostic maintenance.

Flow cell

Flush the flow cell when it becomes contaminated with test sample impurities and before every detector shutdown. A dirty flow cell can cause problems such as decreased energy, increased baseline noise, reduced sensitivity, and failed self-tests.

Rinsing the flow cell:

- a. Rinse the system and the flow cell with 10% methanol aqueous solution if the flowing phase containing acids, bases, and buffer salts.
- b. Remove the column and connect the outlet of the infusion pump to the inlet of the flow cell with a union.
- c. The pressure of the infusion pump delivering isopropyl alcohol to clean the flow cell must not exceed 500 psi.
- d. The pressure of the infusion pump delivering 100% methanol to clean the flow cell must not exceed 500 psi.
- e. Reconnect the chromatographic columns.

Note: if the noise and sensitivity of the detector are not improved after cleaning the flow cell, this part needs to be replaced.

Replacement criteria of the flow cell: the increased noise and the rapidly decreased sensitivity due to the contamination of the flow cell, and there is no obvious improvement after online flushing or dismantling and cleaning, then the replacement is to be considered.

Tools needed: flat-blade screwdriver.

Considerations:

- To dismantle and install the components in the original orientation.

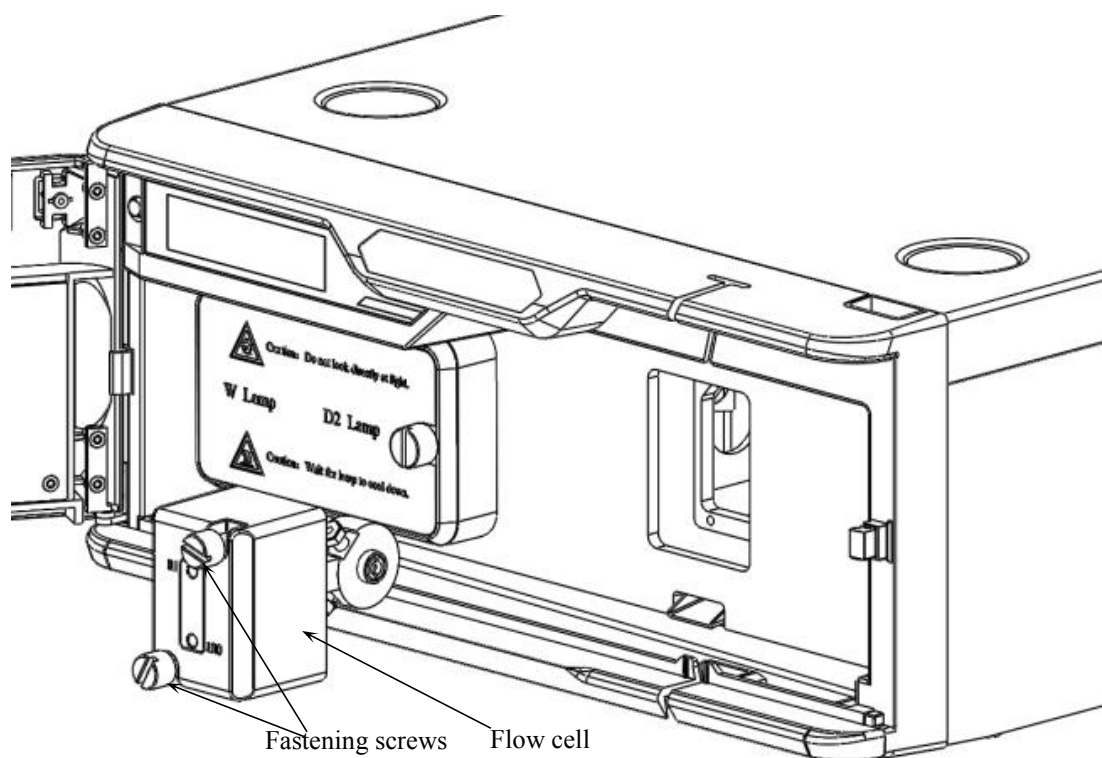


Figure 5-3 Replacement diagram of flow cell

Replacement procedures of flow cell:

