

**UV-VIS DETECTOR
FOR SHIMADZU HIGH PERFORMANCE
LIQUID CHROMATOGRAPH
SPD-20A/20AV
INSTRUCTION MANUAL**

Read the instruction manual thoroughly before you use the product.
Keep this instruction manual for future reference.

SHIMADZU CORPORATION
ANALYTICAL & MEASURING INSTRUMENTS DIVISION
KYOTO, JAPAN

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Introduction

Read this manual thoroughly before using the instrument.

Thank you for purchasing this instrument. This manual describes: the installation, operation, hardware validation, cautions for use, and details on the accessories and options. Read the manual thoroughly before using the instrument. Use the instrument in accordance with the manual's instructions. Keep this manual for future reference.

IMPORTANT

- Do not use this instrument before fully understanding the contents of this manual.
- Provide this documentation to the next user in the event that the instrument is borrowed or sold.
- If this documentation or the warning labels on the instrument become lost or damaged, promptly obtain replacements from your Shimadzu representative.
- To ensure safe operation, read the **Safety Instructions** before using the instrument.

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Warranty and After-Sales Service

Warranty

1. Validity

Please consult your Shimadzu representative for information about the extent of the warranty.

2. Term

The manufacturer will provide free replacement parts for, or repair free of charge, any instrument that fails during the warranty period, if the cause can be attributed to a defect in manufacturing.

3. Items Not Covered by the Warranty

The warranty does not cover malfunctions that result from:

- 1) misuse;
- 2) repairs or modifications made by any company other than the manufacturer or an approved company;
- 3) external factors;
- 4) operation under severe conditions such as environments, with high temperature, high humidity, corrosive gas, vibration, etc.;
- 5) fire, earthquake or other forces of nature;
- 6) moving or transporting the instrument after its initial installation;
- 7) the consumption of items or parts that can be regarded as consumable.
(For example, the service life of an LCD display panel depends on the actual operating conditions.)

After-Sales Service

If any problem occurs with this instrument, inspect it and take appropriate corrective action as described in the Section "[6 Troubleshooting](#)". If the problem persists, or symptoms not covered in the Troubleshooting section occur, contact your Shimadzu representative.

Replacement Parts Availability

Replacement parts for this instrument will be available for a period of seven (7) years after the discontinuation of the product. Thereafter, such parts may cease to be available. Note, however, that the availability of parts not manufactured by Shimadzu shall be determined by the relevant manufacturers.

Hardware Validation

Each LC component and the entire LC system should be checked periodically to ensure that they function normally, or the analysis data may not be reliable. To this end, it is necessary to carry out periodic hardware validation and keep records of the validation. There are two types of hardware validation - component validation and system validation. The purpose of component validation is to check that the individual components of the system function normally, while the system validation checks that the system as a whole (the several components in combination) functions normally.

Before shipment from the factory, this instrument was rigorously inspected. The results are summarized in the Inspection Certificate accompanying the instrument. To inspect the instrument performance after installation, repeat the Hardware Validation as described in "[7 Hardware Validation](#)".

 ["7 Hardware Validation" P. 7-1](#)

Hardware Validation Contract

This is a contract under which a qualified Shimadzu-approved engineer performs periodic component and system validation, and provides reports of the results. Details of the contract can be obtained from your Shimadzu representative.

Safety Instructions

- To ensure safe operation of the instrument, read these Safety Instructions carefully before use.
- Observe all of the **WARNINGS** and **CAUTIONS** described in this section. They are extremely important for safety.
- In this manual, warnings and cautions are indicated using the following conventions;

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in moderate to serious injury or possibly death.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor injury or equipment damage.
NOTE	Emphasizes additional information that is provided to ensure the proper use of this instrument.

■ Application Precautions

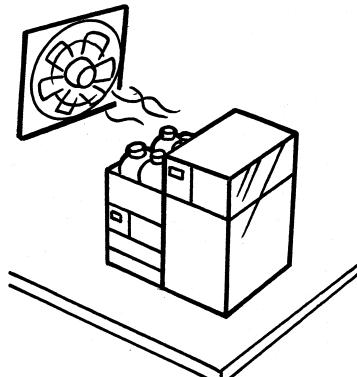
⚠ WARNING
This instrument is a UV-VIS detector for use with a high performance liquid chromatography system.
Use this instrument ONLY for the intended purpose.
Using this instrument for any other purpose could cause accidents.

■ Installation Site Precautions

⚠ WARNING

- The solvents used in high performance liquid chromatograph are flammable and toxic. The room where the instrument is installed should be well ventilated; otherwise, solvent vapors could cause poisoning or ignite and cause a fire.**
- High performance liquid chromatograph uses large amounts of flammable organic solvents. Use of open flame in the vicinity of this instrument must be strictly prohibited. Do not install the instrument in the same room with any other equipment that emits or could potentially emit sparks, since sparks could cause a fire.**

Provide fire extinguishers for use in case of fire.



- Provide protective equipment near the instrument.**

If solvent gets into the eyes or on the skin, it must be flushed away immediately. Provide equipment, such as eye wash stations and safety showers, as close to the instrument as possible.

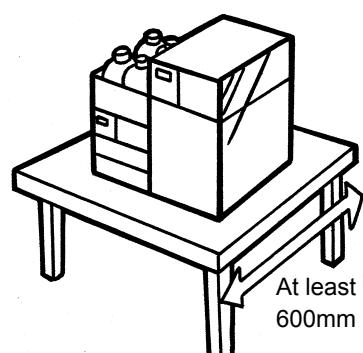


⚠ CAUTION

- The weight of this instrument is 13kg. During installation, consider the entire weight combined with other LC components.**

The lab table on which this instrument is installed should be strong enough to support the total weight of the LC system. It should be level, stable and have depth of at least 600mm.

Otherwise, the instrument could tip over or fall off the table.



- Avoid installation sites that are exposed to corrosive gases or excessive dust.**

These adverse conditions may be detrimental to maintaining the instrument performance and may shorten its service life.

■ Installation Precautions

⚠ WARNING

- Take measures to prevent the instrument from falling in the event of an earthquake or other disaster.**

Strong vibrations could cause the instrument to fall over, resulting in injury.

- The power supply voltages and power consumptions of this instrument are listed below. The power supply voltage of the instrument is indicated on the label on the back of the instrument. Connect the instrument only to a power supply of the voltage indicated;**
otherwise, fire or electric shock could result. Check that the power supply voltage is stable and that its current capacity is sufficient to operate all the components of the system. If not, the instrument will not operate at its rated performance.

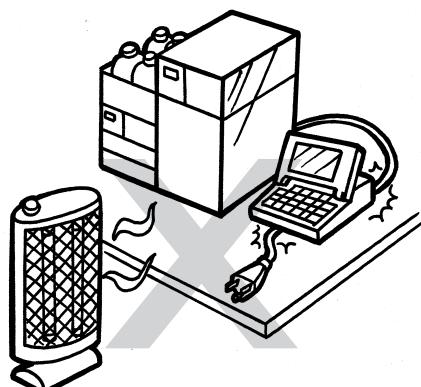
Part No.		Power Supply Voltage (indicated on the instrument)	Power Consumption	Frequency
SPD-20A	SPD-20AV			
228-45003-31	228-45004-31	AC100V (100V~)	160VA	50/60Hz
228-45003-32	228-45004-32	AC120V (120V~)	160VA	50/60Hz
228-45003-28	228-45004-28	AC220V-230V/AC240V (220-230/240V~)	160VA	50/60Hz
228-45003-38	228-45004-38			

- Ground the instrument.**

Grounding is necessary to prevent electric shock in the event of an accident or electrical discharge, and important for ensuring stable operation.

- Do not place heavy objects on the power cord, and keep any hot items away.**

The cord could be damaged, resulting in fire, electrical shock or malfunction. If the cord becomes damaged, contact your Shimadzu representative immediately.



- Do not modify the cord in any way. Do not bend it excessively or pull on it.**

The cord could be damaged, resulting in fire, electrical shock or malfunction. If the cord becomes damaged, contact your Shimadzu representative immediately.

⚠ CAUTION

- When installing the instrument, be careful not to pinch your fingers between the system components, as this could result in injury.
- When opening the doors, be careful not to pinch your fingers as this could result in injury.



■ Operation Precautions

⚠ WARNING

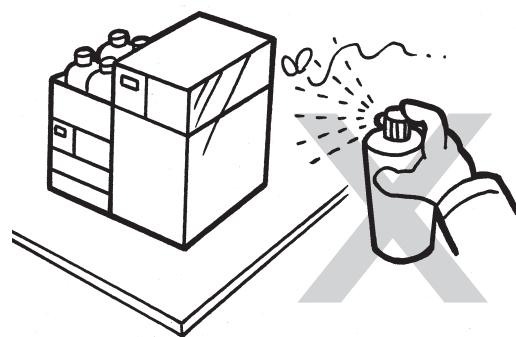
- Take thorough measures to prevent buildup of static electricity.
 "Static Electricity Precautions" P.IX
Static electricity could result in fires or explosions.



- Always wear protective gloves and protective goggles when handling solvents and samples.
If solvent gets into the eyes, blindness could result.
Should solvent get into the eyes, flush immediately with large amounts of water and get medical attention.



- Always wear protective gloves when handling any toxic or biologically infectious samples.



- Never use a cracked reservoir bottle.
If a helium degasser is used, pressure is exerted on the reservoir bottles and may cause cracks in the bottles.
It could break the reservoir bottles and cause injury.

- Do not use flammable sprays (hair sprays, insecticide sprays, etc.) near the instrument.
They could ignite and cause a fire.

■ Precautions for Instrument Inspection, Maintenance, Adjustment and Care

⚠ WARNING

- **Unplug the instrument before inspection, maintenance, or parts replacement.**

Otherwise, electrical shock or short-circuit accidents could occur.

- **Never remove the main cover.**

This may cause injury or malfunction of the instrument.

The main cover does not need to be removed for routine maintenance, inspection and adjustment. Have your Shimadzu representative perform any repairs requiring removal of the main cover.



- **Replace fuses only with fuses of the proper type and capacity.**

Any other fuses could cause a fire.

- **If the power cord plug gets dusty, remove the plug from the power outlet and wipe away the dust with a dry cloth.**

If dust is allowed to accumulate, fire could result.

- **Replacement parts must be of the specifications given in "1.3 Component Parts" or "9.3 Maintenance Parts".**

Use of any other parts may result in instrument damage and malfunction.

- **If any water gets onto the instrument, wipe it away immediately to prevent rust. Never use alcohol or thinner solvents for cleaning the instrument.**

They could cause discoloration.

- **Dispose of the waste liquid properly and in accordance with the instruction by your administrative department.**

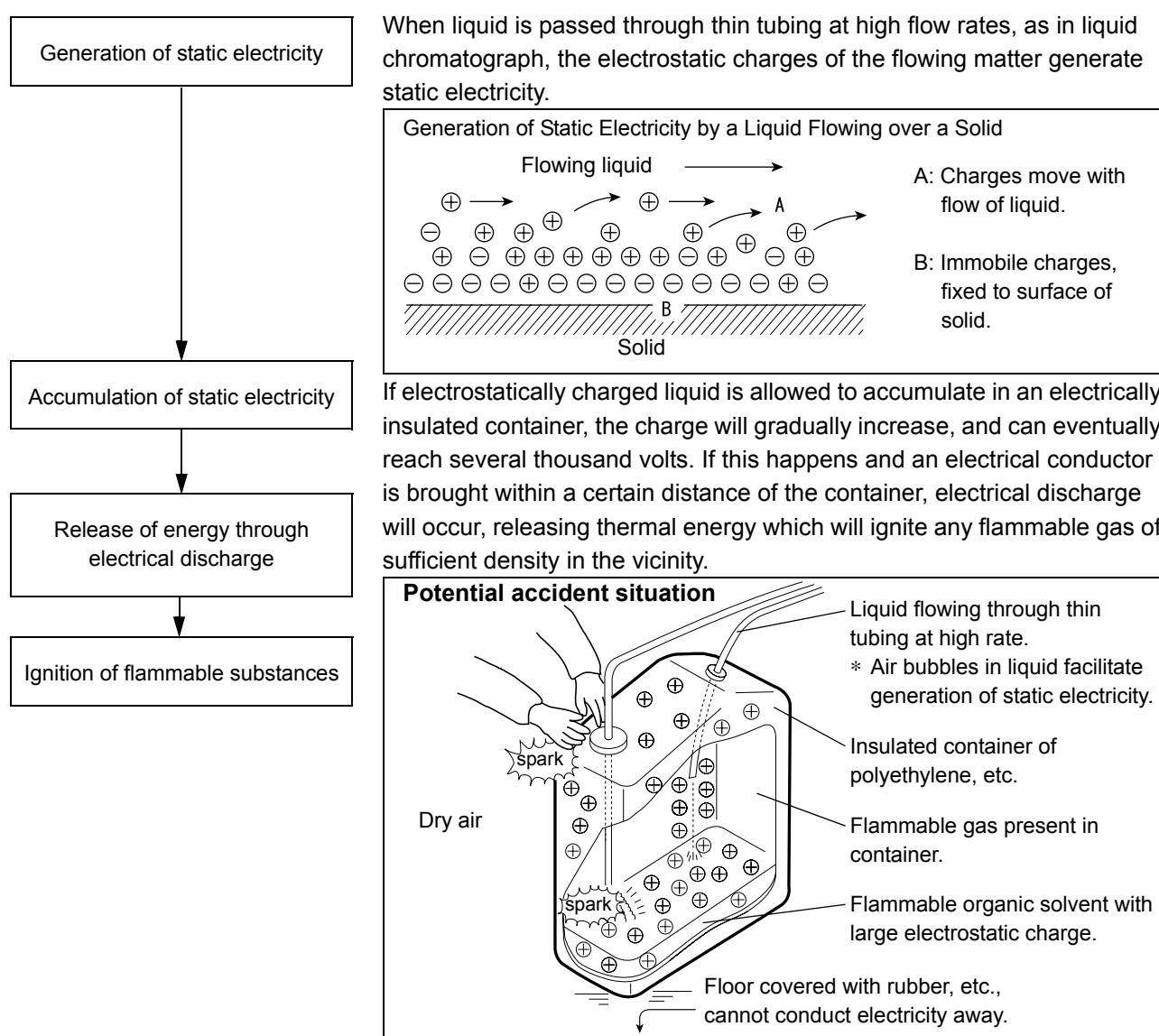
Static Electricity Precautions

Liquid chromatograph (LC) uses flammable organic solvent(s) as the mobile phase. LC systems are also often used where large amount of flammable substances are present. Thus, an accident can produce large scale damage. Operators must be constantly on guard against accidents involving fire or explosion.

The major cause of these accidents is static electricity. Devising preventative measures for static can be difficult, because the symptoms before an accident vary and can be hard to detect, since such accidents occur as a result of several simultaneous coincidences. Recommended methods for preventing static electricity accidents are provided below. Take thorough safety measures based on this information.

■ Typical Cause of Static Electricity Accidents

Static electricity accidents are generally caused by this sequence of events:



■ Preventing Static Electricity Accidents

The best way to prevent static electricity accidents is simply to prevent the occurrence and accumulation of electrostatic charges.

⚠ CAUTION

- It is important to take multiple preventive measures simultaneously.
- If large amounts of flammable solvents are collected in a large container, implement preventative measures 1, 2, and 3 below.

Preventive Measure 1

Use a metal container for the waste liquid, and ground the container.

This will ensure that the electrical charges of the container and liquid pass to the ground.

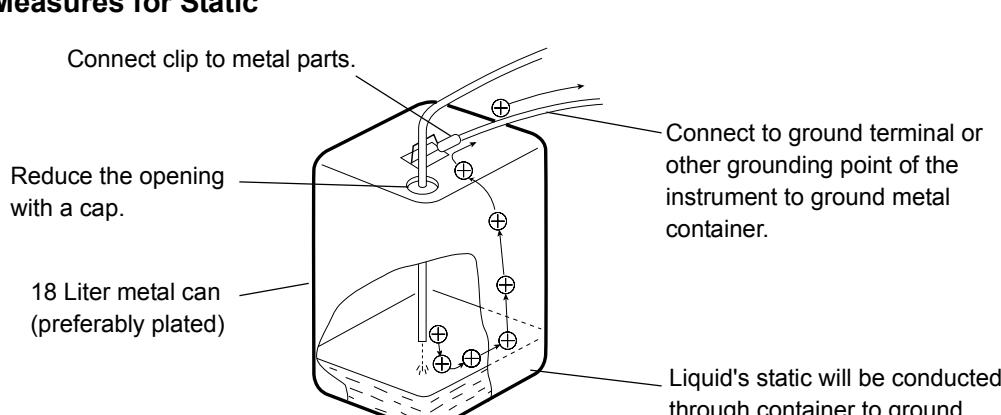
Accessories for this measure

- (1) Grounding wire with clip Part No. 228-21353-91
- (2) 18 Liter metal container Part No. 038-00044
- (3) 4 Liter metal container Part No. 038-00043-01

⚠ CAUTION

- Be sure to ground the metal waste container properly.
If the grounding wire is not properly attached or connected to the ground, static electricity can build up in the container.
- Some metal containers have surfaces that are laminated or oxidized, and therefore do not conduct electricity. After grounding the metal container, use a tester to verify that electricity is conducted to the ground.
- If the liquid to be drained into the waste container is virtually non-conductive (10^{-10} S/m or less), it will be necessary to add properly conductive, and therefore safe, liquid to the tank.
This conductive liquid may be added beforehand.

Preventive Measures for Static



Preventive Measure 2

Cover the spaces between the tubing and the sides of the inlet and outlet openings of the waste container with caps or other protective covering. This will prevent any sparks generated outside the container from getting inside.

Accessories for this measure

Caps for 18 liter or 4 liter containers (with three 3mm diameter openings)

Part No. 228-21354-91

Preventive Measure 3

Keep electrostatically charged objects, including the human body, away from the waste liquid container.

To prevent electrostatic charging of the human body, take the following precautions:

- Wear anti-static clothing and shoes.
- Ground the human body with anti-static wrist straps. (For safety, the wrist strap should be connected to the ground using an intervening resistor of about $1M\Omega$.)
- Spread anti-static matting or the like on the floor, to make the floor conductive.



CAUTION

- **Persons who have not taken anti-static precautions should touch some grounded metal object before coming near the waste liquid container, in order to drain static charges.**

Preventive Measure 4

Use tubing with an inner diameter of at least 2mm for drain lines with high flow rates.



CAUTION

- **Periodically check the tubing connections for leaks.**

Air bubbles in liquid can multiply the electrostatic charge by a factor of 20, 30 or more.

Preventive Measure 5

If it is not possible to use a conductive waste liquid container, take the following precautions:

- Ensure that the end of the inflow tubing is always submerged inside the container. Also, place some type of grounded metal object, such as a ground wire connected to the instrument, into the liquid.

⚠ CAUTION

The above precaution will be ineffective for low conductivity (less than 10^{-10} S/m) liquids.

- **Use as small a container as possible to minimize damage in the event of fire.**

- **Keep the room at a proper humidity.**

Ambient humidity exceeding 65% will prevent static.

For Reference

Anti-static equipment (anti-static clothing, shoes and matting) and charge measurement equipment (potentiometer) are sold by specialty manufacturers.

Precautions for Mobile Phase Selection and Use



CAUTION

- If PEEK resin parts are used in the plumbing, do not use the following mobile phases. These mobile phases weaken the PEEK resin, which could result in cracked plumbing and mobile phase leaks.

Concentrated sulfuric acid, concentrated nitric acid, dichloroacetic acid, acetone, tetrahydrofuran (THF), dichloromethane, chloroform, dimethyl sulfoxide (DMSO).

Note: Briefly using a weak solution of less than 0.5% acetone in water (e.g. in order to check gradient performance) will present no problems.

NOTE

- Use only HPLC grade or comparable mobile phase, and filter it with a filter of 0.45 μ m mesh or finer before use to remove particulates and foreign matter.
- Halogen ions can corrode the stainless steel material (SUS316L) used in the plumbing, so avoid, as much as possible, mobile phases that contain halogen ions - such as KCl, NaCl and NH₄Cl - or mobile phases that generate halogen ions in certain reactions. If such mobile phases must be used, clean all flow lines thoroughly with distilled water immediately after analysis.
- When SPD or a similar UV detector is used for high-sensitivity analysis, be sure to use HPLC grade mobile phases that have a low absorptivity of UV rays.
- Always degas the mobile phase, as air bubbles may tend to form during solvent mixing or during temperature or pressure changes. Air bubbles may cause pump malfunctions and detector signal noise.
- For boiling points, viscosities and other data relating to the mobile phases used,
 "9.5 Mobile Phase Characteristics" P. 9-40

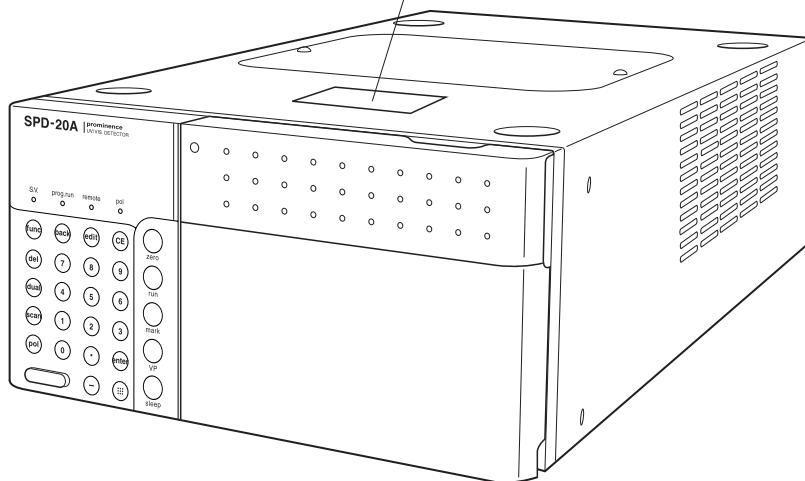
Warning Labels

For safety operation, warning labels are affixed to where special attention is required.
Should any of these labels peel off or be damaged, obtain replacements from Shimadzu Corporation.

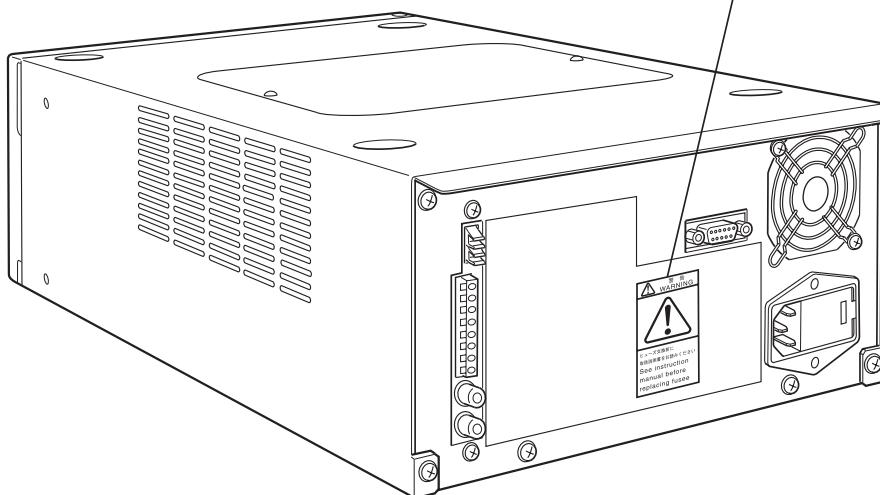
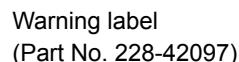
(Front of the instrument)



Warning label
(Part No. 228-42099)



(Back of the instrument)



Precautions on Handling Deuterium (D2) Lamp and Tungsten (W) Lamp

■When Disposing of the Lamp

If the deuterium (D2) lamp and tungsten (W) lamp should be broken or its life is finished, dispose of the lamp separately from general garbage. When disposing of the deuterium (D2) lamp and tungsten (W) lamp provided from Shimadzu Corporation, select a method, which will not harm the environment or cause bodily injury. Consult your local Government Agencies for a proper disposal method.

The materials of deuterium (D2) lamp are as follows:

- Metals (Tungsten, Aluminum)
- Quartz glass
- Ceramic
- Plastic

The materials of tungsten (W) lamp are as follows:

- Metals (Tungsten, Stainless steel)
- Quartz glass
- Ceramic
- Plastic

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1

Configuration

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1.1 Overview

The Shimadzu SPD-20A and SPD-20AV are high-performance, multi-function ultra-violet visible spectrophotometric detectors, for use in high performance liquid chromatograph.

The SPD-20A uses a deuterium lamp as its light source and is intended primarily for analyses in the ultraviolet region.

The SPD-20AV incorporates both deuterium and tungsten halogen lamps. The deuterium lamp is used for ultraviolet applications, as in the SPD-20A, while the tungsten lamp extends the analytical capability into the visible region.

Each instrument has 3 measurement modes - single wavelength, dual wavelength and wavelength scanning. The dual wavelength mode performs simultaneous detection of two wavelengths, and can provide chromatograms of both the wavelengths, or a chromatogram of one wavelength and one ratio chromatogram. In wavelength scanning mode, the absorbance spectrum is measured. The wavelength scanning mode is designed to be used while the flow is stopped.

1.2 Features

- Excellent S/N ratio performance

An improved optical system and a high-order digital filter have enhanced the instrument's Signal to Noise ratio. Enhanced wavelength accuracy, reproducibility, and broader wavelength range measurement have heightened the instrument's basic performance.

- Advanced functions

The dual wavelength mode provides chromatograms or ratio chromatograms of two wavelengths simultaneously, and the wavelength scanning mode provides absorbance spectra. There is also a full set of Time Program functions.

- No optical alignment needed when lamps are replaced

No adjustment of the optical alignment is required when the lamps are replaced.

The instrument records the total time the lamp has been used.

- Flow cell with a temperature adjustment function included

This function allows for the maintenance of a fixed temperature in the flow cell, making it possible to attain greater stability in the baseline even when using a mobile phase with an absorbance that fluctuates easily due to changes in temperature.

It can also help improve analysis reproducibility for a sample with an absorbance that fluctuates easily due to temperature changes.

1.3 Component Parts

This instrument consists of the standard parts listed below. Check the parts against this list after unpacking.

Part	Part No.	Q'ty	Remark
SPD-20A/20AV	–	1	
Signal cable	228-39306-91	2	
AC power cord (for 100V, 120V)	071-60816-12	1	For 100V, 120V area
AC power cord (for 220-240V)	071-60825-51	1	For 220-240V area
Optical cable	070-92025-51	1	
Adapter KPR-1	071-60813	1	100V only
Syringe	046-00001	1	
Syringe adapter	228-15672-91	1	
Male nut PEEK	228-18565	5	
PEEK tubing	670-10324-01	1	50cm, I.D. 0.25mm
Plumbing connection tubing	228-18495-06	1	2m
Gasket for cell	228-35097-01	10	Consumable item (spare)
Instruction manual (Japanese version)	228-30891	1	For 100V area
Instruction manual (English version)	228-30892	1	For 120V, 220-240V area
Event cable	228-28253-91	1	
Drain OUT	228-42205	1	
Drain CTO	228-42206	1	
Straight tubing connector	228-28163	1	
Drain adapter	228-42204	1	
Silicone tubing	228-25162-03	1	1m
Lock catch	037-60177-05	1	For securing tubing
FEP tubing	016-37722-06	1	For protecting the PEEK tubing, 50cm

1.4 Optional Parts

■ Optional Cells

When the optional flow cells described below are used instead of the standard cell, the detector can be used for a wide variety of applications, including semi-micro liquid chromatography (LC), preparative LC, metal-free LC, and FAST LC.

Option	Part No.	Features
Flow cell (Standard flow cell for SPD-20A / SPD-20AV)	228-37440-94	Standard flow cell for SPD-20A / SPD-20AV Optical path length: 10mm Capacity: 12µL Wetting part materials: SUS316L, PFA, quartz Provided with temperature adjustment function
Temperature controlled flow cell for semi-micro LC	228-45605-91	Optical path length: 5mm Capacity: 2.5µL Provided with temperature adjustment function
Flow cell for preparative LC	228-23406-91	Optical path length: 0.5mm (fixed). Low flow-path resistance cell for preparative LC.
Preparative LC flow cell (0.5mm)	228-23405-91	Preparative LC flow cells with variable cell length. Optical path length varied by changing packing. Parentheses give optical path lengths set at factory.
Preparative LC flow cell (0.2mm)	228-23405-92	
Preparative LC flow cell (0.1mm)	228-23405-93	
FAST LC flow cell	228-23407-91	Optical path length: 3mm Cell capacity: 2.4µL
High pressure cell	228-23403-91	Flow cell with maximum pressure of 400kgf/cm ² (39 MPa) For use when SFC (packed column) is used.
Flow cell for inert LC	228-33338-91	As a liquid-contacting part, the flow cell is made of nonmetallic resin. Optical path length: 10mm Cell capacity: 16µL
Flow cell for micro LC	228-25293-92	Flow cell for micro LC Installation of this flow cell requires alteration of the SPD-20A/20AV instrument by a service technician. Optical path length: 3mm Cell capacity: 210nL

■ Solvent Recycling Valve

Option	Part No.	Features
Solvent recycling valve kit	228-45080-91	For recycling the mobile phase solvent. Controlled by the detector.

■ Air Filter

Option	Part No.	Features
Air filter	228-45603-91	Filter to prevent dust from being drawn into the inner parts of the instrument. It is installed on the air intake opening on the right side of the instrument.

2

Parts Identification and Function

Contents

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2.2	Top, Left Side, Behind Front Cover	2-3
2.3	Right Side and Base Panel	2-4
2.4	Back	2-5
2.5	Names and Functions of Displays and Keypad	2-6

2.1 Front Cover

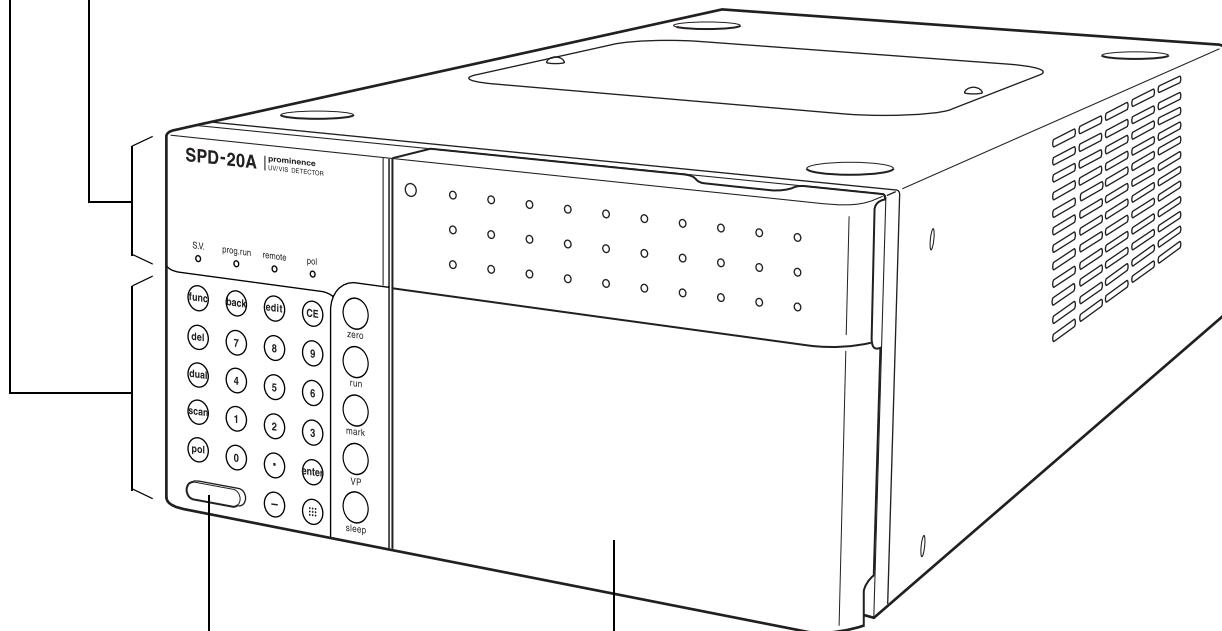
- Operation keys

To operate and configure settings.

Press  to show the operation keys.

- Display panel

Comprising the display screen and LED indicators displays operational settings.



- Front cover

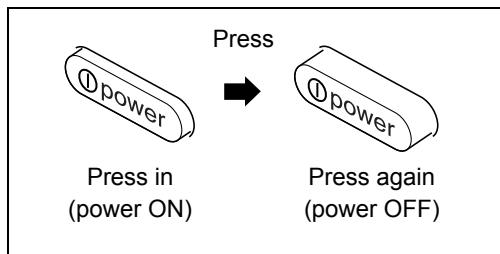
Open the cover to install/remove the flow cell, or to attach tubing. Must be closed during analysis.

- Power switch

To switch the power ON/OFF.

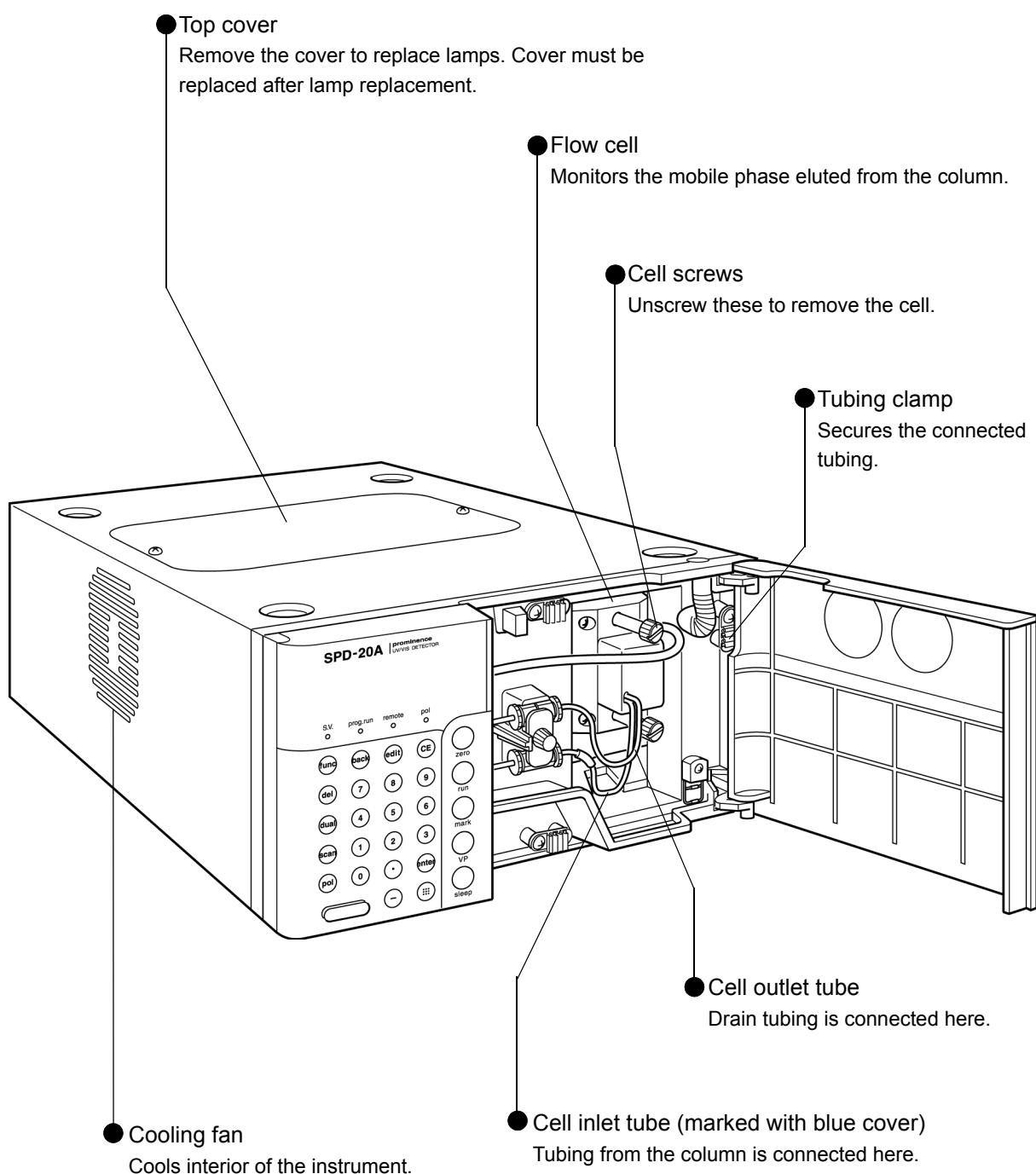
Press the switch in to turn power ON.

Press again to turn power OFF.

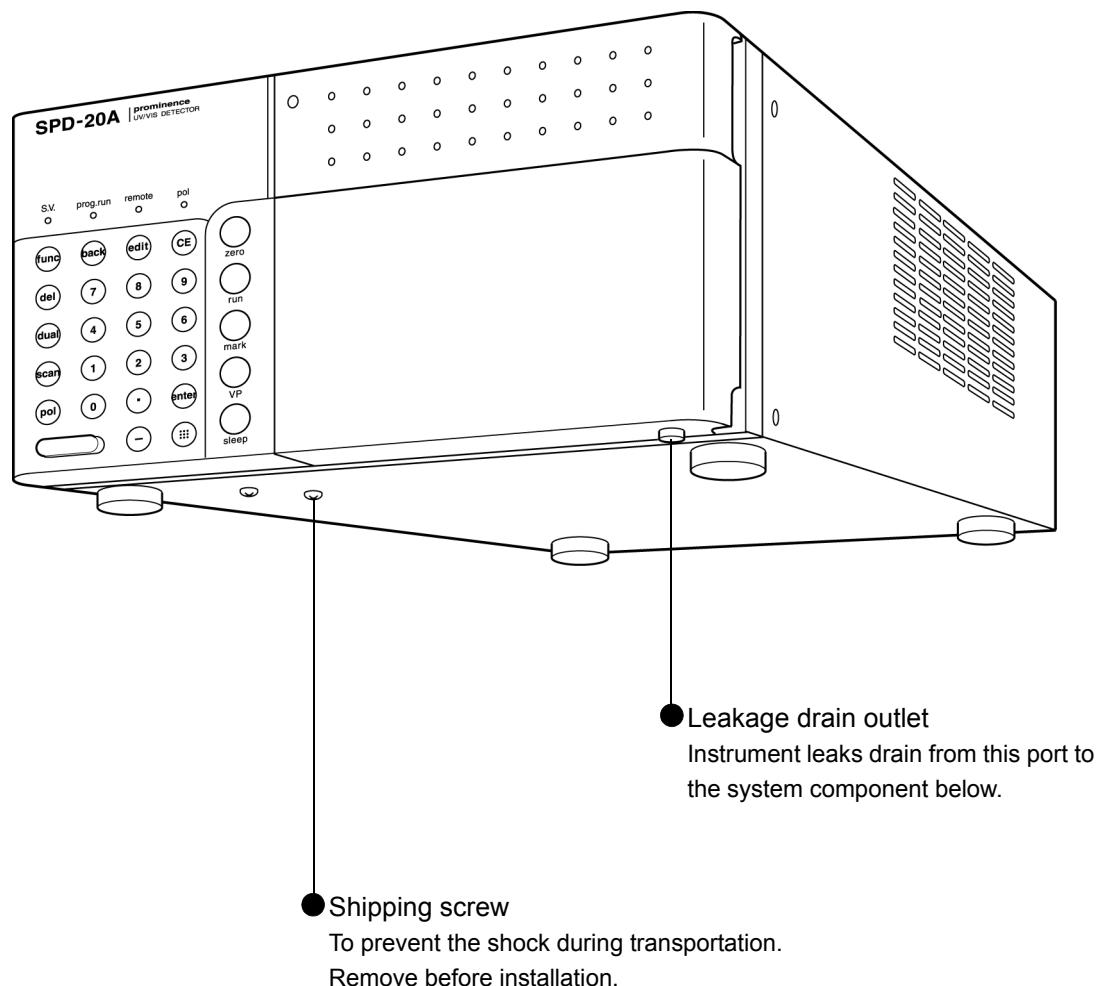


2.2 Top, Left Side, Behind Front Cover

2

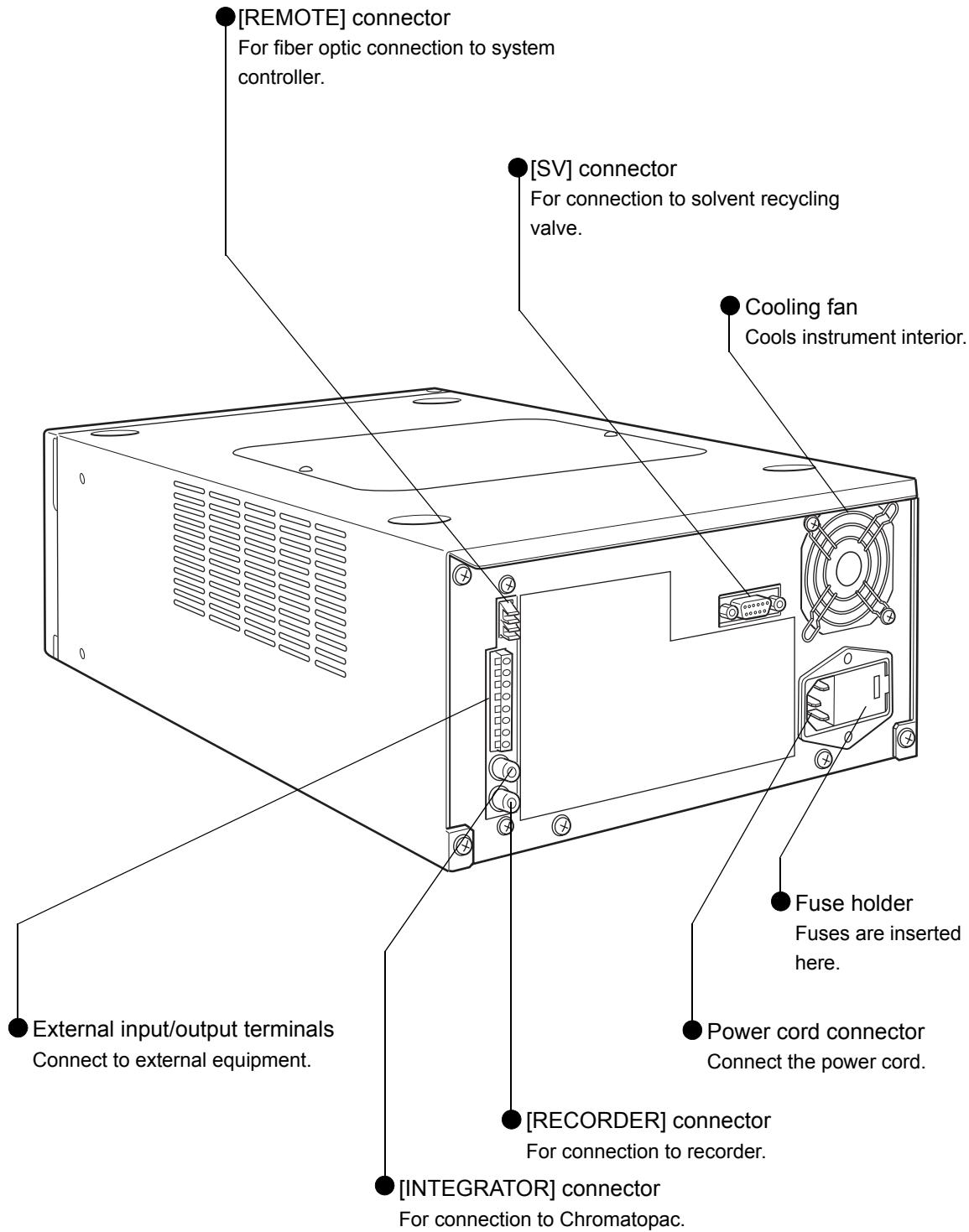


2.3 Right Side and Base Panel



2.4 Back

2

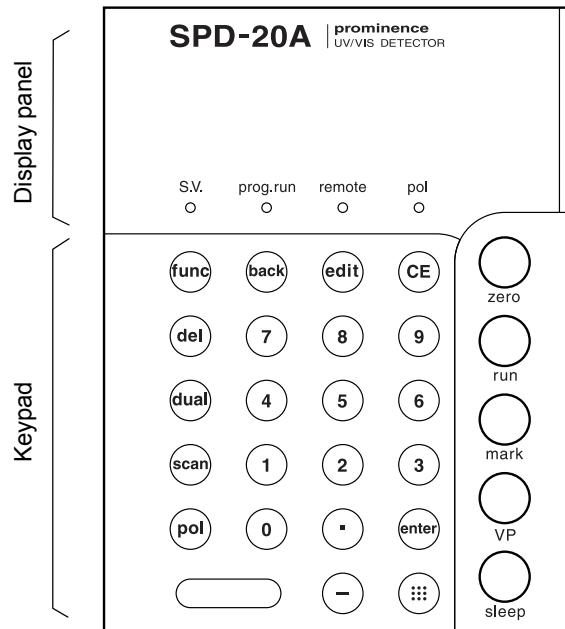


2.5 Names and Functions of Displays and Keypad

This instrument is controlled through the keypad.
The display allows verification of the instruments status.

NOTE

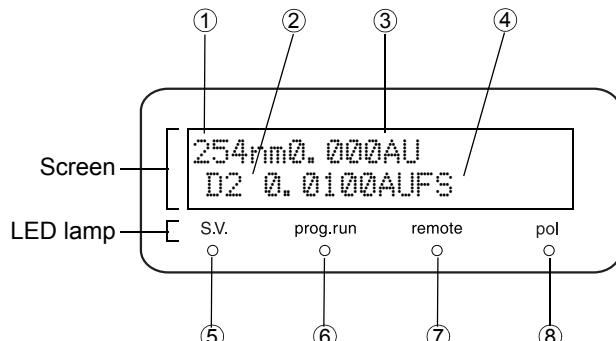
The display screen may become hot when in use.



2.5.1 Display Panel

The display panel consists of a display screen and LED indicators.

Names and functions of the display screen and the indicators are given below.

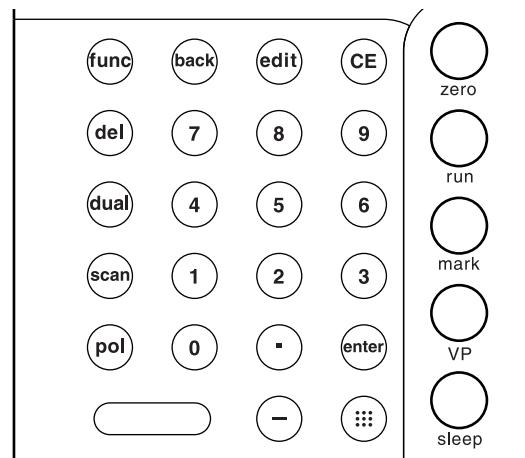


No.	Display or Indicator	Function
①	λ	Displays measurement wavelength (in nm).
②	lamp	Displays [D2] or [W], indicating D2/W source lamp is on. When the deuterium (D2) lamp is on, [D2] is displayed. When the tungsten (W) lamp is on, [W] is displayed. When both the deuterium and tungsten lamps are on, [D2/W] is displayed. The [D2], [W], and [D2/W] indications are selectable.
③	abs	Displays absorbance (in AU).
④	range	Displays full scale value (in AUFS) of signal output to recorder terminals. Can also display full scale value (in AU/V) of signal output to integrator terminals by means of VP function.
⑤	SV	Solvent recycling valve indicator. On when solvent recycling valve is draining liquid.
⑥	prog.run	Time program indicator. On when time program is being executed.

No.	Display or Indicator	Function
(7)	remote	Remote control mode indicator. On when instrument is controlled by system controller.
(8)	pol	Polarity indicator. On in reverse polarity output mode.

2.5.2 Keypad

The 27 keys on the keypad are used to operate the instrument and set parameters. The keys are grouped into two categories as described below.



■ Keys Operable at Anytime

Key	Description	Function
[:::]	Display key	To show the operation keys.
[zero]	Auto zero key	Adjusts recorder zero position, returning baseline to zero position set with [BL OFS ITG] and [BL OFS REC] in parameter settings group (P.5-36).
[run]	Run key	Starts and stops time programs.
[mark]	Marker key	Draws a mark on recorder chart paper. Has no effect on integrator output.
[VP]	VP key	Switches from initial screen to VP mode.
[sleep]	Sleep key	Turns off display screen. Has no effect on operation.

■ Keys Operable by Pressing the Display Key [:::]

Key	Description	Function
[edit]	Edit key	Activates time program edit mode (from initial screen).
[dual]	Dual key	Switches between dual and single wavelength modes.
[pol]	Polarity key	Switches the polarity of recorder output. The [pol (-)] indicator illuminates for (-) polarity.
[scan]	Scan key	Activates the wavelength scanning function.

2. Parts Identification and Function

Key	Description	Function
▪ - 9	Numeric keys	Enter numbers with these keys.
enter	Enter key	Validates entries.
CE	Clear key	<ul style="list-style-type: none">Initializes the screen.Cancels values input since enter was last pressed.Clears error messages and cancels alarms (but does not resolve the source of the error).
del	Delete key	Deletes individual lines of a time program on the display screen (when time program is being written).
func	Function key	<ul style="list-style-type: none">Scrolls forward through auxiliary functions. Press repeatedly to reach desired parameters.In time program editing, scrolls through list of time-programmable functions.
back	Back key	<ul style="list-style-type: none">Scrolls backward through auxiliary functions. Press repeatedly to reach desired parameters.In time program editing, scrolls back through list of time-programmable functions.
—	Minus key	Enters a negative number.

3

Preparation

Contents

3.1	Precautions	3-2
3.2	Turning Power ON/OFF	3-3

3.1 Precautions

■ Precautions before Operation

- The flow cell must be installed in the detector before turning the power switch ON.

If the power switch is turned on with no cell installed, home position will not be detected and the wavelength will be set incorrectly. If this occurs, turn the power switch OFF, install the cell and turn the power ON. The cell may be removed after the initial screen appears.

- Before turning the power switch ON, perform any of the following on the flow cell interior:

- Flush the cell with a mobile phase that does not absorb light in the wavelength range of 230nm or above (such as water, acetonitrile, or methanol).
- Fill the cell with the above described mobile phase.
- Purge the cell with air or nitrogen, and make sure it is dry.

When the power is turned on, the instrument carries out an automatic wavelength accuracy check. The auto wavelength check uses as a reference the intensity of the emission line wavelengths of the deuterium lamp (656nm) and the mercury lamp (254nm). If a sample that absorbs these wavelengths is used, or if bubbles remain in the flow cell, the amount of transmitted light becomes exceedingly small.

This prevents an accurate wavelength check from being performed and can produce errors.

- When highly sensitive analysis is necessary, take into account the time needed for the baseline to stabilize and turn the lamp on ahead of time.

After it is turned on, the lamp requires roughly 1 hour to stabilize for optimal performance.

- Check to make certain there are no leaks in the flow cell and connective tubing.

■ Precautions during Operation

Keep the front cover closed during analysis.

In high-sensitivity analysis, opening or closing the front cover will cause the baseline to fluctuate. The noise level may increase if the front cover is open.

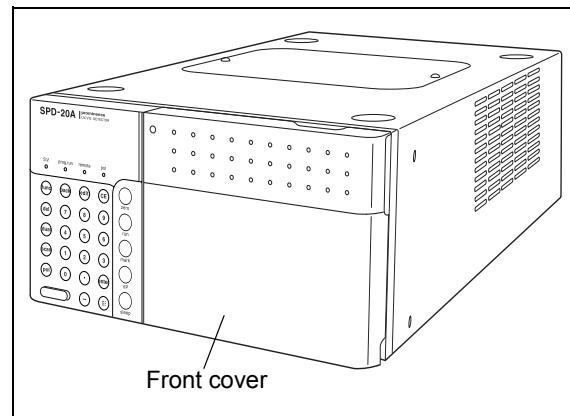


Fig. 3.1

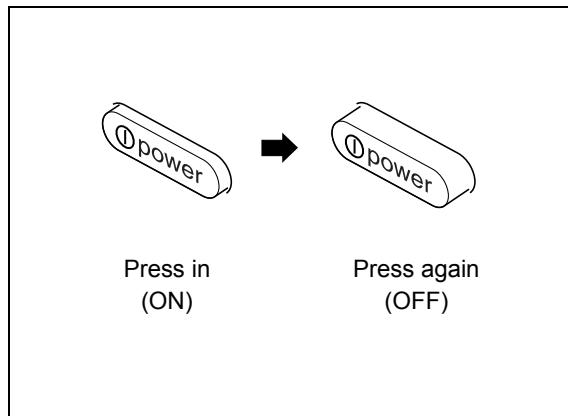
■ Precautions after Operation

To prevent clogging of the flow cell:

Dusty or clogged flow cells are the most frequent cause of detector problems. After analyzing a highly concentrated sample, flush the flow cell thoroughly, using plenty of mobile phase. When a buffer solution is used as the mobile phase, wash the flow cell with water after completing analysis. Buffer solutions crystallize upon evaporation, and can clog the flow cell and tubing.

3.2 Turning Power ON/OFF

- 1** Press the power switch to turn the power ON.
Press it again to turn the power OFF.



- 2** When the power is turned ON, the following sequence of events occurs:

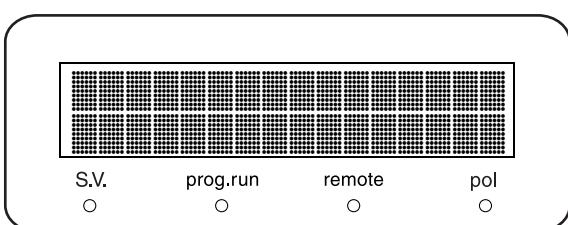
① Power ON



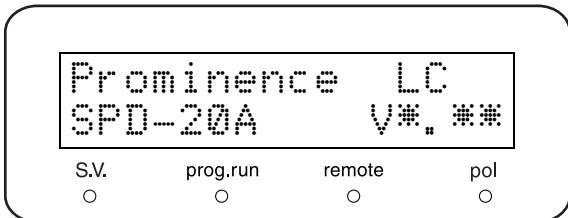
② All the dots in the display matrix and all the indicator lamps illuminate.



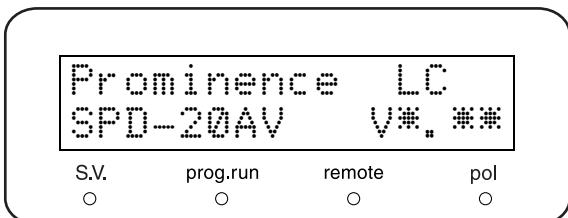
③ The instrument's memory is automatically checked, and the version number of the control program is momentarily displayed. ([V*. **] in the example screens below represents the ROM version.)



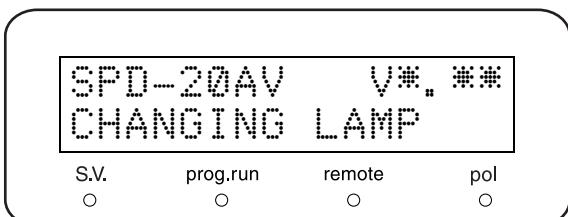
SPD-20A



SPD-20AV



④ The instrument checks the lamp switching function.



3. Preparation

⑤ The lamps are preheated for about 30 seconds.



SPD-20AV V*, ***
PREHEATING LAMP

S.V. prog.run remote pol

⑥ The instrument is initialized for about 1 minute.



SPD-20AV V*, ***
SEEKING HOME

S.V. prog.run remote pol

⑦ The wavelength accuracy is checked for about 20 seconds, by using the 254nm emission line of the mercury lamp and the 656nm emission line of the D2 (deuterium) lamp.



SPD-20AV V*, ***
CHECKING λ

S.V. prog.run remote pol

⑧ If no error is detected, the message on the right appears. This screen remains on for several seconds, followed by the initial screen shown in step ⑨.



SPD-20AV V*, ***
CHECK GOOD

S.V. prog.run remote pol

⑨ If the D2 (deuterium) lamp has been selected, the initial screen shown on the right appears. The instrument is now in the initial state and operation can be done. This is the initial state.

If the D2 (deuterium) lamp has been selected

254nm 0.000 AU
D2 0.0100AUFS

S.V. prog.run remote pol

⑩ If the instrument is a SPD-20AV and the W (tungsten) lamp has been selected, it will be checked at this point. This is the initial state.

If the W (tungsten) lamp has been selected (SPD-20AV)

500nm 0.000 AU
W 0.0100AUFS

S.V. prog.run remote pol

■ Error Display Examples

NOTE

- If an alarm sounds and a [CHECK NO GOOD] message is displayed on the screen:

① No peak has been detected within 1nm of 656nm or 254nm. To stop the alarm, press **CE**.

② Verify that the cell is installed properly.

 ["8.2.3 Re-installing the Flow Cell" P. 8-7](#)

③ Check to be certain that no air bubbles have been introduced into the flow cell, and that no mobile phase or sample which absorbs light in the vicinity of 254nm or 656nm remains in the cell.

The wavelength calibration function [WAVE CALIB] and wavelength accuracy check function [WAVE CHECK] measure the intensity of light transmitted through the cell in the vicinity of the 656nm and 254nm emission lines of the D2 (deuterium) lamp and mercury lamp. The instrument operates based on these intensity values. Consequently, if a sample that absorbs ultraviolet or visible light remains in the cell, or if large air bubbles are introduced, the amount of transmitted light becomes exceedingly small and the instrument will not operate correctly.

Operate using a flow cell that has been flushed or filled with a mobile phase which does not absorb visible and UV light, or that has been purged of air or nitrogen and dried thoroughly.

④ Execute wavelength calibration, referring to [WAVE CALIB] in Section 5.6, VP Functions.

 ["\[WAVE CALIB\]" P. 5-53](#)

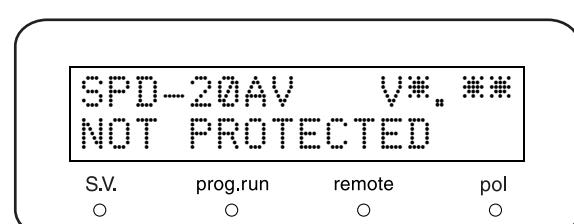
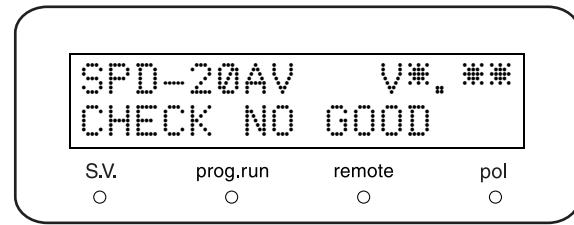
⑤ When the calibration is complete, the [WAVE CHECK] will be run automatically to recheck the wavelength accuracy. If [CHECK NO GOOD] appears once again, turn off the power of the instrument and contact the nearest Shimadzu branch/sales office or agent.

- If an alarm sounds and a [NOT PROTECTED] message is displayed on the screen:

Press **CE** to clear the alarm. When this message is displayed, the time program, along with the [LAMBDA] (wavelength) and certain other parameters, will be initialized (replaced with default values).

- If any other error message is displayed:

 ["6.2 Error Message" P. 6-4](#)



3. Preparation

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4

Basic Operation

Contents

4.1 Single Wavelength Mode Settings	4-2
---	-----

4.1 Single Wavelength Mode Settings

The simplest measurement mode for this detector—the single wavelength mode—is explained here. See below for information about the dual wavelength mode and the wavelength scanning mode.

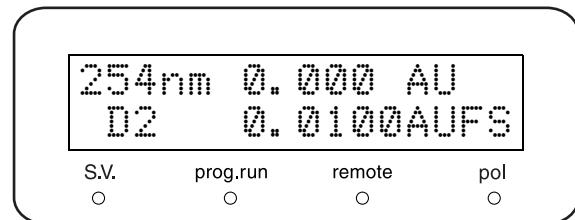
-  "5.2.2 Setting the Ch2 Wavelength" P. 5-11
-  "5.3 Operation in Spectrum Scanning Mode" P. 5-18

4.1.1 Setting Wavelength [LAMBDA 1]

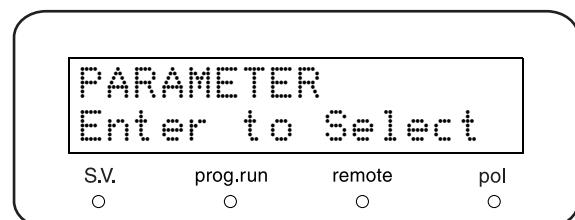
Follow the procedure below to set the wavelength.

■ Example: To Change the Wavelength From 254 nm to 230 nm:

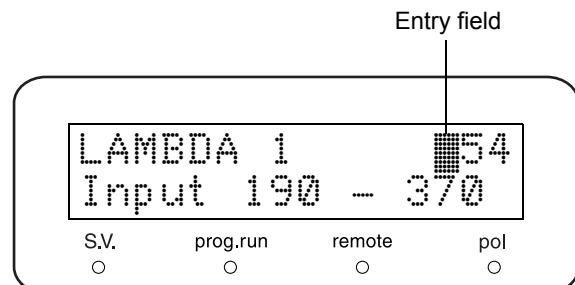
- 1 Press **CE**.
The initial screen appears.



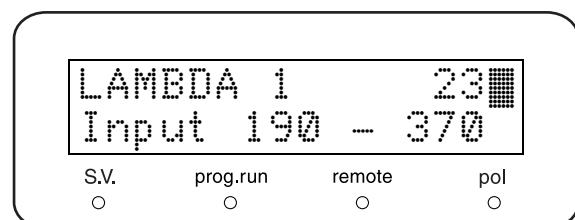
- 2 Press **func** once.
[PARAMETER] appears.



- 3 Press **enter**.
[LAMBDA 1] (ch1 wavelength setting) appears.
* The wavelength parameter entry field blinks, prompting the user to enter a value for wavelength.



- 4 Input **2**, **3**, **0** and press **enter**.
The setting is changed.



NOTE

- Valid setting ranges

The valid setting range shown on the bottom line of the screen varies, depending on the model and the lamp used. Setting ranges are given in the table on the right. Values outside the setting range will not be accepted.

Model	Setting range
SPD-20A	190nm - 700nm
SPD-20AV	With D2 lamp
	190nm - 370nm
	With W lamp
	371nm - 900nm
	When D2 and W lamps are on
	190nm - 900nm

- The detector has two of signal output connectors: [RECODER] connector and [INTEGRATOR] (integrating data processor) connector.

A Chromatopac or variable range recorder can be connected to either of the two connectors, but a Chromatopac should normally be connected to the [INTEGRATOR] connector. A fixed range recorder must be connected to the [RECODER] connector so that its recording range can be adjusted using the instrument's recorder range setting function. If a Chromatopac is connect to the [RECODER] connector, the Chromatopac's input full scale will be equivalent to 100 times the absorbance value set for the recorder range. Accordingly, the absorbance value set for the range should be about 1/80 of the expected maximum peak absorbance.

- When the wavelength is changed:

The [RECODER] connector signal output level changes to 0V for 4 seconds, then returns to the previous signal level. This results in a mark at the point of wavelength change on the chromatogram. However, since this could interfere with area calculations, the [INTEGRATOR] connector output is designed to maintain its signal level unchanged during the 4 second time period.

-  "Connection to Chromatopac" P. 9-30
-  "Connection to Recorder" P. 9-31
-  "When a Strip-Chart Recorder Is Used:" P. 4-5
-  "When a Chromatopac (Integrator) is connected to the [RECODER] Connector" P. 4-6

4.1.2 Setting Range

■ When a Chromatopac Is Used As a Recorder:

- The Shimadzu Chromatopac is typically connected to the [INTEGRATOR] connector.
- It is necessary to make approximate range setting on the detector, since the detector's dynamic range is extremely wide. This is done by setting a value for the detector's [AUX RANGE] parameter.

 "[AUX RANGE]" P. 5-35

(When a Chromatopac is used normally, the range is set by using the Chromatopac's [ATTEN] setting.)

- The relationship between the values set for [AUX RANGE] and the [INTEGRATOR] connector output is given in the table on the right.
- The Chromatopac plot full scales produced by the various [AUX RANGE] and [ATTEN] settings are given in the table below.

[AUX RANGE] setting	[INTEGRATOR] connector output
1	0.5 AU/V
2	1.0 AU/V
3	2.0 AU/V
4	4.0 AU/V
5	1.25 AU/V
6	2.5 AU/V

Relationship between [AUX RANGE] and [ATTEN] settings and a full scale plot (unit: AU)

ATTEN	AUX RANGE					
	1	2	3	4	5	6
0	0.0005	0.001	0.002	0.004	0.00125	0.0025
1	0.001	0.002	0.004	0.008	0.0025	0.005
2	0.002	0.004	0.008	0.016	0.005	0.01
3	0.04	0.008	0.016	0.032	0.01	0.02
4	0.008	0.016	0.032	0.064	0.02	0.04
5	0.016	0.032	0.064	0.128	0.04	0.08
6	0.032	0.064	0.128	0.256	0.08	0.16
7	0.064	0.128	0.256	0.512	0.16	0.32
8	0.128	0.256	0.512	1.024	0.32	0.64
9	0.256	0.512	1.024	2.048	0.64	1.28
10	0.512	1.024	2.048	4.096	1.28	2.56

■ When a Strip-Chart Recorder Is Used:

- Connect the recorder to the [RECODER] connector.
- The recorder range should be set at about 120% of the expected maximum peak. This will produce a chromatogram with maximum peaks of about 80% of the recorder's full scale.

Proceed as follows to set the recorder range.

Example: To change the range from 0.001AUFS to 0.01AUFS.

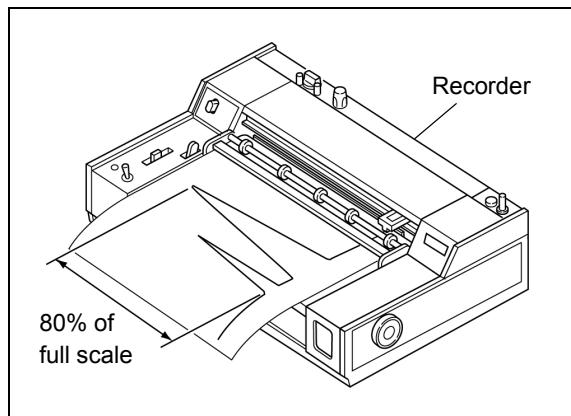


Fig. 4.1

1 Press **CE**.

The initial screen appears.

230nm 0.000 AU
D2 0.0100AUFS
S.V. prog.run remote pol

2 Press **func** once.

[PARAMETER] appears.

PARAMETER
Enter to Select

S.V. prog.run remote pol

3 Press **enter**, and then press **func** several times.
[RANGE] and the current setting appears.

RANGE 0.0010
Input 0 - 2.56

S.V. prog.run remote pol

4 Input **0**, **.**, **0**, **1**, and press **enter**.

RANGE 0.0100
Input 0 - 2.56

S.V. prog.run remote pol

* Press **CE** twice, and the initial screen is displayed.

Initial screen

230nm 0.000 AU
D2 0.0100AUFS

S.V. prog.run remote pol

4. Basic Operation

■ When a Chromatopac (Integrator) is connected to the [RECODER] Connector

- Connect the Chromatopac (integrator) to the [RECODER] connector.
- Peaks approximately 100 times the range can be recorded. Set the range at about 1/80 of the expected maximum peak absorbance during measurement. Normally, the recorder range should be set to about 0.005-0.04 AUFS, and the full scale plot adjusted using the [ATTEN] attenuation control of the Chromatopac.
- The relationship in terms of plot full scale between the range and the Chromatopac's [ATTEN] setting (when the Chromatopac is connected to the [RECODER] connector) is as follows:

$$\text{Plot full scale absorbance} = \text{Range} \times 2^{\text{ATTN}} / 10$$

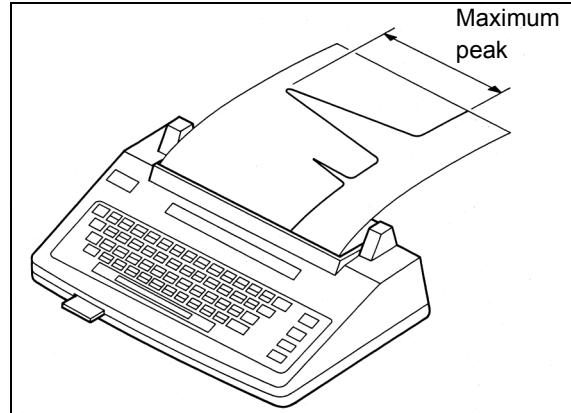


Fig. 4.2

Example: If range = 0.01 AUFS and ATTEN = 2, then :

$$\text{Plot full scale absorbance} = 0.01 \text{ AUFS} \times 2^2 / 10 = \\ 0.004 \text{ AUFS}$$

NOTE

For simultaneous processing of two channels by a Chromatopac:

In the dual wavelength mode, chromatograms for each wavelength can be recorded simultaneously. The wavelength linked to the [INTEGRATOR] connector (the shorter wavelength end) is regarded as channel 1 and that linked to the [RECODER] connector (the longer wavelength end) as channel 2. By using the settings displayed in the table at right for [RANGE] setting value and [AUX RANGE], the signal to output voltage ratio is equalized for both channels.