- a. Switch off the detector and plug out the power cord.
- b. Open the front door of the detector and disconnect the pipelines of the flow cell outlet (OUT) and inlets (IN).
- c. Loosen the upper and lower fastening screws of the flow cell with the use of a flat-blade screwdriver, and take out the flow cell.
- d. Install a new flow cell and note the direction with the flow cell outlet up and the inlet down.
- e. Tighten the two fastening screws by hand first, then with a flat-blade screwdriver.
- f. Reconnect the pipelines of the flow cell outlet and inlet.
- g. Close the front door of the detector.
- h. Connect the power cord, turn on the detector, and if the self-check is normal, it means that the flow cell has been replaced successfully.

Fuse

Replacement criteria: the detector is not working and the fuse is melt, then the fuse needs to be replaced..

Tools needed: flat-blade screwdriver.

Considerations:

- Switch off the instrument and plug out the power cord before the fuse replacement to avoid the electric shock.
- Use the fuse with the same model provided by Chromatographic instrument company Instrument.

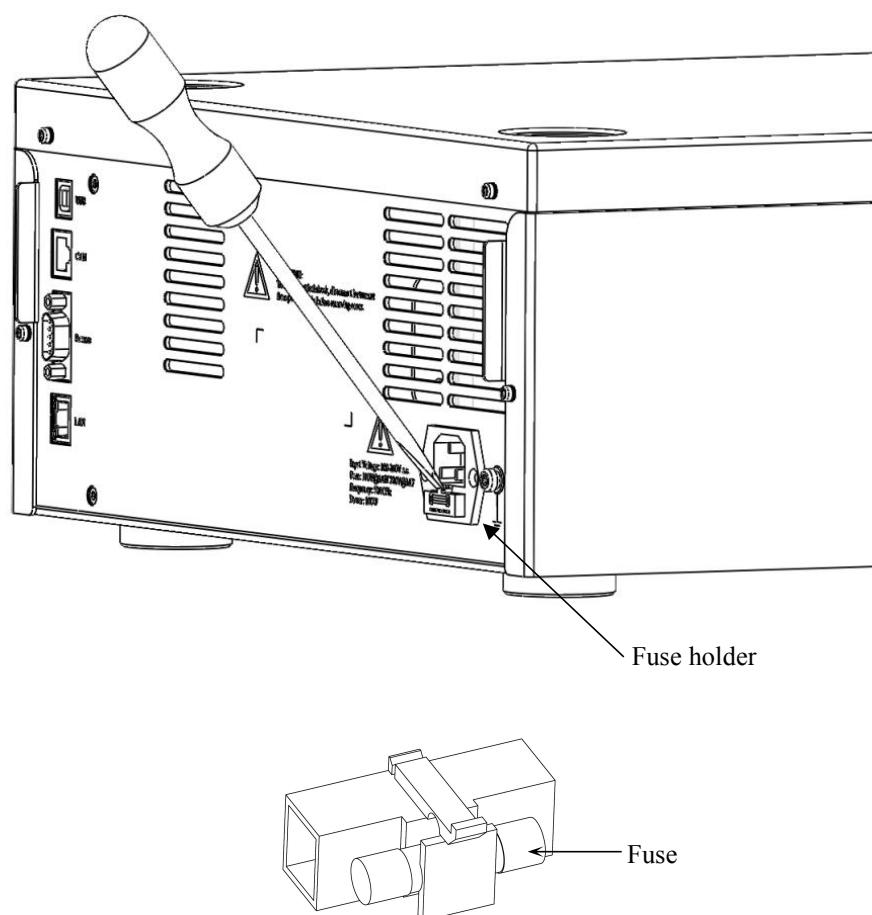


Figure 5-4 Replacement diagram of the fuse

Replacement procedures:

- a. Switch off the detector and plug out the power cord.
- b. Pry open the fuse holder with the flat-blade screwdriver and plug the fuse out.
- c. Take the damaged fuse out and install the new one into the holder.
- d. Reinstall the fuse holder.
- e. Connect the power cord and switch on the detector, if the detector starts up normally, then the fuse is replaced properly.

Chapter VI Reagent considerations

Reagent instructions



Note

Please follow the lab safety requirement during the operation of the instrument to avoid chemical danger.