"5.2.3 Setting the Output Mode" P. 5-12

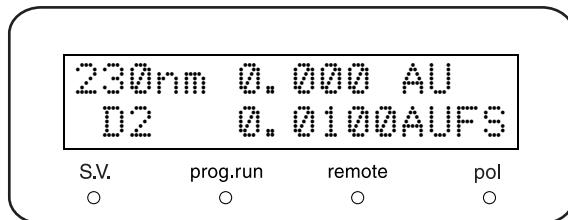
AUX RANGE	RANGE
1 (0.5AU/V)	0.005 AUFS
2 (1AU/V)	0.01 AUFS
3 (2AU/V)	0.02 AUFS
4 (4AU/V)	0.04 AUFS
5 (1.25AU/V)	0.0125 AUFS
6 (2.5AU/V)	0.025 AUFS

4.1.3 Zeroing an Output to a Strip-Chart Recorder

Before beginning analysis, adjust the zero position of the recorder as follows:

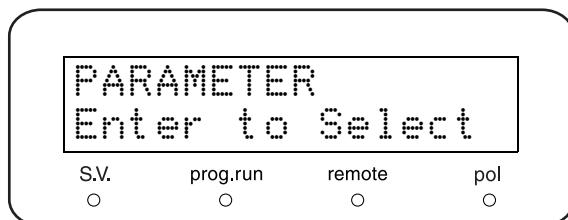
- 1** Press **CE**.

The initial screen appears.



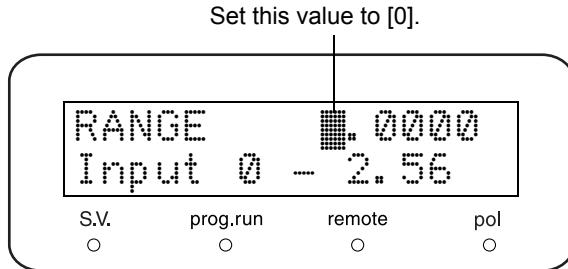
- 2** Press **func** once.

[PARAMETER] appears.



- 3** Press **enter** and then press **func** several times.

[RANGE] (range setting) appears.



- 4** Press **0**, then **enter**.

This sets the recorder output to 0mV.

- 5** Using the recorder's pen position adjusting knob, move the pen to the desired 0 or baseline level.

- 6** Reset the detector's measuring range to a range appropriate for the analysis.

"4.1.2 Setting Range" P. 4-4

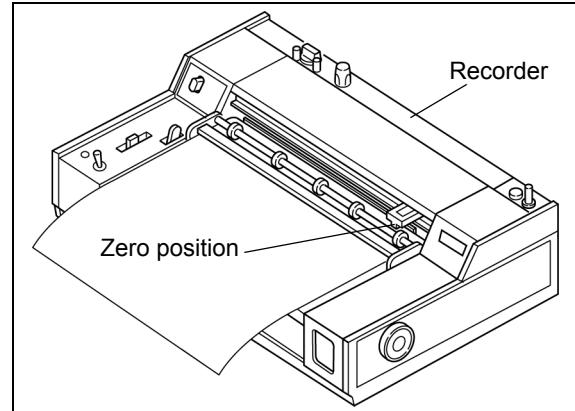


Fig. 4.3

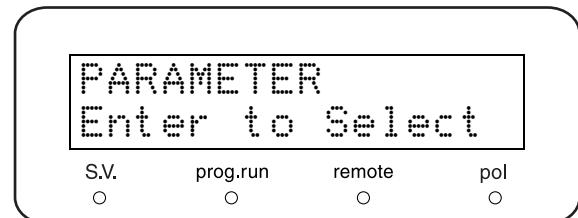
4. Basic Operation

7 Press **zero**.

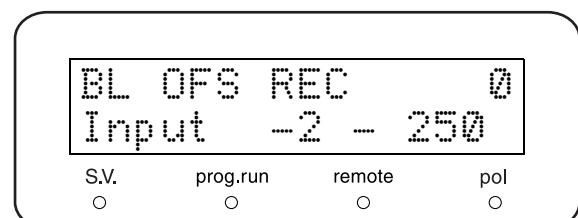
The pen will return to a position close to the selected baseline.

To shift the baseline, perform the steps 8 to 10 below.

8 On the initial screen, press **func** once.
[PARAMETER] appears.



9 Press **enter**, then press **func** several times.
[BL OFS REC] appears.



10 Enter the baseline offset value using the numeric keypad, then press **enter**.
Acceptable values are from -2 to 250 in 1mV steps.

 "[BL OFS REC]" P. 5-36

Pressing **zero** will restore the baseline that was set in this procedure.

4.1.4 Setting [RESPONSE]

This detector uses a digital noise filter to improve the signal-to-noise (S/N) ratio. Noise decreases as the filter's time constant is raised, and increases as it is lowered.

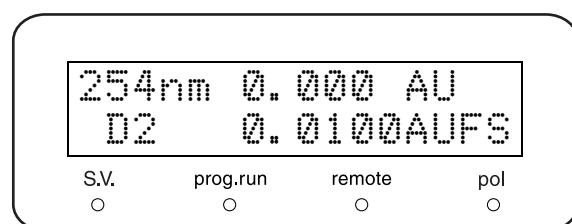
11 filter time constants [RESPONSE] values are available for the [RESPONSE] parameter. [RESPONSE] values and the corresponding time constants for an analog filter are shown in the table below.

Set value	Corresponding time constant of analog filter	Minimum peak width at half-height (See NOTE.)
0	0.02sec	0.08sec
1	0.05sec (FAST)	0.2sec
2	0.1sec	0.4sec
3	0.5sec (STD)	2.2sec
4	1.0sec	4.8sec
5	1.5sec (SLOW)	7.2sec
6	3.0sec	13sec
7	6.0sec	26sec
8	8.0sec	36sec
9	10.0sec	45sec
10	2.0sec	9sec

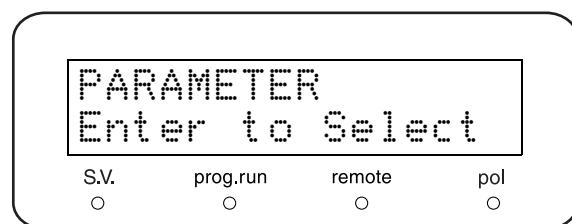
NOTE

When operating in dual wavelength mode, [RESPONSE] values of 4 or less will not increase time constant; use a value of 5 or greater.

- 1 Press **CE**.
The initial screen appears.



- 2 Press **func** once.
[PARAMETER] appears.



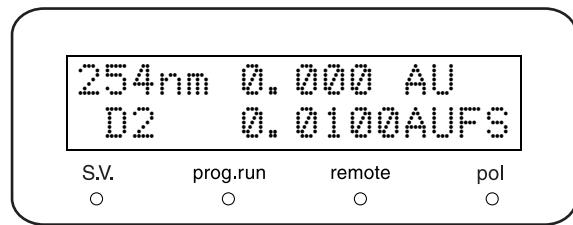
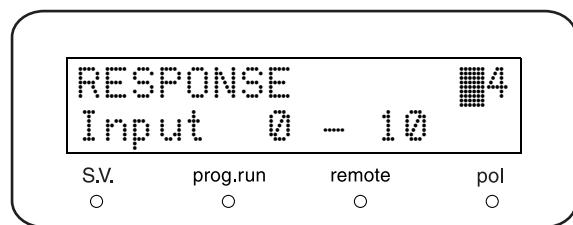
4. Basic Operation

3 Press **enter**, then press **func** once.
The [RESPONSE] value is now active, and can be changed.

4 Input the [RESPONSE] value using numeric keys.
The setting range is given in the table on [P.4-9](#).

5 Press **enter**.

6 Press **CE** twice to return to the initial screen.



NOTE

As [RESPONSE] (time constant) increases, data processor responsiveness and peak height decrease. The smaller a peak's width at half-height, the greater the decrease in the peak's height. It is recommended that [RESPONSE] be set such that, for a given half-height width, the peak height drops no more than 10%. The graph on the right shows the relationship among response time, peak half-height width and peak height reduction. Use it to determine appropriate [RESPONSE] values.

Note that [RESPONSE] has no effect on peak area. Peak area does not change even when a low [RESPONSE] value broadens the peak.

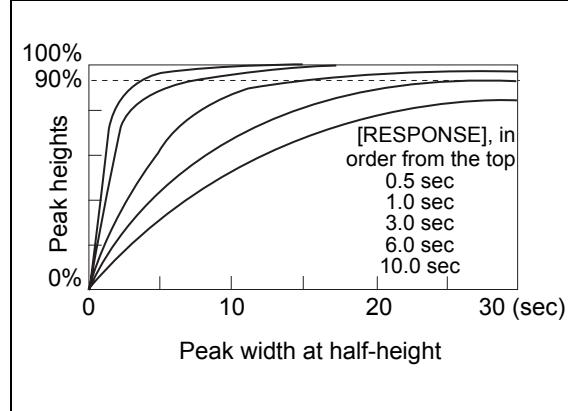


Fig. 4.4

5

Application Operation

Contents

5.1	Display Panel	5-2
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5.7	Control by CBM-20A/20Alite System Controller.....	5-62
5.8	Control by SCL-10Avp or SCL-10A System Controller	5-63
5.9	Connection to External Input/Output Terminals.....	5-65

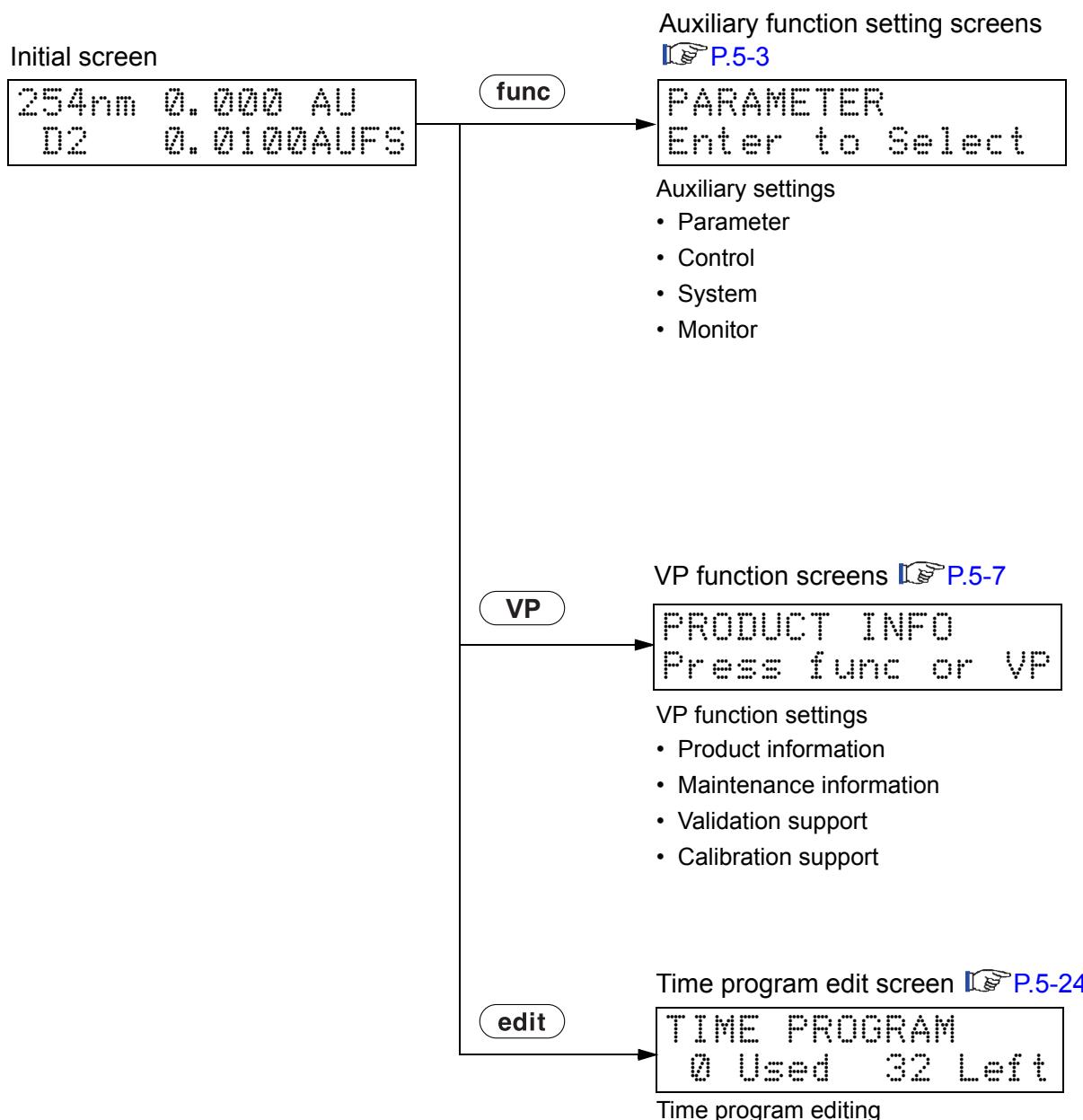
5.1 Display Panel

5.1.1 Types of Screens

Turning the power ON, the initial screen appears.

By pushing the keys **func**, **VP** and **edit**, the screen can be switched from the initial screen to one of the three screens described below.

- Auxiliary function screens
- VP function screen
- Time program edit screen



5.1.2 Auxiliary Function Setting Screen

In this section, auxiliary function setting screens are shown in the following flow diagrams.

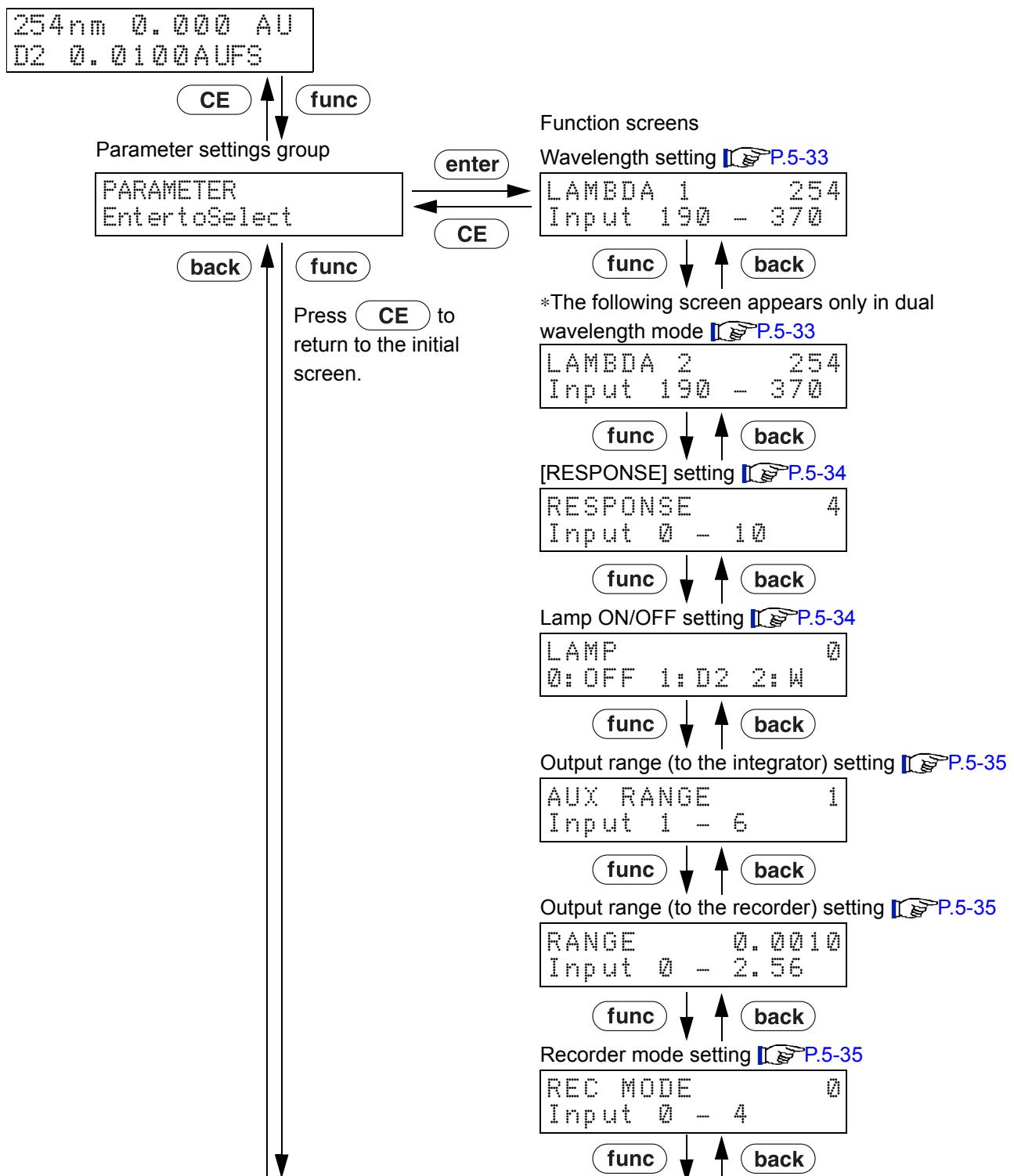
On each screen, press **func** to show the next screen, and press **back** to return.

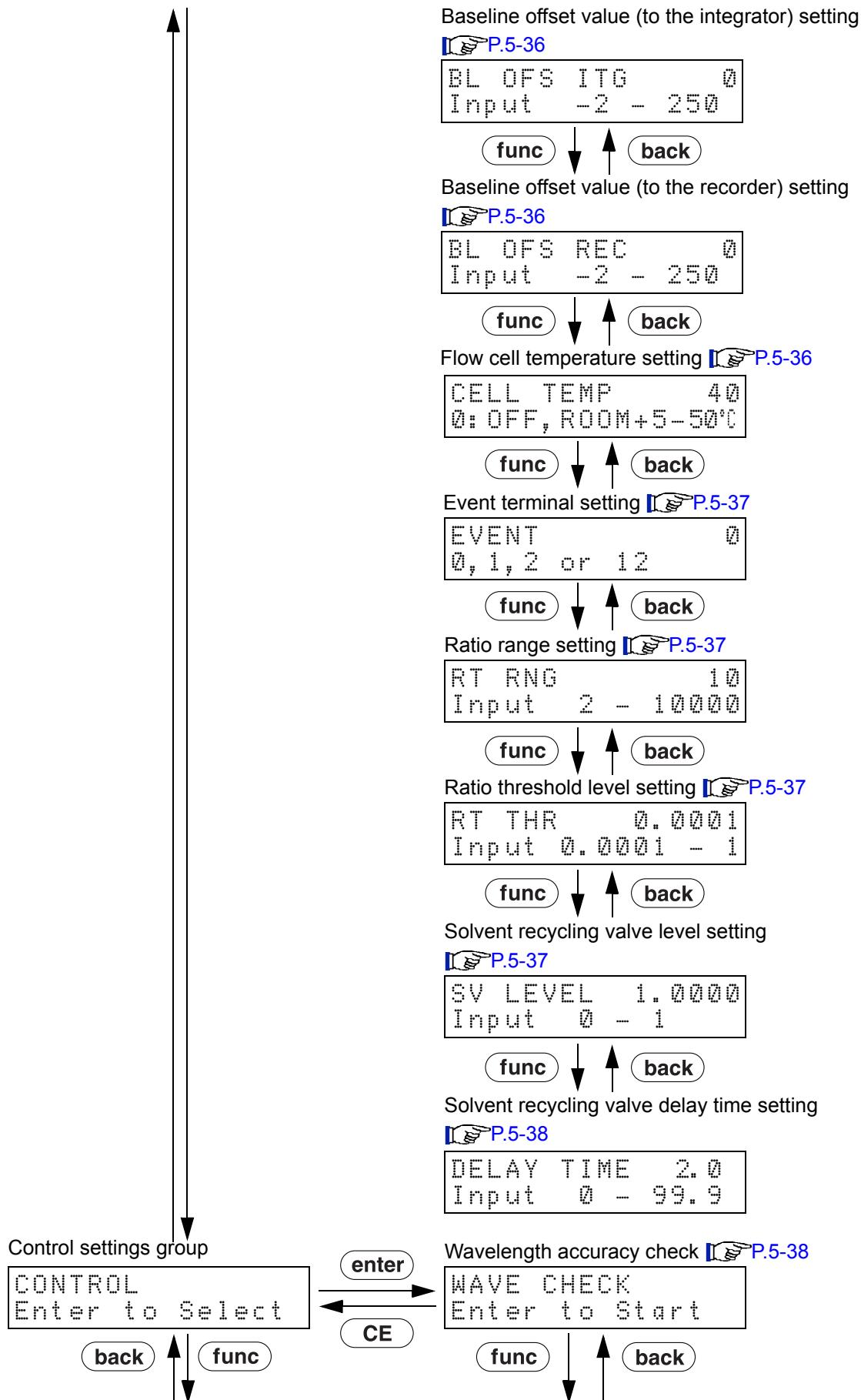
On auxiliary function group screens, press **enter** to enter each group.

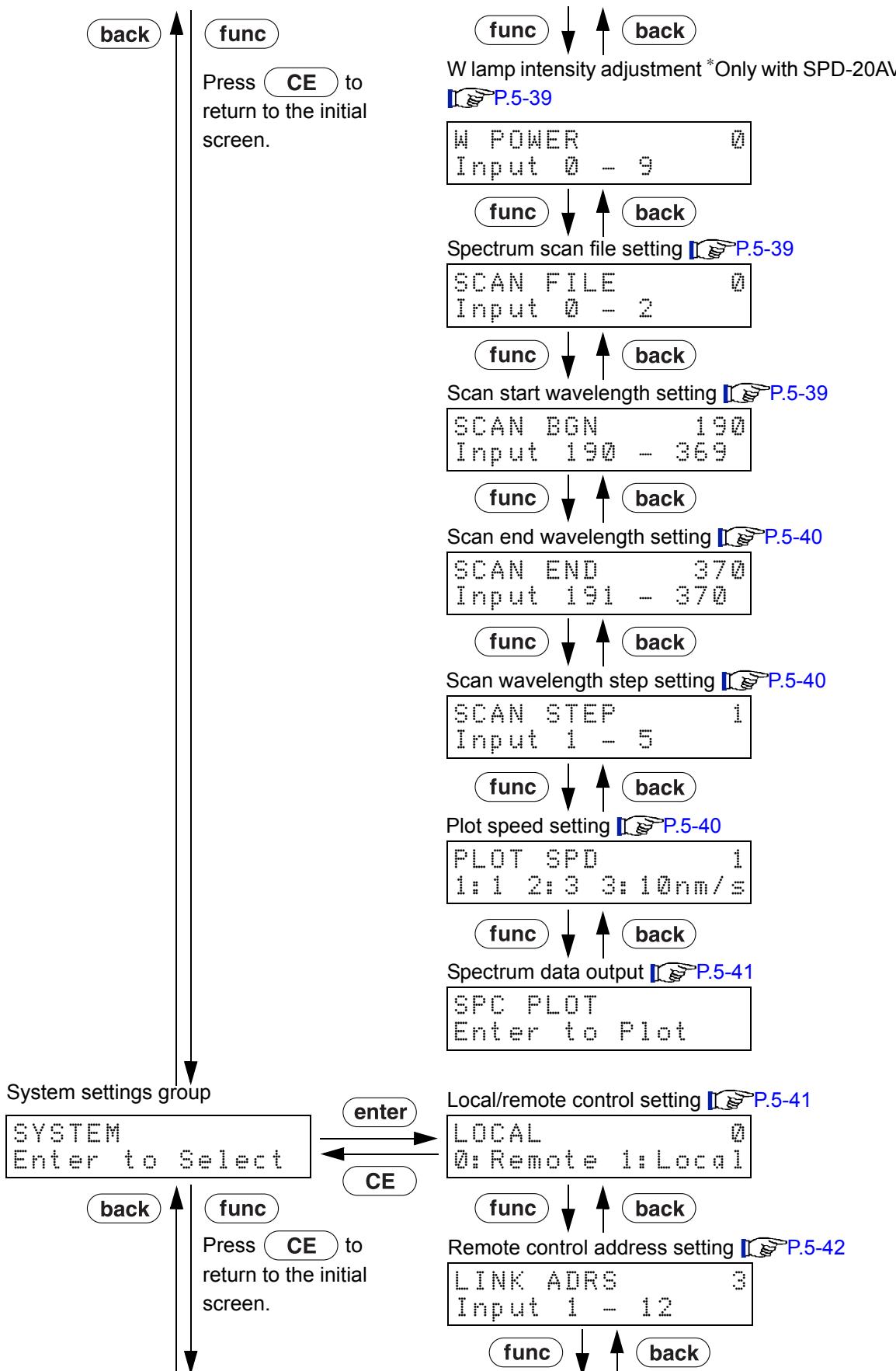
Press **CE** to return the initial screen.

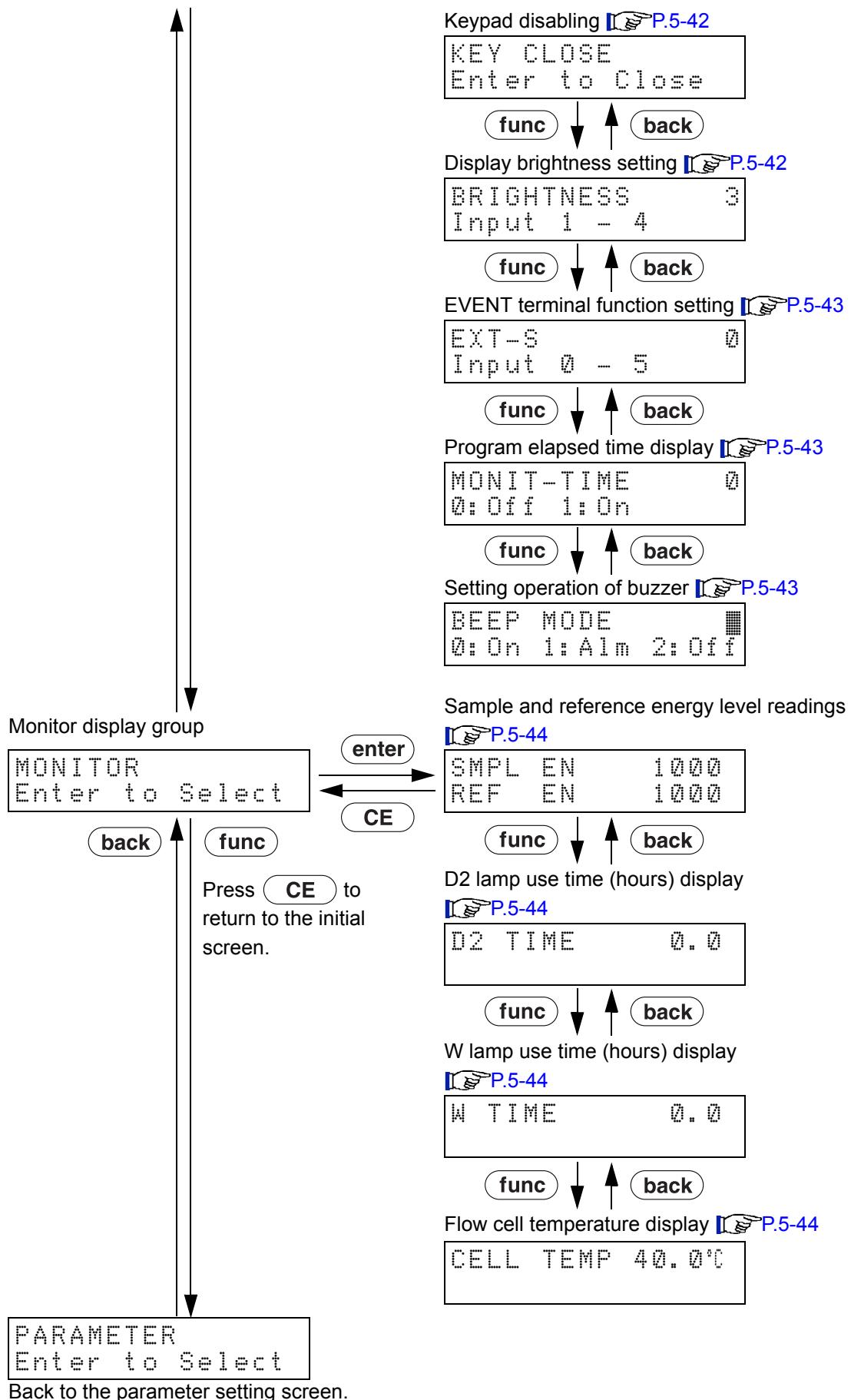
* Screen examples of the SPD-20AV are used in the following diagrams to show the information (such as the setting range) displayed on the bottom line.

Initial screen









5.1.3 VP Function Screens

In this section VP function screens are shown in the following flow diagrams.

VP functions are divided into 4 groups - Product Information, Maintenance Information, Validation Support and Calibration Support.

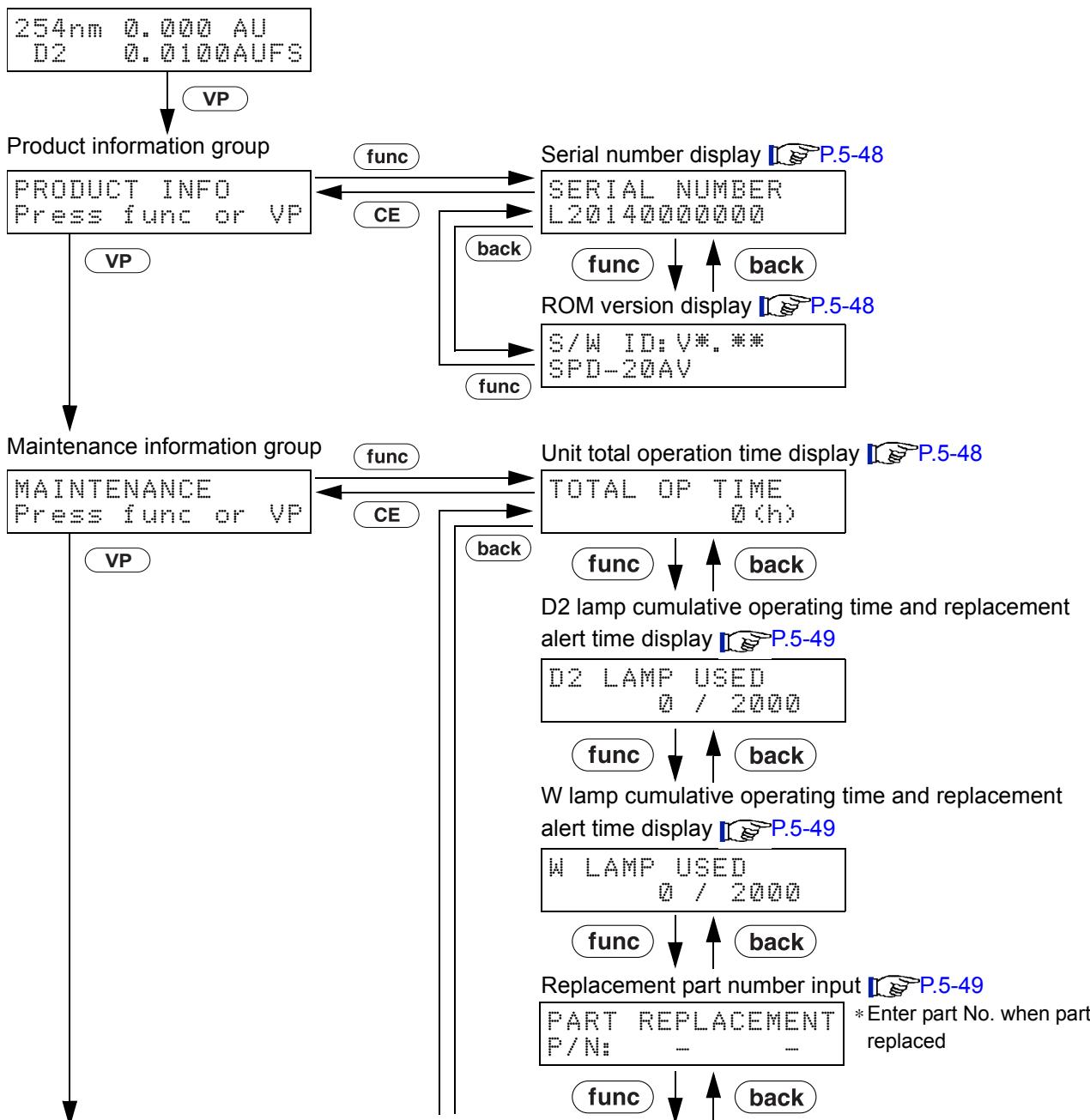
Press **VP** on initial screen to show each group screen.

Press **CE** to return to the initial screen.

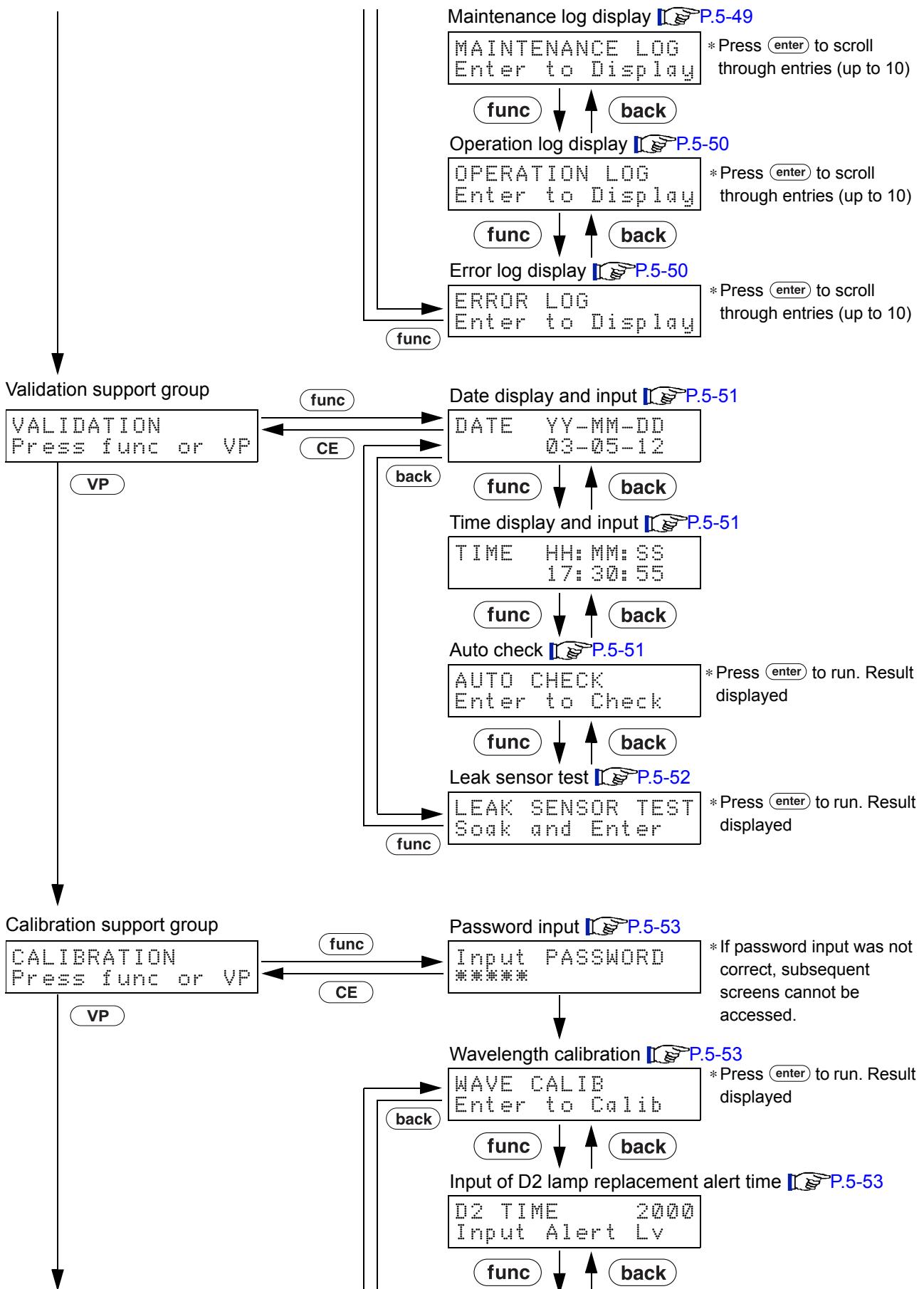
Press **func** or **back** to switch the setting screen within the groups selected by **VP**.

Press **CE** to return to the initial screen in the group.

Initial screen



5. Application Operation



Input of D2 lamp replacement alert energy level

P.5-54

D2 ENERGY 800
Input Alert Lv

Input of W lamp replacement alert time

P.5-54

W TIME 2000
Input Alert Lv

Input of W lamp replacement alert energy level

P.5-54

W ENERGY 1000
Input Alert Lv

Absorbance calibration P.5-54

ABS CALIB
Enter to Calib

Absorbance compensation coefficient input P.5-55

ABS COMP 1.000
Input 0.8 - 1.2

Linearity calibration P.5-55

LINEAR CALIB
1: BG 2: 4AU

Leak sensor auto calibration P.5-55

LEAK CALIB
Enter to Calib

Leak sensor actuation level input P.5-55

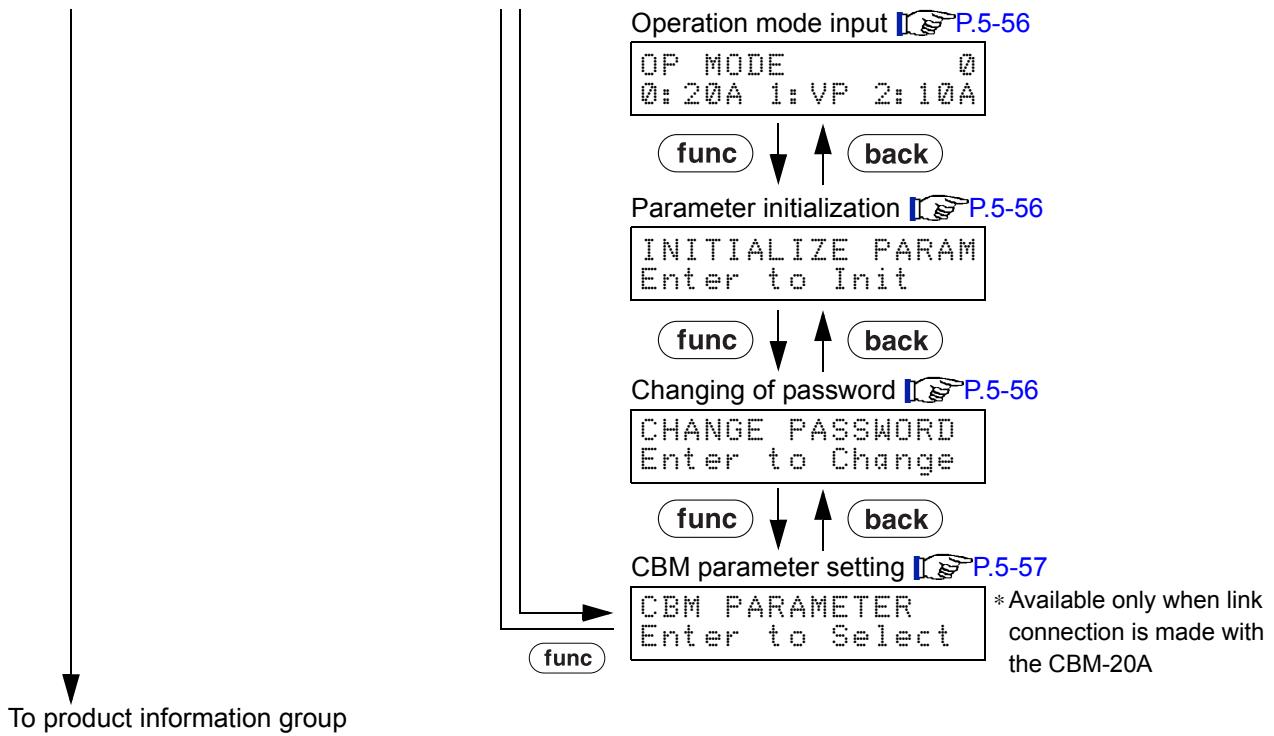
LEAK THR 150
ActLv 100 / 150

Selection of absorbance full scale to be displayed

P.5-55

RNG DISP MODE 0
0: REC 1: ITG

5. Application Operation

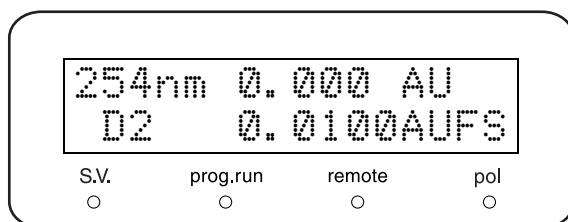


5.2 Operation in Dual Wavelength Mode

5.2.1 Selecting a Measurement Mode

1 Press **CE**.

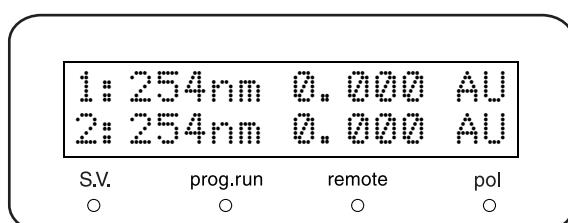
The initial screen appears.



2 Press **dual**.

The detector switches between single wavelength and dual wavelength mode by pressing **dual**. In dual wavelength mode, the display shows the wavelength and absorbance of channel 1 on the top line, and channel 2 on the bottom line.

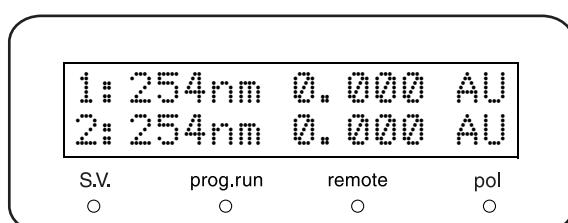
* To switch back to single wavelength mode from dual wavelength mode, press **dual**.



5.2.2 Setting the Ch2 Wavelength

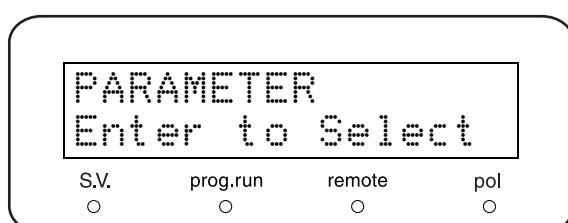
1 Press **CE**.

The initial screen appears.



2 Press **func** once.

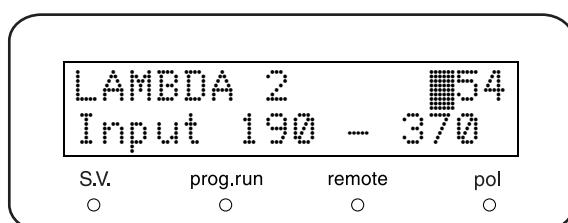
[PARAMETER] appears.



3 Press **enter**, and press **func** repeatedly until [LAMBDA 2] is displayed.

4 Input the Ch2 wavelength within the range indicated on the bottom line of the screen, using the numeric keypad.

Press **enter** to accept the value.



NOTE

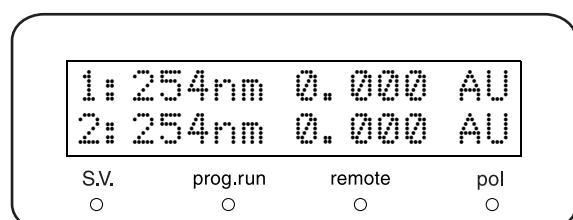
In dual wavelength mode, data is collected by sequential scanning of the grating, which causes some deterioration in reproducibility of very sharp peaks. The dual wavelength mode can be reliably used for peaks with a half-height width of 5 seconds or more (C.V. value less than 0.1%).

5.2.3 Setting the Output Mode

The dual wavelength mode permits either (a) simultaneous recording of chromatograms for two wavelengths or (b) simultaneous recording of a chromatogram from Ch1 wavelength and ratio chromatogram of two wavelengths on Ch2. In this mode, signals are output simultaneously to the [INTEGRATOR] and [RECODER] connectors. Ch1 absorbance signals are always output to the [INTEGRATOR] connector. The signals output to the [RECODER] connector, however, depend on the [REC MODE] function setting:

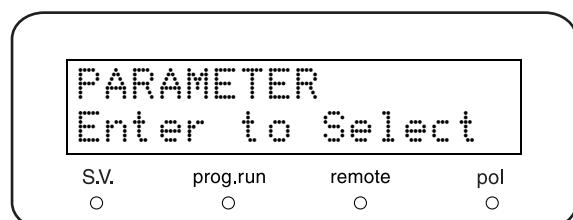
- 1 Press **CE**.

The initial screen appears.



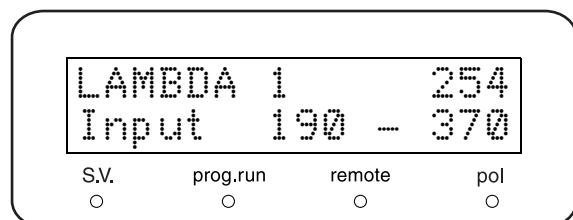
- 2 Press **func** once.

[PARAMETER] appears.



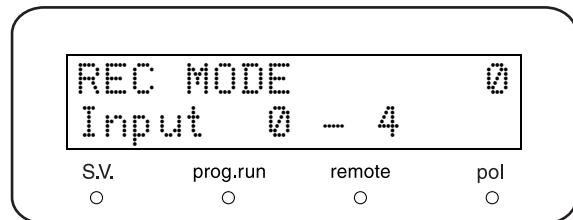
- 3 Press **enter**.

The wavelength setting screen appears.



- 4 Press **func** repeatedly until [REC MODE]

(recorder mode setting) is displayed.



- 5** Select the desired value from the table at right, and input it using numeric keys.

Setting	Output mode
0	Ch1 absorbance output
1	In dual wavelength mode, Ch2 absorbance output
2	In dual wavelength mode, ratio chromatogram signal output to [RECODER] connector
3	In dual wavelength mode, ratio chromatogram signal output to [INTEGRATOR] connector
4	Temperature adjustment cell's temperature output (100°C/10mV)

5

5.2.4 Setting the Ratio Chromatogram Signal Output Value

The output value of the ratio signal is calculated as follows:

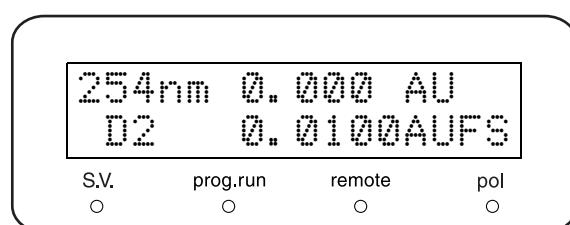
$$R(t) = \frac{A\lambda 1(t)}{A\lambda 2(t)} - 1 \text{ (When } A\lambda 1(t) > A\lambda 2(t))$$

$$R(t) = 1 - \frac{A\lambda 1(t)}{A\lambda 2(t)} \text{ (When } A\lambda 1(t) \leq A\lambda 2(t))$$

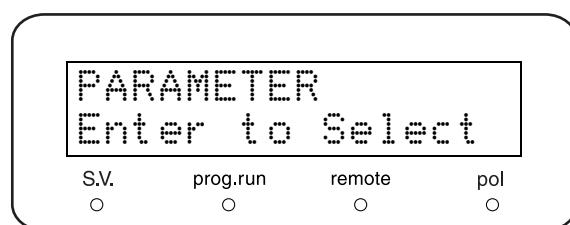
* $A\lambda 1(t)$ and $A\lambda 2(t)$ represent Ch1 absorbance and Ch2 absorbance respectively.

■ Sending a Ratio Chromatogram to the Chromatopac:

- 1** Press **CE**.
The initial screen appears.



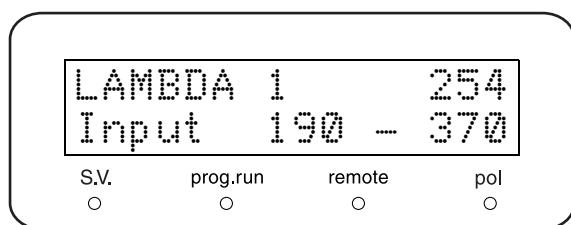
- 2** Press **func** once.
[PARAMETER] appears.



5. Application Operation

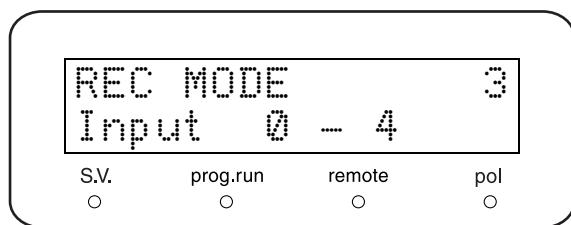
3 Press **enter**.

The wavelength setting screen appears.



4 Press **func** repeatedly until [REC MODE] (recorder mode setting) is displayed.

"[REC MODE]" P. 5-35



5 Press **3**.

6 Set the Chromatopac [ATTEN] parameter to zero.

When a ratio chromatogram signal is being output, the baseline is automatically shifted to the midpoint of the detector's recorder output range (i.e. the baseline will move +5mV at the 10mV recorder terminal). From this midpoint, the plot goes up when Ch1 absorbance exceeds Ch2 and down when the reverse is true.

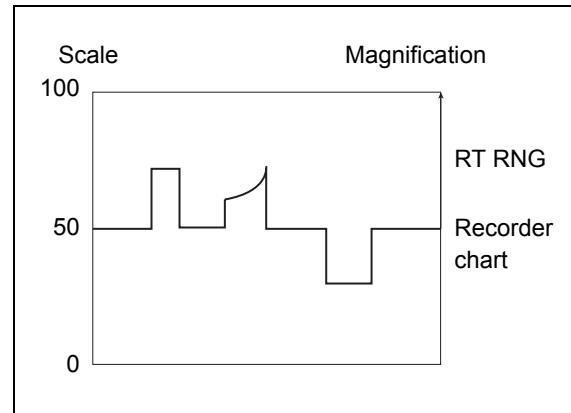


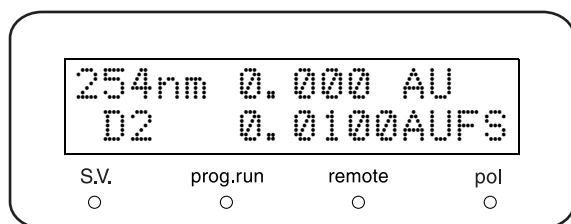
Fig. 5.1

■ Setting [RT RNG] (Ratio Range)

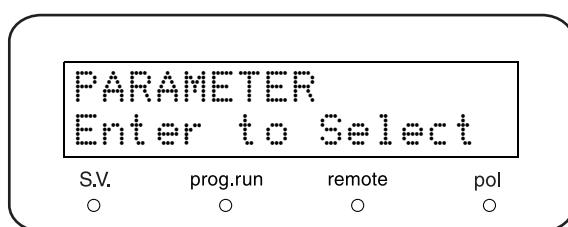
The ratio chromatogram range is set with the [RT RNG] function. If the [RT RNG] (ratio range) is set to 10, then a ratio of ± 10 can be displayed, and a ratio of +5 would result in a ratio chromatogram utilizing half of the positive scale, as shown in the illustration.

1 Press **CE**.

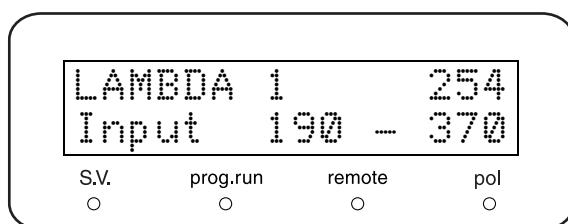
The initial screen appears.



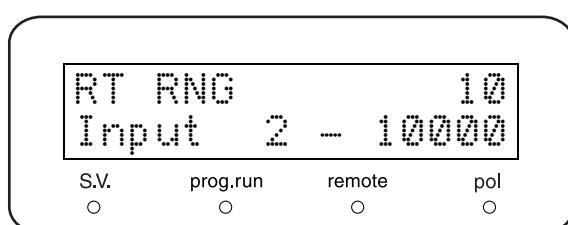
- 2** Press **func** once.
[PARAMETER] appears.



- 3** Press **enter**.
The wavelength setting screen appears.



- 4** Press **func** or **back** repeatedly until [RT RNG] is displayed.



- 5** Press **1**, then **0**.
* The setting range is 2-10000.

$$R(t) = \frac{A\lambda 1(t)}{A\lambda 2(t)} - 1$$

For example, the ratio of peaks with absorbances at $A\lambda 1=0.6\text{AU}$ and $A\lambda 2=0.1\text{AU}$ would be 5.

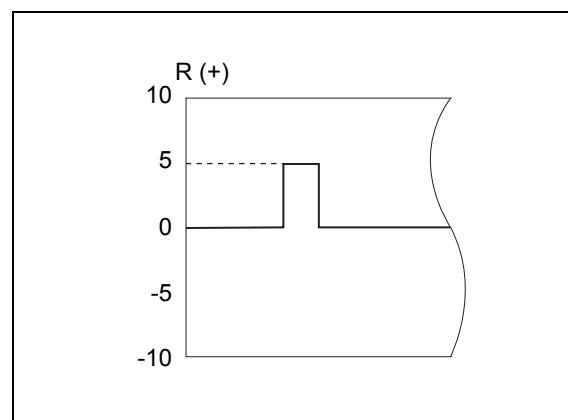
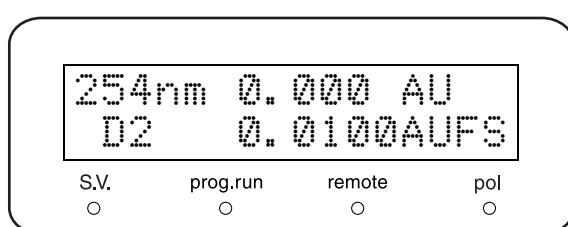


Fig. 5.2

■ Setting [RT THR] (Ratio Threshold)

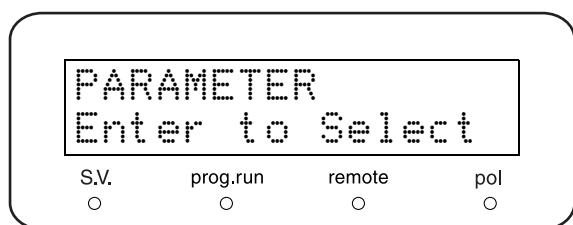
The threshold value, which controls whether or not a ratio is output, is set using [RT THR].

- 1** Press **CE**.
The initial screen appears.

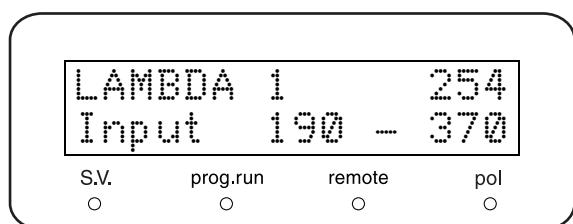


5. Application Operation

- 2 Press **func** once.
[PARAMETER] appears.

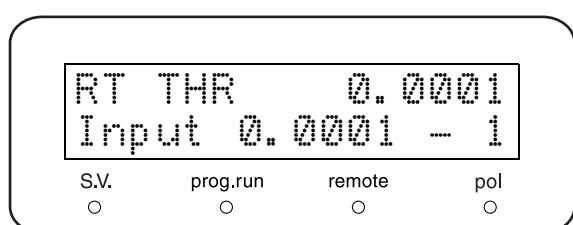


- 3 Press **enter**.
The wavelength setting screen appears.



- 4 Press **func** or **back** repeatedly until [RT THR] is displayed.

- 5 Input the desired value using numeric keys.
* The setting range is 0.0001-1.0 (AU).



A ratio chromatogram is output only when both the Ch1 and Ch2 signals exceed the value set for [RT THR]. Assuming no baseline drift, [RT THR] should be set at a value equal to 1-5% of the full scale measuring range (the Range Value). If the baseline drifts, for example in gradient analysis, execute an auto zero operation in the time program shortly before the peak of interest elutes, and set [RT THR] to a value larger than the expected drift.

NOTE

Be sure to actuate the auto zero function at the beginning of each analysis. Absorbance values used in the calculation of ratios are relative to the auto zero point.

■ Drift-Related Distortion in a Ratio Chromatogram

Ratio chromatograms are derived from the following equation, where $A\lambda 1(t)$ and $A\lambda 2(t)$ represent the change in absorbance, relative to the auto zero point, in wavelengths $\lambda 1$ and $\lambda 2$ respectively.

$$R(t) = \frac{A\lambda 1(t)}{A\lambda 2(t)} - 1 \text{ (in case that } A\lambda 1(t) > A\lambda 2(t))$$

However, since in actuality $A\lambda 1(t)$ and $A\lambda 2(t)$ also include baseline drift $D\lambda 1$ and $D\lambda 2$, the equation from which the ratio chromatograms are derived is, more accurately:

$$R(t) = \frac{A\lambda 1(t) + D\lambda 1}{A\lambda 2(t) + D\lambda 2} - 1$$

When the drift is zero, R for a pure peak maintains a constant value, and the ratio chromatogram shows a flat-topped peak. When drift is present in R, the chromatogram will be distorted as shown on the right.

For minimum distortion in the ratio chromatogram:

- set [RT THR] about 10 times larger than the drift.
- maximum absorbance of peak $A_{MAX\lambda 1}$ and $A_{MAX\lambda 2}$ should be at least twice the [RT THR] value.
- select two wavelengths which are strongly absorbed by the sample but weakly absorbed by the mobile phase.

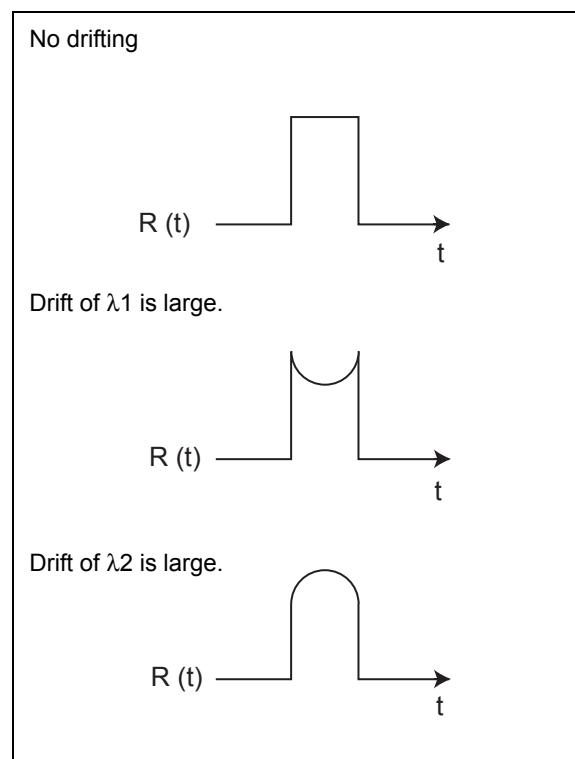


Fig. 5.3

5.3 Operation in Spectrum Scanning Mode

This instrument includes a spectrum scan function in which the flow of the mobile phase is stopped during the scan.

Two sample spectra and a background spectrum can be acquired and stored by the instrument.

5.3.1 Spectrum Scanning Procedure

The liquid in the detector cell must be stationary during scanning. One technique for accomplishing this is to stop the pump as the selected peak begins to rise. When using this method, the operator should compensate for the delay time between stopping the pump and stopping flow in the detector.

An alternative method is to interrupt the flow path using a high-pressure 6-port valve as shown in the figure below. The 6-port valve's nominal flow path (indicated by the solid lines) is switched to the flow path indicated by the dotted lines during the scan, thus trapping the analyte in the detector flow cell.

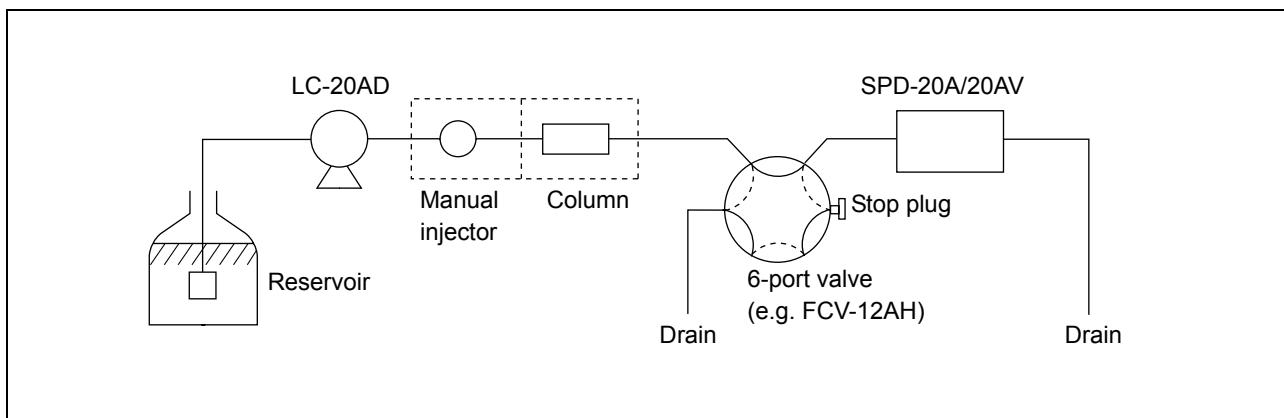


Fig. 5.4

NOTE

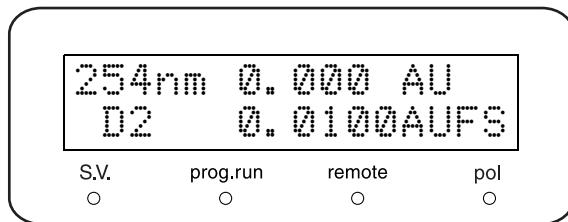
Do not open the pump's drain valve to stop the flow. The service life of the column may be shortened by the resulting pressure shock.

Perform the procedure described in the following section to set parameters necessary to perform the SCAN measurement.

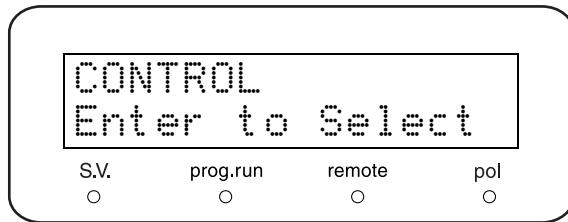
5.3.2 Setting Parameters Necessary to the Spectrum Measurement

1 Press **CE**.

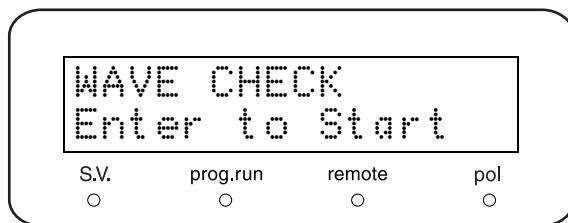
The initial screen appears.

**2** Press **func** twice.

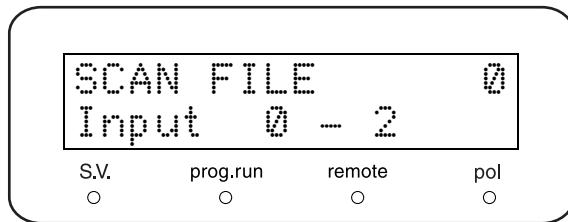
[CONTROL] appears.

**3** Press **enter**.

The wavelength check screen appears.

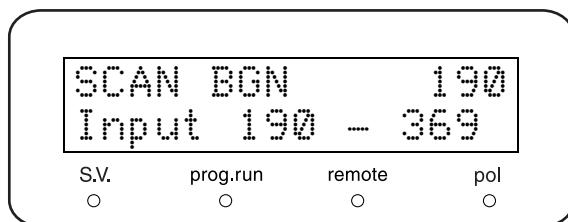
**4** Press the **func** repeatedly until [SCAN FILE] (spectrum scan file) is displayed. Then press **0**.**NOTE**

[SCAN FILE] 0 must be used for storing the background spectrum and Files 1 and 2 for storing samples. During processing, File 0 is automatically subtracted from the scan data in Files 1 and 2. Set the [SCAN FILE] to [0] before filling the cell with mobile phase.

**5** Set the scan start wavelength.① Press **func** repeatedly until [SCAN BGN] (scan start wavelength setting) is displayed.

② Enter the desired wavelength using numeric keys.

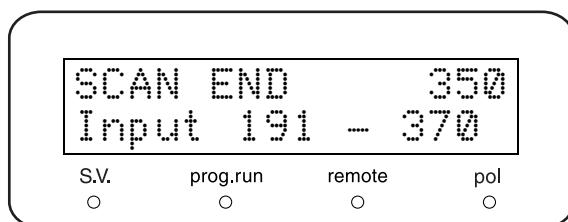
"[SCAN BGN]" P. 5-39

**6** ① Press **func**.

[SCAN END] (scan end wavelength setting) appears.

② Enter the desired wavelength using numeric keys.

"[SCAN END]" P. 5-40



5. Application Operation

NOTE

The setting ranges for the scan start and end wavelengths vary with the model and the type of lamp being used - D2 or W.

Model		Wavelength setting range	
		Start wavelength	End wavelength
SPD-20A		190 - 699nm	(Start wavelength + 1) - 700nm
SPD-20AV	With D2 lamp	190 - 369nm	(Start wavelength + 1) - 370nm
	With W lamp	371 - 899nm	(Start wavelength + 1) - 900nm
	When D2 and W lamps are on	190 - 899nm	If start wavelength is less than or equal to 369nm: (Start wavelength + 1) - 370nm If start wavelength is 371nm or longer: (Start wavelength + 1) - 900nm

- 7 Set the scan wavelength step.

① Press **func**.

[SCAN STEP] (scan wavelength step setting) appears.

② Enter the desired value using numeric keys.

 **"[SCAN STEP]" P. 5-40**

SCAN STEP 1
Input 1 - 5

S.V. prog.run remote pol

- 8 Press **CE** to return to the initial screen.

5.3.3 Measurement Procedure

- 1 When the flow cell has been flushed with the mobile phase, press **scan** and scanning will begin on background ([SCAN FILE] = 0). During scanning, the initial screen seen at right appears and the wavelength displayed in the upper left line is gradually updated. Scan is saved.

254nm 0.000 AU
λ SCANNING

S.V. prog.run remote pol

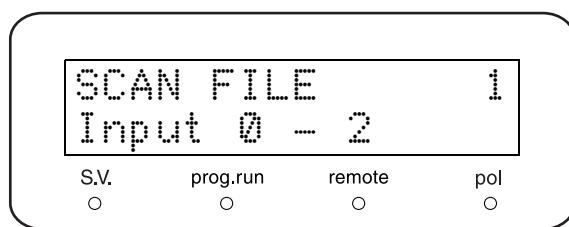
- 2 Run the pump.

- 3 Inject the sample.

- 4 Stop the pump when the peak of interest starts eluting.

5 When the baseline is stabilized, display [SCAN FILE] in the [CONTROL] group, and press **1** or **2**.

6 Press **scan**.
Scanning will begin.

**NOTE**

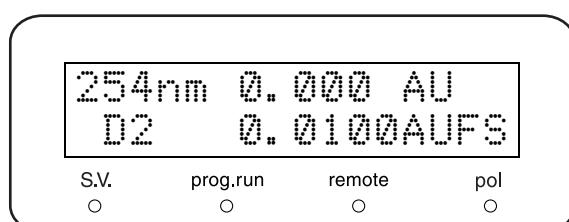
- It is not possible to program different scanning conditions ([SCAN BGN], [SCAN END], [SCAN STEP]) for the background ([SCAN FILE] = 0) and sample ([SCAN FILE] = 1/2). This will prevent spectrum data from being acquired accurately.
- During gradient analysis, the background scanning operation is slightly different:
 1. Perform a gradient run without injecting the sample. (as in. steps 1 to 5 above)
 2. Run the pump.
 3. Stop the flow at the eluting time of peak.
 4. Perform the background spectrum scan. (as in step 6 above)

5

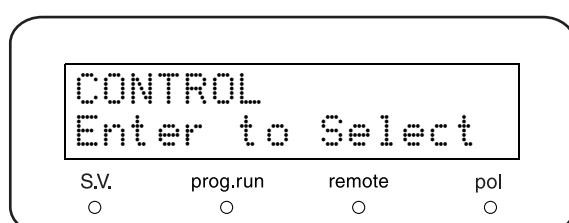
5.3.4 Output of Spectrum Data

The spectrum data contained in the current SCAN Files may be sent to the recorder terminals and plotted on a recorder. First, set the plot speed:

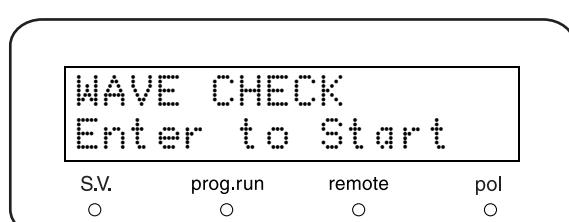
1 Press **CE**.
The initial screen appears.



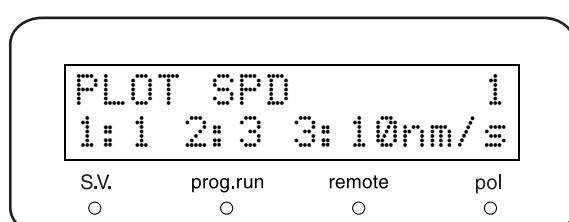
2 Press **func** twice.
[CONTROL] appears.