Reagent quality

Clean reagent can ensure a good repeatability of the experiment and decrease the maintenance frequency of the instrument. Unclean reagent will trigger the noise of the base line and the increased drift, and the contained particles will block the filter. Thus the flowing phase of HPLC leveled reagent is suggested for the optimum result. The used flowing phase shall be filtered through micro-porous filter film of 0.45 μ m or 0.22 μ m and be ultrasonic degassed.

High-quality brown glass-wares can inhibit microbiology to grow.

Buffer solvent

Use high-quality reagent during the use of the buffer solvent. Dissolve salt first and adjust PH value, and eliminate the insoluble substances through micro-porous filter film of 0.45 μ m or 0.22 μ m.

Rinse all the pipelines with 10% methanol aqueous solution of 60mL at least after the use of buffer solvent. If the pump is out of operation for more than one day, rinse and preserve the system with methanol and to avoid the microorganism.

Tetrahydrofuran (THF)

Tetrahydrofuran is not stable, please use the newly-opened reagent. Tetrahydrofuran opened before and long-placed contains impurities of peroxides, which will lead to the baseline drift.



Warnings

Tetrahydrofuran containing high-concentrated peroxides has a risk of explosion.

Solvents which could lead to the iron and steel corrosion shall be avoided.

- Solvents containing halogen: fluorine, bromine or iodine.
- High-concentrated acids: nitric acid, sulfuric acid (only when the concentration is lower than 5% is allowed, excluding as the cleaning solvent, and the acid with pH lower than 1.0 shall not be used as the flowing phase.)
- Chromatographic pure ethers which could contain peroxides (such as THF, dioxane, dipropyl ether). If these ethers need to be used, please use the dry aluminum oxide for filtering to absorb the peroxides.
- Solutions of high-concentrated complexing agents containing EDTA
- Mixing solutions of carbon tetra chloride and isopropyl alcohol or THF.

UV cut-off wavelength of common reagents

UV cut-off wavelength: the reagent loaded with an absorption cell with 1cm optical path, and air as the reference, the irradiation wavelength is changed and when the absorbance A equals 1, the wavelength at this time is called the cut-off wavelength of the reagent. The testing wavelength must be bigger than the cut-off wavelength of the flowing phase when the ultraviolet detector is used. When the wavelength is near to or smaller than the cut-off wavelength, the baseline noise will be increased due to the light absorption of the reagent.

Reagent	UV cut-off wavelength	Reagent	UV cut-off wavelength
1-nitropropane	380	Ethylene glycol	210
2-butoxyethanol	220	Isooctane	215
Acetone	330	Isopropanol	205
Acetonitrile	190	2-chloropropane	225
Amyl alcohol	210	Isopropyl ether	220
Amyl chloride	225	Methyl alcohol	205
Benzene	280	Methyl acetate	260
Carbon disulfide	380	Butanone	330
Tetrachloromethane	265	Methyl isobutyl ketone	334
Trichloromethane	245	Dimethyl formamide	233
Cyclohexane	200	n-pentane	190
Cyclopentane	200	n-propyl alcohol	210
Diethylamine	275	1-chloropropane	225
Dioxacyclohexane	215	Nitromethane	380
Ethyl alcohol	210	Petroleum ether	210
Ethyl acetate	256	Pyrimidine	330
Diethyl ether	220	Tetrahydrofuran	230
Diethyl sulfide	290	Methylbenzene	285
Dichloroethylene	230	Xylene	290

Solvent miscible table

Name
Acetic acid
Acetone
Acetonitrile
Benzene
n-butyl alcohol
Tetrachloromethane
Chloroform
Cyclohexane
Cyclopentane
Dichloroethane
Dimethylformamide
Dimethylformamide
Dimethyl sulfoxide
Dioxane
Ethyl acetate
Ethyl alcohol
Diethyl ether
n-heptane
n-hexane
Methyl alcohol
Methyl ethyl ketone
Isooctane
Pentane
Isopropanol
Diisopropylether
Tetrachloroethane
Tetrahydrofuran
Methylbenzene
Trichloromethane
Water
Xylene

■ Immiscible
□ Miscible