3 Press **enter**.
The wavelength check screen appears.



4 Press **func** repeatedly until [PLOT SPD] is displayed.



5. Application Operation

5 Choose the plot speed.

- Enter the speed using numeric keys.
* Appropriate settings are given in the table on the right.

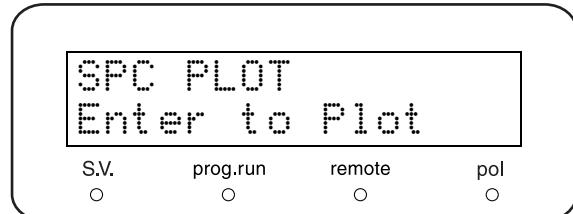
[PLOT SPD] Setting	Plot speed
1	1nm/sec
2	3nm/sec
3	10nm/sec

6 Press **func**.

[SPC PLOT] appears.

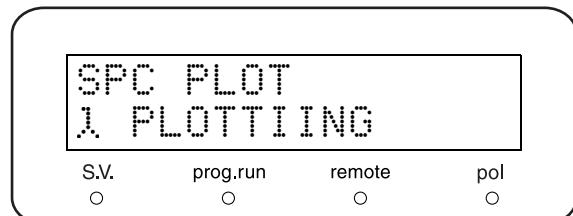
7 Press **enter**.

Plotting begins.



■ To Stop Plotting:

While the screen on the right is displayed, press **enter**.



The spectrum data is sent only to the [RECODER] terminals, and is normalized so the plotted absorbance in the specified wavelength range peaks at about 70% of full scale.

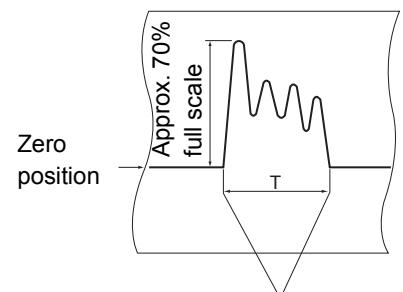
For a Chromatopac, set [ATTEN] at [3] or [4] for plotting.

Example of output

Output duration T is as follows:

$$T = (\text{SCAN END} - \text{SCAN BGN}) / \text{PLOT SPEED}$$

(1, 3, or 10nm/sec)



A mark is added at the start and end.

Fig. 5.5

For example, when a 200nm to 350nm range is to be plotted at a plot speed of 3nm/sec (PLOT SPD = 2):

$$T = (350 - 200) \text{ nm /3nm /sec} = 50\text{sec}$$

NOTE

- Files which do not contain scanned data cannot be plotted. If an empty file is specified, the message [DATA NOT EXIST] is displayed. Similarly, plotting cannot be performed if there is no data in the background file ([SCAN FILE] = 0).
- If the scanning range includes 370nm in the SPD-20A or 700nm in the SPD-20AV, noise caused by insertion of the second-order diffraction filter will appear at these wavelengths.
- Spectrum data cannot be output to the [INTEGRATOR] connector.
- Spectrum data is lost when the detector is turned off.
- Changing the scanning conditions ([SCAN BGN], [SCAN END], [SCAN STEP]) from those that were used when scanning was started can prevent data from being plotted correctly.

■ Peak Intensity Required for Spectrum Scanning

When the absorbance of the mobile phase varies substantially over the scanning wavelength range, the effect of the instrument's wavelength reproducibility error (0.2nm Max) on the spectrum data can be significant. To minimize this effect, the absorbance value of the peak of interest should be as high as possible. More specifically, absorbance at the maximum absorbance wavelength of the peak of interest should be about 100 times the maximum absorbance change of the mobile phase per 0.2nm increment of the scanning wavelength range.

Example

In the mobile phase absorbance spectrum shown below, the absorbance change per wavelength is greatest in the section between 210nm and 220nm. The rate of change per nanometer in this section is $(1.0 - 0.5) / (220 - 210) = 0.05\text{AU/nm}$. Therefore, the maximum spectrum error which could be introduced by wavelength reproducibility error is $0.2\text{nm} \times 0.05\text{AU/nm} = 0.01\text{AU}$. To obtain a spectrum in which this error may be ignored, the absorbance maximum of the peak of interest should be about 100 times the possible error, or about 1 AU.

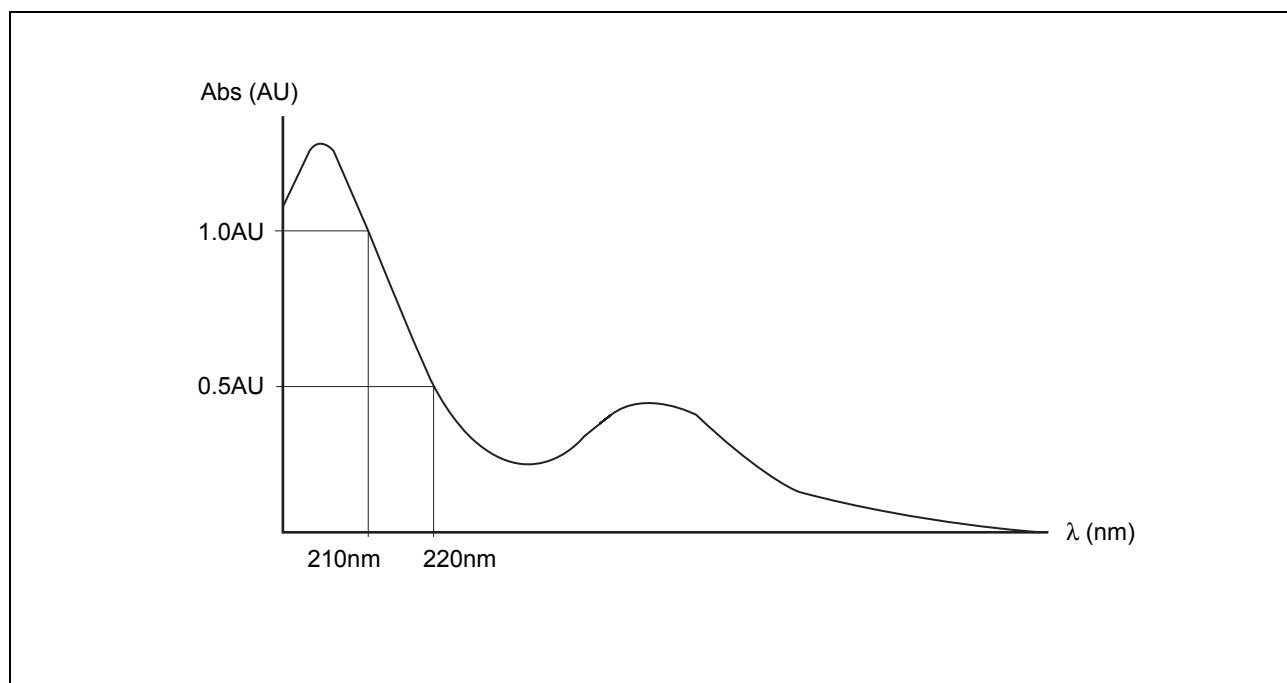


Fig. 5.6

5.4 Creating Time Program

A time program is used to program certain functions of the instrument automatically during an analysis. time programs are retained in memory when the power is turned off.

5.4.1 Program Commands

The commands for the time program are listed below.

Command	Description	Setting Range	Remark
$\lambda 1, \lambda 2$	Wavelength 1, Wavelength 2	Refer to the setting ranges in the table on P.5-25	
ZERO	Executes detector autozero	None	
MARK	Marks recorder output	None	
RANG	Sets full scale output range of recorder terminals	0 -2.56	Units: AUFS. A range of 0 short-circuits the recorder terminals, preventing signal output.
RESP	Sets detector time response	0 -10	Refer to P.4-9
SCAN	Executes wavelength scanning	0 -2	Value specifies file No. where data is to be stored.
EVNT	Sets EVENT outputs ON/OFF	0, 1, 2, 12	Set one of 4 available values. Refer to P.5-37
LAMP	Turns D2/W lamp ON/OFF	0: OFF 1: D2 lamp ON 2: W lamp ON 3: D2 and W lamps ON	W lamp is available only in the SPD-20AV.
POL	Sets polarity of detector output	0: Positive polarity 1: Reversed polarity	
CELT	Sets temperature of the flow cell	0: OFF Room temperature + 5°C - 50°C	
LOOP	Repeats preceding time program steps the specified number of times	0 - 255 0: Repeats program 256 times	
STOP	Stops time program	None	

Setting ranges for $\lambda 1$ and $\lambda 2$

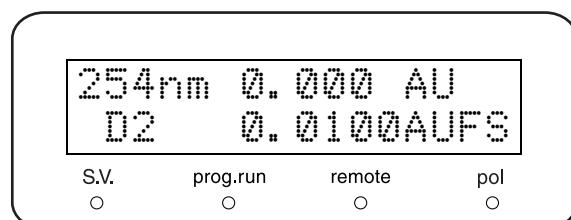
In single wavelength mode	SPD-20A	190 - 700nm
	SPD-20AV (D2 lamp)	190 - 370nm
	SPD-20AV (using W lamp)	371 - 900nm
	SPD-20AV (using both D2 and W lamps)	190 - 900nm
In dual wavelength mode	SPD-20A	190 - 370nm or 371 - 700nm
	SPD-20AV (using D2 lamp)	190 - 370nm
	SPD-20AV (using W lamp)	371 - 700nm or 701 - 900nm
	SPD-20AV (using both D2 and W lamps)	190 - 370nm, 371 - 700nm or 701 - 900nm

5.4.2 Setting Time Programming Parameters

To write or edit a time program, enter the edit mode as described below. Note that, in edit mode, the labels above the display screen do not apply to the information in the display.

1 Press **CE**.

The initial screen appears.

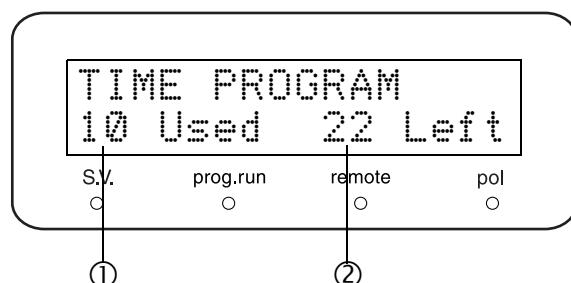


2 Press **edit**.

The time program edit screen appears.

- ① Number of steps already set
- ② Number of steps remaining

This example shows that 10 steps have been used, and that 22 steps remain for programming.

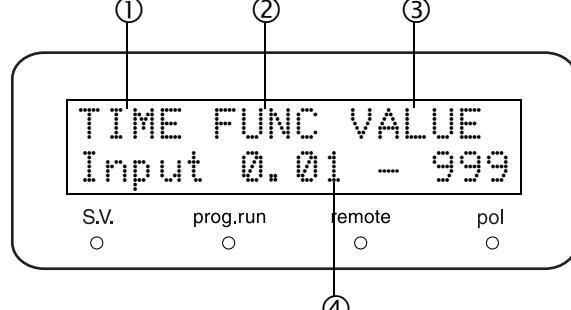


3 Press **enter**.

Set the program elapsed time.

- ① Elapsed time from program start (minutes)
 - ② Command
 - ③ Set value
 - ④ Possible range for each parameter (0.01 - 999 minutes shown here for time)
- * The blinking [TIME] field indicates that a new step can be entered.

Input the desired value and press **enter**.



4 Press **func** to display the desired command (function), and press **enter**.

5. Application Operation

5 Input the desired value for the command using numeric keys ([ZERO], [MARK] and [STOP] have no value associated with them) and press **enter**.

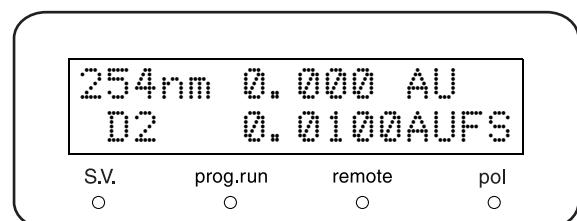
6 Press **CE** to return to the initial screen.

5.4.3 Creating a Typical Time Program

The following example shows the steps involved in creating a time program which will execute a spectral scan at five minutes into the analysis. The scanned spectrum data will be stored in file number two.

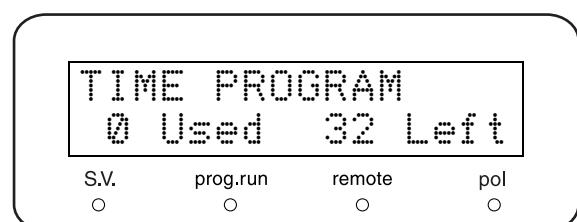
1 Press **CE**.

The initial screen appears.



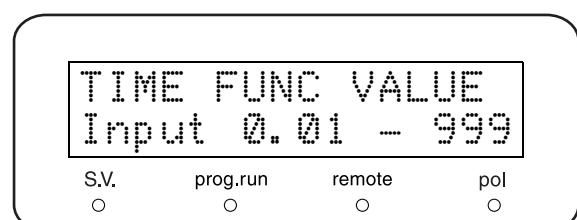
2 Press **edit**.

The screen shows the number of the time program steps.

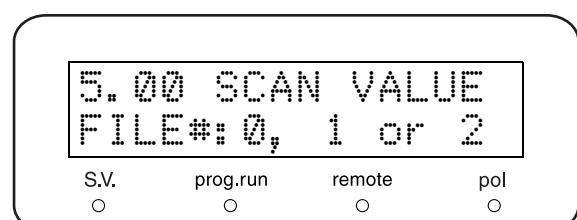


3 Press **enter**.

The time (minute) setting screen appears.

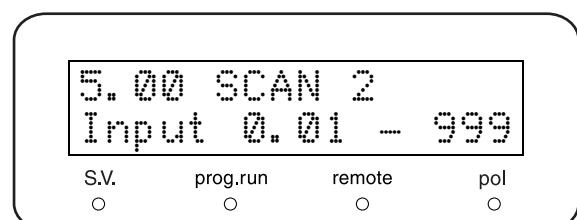


4 Press **5**, then **enter**.



7 Input the file No. for storing the data.

Press **2**, then **enter**.



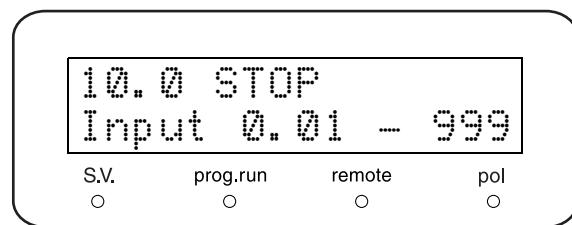
8 To input the next and following program steps, repeat the above steps 4 to 7.

9 To input the final step, which will stop the program at 10 minutes, first input the time and press **enter**.

10 Press **func** repeatedly until [STOP] is displayed.

11 Press **enter**.

12 Press **CE** to exit the time program mode and return to the initial screen.

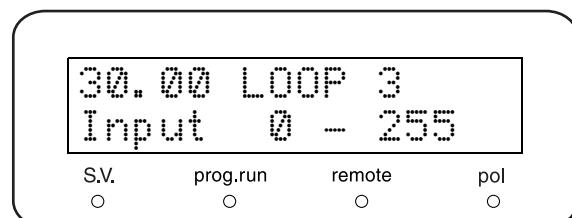


NOTE

- When setting several steps, they are ordered automatically in sequence.
- Always end the program with a [STOP] command, unless the program is to run indefinitely and be stopped manually.
- When selecting commands, press **back** to display the previous command.

5.4.4 Repeating the Time Program Steps [LOOP]

[LOOP] function can register the loop count of time program.



Set as right table for example. Step ① and ② will be repeated three times in 30 minutes interval. At the end of the third cycle, the time program will stop.

	TIME	FUNC	VALUE
①	15.00	λ1	210
②	20.00	λ1	220
③	30.00	LOOP	3

NOTE

- Value of [LOOP] command can be set to 255. When [0] is set, time program will be repeated 256 times.
- Steps which follow a [LOOP] command are ignored.

5.4.5 Deleting Steps

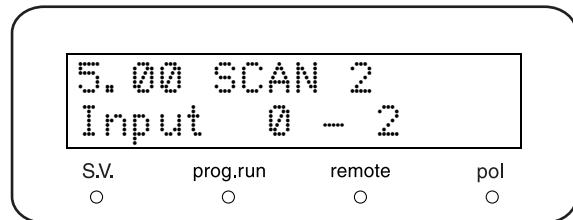
Call up the steps and press **del**.

Example: Delete step 1 of the program set in "5.4.3 Creating a Typical Time Program" P. 5-26.

1 Show the step to be deleted.

To display the step, follow the same procedure as creating the programs.

* To delete a subsequent step, press **enter** repeatedly until the desired step appears.



2 Press **del**.

The displayed step will be deleted. If there is a subsequent step, this step will be displayed.

5.4.6 Starting a Time Program

There are 2 ways to begin the time program after completing the time program settings:

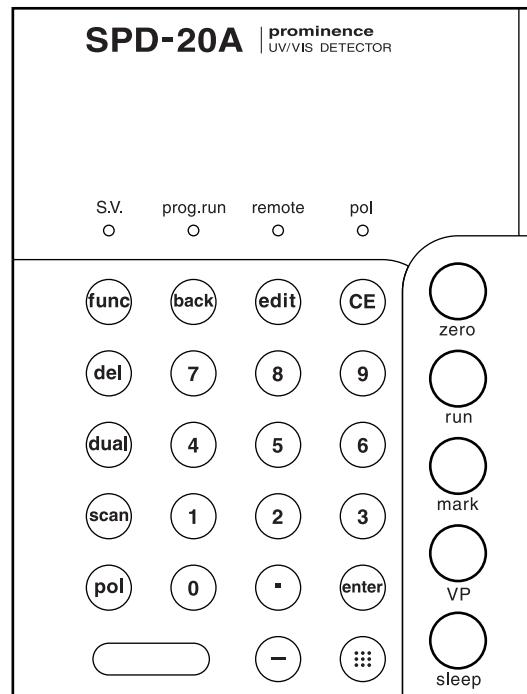
- Press **run**.
- A contact closure signal is received through the external input/output terminal.

 "5.9 Connection to External Input/Output Terminals" P. 5-65

In either case, the time program starts and the time program lamp on the display is turned on.

NOTE

If any parameters are changed while the time program is running, the new parameter take effect during the time program run. After the time program ends, the parameters changed while the time program was running are set to the previous values entered before the time program start.



5.4.7 Stopping a Time Program

There are 3 ways to stop the time program:

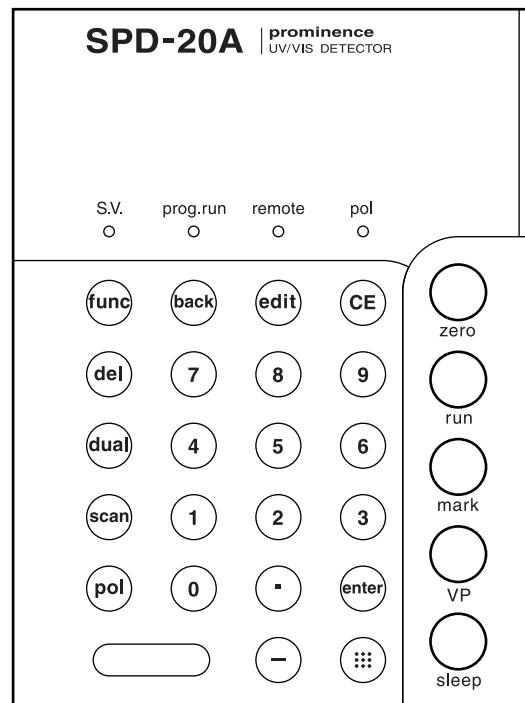
- Press **run** to force a program in progress to stop.
- A contact closure signal is received through the external input/output terminal.
- Use the [STOP] command to force a program in progress to stop.

To stop a time program by inserting [STOP] command in the program.

 "5.4.3 Creating a Typical Time Program" P. 5-26

Stopping a program using the contact signal

 "5.9 Connection to External Input/Output Terminals" P. 5-65



5.5 Parameters in Auxiliary Functions

There are four groups for auxiliary functions:

Parameter Setting, Control, System Setting and Monitor Display.

5.5.1 List of Auxiliary Functions

The auxiliary functions are listed in the tables below.

 "5.1.2 Auxiliary Function Setting Screen" P. 5-3

Submenu	Command	Operation	Function	Page
PARAMETER	LAMBDA 1	Numeric keypad	Sets wavelength.	P.5-33
	LAMBDA 2	Numeric keypad	Sets ch2 wavelength in dual wavelength mode.	P.5-33
	RESPONSE	Numeric keypad	Sets [RESPONSE].	P.5-34
	LAMP	Numeric keypad	Sets lamp ON/OFF.	P.5-34
	AUX RANGE	Numeric keypad	Sets integrator output range.	P.5-35
	RANGE	Numeric keypad	Sets recorder output range.	P.5-35
	REC MODE	Numeric keypad	Sets recorder output mode.	P.5-35
	BL OFS ITG	Numeric keypad	Sets baseline offset value for integrator zero position adjustment.	P.5-36
	BL OFS REC	Numeric keypad	Sets baseline offset value for recorder zero position adjustment.	P.5-36
	CELL TEMP	Numeric keypad	Sets temperature for flow cell temperature adjustment.	P.5-36
	EVENT	Numeric keypad	Sets external event terminal status.	P.5-37
	RT RNG	Numeric keypad	Sets range in ratio chromatogram output.	P.5-37
	RT THR	Numeric keypad	Sets threshold value in ratio chromatogram output.	P.5-37
	SV LEVEL	Numeric keypad	Sets threshold level for switching of solvent recycling valve.	P.5-37
	DELAY TIME	Numeric keypad	Sets solvent recycling valve delay time.	P.5-38
CONTROL	WAVE CHECK	enter	Checks wavelength accuracy.	P.5-38
	W POWER*	Numeric keypad	Sets intensity of tungsten lamp.	P.5-39
	SCAN FILE	Numeric keypad	Sets the file number where scanned data is to be stored.	P.5-39
	SCAN BGN	Numeric keypad	Sets scan start wavelength.	P.5-39
	SCAN END	Numeric keypad	Sets scan end wavelength.	P.5-40
	SCAN STEP	Numeric keypad	Sets scanning wavelength step.	P.5-40
	PLOT SPD	Numeric keypad	Sets output speed of spectrum data to recorder.	P.5-40
	SPC PLOT	enter	Outputs spectrum data to recorder.	P.5-41

Submenu	Command	Operation	Function	Page
SYSTEM	LOCAL	Numeric keypad	Selects local control or control by system controller.	P.5-41
	LINK ADRS	Numeric keypad	Sets address when controlled by system controller.	P.5-42
	KEY CLOSE	(enter)	Locks key input.	P.5-42
	BRIGHTNESS	Numeric keypad	Sets display brightness.	P.5-42
	EXT-S	Numeric keypad	Used with event terminal for control of external events.	P.5-43
	MONIT-TIME	Numeric keypad	Controls display of elapsed time when executing a time program.	P.5-43
	BEEP MODE	Numeric keypad	To set the operation of buzzer.	P.5-43
MONITOR	SMPL EN	Display	Displays the sample cell light intensity.	P.5-44
	REF EN	Display	Displays the reference cell light intensity.	P.5-44
	D2 TIME	Display	Displays cumulative operating time of deuterium lamp.	P.5-44
	W TIME*	Display	Displays cumulative operating time of tungsten lamp.	P.5-44
	CELL TEMP	Display	Displays monitor temperature of the temperature adjustment cell.	P.5-44

* The W (tungsten) lamp is present in the SPD-20AV only.

* Operation in the table head shows the types of operation described below.

Display : Check the monitor.

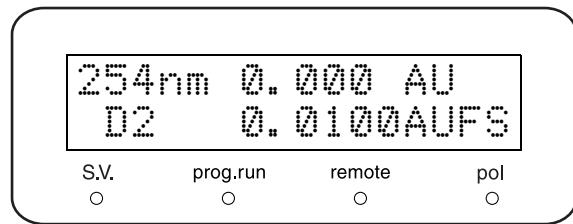
(enter) : Press (enter) to activate the function.

Numeric keypad : Press (-) - (9) to enter a value and press (enter) to accept the value.

5.5.2 Showing the Auxiliary Function Screen

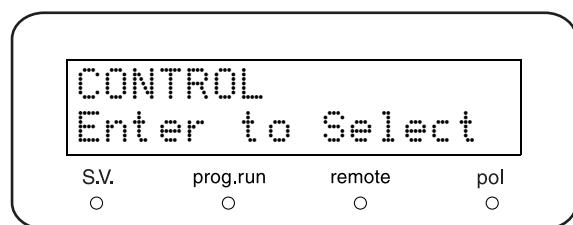
1 Press **CE**.

The initial screen appears.



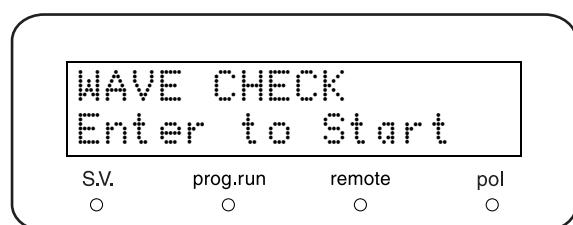
2 Press **func** repeatedly.

The auxiliary function groups change in the order of [PARAMETER], [CONTROL], [SYSTEM], and [MONITOR].



3 Select a desired group and press **enter**.

The first item in the selected group appears.



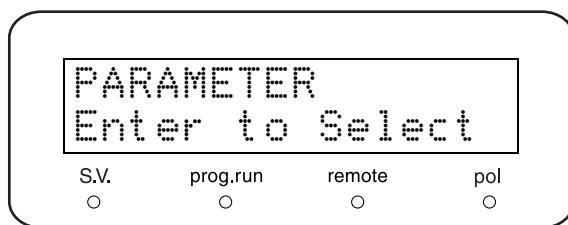
4 Press **func** or **back** repeatedly to move to the other functions.

5 Press **CE** to show the group screen.

Press **CE** to return to the initial screen.

5.5.3 Parameter Settings Group

This group is for setting detector parameters.



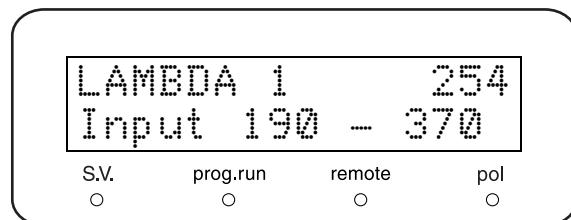
■ [LAMBDA 1]

"4.1.1 Setting Wavelength [LAMBDA 1]" P. 4-2

Enter wavelength by numeric keypad, then press **enter**.

Model	Setting range
SPD-20A	190nm - 700nm
SPD-20AV	With D2 lamp
	371nm - 900nm
	When D2 and W lamps are on

- * In dual wavelength mode, the available setting range for [LAMBDA 1] and that for [LAMBDA 2] are the same.



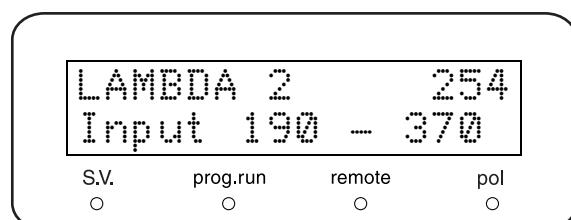
■ [LAMBDA 2]

Sets the Ch2 wavelength in dual wavelength mode.

"5.2.2 Setting the Ch2 Wavelength" P. 5-11

Enter wavelength by numeric keypad, then press **enter**.

Model	Setting range
SPD-20A	190nm - 370nm or 371nm - 700nm
SPD-20AV	With D2 lamp
	371nm - 700nm or 701nm - 900nm
	190nm - 370nm, 371nm - 700nm, or 701nm - 900nm



5. Application Operation

■ [RESPONSE]

 "4.1.4 Setting [RESPONSE]" P. 4-9

Select a set value by numeric keypad, then press **enter**.

Set value	Corresponding time constant of analog filter
0	0.02sec
1	0.05sec
2	0.1sec
3	0.5sec
4	1.0sec
5	1.5sec
6	3.0sec
7	6.0sec
8	8.0sec
9	10.0sec
10	2.0sec

RESPONSE		4	
Input 0 - 10			
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>

■ [LAMP]

Turns lamp ON/OFF.

Select a set value by numeric keypad, then press **enter**.

* Set values [2] and [3] below are only for SPD-20AV.

Set value	Lamp status
0	OFF
1	Deuterium lamp ON
2	Tungsten lamp ON
3	Deuterium lamp ON / Tungsten lamp ON

LAMP		1	
0: OFF 1: D2 2: W			
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>

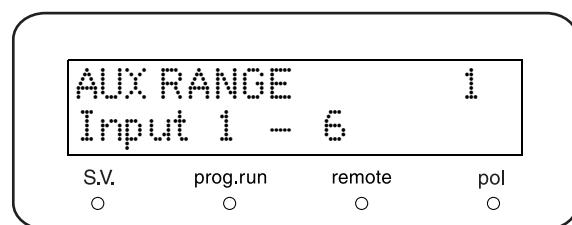
■ [AUX RANGE]

Set this parameter when using the Chromatopac as a recorder.

 "When a Chromatopac Is Used As a Recorder:" P. 4-4

Select a set value by numeric keypad, then press **enter**.

Set value	Range
1	0.5 AU/V
2	1.0 AU/V
3	2.0 AU/V
4	4.0 AU/V
5	1.25 AU/V
6	2.5 AU/V



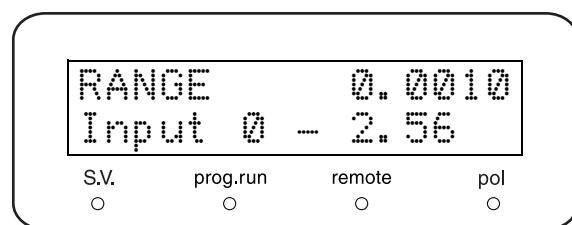
■ [RANGE]

 "When a Strip-Chart Recorder Is Used:" P. 4-5

Select a range by numeric keypad, then press **enter**.

Set range
0 - 2.5600 AU/10mV

* When [0] is selected, the recorder output is set to 0mV.

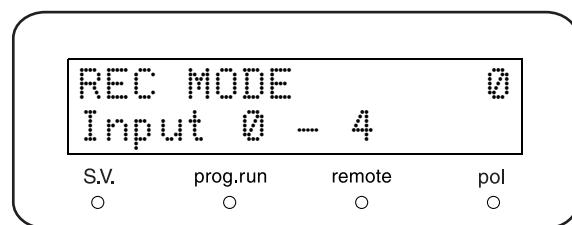


■ [REC MODE]

Sets the [RECODER] connector output mode.

Select a set value by numeric keypad, then press **enter**.

Set value	Output mode
0	Ch1 absorbance output
1	In dual wavelength mode, Ch2 absorbance output
2	In dual wavelength mode, ratio chromatogram signal output to [RECODER] connector
3	In dual wavelength mode, ratio chromatogram signal output to [INTEGRATOR] connector
4	Flow cell's temperature reading output (100°C/10mV)



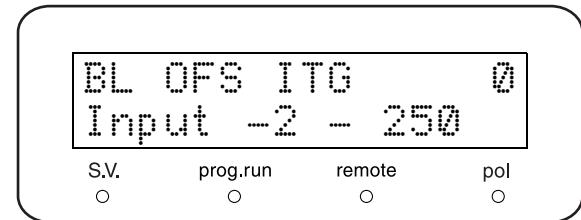
* When [1], [2] or [3] is selected, the ch1 absorbance is output in single wavelength mode.

5. Application Operation

■ [BL OFS ITG]

Sets the baseline offset value for the integrator output.
Press **zero** to fix the integrator output to the value specified here. This is the offset value for the integrator output connector.
Select a set value by numeric keypad, then press **enter**.

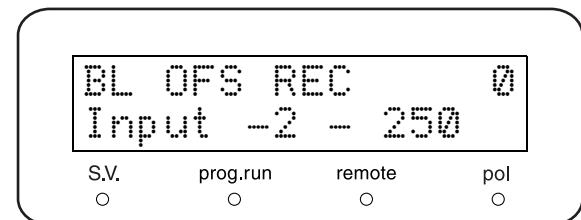
Set range
-2 - 250mV



■ [BL OFS REC]

Sets the baseline offset value for the recorder output.
Press **zero** to fix the recorder output to the value specified here. This is the offset value for the recorder output connector.
Select a set value by numeric keypad, then press **enter**.

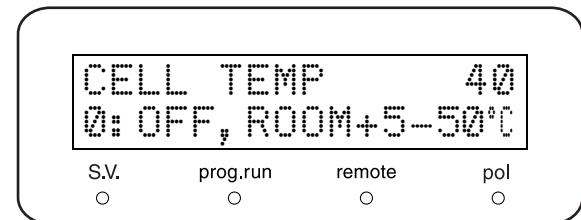
Set range
-2 - 250mV



■ [CELL TEMP]

Sets the temperature of the temperature controlled flow cell.
Select a set value by numeric keypad, then press **enter**.

Set range (°C)
0: temperature adjustment OFF 9 to 50



* It is possible to set the temperature setting as low as 9 (°C), but it should be set at a value at least 5 (°C) or more above room temperature. Setting it at some other value can result in a [LOW SET TEMP] error.

■ [EVENT]

Sets the relays ON (close) / OFF (open) accessed by the EVENT output terminals on the back of the instrument.
Enter the value and press **enter**.

Set value	EVENT1	EVENT2
0	OFF	OFF
1	ON	OFF
2	OFF	ON
12	ON	ON

EVENT		0	
0, 1, 2 or 12			
S.V.	prog.run	remote	pol
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

☞ "5.9 Connection to External Input/Output Terminals" P. 5-65

■ [RT RNG]

Sets the full-scale output for a ratio chromatogram.

Setting range: [2-10000].

Select a value by numeric keypad, then press **enter**.

☞ "Setting [RT RNG] (Ratio Range)" P. 5-14

RT RNG		10	
Input 2 - 10000			
S.V.	prog.run	remote	pol
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

■ [RT THR]

Sets the threshold level for a ratio chromatogram.

A ratio chromatogram is output only when the absorbance signals for both wavelengths exceed this value.

Setting range: 0.0001-1.0(AU).

Select a value by numeric keypad, then press **enter**.

☞ "Setting [RT THR] (Ratio Threshold)" P. 5-15

RT THR		0.0001	
Input 0.0001 - 1			
S.V.	prog.run	remote	pol
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

■ [SV LEVEL]

Sets the threshold level for switching the solvent recycling valve.

When the absorbance signal for the wavelength exceeds this value, the solvent recycling valve is switched to the liquid draining (waste) position.

Setting range: 0-1 AU, in steps of 0.0001.

- If the solvent recycling valve is not used, or to set the valve permanently to the recycling position, set [0] for this function.
- To set the valve permanently to the waste position, set [1].

Select a value by numeric keypad, then press **enter**.

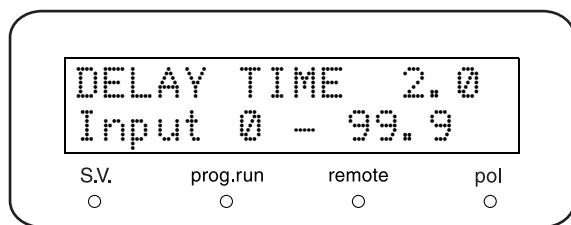
SV LEVEL		0.0000	
Input 0 - 1			
S.V.	prog.run	remote	pol
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. Application Operation

■ [DELAY TIME]

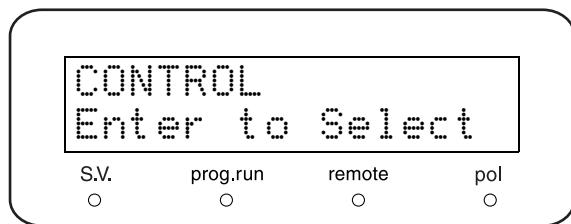
This sets the delay time for switching the solvent recycle valve back to the recycling position, after the absorbance signal has fallen below the [SV LEVEL].

Setting range: 0-99.9 (seconds).



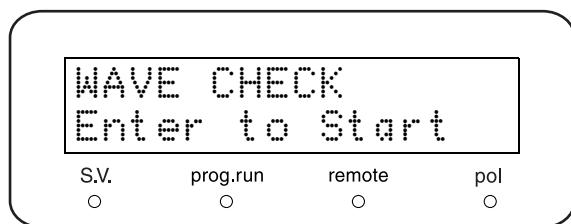
5.5.4 Control Settings Group

This is the group for system control.



■ [WAVE CHECK]

- 1 Press **enter** when [WAVE CHECK] is displayed to initiate a wavelength accuracy check.



- 2 The display on the right appears during the check.

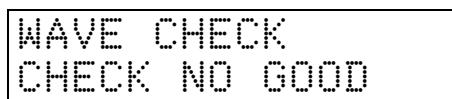


- 3 If wavelength accuracy is within specifications, the message on the right is displayed.

The screen on the right indicates that the wavelength accuracy is 0.03nm for the 656nm emission line of the D2 lamp, and 0.23nm for the 254nm emission line of the Hg lamp.



If the wavelength is checked and found to be inaccurate, the screen on the right is displayed. In this case, calibrate the wavelength using the [WAVE CALIB] function.



 [CHECK NO GOOD] (Wavelength check failed) [P.6-6](#)

NOTE

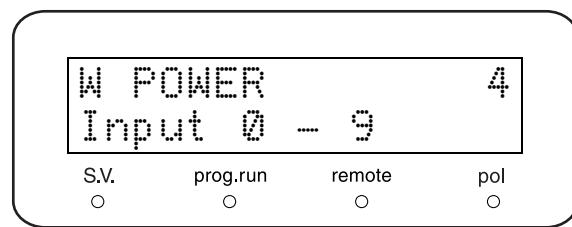
[WAVE CHECK] does not operate in dual wavelength mode.

■ [W POWER]

This function adjusts the intensity of the tungsten lamp, and is applicable only to the SPD-20AV.

Range 0-9 (9 is maximum intensity).

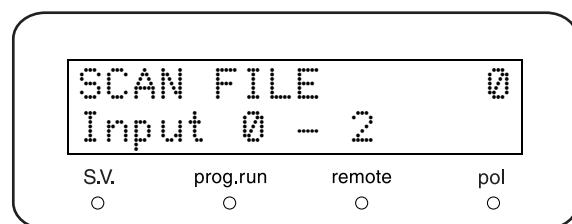
 "Setting Brightness" [P. 8-17](#)



5

■ [SCAN FILE]

Sets the file number where the scanned data is to be stored. Select a number (0-2) by numeric keypad, then press **enter**.

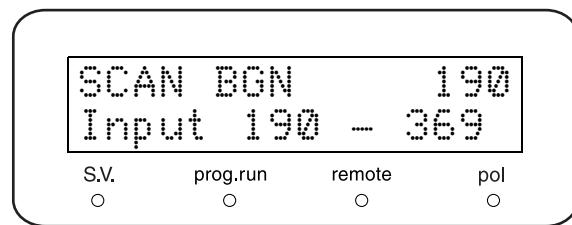


■ [SCAN BGN]

Sets scan starting wavelength.

Select the scan starting wavelength by numeric keypad, then press **enter**.

* The wavelength settings range displayed on the bottom line differs by model according to the chart on [P.5-40](#).



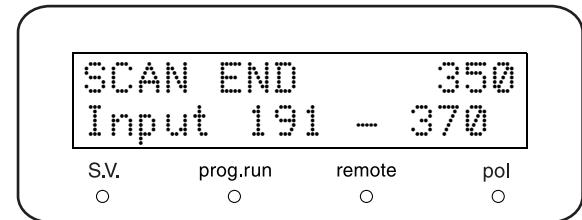
5. Application Operation

■ [SCAN END]

Sets scan ending wavelength. [SCAN END] should always be higher than [SCAN BGN].

Select the scan ending wavelength by numeric keypad, then press **enter**.

- * The wavelength settings range displayed on the bottom line differs by model according to the chart below.



Model		Wavelength setting range					
		Start wavelength	End wavelength				
SPD-20A		190 - 699nm	(Start wavelength + 1) - 700nm				
SPD-20AV	With D2 lamp	190 - 369nm	(Start wavelength + 1) - 370nm				
	With W lamp	371 - 899nm	(Start wavelength + 1) - 900nm				
	When D2 and W lamps are on	190 - 899nm	If start wavelength is less than or equal to 369nm: (Start wavelength + 1) - 370nm If start wavelength is 371nm or longer: (Start wavelength + 1) - 900nm				

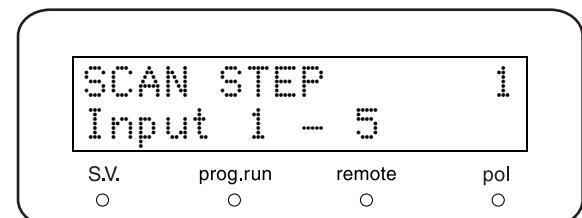
■ [SCAN STEP]

Scan step controls the speed of wavelength scanning.

Select the scanning step by numeric keypad, then press **enter**.

The valid setting range for the deuterium lamp is 1-5nm; for the tungsten lamp, the range is 2-5nm.

- * Tungsten lamp: only for SPD-20AV.

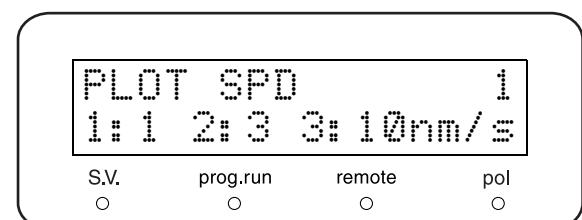


■ [PLOT SPD]

Sets the speed at which spectrum data is sent to the recorder.

Select a set value by numeric keypad, then press **enter**.

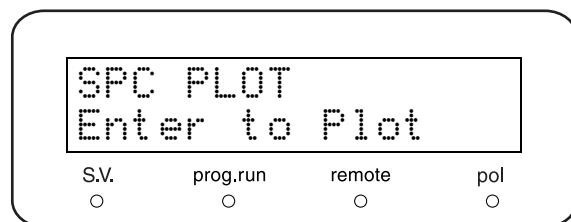
Set value	Output speed
1	1nm/sec
2	3nm/sec
3	10nm/sec



■ [SPC PLOT]

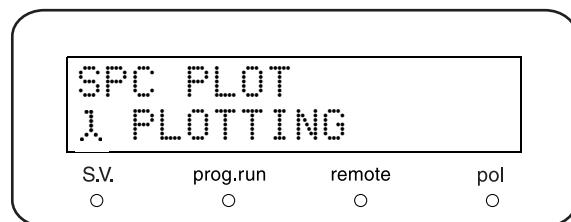
Outputs spectrum data to the recorder.

- 1 Press **enter**.



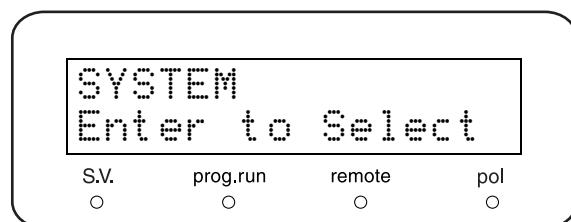
- 2 During data output, the display appears as shown on the right.

* To stop the output to the recorder, press **enter** again while the screen on the right is displayed.



5.5.5 System Settings Group

This is the group for system settings.

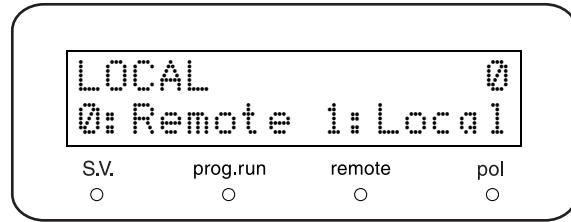


■ [LOCAL]

Sets whether this instrument is operated by system controller or the instrument operates independently when system controller is connected.

Enter the desired value, and press **enter**.

Set value	Mode	Function
0	Remote	Operate via system controller (initial setting)
1	Local	Operate independently (in local mode)

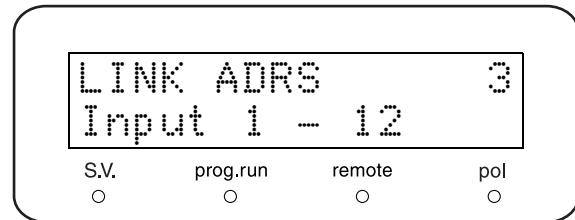


■ [LINK ADRS]

Sets the address (channel number) when this instrument is connected to system controller.

Enter the address number, and press **enter**.

 "Connection to System Controller" P. 9-29

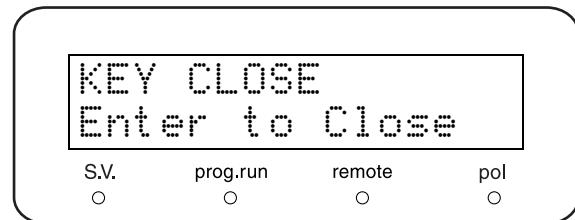


■ [KEY CLOSE]

Press **enter** to prohibit the keypad entry.

After this, key operation is not available.

* To release this function, press **del** while pressing **CE**.

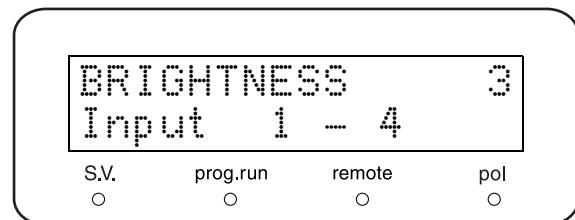


■ [BRIGHTNESS]

The fluorescent display contrast can be adjusted to four levels of brightness.

Select a set value (brightness) by numeric keypad, then press **enter**.

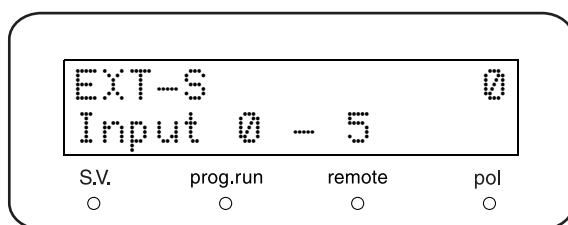
Set value	Brightness level
1	25%
2	50%
3	75%
4	100%



■ [EXT-S]

Sets specialized control of [EVENT1] and [EVENT2] relays.
Select a set value by numeric keypad, then press **enter**.

Set value	Control mode
0	[EVENT] outputs are controlled by the [EVENT] value.
1	[EVENT1] operates as a time program start signal.
2	[EVENT2] operates as an error output signal.
3	[EVENT1] operates as a time program start signal and [EVENT2] operates as an error output signal.
4	[EVENT1] operates as a scan start signal. When the detector scans, [EVENT1] is closed.
5	[EVENT2] operates as an error output signal and [EVENT1] operates as a scan start signal.



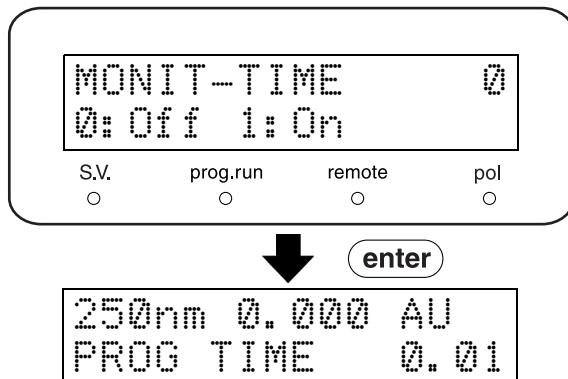
 "5.9 Connection to External Input/Output Terminals" P. 5-65

■ [MONIT-TIME]

Displays the elapsed time of the time program.
Select a set value by numeric keypad, then press **enter**.

Set value	Function
0	Cancels display of elapsed time
1	Enables display of elapsed time

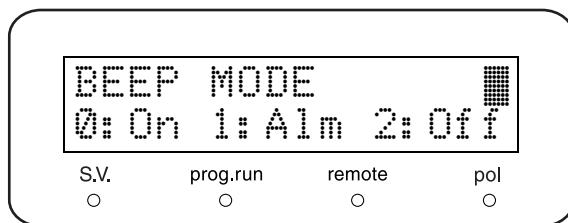
When this function is enabled, the display appears as shown on the right.



■ [BEEP MODE]

Sets the operation of buzzer.
Enter a set value and press **enter**.

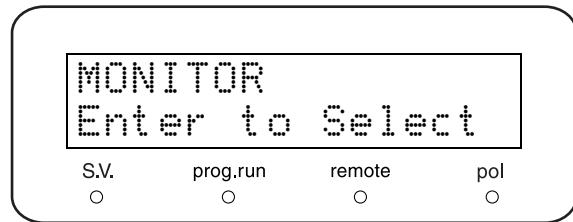
Set value	Function
0	Alarm sound when error occurs and key entry sound are enabled. (default)
1	Only alarm sound when error occurs is enabled. Key entry sound is disabled.
2	All sounds are disabled.



5. Application Operation

5.5.6 Monitor Display Group

This is the group for monitor setting.



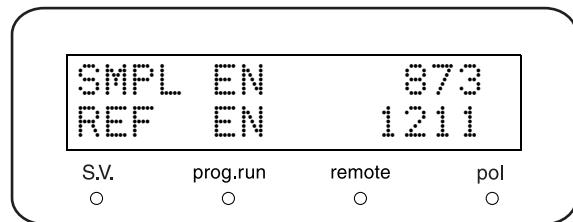
■ [SMPL EN, REF EN]

Displays light intensity at the sample end of the cell.

Useful for troubleshooting. (Units: mV)

Displays light intensity at the reference end of the cell.

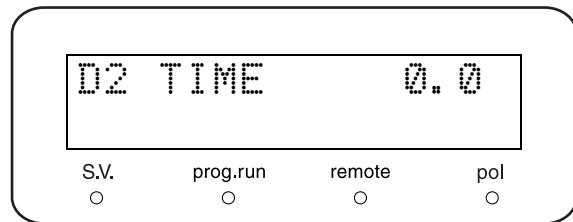
Useful for troubleshooting. (Units: mV)



■ [D2 TIME]

Displays cumulative operating time of deuterium lamp.

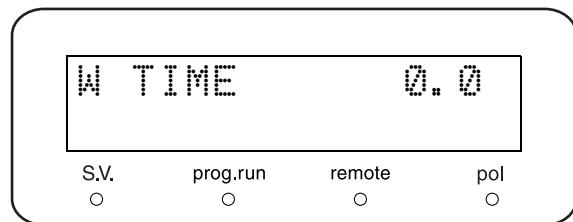
(Units: hours)



■ [W TIME]

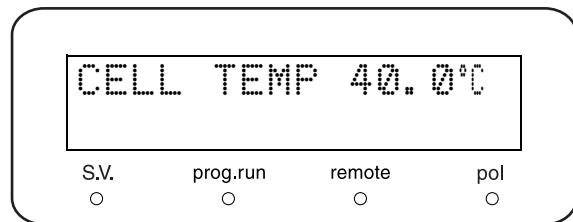
Displays cumulative operating time of tungsten lamp.

(Units: hours) (SPD-20AV only.)



■ [CELL TEMP]

Displays the temperature of the temperature controlled flow cell. (Units: °C)



5.6 VP Functions

VP functions support the validation of the instrument by check functions or displaying the instrument information.

There are four groups for VP functions: Product Information, Maintenance Information, Validation Support, and Calibration Support.

5.6.1 List of VP Functions

The VP functions are listed in the tables below.

 "5.1.3 VP Function Screens" P. 5-7

■ Product Information Group

Command	Operation	Function	Page
SERIAL NUMBER	Display	Displays the instrument serial number	P.5-48
S/W ID : V *.*.*	Display	Displays the instrument name and ROM version	P.5-48

■ Maintenance Information Group

Command	Operation	Function	Page
TOTAL OP TIME	Display	Displays the instrument's total cumulative operating time	P.5-48
D2 LAMP USED	Display	Displays deuterium lamp operating time and replacement alert time	P.5-49
W LAMP USED	Display	Displays tungsten lamp operating time and replacement alert time	P.5-49
PART REPLACEMENT	Numeric keypad	For inputting records of parts replacement	P.5-49
MAINTENANCE LOG	Display	Displays maintenance log	P.5-49
OPERATION LOG	Display	Displays operation log	P.5-50
ERROR LOG	Display	Displays error log	P.5-50

■ Validation Support Group

Command	Operation	Function	Page
DATE YY-MM-DD	Numeric keypad	Displays/sets the date	P.5-51
TIME HH:MM:SS	Numeric keypad	Displays/sets the time	P.5-51
AUTO CHECK	enter	Runs auto checks on memory, wavelength accuracy and light intensity	P.5-51
LEAK SENSOR TEST	enter	Runs check on leak sensor	P.5-52

* Operation in the table head shows the types of operation described below.

Display : Check the monitor.

enter : Press **enter** to activate the function.

Numeric keypad : Press **-** - **9** to enter a value and press **enter** to accept the value.

5. Application Operation

■ Calibration Support Group

Command	Operation	Function	Page
Input PASSWORD *1	Numeric keypad	For input of password	P.5-53
WAVE CALIB	(enter)	For execution of wavelength calibration	P.5-53
D2 TIME	Numeric keypad	For inputting D2 lamp replacement alert time	P.5-53
D2 ENERGY	Numeric keypad	For inputting alert energy value for D2 lamp replacement	P.5-54
W TIME	Numeric keypad	For inputting W lamp replacement alert time	P.5-54
W ENERGY	Numeric keypad	For inputting alert energy value for W lamp replacement	P.5-54
ABS CALIB	(enter)	For absorbance calibration (absorbance compensation coefficient is set with [ABS COMP])	P.5-54
ABS COMP	Numeric keypad	For inputting absorbance calibration coefficient	P.5-55
LINEAR CALIB	Numeric keypad	For linearity compensation	P.5-55
LEAK CALIB	(enter)	For leak sensor primary calibration	P.5-55
LEAK THR	Numeric keypad	For inputting leak sensor actuation level	P.5-55
RNG DISP MODE	Numeric keypad	For setting the full scale absorbance initially displayed	P.5-55
OP MODE	Numeric keypad	For setting operation mode	P.5-56
INITIALIZE PARAM	(enter)	For initializing parameters	P.5-56
CHANGE PASSWORD	(enter)	For changing password	P.5-56
CBM PARAMETER	Numeric keypad, (enter)	For showing and setting CBM parameters Displayed when link connection is made with the CBM-20A.	P.5-57

*1 If the password is not input correctly, the functions in the Calibration Support Group cannot be accessed, even if (func) is pressed.

* Operation in the table head shows the types of operation described below.

Display : Check the monitor.

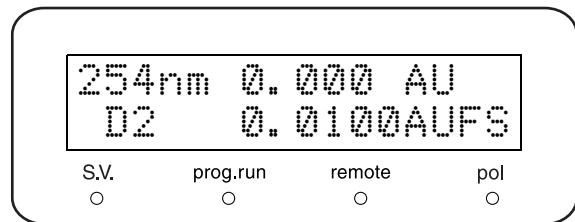
(enter) : Press (enter) to activate the function.

Numeric keypad : Press (-) - (9) to enter a value and press (enter) to accept the value.

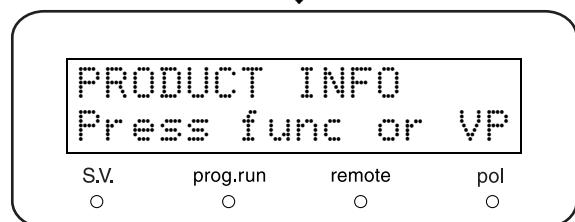
5.6.2 Displaying the VP Functions

1 Press **CE**.

The initial screen appears.

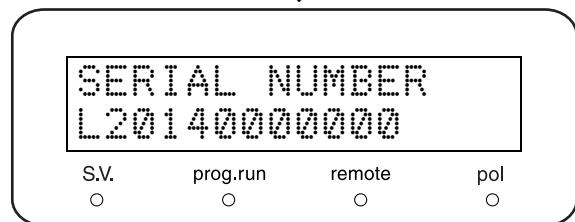


2 Press **VP** to select the desired Group.



3 Press **func** repeatedly until the desired function appears.

* To return to the previous screen, press **back**.



4 Follow the further instructions of the selected function.

5 To select a different VP Function Group, press **VP** repeatedly.

To select the desired function, press **func** or **back** repeatedly.

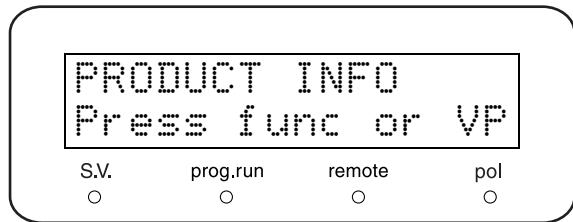
6 To return to the group's title screen, press **CE** within the function.

To return to the initial screen, press **CE** again.

5. Application Operation

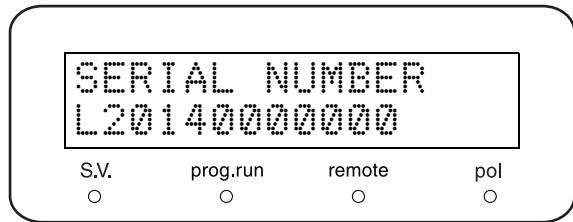
5.6.3 Product Information Group

This group provides information about the instrument.



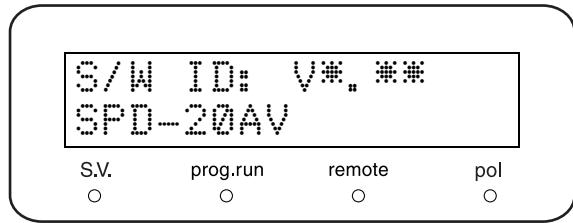
■ [SERIAL NUMBER]

Shows the serial number of this instrument.



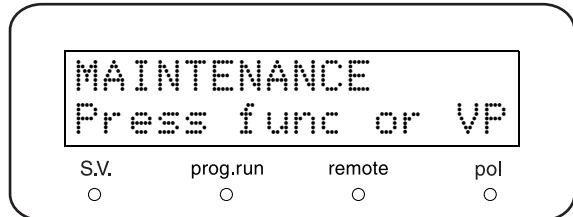
■ [S/W ID]

Shows the name of software (same as the model name) and version.



5.6.4 Maintenance Information Group

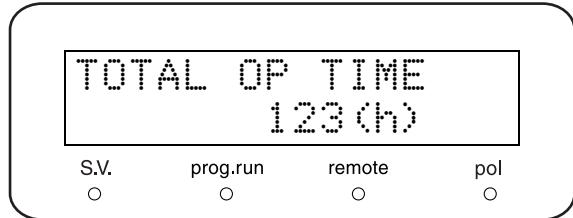
This group provides the maintenance-related information.



■ [TOTAL OP TIME]

Shows the total operating time of this instrument.

- * The example on the right shows an operating time of 123 hours.

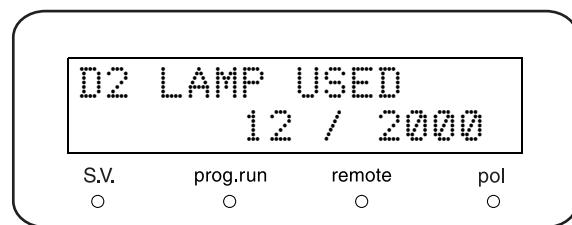


■ [D2 LAMP USED]

Displays the deuterium lamp cumulative operating time and replacement alert time.

When the deuterium lamp is replaced, access this item and press **0**, **enter** to reset the operating time to zero (the replacement will be entered in the maintenance log).

- * The example on the right shows an operating time of 12 hours, and replacement alert time of 2000 hours.

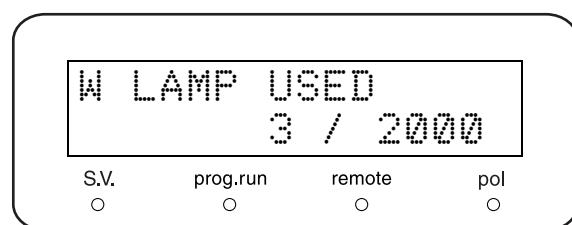


■ [W LAMP USED]

Displays the tungsten lamp cumulative operating time and replacement alert time. This item is only displayed in the SPD-20AV.

When the tungsten lamp is replaced, access this item and press **0**, **enter** to reset the operating time to zero (the replacement will be entered in the maintenance log).

- * The example on the right shows an operating time of 3 hours, and replacement alert time of 2000 hours.

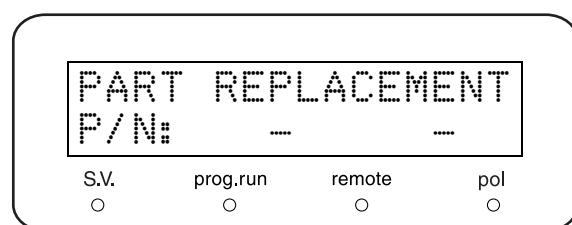


■ [PART REPLACEMENT]

Enters the replaced part No.

The part No. is recorded in the maintenance log.

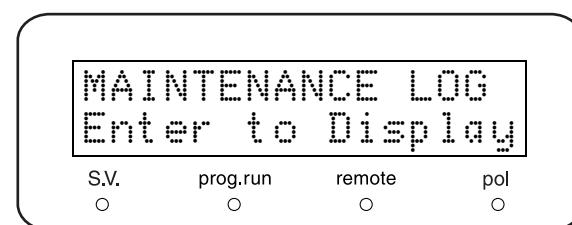
- * This input is generally performed by a service representative.



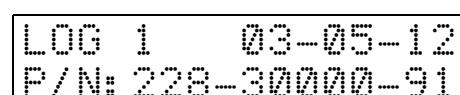
■ [MAINTENANCE LOG]

Shows the maintenance log, which contains the most recent parts replacement records (part No. and date) (up to 10).

Press **enter** repeatedly to show Log1 to Log10 in sequence, and return to the title screen.



In the example on the right, Log1 indicates that part No. 228-30000-91 was replaced on May 12, 2003.



If less than 10 logs are recorded, the screen displays the message as shown on the right.

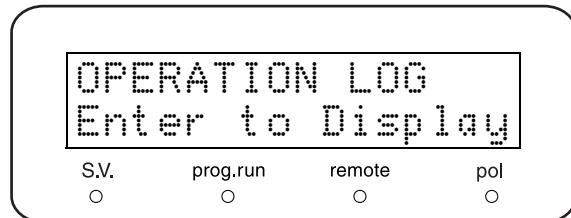
Press **CE** to return to the title screen.

5. Application Operation

■ [OPERATION LOG]

Shows the operation log, which contains the most recent password changes, parameter initializations, etc. (up to 10).

Press **(enter)** repeatedly to show Log1 to Log10 in sequence, and return to the title screen.



In the example on the right, Log1 indicates that password was changed on May 12, 2003.

LOG 1 03-05-12
CHANGE PASSWORD



No more Logs

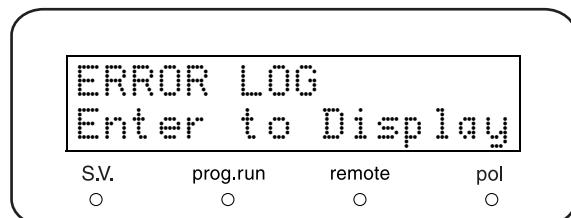
If less than 10 logs are recorded, the screen displays the message as shown on the right.

Press **(CE)** to return to the title screen.

■ [ERROR LOG]

Shows the error log, which contains the most recent errors (up to 10) with their dates.

Press **(enter)** repeatedly to show Log1 to Log10 in sequence, and return to the title screen.



In the example on the right, Log1 indicates that a leak detection error occurred on May 12, 2003.

LOG 1 03-05-12
ERR LEAK DETECT



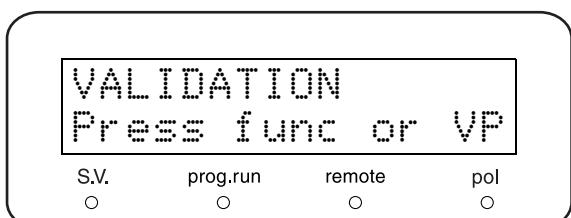
No more Logs

If less than 10 logs are recorded, the screen displays the message as shown on the right.

Press **(CE)** to return to the title screen.

5.6.5 Validation Support Group

This group checks whether the instrument is running correctly.



■ [DATE]

Shows/enters the date.

However, the value returns to the initial value [00-00-00] after turning the power OFF.

When the instrument is controlled by a system controller, the date is transmitted when connecting, and cannot be changed.

Date

DATE	YY-MM-DD		
00-00-00			
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>



Example: Set January 2, 2003.

1 Enter year, month and day in 2 digits.

Entered

DATE	YY-MM-DD
03-01-02	

2 Press **enter**.

5

■ [TIME]

Shows/enters the time.

However, the value returns to the initial value [00:00:00] after turning the power OFF.

When the instrument is controlled by a system controller, the time is transmitted when connecting, and cannot be changed.

Time

TIME	HH: MM: SS		
00: 00: 00			
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>



Example: Setting 5:30:55 p.m.

1 Enter hour, minute and second in 2 digits.

Entered

TIME	HH: MM: SS
17: 30: 55	

■ [AUTO CHECK]

1 Press **enter**.

The following checks will be executed consecutively:

- Memory check
- Wavelength accuracy check
- Light intensity check

The result of each check is displayed when it is completed.

AUTO CHECK			
Enter to Check			
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>



2 Press **CE** to erase the resulting display.

Result

AUTO CHECK			
CHECK GOOD			

5. Application Operation

■ [LEAK SENSOR TEST]

Carries on the operation test for leak sensor.

- 1 Use a syringe filled with water to wet the thermosensor at the bottom of the leak sensor.
- 2 Wait about 10 seconds. Then press **enter**.

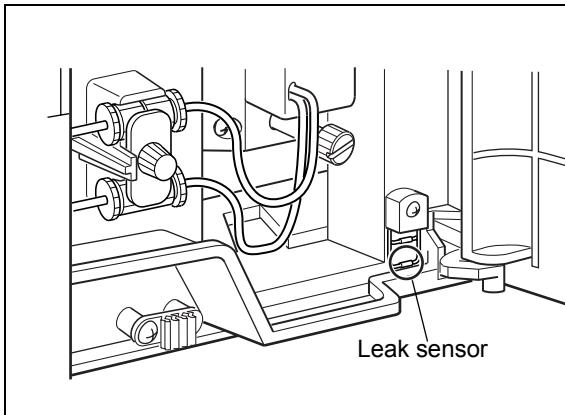
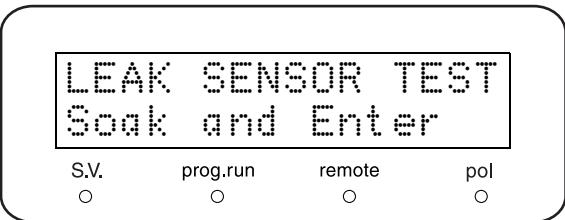


Fig. 5.7



LEAK SENSOR TEST
CHECK GOOD

LEAK SENSOR TEST
SENSOR NO GOOD

- 3 Press **CE** to clear the result display.

If the result is [SENSOR NO GOOD], adjust the detection level using the [LEAK CALIB] and [LEAK THR] functions in the Calibration Support Group.

NOTE

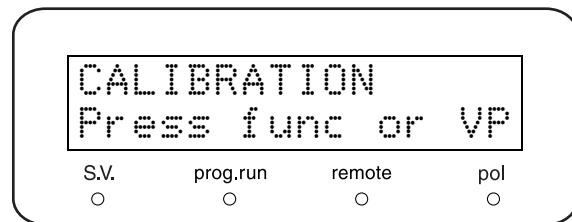
Take care not to let the leak sensor come in contact with any of the detector's resin parts.

5.6.6 Calibration Support Group

This group calibrates the instrument.

NOTE

The instrument is adjusted before leaving the factory. Do not change values unnecessarily.



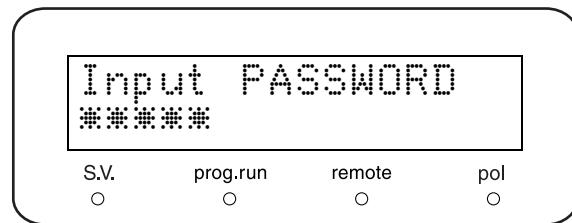
■ [Input PASSWORD]

Password should be registered by a system manager.
Input five numbers and press **enter**.

- * Be sure to input five numbers. The default password is [00000].

If the password is input correctly, [WAVE CALIB] function (subsequent function) appears.

If the password is not input correctly, succeeding steps cannot be accessed.

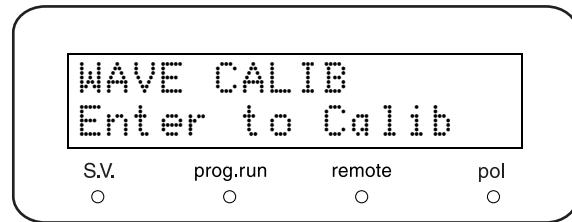


■ [WAVE CALIB]

- 1 Press **enter**.
The instrument's wavelengths will be calibrated automatically.
- 2 When calibration is complete, the [WAVE CHECK] (wavelength accuracy check) will be run automatically, and the result ([GOOD] or [NO GOOD]) displayed.

- * In about 90 seconds, calibration will complete, and within the succeeding 60 seconds, wavelength accuracy check will complete.

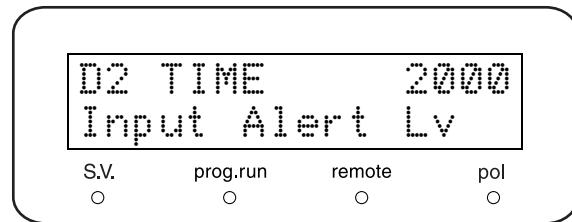
☞ "8.6 Wavelength Accuracy Calibration" P. 8-21



■ [D2 TIME]

Enter the replacement alert time for the deuterium lamp.
Use numeric keys to input the time, and press **enter**.

When the [AUTO CHECK] (☞ P.5-51) is run, [WARNING] is displayed if the operating time of the deuterium lamp has exceeded the value set here.
The default setting is 2000 hours.

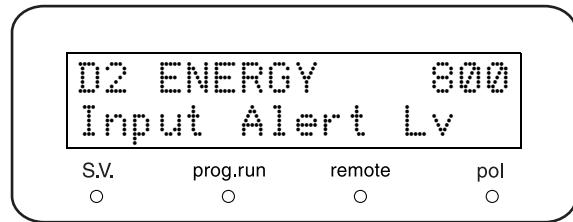


■ [D2 ENERGY]

Input the energy alert value for replacement of the deuterium lamp. Specifically, set the minimum acceptable reference energy level of the deuterium lamp at a wavelength of 220nm.

Use numeric keys to input the value, and press **enter**. When the [AUTO CHECK] (☞ P.5-51) is run, [WARNING] is displayed if the energy level of the deuterium lamp at 220nm is lower than the value set here.

The default setting is 800 [mV].



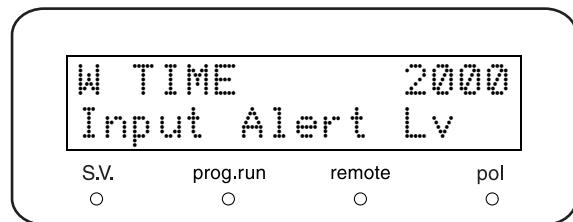
■ [W TIME]

Input the replacement alert time for the tungsten lamp. Use numeric keys to input the time, and press **enter**.

When the [AUTO CHECK] (☞ P.5-51) is run, [WARNING] is displayed if the operating time of the tungsten lamp has exceeded the value set here.

The default setting is 2000 hours.

* This function is only available in the SPD-20AV.



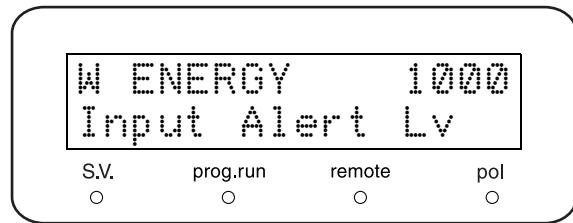
■ [W ENERGY]

Input the energy alert value for replacement of the tungsten lamp. Specifically, set the minimum acceptable reference energy level of the tungsten lamp at a wavelength of 540nm.

Use numeric keys to input the value, and press **enter**. When the [AUTO CHECK] (☞ P.5-51) is run, [WARNING] is displayed if the energy level of the tungsten lamp at 540nm is lower than the value set here.

The default setting is 1000 [mV].

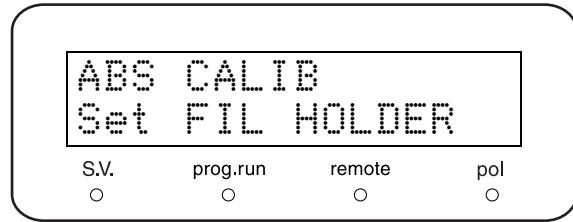
* This function is only available in the SPD-20AV.



■ [ABS CALIB]

Using an appropriate reference filter, calibrate the absorbance accuracy.

☞ "8.7 Absorbance Accuracy Calibration" P. 8-23

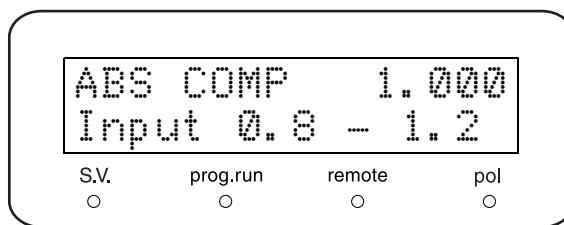


■ [ABS COMP]

Input the absorbance compensation coefficient.

This coefficient compensates for inconsistencies in absorbance values resulting from non-uniformities in the hardware (optical and electrical systems) of the various system components.

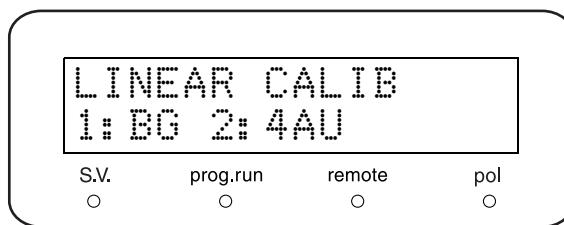
Use numeric keys to input the value, and press **enter**.
Factory default values are input before shipping.



■ [LINEAR CALIB]

Calibrates the absorbance linearity.

"8.8 Absorbance Linearity Calibration" P. 8-27



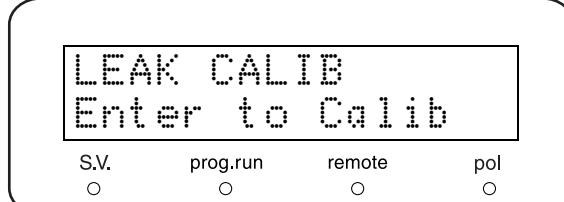
■ [LEAK CALIB]

Perform primary calibration of leak sensor.

After checking to be sure that the leak sensor is dry and that it is not in contact with the wall(s) of the resin panel, turn on the instrument and wait at least 3 minutes before pressing **enter**.

* After replacement of the leak sensor:

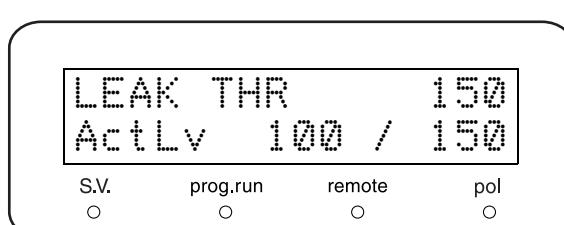
Once this operation has been performed, follow the instructions in the next section to re-adjust the leak sensor performance level settings.



■ [LEAK THR]

Input the level (threshold value) at which the leak sensor is actuated. Use numeric keys to input the level, and press **enter**. The setting range is [0-255].

The [ActLv] in the bottom line of the display shows the leak sensor's current (actual) value. If this value exceeds the value set for [LEAK THR], the sensor detects a leak.
Factory default values are input before shipping.



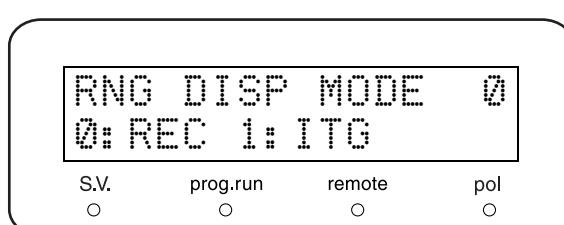
■ [RNG DISP MODE]

Specify whether the absorbance full scale displayed on the initial screen is the recorder full scale (AUFS) or integrator full scale (AU/V).

Press [0] or [1], then **enter**.

The default setting is [0].

- For display of AUFS full scale, set [0].
- For display of AU/V full scale, set [1].



5. Application Operation

■ [OP MODE]

Select the operation mode according to the type of connected system controller.

Enter the number and press **enter**.

The default setting is [0].

- For control by an CBM-20A/20Alite, set [0].
- For control by an SCL-10Avp, set [1].
- For control by an SCL-10A, set [2].

Attentions when setting [OP MODE] to [1] or [2].

 "5.8.3 Attention" P. 5-64

OP MODE 0			
0: 20A	1: VP	2: 10A	
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>

■ [INITIALIZE PARAM]

Initializes [LAMBDA] (wavelength) and other parameters, and deletes the time program. (This operation is recorded in the operation log.)

Press **enter** to execute.

INITIALIZE PARAM			
Enter to Init			
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>

■ [CHANGE PASSWORD]

Changes password.

1 Press **enter**.

The input screen appears.

CHANGE PASSWORD			
Enter to Change			
S.V. <input type="radio"/>	prog.run <input type="radio"/>	remote <input type="radio"/>	pol <input type="radio"/>

2 Input a new password and press **enter**.
The password must consist of five digits.

New PASSWORD			
			

3 To confirm, input the same password again.

Input Again			
			

4 When the new password is registered,
[PASSWORD CHANGED] appears.

Input Again			
PASSWORD CHANGED			

If not, [PASSWORD WRONG] appears. In this case, the password newly entered is not registered.

Input Again			
PASSWORD WRONG			

- 5** Press **enter** to return to the title screen.

NOTE

Record the new password in a secure place. Do not share the password.

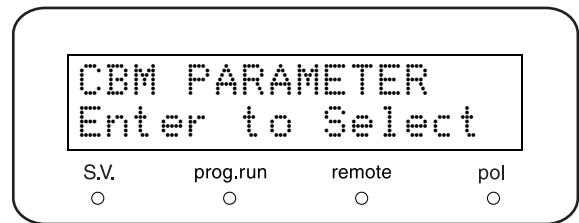
■ [CBM PARAMETER]

Shows/sets parameters of CBM-20A which controls the instrument.

Press **enter** to move to the CBM parameter setting screen.

To select the desired function, press **func** or **back** repeatedly.

To return to the title screen on the right, press **CE**.

**NOTE**

When the instrument is not connected to CBM-20A, or is set to local mode, the CBM parameter screen will not appear, even if **enter** is pressed.

List of CBM Parameters

SERIAL NUMBER	To show the serial No. of CBM
S/W ID	To show the program version No. of CBM
INTERFACE	To set the transmitting protocol to data processing instrument
ETHERNET SPEED	To set the transmitting speed of ethernet ^{*1}
USE GATEWAY	To set usage of default gateway ^{*1}
IP ADDRESS	To set IP address of CBM ^{*1}
SUBNET MASK	To set subnet mask ^{*1}
DEFAULT GATEWAY	To set default gateway ^{*1*2}
TRS MODE	To select the communication destination when connecting to a LC workstation or a Chromatopac.

*1 Available only to show, when not allowed to change on CBM-20A side.

*2 Not available when [Default gateway] is not used.

NOTE

Each parameter is activated after CBM is restarted.

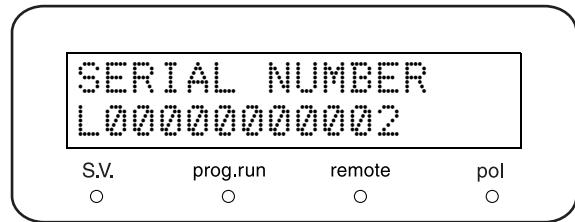
Refer to CBM-20A instruction manual for details of each parameter.

5. Application Operation

[SERIAL NUMBER]

Shows the serial No. of CBM which controls the instrument.

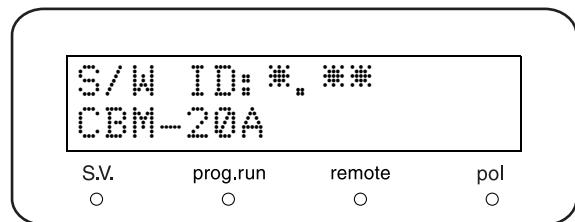
On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed. The serial number of the CBM-20A is shown on the bottom line.



[S/W ID]

Shows the name of software and version No. of CBM which controls the instrument.

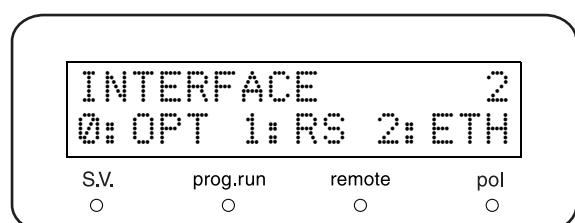
On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed. The program version number is shown on the top line, and the system controller name is shown on the bottom line.



[INTERFACE]

Sets the transmitting protocol from CBM which controls the instrument to data processing instrument.

- 1 On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed.
The currently set value is shown on the top line.
- 2 Select a set value by numeric keypad, and press **enter**.



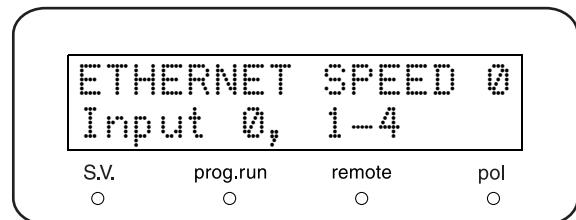
Set value	Transmitting protocol
0	To connect with optical cable
1	To connect with serial transmission (RS-232C)
2	To connect with ethernet

[ETHERNET SPEED]

Sets transmitting speed of CBM ethernet which controls the instrument.

- 1 On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed.
The currently set value is shown on the top line.
- 2 Select a set value by numeric keypad, and press **enter**.

Set value	Transmitting speed
0	Auto Detect
1	10Mbps, Half Duplex
2	10Mbps, Full Duplex
3	100Mbps, Half Duplex
4	100Mbps, Full Duplex

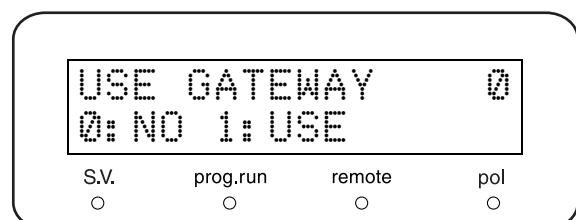


[USE GATEWAY]

Sets usage of default gateway of CBM which controls the instrument.

- 1 On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed.
The currently set value is shown on the top line.
- 2 Select a set value by numeric keypad, and press **enter**.

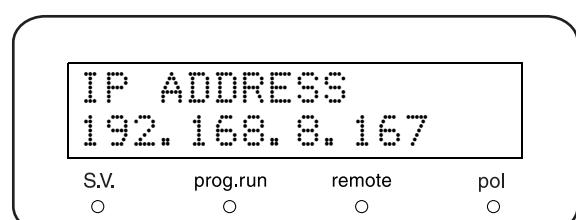
Set value	Default gateway
0	Not use
1	Use



[IP ADDRESS]

Sets the IP address of the CBM which controls the instrument.

- 1 On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed.
The current set value is shown on the bottom line.



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- 2** Select a set value by numeric keypad, and press **enter**.

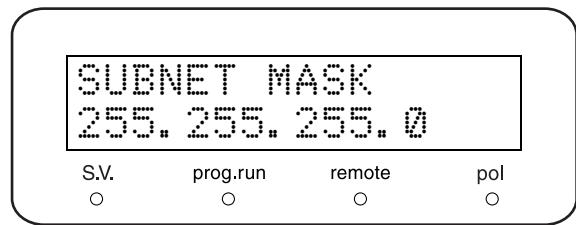
NOTE

Consult the network administrator for the value to be set.

[SUBNET MASK]

Sets subnet mask of CBM which controls the instrument.

- 1** On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed.
The current set value is shown on the bottom line.



- 2** Select a set value by numeric keypad, and press **enter**.

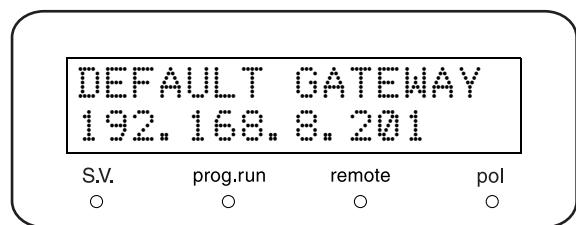
NOTE

Consult the network administrator for the value to be set.

[DEFAULT GATEWAY]

Sets default gateway of CBM which controls the instrument.

- 1** On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed.
The current set value is shown on the bottom line.
- 2** Select a desired set value by numeric keypad, and press **enter**.



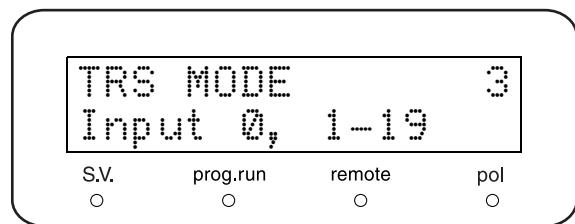
NOTE

Consult the network administrator for the value to be set.

[TRS MODE]

Selects the communication destination when CBM is connected to a LC workstation or a Chromatopac.

- 1** On the [CBM PARAMETER] screen, press **func** repeatedly until the screen on the right is displayed.
The currently set value is shown on the top line.
- 2** Select a set value by numeric keypad, and press **enter**.



Set value	Remark
0	No change in communication setting (default)
1	Not available (reserved)
2	To connect to CLASS-VP5/6/7
3	To connect to LCsolution
4 - 10	Not used (reserved)
11	To connect to C-R8A
12	To connect to C-R7A/C-R5A
13	To connect to C-R4A
14	To connect to C-R6A (without extended ROM board)
15	To connect to C-R6A (with extended ROM board)
16 - 19	Not used (reserved)

5.7 Control by CBM-20A/20Alite System Controller

5.7.1 Preparation

To control the instrument by the CBM-20A/20Alite system controller, set the parameters as follows:

Command	Set value	References
LOCAL	0 : Remote	 "[LOCAL]" P. 5-41
ADRS	Link address	 "[LINK ADRS]" P. 5-42
OP MODE	0 : 20A	 "[OP MODE]" P. 5-56

5.7.2 Basic Parameters

The following settings and operations can be performed from the CBM-20A/20Alite. For more details, see the CBM-20A instruction manual.

- Setting wavelength
- Switching between single and dual wavelength modes
- Turning lamp on/off
- Switching between different lamps (D2, W, D2 and W simultaneous lighting) (SPD-20AV only)
- Setting output range for integrator
- Setting response
- Setting parameters for solvent recycle valve
- Activating / deactivating cell temperature adjustment and setting temperature
- Creating a time program

5.8 Control by SCL-10Avp or SCL-10A System Controller

5.8.1 Preparation

To control the instrument by the SCL-10Avp or SCL-10A system controller, set the parameters as follows:

Command	Set value	References
LOCAL	0 : Remote	 "[LOCAL]" P. 5-41
ADRS	Link address	 "[LINK ADRS]" P. 5-42
OP MODE	1 : VP * ¹ 2 : 10A * ²	 "[OP MODE]" P. 5-56

*1 To connect to SCL-10Avp : the instrument is recognized as SPD-10Avp or SPD-10AVvp.

*2 To connect to SCL-10A : the instrument is recognized as SPD-10A or SPD-10AV.

5.8.2 Basic Parameters

The following settings and operations can be performed from the SCL-10Avp and SCL-10A. For more details, see the SCL-10Avp and SCL-10A instruction manuals.

- Setting wavelength
- Switching between single and dual wavelength modes
- Turning lamp on/off
- Switching between different lamps (D2 and W) (SPD-20AV only)
- Setting output range for integrator / recorder
- Setting response
- Setting polarity
- Setting spectrum measurement parameters and executing measurements
- Setting recorder mode
- Setting parameters for ratio chromatogram signal output
- Setting parameters for solvent recycle valve*¹
- Creating a time program

*¹ Can be set from the SCL-10Avp but not the SCL-10A

5.8.3 Attention

When the instrument is connected to a SCL-10Avp or SCL-10A, the instrument will work in compatibility mode for SPD-10Avp/SPD-10AVvp or SPD-10A/SPD-10AV. In this case, the following applies.

- The set wavelength range and spectrum measurement wavelength range of the SPD-20A becomes 190 to 600nm.
- It is not possible to turn on both the D2 lamp and W lamp of the SPD-20AV simultaneously (LAMP:3).

The wavelength range that can be set differs depending on which lamp is turned on. For details, see below.

 "[LAMBDA 1]" P. 5-33

 "[LAMBDA 2]" P. 5-33

 "5.3.2 Setting Parameters Necessary to the Spectrum Measurement" P. 5-19

- Response cannot be set to [0] (time constant equal to 0.02 seconds).
 "4.1.4 Setting [RESPONSE]" P. 4-9
- Set the flow cell temperature from the keypad on the SPD-20A/20AV, as it cannot be set from either the SCL-10Avp or SCL-10A.
 "[CELL TEMP]" P. 5-36
- Recorder mode cannot be set to [4] (output temperature of the temperature adjustment flow cell to the recorder).
 "[REC MODE]" P. 5-35
- Using [OP MODE=1/2], system controller displays SPD's ROM version and name as follows.

If SPD's ROM version is less than 3.00, system controller add 5.00 to SPD's ROM version automatically.

In case the SPD-20A/20AV of V1.02 connect to the SCL-10Avp with [OP MODE=1], the SCL-10Avp displays SPD-10Avp/10Avp of V6.02.

In case the SPD-20A/20AV of V1.02 connect to the SCL-10A with [OP MODE=2], the SCL-10A displays SPD-10A/10AV of V6.02.

Be careful that system check report of SCL-10Avp and PC workstation record real ROM version and name (i.e. V1.02 and SPD-20A/20AV).

5.9 Connection to External Input/Output Terminals

The external input/output terminals are connected to a event output device or another external device with a provided event cable.

Details of the terminal and wiring are described as follows.

⚠️ WARNING

- Before connecting the cable, turn off the power and unplug the instrument.
- Use only the specified cable.
- Connect as specified.

Otherwise, fire, electric shock or malfunction may occur.

5

5.9.1 External Input/Output Terminals

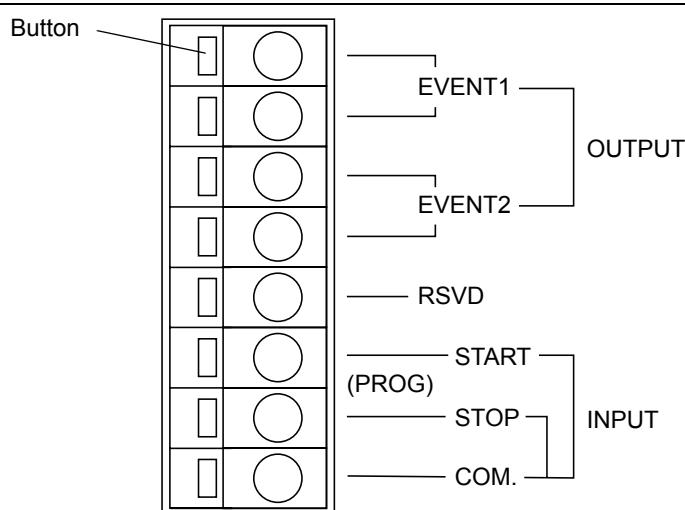


Fig. 5.8

Signals	Description	Remark
EVENT1	[Event1/2] output terminals. To connect to relay and be turned ON/OFF according to a time program or the [EVENT] value of auxiliary function.	Contact rating: 30VDC/1A
EVENT2	Not available. Do not connect anything to this terminal.	
RSVD		
PROG. START (Input)	Initiates a time program on this instrument by external contact signal. If a start signal is received while a time program is running, the program is initiated again starting at 0 minutes.	These signals are implemented by shorting the appropriate wire pair between the input command terminal and the common terminal.
PROG. STOP (Input)	Stops a time program on this instrument by external contact signal.	Duration of shorting (tc) should be as follows. 0.5 sec < tc < 10 sec.
COM.	The common input terminal.	

5. Application Operation

5.9.2 Connection of Event Cable

1 Peel the cable about 10mm.

It is not necessary for provided event cable.

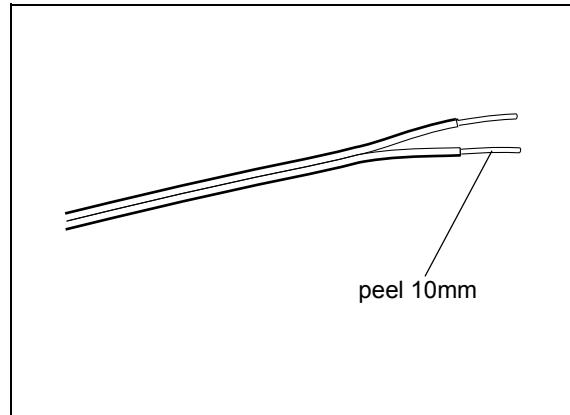


Fig. 5.9

2 Insert the cable.

When the cable has the single core wire, just insert the cable.

When the cable has the stranded wires, strand the wires enough and insert with pressing the button of the terminal.

When removing the cable, remove the cable by pressing the button of the terminal.

NOTE

The instrument provides one event cable. When more than 2 cables are required, use the following cables.

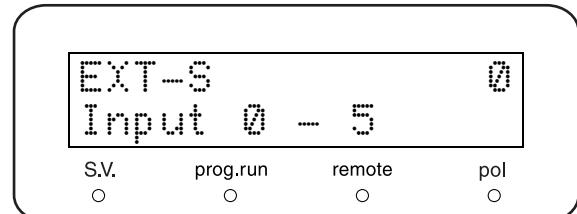
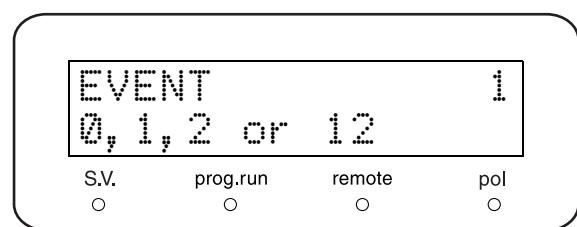
- Cable with single wire : ϕ 0.4 to ϕ 1.2 (AWG26 to 16)
- Cable with stranded wire : 0.3mm^2 to 1.25mm^2 (AWG22 to 16), diameter of single wire thicker than ϕ 0.18.

The cable with stranded wire is suitable to prevent disconnection.

NOTE

If [EVENT1] or [EVENT2] signal is used, set [EVENT] and [EXT-S] parameters.

- ☞ "[EVENT]" P. 5-37
☞ "[EXT-S]" P. 5-43



6

Troubleshooting

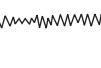
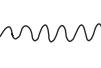
Contents

6.1	Troubleshooting and Corrective Action	6-2
6.2	Error Message.....	6-4

6.1 Troubleshooting and Corrective Action

This section describes the probable causes of problems that can arise, and the corrective action to be taken to eliminate the causes. For more detailed procedures, refer to the indicated page.
If the problem cannot be resolved even after taking the indicated measures, or if there are problems not included in the following tables, contact your Shimadzu representative.

Symptom	Probable Cause	Corrective Action	Page
Power does not turn ON even after switching ON power.	Power plug is disconnected.	• Connect plug correctly.	P.9-8
	Power cord internal wires are cut.	• Replace with a new cord of the same type.	P.1-3
	Power supply does not meet specifications for this instrument.	• Use power supply that meets specifications for this instrument.	P.9-6
	Fuse is blown.	• Replace the fuse.	P.8-19
[OVER] is displayed for absorbance value.	Recorder pen is far below the original baseline.	• Press zero .	P.4-7
Recorder baseline does not change.	[RANGE] set to 0.	• Set appropriate value for [RANGE].	P.4-4
	Lamp is not on.	• Set [LAMP] parameter to 1, 2 or 3 (SPD-20AV only) to turn on the lamp.	P.5-34
	Recorder pen is far below the original baseline. ([OVER] will be displayed for the absorbance value.)	• Press zero . The pen will return to the baseline.	P.4-7
	Fault in the circuits.	• Replace any faulty parts.	
Noise amplitude is 10 or more times higher in dual wavelength mode than in single wavelength mode.	Changes in mobile phase absorbance for small changes in wavelength are excessively large. The instrument detects wavelengths by means of scanning using a grating, which produces small fluctuations in measurement wavelength - so small as to be in the range of the instrument's wavelength reproducibility. This produces some noise. The greater the absorbance variation, the greater the noise.	• Change to a wavelength that produces the smallest possible absorbance change per unit of wavelength change.	
		• Set the response to a higher value.	

Symptom	Probable Cause	Corrective Action	Page
 Transient spiking  Sawtooth baseline  Continuous spiking	Bubbles flowing through the cell. (*1)	<ul style="list-style-type: none"> • Connect a back pressure device or 0.3mm I.D. × 2m tubing to apply back pressure to the cell outlet. 	
		<ul style="list-style-type: none"> • Degas the mobile phase. 	
 Spiking occurring at every stroke of the pump  No equilibration of baseline	Bubbles trapped in the cell. (*1)	<ul style="list-style-type: none"> • Connect a back pressure device or 0.3mm I.D. × 2m tubing to apply back pressure to the cell outlet. 	
		<ul style="list-style-type: none"> • Use 2-propanol (injected with provided syringe) to rinse the cell interior. 	P.8-5
 Drift  Excessive noise  Swell	<p>Cell lenses are dirty. (*1)</p> <p>If drift stops when pump is turned off or the air cell is used (*2), then there are impurities in the mobile phase.</p> <p>If excessive noise continues when the air cell is used (*2), then the lamp intensity has deteriorated.</p>	<ul style="list-style-type: none"> • Dismantle cell and clean lenses. If stains cannot be removed, install new lenses. • Inspect mobile phase and flow line, and eliminate impurities. • Replace the lamp with a new one. 	P.8-8 P.8-11
 Baseline wanders	The instrument is in the presence of a strong air current or changes in room temperature are excessive.	<ul style="list-style-type: none"> • Change the location of the instrument, or protect it from excessive changes. 	
 Noise occurs corresponding to the pump stroke	Mobile phase pulsation.	<ul style="list-style-type: none"> • Eliminate pump pulsation with a damper. 	

*1) For the procedure for checking for bubbles or stains in the flow cell:  "8.2 Flow Cell Inspection and Basic Cleaning" P. 8-4

*2) An air cell refers to a flow cell that has no cell lenses and no gaskets, and is dried thoroughly.

6.2 Error Message

The instrument has several diagnostic functions. Upon detection of a problem, an alarm sounds and an error message appears on the display panel.

The following list describes the error messages along with the causes and corrective actions.

NOTE

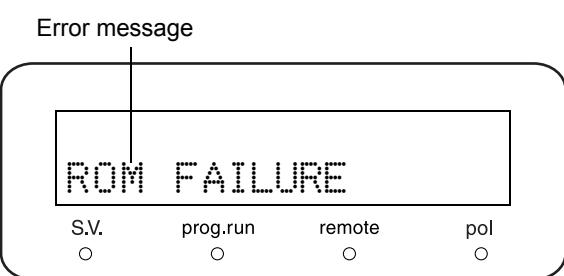
Each message is classified into the following three types.

The type is indicated under the type column.

Fatal: The instrument stops operation.
Pressing **CE** will not clear the error message.

Alarm: The instrument stops operation.
Press **CE** to clear the error message.

Warning: The instrument does not stop operation.
Press **CE** to clear the error message.



Error Message	Type	Cause and Action
ROM FAILURE (ROM error)	Fatal	Cause: ROM error (electronic failure) Action: Turn power OFF and contact your Shimadzu representative.
RAM FAILURE (RAM error)	Fatal	Cause: RAM error (electronic failure) Action: Turn power OFF and contact your Shimadzu representative.
ERR GR HOME POS (Grating home position error)	Fatal	
ERR FIL HOME POS (Filter home position error)	Fatal	Cause: Motor home position sensor does not operate properly. Action: Turn power OFF and contact your Shimadzu representative.
ERR LAMP HOME PO (Lamp home position error)	Fatal	
ERR EEPROM WRITE (EEPROM write error)	Fatal	Cause: A write error onto non-volatile memory (EEPROM) has occurred. Action: Turn power OFF and contact your Shimadzu representative.

Error Message	Type	Cause and Action
ERR OVER CURRENT (Lamp over current error)	Alarm	Cause: Abnormally high current flowing through lamp. Action: Replace the D2 lamp. If this error is displayed after replacing the lamp, turn the power switch off and contact your Shimadzu representative.
ERR D2 LAMP (Deuterium lamp error)	Alarm	Cause: Fault in deuterium lamp or in its circuits. Action: Replace the D2 lamp. If this error is displayed after replacing the lamp, turn the power switch off and contact your Shimadzu representative.
ERR OVER HEAT (Overheating)	Alarm	Cause: Instrument interior temperature has risen to an abnormal level. Action: Check to be sure that the rear fan can move, and that the exhaust vent and side air intake are not blocked. If this error is still displayed, turn the power switch off and contact your Shimadzu representative.
ERR LEAK DETECT (Leak detected)	Alarm	Cause: Leak detected. Action: Inspect and repair plumbing. Wipe away leakage.
NOT PROTECTED (Set value loss error)	Alarm	Cause: When power was turned ON, previous parameters and time programs were not saved. Action: Pressing CE while this message is displayed initializes parameters and time program. Make new settings and write new programs.

6. Troubleshooting

Error Message	Type	Cause and Action								
CHECK NO GOOD (Wavelength check failed)	Alarm	<p>Cause: Wavelength discrepancy exceeds 1nm.</p> <table border="1"> <thead> <tr> <th>Cause</th> <th>Action</th> </tr> </thead> <tbody> <tr> <td>1. Cell is not installed properly</td> <td> <ul style="list-style-type: none"> Install cell properly </td> </tr> <tr> <td>2. Error in wavelength calibration</td> <td> <ul style="list-style-type: none"> Run [WAVE CALIB.] (VP function) to calibrate wavelength, then run [WAVE CHECK] to check wavelength accuracy. ( P.5-38, P.8-21) </td> </tr> <tr> <td>3. Sample in cell is highly absorptive of UV and visible light, or large air bubbles in sample greatly restrict amount of light transmitted through cell at emission line wavelengths (656 & 254nm) of deuterium lamp.</td> <td> <ul style="list-style-type: none"> Flush the inside of the cell with a mobile phase solvent that does not absorb light in the vicinity of 254nm and 656nm. Purge cell interior with air or nitrogen. </td> </tr> </tbody> </table>	Cause	Action	1. Cell is not installed properly	<ul style="list-style-type: none"> Install cell properly 	2. Error in wavelength calibration	<ul style="list-style-type: none"> Run [WAVE CALIB.] (VP function) to calibrate wavelength, then run [WAVE CHECK] to check wavelength accuracy. ( P.5-38, P.8-21) 	3. Sample in cell is highly absorptive of UV and visible light, or large air bubbles in sample greatly restrict amount of light transmitted through cell at emission line wavelengths (656 & 254nm) of deuterium lamp.	<ul style="list-style-type: none"> Flush the inside of the cell with a mobile phase solvent that does not absorb light in the vicinity of 254nm and 656nm. Purge cell interior with air or nitrogen.
Cause	Action									
1. Cell is not installed properly	<ul style="list-style-type: none"> Install cell properly 									
2. Error in wavelength calibration	<ul style="list-style-type: none"> Run [WAVE CALIB.] (VP function) to calibrate wavelength, then run [WAVE CHECK] to check wavelength accuracy. ( P.5-38, P.8-21) 									
3. Sample in cell is highly absorptive of UV and visible light, or large air bubbles in sample greatly restrict amount of light transmitted through cell at emission line wavelengths (656 & 254nm) of deuterium lamp.	<ul style="list-style-type: none"> Flush the inside of the cell with a mobile phase solvent that does not absorb light in the vicinity of 254nm and 656nm. Purge cell interior with air or nitrogen. 									

Action: If [CHECK NO GOOD] appears again when [WAVE CHECK] is run after the above action has been taken, turn the power OFF and contact your Shimadzu representative.

Other Message	Type	Cause and Action
LAMP NOT LIT (Lamp not lit)	Warning	<p>Cause: zero or mark is pressed when the lamp is not on.</p> <p>Action: Set the [LAMP] parameter to [1], [2] or [3] (SPD-20AV only) to turn on the lamp. ( P.5-34)</p>
SELECT D2 SINGLE (Wavelength check error)	Warning	<p>Cause: The [WAVE CHECK] function can only be used in single wavelength mode, with the deuterium lamp on. This message is displayed if [WAVE CHECK] is run under any other conditions. ( P.5-38)</p> <p>Action: Switch to single mode, and switch light the deuterium lamp.</p>

Other Message	Type	Cause and Action								
SET ANOTHER λ (Wavelength setting error in dual wavelength mode)	Warning	<p>Cause: Wavelength(s) outside the ranges given below was set in dual wavelength mode.</p> <table style="margin-left: 20px;"> <tr><td>(SPD-20A)</td><td>(SPD-20AV)</td></tr> <tr><td>190 - 370nm</td><td>190 - 370nm</td></tr> <tr><td>371 - 700nm</td><td>371 - 700nm</td></tr> <tr><td></td><td>701 - 900nm</td></tr> </table> <p>Action: Set wavelength(s) inside the applicable ranges.</p>	(SPD-20A)	(SPD-20AV)	190 - 370nm	190 - 370nm	371 - 700nm	371 - 700nm		701 - 900nm
(SPD-20A)	(SPD-20AV)									
190 - 370nm	190 - 370nm									
371 - 700nm	371 - 700nm									
	701 - 900nm									
KEY CLOSED (Keypad disabled)	Warning	<p>Cause: Keys were pressed after keypad was disabled using the [KEY CLOSE] auxiliary function.</p> <p>Action: Press and hold down del and press CE. The keypad will be reenabled.</p>								
DATA NOT EXIST (Empty file)	Warning	<p>Cause: Spectrum data was requested for output from a file which does not contain scanned data.</p> <p>Action: Check the file number set when scanning was executed, and use that file.</p>								
LOW SET TEMP (Temperature control error in the temperature controlled flow cell)	Warning	<p>Cause: This warning is displayed when the flow cell temperature fails to coincide with temperature settings after undergoing 5 minutes or more of temperature adjustment control. This is caused by setting the flow cell temperature at a value too close to room temperature, or setting the column oven at a higher temperature than the flow cell.</p> <p>Action: Set the temperature setting to a value at least 5°C above room temperature. If the warning is still displayed, set the flow cell temperature to a value near or above the column oven temperature. If the temperature setting satisfies the above requirements and the warning is still displayed, turn the power switch off and contact your Shimadzu representative.</p>								
NO D2 LAMP (D2 lamp disconnected)	Warning	<p>Cause: This warning is displayed when the D2 lamp is turned on and the lamp is not recognized.</p> <p>Action: Check to be sure the D2 lamp is connected and replace it if necessary. If the lamp has been replaced and this warning is still displayed, turn the power switch off and contact your Shimadzu representative.</p>								

6. Troubleshooting

Other Message	Type	Cause and Action
NO W LAMP (W lamp disconnected)	Warning	<p>Cause: This warning is displayed when the W lamp is turned on and the lamp is not recognized.</p> <p>Action: Check to be sure the W lamp is connected and replace it if necessary. If the lamp has been replaced and this warning is still displayed, turn the power switch off and contact your Shimadzu representative.</p>

7

Hardware Validation

This chapter provides instruction on hardware validation, which verifies the performance of individual components and the instrument as a whole.

Contents

7.1	Overview of Hardware Validation	7-2
7.2	Implementation of Hardware Validation	7-3
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7.5	Validation: Detector	7-7
7.6	System Validation.....	7-34
7.7	If Validation Fails	7-42
7.8	Reference Materials	7-43

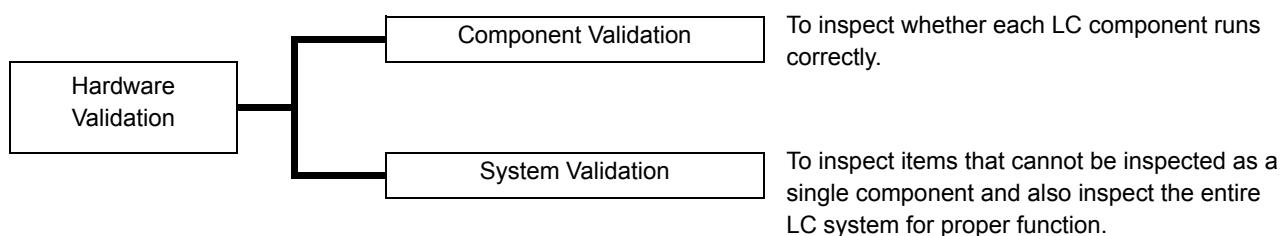
7.1 Overview of Hardware Validation

7.1.1 Hardware Validation

Hardware validation examines whether the LC system runs correctly and the instrument is suitable for the intended analysis. Validation is performed through LC system Installation, Operation and Performance Qualifications followed by periodic inspections. The performance of the LC system deteriorates with age, reflecting the wear of consumable parts. Hardware validation must therefore be performed periodically from the time of installation until the system is retired. Although validation aspects related to analysis, such as method validation and system suitability tests should also be performed, hardware validation is a prerequisite for these items.

7.1.2 Types of Hardware Validation

A High Performance Liquid Chromatograph consists of several LC components such as pump(s), autosampler, column oven, and detector(s). For this reason, hardware validation is divided into the inspection of individual components and system validation as a whole.



The operational protocol and criteria for this component and the HPLC system are described in this chapter to assist the user in conducting validation. Refer to each the instruction manual for each component for operational protocol of that specific component.

7.2 Implementation of Hardware Validation

7.2.1 Periodic Validation

Component and system validation must be performed at installation and every 6-12 months, as the performance of an LC instrument changes with age. It is also important to perform maintenance such as replacement of consumables in advance of hardware validation.

7.2.2 Daily Inspection

Daily inspection of the components and HPLC system examine the condition of maintenance parts to ensure a high level of analysis data reliability.

Items such as column deterioration and mobile phase adjustment are examined during system suitability tests.

7.2.3 Validation at Maintenance

After any maintenance, component performance must be re-validated. The type of validation depends on the actual work done.

If the maintenance inspection cannot be performed solely by the specific component validation, system validation is required.

NOTE

Maintenance information and results of hardware validation must be recorded and kept for future reference.

7.3 Precautions for Validation

7.3.1 Environment

Instrument performance may be affected by abrupt changes in ambient temperature such as drafts from heating and air conditioning vents.

The equipment should be installed in a room with minimal (< 2°C) temperature fluctuation and away from sources of drafts and air currents.

7.3.2 Installation Site

The installation site is very important for ensuring correct validation. The site should satisfy the following conditions:

WARNING

- Provide ample ventilation with no fire sources in vicinity
When flammable or toxic solvents are used as the mobile phase, the room must be properly ventilated.
When flammable solvents are used, open flame or other fire sources must be strictly prohibited.

CAUTION

- Avoid dust or corrosive gas
Avoid installing the instrument in places subject to excessive dust or corrosive gas since service life and performance levels may be affected.
- Keep away from strong magnetic fields
Do not install the instrument near equipment that generates strong magnetic fields. If the power supply line is subject to high electrical noise, use a commercially-available power surge protector.
- Provide adequate installation surface and space
The weight of SPD-20A/20AV is 13kg. During installation, consider the entire weight combined with other LC components.
The lab table on which this instrument is installed should be strong enough to support the total weight of the LC system. It should be level, stable and have depth of at least 600mm.
If these precautions are not followed, the instrument could tip over or fall off the table.
When components are installed side by side, maintain a keep space of at least 30 mm between the components.
- Regulate room temperature and humidity
The room temperature should be between 4 and 35°C, with minimal temperature variations throughout the course of a day. Humidity should be kept within 20-85%.
- Position instrument properly in the room
Install the instrument in a location that is free from vibration and away from sunlight, and heat/air conditioning drafts.

7.4 Equipment Required for Validation

The equipment and samples listed below are required for hardware validation. Prepare necessary equipment and samples depending on the system configuration of the instrument.

■ Testing Equipment

A list of testing equipment required for hardware validation is shown below. A certificate ensuring traceability or inspection results should accompany each item of testing equipment that is used.

Equipment	Description
Thermo recorder	For inspection of the temperature setting accuracy for the column oven and the autosampler's sample cooler. The thermo recorder must be certified as having an accuracy rating of $\pm 1.0^{\circ}\text{C}$ for the required temperature range (0°C to 50°C) at the time of inspection.
Resistance thermometer	For inspection of the temperature accuracy for the column oven. The resistance thermometer must have a testing accuracy of $\pm 0.5^{\circ}\text{C}$ for the required temperature range (0°C to 50°C) at the time of inspection.
Thermocouple	For inspection of the temperature accuracy for the column oven and autosampler's sample cooler. The thermocouple must have a testing accuracy of $\pm 0.6^{\circ}\text{C}$ for the required temperature range (0°C to 50°C) at the time of inspection.
DC voltage/current generator	For the hardware validation of the chromatopac. The DC voltage/current generator must be certified as having an accuracy rating of $\pm 0.15\%$ at the time of testing.
Stopwatch	For inspection of the flow rate accuracy for the solvent delivery module. The stopwatch must be certified at $5'30'' \pm 0.3\text{sec}$ at the time of inspection.
Measuring flask	For inspection of the flow rate accuracy for the solvent delivery module. Obtain a 5mL-measuring flask.
Electronic balance	For inspection of the injection volume accuracy for the autosampler. The balance must be calibrated and able to perform measurement with a 0.001g precision at the time of inspection.

7. Hardware Validation

■ Standard Reagents for Validation

A list of standard reagents required for validation is shown below. The customer should prepare standard reagents to the stated specifications.

Standard sample	Part No.	Description
Caffeine set (5 concentrations)	228-45725-91	For inspection of the absorbance linearity for the UV-VIS spectrophotometric and photodiode array detectors. For also inspection of system reproducibility for a system equipped with a UV-VIS spectrophotometric or photodiode array detector.
Caffeine (250mg/L)	228-45725-06	For inspection of system reproducibility for a system equipped with a refractive index detector, inspection of autosampler carry-over, and inspection of the gradient concentration accuracy for gradient systems.
Naphthalene (60mg/L)	228-32996-01	For inspection of system reproducibility for a system equipped with a spectrofluorometric detector.
Glycerol (0.872mg/L)	228-32996-05	For inspection of the span for the refractive index detector.

■ Hardware Testing Supplies

A list of supplies required for hardware validation is shown below. Note that items such as autosampler vials or mobile phase solutions may be required in addition to the items listed.

Implement	Part No.	Description
Resistor tube	228-45726-91	I.D. 0.13mm × 2m + I.D. 0.8mm × 2m For inspection of flow rate and gradient concentration accuracy for solvent delivery module, etc.
Syringe	046-00001 or 046-00038-01	For inspection of the absorbance linearity for the UV-VIS spectrophotometric and photodiode array detectors. For also inspection of the span for the refractive index detector. This item is provided with detectors as a standard accessory.
Syringe adapter	228-15672-91	Same as above.
Coupling 1.6C	228-16004-13	For each kind of inspection and in plumbing the detector. This item is provided with each component as a standard accessory.
Male nut, PEEK	228-18565	Same as above.
Plug	228-16006	For inspection of the drift/noise for the refractive index detector.
Low-pressure Hg (Mercury) lamp set	200-38423	For inspection of the wavelength accuracy for the UV-VIS photodiode array detector and the spectrofluorometric detector.
Hg (Mercury) lamp holder	228-34170-91	For inspection of the wavelength accuracy for the UV-VIS photodiode array detector.
	228-34478-91	For inspection of the wavelength accuracy for the spectrofluorometric detector.
PTFE block assembly	228-34319-91	For inspection of the wavelength accuracy for the spectrofluorometric detector.
Column Shim-pack VP-ODS or LUNA C18(2)	228-34937-91 or 00F-4252-E0	Particle size: 5µm Column Dimension: I.D. 4.6mm × length 150mm (An equivalent ODS column may also be used.) For the system validation.

7.5 Validation: Detector

7.5.1 Check Terms

Check terms for the detector validation are listed below.

	Check Term	Description
7.5.2	Initialization Check and ROM / RAM Self Diagnostics	Checks to make sure that the display, LED(s), and driven parts are working properly, and that the low pressure mercury lamp and deuterium lamp emission lines used for the wavelength accuracy check are operating normally. Also runs a self-diagnostic on the system memory (ROM / RAM).
7.5.3	Firmware Version Check	Checks the version of firmware.
7.5.4	Light Source Usage Time Check	Checks the amount of time the light source has been used.
7.5.5	Wavelength Accuracy Check	Checks the wavelength accuracy using the mercury lamp and deuterium lamp emission lines.
7.5.6	Light Intensity Check	Checks the intensity of the light source in use.
7.5.7	Linearity Check	The linearity check flushes the flow cell with a caffeine solution, measures the absorbance at different caffeine concentrations, and checks that linearity is evident in the caffeine absorbance value versus concentration.
7.5.8	Displayed Absorbance Value vs. Output Voltage Check	Checks that the displayed absorbance equals to the output signal to the data processor.
7.5.9	Drift/Noise Check	Checks that drift and noise values satisfy criteria.
7.5.10	Leak Sensor Test	Checks the operation of leak sensor.

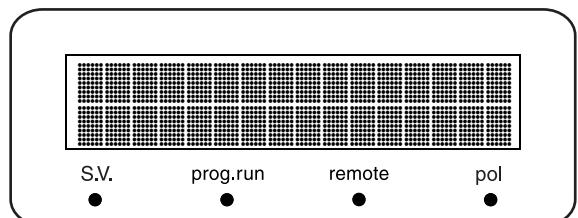
7.5.2 Initialization Check and ROM / RAM Self Diagnostics

■ Objective

Checks to make sure that the display, LED(s), and driven parts are working properly, and that the low pressure mercury lamp and deuterium lamp emission lines used for the wavelength accuracy check are operating normally. Also runs a self-diagnostic on the system memory (ROM / RAM).

■ Check Procedure

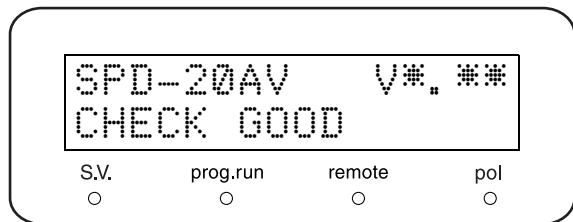
- 1 Turn the power switch ON.
- 2 Immediately after the power is turned on, check to be sure that all pixels on the screen and all key panel LEDs are turned on.



7. Hardware Validation

- 3** Wait for the initialization check to finish and for the results to be displayed.

 "3.2 Turning Power ON/OFF" P. 3-3



CHECK CRITERIA : [CHECK GOOD] is displayed on the screen.

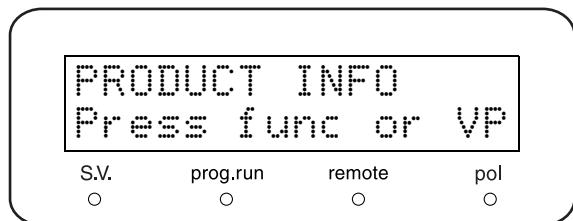
7.5.3 Firmware Version Check

■ Objective

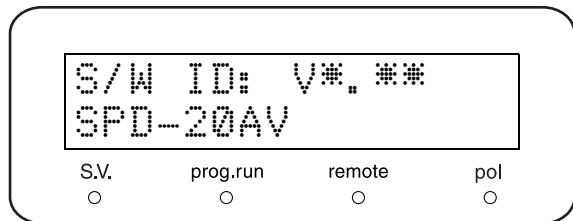
Checks the version of firmware.

■ Check Procedure

- 1** Press **VP** twice on the initial screen.
[PRODUCT INFO] appears.



- 2** Press **func** twice to display the version number.
 "[S/W ID]" P. 5-48



**CHECK CRITERIA : Version number appears.
The number is same as the administrated one.**

7.5.4 Light Source Usage Time Check

■ Objective

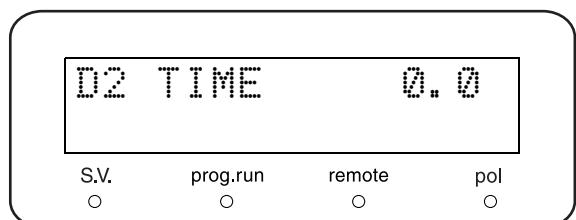
Checks the amount of time the light source has been used.

■ Check Procedure

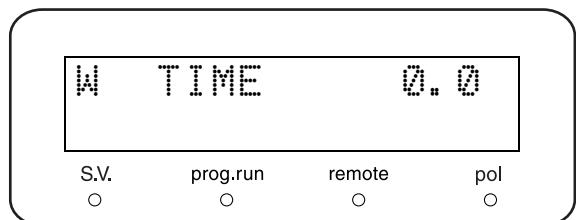
1 Press **func** four times.
[MONITOR] appears.

2 Press **enter**.

3 Press **func**.
[D2 TIME] appears. (Units: hour)



4 When the instrument is equipped with a W (tungsten) lamp (in the case of an SPD-20AV), press **func** again. [W TIME] (Displays usage time for the tungsten lamp) is displayed. (Units: hour)



CHECK CRITERIA:

D2 (deuterium) lamp maximum usage time : within 2,000 hours
W (tungsten) lamp maximum usage time : within 2,000 hours

7. Hardware Validation

7.5.5 Wavelength Accuracy Check

■ Objective

Verifies that the difference between set and actual wavelength is within specifications.

This check consists of running the detector's own automatic [WAVE CHECK] function, which performs analysis with the 254nm emission line of the mercury lamp and 656nm emission line of the deuterium lamp, and checks that the readings are within 254nm $\pm 1\text{nm}$ and 656nm $\pm 1\text{nm}$ respectively.

 "[WAVE CHECK]" P. 5-38

To perform this check manually:  "7.8.3 Manual Wavelength Accuracy Check" P. 7-45

■ Items Required for Check

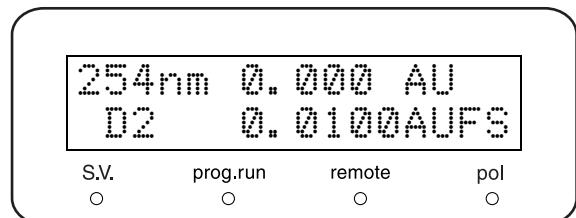
Solvent or nitrogen gas to dry the flow cell	Solvent: distilled water, methanol, or acetonitrile. * Solvent/nitrogen not required if cell is filled with air.
--	---

■ Preparation

- Either flush the flow cell with distilled water, methanol, or acetonitrile, or purge it with air or nitrogen and dry it thoroughly.
- Run the check with the flow cell installed in the detector.

■ Check Procedure

- 1 Turn the power switch ON.
The initial screen is displayed.

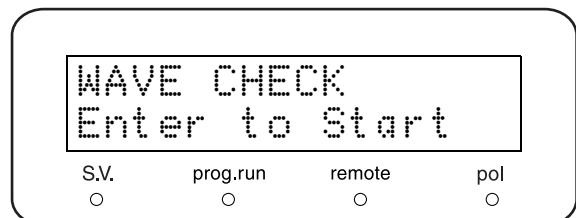


- 2 If the instrument is in dual wavelength mode,
switch to single wavelength mode.
 "5.2.1 Selecting a Measurement Mode" P. 5-11

- 3 Press **func** twice.
[CONTROL] appears.

- 4 Press **enter**.
[WAVE CHECK] (wavelength accuracy check)
appears.

- 5 Press **enter**.
The wavelength accuracy is checked
automatically.



- 6** When the wavelength accuracy is checked, the screen on the right appears.

WAVE CHECK
CHECK GOOD

The screens on the right show that the wavelength accuracy at the 656nm emission line of the D2 lamp is 0.03nm, and wavelength accuracy at the 254nm emission line of the Hg lamp is 0.23nm.

WAVE CHECK
Dif 656: 0.03nm

WAVE CHECK
Dif 254: 0.23nm

CHECK CRITERIA: 254nm wavelength accuracy: within $\pm 1\text{nm}$
656nm wavelength accuracy: within $\pm 1\text{nm}$

■ About Wavelength Accuracy Measuring Method

The SPD-20A/20AV performs wavelength calibration using a zero-order light peak (0nm) and the emission line (656.1nm) of the deuterium lamp (D2 lamp). The instrument ensures wavelength accuracy by making adjustments based on these reference wavelengths.

 "7.8.1 Auto Wavelength Calibration Function: Reference Data" P. 7-43

7. Hardware Validation

7.5.6 Lamp Intensity Check

■ Objective

Checks whether the lamp's intensity is sufficient.

■ Check Procedure

Perform this check after doing "7.5.5 Wavelength Accuracy Check" P. 7-10.
Leave the flow cell mounted.

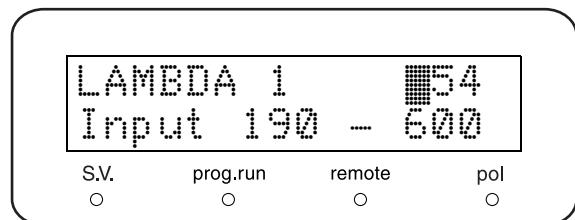
For the SPD-20A

1 Press **func**.

[PARAMETER] appears.

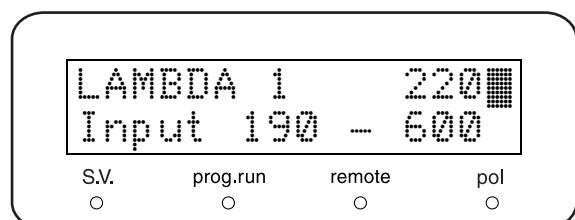
2 Press **enter**.

[LAMBDA 1] (ch1 wavelength setting) appears.



3 Press **2**, **2**, **0** and **enter**.

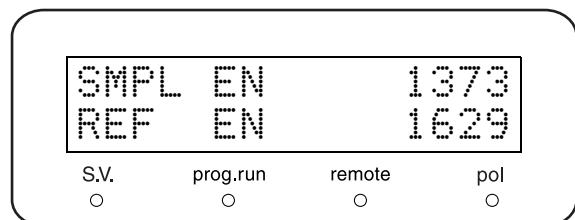
This sets a wavelength of 220nm.



4 Press **CE**.

[PARAMETER] appears.

5 Press **func** repeatedly until [MONITOR] is displayed.



6 Press **enter**.

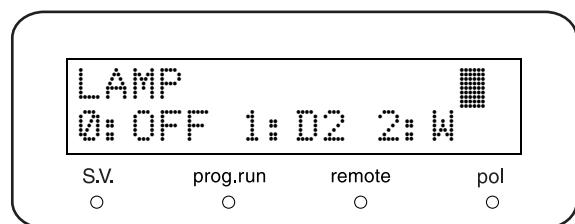
[SMPL EN / REF EN] (cell sample / reference side output level) appears.

Record the reference intensity value displayed (i.e. the [REF EN] value on the bottom line).

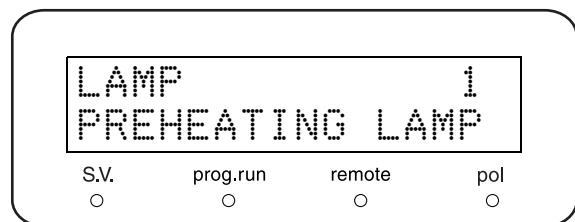
CHECK CRITERIA : Reference intensity at 220nm ≥ 400

For the SPD-20AV

- 1** Press **func**.
[PARAMETER] appears.
- 2** Press **enter**.
The wavelength setting screen appears.
- 3** Press **func** repeatedly until [LAMP] (lamp ON/OFF setting) is displayed.



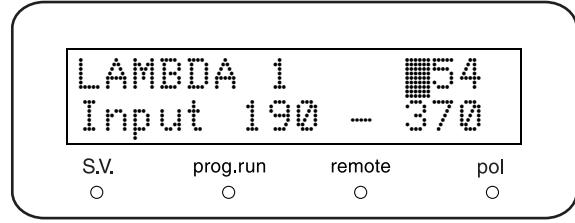
- 4** Press **1**, then **enter**.
This turns on the D2 (deuterium) lamp.



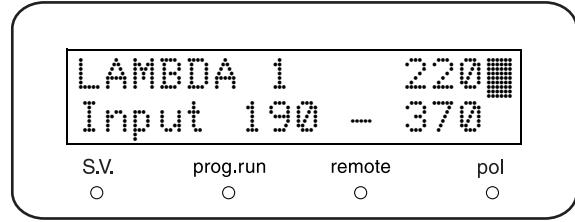
- 5** Press **back** repeatedly until [LAMBDA 1] (ch1 wavelength setting) is displayed.



- 6** Press **2**, **2**, **0** and **enter**.
This sets a wavelength of 220nm.



- 7** Press **CE**.
[PARAMETER] appears.
- 8** Press **func** repeatedly until [MONITOR] is displayed.



7. Hardware Validation

9 Press **enter**.

[SMPL EN / REF EN] (cell sample / reference side output level) appears.

Record the reference intensity value displayed (i.e. the [REF EN] value on the bottom line).

SMPL EN 1373
REF EN 1629

S.V. prog.run remote pol

10 Press **CE**.

[MONITOR] appears.

11 Press **func**.

[PARAMETER] appears.

12 Press **enter**.

The wavelength setting screen appears.

LAMBDA 1 220
Input 190 - 370

S.V. prog.run remote pol

13 Press **func** repeatedly until [LAMP] (lamp ON/OFF setting) is displayed.

LAMP
0: OFF 1: D2 2: W

S.V. prog.run remote pol

14 Press **2**, then **enter**.

This turns on the W (tungsten) lamp.

LAMP 2
PREHEATING LAMP

S.V. prog.run remote pol

LAMP 2
0: OFF 1: D2 2: W

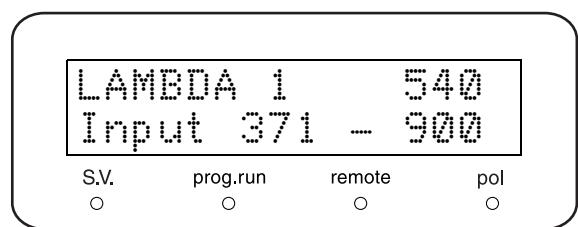
S.V. prog.run remote pol

15 Press **back** repeatedly until [LAMBDA 1] (ch1 wavelength setting) is displayed.

LAMBDA 1 500
Input 371 - 900

S.V. prog.run remote pol

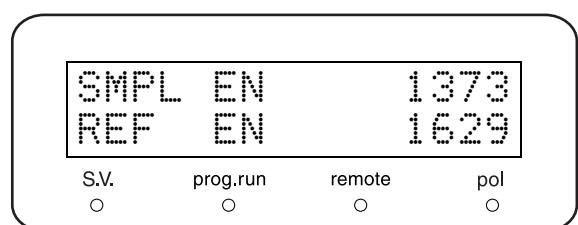
- 16** Press **5**, **4**, **0** and **enter**.
This sets a wavelength of 540nm.



- 17** Press **CE**.
[PARAMETER] appears.

- 18** Press **func** repeatedly until [MONITOR] is displayed.

- 19** Press **enter**.
[SMPL EN / REF EN] (cell sample / reference side output level) appears.
Record the reference intensity value displayed (i.e. the [REF EN] value on the bottom line).



**CHECK CRITERIA : Reference intensity at 220nm ≥ 400
Reference intensity at 540nm ≥ 500**

7

■ Setting Acceptance Criteria (Management Criteria) for Periodic Validation

- As the deuterium and tungsten lamps age, their intensity fades and baseline noise gradually increases.
- The deuterium lamp can be used beyond its specified 2000 hour life-span, provided that during an actual analysis, the S/N ratio of the peaks of interest is sufficiently large.

The acceptance criterion for intensity of the deuterium lamp should be set in accordance with the required analysis sensitivity. Specifically, if high sensitivity is not required, a relatively low intensity value will be acceptable and the lamp can continue to be used beyond 2000 hours.

However, the lower the lamp intensity becomes, the more noise increases. When noise levels are high, the lamp will not be useful for small peaks. The acceptance criterion set for the lamp intensity should take this fact into account.

- The tungsten lamp cannot be used beyond 2000 hour that is its average life-span (its operation becomes unstable). It must be replaced as soon as it has been used for 2000 hours.

7. Hardware Validation

7.5.7 Linearity Check

■ Objective

Flushes the flow cell with a caffeine solution, measures the absorbance at different caffeine concentrations, and checks that linearity is evident in the caffeine absorbance value versus concentration.

■ Items Required for Check

Caffeine set (5 concentrations)	Part No: 228-45725-91 Caffeine solution
Syringe	Standard accessory for the caffeine set (5 concentrations) and the instrument
Syringe adapter	Standard accessory
Water	For cleaning, HPLC grade or equivalent
Methanol	For cleaning, HPLC grade or equivalent

■ Preparations

Turn off flow cell temperature control and wait for the flow cell temperature to return to room temperature.

- Turn off flow cell temperature control

 "[CELL TEMP]" P. 5-36

- Check the flow cell temperature

 "[CELL TEMP]" P. 5-44

■ Check Procedure

- 1 Flush the flow path of the flow cell with methanol using a syringe and the syringe adapter.

 "8.2 Flow Cell Inspection and Basic Cleaning" P. 8-4

NOTE

Accurate measurements cannot be taken when the flow cell is dirty. Flush with 2-propanol as necessary.

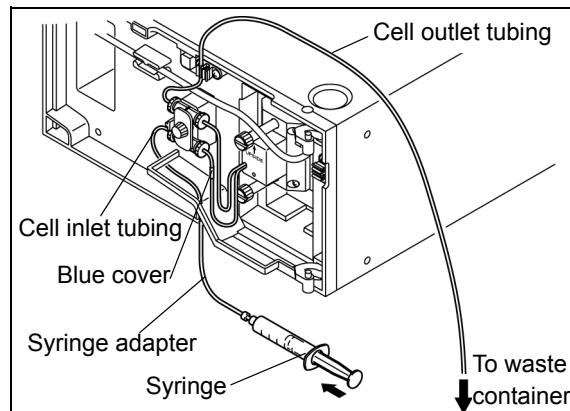
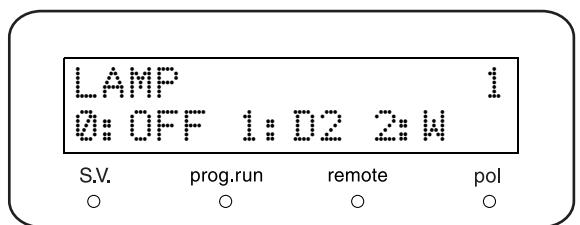


Fig. 7.1

- 2 On the initial screen, press **func**. [PARAMETER] appears.

- 3 Press **enter**. [LAMBDA 1] (ch1 wavelength setting) appears.

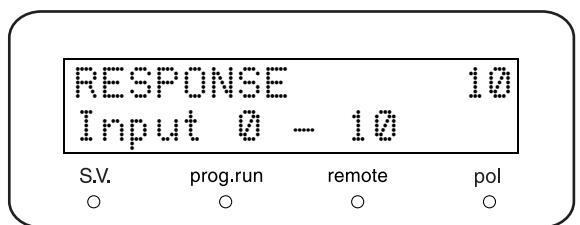
4 Press **func** repeatedly until [LAMP] (lamp ON/OFF setting) is displayed.



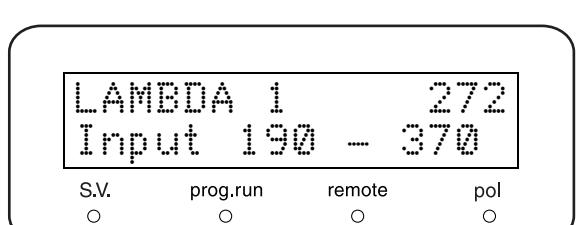
5 Press **1**, then **enter**.
This turns on the D2 (deuterium) lamp.

"[LAMP]" P. 5-34

6 Press **back**.
[RESPONSE] (response setting) appears.



7 Press **1**, **0** and **enter**.
(equivalent to the response of 2 seconds)

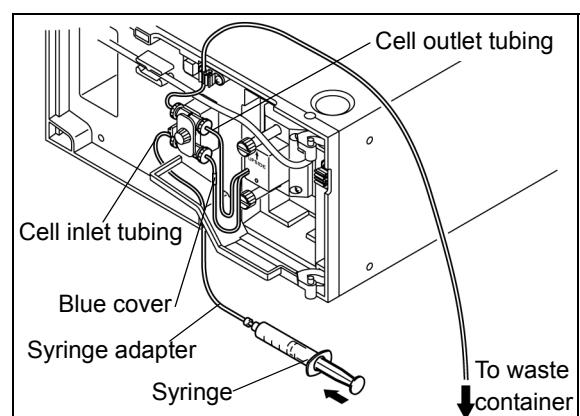


8 Press **back**.
[LAMBDA 1] (ch1 wavelength setting) appears.

9 Press **2**, **7**, **2** and **enter**.
This sets a wavelength of 272nm.

10 Flush the flow cell with water using a syringe and the syringe adaptor. Wait about 30 seconds before removing the syringe to confirm that the absorbance value displayed on the screen has stabilized.

11 Press **zero**.
Make sure [0.000] is displayed on the screen.



12 Flush the syringe with about 2mL of caffeine solution (10mg/L). After flushing, dispose of the fluid in the syringe.

13 Using the syringe, fill the flow cell with about 2mL of caffeine solution (10mg/L).

NOTE

Take care not to let air bubbles in.

14 Wait about 30 seconds before removing the syringe to confirm that the absorbance value displayed on the screen has stabilized.

15 Record the absorbance value displayed on the screen.

7. Hardware Validation

- 16** Perform the same procedure of flush the syringe and filling the flow cell for the remaining four caffeine solutions (15mg/L, 20mg/L, 25mg/L, and 30mg/L), and record the absorbance values displayed on the screen for each.
- 17** Calculate the absorbance deviations for each concentrations.

For (1) through (5) in the table below, fill in the sample concentration values.

For (A) through (E) in the table below, fill in the measured absorbance for each solution.

Calculate and record the relative sensitivity for each concentration, ① through ⑤, according to the formula given in the table below.

Calculate and record the standard relative sensitivity with the following formula.

$$\text{Standard relative sensitivity} = (\textcircled{1} + \textcircled{2} + \textcircled{3}) / 3$$

Calculate and record the deviation of each concentration with the following formula.

$$\text{Deviation [\%]} = (\text{relative sensitivity} - \text{standard relative sensitivity}) / \text{standard relative sensitivity} \times 100[\%]$$

Part name	Sample concentration [mg/L]	Absorbance [AU]	Relative sensitivity [AU/(mg/L)]	Deviation [%]
Caffeine solution (10 mg/L)	(1)	(A)	$\textcircled{1} = (A) / (1)$	
Caffeine solution (15 mg/L)	(2)	(B)	$\textcircled{2} = (B) / (2)$	
Caffeine solution (20 mg/L)	(3)	(C)	$\textcircled{3} = (C) / (3)$	
Caffeine solution (25 mg/L)	(4)	(D)	$\textcircled{4} = (D) / (4)$	
Caffeine solution (30 mg/L)	(5)	(E)	$\textcircled{5} = (E) / (5)$	

CHECK CRITERIA: Deviation of no more than $\pm 5.0\%$ for each concentrations

7.5.8 Displayed Absorbance Value Vs. Output Voltage Check

■ Objective

Checks that the correct relationship is obtained between the absorbance values displayed by the detector and the signal voltage from the output terminals.

■ Items Required for Check

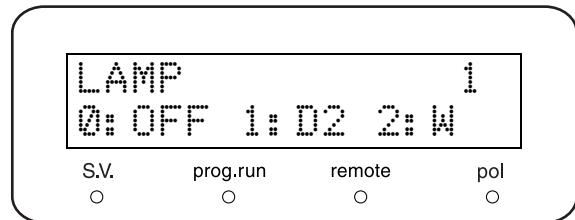
Caffeine solution (10mg/L)	Part No. 228-45725-92, included in the caffeine set (5 concentrations), part No. 228-45725-91
Water	HPLC grade or equivalent
Syringe	Standard accessory for the instrument and the caffeine solution
Methanol	For cleaning, HPLC grade or equivalent

■ Preparation

Clean the flow cell with methanol.

■ Check Procedure

- 1** Make sure the detector is connected to the data processor using the specified signal cable.
- 2** Press **func**. [PARAMETER] appears.
- 3** Press **enter**. The wavelength setting screen appears.
- 4** Press **func** repeatedly until [LAMP] (lamp ON/OFF setting) is displayed.
- 5** Press **1**, then **enter**. This turns on the D2 (deuterium) lamp.



- 6** Press **func**. [AUX RANGE] (setting the output level to the integrator) appears.
- 7** Press **2**, then **enter**. The output level to the integrator is set to 1 AU/V.

- 8** Change settings so that the data processor range is around 1.00 AUFS.

Setting the chromatopac [ATTEN] parameter to 10 will set the range to 1.024 AUFS.

For an LCsolution, adjust the display range with the \oplus/\ominus on the chromatogram view strength axis.

For CLASS-VP6, open the [Trace setup] tab under [Data graph properties] and set [Scale To] to [Normalized].

7. Hardware Validation

- 9 Inject water into the flow cell using the syringe.

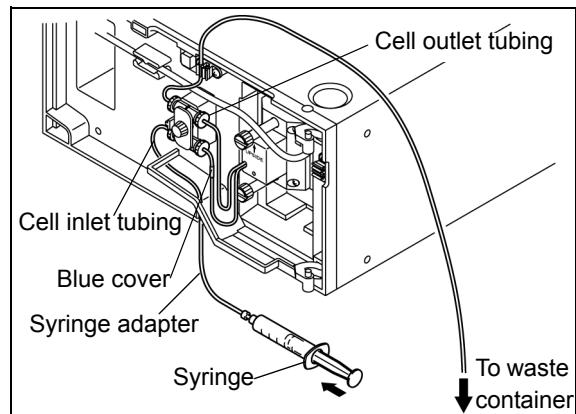


Fig. 7.3

- 10 Press **back** or **func** repeatedly until [LAMBDA 1] (ch1 wavelength setting) is displayed.

254nm 0.000 AU
D2 0.0100AUFS
S.V. prog.run remote pol

- 11 Set the wavelength to 272nm and press **CE** twice to return to the initial screen. Then press **zero**.
The absorbance on the screen is set to zero.

272nm 0.000 AU
D2 0.0100AUFS
S.V. prog.run remote pol

- 12 Using the syringe, inject the caffeine solution (10mg/L) into the flow cell. Do not let any air bubbles enter the flow cell.

- 13 Take the output signal readings indicated by the data processor, convert them into AU units, and record these AU values.

For a Chromatopac: divide the level values by 1,000,000 to convert them into AU.

For LC workstation: Use the mouse to read the absorbance value.

- 14 Finally, read the absorbance value displayed by the detector, and calculate the ratio of the displayed value to the actual output signal value.

CHECK CRITERIA:

For digital signals: Displayed absorbance value / output signal value = 1.00±0.01

For analog signals: Displayed absorbance value / output signal value = 1.00±0.02

7.5.9 Drift / Noise Check

■ Objective

It checks that drift and noise do not exceed the specified tolerance levels.

■ Items Required for Check

Data processor	
Calipers or measuring ruler	Not required when the CLASS-VP or LCsolution is used as a data processor.
Resistor tube	O.D. 1.6mm × I.D. 0.1mm × 2m
Methanol	HPLC grade or equivalent

■ Connecting the Testing Parts

- 1 Remove the column, and attach resistance tubing (I.D. 0.1 mm × length 2 m, part No. 228-32722-91).
- 2 Pump methanol through the system at a rate of 1mL/min.

NOTE

Check that the cell window is clean before plumbing. Accurate measurements cannot be taken when the cell window is dirty. Clean the window of a dirty cell in 2-propanol ultrasonic bath, or replace it with a new window.

 "8.3 Flow Cell Disassembly/Cleaning and Replacement" P. 8-8

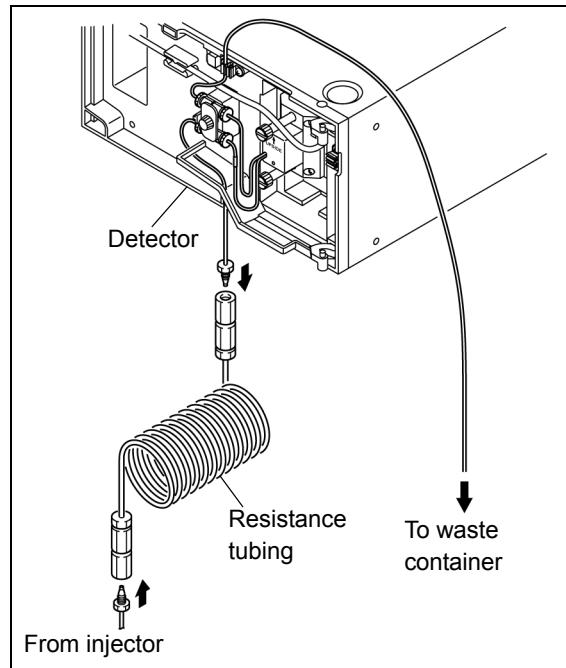


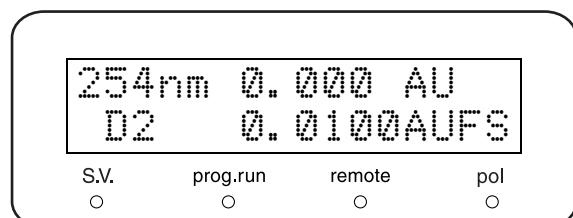
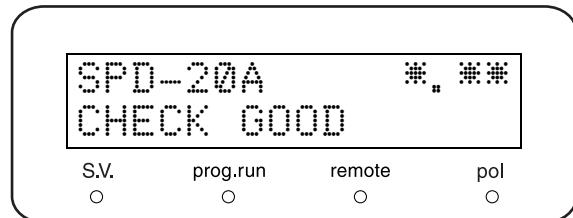
Fig. 7.4

7. Hardware Validation

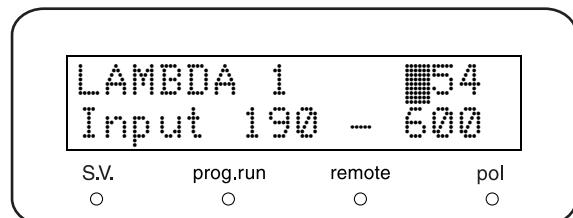
■ Check Procedure

To check the SPD-20A using an integrator

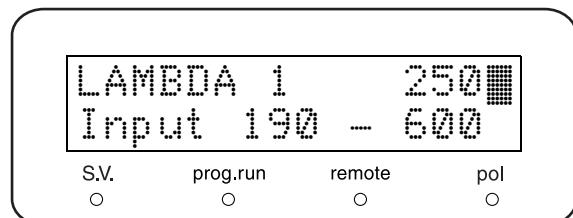
- 1** Turn the power switch ON.
Make sure [CHECK GOOD] is displayed for several seconds.



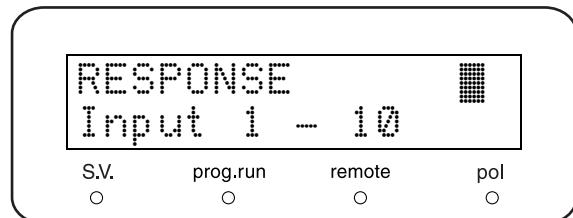
- 2** Press **func**.
[PARAMETER] appears.
- 3** Press **enter**.
[LAMBDA 1] (ch1 wavelength setting) appears.



- 4** Press **2**, **5**, **0** and **enter**.
This sets a wavelength of 250nm.



- 5** Press **func** repeatedly until [RESPONSE] (response setting) is displayed.
- 6** Press **1**, **0** and **enter**.
This sets the time constant to 2 seconds.



- 7** After setting the data processor range to 4mAUFS and pressing **zero**, record the baseline for 2 hours.

When 1 hour has passed, measure the amount of drift in the baseline for the next hour, as shown in the figure, and record the drift value.

(For the Chromatopac, when [AUXRANGE] is set to 2 then ATTEN = 2)

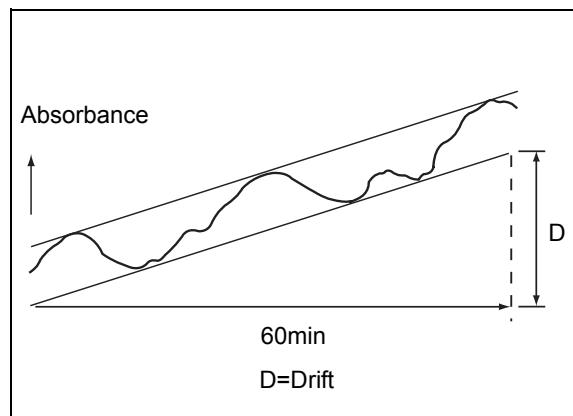


Fig. 7.5

- 8** Set the data processor range to 1mAUFS and measure the baseline for 15 minutes.

Break this 15-minute baseline recording into 0.5-minute intervals along the time axis. For each interval, draw a set of parallel lines that most closely encloses the span of the baseline noise. Along the absorbance axis, measure the width between the parallel lines for each interval, and calculate the average for all intervals as the noise value.

NOTE

- Plotting data and taking readings if Chromatopac is used:

Press the [Plot] key to begin plotting. Guidelines for when to take readings are as follows:

- With C-R8A, C-R7Aplus: 14.0mm on the chart corresponds to 1/10 of the chart's full height
- With C-R7A: 15.0mm on the chart corresponds to 1/10 of the chart's full height
- With C-R4A: 16.0mm on the chart in A4 size mode corresponds to 1/10 of the chart's full height
- With C-R5A, C-R6A: 13.5mm on the chart corresponds to 1/10 of the chart's full height

To check the SPD-20A using the LC workstation

- 1** Input the SPD-20A settings for the LC workstation as follows.

- With LCsolution

Input the settings at right on the SPD-20A [Data acquisition] screen.

Lamp	D2
Polarity	+
Response	2 sec
Cell temperature	40°C
Wavelength	250nm
Intensity unit	AU

7. Hardware Validation

- With CLASS-VP6

Input the settings at right for [Detector configuration] under [Instrument configuration].

Detector model	SPD20A
Acquisition source	Digital
Y-axis unit	AU
Y-axis multiplier	1e-006

Input the settings at right for [Instrument setup] screen under the [Method] menu on the SPD-20A.

Lamp	D2
Polarity	+
Response	10 (2 seconds)
Temp. checkbox	To be checked
Cell temp.	40°C
Wavelength	250nm
Auxiliary range	2 (1AU/V)

- 2** Download the settings from the LC workstation to the instrument.
- 3** Wait for an hour or longer for the device to stabilize.
- 4** Set LC workstation measurement conditions for drift and noise.

- With LCsolution

Set the [Baseline check parameters] under the [Method] menu on the [Data acquisition] screen in accordance with the figure at right.

Noise calculation method	ASTM
Detector channel	Specify the channel to which the SPD-20A is connected
Noise checkbox	To be checked
Start	45min
End	60min
Threshold	20µV
Drift checkbox	To be checked
Start	0min
End time	60min
Threshold	600µV/h

- With CLASS-VP6

Click the [Baseline check] button on the [LC setup assistant] screen and the [Baseline check] screen is displayed. Input the settings shown in the figure at right.

Channel	Specify the channel to which the SPD-20A is connected
Noise checkbox	To be checked
Start	45min
End	60min
Threshold	20µV
Drift checkbox	To be checked
Start	0min
End	60min
Threshold	600µV/h
Noise test method	ASTM

5 Measure drift and noise.

- With LCsolution

Click the [Baseline check] button on the [Data acquisition] screen.

- With CLASS-VP6

Click the [Start] button on the [Baseline check] screen.

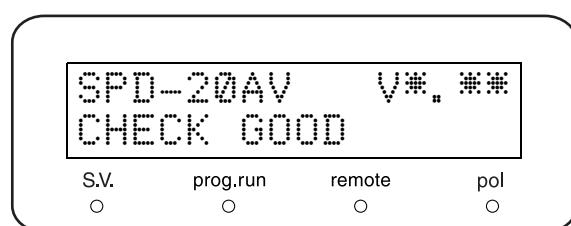
6 Record the results that are displayed after measurement is complete.

The results are displayed in units of µV. Because the ratio has been set for this procedure at 1V=1AU, convert the results using 1µV=1µAU.

7

To check the SPD-20AV using an integrator

1 Turn the power switch ON. Check that the display screen changes and [CHECK GOOD] appears for a few seconds.



2 Press **func**. [PARAMETER] is displayed.

7. Hardware Validation

3 Press **enter**.

The wavelength settings screen is displayed.

254nm 0.000 AU
D2 0.0100AUFS

S.V. prog.run remote pol

4 Press **func** repeatedly until [LAMP] (lamp on/off setting) is displayed.

LAMP
0: OFF 1: D2 2: W

S.V. prog.run remote pol

5 Press **1**, then **enter**.

This turns on the D2 (deuterium) lamp.

LAMP
PREHEATING LAMP 1

S.V. prog.run remote pol

6 Press either **back** or **func** repeatedly until [LAMBDA 1] (ch1 wavelength setting) is displayed.

LAMBDA 1 54
Input 190 - 370

S.V. prog.run remote pol

7 Press **2**, **5**, **0**, and **enter**.
This sets a wavelength of 250nm.

LAMBDA 1 250
Input 190 - 370

S.V. prog.run remote pol

8 Press **func** repeatedly until [RESPONSE] (response setting) is displayed.

RESPONSE
Input 1 - 10

S.V. prog.run remote pol

9 Press **1**, **0**, and **enter**.
This sets the time constant to 2 seconds.

- 10** After setting the data processor range to 4mAUFS and pressing **zero**, record the baseline for 2 hours.

When 1 hour has passed, measure the amount of drift in the baseline for the next hour, as shown in the figure, and record the drift value.
(For the Chromatopac, when [AUXRANGE] is set to 2 then [ATTEN] = 2)

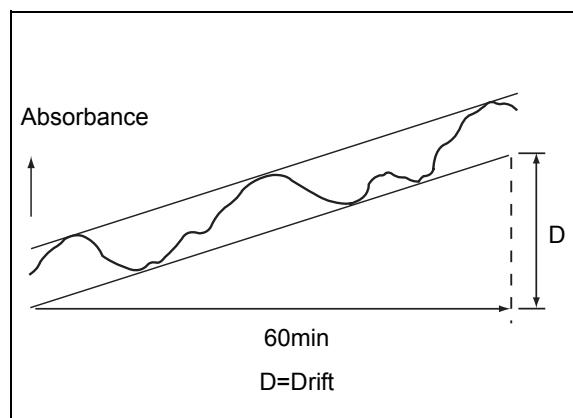


Fig. 7.7

- 11** Set the data processor range to 1mAUFs and measure the baseline for 15 minutes. Break this 15-minute baseline recording into 0.5-minute intervals along the time axis. For each interval, draw a set of parallel lines that most closely encloses the span of the baseline noise. Along the absorbance axis, measure the width between the parallel lines for each interval, and calculate the average for all intervals as the noise value.

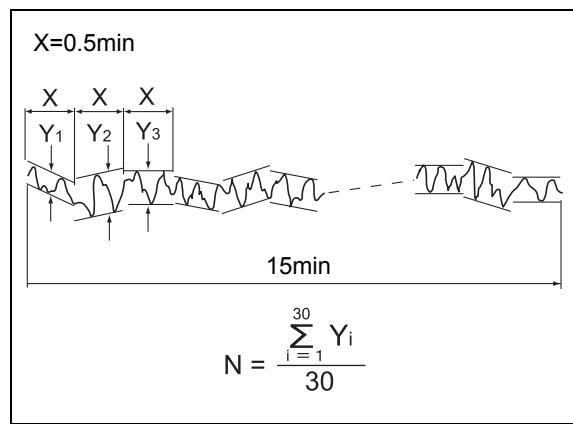


Fig. 7.8

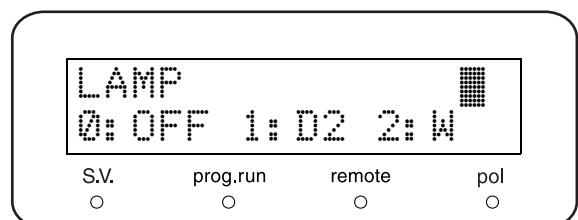
NOTE

- Plotting data and taking readings if Chromatopac is used:

Press the [Plot] key to begin plotting. Guidelines for when to take readings are as follows:

- With C-R8A, C-R7Aplus: 14.0mm on the chart corresponds to 1/10 of the chart's full height
- With C-R7A: 15.0mm on the chart corresponds to 1/10 of the chart's full height
- With C-R4A: 16.0mm on the chart in A4 size mode corresponds to 1/10 of the chart's full height
- With C-R5A, C-R6A: 13.5mm on the chart corresponds to 1/10 of the chart's full height

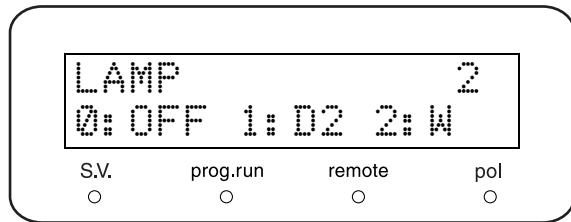
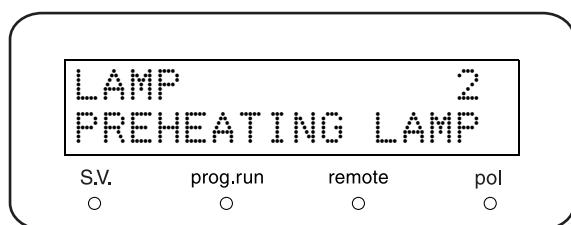
- 12** Press **func** repeatedly until [LAMP] (lamp on/off setting) is displayed.



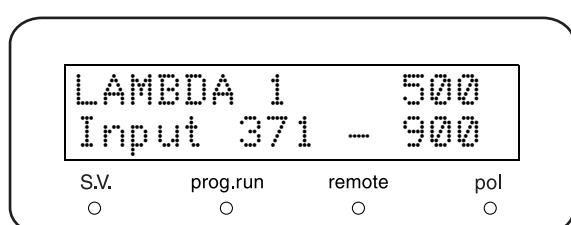
7. Hardware Validation

13 Press **2**, then **enter**.

This turns on the W (tungsten) lamp.

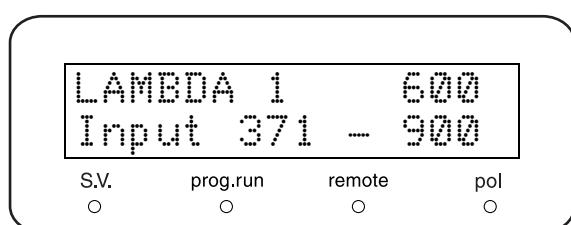


14 Press either **back** or **func** repeatedly until [LAMBDA 1] (ch1 wavelength setting) is displayed.

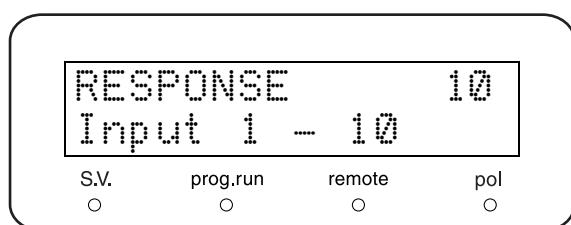


15 Press **6**, **0**, **0**, and **enter**.

This sets a wavelength of 600nm.



16 Press **func** repeatedly until [RESPONSE] (response setting) is displayed. Check that response is set to 10 (time constant of 2 seconds).



17 After the W lamp has been turned on for 1 hour, measure drift and noise following the same method as was used for the D2 lamp with a wavelength of 250nm.

To check the SPD-20AV using the LC workstation

1 Input the SPD-20AV settings for the LC workstation as follows.

- With LCsolution

Input the settings at right on the SPD-20AV [Data acquisition] screen.

Lamp	D2
Polarity	+
Response	2 sec
Cell temperature	40°C
Wavelength	250nm
Intensity unit	AU

- With CLASS-VP6

Input the settings at right for [Detector configuration] under [Instrument configuration].

Detector model	SPD20AV
Acquisition source	Digital
Y-axis unit	AU
Y-axis multiplier	1e-006

Input the settings at right for [Instrument setup] screen under the [Method] menu on the SPD-20AV.

Lamp	D2
Polarity	+
Response	10 (2 seconds)
Temp. checkbox	To be checked
Cell temp.	40°C
Wavelength	250nm
Auxiliary range	2 (1AU/V)

2 Download the settings from the LC workstation to the instrument.

3 Wait for an hour or longer for the device to stabilize.

7. Hardware Validation

4 Set LC workstation measurement conditions for drift and noise.

- With LCsolution

Set the [Baseline check parameters] under the [Method] menu on the [Data aquisition] screen in accordance with the figure at right.

Noise calculation method	ASTM
Detector channel	Specify the channel to which the SPD-20AV is connected
Noise checkbox	To be checked
Start	45min
End	60min
Threshold	20µV
Drift checkbox	To be checked
Start	0min
End	60min
Threshold	600µV/h

- With CLASS-VP6

Click the [Baseline check] button on the [LC setup assistant] screen and the [Baseline check] screen is displayed. Input the settings shown in the figure at right.

5 Measure drift and noise.

- With LCsolution

Click the [Baseline check] button on the [Data acquisition] screen.

- With CLASS-VP6

Click the [Start] button on the [Baseline check] screen.

6 Record the results that are displayed after measurement is complete.

The results are displayed in units of µV. Because the ratio has been set for this procedure at 1V=1AU, convert the results using 1µV=1µAU.

7 Go on to perform measurements of drift and noise at 600nm.

Channel	Specify the channel to which the SPD-20AV is connected
Noise checkbox	To be checked
Start	45min
End	60min
Threshold	20µV
Drift checkbox	To be checked
Start	0min
End	60min
Threshold	600µV/h
Noise test method	ASTM

8 Input the SPD-20AV settings for the LC workstation as shown in the figure at right.

- With LCsolution

Input the settings at right on the SPD-20AV [Data acquisition] screen.

Lamp	W
Polarity	+
Response	2 sec
Cell temperature	40°C
Wavelength	600nm
Intensity unit	AU

- With CLASS-VP6

Input the settings at right for [Instrument setup] screen under the [Method] menu on the SPD-20AV.

Lamp	W
Polarity	+
Response	10 (2 seconds)
Temp. checkbox	To be checked
Cell temp.	40°C
Wavelength	600nm
Auxiliary range	2 (1AU/V)

7

9 Download the settings from the LC workstation to the instrument.

10 Wait for an hour or longer for the device to stabilize.

11 As in step 4, set LC workstation measurement conditions for drift and noise.

12 As in step 5, measure drift and noise.

13 Record the results that are displayed after measurement is complete.

CHECK CRITERIA:

Drift must not exceed 6×10^{-4} AU/hr (with Max. room temperature fluctuation 2 °C)
Noise level must not exceed 2×10^{-5} AU (with RESPONSE time constant of 2 sec.)

7. Hardware Validation

■ Establishing Acceptance Criteria for Periodic Validation

For validation of detectors that have been in use, it is most realistic to set criteria according to the particular analysis sensitivity required.

This is explained below.

For reference

As the detector ages, the intensity (brightness) of its lamp(s) decreases, and noise increases correspondingly. Usually, the noise level (N) is inversely proportional to the $1/2$ power of the intensity (E). This means that, generally, when intensity has fallen to one half of its initial level, noise will be 1.4 times its initial level.

An acceptable noise level for analysis data of satisfactory accuracy depends on the analysis sensitivity required. Specifically, provided that the signal-to-noise (S/N) ratio of the peaks of interest is sufficiently high, a high noise level will not significantly affect the accuracy of analysis data. To set a realistic noise level criterion value, it is advisable to first determine the S/N ratio required for testing the lowest concentration of interest. The criterion value can then be set on the basis of the ratio. (The criterion value must also, however, assure the analysis data reliability that is required for particular circumstances.)

Procedure

① Determine the heights, S (= signal), of the peaks of interest from a chromatogram, and use them to calculate S for the lowest concentration of interest.

② Set the required S/N ratio.

③ The required noise level (noise level acceptance criterion, N) is derived using the following equation:

$$N = \frac{\text{Value for } S \text{ at low concentration, obtained in } ①}{\text{S/N ratio at low concentration, set in } ②}$$

Example

Suppose signals (S) for peak heights of 500mAU are obtained during analysis of a control sample of concentration 100. Then, if the concentrations of the constituents of interest in the samples analyzed range from 1 to 100, the peak height (S) at the lowest concentration (concentration of 1) will be 5mAU.

In this case, it is desirable to have a S/N ratio of 20 or more at the lowest concentration.

Accordingly, the criterion noise level should be set at $N = 5/20 = 0.25\text{mAU}$, or $2.5 \times 10^{-4}\text{AU}$.

* Generally speaking, S/N ratios of 10 or less should be avoided, since they will cause decreased reproducibility of peaks (peak area C.V. values).

7.5.10 Leak Sensor Test

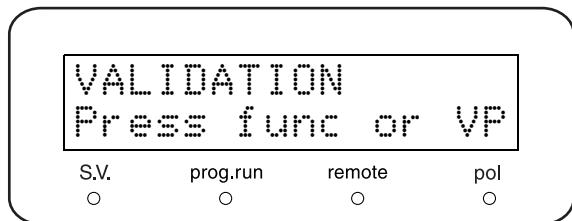
■ Objective

Checks the operation of leak sensor.

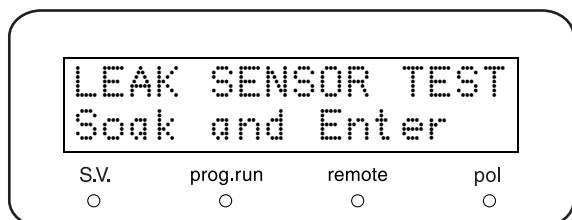
 "[LEAK SENSOR TEST]" P. 5-52

■ Check Procedure

- 1 Press **VP** three times on the initial screen.
[VALIDATION] appears.



- 2 Press **func** repeatedly until [LEAK SENSOR TEST] is displayed.



- 3 Use a syringe filled with water to wet the thermosensor at the bottom of the leak sensor.

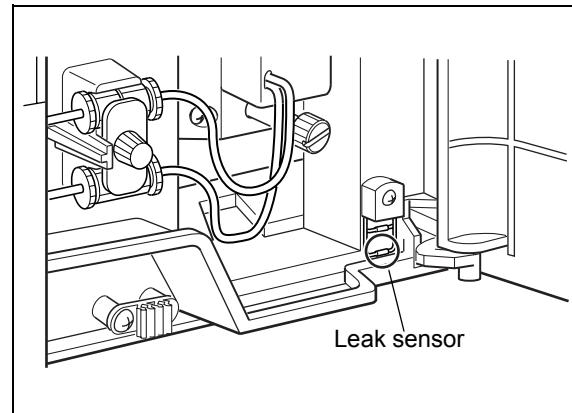
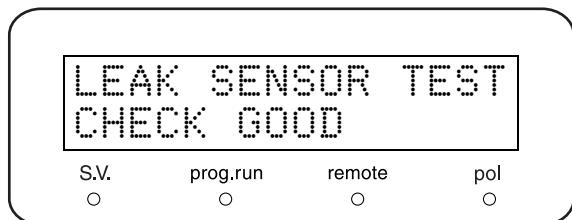


Fig. 7.9

- 4 In about 10 seconds, press **enter** to display the test result.



CHECK CRITERIA : [CHECK GOOD] appears on the screen.

NOTE

Take care not to let the leak sensor come in contact with any of the resin parts.
When the check is complete, wipe up any water around the leak sensor.

7.6 System Validation

- The LC system is comprised of many individual components. System validation is used to confirm the function of each component as well as the performance of the entire system.
- The standard system validation procedure described in this section is used to determine whether the LC system is functioning normally. This procedure constitutes the basis of the LC system capability inspection.
- System validation is performed at installation, and periodically thereafter. If a problem occurs during operation, system validation may be performed to determine whether the problem is in the LC system or in the analysis method.
- If the LC system passes the system validation, it can be assumed that the LC system is normal and that the problem lies in the particular analysis method or conditions being used.
- If the LC system does not pass the system validation, it may be assumed that there is an abnormality in the system, and component validation must be performed to identify the malfunctioning component(s).

7.6.1 Validation of Isocratic LC system

■ Objective

An analysis is performed and the retention time and peak area are obtained for each peak. The data is then examined to check for reproducibility. Reproducible data validates the system.

Generally, the system being validated consists of a minimum of the following components: pump, column oven, autosampler, detector, system controller and data processor.

■ Items Required for Validation

Item	Description
Mobile phase	Mixture of water and methanol (3/2, v/v) * Both the water (distilled) and the methanol should be HPLC grade.
Column	Shim-pack VP-ODS (Part No. 228-34937-91), LUNA C18 (2) (Part No. 00F-4252-E0) or equivalent ODS column (Particle size 5µm, Column Dimension : I.D. 4.6mm × length 150mm)
Sample	20mg/L caffeine solution (included in Caffeine set (5 concentrations) Part No. 228-45725-91) <Preparation> Weigh 20mg of anhydrous caffeine, transfer to a 100mL volumetric flask and dilute to volume with water. Transfer 1mL of the solution to a 10mL volumetric flask, and dilute to volume with water.
Water	HPLC grade, or equivalent
2-propanol	HPLC grade, or equivalent

■ Checking and Preparing the LC system

- 1** Check all the wiring connections in the LC system. Refer to individual component instruction manuals for details. If a Chromatopac is used, it should be connected to the detector with the signal cable connector provided with the Chromatopac, and the signal cable should then be connected to the integrator terminal of the detector.
 - * If the system normally uses Chromatopac or LC workstation, the connections used for regular analysis will be satisfactory.

- 2** Check the LC system plumbing. Ensure that the tubing between (a) the autosampler outlet and the column inlet, (b) the column outlet and the detector inlet, has an I.D. of less than 0.3mm, and is shorter than 300mm. Keep the liquid volume that is not in the column as low as possible.

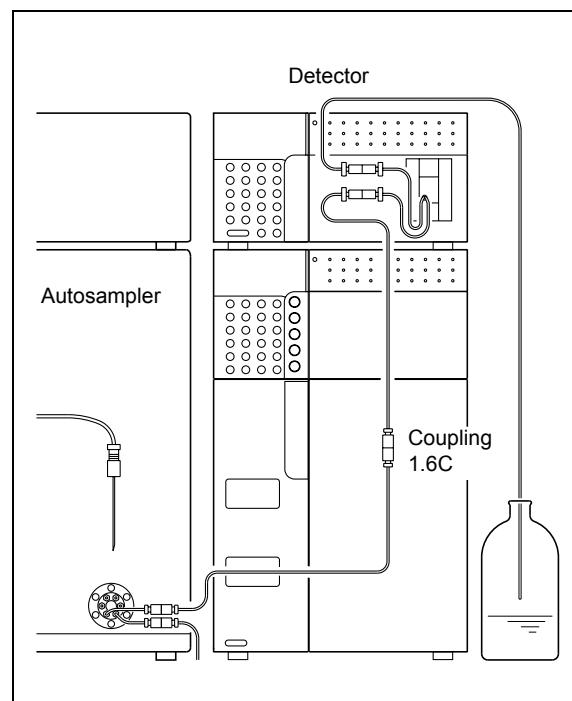


Fig. 7.10

- 3** Clean the system flow lines using one of the procedures described below. Before cleaning the flow lines, remove the column from the system, and connect the column inlet to the column outlet with a coupling 1.6C (Fig. 7.10).

<For a new system>

Clean the flow lines first with 2-propanol, then with water. In each case, pass the liquid through the flow lines for 10 minutes, at a rate of 2mL/min.

<For a system in use that uses a mobile phase with a low dielectric constant, such as hexane>

The procedure is the same as that of a new system, given above.

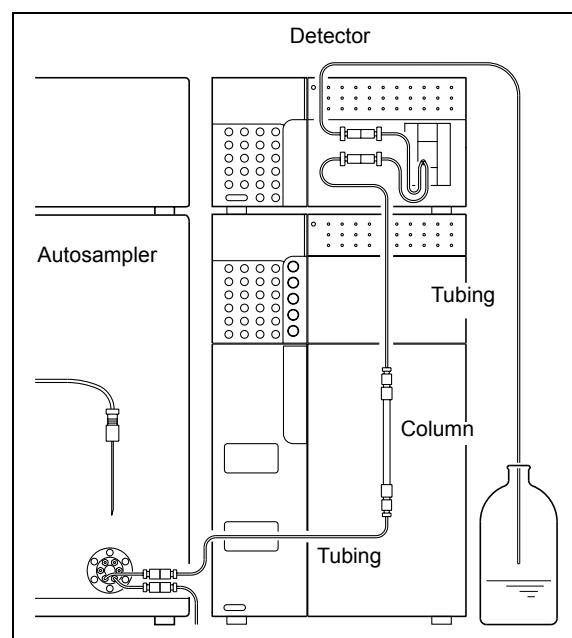


Fig. 7.11

<For a system that has been using a mixture of a water solution and an organic solvent as mobile phase, or water plus an organic solvent miscible with water (methanol, acetonitrile, etc.)>

Clean the flow lines with water. Pass water through the flow lines for 10 minutes, at a rate of 2mL/min.

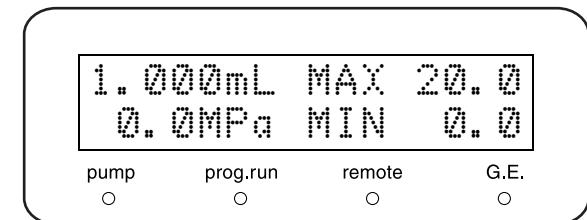
7. Hardware Validation

- 4** When cleaning is finished, pour mobile phase (mixture of water and methanol (3/2, (v/v)) into the reservoir, and reconnect the column with the LC system (Fig. 7.11).

■ Validation Procedure

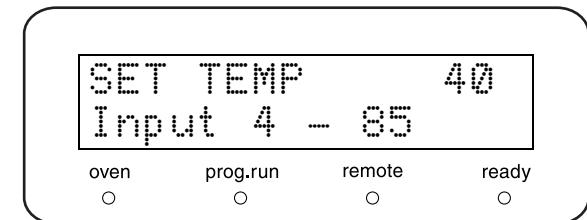
- 1** Set the pumping flow rate to 1mL/min.
See the pump's instruction manual for setting procedures.

Pump's display screen



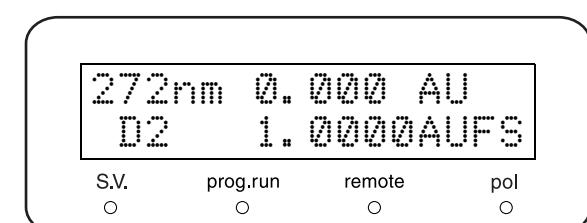
- 2** Set the column oven temperature to 40°C.
See the column oven's instruction manual for setting procedures.

Column oven's display screen



- 3** Press **pump** on the pump keypad, and **oven** on the column oven keypad. Pumping and temperature regulation will start.
Verify that liquid flows through the detector outlet tubing, and that there are no leaks from any of the connections.

Detector's display screen



- 4** Set the detector parameters.
 "Parameter Settings for Isocratic System Validation" P. 7-37

See the detector's instruction manual for setting procedures.

- 5** Set the autosampler parameters.
 "Parameter Settings for Isocratic System Validation" P. 7-37

See the autosampler's instruction manual for setting procedures.

- 6** Set the data processor parameters.
 "Parameter Settings for Isocratic System Validation" P. 7-37

See the data processor's instruction manual for setting procedures.

- 7** Monitor the baseline.
When the baseline has stabilized, press the detector **zero** key, then inject 10 μ L of mobile phase, and verify that no peaks are observed.

- 8** Inject 10 μ L of the test standard six times, and analyze the data obtained.
- 9** From the peak data obtained from the six analyses, derive the relative standard deviation (coefficient of variation (C.V.)) for: retention time and peak area (Fig. 7.12).

$$RSD(C.V.) = (SD/\bar{X}) \times 100$$

$$SD = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1}}$$

$$\bar{X} = (X_1 + X_2 + \dots + X_n)/n$$

n : Number of analyses

X₁•••X_n : Retention time (or areas) of each peak

\bar{X} : Average

SD : Standard deviation

RSD : Relative standard deviation

C.V. : Coefficient of variation

Fig. 7.12

■ Parameter Settings for Isocratic System Validation

The parameters to be set for the various devices when validation analysis of an isocratic system is performed are given below.

• Pump	Flow rate	: 1mL/min
	P.Max	: 20.0MPa
• Column oven	Oven temperature	: 40°C
• Time program	5.00 STOP	
• Autosampler	RINSE VOLUME	: 200 μ L
	RINSE SPEED	: 35 μ L/s
	SAMPLING SPEED	: 15 μ L/s
	RINSE MODE	: 0 (No needle rinsing)
• Detector	Wavelength	: 272nm
	RESPONSE	: 3 (0.5s)
• Data processor	WIDTH	: 5
	DRIFT	: 0
	T.DBL	: 1000
	ATTEN	: 10 (1,024mAUFs)
	SLOPE	: 1000
	MIN.AREA	: 100000
	STOP.TM	: 5

CHECK CRITERIA

The RSD (C.V.)'s obtained must satisfy the following criteria:

Retention time RSD must not exceed 0.5%.

Peak area RSD must not exceed 1.0%.

7. Hardware Validation

7.6.2 Validation of Gradient LC System

■ Objective

An analysis is performed and the retention time and peak area are obtained for each peak. The data is then examined to check for repeatability. Reproducible data validates the system.

Generally, the system being validated consists of a minimum of the following components: pump, column oven, autosampler, detector, system controller and data processor.

■ Items Required for Validation

Item	Description
Mobile phases	A: Distilled water B: Methanol A /B =60%/40% * Both the water (distilled) and the methanol should be HPLC grade.
Column	Shim-pack VP-ODS (Part No. 228-34937-91), LUNA C18 (2) (Part No. 00F-4252-E0) or equivalent ODS column (Particle size 5µm, Column Dimension : I.D. 4.6mm × length 150mm)
Sample	20mg/L caffeine solution (included in Caffeine set (5 concentrations) Part No. 228-45725-91) < Preparation > Weigh 20mg of anhydrous caffeine, transfer to a 100mL volumetric flask and dilute to volume with water. Transfer 1mL of the solution to a 10mL volumetric flask, and dilute to volume with water.
Water	HPLC grade, or equivalent
2-propanol	HPLC grade, or equivalent

■ Checking and Preparing the LC System

- 1** Check all the wiring connections in the LC system.
Refer to individual component instruction manuals for details. If a Chromatopac is used, it should be connected to the detector with the signal cable connector provided with the Chromatopac, and the signal cable should then be connected to the integrator terminal of the detector.
 - * If the system normally uses Chromatopac or LC workstation, the connections used for regular analysis will be satisfactory.

- 2** Check the LC system plumbing.
Ensure that the tubing between (a) the autosampler outlet and the column inlet, (b) the column outlet and the detector inlet, has an I.D. of less than 0.3mm, and is shorter than 300mm.
Keep the liquid volume that is not in the column as low as possible.

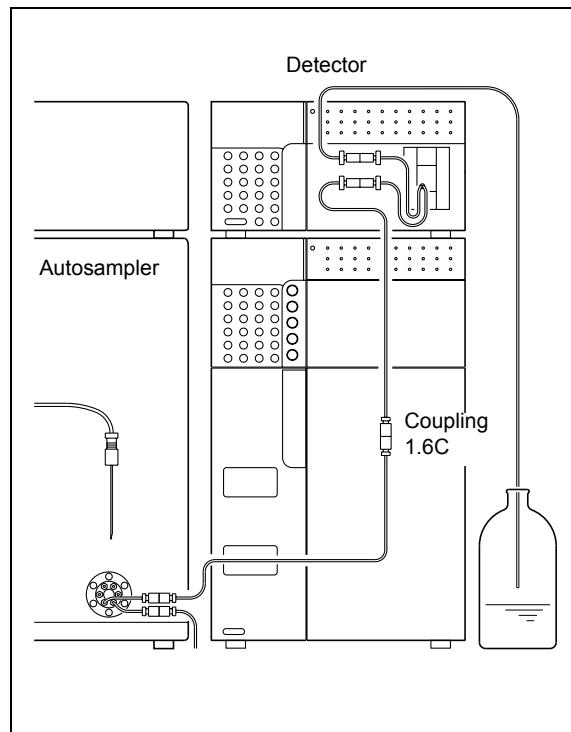


Fig. 7.13

- 3** Clean the system flow lines using one of the procedures described below.

Before cleaning the flow lines, remove the column from the system, and connect the column inlet to the column outlet with a coupling 1.6C (Fig. 7.13).

< For a new system >

Clean the flow lines first with 2-propanol, then with water. In each case, pass the liquid through the flow lines for 10 minutes, at a rate of 2mL/min.

<For a system in use that uses a mobile phase with a low dielectric constant, such as hexane>

The procedure is the same as that of a new system, given above.

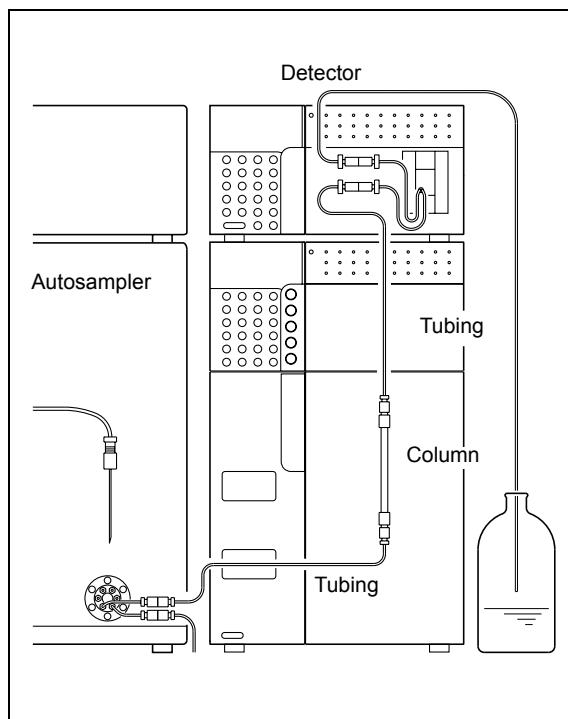


Fig. 7.14

<For a system that has been using a mixture of a water solution and an organic solvent as mobile phase, or water plus an organic solvent miscible with water (methanol, acetonitrile, etc.)>

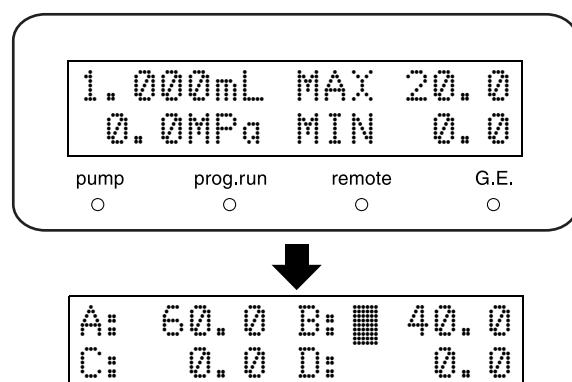
Clean the flow lines with water. Pass water through the flow lines for 10 minutes, at a rate of 2mL/min.

- 4** When cleaning is finished, pour mobile phase (A: water, B: methanol) into the reservoir, and reconnect the column with the LC system (Fig. 7.14).

■ Validation Procedure

- 1** Set the pumping flow rate to 1mL/min, and set the concentration of mobile phase B parameter to 40%.
See the pump's instruction manual for setting procedures.

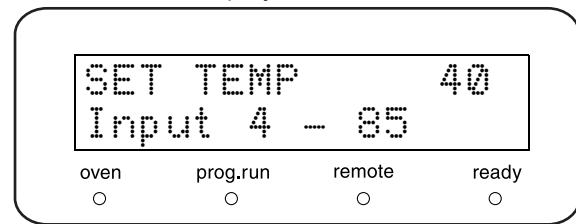
Pump's display screen



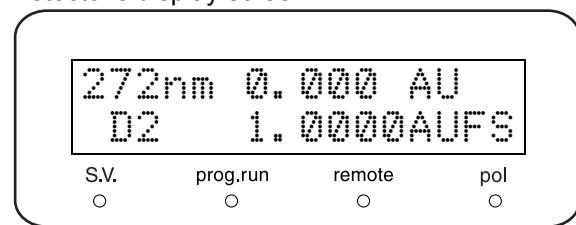
7. Hardware Validation

- 2** Set the column oven temperature to 40°C.
See the column oven's instruction manual for setting procedures.
- 3** Press **pump** on the pump panel, and **oven** on the column oven panel. Pumping and temperature regulation will start.
Verify that liquid flows through the detector outlet tubing, and that there are no leaks from any of the connections.
- 4** Set the detector parameters.
 "Parameter Settings for Gradient System Validation" P. 7-41
See the detector's instruction manual for setting procedures.
- 5** Set the autosampler parameters.
 "Parameter Settings for Gradient System Validation" P. 7-41
See the autosampler 's instruction manual for setting procedures.
- 6** Set the data processor parameters.
 "Parameter Settings for Gradient System Validation" P. 7-41
See the data processor's instruction manual for setting procedures.
- 7** Monitor the baseline.
When the baseline has stabilized, press the detector **zero** key. Then inject 10 μ L of mobile phase and verify that no peaks are observed the second time.
- 8** Inject 10 μ L of the test sample six times, and analyze the data obtained.
- 9** From the peak data obtained from the six analyses, derive the relative standard deviation (coefficient of variation (C.V.)) for: retention time and peak area (Fig. 7.15).

Column oven's display screen



Detector's display screen



$$RSD(C.V.) = (SD/\bar{X}) \times 100$$

$$SD = \sqrt{\frac{\sum_{i=1}^n (Xi - \bar{X})^2}{n-1}}$$

$$\bar{X} = (X_1 + X_2 + \dots + X_{n-1} + X_n)/n$$

n : Number of analyses

X₁..X_n : Retention time (or areas) of each peak

\bar{X} : Average

SD : Standard deviation

RSD : Relative standard deviation

C.V. : Coefficient of variation

Fig. 7.15

■ Parameter Settings for Gradient System Validation

The parameters to be set for the various devices when validation analysis of a gradient system is performed are given below.

• Pump	Flow rate : 1mL/min
	B.CONC : 40%
	P.Max : 20.0MPa
• Column oven	Oven temperature : 40°C
• Time program	5.00 STOP
• Autosampler	RINSE VOLUME : 200µL
	RINSE SPEED : 35µL/s
	SAMPLING SPEED : 15µL/s
	RINSE MODE : 0 (No needle rinsing)
• Detector	Wavelength : 272nm
	AUX RNG : 2 (1AU/V)
	RESPONSE : 3 (0.5s)
• Data processor	WIDTH : 5
	DRIFT : 0
	T.DBL : 1000
	ATTEN : 10 (1,024mAUFs)
	SLOPE : 1000
	MIN.AREA : 100000
	STOP.TM : 5

CHECK CRITERIA

The RSD (C.V.)'s obtained must satisfy the following criteria:

Retention time RSD must not exceed 0.5%.

Peak area RSD must not exceed 1.0%.

7.7 If Validation Fails

Should the system fail to satisfy any of the system validation check criteria, or should a component fail to satisfy any of the component validation check criteria, proceed as follows.

- Check whether any consumable items have reached the end of their service life:
The cause of failure to satisfy check criteria could be a consumable part that is no longer usable.
Check consumable parts and replace them if necessary.
- Perform troubleshooting:
It is possible that some minor problem (such as air bubbles) has caused the system to fail the criteria.
Perform troubleshooting to check for such problems, and take action to eliminate any problems found.
For troubleshooting procedures for individual system components, see the applicable instruction manuals.
- If a cause cannot be determined, contact your Shimadzu representative:
If you are unable to determine the cause of the failure, or if you are unclear about troubleshooting or corrective action procedures, contact your Shimadzu representative.

7.8 Reference Materials

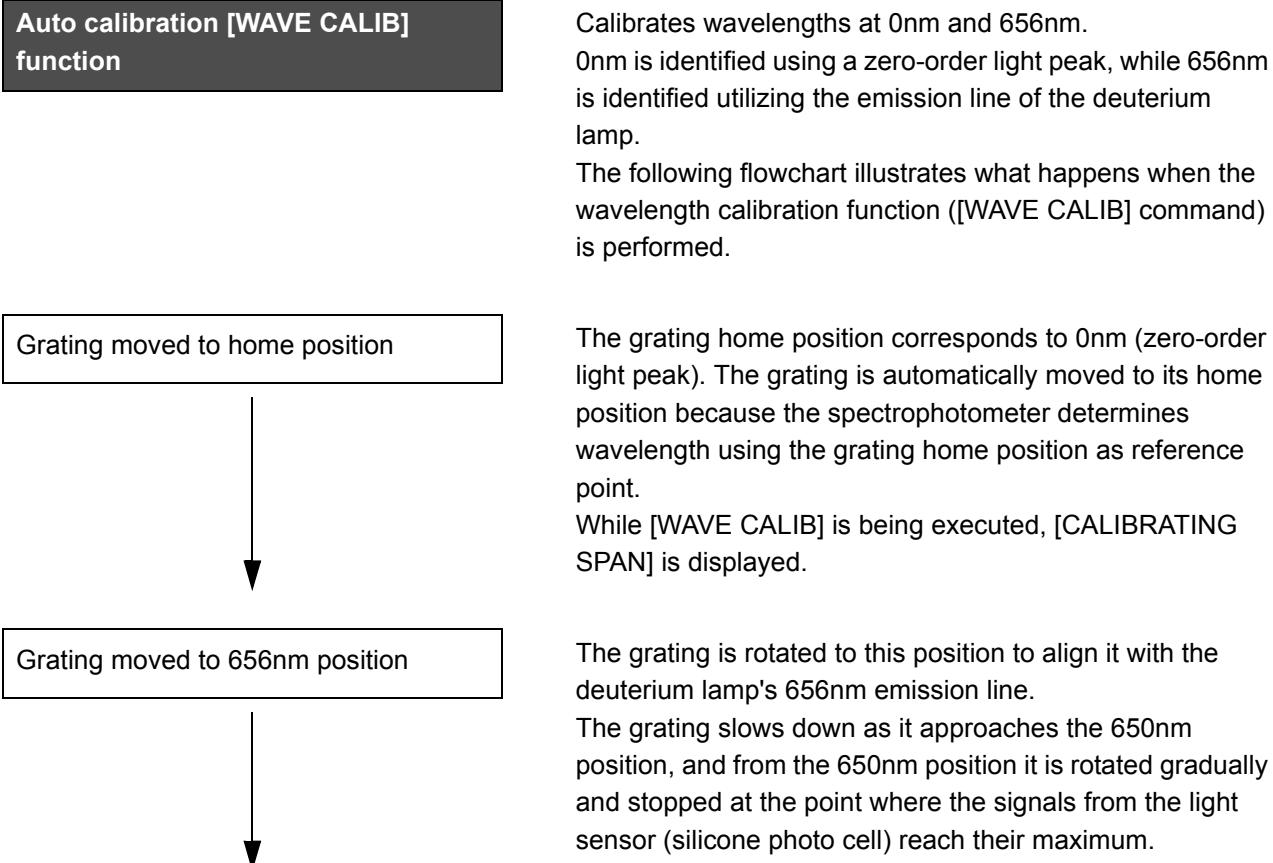
Validation of the instrument is usually performed as described in "7.5 Validation: Detector." As reference materials for use in validation of the instrument, the following items are explained here.

- How to perform the wavelength auto calibration and auto accuracy check functions.
- How to perform a manual wavelength accuracy check.
- How to perform a wavelength accuracy check using a compound with an absorbance that peaks in the UV range.
- How to perform a drift/noise check with an air-filled flow cell
(This is a means of checking the performance of the optical system itself by omitting such effects as dirty cell windows and changes to the liquid flowing through the cell.)

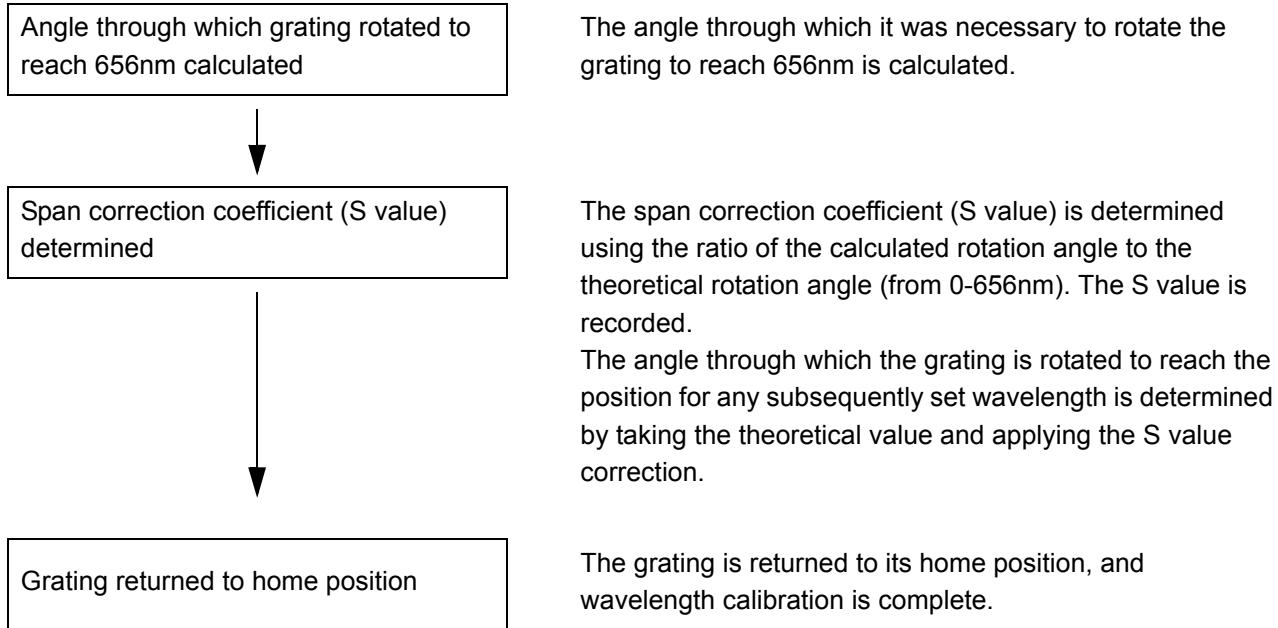
7.8.1 Auto Wavelength Calibration Function: Reference Data

The detector performs wavelength calibration (and also wavelength checks) automatically. An overview of this function is provided below.

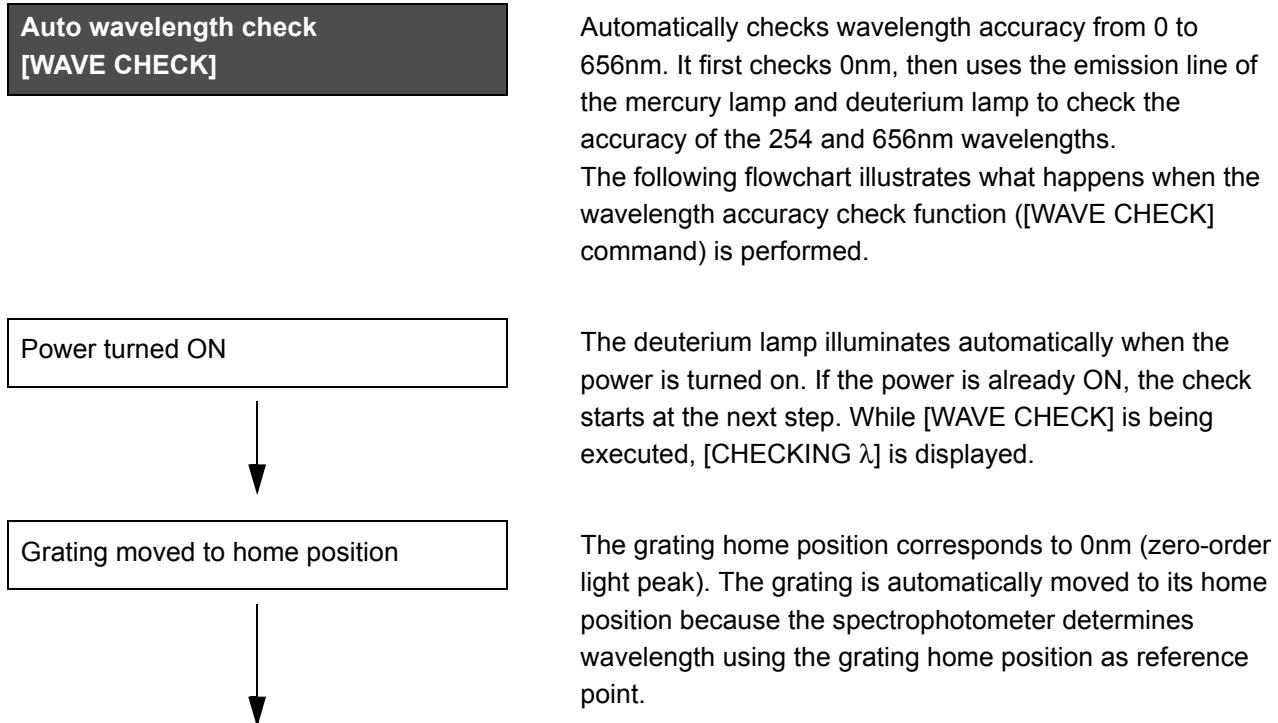
■ Wavelength Auto Calibration

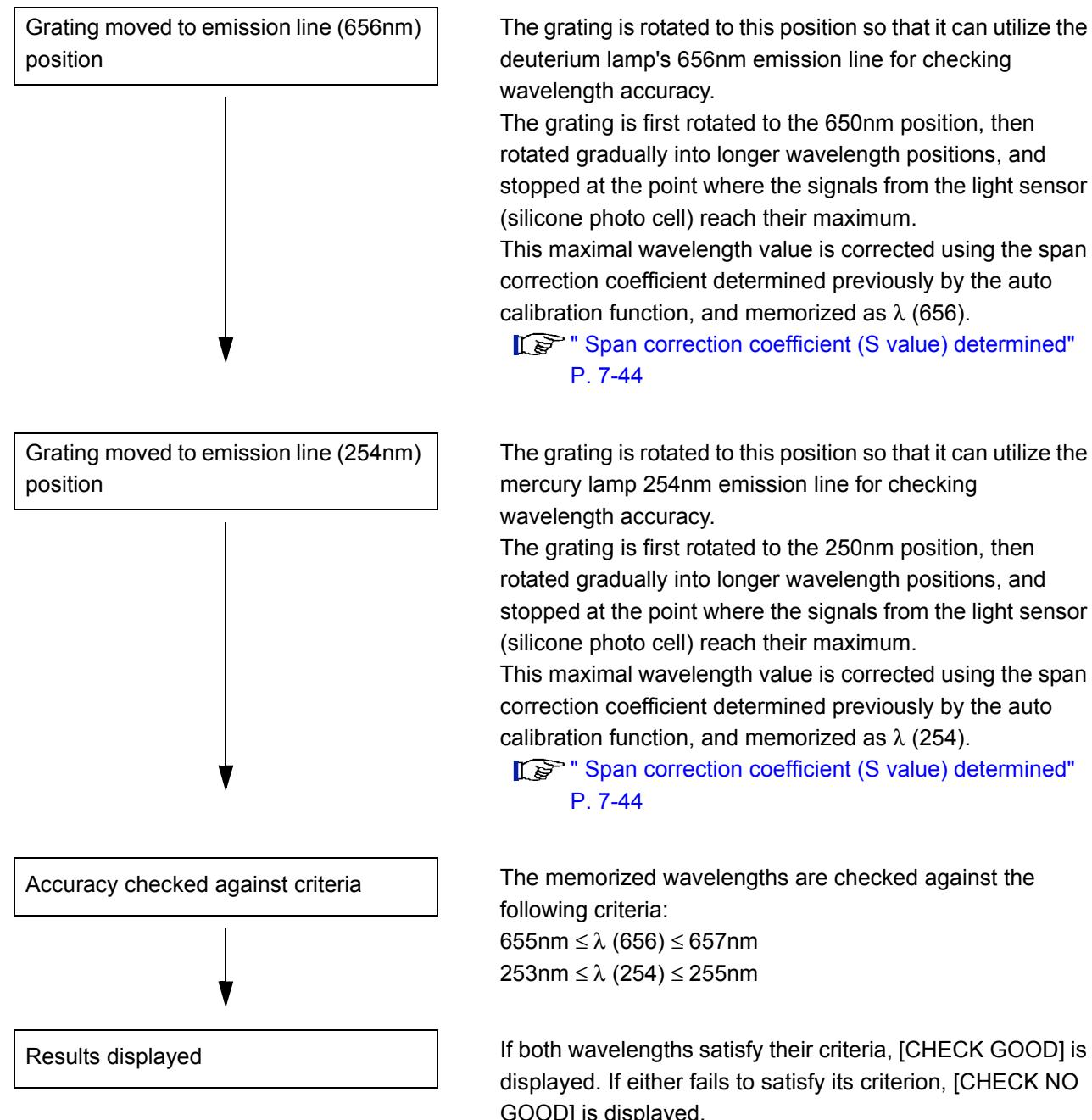


7. Hardware Validation



7.8.2 Auto Wavelength Accuracy Check Function: Reference Data





7.8.3 Manual Wavelength Accuracy Check

■ Objective

Checking the wavelength accuracy of this instrument is usually performed using the instrument's automatic wavelength check function, as described in "[7.5.5 Wavelength Accuracy Check](#)". This section, however, offers an explanation of how to check that the difference between a manually set wavelength and the true wavelength is within specifications.

This check consists of analysis with the 254nm emission line of the mercury lamp and 656nm emission line of the deuterium lamp, and checks that the readings are within 254nm ±1nm and 656nm ±1nm respectively.

7. Hardware Validation

■ Items Required for Check:

Solvent or nitrogen gas to fill the flow cell	Solvent: distilled water, methanol, or acetonitrile. * Solvent/nitrogen not required if cell is filled with air.
---	---

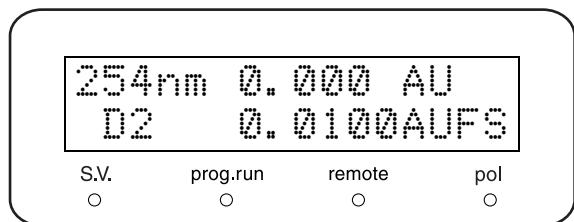
■ Preparation

- Either flush the flow cell with distilled water, methanol, or acetonitrile, or purge it with air or nitrogen and dry it thoroughly.
- Run the check with the flow cell installed in the detector.

■ Check Procedure

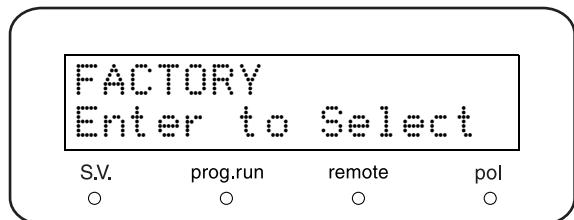
1 Make sure the detector is connected to the data processor using the specified signal cable.

2 Turn the power switch ON while pressing and holding **func** until a beep tone is heard.

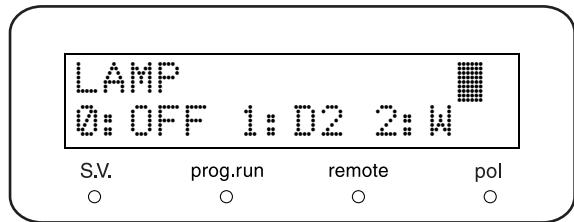


3 Press **func** repeatedly until [FACTORY] is displayed.

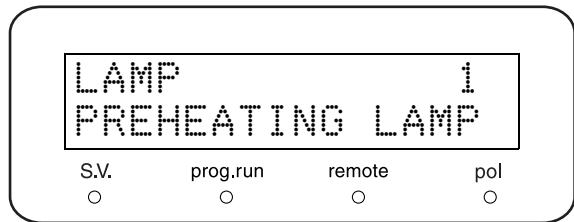
4 Press **enter**.
The wavelength setting screen appears.



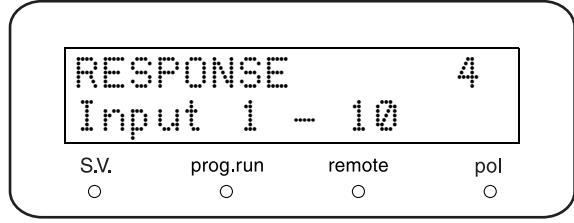
5 Press **func** repeatedly until [LAMP] (lamp ON/OFF setting screen) is displayed.



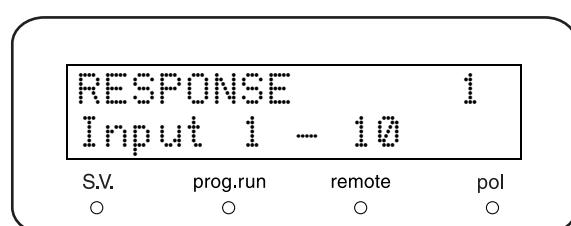
6 Press **1**, then **enter**.
The deuterium lamp comes on.



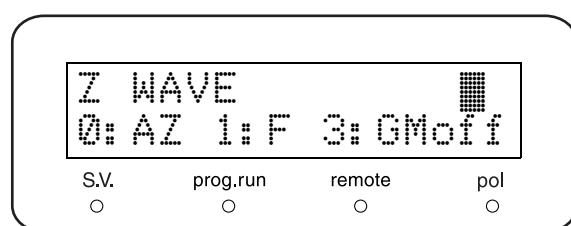
7 Press **back**.
[RESPONSE] (response setting) appears.



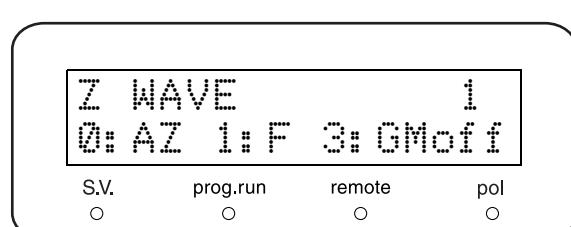
8 Press **1**, then **enter**.



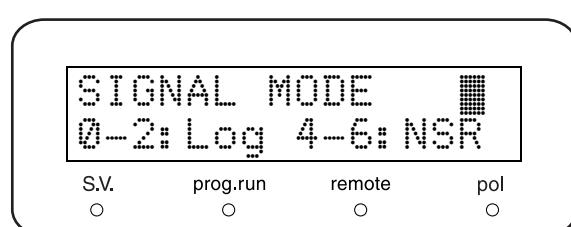
9 Press **func** repeatedly until [Z WAVE] (autozero setting) is displayed.



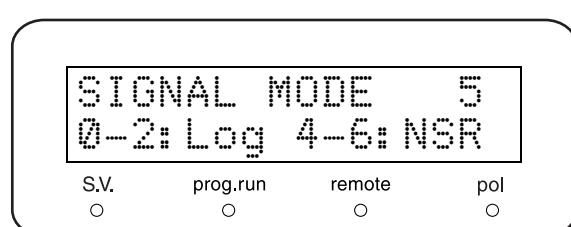
10 Press **1**, then **enter**.



11 Press **func** repeatedly until [SIGNAL MODE] (signal mode setting screen) is displayed.



12 Press **5**, then **enter**.



13 In the case of SPD-20AV, press **back** to display [LAMP POSI] (lamp mirror setting) and press **1**, then **enter**.

14 Following the procedure below, run the test while changing the wavelength. If the signal of the instrument is output to the data processor, using the table to the right as a guide, make adjustments to the measurement range as necessary.

Measurement range guidelines

	254nm	656nm
SPD-20A	2AU	2AU
SPD-20AV	16mAU	2AU

* To set wavelength

↳ "4.1.1 Setting Wavelength [LAMBDA 1]" P. 4-2

* To set range

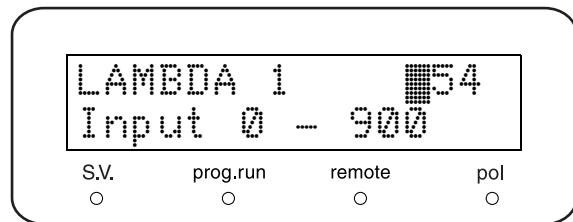
↳ "4.1.2 Setting Range" P. 4-4

7. Hardware Validation

① On the initial screen, press **func**.

② Press **enter**.

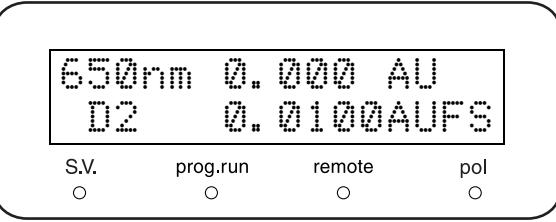
[LAMBDA 1] (ch1 wavelength setting) appears.



③ Set the wavelength to 650nm and press **CE** twice to return to the initial screen.

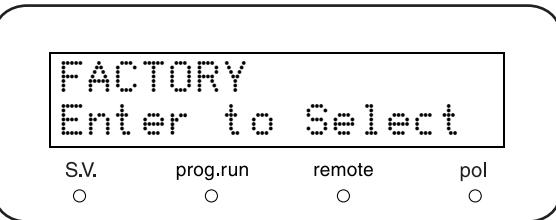
Then press **zero**.

The absorbance on the screen is set to zero.



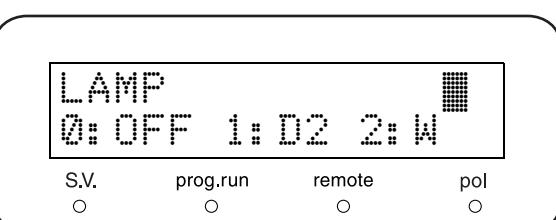
④ Change the wavelength 1nm at a time, recording the displayed absorbance value each time, until reaching 660nm, and find the wavelength with the highest value.

⑤ Press **func** repeatedly until [FACTORY] is displayed.



⑥ Press **enter**.

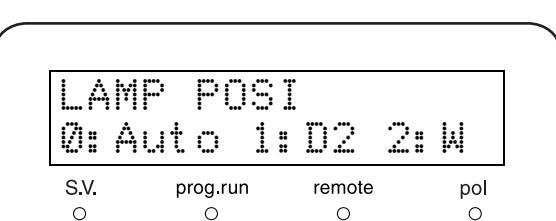
The wavelength setting screen appears.



⑦ Press **func** repeatedly until [LAMP] (lamp ON/OFF setting) is displayed.

⑧ Press **4**, then **enter**.

This turns on the mercury lamp.



⑨ Press **func** repeatedly until [LAMP POSI] is displayed.

⑩ Press **2**, then **enter**.

⑪ Wait for about 1 minute until the lamp is stabilized.

⑫ Set the wavelength to 250nm and press **CE** twice to return to the initial screen.

Then press **zero**.

The absorbance on the screen is set to zero.

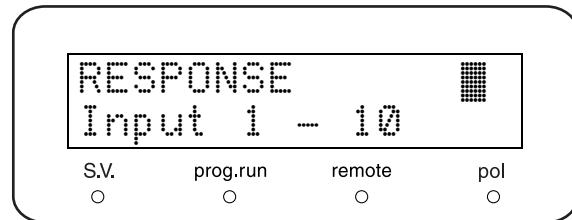
⑬ Change the wavelength 1nm at a time, recording the displayed absorbance value each time, until reaching 260nm, and find the wavelength with the highest value.

CHECK CRITERIA: Peak wavelength must be **656±1nm** and **254±1nm**.

■ Post-Check Procedure

- 1** After the check is complete, return the [RESPONSE] (response setting) to the value it was set to before the check.

 "4.1.4 Setting [RESPONSE]" P. 4-9



- 2** Return the [LAMP] (lamp on/off setting) to the value it was set to before the check.

 "[LAMP]" P. 5-34

- 3** Return the [LAMBDA 1] (ch1 wavelength setting) to the value it was set to before the check.

 "[LAMBDA 1]" P. 5-33

- 4** Turn the power switch OFF and back ON again.

The values for [SIG MODE], [Z WAVE], and [LAMP POSI] will automatically initialize.

■ Supplemental Explanation

[Z WAVE] and [SIG MODE], which are used in checking wavelength accuracy, have the following functions.

7

- [Z WAVE]

Selects whether to automatically zero the output indicator on the display and the output voltage when the wavelength setting is changed.

To compare intensity levels for each wavelength when measuring wavelength accuracy, set [Z WAVE] to [1] so that automatic zeroing will not be performed.

- [SIG MODE]

Selects which type of signal (absorbance, light intensity on the sample cell, light intensity on the reference cell, etc.) will be transmitted to the output indicator on the display and the output voltage terminal.

When measuring wavelength accuracy, set [SIG MODE] to [5] so that the intensity of light transmitted through the sample cell will appear on the output indicator on the display.

- [LAMP POSI]

On this instrument, the [LAMP POSI] function selects which lamp's light will enter the spectrometer by changing the direction the mirror inside the lamp housing.

The mirror is oriented such that light from the deuterium lamp enters the instrument when [LAMP POSI] is set to [1], and that light from the mercury lamp enters the instrument when [LAMP POSI] is set to [2].

7. Hardware Validation

7.8.4 UV Wavelength Accuracy Check Using Maximum Absorbance Wavelength of Caffeine

This instrument ensures wavelength accuracy in the UV and visible light ranges by using the combined emission line wavelengths (254nm and 656nm) of the Hg (mercury) lamp and the D2 (deuterium) lamp. Checking the wavelength accuracy of this instrument is usually performed as described in "7.5.5 Wavelength Accuracy Check." This section explains how to perform a wavelength accuracy check using a compound with an absorbance that peaks in the UV range.

■ Objective

The flow cell is filled with caffeine + methanol solution, and absorbance is measured for a number of different wavelengths. Accuracy is gauged by determining whether the caffeine maximum absorbance wavelength is within specifications.

■ Items Required for Check

Caffeine + methanol solution (2mg/100mL)	Part No. 228-32996-04
Methanol	For diluting caffeine, and cleaning
Syringe (standard accessory)	Part No. 046-00001
Syringe adapter (standard accessory)	Part No. 228-15672-91
Male PEEK nut (standard accessory)	Part No. 228-18565

■ Preparation

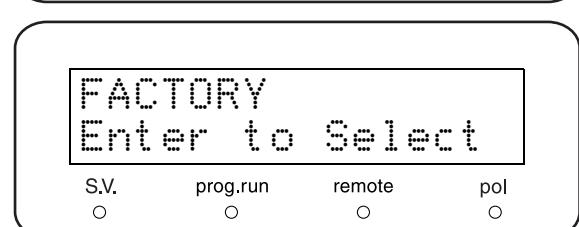
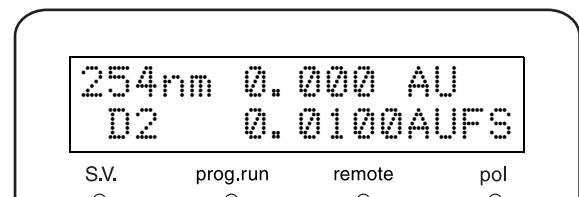
Using the syringe, inject methanol into the flow cell flow lines for cleaning.

NOTE

Measurement will not be correct if the cell window is dirty. If necessary, clean the window with 2-propanol or the like.

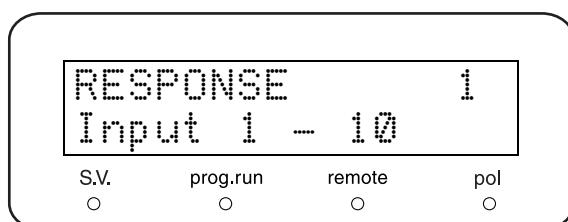
■ Check Procedure

- 1 Make sure the detector is connected to the data processor using the specified signal cable.
- 2 Press and hold down **func**, and turn the power switch ON.
The initial screen appears.
- 3 Press **func** repeatedly until [FACTORY] is displayed.
- 4 Press **enter**.
The wavelength setting screen appears.



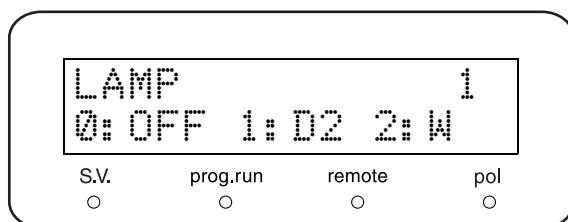
5 Press **func** repeatedly until [RESPONSE] (response setting) is displayed.

6 Press **1**, then **enter**.



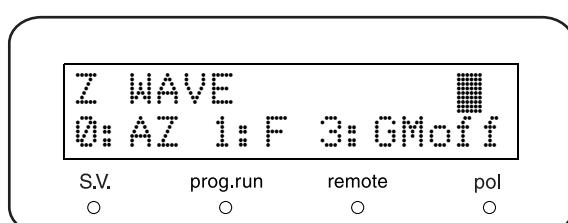
7 Press **func** repeatedly until [LAMP] (lamp ON/OFF setting) is displayed.

8 Press **1**, then **enter**.
This turns on the deuterium lamp.



9 Press **func** repeatedly until [Z WAVE] (autozero setting) is displayed.

10 Press **1**, then **enter**.



11 Change settings so that the data processor range is around 1.00AUFS.

"4.1.2 Setting Range" P. 4-4

12 Inject methanol into the flow cell using the syringe.

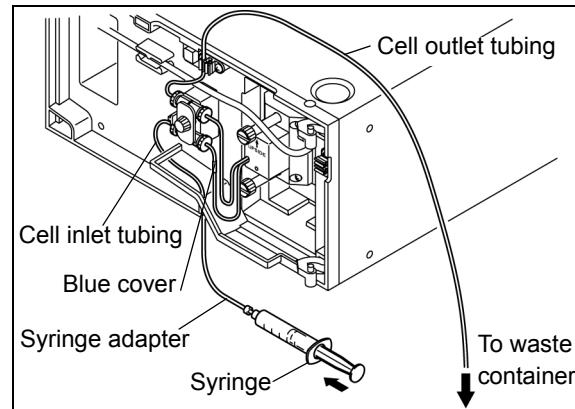
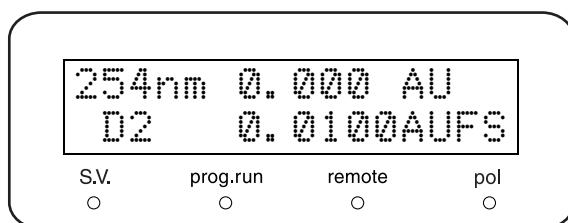


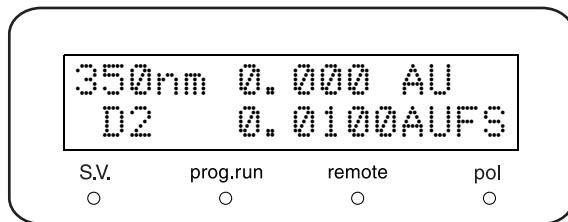
Fig. 7.16

13 Press **func** repeatedly until [LAMBDA 1] (ch1 wavelength setting) is displayed.



14 To display the detector's output on the data processor, set the wavelength to 350nm and press **CE** two times to return to the initial screen.
Then press **zero**.

The absorbance on the screen is set to zero.



7. Hardware Validation

15 Zero the data processor.

16 Using the syringe, inject the caffeine + methanol solution (2mg/100ML) into the flow cell. Do not let any air bubbles enter the flow lines.

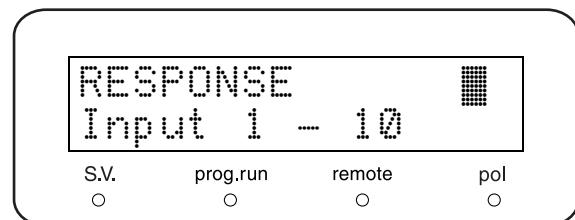
17 Increase the wavelength setting from 266nm to 277nm by 1nm increments, and record the absorbance value displayed after each 1nm increment rise.

18 Record the wavelength that produces the maximum absorbance value. To pass the test, this wavelength should satisfy the following criterion:

CHECK CRITERIA: Peak wavelength must be $272 \pm 2\text{nm}$.

■ Post-Check Procedure

- 1** Return the [LAMP], [LAMBDA 1], and [RESPONSE] settings to the values they were set to before the check.
- 2** Turn the power off and back on again. The value for [Z WAVE] will automatically initialize.



■ Supplemental Explanation

- Acceptance criteria for a wavelength accuracy check that uses caffeine.

Caffeine has a peak absorbance of 272nm and can be used as a reference wavelength in the ultraviolet range. Caffeine, moreover, is an ideal compound considering it does not deteriorate easily, is readily available, is simple to handle, etc. Wavelength accuracy in the UV range can be determined by comparing the wavelength peak as it is measured with this reference wavelength.

Acceptance criteria are defined as $272 \pm 2\text{nm}$ when using caffeine, as opposed to $254 \pm 1\text{nm}$ when using the low pressure mercury lamp. In contrast to the monochromatic emission line of the mercury lamp, precise measurement of the peak wavelength for caffeine can be difficult to determine because the maximum absorbance is spread out to a certain degree. For this reason, the acceptance criteria have been set low.

- About the [Z WAVE] function

Selects whether to automatically zero the output indicator on the display and the output voltage when the wavelength setting is changed.

To compare intensity levels for each wavelength when measuring wavelength accuracy, set [Z WAVE] to [1] so that automatic zeroing will not be performed.

7.8.5 Checking Drift and Noise With an Air Cell

■ Objective

An air cell refers to a flow cell that has had its contents replaced with air and been thoroughly dried.

The purpose of this check is to inspect the performance of the optical system itself by omitting such effects as dirty cell windows and the liquid flowing through the cell.

If drift and noise are high when the flow cell is filled with liquid, such as in "7.5.9 Drift / Noise Check", perform this check to distinguish whether the cause is related to a dirty flow cell and the liquid flowing through it or whether it is related to the instrument's optical system.

■ Items Required for the Check

A dummy cell assembly or regular flow cell	Dummy cell part No. 228-32686-91
Data processor	
Calipers or measuring ruler	In the case of using a chromatopac as a data processor

■ Preparation

When using a regular flow cell

- 1 Pump methanol through the flow cell to flush it.
- 2 Using a syringe and syringe adapter push out the methanol in the flow cell.
- 3 Remove the cell window screw and packing.

 "8.3 Flow Cell Disassembly/Cleaning and Replacement" P. 8-8

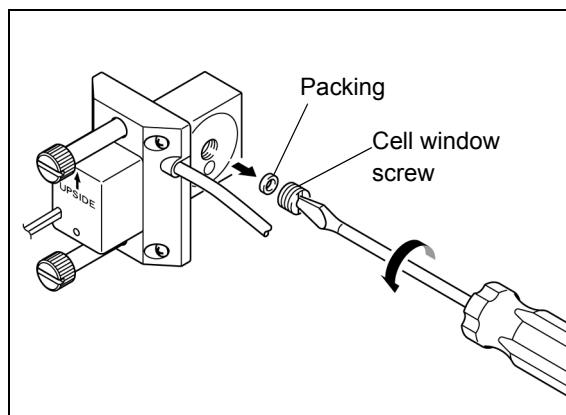


Fig. 7.17

7. Hardware Validation

- 4** Wait for the flow paths inside cell to dry naturally.
Then reinstall the flow cell.

* To reinstall the flow cell:

Orient the cell so that the arrow on it points upward. Then align the pin holes in the cell with the positioning pins on the detector, and slide in the cell.

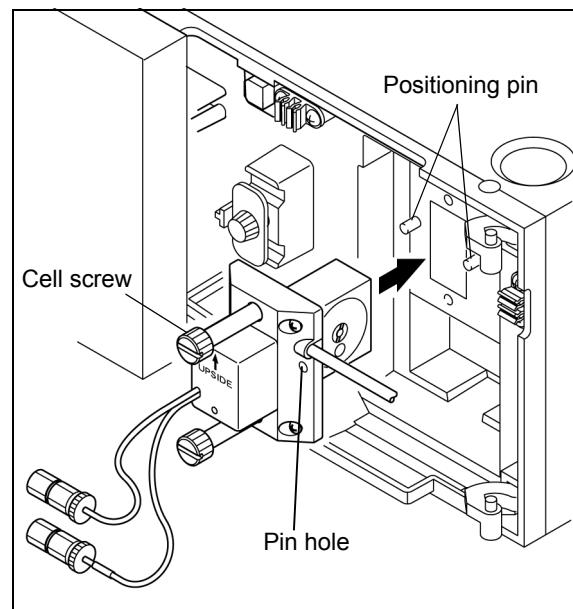


Fig. 7.18

When using the dummy cell assembly

- 1** Remove the flow cell.
2 Install the dummy cell assembly.

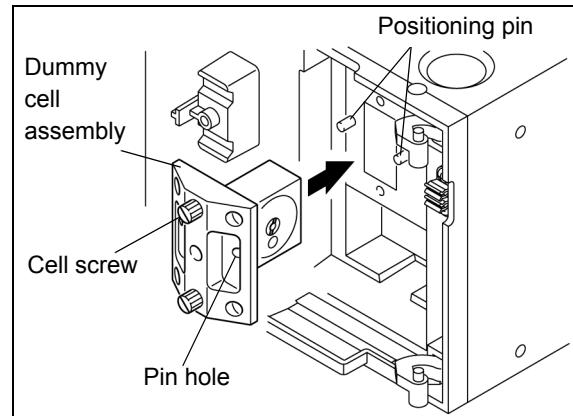


Fig. 7.19

■ Check Procedure

Perform the check according to the instructions given in "7.5.9 Drift / Noise Check".

 "7.5.9 Drift / Noise Check" P. 7-21

8

Maintenance

Contents

8.1	Periodic Inspection and Maintenance	8-2
8.2	Flow Cell Inspection and Basic Cleaning	8-4
8.3	Flow Cell Disassembly/Cleaning and Replacement.....	8-8
8.4	Lamp Replacement.....	8-11
8.5	Fuse Replacement.....	8-19
8.6	Wavelength Accuracy Calibration	8-21
8.7	Absorbance Accuracy Calibration	8-23
8.8	Absorbance Linearity Calibration	8-27
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8.1 Periodic Inspection and Maintenance

It is necessary to perform periodic inspections of this instrument to ensure its safe use.

It is possible to have these periodic inspections performed by Shimadzu service representatives on a contractual basis.

For information regarding the maintenance inspection contract, contact your Shimadzu representative.

WARNING

- Unless the instructions here specified, turn off the power always and unplug the instrument prior to performing inspections and maintenance. Otherwise, fire, electric shock or malfunction may occur.

CAUTION

- When replacing parts, use only the parts listed in "[1.3 Component Parts](#)" and "[9.3 Maintenance Parts](#)". If any other parts are used, injury or malfunction may occur.
- Never remove the main cover. Otherwise, injury or malfunction may occur. Contact your Shimadzu representative to remove the main cover.

8.1.1 Prior to Inspection and Maintenance

- Replace the mobile phase in the flow lines with water.
- Wipe away any dirt from the front panel and the main cover.
- Wipe away any dirt from the keypad with tissue paper or a soft cloth moistened with water.

8.1.2 List of Periodic Inspection and Maintenance

CAUTION

The replacement and maintenance periods listed in this table are presented only as guidelines. These are not guarantee periods. These will vary depending on usage conditions.

Inspection/Maintenance Item	1 year	2 year	3 year	6 year	Remark	Page
Cell gasket replacement	x				Replace whenever the cell is dismantled	P.8-8
Dismantling, cleaning & inspection of flow cell		x				
D2 lamp replacement		x			Service life: 2000 cumulative hours ([D2 LAMP USED] VP function provides alert)	P.8-11
W lamp replacement (SPD-20AV only)			x		Service life: 2000 cumulative hours ([W LAMP USED] VP function provides alert)	
Fuse replacement			x			P.8-19

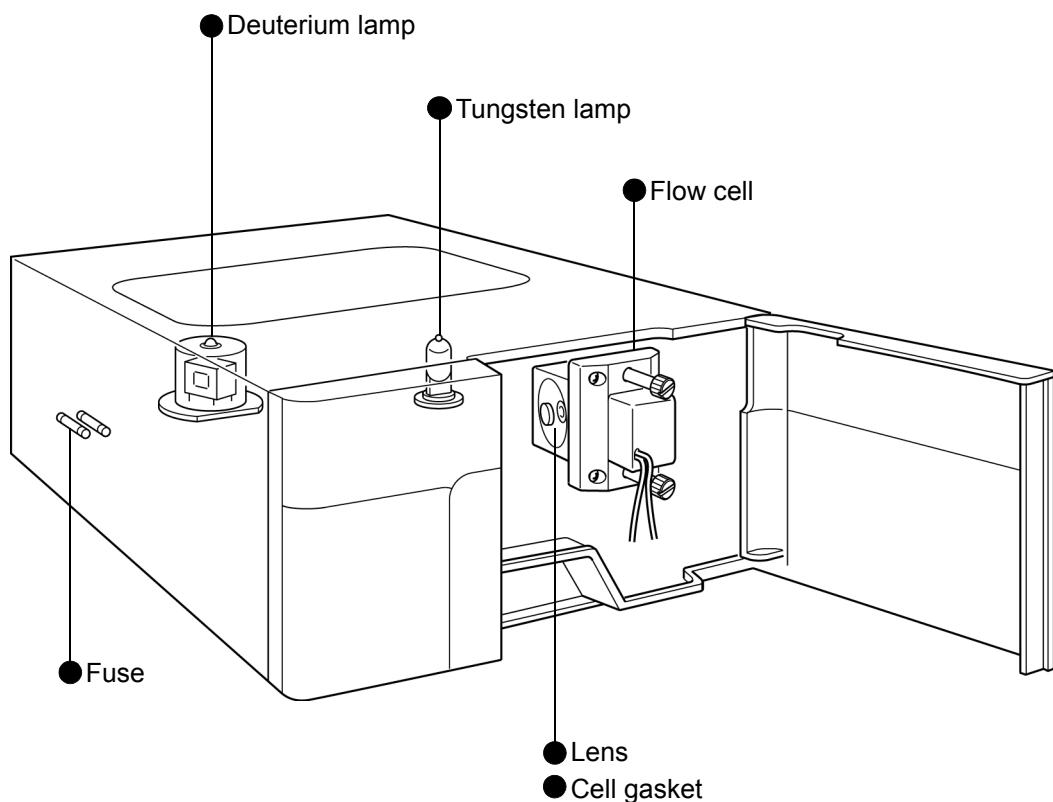


Fig. 8.1

8.1.3 Post-Inspection/Maintenance Leakage Check

8

After inspection and maintenance, check any leakage during pumping.

 "6.1 Troubleshooting and Corrective Action" P. 6-2

8.2 Flow Cell Inspection and Basic Cleaning

8.2.1 Removal and Inspection of Flow Cell

■ Names of Flow Cell Parts

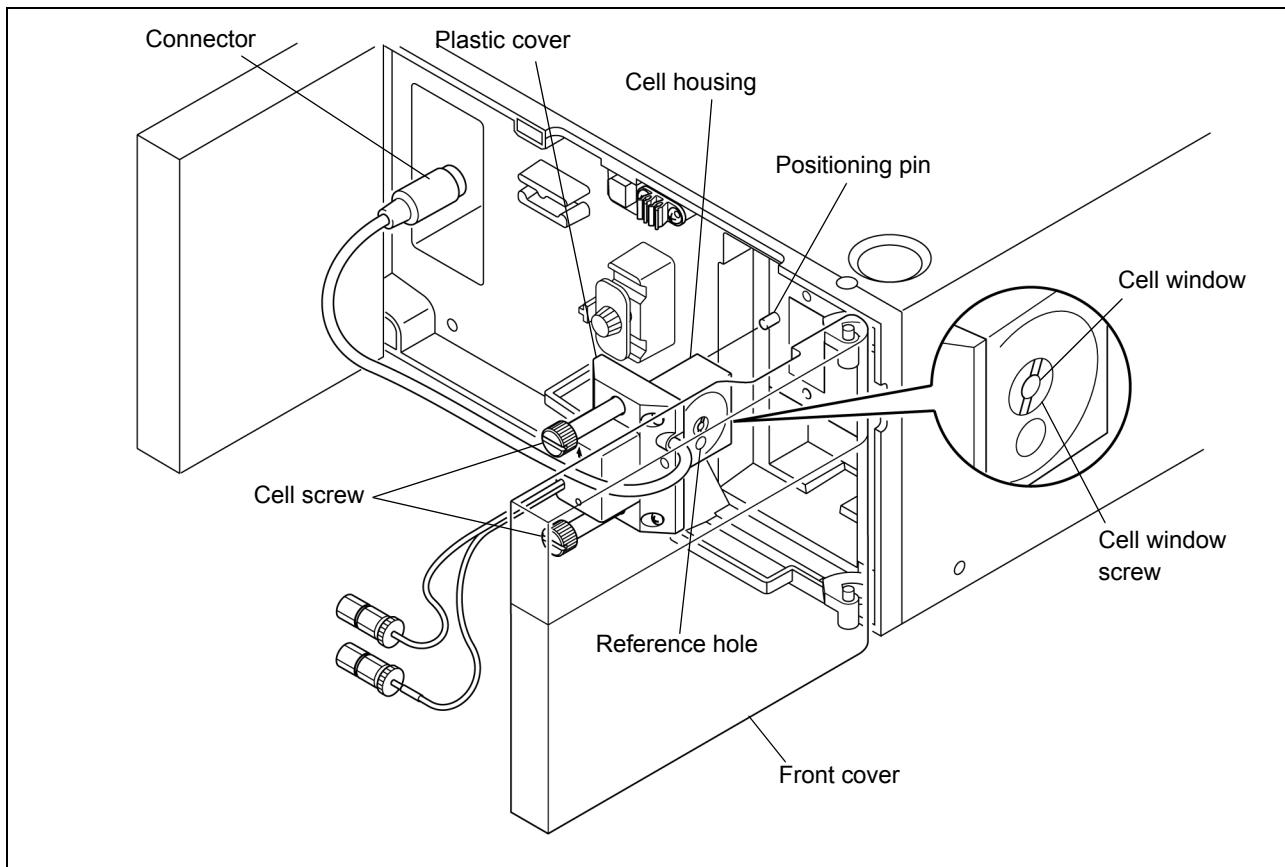


Fig. 8.2

- 1** Open the front cover.
- 2** Unscrew the coupling screw and remove the coupling 1.6-0.8C from the detector.
- 3** Remove the connector from the detector, unscrew the two cell screws (upper and lower), and remove the flow cell from the detector.

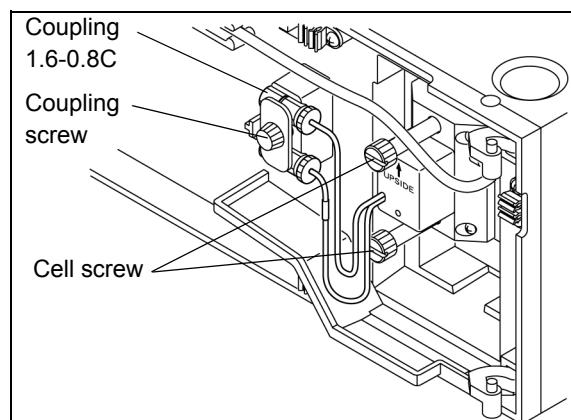


Fig. 8.3

NOTE

Do not remove the plastic cover from the cell housing.

- 4** Leave the flow line plumbing connected, and pump mobile phase through the flow lines.
- 5** With the mobile phase flowing through the flow lines, observe the cell interior through the cell window to check for air bubbles or dirt. If there are any, clean the flow cell. (See next section.)

8.2.2 Cleaning the Flow Cell

The procedure for cleaning air bubbles or dirt from the flow cell interior is described below.

Necessary parts

Part	Type	Part No.
Syringe	Standard accessory	046-00001
Syringe adapter	Standard accessory	228-15672-91

Arrow indicates direction of flow.

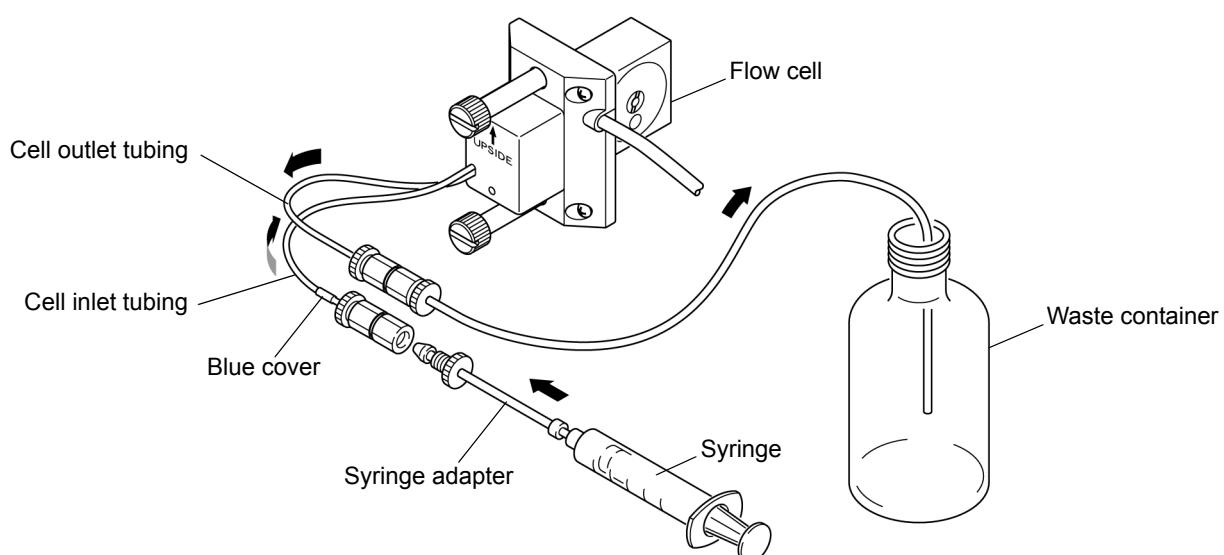


Fig. 8.4

8. Maintenance

- 1** Insert the syringe adapter on the tip of the syringe, and turn it clockwise to fix it in place.

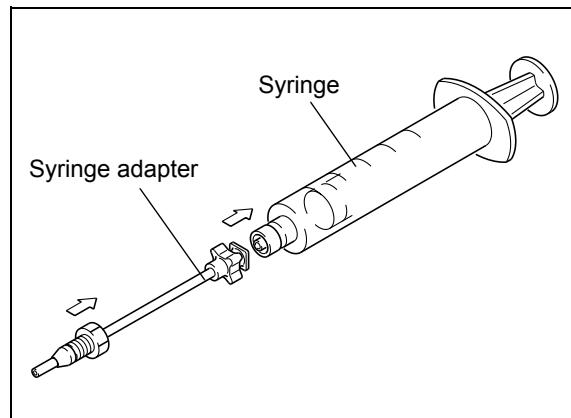


Fig. 8.5

- 2** Unscrew and remove the male PEEK nut from the coupling 1.6-0.8C on the end of the cell inlet tubing (marked with blue cover).

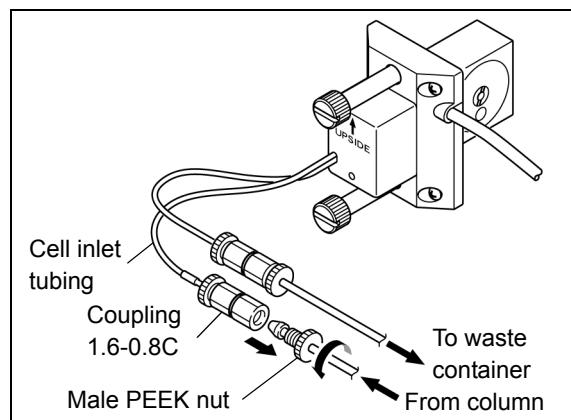


Fig. 8.6

- 3** Insert the end of the syringe adapter, with its 1.6MN male nut, into the coupling 1.6-0.8C, and screw in the male nut.

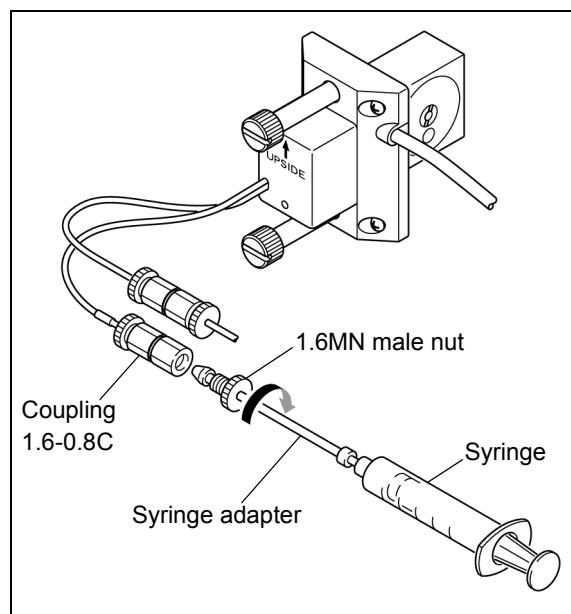


Fig. 8.7

- 4** Fill the syringe with 2-propanol, and gently push in the plunger.
The alcohol will be injected into the cell interior, cleaning it.

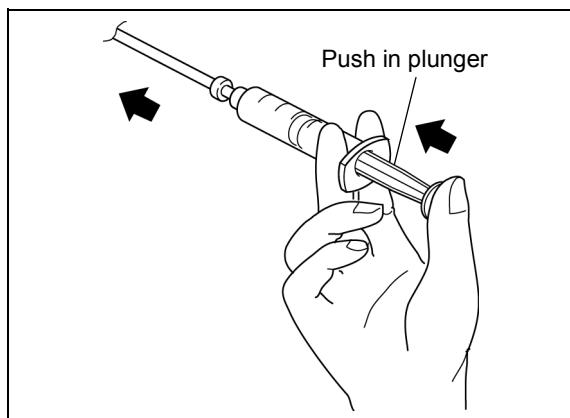


Fig. 8.8

- 5** Fill the syringe with mobile phase and press the syringe plunger.
The mobile phase will be injected into the cell interior, cleaning it further.

- 6** Unscrew the 1.6MN male nut on the end of the syringe adapter, and remove the end of the syringe adapter from the union.

8.2.3 Re-installing the Flow Cell

- 1** Orient the cell so that the arrow on it points upward. Then align the pin holes in the cell with the positioning pins on the detector, slide the cell onto the pins, and press it flush against the detector.
- 2** Tighten the two cell screws alternately.
- 3** Insert the connector into the detector.
- 4** Affix coupling 1.6-0.8C to the detector using the coupling screw.

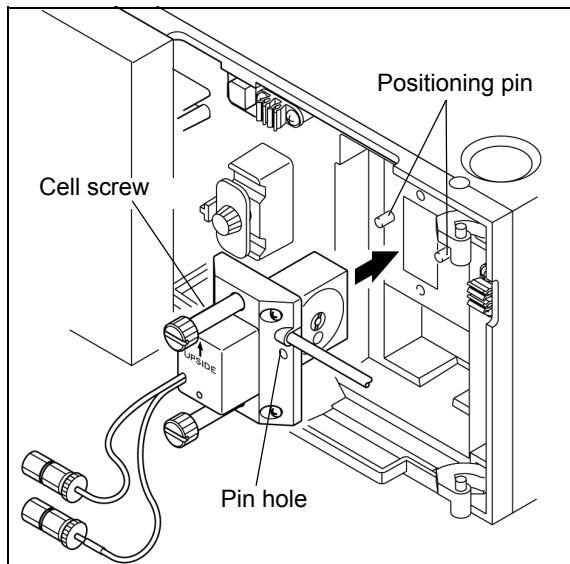


Fig. 8.9

- 5** Connect the tubing from the column to the cell inlet tube (marked with blue cover), and the cell outlet tube to the tubing going to the waste container.

NOTE

When performing the above operation, do not let any air enter the flow lines.

- 6** Re-attach the front cover.

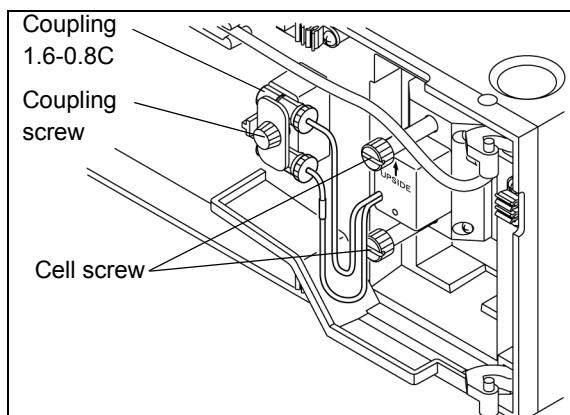


Fig. 8.10

8.3 Flow Cell Disassembly/Cleaning and Replacement

Necessary parts

Part	Type	Part No.
Cell gaskets	Consumable item	228-35097-95 (2 pieces)
Lens	Consumable item	228-14572
Cell window	Consumable item	228-18058

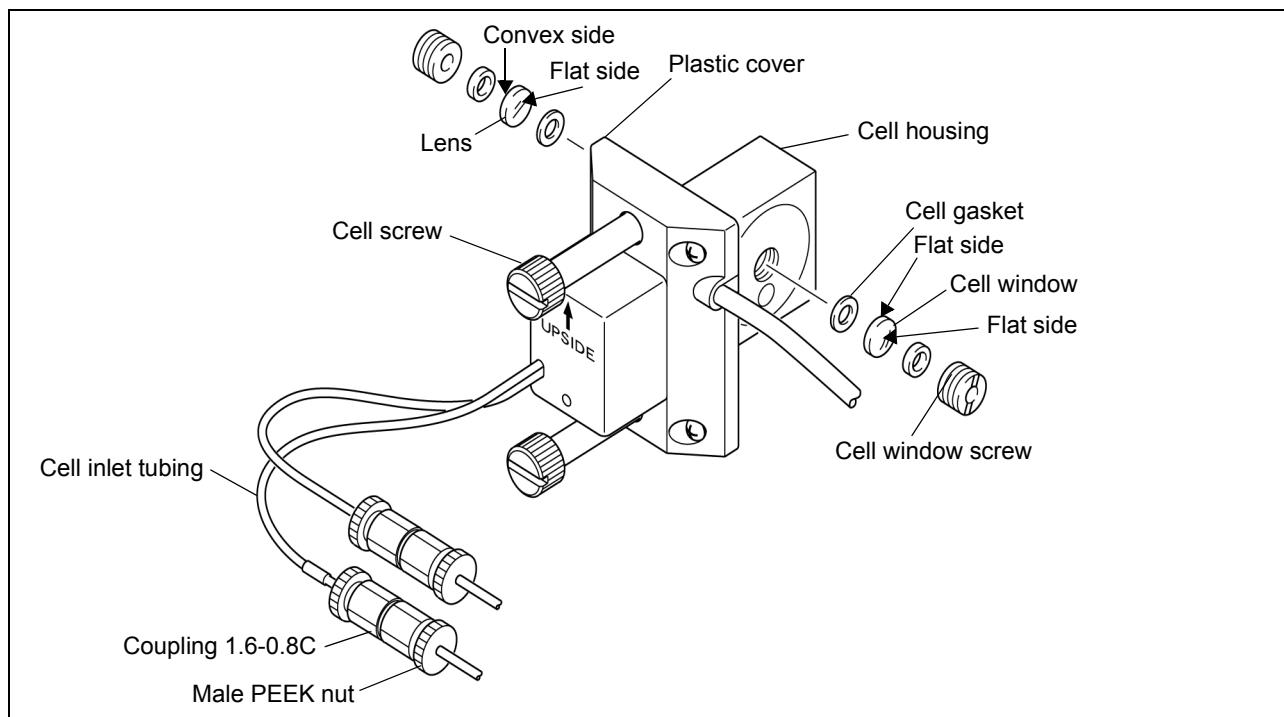


Fig. 8.11

- 1** Open the front cover.
- 2** Unscrew and remove the male PEEK nut from the coupling 1.6-0.8C on the end of the cell inlet tubing (marked with blue cover).
- 3** Remove the flow cell connector and coupling 1.6-0.8C, unscrew the cell screws (1 upper and 1 lower), and remove the flow cell from the instrument.

NOTE

Do not remove the plastic cover from the cell housing.

- 4** Unscrew and remove the cell window screws on either side of the cell. Remove the packing at the same time.

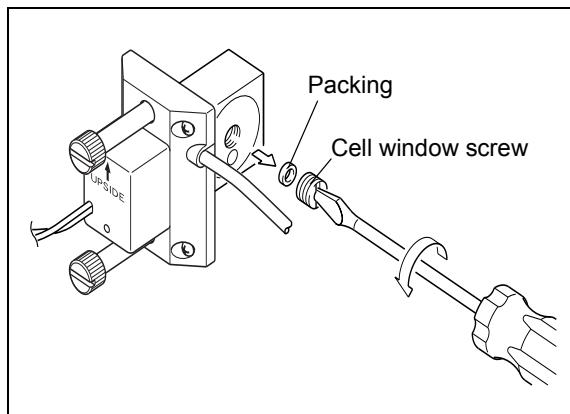


Fig. 8.12

- 5** Using a toothpick or similar utensil, remove the lens, cell window and gaskets from both sides of the cell.

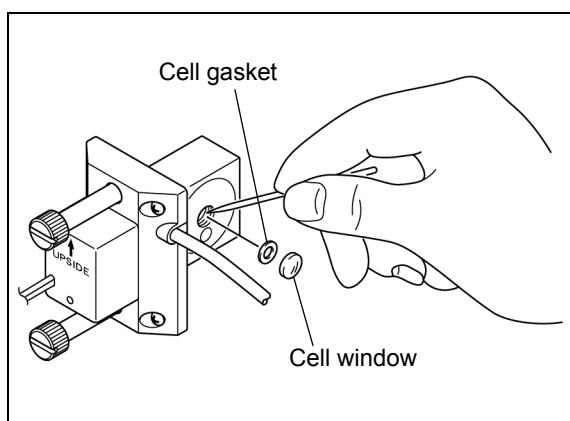


Fig. 8.13

- 6** Clean the lens and cell window for 5 minutes in an ultrasonic bath of 2-propanol. If this does not remove the stains, discard the lens or cell window, and install new ones.

NOTE

- Clean the inner surfaces of the cell housing using a clean swab moistened with 2-propanol.
- Replace the cell gaskets whenever the flow cell is dismantled.
- Remove any dust from the new gaskets before use.

- 7** Install the new cell gaskets, lenses and packing, in that order, and tighten the cell window screws.

NOTE

- Install the lens with their convex sides facing outward. Otherwise, they will be damaged.
- Do not install the lens and cell window in reverse. Doing so can ruin the performance of the detector.

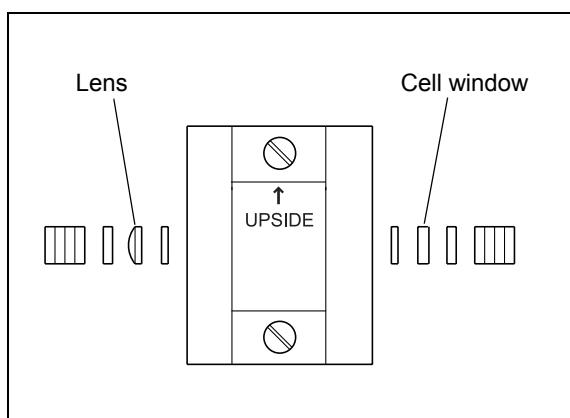


Fig. 8.14

8. Maintenance

NOTE

- Post-assembly Check

Before re-installing the flow cell on the instrument, pass mobile phase through the cell through the cell inlet tubing, and check for leaks.

- 8** Orient the cell so that the arrow on it points upward. Then align the pin holes in the cell with the positioning pins on the detector, slide the cell onto the pins, and press it flush against the detector.
- 9** Tighten the two cell retaining screws alternately.
- 10** Fix coupling 1.6-0.8C to the detector using the coupling screw.
- 11** Insert the flow cell connector into the detector.
- 12** Screw the male PEEK nut removed in step 2 into the coupling 1.6-0.8C of the cell inlet tubing.
- 13** Re-attach the front cover.

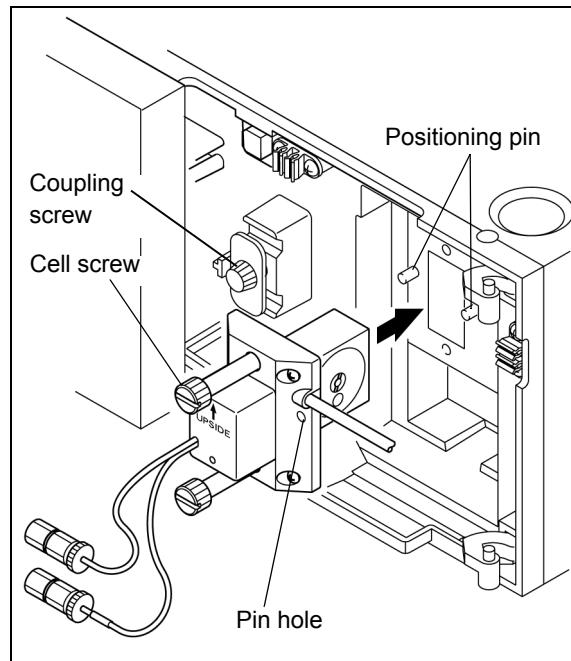


Fig. 8.15

8.4 Lamp Replacement

The SPD-20A has a D2 lamp, and the SPD-20AV has a D2 lamp and a tungsten lamp. The lamps need to be replaced periodically.

As the D2 lamp and W lamp in this detector approach the end of their life, their intensity decreases and baseline noise increases. Replace the lamps with new ones using the life ratings listed below as a guide.

Lamp life ratings

D2 (deuterium) lamp: about 2,000 hours

W (tungsten) lamp: about 2,000 hours*

* About the guaranteed life of the W lamp

According to the manufacturer, the life rating for the W lamp is defined as the average lifespan of numerous lamps. Understand that, depending on the individual lamp, it may burn out before reaching the 2,000-hour life rating.

The guaranteed life of the W lamp is 1,200 hours. The lamp can be replaced free of charge if it burns out before reaching 1,200 hours of use.

The guaranteed life of the D2 lamp is the same as the life rating, 2,000 hours.

WARNING

Before replacing a lamp, turn the detector power switch OFF and unplug it. Otherwise, fire, electric shock, or malfunction could result.

Also, do not turn on the power while the lamp housing is exposed to view. You could be exposed to harmful ultraviolet rays.

CAUTION

- Before replacing a lamp, turn off the power and allow sufficient time for the lamp to cool thoroughly. A hot lamp will cause burns.
- When replacing the lamp, be careful not to get any dust or stains on the mirror surfaces, D2 lamp, filter surfaces or tungsten lamp. If these surfaces become dirty, accurate analyses will not be possible.
- Be careful not to touch the glass parts directly with your hands when replacing the lamp. Wrap the lamp in cotton gauze when carrying it.
- When the lamp is dirty, wipe it off with lens paper soaked in ethanol.
- Be careful that the lamp does not break.
- Do not shake the lamp.

Necessary parts

Part	Type	Part No.
D2 (deuterium) lamp	Consumable item	228-34016-02
W (tungsten) lamp (SPD-20AV only)	Consumable item	670-14602

8. Maintenance

8.4.1 Removal of Top Cover and Radiating Fin Assembly

- 1** Unscrew the two top cover installation screws, and remove the top cover.
- 2** Loosen the four screws holding the radiating fin assembly in the lamp compartment, and remove the fin assembly.
The D2 lamp (and tungsten lamp for an SPD-20AV) will now be visible inside the lamp housing.

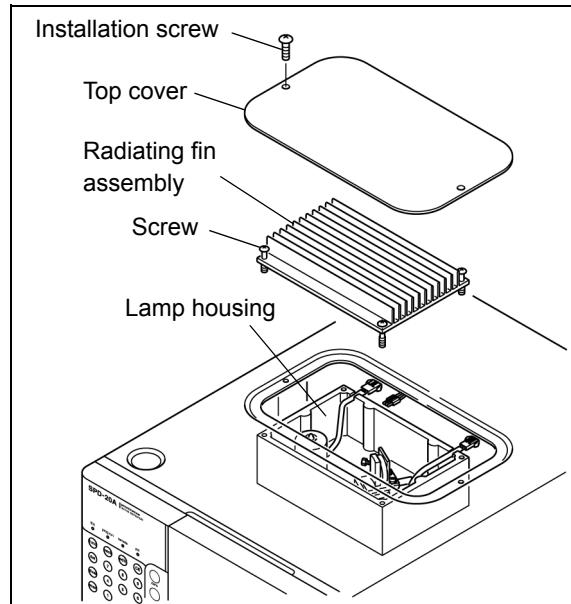


Fig. 8.16

NOTE

The fin assembly's four screws cannot be removed.

● Lamp installation layout

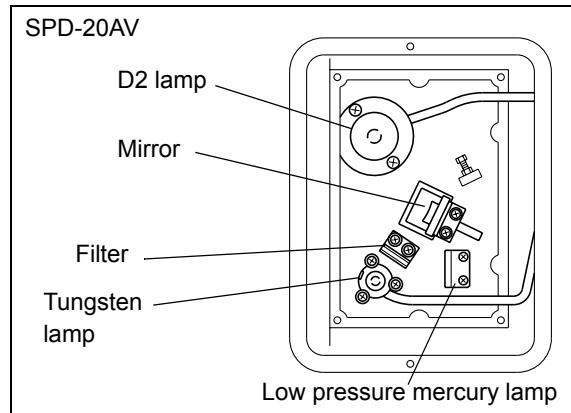


Fig. 8.17

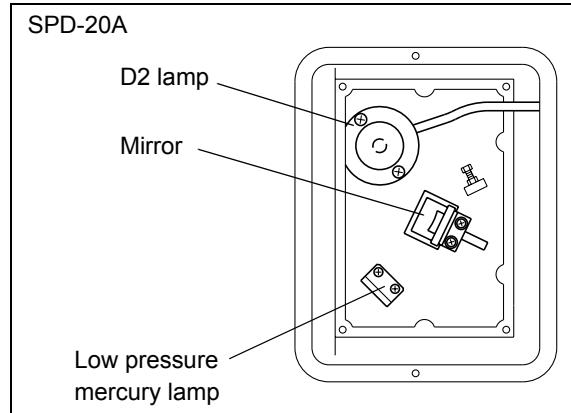


Fig. 8.18

8.4.2 Deuterium Lamp Replacement

- 1** Disconnect the 3-pin connector on the D2 lamp cable.

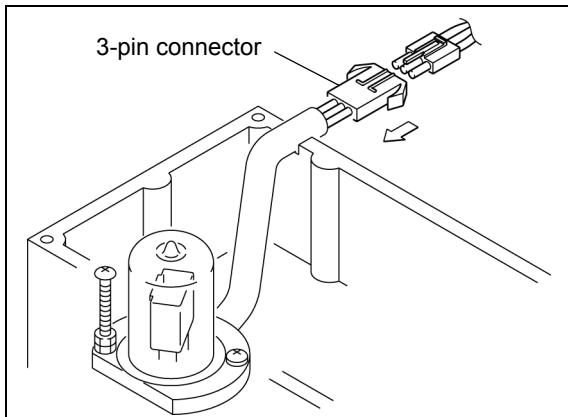


Fig. 8.19

- 2** Remove the D2 lamp screws (one long, one short), and remove the D2 lamp.

NOTE

- The nut on the long screw has been set to a particular position. Do not loosen or move it.
- Avoid dropping the screws into the detector chassis; it is difficult to retrieve them. However, be sure to retrieve them if they are dropped.

CAUTION

- Be careful that the glass of the D2 lamp does not break.
- If it is difficult to remove the D2 lamp, screw in two of the screws slowly and evenly and remove the D2 lamp from the lamp housing.

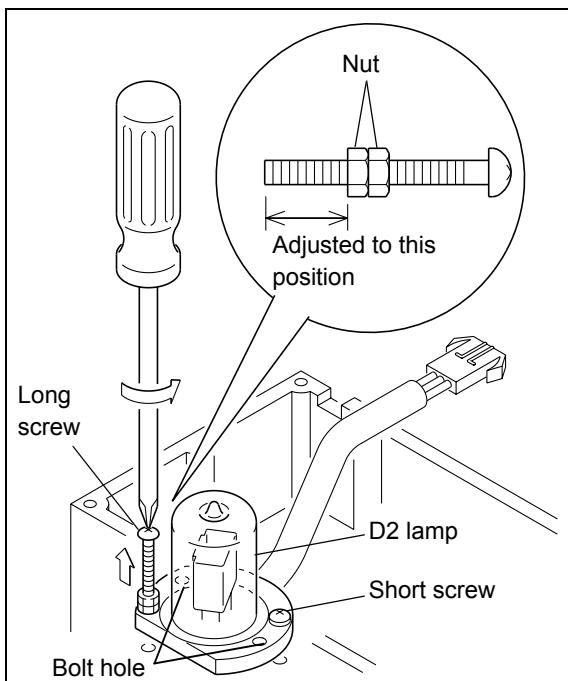


Fig. 8.20

- 3** Fit the new D2 lamp in place, and secure it with the screws.

NOTE

When positioning the lamp, hold it with gauze to keep the surfaces clean. If the lamp gets dirty, accurate analysis will not be possible.

Accurate readings cannot be taken when the glass surface is dirty.

Wipe off fingerprints on the glass using a cloth moistened with alcohol.

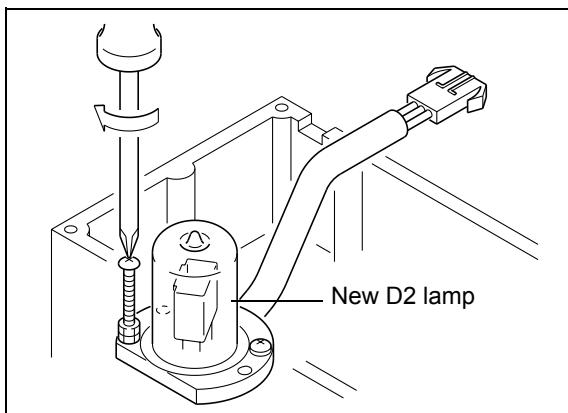


Fig. 8.21

8. Maintenance

- 4** Re-attach the 3-pin connector.

! CAUTION

Ensure that the cable is fitted into the notch in the lamp housing, with the 3-pin connector located outside the housing. If the cable is not in the notch, it could be broken, resulting in shorting or lamp failure. (The same applies for the W lamp.)

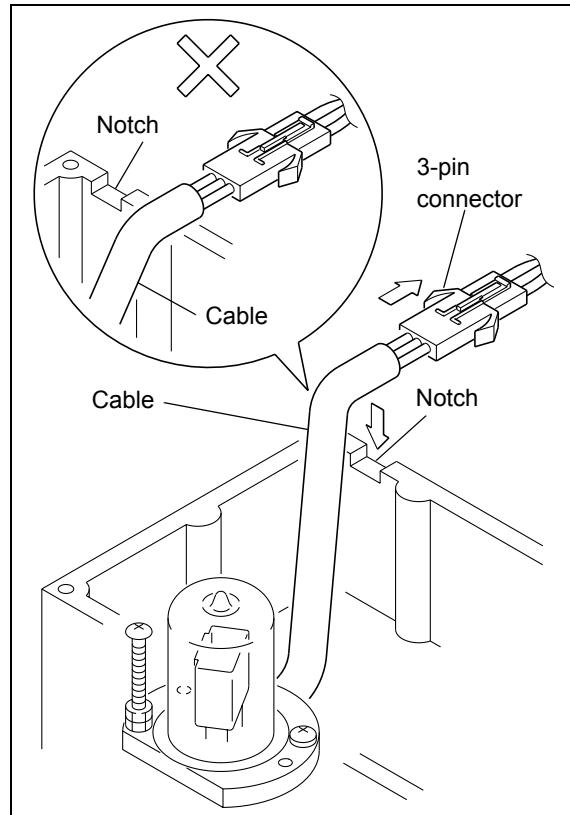


Fig. 8.22

- 5** Replace the fin assembly and top cover of the lamp housing and detector respectively, and tighten the screws.

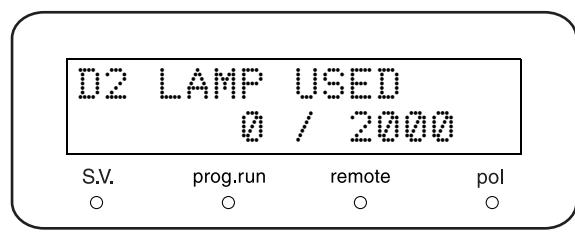
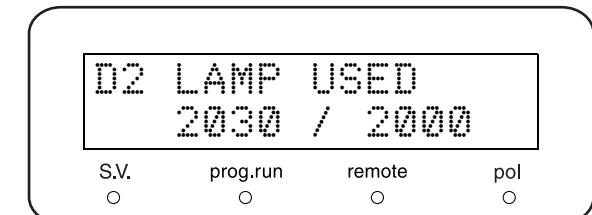
■ Resetting the Lamp Operating Time

- 1** Plug in the detector, and turn the power switch ON. The initial screen is displayed.
- 2** Display the [D2 LAMP USED] VP function (in the Maintenance Support Group).

"5.1.3 VP Function Screens" P. 5-7

"[D2 LAMP USED]" P. 5-49

[D2 LAMP USED] display



- 3** Press **0**, then **enter**.
The timer is reset, and the [D2 LAMP USED] value changes to [0].

NOTE

Dispose of used up deuterium (D2) lamps as a form of industrial waste.

"Precautions on Handling Deuterium (D2) Lamp and Tungsten (W) Lamp" P.XV

8.4.3 Tungsten Lamp Replacement (for the SPD-20AV Only)

- 1** Disconnect the 2-pin connector at the end of the W lamp cable.

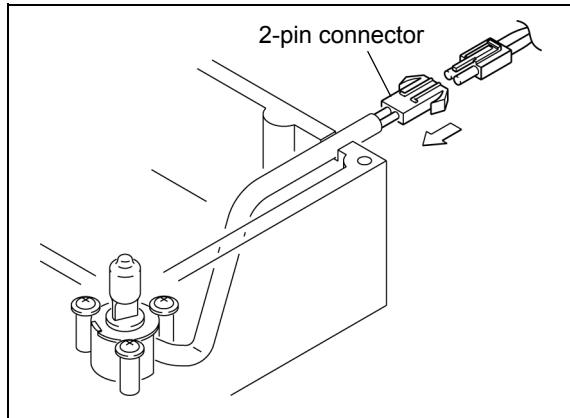


Fig. 8.23

- 2** Loosen the three lamp screws, and remove the W lamp.

NOTE

The tungsten lamp is secured by means of washers (one for each screw). To remove the lamp the screws need only to be loosened. Do not remove the screws or washers from the lamp housing.

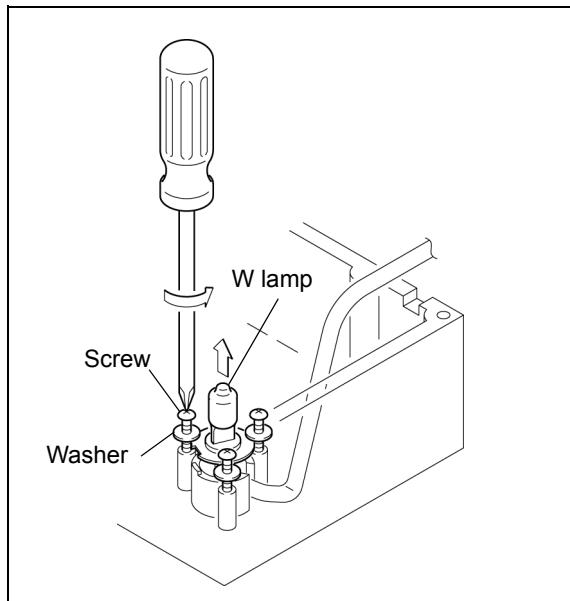


Fig. 8.24

- 3** Place the new lamp in position in the lamp socket, matching the projection on the socket to the notch in the lamp flange.

NOTE

When positioning the lamp, hold it with gauze to keep the surface clean.

Accurate readings cannot be taken when the glass surface is dirty.

Wipe off fingerprints on the glass using a cloth moistened with alcohol.

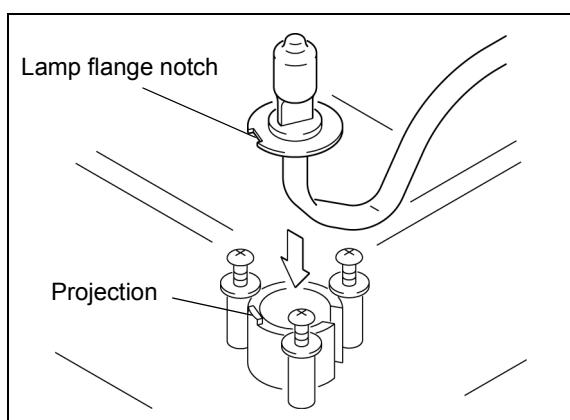


Fig. 8.25

- 4** Re-tighten the three lamp screws alternately.

8. Maintenance

- 5** Re-attach the 2-pin connector.

! CAUTION

Ensure that the cable is fitted into the notch in the lamp housing, with the 2-pin connector located outside the housing. If the cable is not in the notch, it could be broken, resulting in shorting or lamp failure. (The same applies for the D2 lamp.)

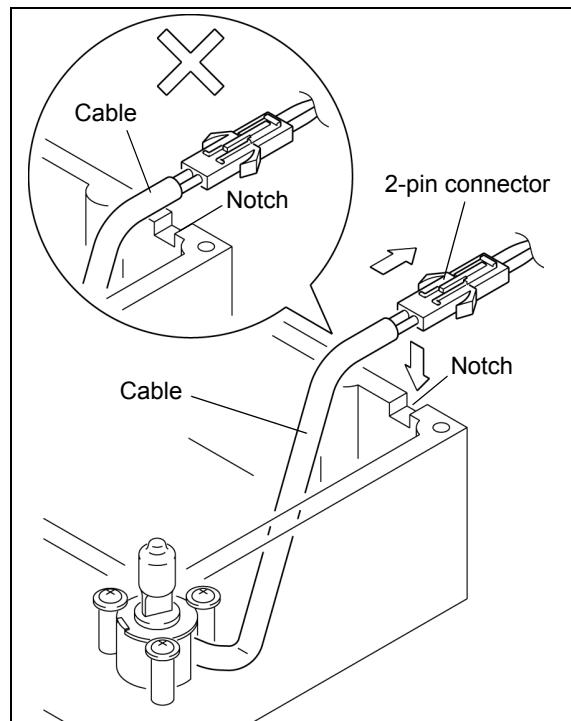


Fig. 8.26

- 6** Replace the fin assembly and top cover of the lamp housing and detector respectively, and tighten the screws.

■ Resetting the Lamp Operating Time

- 1** Plug in the detector, and turn the power switch ON.
The initial screen is displayed.

- 2** Display the [W LAMP USED] VP function (in the Maintenance Support Group).
 "[W LAMP USED]" P. 5-49

[W LAMP USED] display

W LAMP USED
2020 / 2000

S.V. prog.run remote pol

- 3** Press **0**, then **enter**.
The timer will be reset, and the [W LAMP USED] value will change to [0].

W LAMP USED
0 / 2000

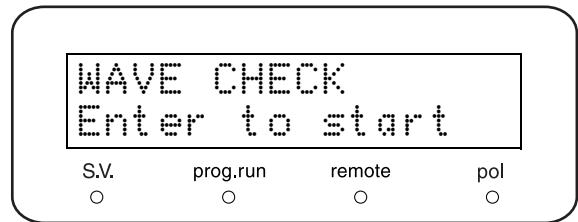
S.V. prog.run remote pol

- 4** Press **CE** twice.
The initial screen is displayed.

■ Setting Brightness

1 Press **func** repeatedly until [CONTROL] is displayed.

2 Press **enter**.
[WAVE CHECK] is displayed.



3 Press **func** repeatedly until [W POWER] is displayed.

4 If the [W POWER] value is above 0, press **0**, then **enter** to reset the value to 0.

5 Press **CE**.
[CONTROL] is displayed.

6 Press **back**.
[PARAMETER] is displayed.

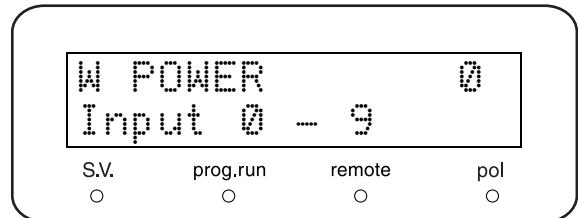
7 Press **enter**.
[LAMBDA 1] is displayed.

8 Press **5**, **4**, **0** and **enter**.
This sets a wavelength of 540nm.

"4.1 Single Wavelength Mode Settings"
P. 4-2

Set [LAMP] to [2] previously.

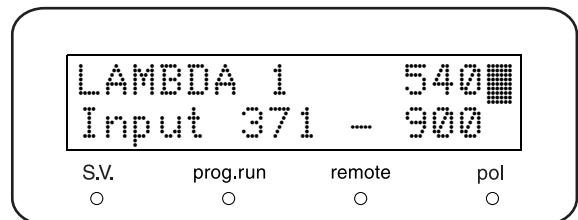
[W POWER] display



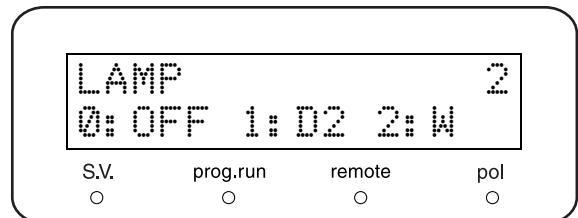
9 Press **CE**.
[PARAMETER] is displayed.

10 Press **func** repeatedly until [MONITOR] is displayed.

[LAMBDA] display



[LAMP] display



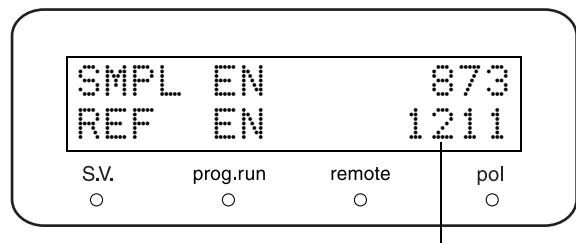
8. Maintenance

11 Press **enter**.

[REF EN] is displayed.

- If the value for [REF EN] is greater than [1000], lamp replacement is complete.
- If the value for [REF EN] is lower than [1000], proceed to step 12 below.

[REF EN] display



Lamp replacement complete if this is over [1000]

12 Return the display to [W POWER]. Increase the [W POWER] value to [1]. Increasing this value causes the [REF EN] reading at 540nm to increase proportionally. Then return the display to [REF EN]. If the value for [REF EN] is greater than [1000], lamp replacement is complete. If not, continue incrementing [W POWER] by units of 1 until this occurs.

NOTE

The maximum [W POWER] value is [9].

["\[W POWER\]" P. 5-39](#)

NOTE

Dispose of used up tungsten (W) lamps as a form of industrial waste.

["Precautions on Handling Deuterium \(D2\) Lamp and Tungsten \(W\) Lamp" P.XV](#)

8.5 Fuse Replacement

⚠️ WARNING

- Before replacing fuses, turn off the power and unplug the instrument.
 - For replacement, only use fuses of the correct type and rating.
- Failure to heed the above could result in fire, electric shock or short circuits.

The correct rating for the fuses is:

- Necessary parts for 100V AC / 120V AC instrument

Part	Type	Part No.
250V 4AT (5 × 20)	Replacement part	072-02004-22

- Necessary parts for 230V AC / 240V AC instrument

Part	Type	Part No.
250V 3.15AT (5 × 20)	Replacement part	072-02004-21

- 1** Use a flathead screwdriver to pry off the fuse holder cover.

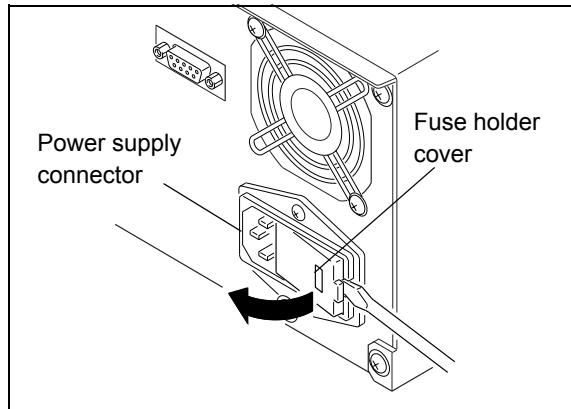


Fig. 8.27

- 2** Remove both fuse holders.

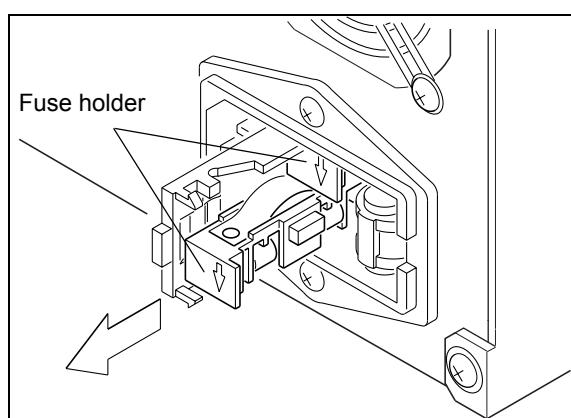


Fig. 8.28

8. Maintenance

3 Remove the blown fuse from its holder.

4 Press the new fuse into the holder.

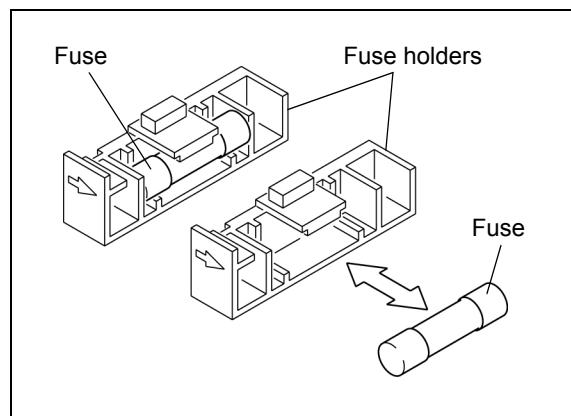


Fig. 8.29

5 Orient the fuse holders so that the arrows point to the bottom, and place them into the detector.

6 Replace the fuse holder cover, so that it clicks into place.

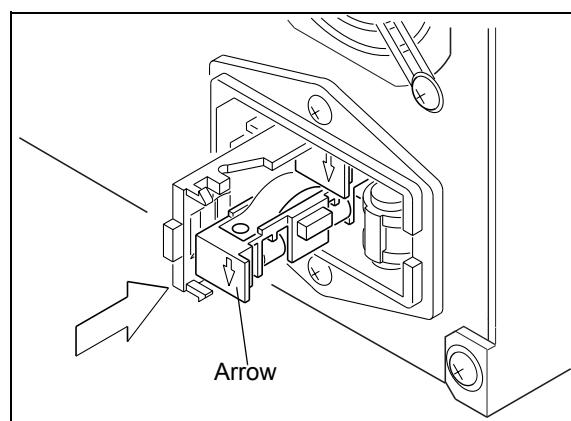


Fig. 8.30

⚠ CAUTION

When the fuse holder cover is opened, the power voltage selector (a rotary switch) is exposed. Do not touch this selector, or the instrument could be damaged.

"9.1.3 Power Supply Connection" P. 9-6

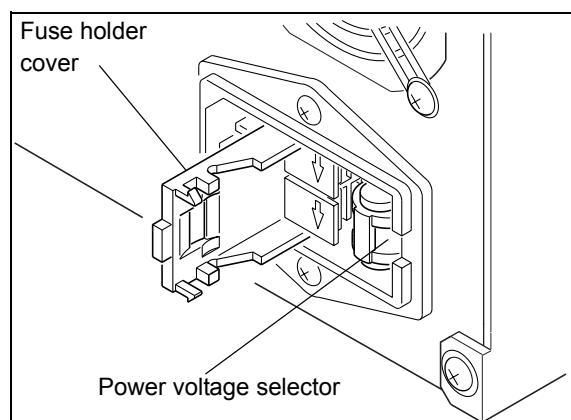


Fig. 8.31

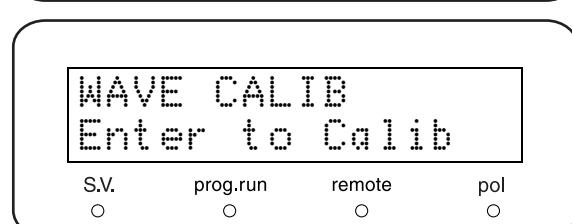
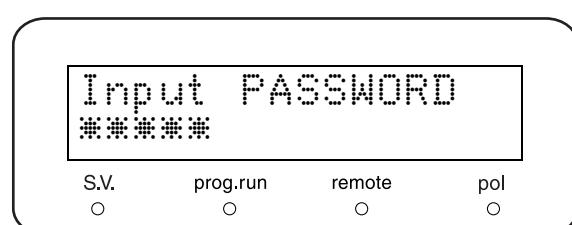
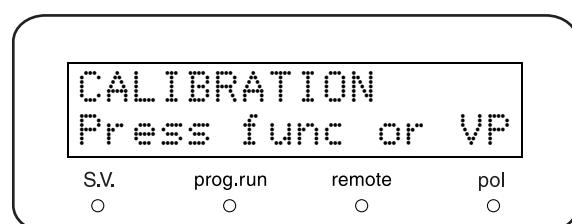
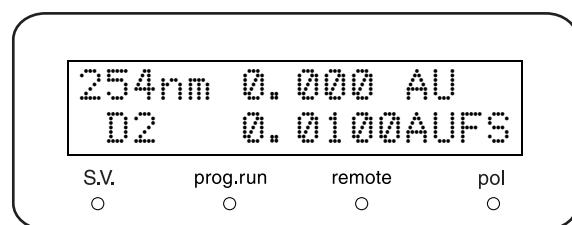
8.6 Wavelength Accuracy Calibration

Measure the peak wavelengths in the emission line spectra produced by the mercury lamp and deuterium lamp, and calibrate them to minimize wavelength variance.

Necessary parts

Part	Type	Part No.
Distilled water, methanol, or acetonitrile	-	-
Syringe	Standard accessory	046-00001
Syringe adapter	Standard accessory	228-15672-91

- 1 Use the pump to pump water, methanol, or acetonitrile through the flow cell, or fill the cell with any of these three using a syringe and syringe adapter.
Refer to "8.2.2 Cleaning the Flow Cell" for the proper use of the syringe and syringe adapter.
- 2 Make sure there are no air bubbles in the flow cell, and then install the cell into the detector.
- 3 Press **CE** repeatedly until the initial screen is displayed.
- 4 Press **VP** repeatedly until [CALIBRATION] is displayed.
- 5 Press **func**.
The password input screen appears.
- 6 Input the password.
The default password is [00000].
- 7 Press **func** repeatedly until [WAVE CALIB] is displayed.

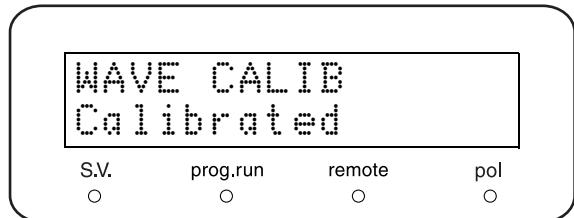


8. Maintenance

8 Press **enter**.

Wavelength accuracy calibration is run automatically.

9 [Calibrated] appears on the screen when the calibration ends.



10 Make sure that the calibration has ended successfully.

 ["7.5.5 Wavelength Accuracy Check" P. 7-10](#)

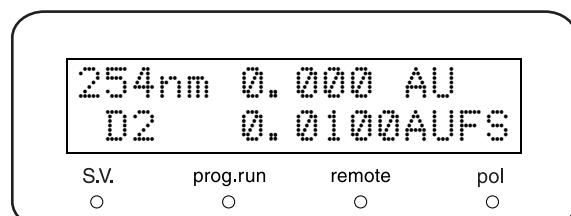
8.7 Absorbance Accuracy Calibration

Calibrate absorbance accuracy so as to minimize the difference between the absorbance value displayed on the instrument when the tested absorbance calibration filter is in place and the absorbance value of the filter.

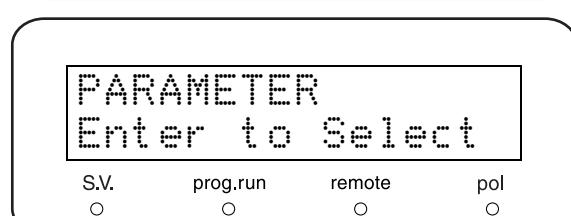
Necessary parts

Part	Type	Part No.
Filter holder	Tool	228-35011-91
Absorbance calibration filter (certification sheet included)	Tool	228-40251

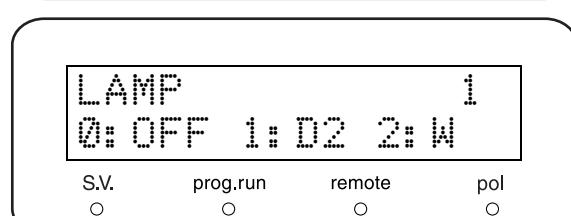
- 1 Press **CE** repeatedly until the initial screen is displayed. And set the instrument to the single wavelength mode.



- 2 Press **func**. [PARAMETER] appears.

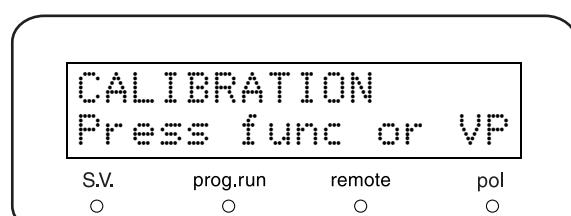


- 3 Press **func** repeatedly until [LAMP] is displayed.



- 4 Press **1**. This turns on the deuterium lamp.

- 5 Press **CE** repeatedly until the initial screen is displayed.

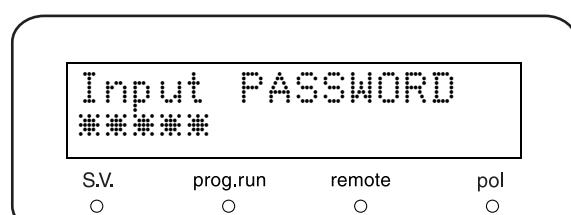


- 6 Press **VP** repeatedly until [CALIBRATION] is displayed.

- 7 Press **func**.

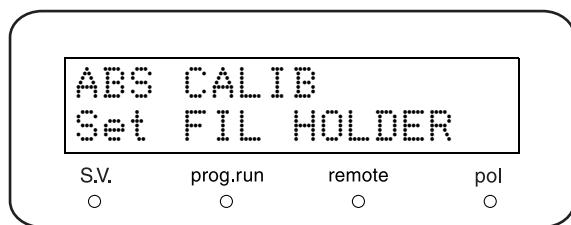
- 8 The password input screen appears.

- 9 Input the password.
The default password is [00000].



8. Maintenance

- 10** Press **func** repeatedly until [ABS CALIB] is displayed.



- 11** [ABS CALIB Set FIL HOLDER] and [ABS CALIB Enter to Calib] will display alternately. Remove the standard flow cell, attach the filter holder to the detector and place the cover over the filter holder.

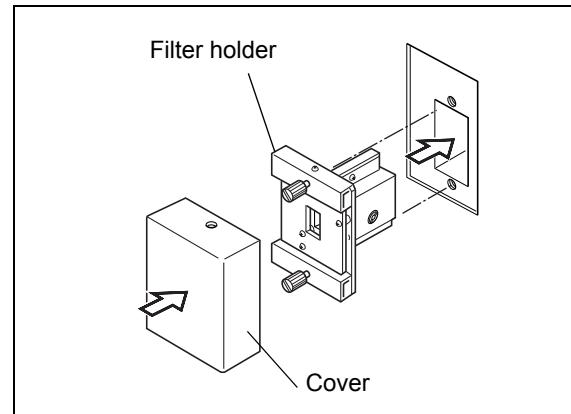
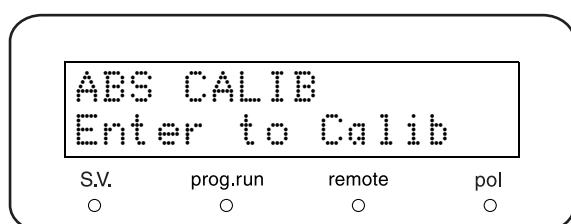
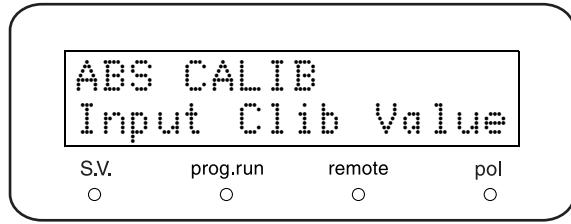
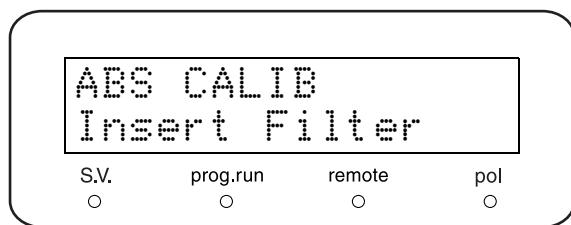


Fig. 8.32

- 12** Press **enter**.

- 13** After about 10 seconds, [ABS CALIB Insert Filter] and [ABS CALIB Input Clib Value] will display alternately. Insert the absorbance calibration filter and place the cover over it.



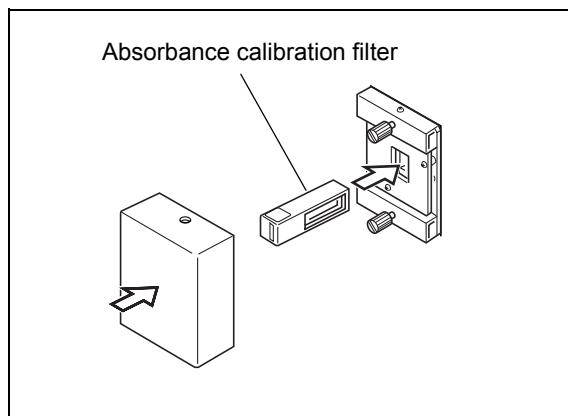


Fig. 8.33

14 Input the absorbance value [0.***] for a 6nm bandwidth at 245nm, which is printed on the certificate attached to the absorbance calibration filter, and press **enter**.

15 The [Calibrating] indication changes to [Calibrated] after about 2 minutes, and the calibration ends.

16 Follow the steps below to make sure that the calibration has ended successfully.

17 Remove the absorbance calibration filter from the filter holder, and attach the filter holder cover.

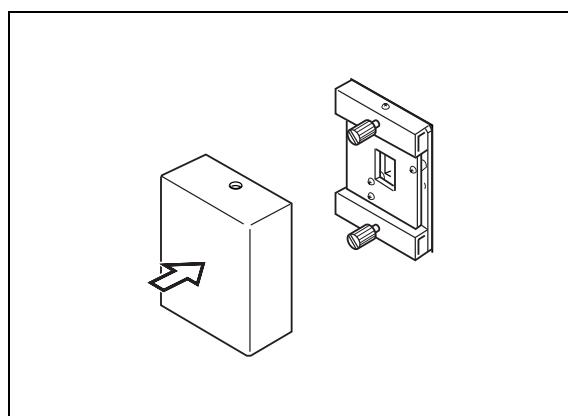
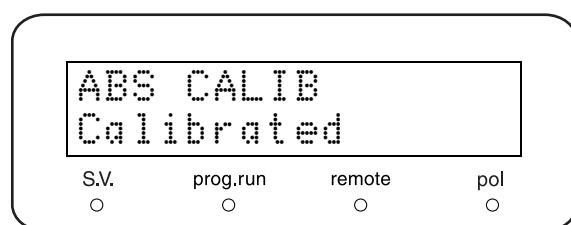
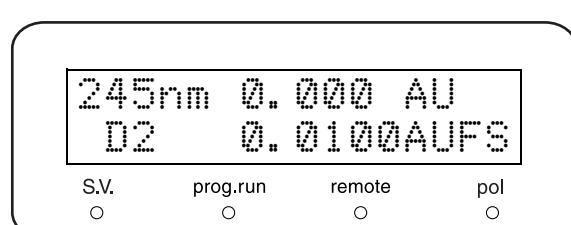


Fig. 8.34

18 Set the wavelength to 245nm.

["4.1.1 Setting Wavelength \[LAMBDA 1\]"
P. 4-2](#)



19 Press **CE** twice to return to the initial screen.

8. Maintenance

20 Press **zero**.

21 Make sure the absorbance is [0] on the display.

22 Insert the absorbance calibration filter, then attach the cover.

23 Record the absorbance value shown on the initial screen.

24 Confirm that the discrepancy between the displayed absorbance value and the absorbance value for a 6nm bandwidth at 245nm, printed on the certificate attached to the absorbance calibration filter, is within $\pm 3\%$.

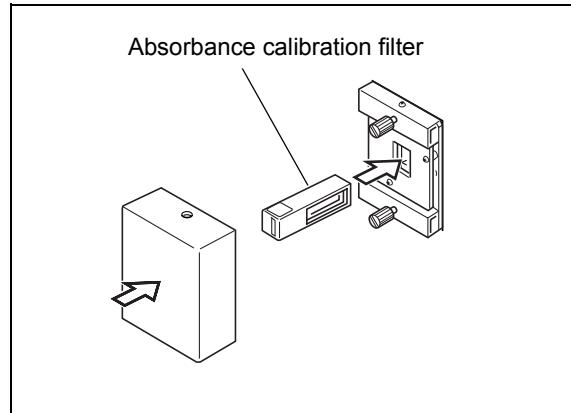


Fig. 8.35

8.8 Absorbance Linearity Calibration

When the flow cell is filled with a solution that has an extremely high absorbance, measure the intensity of light transmitted through the flow cell and correct the absorbance linearity.

Necessary parts

Part	Type	Part No.
Methanol for LC	-	-
Caffeine + methanol solution Concentration: 90mg/L	-	-
Syringe	Standard accessory	046-00001
Syringe adapter	Standard accessory	228-15672-91

- 1 Set the detector to single wavelength mode, the wavelength to 272nm, [AUX RANGE] to 4 (4AU/FS), [RESPONSE] to 10 (2 sec.), and [LAMP] to 1 (deuterium lamp).

 "4.1 Single Wavelength Mode Settings"
P. 4-2

272nm 0.000 AU
D2 0.0100AUFS

S.V. prog.run remote pol

- 2 Pump methanol through the flow cell with the pump.

- 3 Make sure the baseline is stabilized, and press **zero**.

- 4 Press **CE** repeatedly until the initial screen is displayed.

- 5 Press **VP** repeatedly until [CALIBRATION] is displayed.

CALIBRATION
Press func or VP

S.V. prog.run remote pol

- 6 Press **func**.
The password input screen appears.

- 7 Input the password.
The default password is [00000].

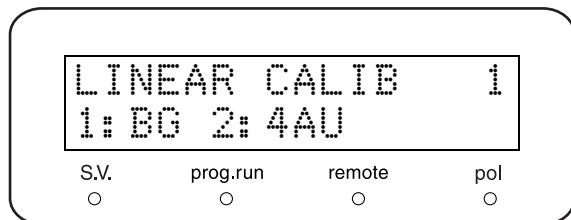
Input PASSWORD

S.V. prog.run remote pol

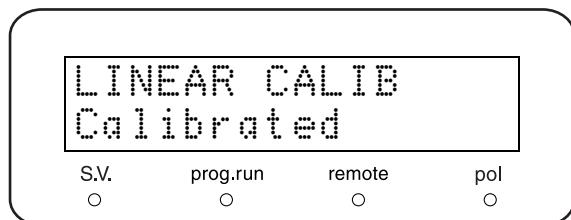
- 8 Press **func** repeatedly until [LINEAR CALIB] is displayed.

8. Maintenance

9 Press **1**, then **enter**.



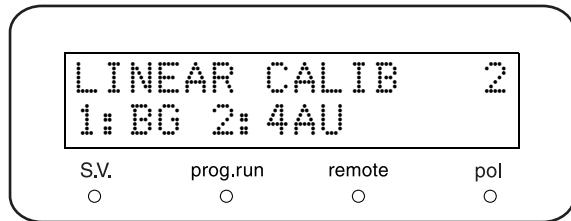
10 After [Calibrated] is displayed, press **func** or **back** to change the display.



11 Press **func** or **back** repeatedly until [LINEAR CALIB] is displayed.

12 Inject the caffeine + methanol solution (concentration: 90mg/L) into the flow cell using the syringe and syringe adapter.

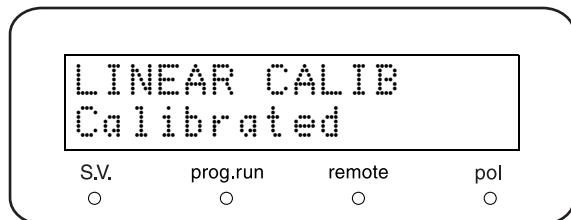
13 Press **2**, then **enter**.



14 When [Calibrated] appears on the screen, turn the power switch OFF and turn it back ON again. The detector restarts and the compensation becomes effective.

15 Pump methanol through the flow cell and thoroughly flush out the caffeine + methanol solution.

16 Make sure the calibration has ended successfully.
 "7.5.7 Linearity Check" P. 7-16



8.9 Exterior Cleaning

If the instrument cover or front panel becomes dirty, wipe it clean with a soft dry cloth or tissue paper. For persistent stains, clean the exterior using the following procedure.

- 1** Dip a piece of cloth in a dilute neutral detergent and twist firmly to remove excess liquid. Use this cloth to scrub the soiled area of the exterior surface of the instrument.
- 2** Dip a piece of cloth into water and twist firmly to remove excess liquid. Use this cloth to wipe away all the remaining detergent. Use a dry cloth to remove all moisture from the exterior surface of the instrument.

NOTE

Do not allow spilled water to remain on the instrument surface, and do not use alcohol or thinner-type solvents to clean the surfaces. These can cause rusting and discoloration.

8. Maintenance

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9

Technical Information

Contents

9.1	Installation	9-2
9.2	Specifications	9-33
9.3	Maintenance Parts	9-35
9.4	Introduction to HPLC System.....	9-37
9.5	Mobile Phase Characteristics.....	9-40

9.1 Installation

9.1.1 Installation Site

■ Suitable Sites and Preparation

To ensure safe operation, install the instrument in a suitable location that satisfies the following conditions.

WARNING

- Ample ventilation

The solvents used with the HPLC system are often flammable and toxic.

Therefore, the room where the instrument is installed must be well-ventilated.

- No fire sources used near the instrument

The solvents used with the HPLC are often flammable. Therefore, the use of open flame where the instrument is installed must be strictly prohibited. Also, do not install in the same room with equipment that emits or could potentially emit sparks.

- Fire extinguishers permanently available

Have fire extinguishers permanently available in case of fire.

- Protective equipment provided near the instrument

If solvent gets into the eyes or onto the skin, it must be flushed away immediately.

Provide equipment, such as eye wash stations and safety showers, as close to the instrument as possible.

CAUTION

- Avoid dust or corrosive gas

To ensure a long service life of the instrument and preserve its performance levels, avoid installing it in places subject to large amounts of dust or corrosive gas.

- Keep away from equipment generating strong magnetic fields

To ensure proper operation, do not install the instrument in places subject to strong magnetic fields.

If the power supply line is subject to high electrical noise, install a surge protector.

- Install the instrument in the location that satisfies the following conditions to preserve the performance:

- room temperature is between 4 and 35°C, with minimal temperature variation through a day.
- air currents from heating or air conditioning equipment are not directed on the instrument.
- sunlight does not shine directly on the instrument.
- there is no vibration.
- humidity stays within 20 - 85%.
- place without condensation

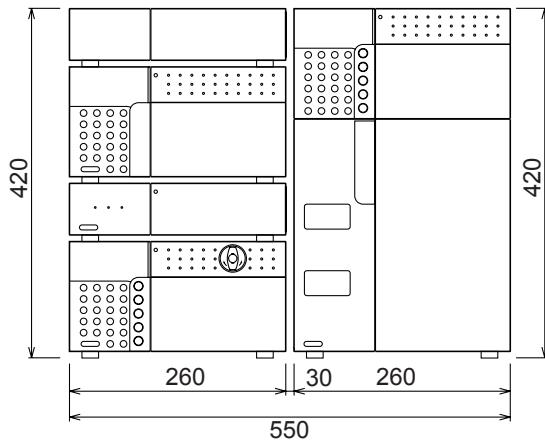
■ Required Installation Space

CAUTION

- The weight of this instrument is 13kg. During installation, consider the entire weight combined with other LC components.
The lab table on which this instrument is installed should be strong enough to support the total weight of the LC system. It should be level, stable and have depth of at least 600mm.
If these precautions are not followed, the instrument could tip over or fall off the table.
- Keep at least 100mm between the rear of the instrument and the wall.
This allows for sufficient air circulation to provide cooling and prevent the instrument from overheating and impairing the performance.

Typical system configurations and required installation spaces are shown in the figures below.

● System 1 (with Manual Injector)



● System 2 (with Autosampler)

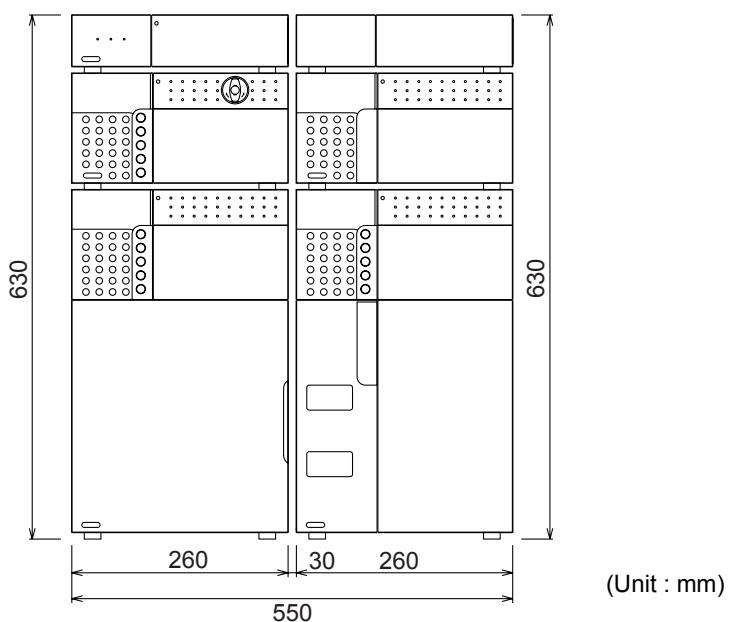


Fig. 9.1

9. Technical Information

9.1.2 Installation

■ Remove the Shipping Screws

In order to prevent shock during transportation, the instrument is fixed with the shipping screws. Remove these screws prior to installation.

NOTE

When the instrument is used without removing the shipping screws, system makes noise because of vibration.

- 1 Loose and remove the shipping screws (with washer).

 "2.3 Right Side and Base Panel" P. 2-4

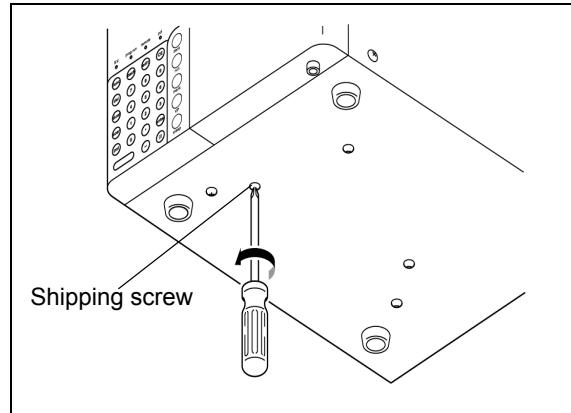


Fig. 9.2

■ Installation

The instrument is designed for stacking with other Shimadzu HPLC components.

 "9.4 Introduction to HPLC System" P. 9-37

NOTE

In order to achieve the most sensitive and precise detection, set the detector up near the column oven. It is standard to place it on top of the column oven.

⚠ CAUTION

When the LC-20A series components are stacked on each other, the clearance between the components is only 5 mm.

Use caution to avoid pinching your fingers between the components.



Fig. 9.3

■ Stacking Brackets

The use of commercially available stacking brackets is recommended. These brackets limit the possibility of the instrument falling off the lab table during an earthquake or the like. Various grades of stacking brackets are available.

Fasten the instrument firmly in place by attaching stacking brackets to both the right and left sides.

For more details, contact your Shimadzu representative.

An example of stacking bracket placement is shown in "Fig. 9.4".

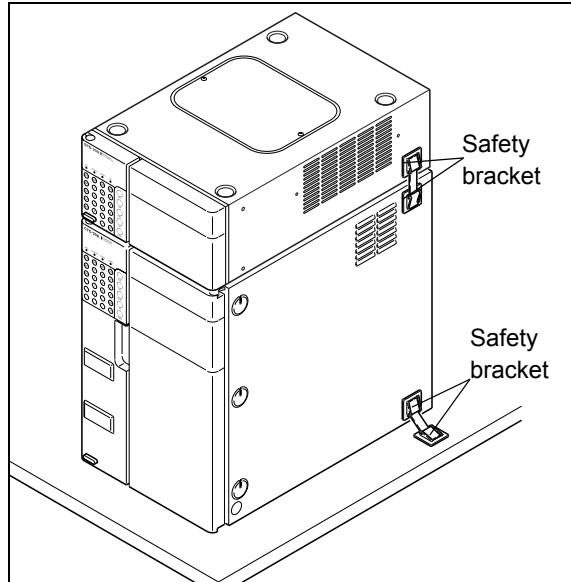


Fig. 9.4

9. Technical Information

9.1.3 Power Supply Connection

The following table shows the electrical voltage, power consumption, and frequency.

Part No.		Power Supply Voltage (indicated on the instrument)	Consumption	Frequency
SPD-20A	SPD-20AV			
228-45003-31	228-45004-31	AC100V (100V~)	160VA	50/60Hz
228-45003-32	228-45004-32	AC120V (120V~)		
228-45003-28	228-45004-28	AC220V-230V/AC240V		
228-45003-38	228-45004-38	(220V-230V/240V~)		

⚠️ WARNING

The power supply voltage is indicated on the cover of the fuse holder on the back of the instrument. Be sure to connect the instrument to a power supply of the voltage indicated. Use of any other voltage could result in fire, electric shock or malfunction.

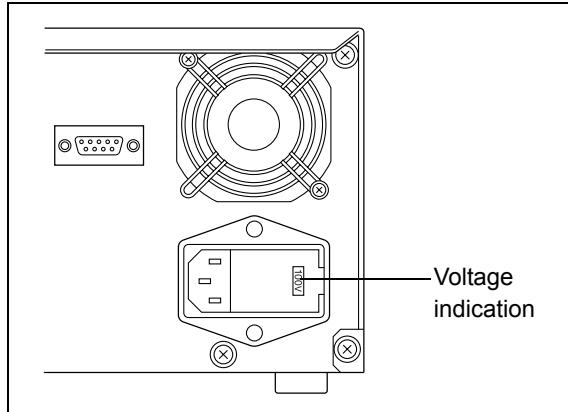


Fig. 9.5

Power Supply Voltage	Voltage Indication on Fuse Holder
100V±10%	100V a.c
120V±10%	120V a.c
220V±10% 230V±10%	230V a.c
240V±10%	240V a.c

Verify that the power outlet to be used for connection has sufficient capacity. If capacity is insufficient, a power outage or voltage drop can occur, affecting not only this instrument, but other instruments connected to the same power supply.

■ Notes on 200V Systems

For Product Nos. 228-45003-28/38 and 228-45004-28/38, it is necessary to change the internal voltage setting of the power connector depending on the voltage of the power source being used. If the power source is 220V to 230V, the factory setting (230V) need not be changed, but for 240V follow the procedure below to change the voltage setting.

- 1** Turn the power switch OFF.
- 2** Disconnect the power cord from the power cord connector.
- 3** Open the fuse holder cover using a flathead screwdriver.

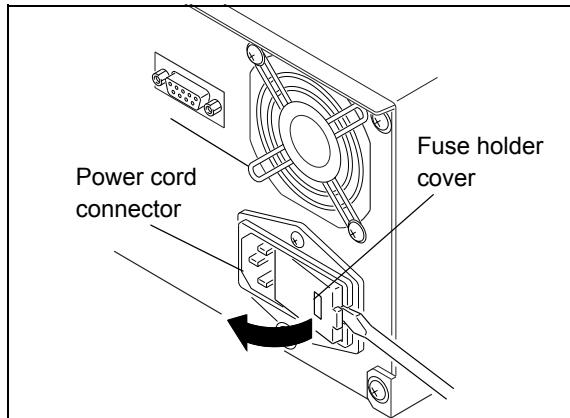


Fig. 9.6

- 4** After removing the rotary switch, which displays the fuse holder voltage, from the fuse holder, change the setting by turning the switch to one of the values given below.

Power Supply Voltage	Power voltage selector setting
100V±10%	100V a.c
120V±10%	120V a.c
220V±10%	230V a.c
230V±10%	230V a.c
240V±10%	240V a.c

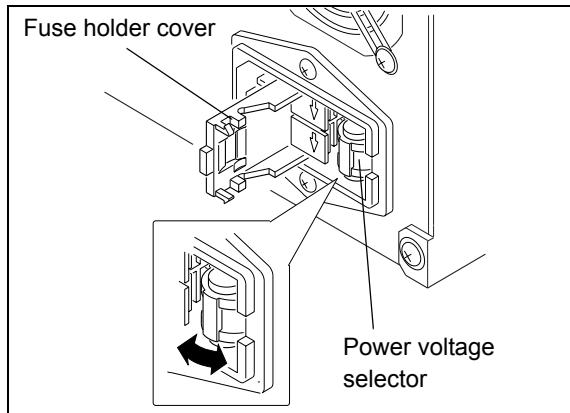


Fig. 9.7

- 5** Replace the fuse holder cover, so that it clicks into place.

9. Technical Information

■ Connection to Power Outlet

! WARNING

Handle the power cord with care, and observe the following precautions to avoid cord damage, fire, electric shock or instrument malfunction.

- Do not place heavy objects on the cord.
- Keep hot items away from the cord.
- Do not modify the cord.
- Do not bend the cord excessively or pull on it.
- To unplug the instrument, pull the plug itself, NOT the cord.

If the cord is damaged, replace it immediately.

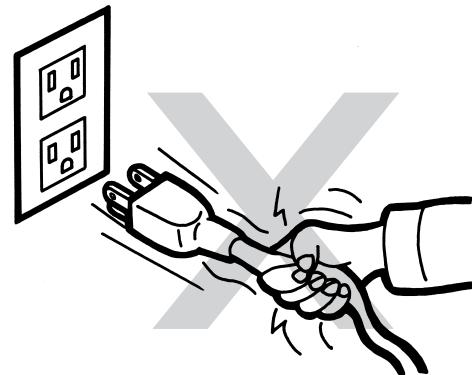


Fig. 9.8

! CAUTION

Before plugging in the instrument, make sure that the power switch is OFF.

- 1 Insert the connector side of the power cord into the power cord connector at the back of the instrument.
- 2 Insert the plug side of the power cord into the power supply outlet.

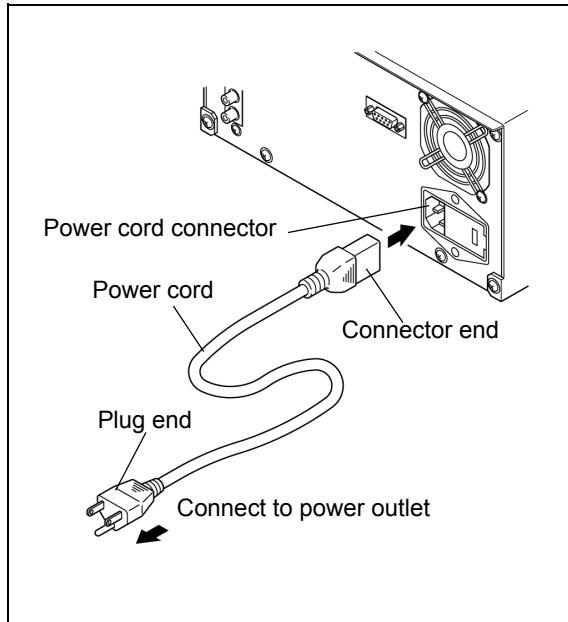


Fig. 9.9

■ Grounding

! WARNING

The three-line type power cable provided as an accessory includes the grounding wire.

Be sure to ground through this cable in order to prevent electrical shock and to ensure stable operation of the instrument.

9.1.4 Prior to Plumbing

Many different types of tubings and connectors are used to plumb the instrument at installation. It is necessary to cut tubings and mount connectors prior to the plumbing. In this section, instructions and precautions for these preparations are described.

■ Types of Tubing and Connectors

The tubing and connectors used for the plumbing are made of stainless steel (SUS) or resin as follows.

Stainless steel (SUS)

- Stainless steel tubing 1.6 O.D. × 0.3 I.D.
- Male nuts, 1.6 MN
- Ferrules 1.6F

Resin

- FEP tubing, PTFE tubing, ETFE tubing, PEEK tubing, PE tubing, etc.
- Male PEEK nut
- PEEK ferrules
- PTFE ferrules

■ Cutting Tubing

Cut provided tubing to the proper lengths for installation.

Cutting SUS Tubing

- 1** Position the provided file (for cutting SUS tubing, part No. 670-18928-0) diagonally against the tubing, and cut up around the tubing.

NOTE

Cut up the tubing so that the cut surface is at a right angle.

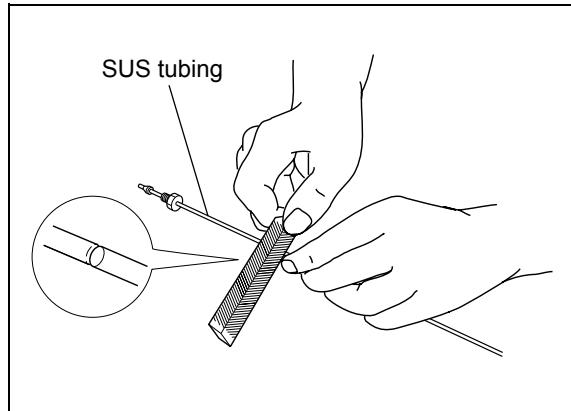


Fig. 9.10

- 2** Holding the tubing at equal distances from the cutting up line, bend it up and down and from side to side to cut off.

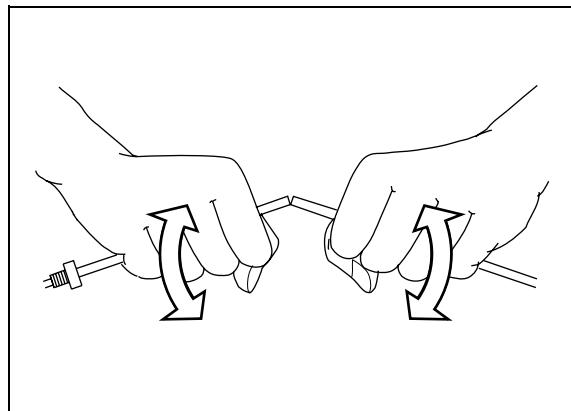


Fig. 9.11

- 3** File the cut surface to make smooth and straight.

⚠ CAUTION

- Make the cut surface at right angle. Otherwise, dead volume will be created and may cause chromatographic peak broadening.
- Make sure that the inner diameter of the tubing is not deformed. Otherwise, the tubing may be clogged.

Cutting Resin Tubing

Cut off the resin tubing at a right angle using a cutter.

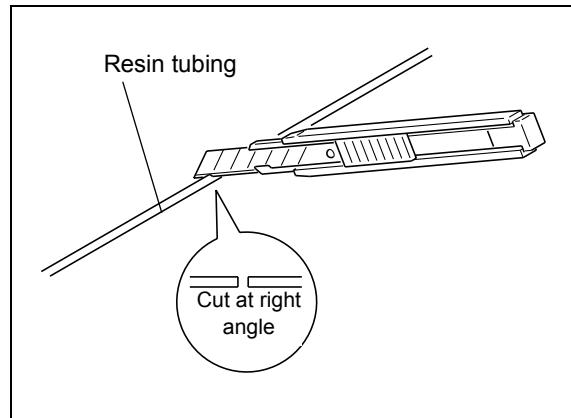


Fig. 9.12

■ Connecting Tubing

1 Mount a male nut and a ferrule to the tubing.

⚠ CAUTION

Install stainless steel male nuts and ferrules on SUS tubing, and resin nuts and ferrules on resin tubing. If resin male nuts are mounted on SUS tubing, the nuts will be damaged and leakage may occur.

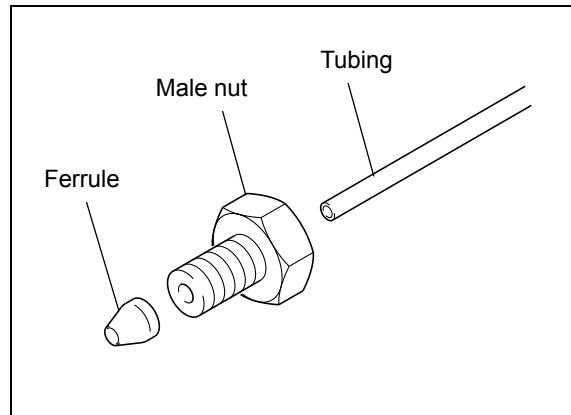


Fig. 9.13

- 2** Insert the end of the tubing, with the ferrule on it, into the appropriate opening. Then tighten the male nut.

The ferrule will be secured on the tubing.

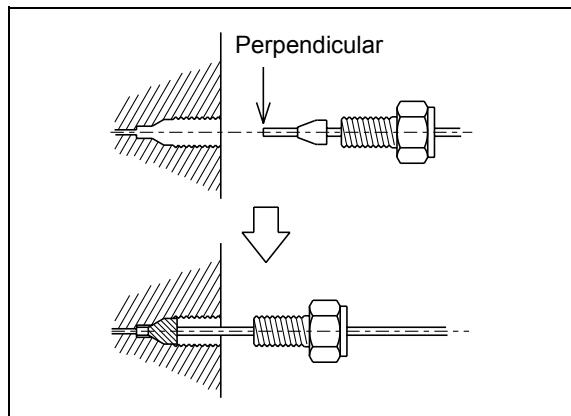


Fig. 9.14

⚠ CAUTION

- Insert the tubing completely into the opening, until it butts against the end of the opening.
Otherwise, dead volume will be created and may cause chromatographic peak broadening.
- Do not overtighten the male nut.
Otherwise, the threads will be damaged.

NOTE

- For an SUS male nut:
Use the open-end wrench to tighten and loosen the nut.
If the nut is to be connected to a union or other part that is not secured, use a second wrench to secure the union.
- For a resin male nut:
Tighten and loosen the nut by hand.

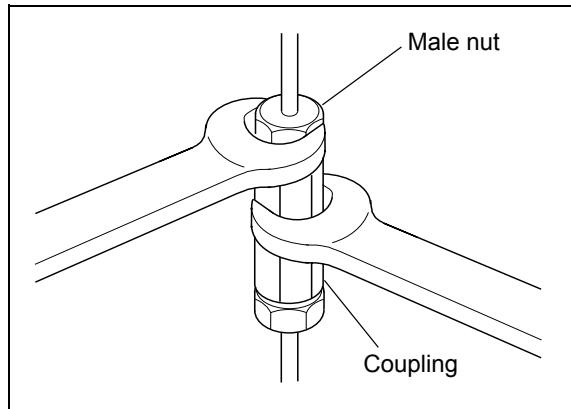


Fig. 9.15

- 3** Loosen and move the male nut slightly to verify that the ferrule is secured on the tubing.

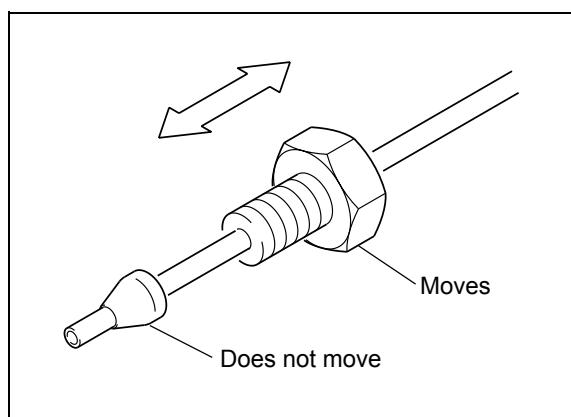


Fig. 9.16

■ Protective Plugs

Inlets and outlets of the instrument are fitted with protective plugs (bushings, stop plugs, caps and similar items) to keep out dirt and dust during shipment.

When the instrument is not connected to other LC system components, replace the protective plugs.

Otherwise, dirt and dust may cause clogging of the instrument.

Keep the plugs, and replace them when the instrument will be left not in use for a long time.

NOTE

- For stop plugs:
Use the wrench provided to unscrew and screw in the plugs.
- For resin plugs:
Remove and replace the plugs by hand.

9.1.5 Plumbing

⚠ CAUTION

- Before plumbing, turn OFF the power supply to all the system components and unplug them.
- For plumbing, use the appropriate parts listed in "1.3 Component Parts".
- Connect only the tubing described in the instructions.

Otherwise, injury or equipment failure may cause.

The necessary plumbing is as follows:

- **Cell inlet plumbing** Tubing that carries mobile phase from the column outlet to the instrument.
- **Cell outlet plumbing** Tubing that drains away mobile phase after analysis.
- **Leakage plumbing** If leakage occurs in any of the system devices, it is directed to the lowest instrument in the stack, and from there, out of the system.

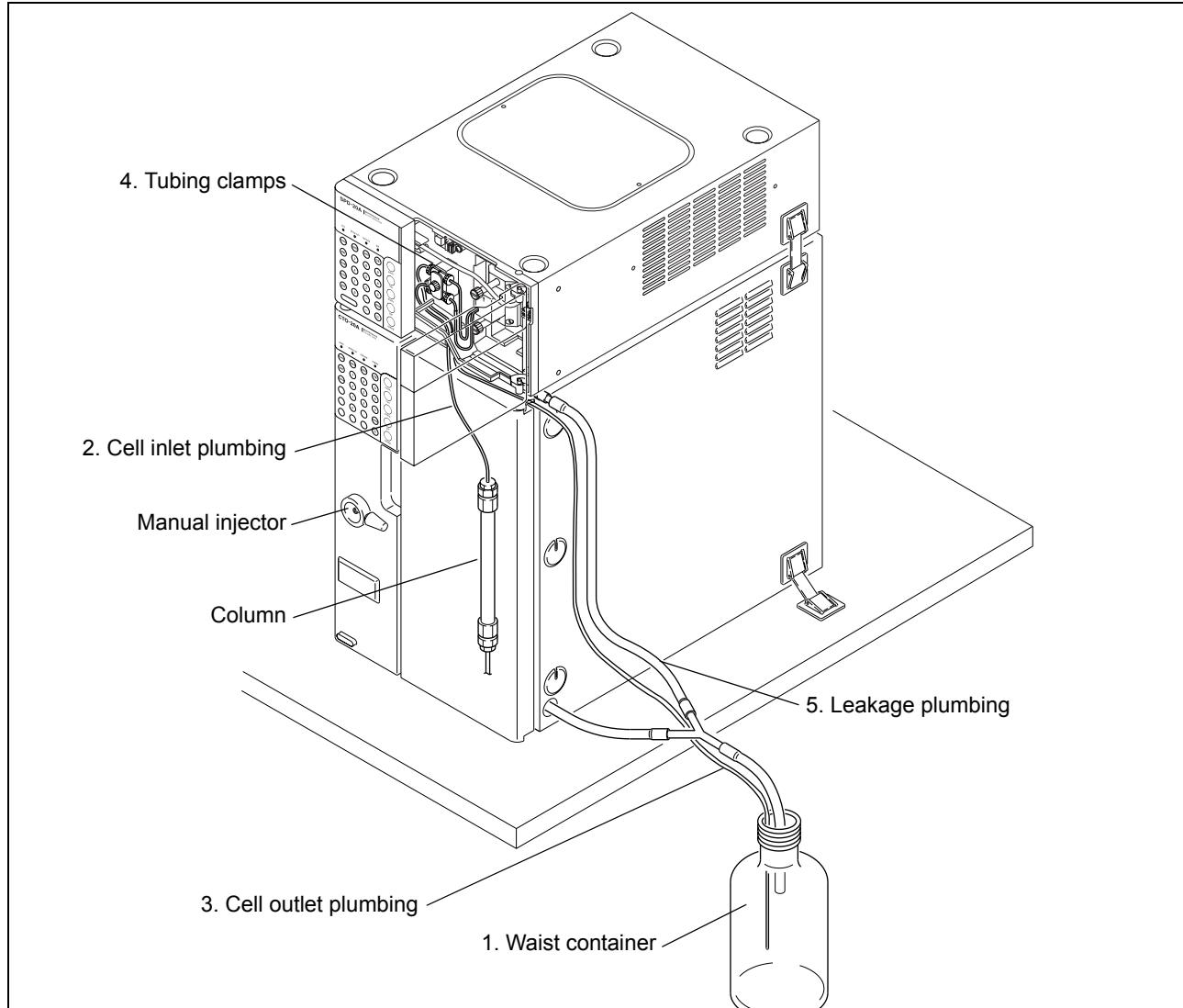


Fig. 9.17

■ Waste Container Preparation

Before connecting the plumbing, prepare glass or metal waste containers to receive the mobile phase drained after analysis.

WARNING

Do not use cracked or damaged bottles. They could break.

CAUTION

A mobile phase with a low dielectric constant, such as hexane, requires special precautions. Its insulating properties can cause static electricity to collect in the waste liquid container. When using such a mobile phase, use a metal waste container and ground the container.

CAUTION

The waste container must be positioned lower than the instrument (for example, on the floor). If it is positioned higher than the instrument, liquid will not drain, and will leak from the connections.

■ Cell Inlet Plumbing

- 1** Open the front cover.

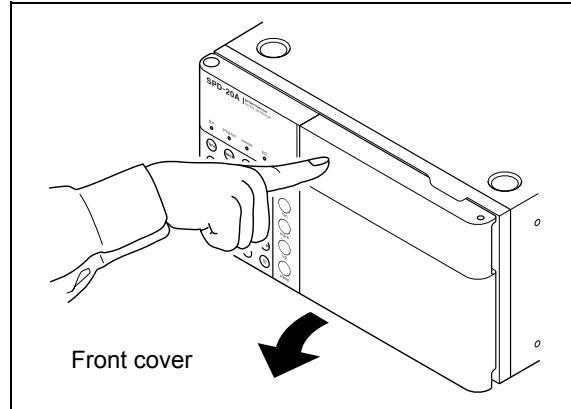


Fig. 9.18

- 2** Cut the PEEK tubing (50 cm) to a length appropriate for connecting the column outlet and the cell inlet tubing.

NOTE

For safety and to be prepared in case of an accident, such as damage to the PEEK tubing, cover the outside of the PEEK tubing with FEP tubing before use. Cut the FEP tubing 35 to 40mm shorter than the PEEK tubing and slide it over the PEEK tubing. Expose the ends of the PEEK tubing equally, so that male nuts can be affixed to both ends.

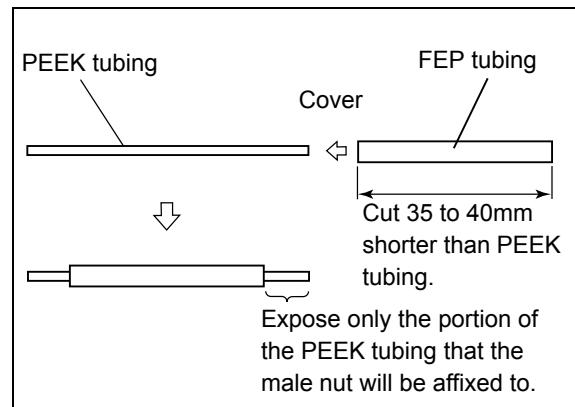


Fig. 9.19

- 3** Attach the male PEEK nut to the both ends of the PEEK tubing.

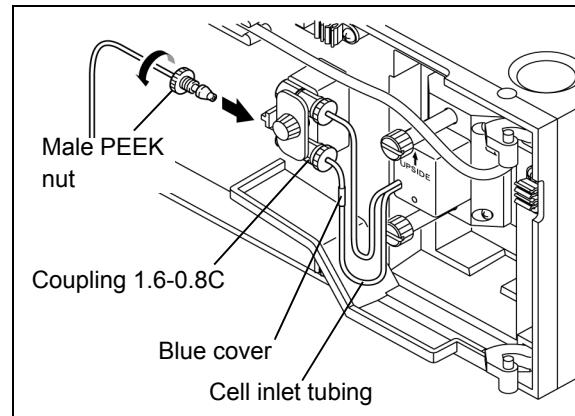


Fig. 9.20

- 4** Remove the stop plug from the column outlet.

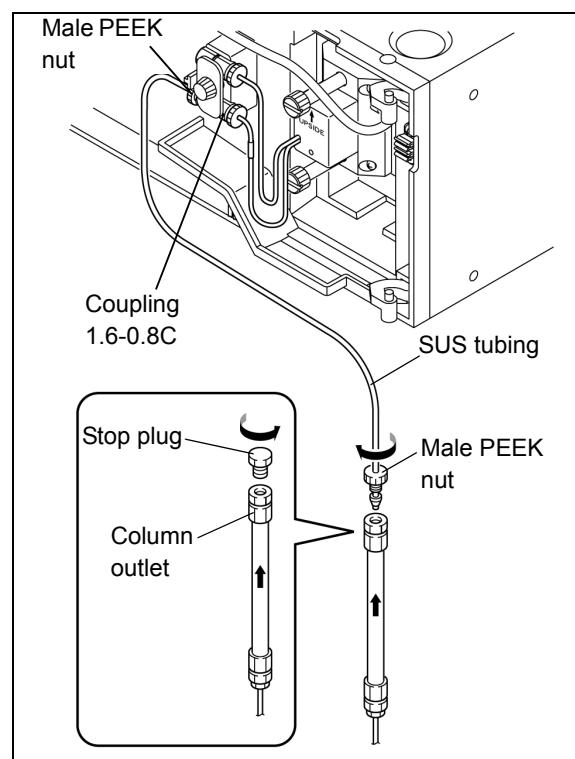


Fig. 9.21

- 5** Insert the male PEEK nuts on the PEEK tubing into the column outlet and the coupling 1.6-0.8C connected to the cell inlet tubing (marked with blue cover).

9. Technical Information

■ Warnings Concerning the Handling of Tubing

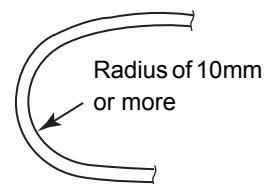
⚠ WARNING

(1) Solvents that cannot be used

Do not use any of the solvents below, as the stress cracking they can cause will greatly weaken the PEEK resin.
concentrated sulfuric acid, concentrated nitric acid, dichloroacetic acid, acetone*, tetrahydrofuran (THF), dichloromethane, chloroform, dimethyl sulfoxide (DMSO)

*With a gradient or similar performance check, a low-concentration water solution of 0.5% acetone concentration or less may be used temporarily without causing problems.

(2) Bending the PEEK tubing through a small bend radius weakens the strength of the bent section. If the PEEK tubing must be bent, bend it at a radius of 10mm or more. Moreover, position the tubing as naturally as possible, without forcing it to bend or fastening it in place.



(3) Damage to the surface of the PEEK tubing can also decrease the strength of the tubing.

Be careful not to damage the surface when cutting the tubing.

■ Cell Outlet Plumbing

1 Attach a male PEEK nut to one of the ends of the tubing (provided, 2m).

2 Screw the male PEEK nut of the tubing into the coupling 1.6-0.8C.

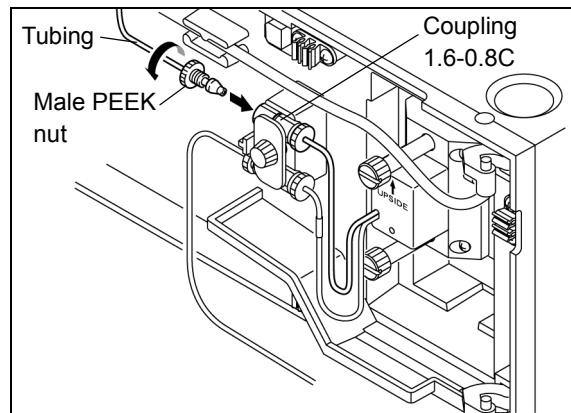


Fig. 9.22

- 3** Put the other end of the tubing into the waste container.

NOTE

- To ensure a smooth flow of liquid, put the tubing into the container with its end pointing downward.
- Do not shorten the tubing on the cell outlet tubing side. One of its functions is to apply back pressure to the flow cell outlet, which prevents the generation of air bubbles.
Cutting the tubing to less than 2m will interfere with this function.

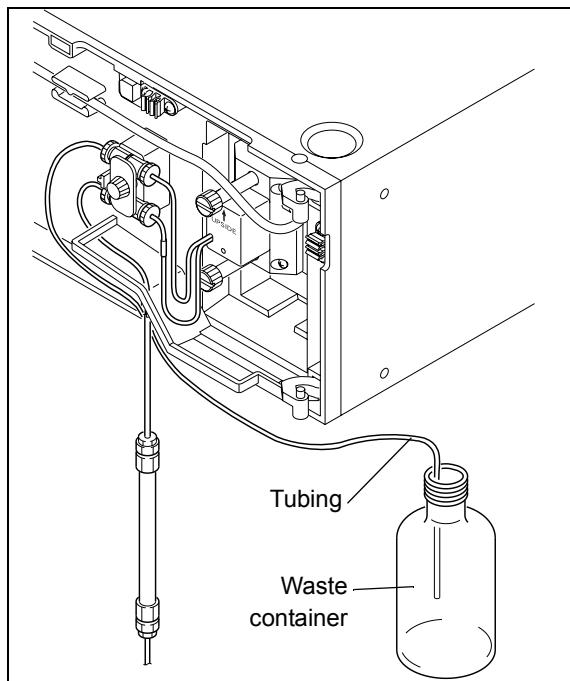


Fig. 9.23

■ Supporting the Plumbing

- 1** Press the tubing into the tubing clamps.

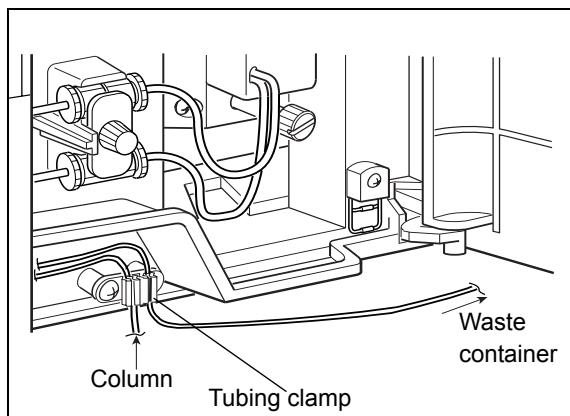


Fig. 9.24

- 2** Close the front cover.

NOTE

Route the tubing through the bottom of the front cover.

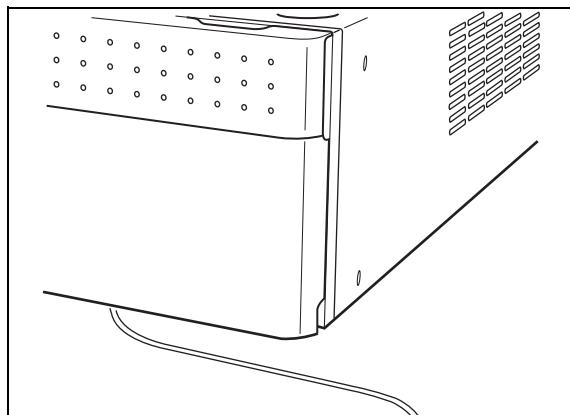


Fig. 9.25

■ Connecting Leakage Drain Tubing

This instrument is designed so that if leaks occur internally (except the column oven), the leaked liquid flows down to the lowest level of the instrument and is drained into the waste container.

The procedure for connecting leakage drain tubing is given below.

(Apart from the waste container and L-Joint, all parts indicated in the figure at right are provided with the instrument. The L-Joint is provided with the pump.)

NOTE

- For connecting, cut a silicone tubing into the length in which both of the cut parts will not sag.
- Set the silicone tubing so that its edge does not touch the liquid surface in the waste container; otherwise the drainage becomes difficult to flow.
- There is an opening for replacing the lamp in the top of the instrument. Therefore, avoid placing it on the bottom tier and place it as close to the top as possible.

Bottom of Instrument

- 1** Insert the drain OUT, STD into leakage drain outlet from the front of the instrument.
- 2** Turn the drain OUT, STD counterclockwise 45° to secure.

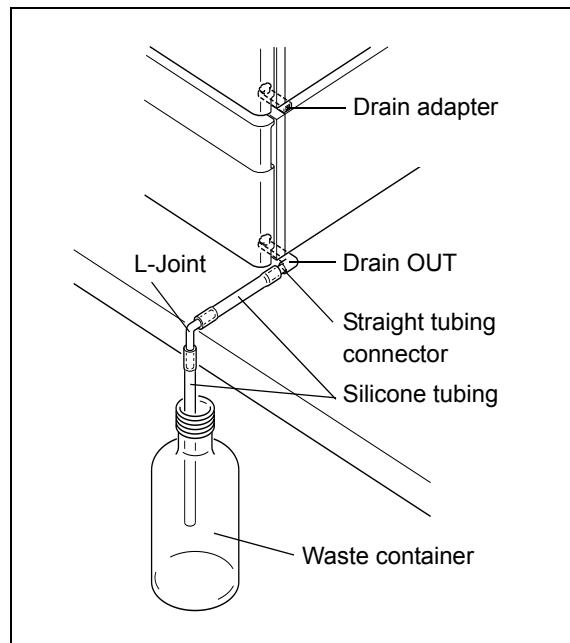


Fig. 9.26

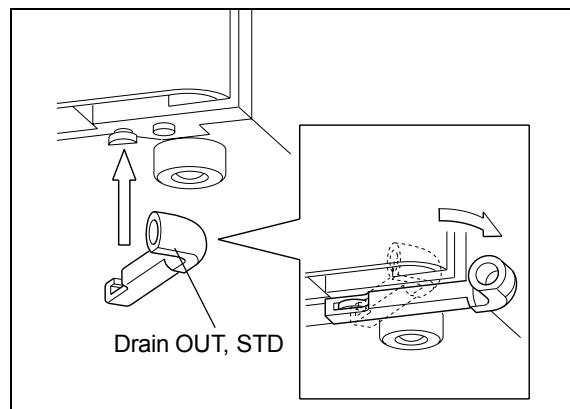


Fig. 9.27

- 3** Connect one end of the silicone tubing to the drain OUT, STD with a straight tubing connector.

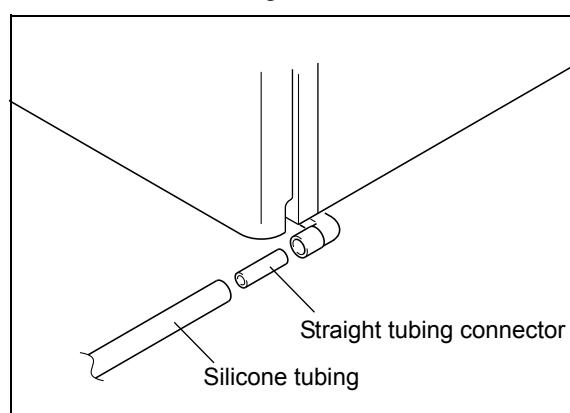


Fig. 9.28

- 4** Cut the silicone tubing at the edge of the table, and connect an L-Joint. Let the L-Joint head downward as in the right figure and connect the other cut part of the silicone tubing.
- 5** Insert the other end of the silicone tubing into the waste container.

NOTE

To ensure a smooth flow of liquid, insert the silicone tubing into the container with its tip pointing downward.

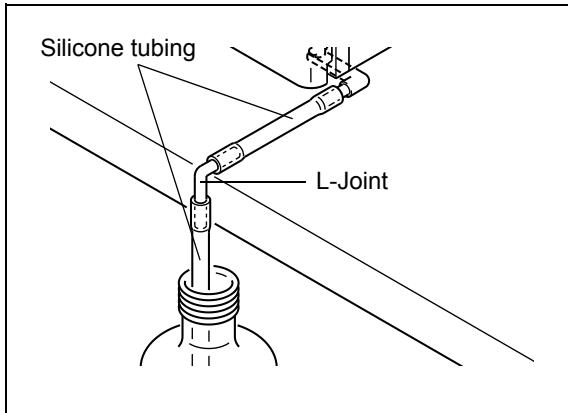


Fig. 9.29

Second Instrument from Bottom**NOTE**

Leaks from the column oven are drained separately (See column oven Instruction Manual.). If any components are installed on top of the column oven, carry out the same procedure as in "[Installation on Top of the Column Oven](#)" on next page.

- 1** Insert the drain adapter into the position shown in the illustration, and slide it on the instrument of bottom.

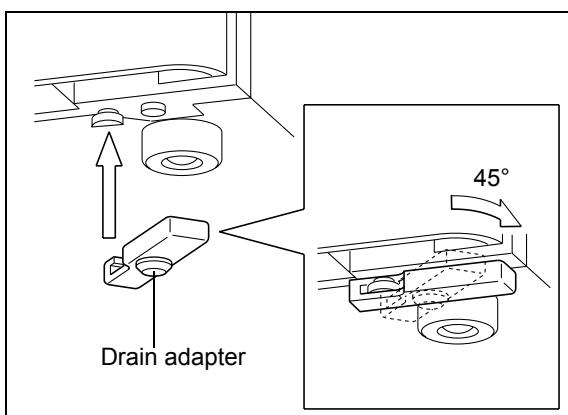


Fig. 9.30

- 2** The drain adapter connects the drain outlet to the leakage hole of the bottom unit.
- 3** Pour some water onto a spot near the drain outlet of the top unit, and verify that the water flows to the waste container.

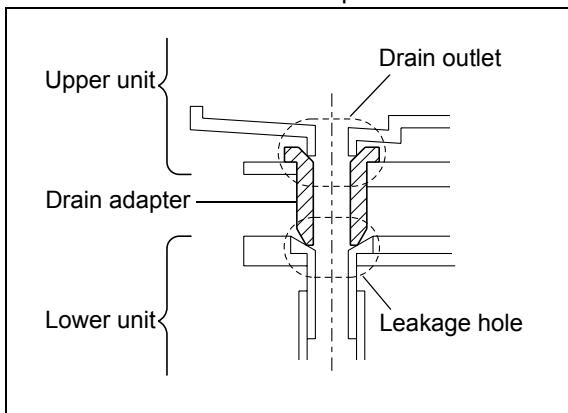
Cross-section of connection parts

Fig. 9.31

Installation on Top of the Column Oven

NOTE

When the bottom unit has no leakage hole ("Fig. 9.31"), carry out the same procedure described below.

- 1** Insert the drain OUT, CTO into leakage drain outlet from the front of the instrument.
- 2** Turn the drain OUT, CTO counterclockwise 45° to secure.

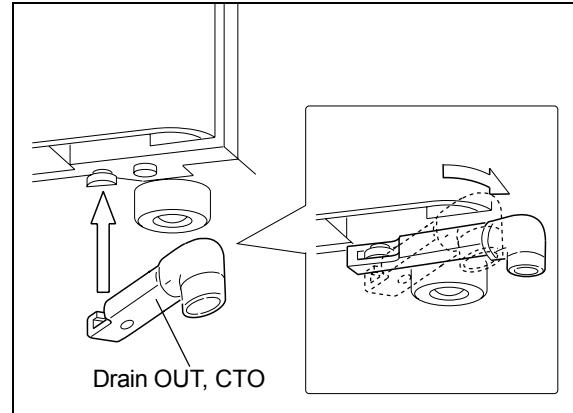


Fig. 9.32

- 3** Connect one end of the silicone tubing to the drain OUT, CTO with a straight tubing connector.

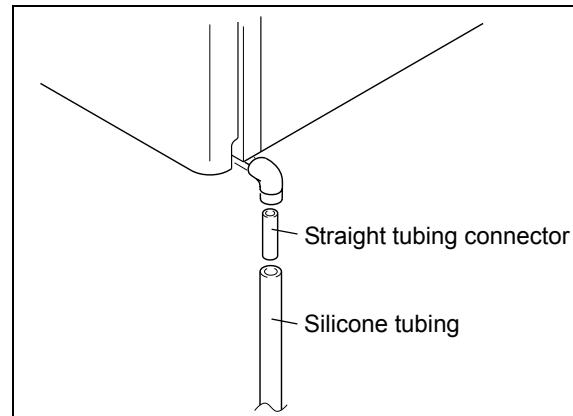


Fig. 9.33

- 4** Insert the other end of the silicone tubing into the waste container as shown in "Fig. 9.17".

NOTE

- To ensure a smooth flow of liquid, insert the silicone tubing into the container with its tip pointing downward.
- Set the silicone tubing so that its edge does not touch the liquid surface in the waste container. When the tip of tubing touches into the liquid of waste container, the drainage becomes difficult to flow.

■ Front Cover Installation

- 1** After performing the plumbing, install the front cover using the reverse of the removal procedure.
- 2** Close the front door.

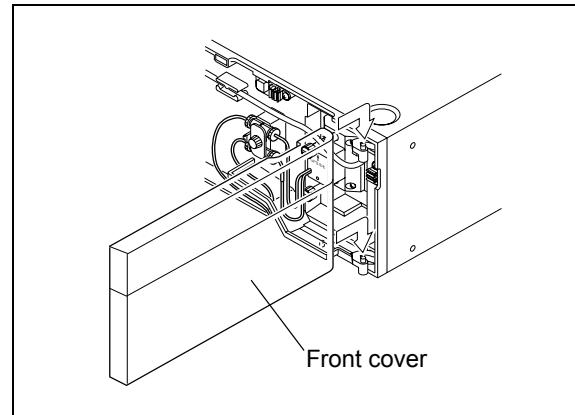


Fig. 9.34

9. Technical Information

9.1.6 Installation of Manual Injector and Column

Use the manual injectors listed below.

Option name	Part No.	Features
Manual injector Type 7725	228-32210-91	Manual injector for general purpose analysis. Standard sample loop: 20µL
Manual injector Type 7725i	228-32210-93	Same as type 7725, but with a position sensing switch. Can send signals synchronized with injection of samples to system controller or Chromatopac.
Semi-micro manual injector Type 8125	228-23200-91	Manual injector for semi micro volume range. Standard sample loop: 5µL. Includes position sensing switch. Can send signals synchronized with injection of samples to system controller or Chromatopac.
Non-metallic manual injector Type 9725	228-32650-91	Has liquid-contacting parts made of non-metallic materials. Maximum use temperature: 60°C
Non-metallic manual injector Type 9725i	228-32650-93	Same as type 9725, but with a position sensing switch. Can send signals synchronized with injection of samples to system controller or Chromatopac.

Install the manual injector and column as shown in the figures below.

For detailed installation procedures, see the Instruction Manual for the pump or the column oven.

- When parts are installed on the pump:

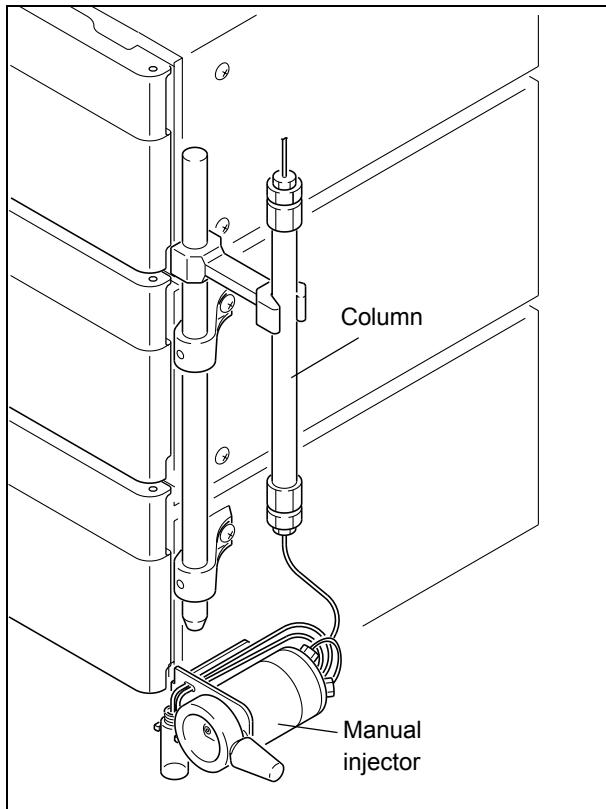


Fig. 9.36

- When parts are installed in the column oven:

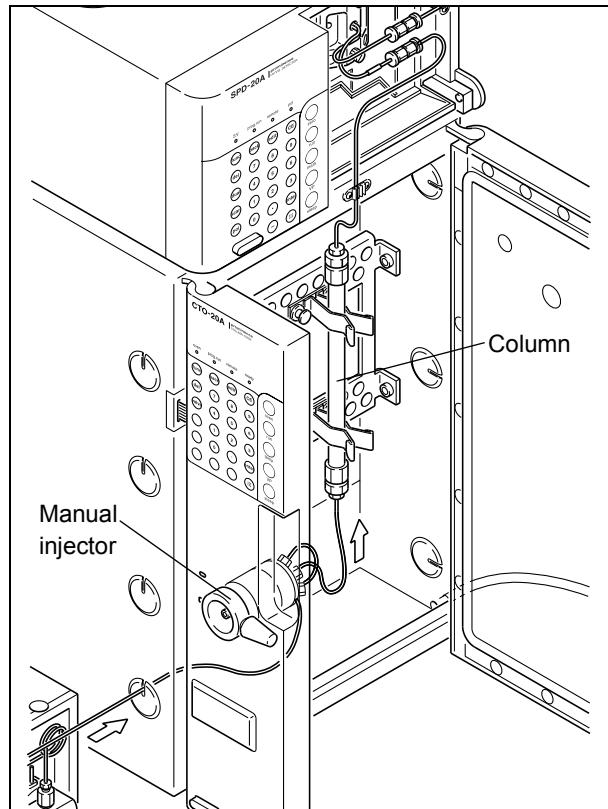


Fig. 9.35

9.1.7 Flow Line Plumbing

The figure below shows the plumbing for a basic system, including this detector instrument. The manual injector and column are installed in the column oven. The flow line plumbing should be based on this example, with appropriate changes to adapt it to your system.

For details on the plumbing between the reservoir bottle and pump, see the pump instruction manual.

For details on the plumbing between the column and the detector,  "9.1.5 Plumbing" P. 9-13

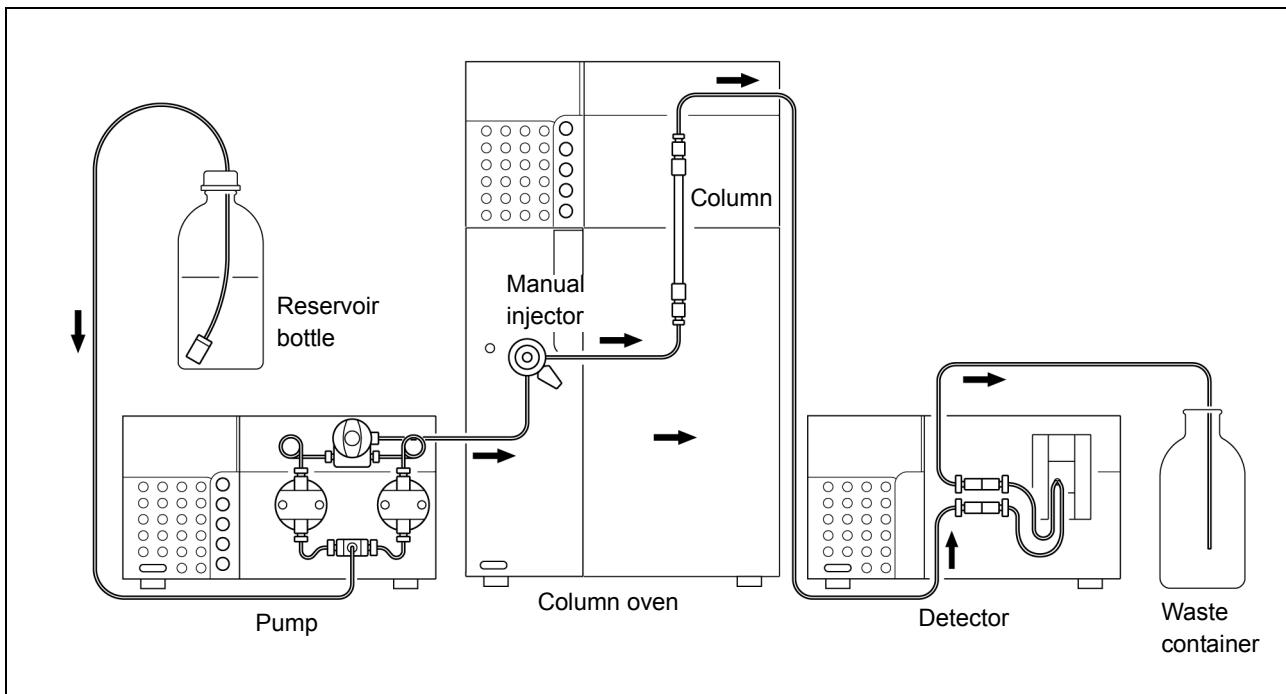


Fig. 9.37

■ Manual Injector Plumbing

NOTE

For connecting ports 1 to 6 of the manual injector, use the male nuts (with long bushing) and ferrules, provided as manual injector standard accessories.

- 1 Screw the sample loop male nuts (with long bushing) into the ports 1 and 4 of the manual injector.

● Back of manual injector

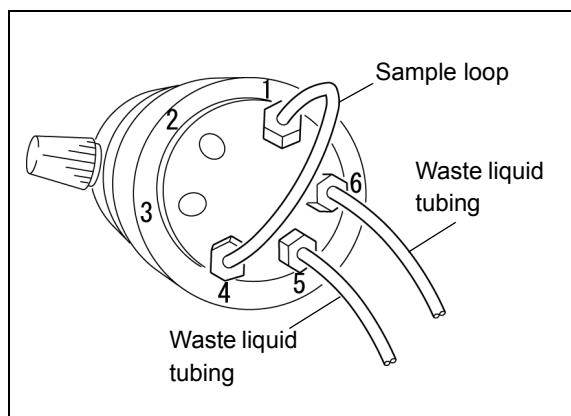


Fig. 9.38

9. Technical Information

2 Install a male nut (with long bushing) and ferrule to one end of each of the two waste liquid tubing sections. Then attach the tubing and ferrules into ports 5 and 6 of the manual injector. Tighten the nuts.

3 Unscrew off and remove the vial cap.

4 Route the other ends of the waste liquid tubing through the tubing outlet and into the vial.

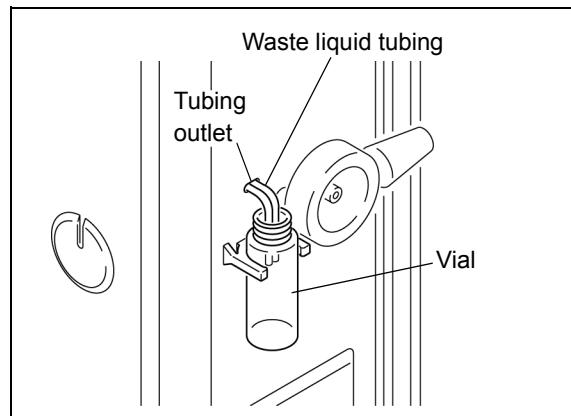


Fig. 9.39

NOTE

To prevent liquid from flowing out due to the syphon effect, position the ends of the waste liquid tubing level with the needle port.

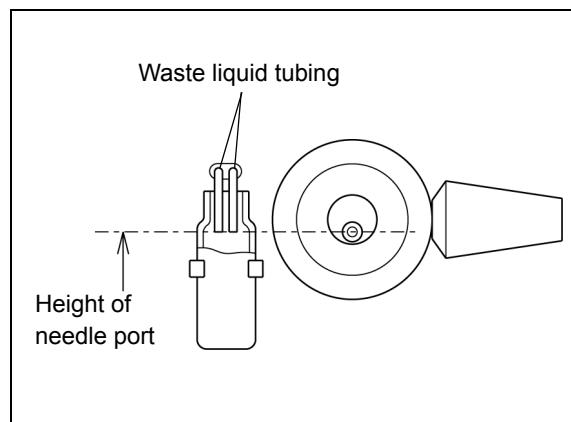


Fig. 9.40

NOTE

When the manual injector is attached to the column oven, the waste liquid tubing should be straight, and perpendicular to the left door. If the tubing curves outward, it could lodge against the side of the instrument and prevent closing of the left door.

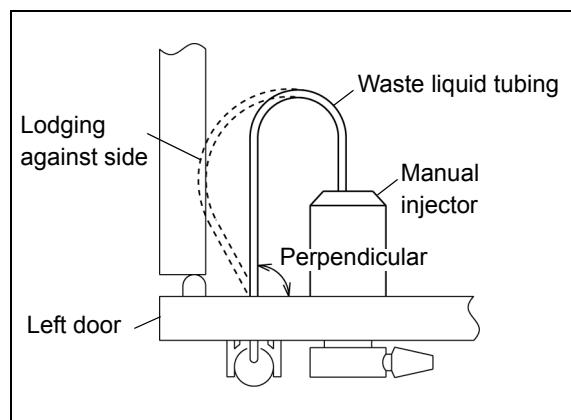


Fig. 9.41

■ Plumbing Between Pump and Manual Injector

- 1** Cut the 1.6 O.D. × 0.3 I.D. SUS tubing (standard accessory of the pump) long enough to connect the pump outlet and port 2 of the manual injector.
- 2** Attach male nut and ferrule to both ends of the SUS tubing.
 - Pump outlet end: 1.6MN male nut and 1.6F ferrule provided as pump standard accessories.
 - Manual injector end: Male nut (long bushing) and ferrule (provided as manual injector standard accessories).
- 3** Insert the ends of the SUS tubing into the pump outlet and port 2 of the manual injector, and tighten the male nuts.

NOTE

The SUS tubing should have a little extra length. Otherwise, it will not bend easily, and may prevent closing of the door.

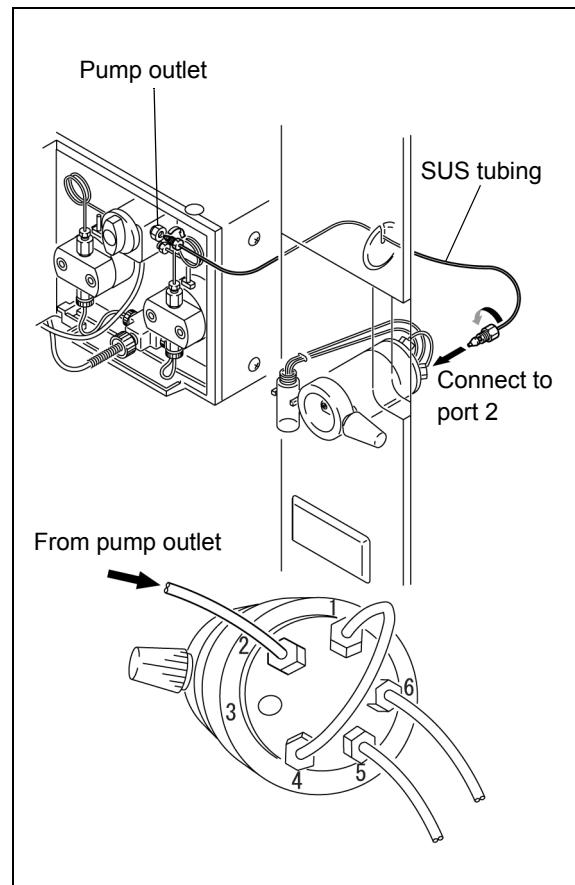


Fig. 9.42

■ Plumbing Between Manual Injector and Column

- 1** Cut the $\phi 1.6 \times \phi 0.3$ SUS tubing (provided with the pump) to a length appropriate for connecting port 3 of the manual injector to the column inlet.

NOTE

The SUS tubing should have a little extra length. Otherwise, it may pull on the column when the left door is opened.

- 2** Slide a male nut and ferrule onto both ends of the SUS tubing.
 - Manual injector end: Male nut (long bushing) and ferrule provided as standard accessories of the manual injector
 - Column inlet end: Male nut and ferrule provided as standard accessories of the column
- 3** Unscrew and remove the stop plug from the column inlet.

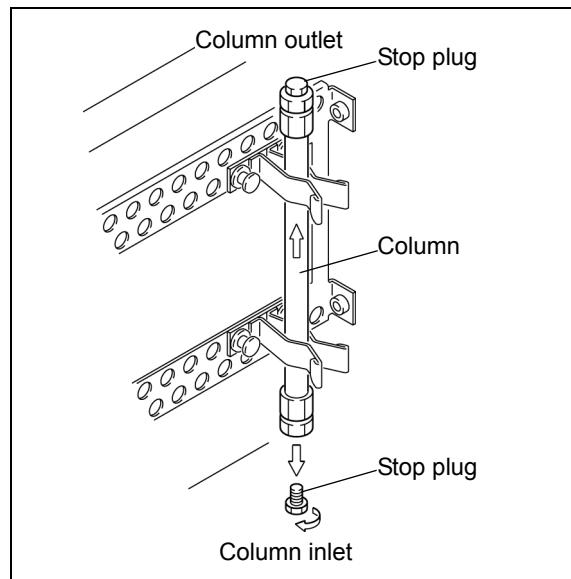


Fig. 9.43

- 4** Screw the ends of the SUS tubing into port 3 of the manual injector and the column inlet.

NOTE

If the SUS tubing has no extra length, unscrew and remove the male nut from the column inlet before opening the left door.

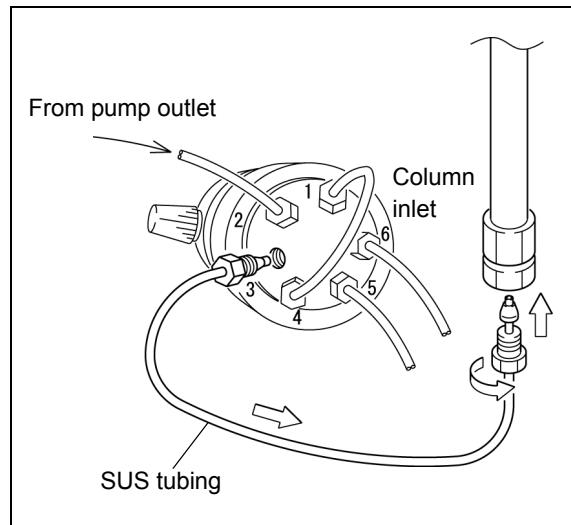


Fig. 9.44

9.1.8 Wiring

⚠ WARNING

- Before performing wiring, turn OFF all components and unplug the power cables.
- Do not use any other than specified cables for wiring.
- Do not perform any other than the indicated wiring operations.

Failure to observe the above cautions could result in fire, electric shock or instrument m

■ Connectors

- [REMOTE] connector For connection to the system controller
- [INTEGRATOR] connector
(Chromatopac output connector) For connection to Chromatopac
- [RECORDER] connector
(recorder output connector)..... For connection to recorder
- [SV] connector For connection to optional solvent recycling valve
- External input/output terminals For connection to external equipment. For connection instructions
 "5.9 Connection to External Input/Output Terminals" P. 5-65

Use the connectors above needed for the system. Connection instructions are provided on the following pages.

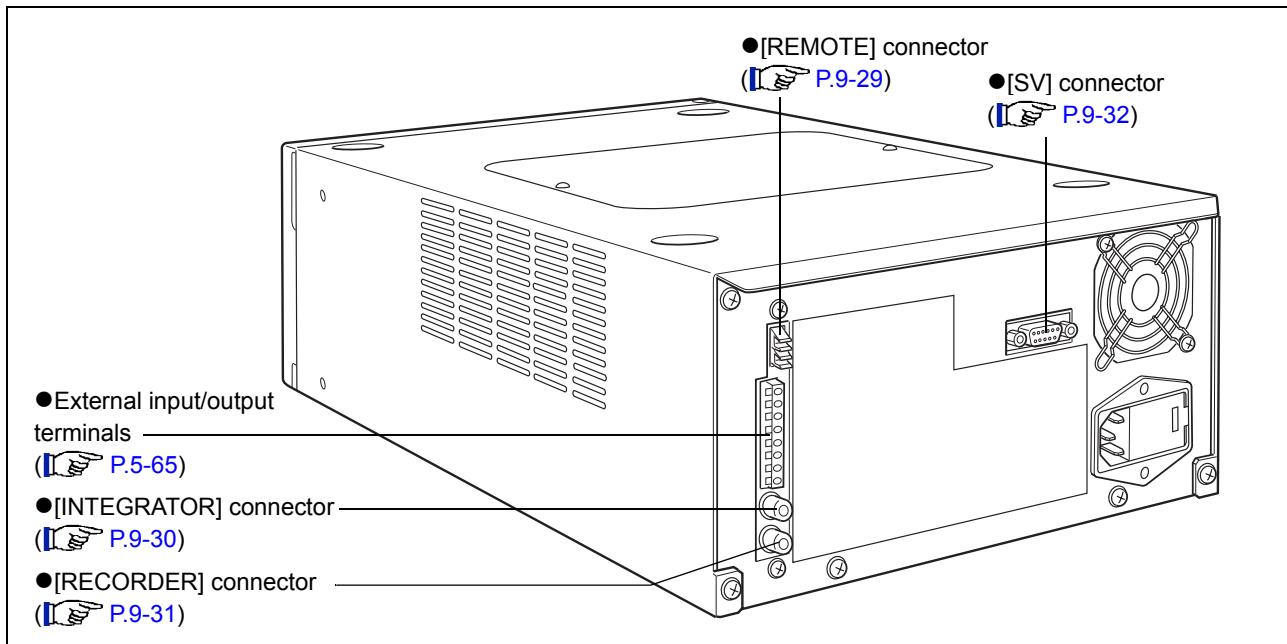


Fig. 9.45

■ Connecting the Optical Cable

The optical cable provided with this instrument is a two-way assembly for both transmission and reception of signals, and is connected to the [REMOTE] connector.

Instructions and precautions for connecting the optical cable are provided below.

- Before connection, remove the cap from the connection channel to be used.

! CAUTION

The caps on the [REMOTE] connectors prevent dirt or dust from getting into the connector.

If a [REMOTE] connector is not used, leave the cap on it to prevent dirt or dust from interfering with communication.

When a cap is removed, keep it in a safe place for future use.

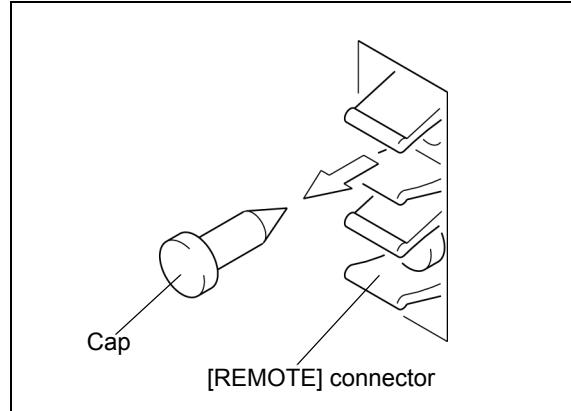


Fig. 9.46

- Insert the fiber optic cable plug into the [REMOTE] connector until it clicks into place.

! CAUTION

- Make sure there is no dirt or dust on the plug. Dirt or dust on the plug will get inside the [REMOTE] connector.
- Be careful not to insert the plug across two different channels.

Failure to follow these precautions above could result in malfunction or communication problems.

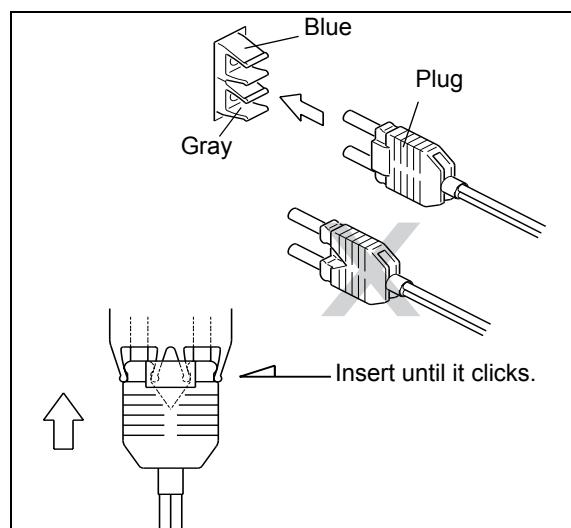


Fig. 9.47

! CAUTION

- Do not bend the optical cable less than 35 mm in radius.
 - When inserting and removing the plug, grip the plug itself, not the cable.
 - Do not bend the cable where it joins the plug.
- Failure to follow these above precautions could result in damage to the plug or a broken wire in the cable.

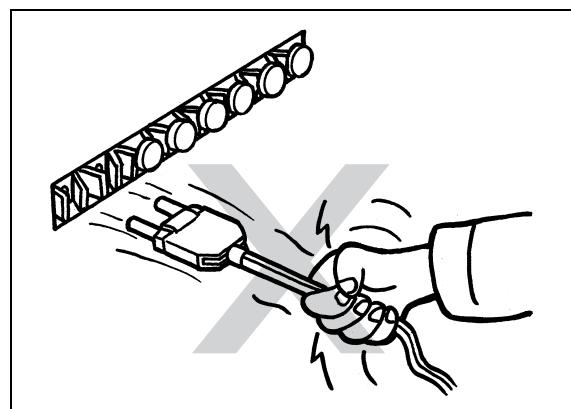


Fig. 9.48

■ Connection to System Controller

- 1** Referring to "Connecting the Optical Cable", connect the detector [REMOTE] connector to the system controller [REMOTE] connector with the optical cable.

NOTE

Channels between 3 and 8 of the system controller [REMOTE] connector are typically used for this purpose.

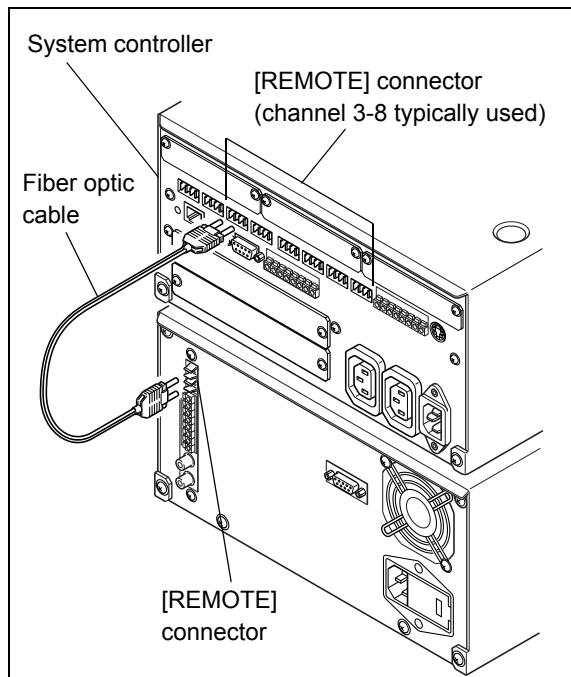


Fig. 9.49

- 2** Insert the power plug into the outlet, and turn the power switch on.

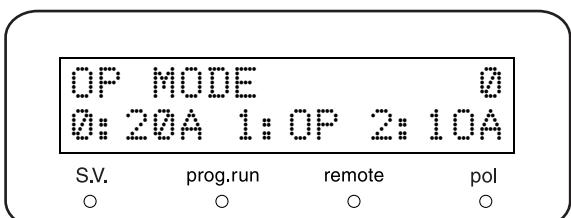
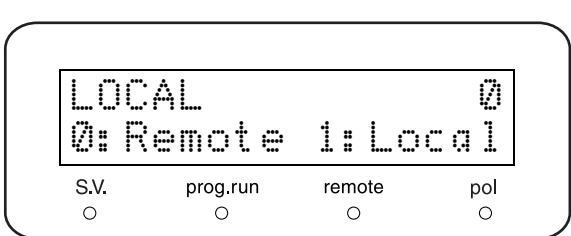
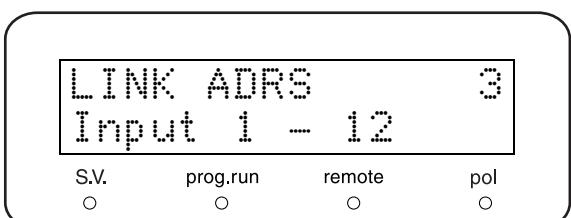
- 3** Set the [LINK ADRS], [LOCAL] and [OP MODE] parameters.

☞ "[LINK ADRS]" P. 5-42

☞ "[LOCAL]" P. 5-41

☞ "[OP MODE]" P. 5-56

- [LINK ADRS]: Enter the number of the system controller [REMOTE] channel.
- [LOCAL]: Enter [0] (for remote mode).
- [OP MODE]: Set the parameter according to the system controller to be connected



■ Connection to Chromatopac

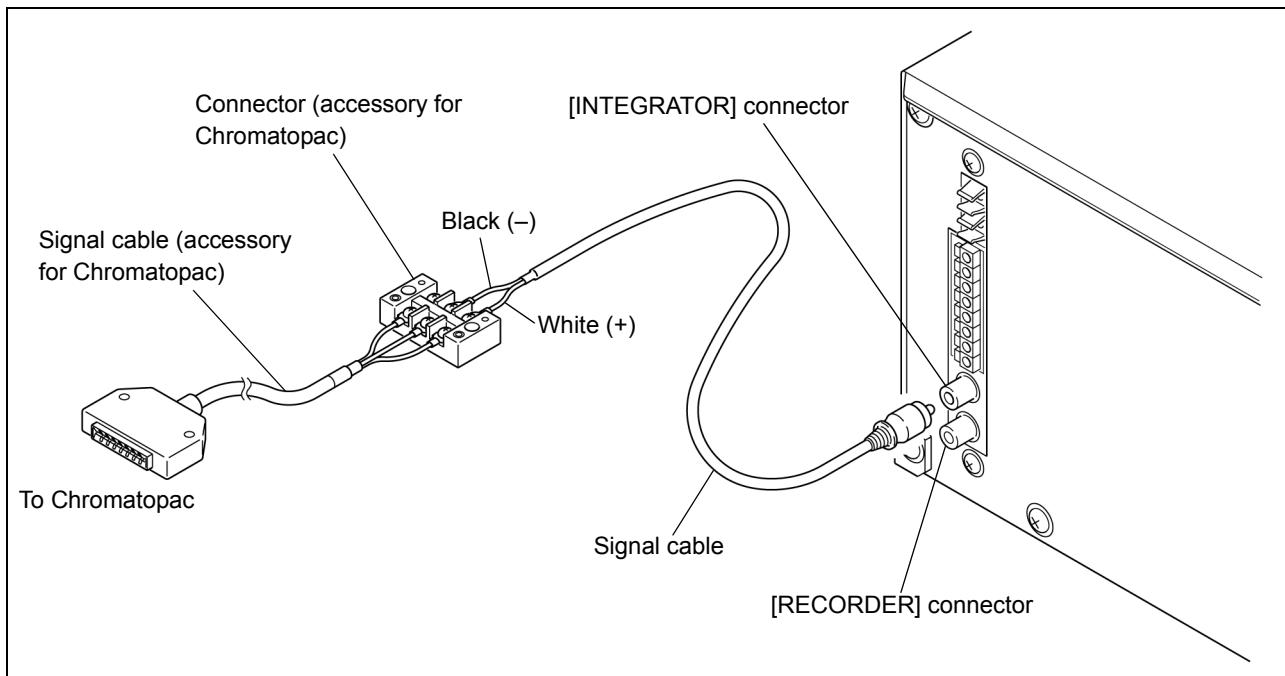


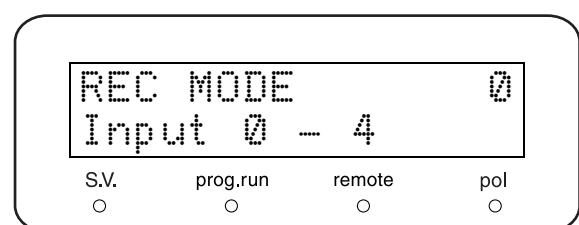
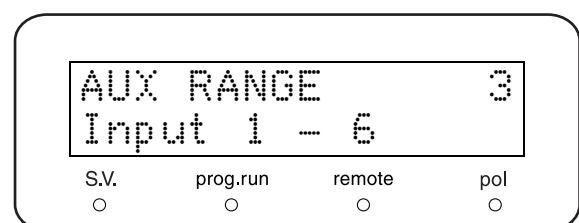
Fig. 9.50

- 1 Connect the signal cable (provided) to the [INTEGRATOR] connector. Then connect the instrument to the Chromatopac as shown in the figure above.

NOTE

To record absorbance from channel 2 or ratio chromatogram in dual wavelength mode, connect the signal cable also to the [RECODER] connector.

- 2 Insert the power plug into the outlet, and turn the power switch on.
- 3 Set the [AUX RANGE] and [REC MODE] parameter (if in dual wavelength mode).
☞ "AUX RANGE" P. 5-35
☞ "REC MODE" P. 5-35



■ Connection to Recorder

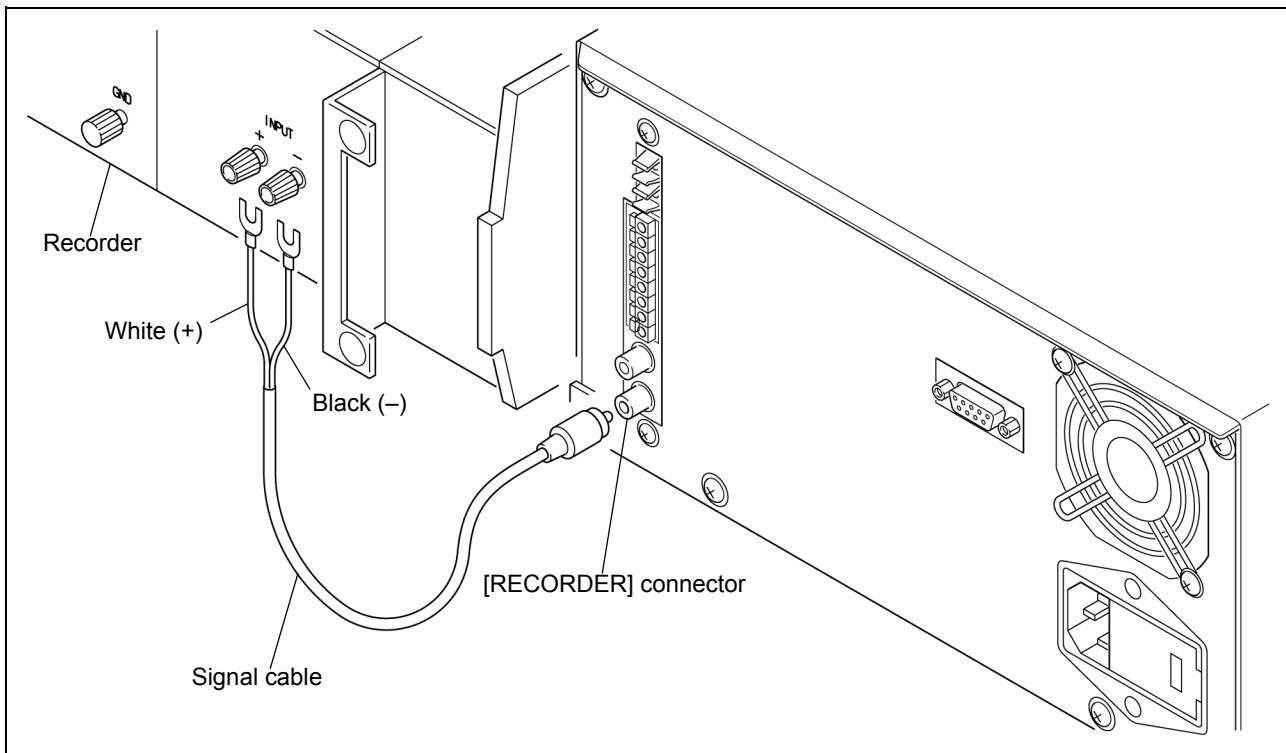
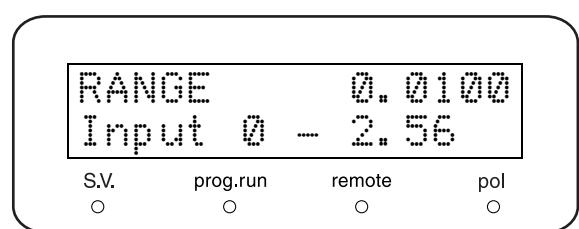


Fig. 9.51

- 1** Connect the signal cable (provided) to the [RECODER] connector.
- 2** Connect the other end of the signal cable to the recorder terminal.
- 3** Insert the power plug into the outlet, and turn the power switch ON.
- 4** Set the recorder range.
☞ "4.1 Single Wavelength Mode Settings"
P. 4-2

9



■ Connection of (Optional) Solvent Recycling Valve

- 1** Insert the solvent recycling valve plug into the [SV] connector.
- 2** Tighten the plug screws.
- 3** Insert the power plug into the outlet, and turn the power switch ON.

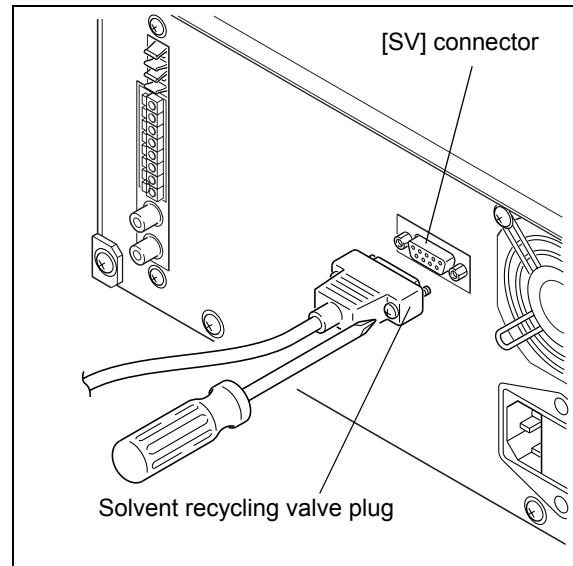


Fig. 9.52

- 4** Set the [SV LEVEL] and [DELAY TIME] parameters.

"[SV LEVEL]" P. 5-37
 "[DELAY TIME]" P. 5-38

SV LEVEL 0.0000
Input 0 - 1

S.V. prog.run remote pol

DELAY TIME 2.00
Input 0 - 99.9

S.V. prog.run remote pol

9.2 Specifications

Item	SPD-20A	SPD-20AV
Light source	Deuterium lamp, mercury lamp (for wavelength accuracy check)	Deuterium lamp, tungsten lamp, mercury lamp (for wavelength accuracy check)
Wavelength range	190-700nm Cut-off filter to eliminate second-order diffraction is automatically activated for the 371-700nm range.	190-900nm 190-370nm (deuterium lamp) 371-900nm (tungsten lamp) Cut-off filter to eliminate second-order diffraction is automatically activated for the 701-900nm range.
Spectral bandwidth	8nm	
Wavelength accuracy	±1nm	
Wavelength reproducibility	±0.1nm (*1)	
Drift	1×10 ⁻⁴ AU/hour Max. (250nm, room temperature constant, air in the cell) 3×10 ⁻⁴ AU/hour Max. (250nm, room temperature fluctuation less than 2°C, air in the cell)	1×10 ⁻⁴ AU/hour Max. (250nm, 600nm, room temperature constant, air in the cell) 3×10 ⁻⁴ AU/hour Max. (250nm, 600nm, room temperature fluctuation less than 2°C, air in the cell)
Noise Level	±0.25×10 ⁻⁵ AU Max. (250nm, air in the cell, equivalent to 2 sec time constant) (*2)	±0.25×10 ⁻⁵ AU Max. (250nm, 600nm, air in the cell, equivalent to 2 sec time constant) (*2)
Cell path length	10mm	
Cell volume	12µL	
Cell pressure tolerance	12MPa {120kgf/cm ² }	
Cell materials in contact with liquid	SUS316L, PFA (fluorocarbon polymers), quartz	
Cell inlet, outlet tubing diameter	SUS316L tubing O.D. 0.8mm × I.D. 0.25mm	
Cell temperature input range	9 - 50°C, at 1°C step	
Dual wavelength mode (*3)	Measurement wavelength Selectable, two wavelengths in 190-370nm or 371-700nm range	Selectable, two wavelengths in 190-370nm, 371-700nm or 701-900nm range
Sampling frequency	1.2 sec for one wavelength	
Response	Selectable in 11 steps corresponding to time constant 0.02, 0.05, 0.1, 0.5, 1.0, 1.5, 2.0, 3.0, 6.0, 8.0, 10.0 seconds	
Range	Can be set between 0.0001 and 2.56 AUFS in 0.0001 AUFS steps	

*1 Reproducibility when the wavelength is changed after turning the power ON in single wavelength mode.

*2 In single wavelength mode.

*3 Noise level in dual wavelength mode varies depending on the wavelength. It may be necessary to use less sensitive detector settings (higher Range values) when performing dual wavelength analysis.

9. Technical Information

Item	SPD-20A	SPD-20AV																
Zero adjustment	Auto zero function, baseline shift function																	
Polarity switching	Possible																	
Wavelength scanning function	Performs wavelength scanning with flow stopped. Data stored in three files, one of which stores background. Background is subtracted from sample scans. File data is not saved up (lost when power is turned OFF).																	
Wavelength steps	1-5nm, selectable in 5 steps, 2-5nm when W lamp is used.																	
Scanning speed	10-50nm/sec, settable in 5 steps (according to the wavelength step)																	
Spectrum plot output speed	1, 3, 10nm/sec																	
Ratio chromatogram	Outputs the absorption ratio of two wavelengths																	
Time Program	Available in detector or by system controller																	
Set items	Wavelength (including dual wavelengths), auto zero, range, marker, response, wavelength scanning, event, polarity, lamp ON/OFF, loop, cell temperature, stop																	
Number of steps (detector program)	Maximum 32 steps																	
Output	Output for recorder Output for integrator	10mV recorder connectors																
		6 steps: 0.5, 1, 2, 4, 1.25 and 2.5 AU/V Integrator output connectors output chromatogram in single wavelength mode or the Ch1 chromatogram in dual wavelength mode. Ratio chromatogram, spectrum, and Ch2 chromatogram are output from the recorder output connectors.																
Lamp hour-meter	Records up to 9999.9 hours																	
Dimensions	260(W) × 140(H) × 420(D) mm																	
Weight	13 kg																	
Operating temperature range	4°C-35°C																	
Power supply	<ul style="list-style-type: none"> • SPD-20A <table border="1"> <tr> <th>Part No.</th> <th>Power Supply Voltage</th> </tr> <tr> <td>228-45003-31</td> <td>100V AC ±10V 160VA 50-60Hz</td> </tr> <tr> <td>228-45003-32</td> <td>120V AC ±10V 160VA 50-60Hz</td> </tr> <tr> <td>228-45003-28 228-45003-38</td> <td>(220-230V AC) ±20V/240V AC ±20V 160VA 50-60Hz</td> </tr> </table> • SPD-20AV <table border="1"> <tr> <th>Part No.</th> <th>Power Supply Voltage</th> </tr> <tr> <td>228-45004-31</td> <td>100V AC ±10V 160VA 50-60Hz</td> </tr> <tr> <td>228-45004-32</td> <td>120V AC ±10V 160VA 50-60Hz</td> </tr> <tr> <td>228-45004-28 228-45004-38</td> <td>(220-230V AC) ±20V/240V AC ±20V 160VA 50-60Hz</td> </tr> </table> 		Part No.	Power Supply Voltage	228-45003-31	100V AC ±10V 160VA 50-60Hz	228-45003-32	120V AC ±10V 160VA 50-60Hz	228-45003-28 228-45003-38	(220-230V AC) ±20V/240V AC ±20V 160VA 50-60Hz	Part No.	Power Supply Voltage	228-45004-31	100V AC ±10V 160VA 50-60Hz	228-45004-32	120V AC ±10V 160VA 50-60Hz	228-45004-28 228-45004-38	(220-230V AC) ±20V/240V AC ±20V 160VA 50-60Hz
Part No.	Power Supply Voltage																	
228-45003-31	100V AC ±10V 160VA 50-60Hz																	
228-45003-32	120V AC ±10V 160VA 50-60Hz																	
228-45003-28 228-45003-38	(220-230V AC) ±20V/240V AC ±20V 160VA 50-60Hz																	
Part No.	Power Supply Voltage																	
228-45004-31	100V AC ±10V 160VA 50-60Hz																	
228-45004-32	120V AC ±10V 160VA 50-60Hz																	
228-45004-28 228-45004-38	(220-230V AC) ±20V/240V AC ±20V 160VA 50-60Hz																	

9.3 Maintenance Parts

9.3.1 Consumable Parts

Part	Part No.	Remark
Deuterium lamp*	228-34016-02	Light source
Tungsten halogen lamp*	670-14602	Light source (SPD-20AV only)
Flow cell gasket*	228-35097-95	A set of 2 pcs
Flow cell lens*	228-14572	
Cell window	228-18058	

9.3.2 Replacement Parts

■ Optical System

Part	Part No.	Remark
Deuterium lamp*	228-34016-02	Light source
Tungsten halogen lamp*	670-14602	Light source (SPD-20AV only)
Low pressure mercury lamp	228-38214-96	For wavelength check/calibration
Filter Assy (VIS)	228-42066-91	For tungsten/halogen lamp (SPD-20AV only)
Mirror M1 Assy (UV/VIS)	228-23037-95	
Mirror M2 Assy*	228-23014-91	
Mirror M3 Assy	228-23041-93	
Grating Assy	228-15257-95	
Window	228-34795	Quartz window between lamp housing and spectroscope
Filter Assy (UV)	228-42008-91	Cut-off filter for second-order diffracting light (SPD-20A)
Filter Assy (UV/VIS)	228-42008-92	Cut-off filter for second-order diffracting light (SPD-20AV)
Photocell Assy*	228-23016-91	
PB-1 Assy	228-23691-95	
Motor Assy*	228-23027-92	Grating drive motor
Photosensor A Assy	228-25421-94	Grating drive unit sensor
Photosensor A Assy*	228-25421-91	Mirror switching unit sensor
Motor Assy	228-45608-91	Mirror switching motor
Belt*	670-11222	For grating drive

* Common for SPD-10A/SPD-10AVvp

9. Technical Information

■ Flow Cell, Plumbing Parts

Part	Part No.	Remark
Flow cell assembly	228-37440-94	
Cell gasket (2 pcs)*	228-35097-95	
Lens*	228-14572	
Cell window	228-18058	
Packing*	228-14569	
Cell window screw*	228-14568	
Cell window screw Assy*	228-40239-91	Composed of 228-14568 and 228-14569
Cell inlet tubing Assy	228-45609-91	Composed of cell inlet tubing, male nut and ferrule
Cell outlet tubing Assy	228-45610-91	Composed of cell outlet tubing, male nut and ferrule
Ferrule 0.8F	228-40997-10	For cell inlet tubing/cell outlet tubing
Male nut 0.8MN PEEK	228-46363	For cell inlet tubing/cell outlet tubing (coupling end)
Male nut 0.8MN-M4	228-42605	For cell inlet tubing/cell outlet tubing (cell housing end)
Coupling 1.6-0.8C	228-40998-10	For tubing connection of cell inlet tubing/cell outlet tubing and 1.6mmOD
Tubing clamp*	228-39621	For attaching plumbing tubing
Plumbing tubing*	228-18495-06	For waste liquid tubing. Purchase unit: m
Male PEEK nuts*	228-18565	

■ Electrical Parts

Part	Part No.	Remark
Fuse, 4AT, 250A	072-02004-22	Fuse for 100-120V
Fuse, 3.15AT, 250V	072-02004-21	Fuse for 220-240V
PCB SPD20-MAIN	228-45601-92	EEPROM (M15) not mounted
PCB SPD20-PWR	228-45602-91	
Transformer SPD20	228-42040-02	
Fan Assy	228-42098-91	Fan, back panel
Fan Assy	228-42098-92	Fan, side panel
PCB LC20-KEY	228-45600-91	PCB included in the key panel Assy
Leak sensor	228-39247-94	
Display VFD CU16025ECPB-W9J	228-42043	Display included in the key panel Assy
Connector LC2K-CMD1	228-37260-91	Joint connector of the temperature controlled cell on the front panel

* Common for SPD-10A/SPD-10AVvp

9.4 Introduction to HPLC System

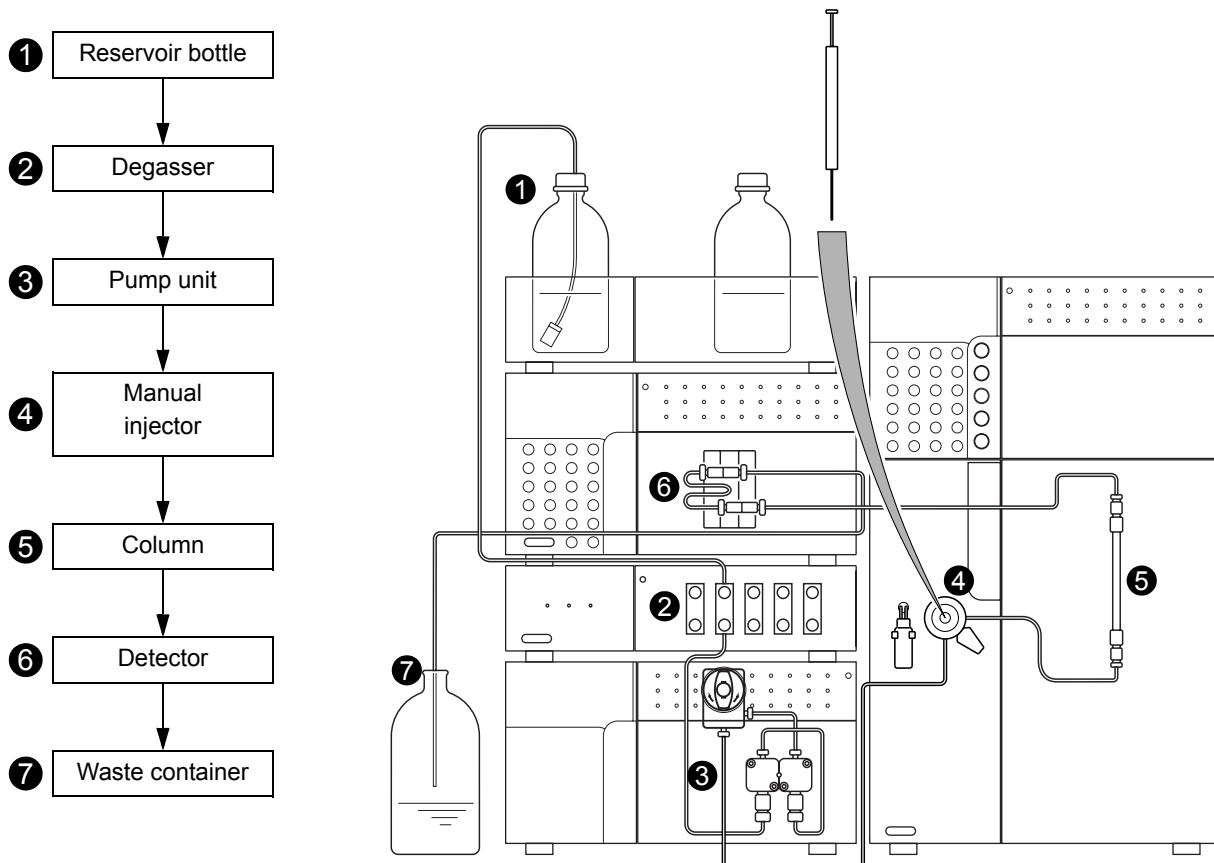
The Prominence LC (LC-20A) series components are for use with Shimadzu high performance liquid chromatography (HPLC) systems, which are designed to provide high accuracy and high sensitivity analyses. Example system configurations are provided below, along with descriptions of the operations of the various components.

9.4.1 Example of a Simple (Isocratic) System

Each component of the system is controlled locally. This is a simple system composed of the minimum number of components for stable analysis.

■ Solvent Flow

■ Function of Components



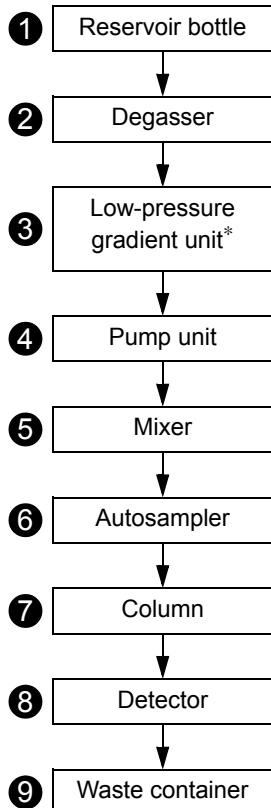
- ① Mobile phase is drawn out of the reservoir bottle and pumped through the tubing by the pump.
- ② The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
- ③ The pump sends the mobile phase through the manual injector, column and detector, in that order, and finally into the waste container.
- ④ Samples are injected into the system by the manual injector, with a syringe.
- ⑤ In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
- ⑥ The detector detects the components eluted from the column, and sends the signal data to a Chromatopac or PC.
- ⑦ Mobile phase from the detector drains into the waste container.

9. Technical Information

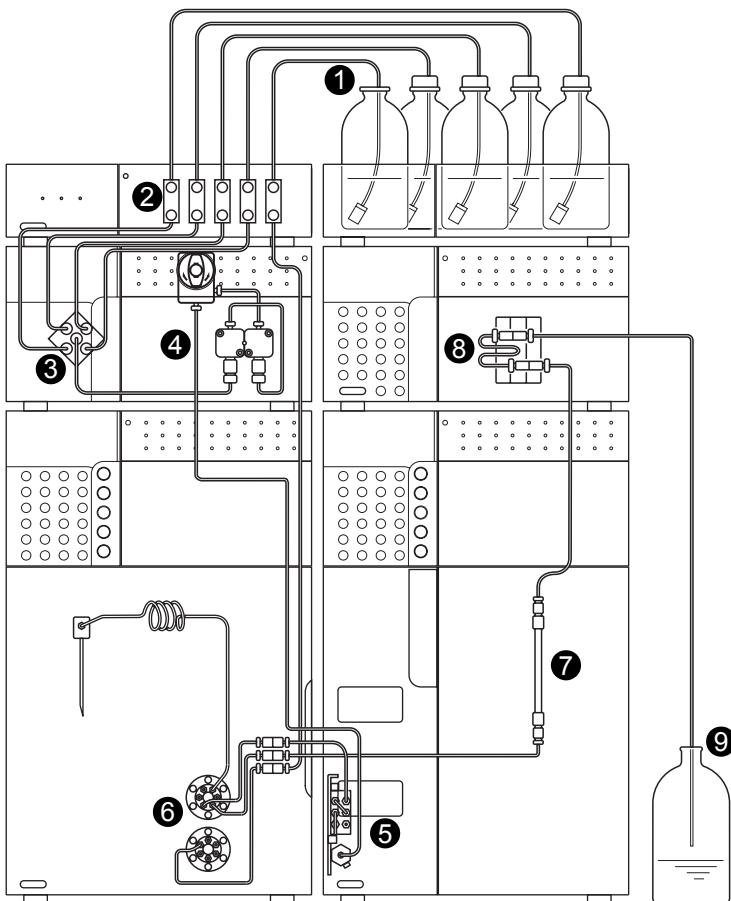
9.4.2 Example of Autosampler System (1)

Centralized control of all the components by a CBM-20Alite system controller enhances ease operation and is well suited for automated analyses. The CBM-20Alite can control a maximum of 5 LC components. Since it is installed in the pump unit or autosampler, the system requires a smaller space.

■ Solvent Flow



■ Function of Components



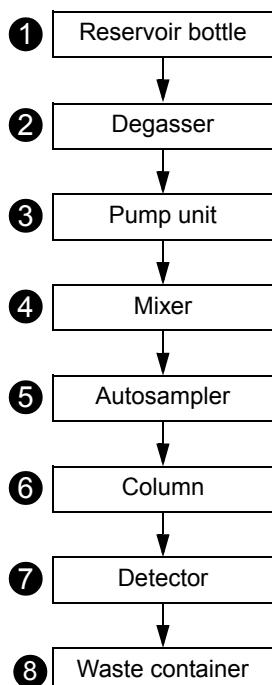
- ① Mobile phase is drawn out of the reservoir bottles and pumped through the tubing by the pump.
- ② The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
- ③ The low-pressure gradient unit mixes up to 4 mobile phases that have been degassed by the degasser.
(*This item is necessary for a low-pressure gradient system.)
- ④ The pump sends the mobile phase through the autosampler, column and detector, in that order, and finally into the waste container.
- ⑤ The mixer enhances the mixing efficiency of the mobile phases. This item is required for low or high-pressure gradient system.
- ⑥ The autosampler automatically injects the sample into the flow lines. By adding a rack changer, it is possible to automatically change the autosampler racks.
- ⑦ In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
- ⑧ The detector detects the components separated in the column, and sends the signal data to a Chromatopac or PC.
- ⑨ Mobile phase from the detector drains into the waste container.

9.4.3 Example of Autosampler System (2)

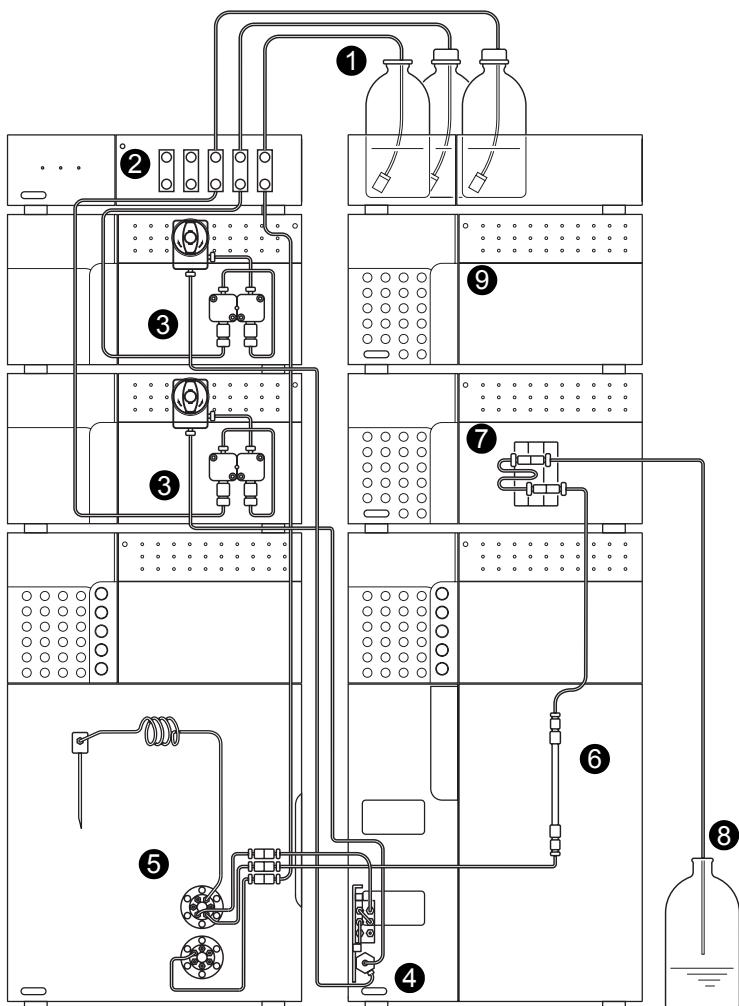
The CBM-20A system controller can control a maximum of 8 LC components (12 LC components as an option).

Use the same type of pumps for high-pressure gradient system.

■ Solvent Flow



■ Function of Components



- ① Mobile phase is drawn out of the reservoir bottles and pumped through the tubing by the pump.
- ② The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
- ③ The pump sends the mobile phase through the autosampler, column and detector, in that order, and finally into the waste container.
- ④ The mixer enhances mixing efficiency of the mobile phases.
- ⑤ The autosampler automatically injects the sample into the flow lines. By adding a rack changer, it is possible to automatically change the autosampler racks.
- ⑥ In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
- ⑦ The detector detects the components eluted from the column, and send the signal data to a Chromatopac or PC.
- ⑧ Mobile phase from the detector drains into the waste container.
- ⑨ The CBM-20A system controller can control a maximum of 8 LC components (12 LC components as an option) including a maximum of 4 pump units.

9.5 Mobile Phase Characteristics

	(1) Solvent (*) $\eta < .5 \text{ cP}$, $> 45^\circ\text{C}$ (**) $\eta < .5 \text{ cP}$, $< 45^\circ\text{C}$	(2) Source	(3) UV Cutoff	(4) R.I. 25°	Boiling Point ($^\circ\text{C}$)	Viscosity (cP, 25°C)	(5) p'	(6) $e^\circ\text{a}$	(7) Water Solubility %W in 20°C Solvent	(8) Dielectric Constant e^{20}	(9) $p' +$ $0.25e$
1	FC-78 (*) FC-75 (Fluorescent solvent) FC-43	(LC specific)	210nm 210(opaque under 210)	1.267 1.276 1.291	50 102 174	0.4 0.8 2.6	<-2 <-2 <-2	-.25 -.25 -.25		1.88 1.86 1.9	p' and Dielectric const. (Function proportional to strength)
2	Isooctane(*) (2,2,4-tri methylpentane)	LC	197	1.389	99	0.47	0.1	0.01	0.011	1.94	0.1
3	n-Heptane(*)	LC	195	1.385	98	0.40	0.2	0.01	0.010	1.92	0.5
4	n-Hexane(*)	LC	190	1.372	69	0.30	0.1	0.01	0.010	1.88	0.5
5	n-Pentane(**)	LC	195	1.355	36	0.22	0.0	0.00	0.010	1.84	0.5
6	Cyclohexane	LC	200	1.423	81	0.90	-0.2	0.04	0.012	2.02	0.5
7	Cyclopentane(*)	LC	200	1.404	49	0.42	-0.2	0.05	0.014	1.97	0.6
8	I-Chlorobutane(*)	LC	220	1.400	78	0.42	1.0	0.26		7.4	2.8
9	Carbon disulfide	LC	380	1.624	46	0.34	0.3	0.15	0.005	2.64	1.7
10	2-Chloropropane(**)	LC	230	1.375	36	0.30	1.2	0.29		9.82	3.7
11	Carbon tetrachloride	LC	265	1.457	77	0.90	1.6	0.18	0.008	2.24	2.3
12	n-Butyl ether		220	1.397	142	0.64	2.1	0.25	0.19	2.8	2.4
13	Triethylamine			1.398	89	0.36	1.9	0.54		2.4	2.4
14	Bromoethane(*)			1.421	38	0.38	2.0	0.35		9.4	4.3
15	i-Propyl ether(*)		220	1.365	68	0.38	2.4	0.28	0.62	3.9	3.2
16	Toluene	LC	285	1.494	110	0.55	2.4	0.29	0.046	2.4	2.9
17	p-Xylene		290	1.493	138	0.60	2.5	0.26		2.3	3.0
18	Chlorobenzene			1.521	132	0.75	2.7	0.30		5.6	4.1
19	Bromobenzene			1.557	156	1.04	2.7	0.32		5.4	4.1
20	Iodobenzene						2.8	0.35			
21	Phenyl ether			1.580	258	3.3	3.4			3.7	3.7
22	Phenetole			1.505	170	1.14	3.3			4.2	4.9
23	Ethyl ether(**)	LC	218	1.350	35	0.24	2.8	0.38	1.3	4.3	4.0
24	Benzene	LC	280	1.498	80	0.60	2.7	0.32	0.058	2.3	3.6
25	Tricresyl phosphate										
26	Ethyl iodide			1.510	72	0.57	2.2			7.8	4.2
27	n-Octanol		205	1.427	195	7.3	3.4	0.5	3.9	10.3	5.8
28	Fluorobenzene			1.46	85	0.55	3.1			5.4	4.6
29	Benzylether			1.538	288	4.5	4.1				
30	Methylene chloride(**)	LC	233	1.421	40	0.41	3.1	0.42	0.17	8.9	5.6
31	Anisole			1.514	154	0.9	3.8			4.3	4.6
32	i-Pentanol			1.405	130	3.5	3.7	0.61	9.2	14.7	7.3
33	1,2-Dichloroethane	LC	228	1.442	83	0.78	3.5	0.44	0.16	10.4	6.3

	(1) Solvent (*) $\eta < 5 \text{ cP}$, $> 45^\circ\text{C}$ (**) $\eta < 5 \text{ cP}$, $< 45^\circ\text{C}$	(2) Source	(3) UV Cutoff	(4) R.I. 25°	Boiling Point ($^\circ\text{C}$)	Viscosity (cP, 25°C)	(5) p'	(6) $e^\circ\text{a}$	(7) Water Solubility %W in 20°C Solvent	(8) Dielectric Constant ϵ^{20}	(9) $p' +$ $0.25e$
34	t-Butanol			1.385	82	3.6	4.1	0.7	miscible	12.5	
35	n-Butanol	LC	210	1.397	118	2.6	3.9	0.7	20.1	17.5	8.3
36	n-Propanol	LC	240	1.385	97	1.9	4.0	0.82	miscible	20.3	
37	Tetrahydrofuran(*)	LC	212	1.405	66	0.46	4.0	0.57	miscible	7.6	
38	Propylamine(*)			1.385	48	0.35	4.2		miscible	5.3	
39	Ethylacetate(*)	LC	256	1.370	77	0.43	4.4	0.58	8.8	6.0	5.8
40	i-Propanol	LC	205	1.384	82	1.9	3.9	0.82	miscible	20.3	
41	Chloroform(*)	LC	245	1.443	61	0.53	4.1	0.40	0.072	4.8	5.6
42	Acetophenone			1.532	202	1.64	4.8			17.4	8.7
43	Methylethyl	LC	329	1.376	80	0.38	4.7	0.51	23.4	18.3	9.1
44	Cyclohexanone			1.450	156	2.0	4.7			18.3	9.1
45	Nitrobenzene			1.550	211	1.8	4.4			34.8	13.2
46	Benzonitrile			1.536	191	1.2	4.8			25.2	10.9
47	Dioxane	LC	215	1.420	101	1.2	4.8		miscible	2.2	
48	Tetramethyl urea	LC	265	1.449	175		6.0	0.56		23.0	10.7
49	Quinoline			1.625	237	3.4	5.0			9.0	7.4
50	Pyridine			1.507	115	0.88	5.3		miscible	12.4	
51	Nitroethane		380	1.390	114	0.64	5.2			0.9	
52	Acetone(*) Benzyl alcohol	LC	330	1.356 1.538	56 205	0.30 5.5	5.1 5.7	0.71	miscible	13.1	8.8
53	Tetramethyl guanidine						6.1	0.6			
54	Methoxyethanol	LC	210	1.400	125	1.60	5.5		miscible	19.9	
55	Tris(cyanoethoxy) propane	GC					6.6	0.56			
56	Propylene carbonate	LC					6.1				
57	Ethanol	LC	210	1.359	78	10.8	4.3		miscible	24.6	
58	Oxydipropionitrile	GC					6.8				
59	Aniline			1.584	184	3.77	6.3			6.9	8.1
60	Acetic acid			1.370	118	1.1	6.0		miscible	6.2	
61	Acetonitrile(*)	LC	190	1.341	82	0.34	5.8		miscible	37.5	
62	N,N-dimethylacetamide	LC	268	1.436	166	0.78	6.5	0.88		37.8	
63	Dimethylformamide	LC	268	1.428	153	0.80	6.4			36.7	
64	Dimethylsulfoxide	LC	268	1.477	189	2.00	7.2	0.62	miscible	4.7	
65	N-methyl-2-pyrrolidone	LC	285	1.468	202	1.67	6.7			32	
66	Hexamethyl phosphoric acid triamide			1.457	233	3	7.4	0.65		30	
67	Methanol(*)	LC	205	1.326	65	0.54	5.1		miscible	32.7	
68	Nitromethane		380	1.380	101	0.61	6.0			2.1	
69	m-Cresol			1.540	202	14	7.4			11.8	10.0
70	N-methylformamide			1.447	182	1.65	6.0		miscible	182	

9. Technical Information

	(1) Solvent (*) $\eta < 5 \text{ cP}$, $> 45^\circ\text{C}$ (**) $\eta < 5 \text{ cP}$, $< 45^\circ\text{C}$	(2) Source	(3) UV Cutoff	(4) R.I. 25°	Boiling Point ($^\circ\text{C}$)	Viscosity (cP, 25°C)	(5) p'	(6) $e^\circ\text{a}$	(7) Water Solubility %W in 20°C Solvent	(8) Dielectric Constant ϵ^{20}	(9) $p' +$ $0.25e$
71	Ethylene glycol			1.431	182	16.5	6.9		miscible	37.7	
72	Formamide			1.447	210	3.3	9.6		miscible	111	
73	Water	LC		1.333	100	0.89	10.2			80	

- (1) An asterisk (*) indicates solvents most suitable for LC, with low boiling points ($> 45^\circ\text{C}$) and low viscosity ($< 0.5 \text{ cP}$).
 Double asterisks (**) indicates solvents with a very low viscosity and boiling point.
- (2) [LC] indicates that a grade of solvent specifically for LC is commercially available from companies like the following:
 Burdick & Jackson, Baker Chemical, Mallinckrodt Chemical, Fischer Scientific, Waters Associate, Manufacturing Chemists. Inc.
 [GC] indicates that a solvent is used as a stationary phase for gas chromatography, and can be purchased from companies selling GC columns and stationary phases. (These solvents are used as stationary phase in liquid-to-liquid LC.)
- (3) The wavelength below which the solvent becomes opaque.
 (4) Refractive index at 25°C .
 (5) Polarity parameter of solvent.
 (6) Solvent's strength parameter in relation to liquid-to-solid adsorption in alumina.
 (7) Water solubility (%W) at 20°C of solvent used in liquid-to-solid adsorption.
 (8) Value at 20°C .
 (9) Function consisting of P' (proportional to solvent strength) plus the dielectric constant, in ion chromatography.

Source : A.Krstulovic and P.R.Brown, *Reversed-Phase High-Performance Liquid Chromatography*, Wiley Interscience, 1982.

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