AUTOSAMPLER

FOR SHIMADZU HIGH PERFORMANCE LIQUID CHROMATOGRAPH

SIL-20A/20AC

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

Introduction

Read this manual thoroughly before using this 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 this instrument. Use this 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

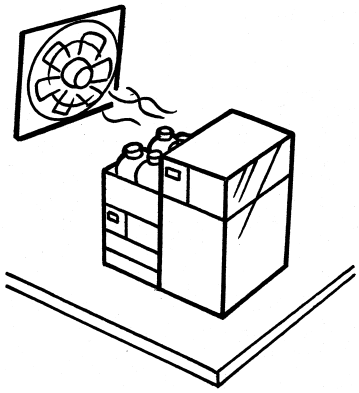
⚠ WARNING

This instrument is an autosampler 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.

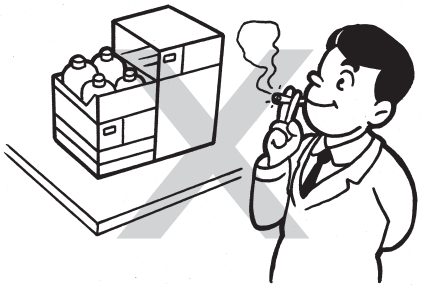
■ Installation Site Precautions

⚠ 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.



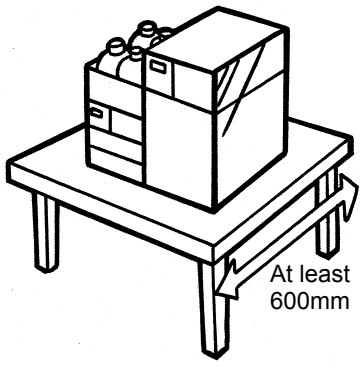
- **High performance liquid chromatograph uses large amounts of flammable organic solvents. Use of open flame in the vicinity of this instrument must be strictly prohibited. Do not install the instrument in the same room with any other equipment that emits or could potentially emit sparks, since sparks 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 SIL-20A is approx. 27kg and SIL-20AC approx. 30kg.**
  During installation, consider the entire weight combined with other LC components.
  The lab table on which this instrument is installed should be strong 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.

  [SIL-20A]

Part No.	Power Supply Voltage (indicated on the instrument)	Power Consumption	Frequency
228-45006-31	AC100V ± 10% (100V~)	100VA	50/60Hz
228-45006-32	AC110-120V ± 10% (110-120V~)		
228-45006-38	AC220-240V ± 10% (220-240V~)		

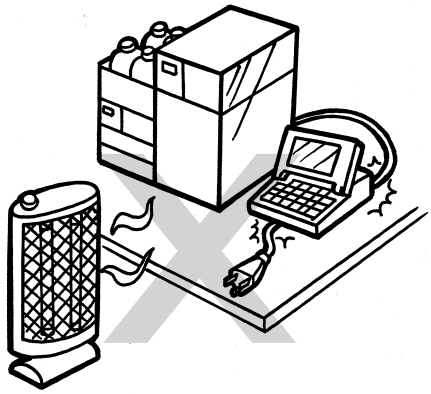
  [SIL-20AC]

Part No.	Power Supply Voltage (indicated on the instrument)	Power Consumption	Frequency
228-45007-31	AC100V ± 10% (100V~)	300VA	50/60Hz
228-45007-32	AC110-120V ± 10% (110-120V~)		
228-45007-38	AC220-240V ± 10% (220-240V~)		

- **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.

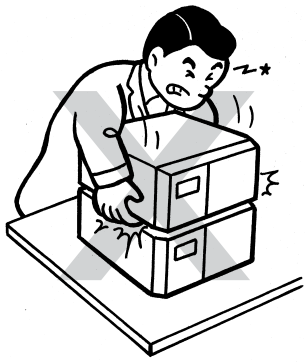
- **Do not modify the cord in any way. Do not bend it excessively or pull on it.**
  The cord could be damaged, resulting in fire, electrical shock or malfunction. If the cord becomes damaged, contact your Shimadzu representative immediately.



⚠ 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

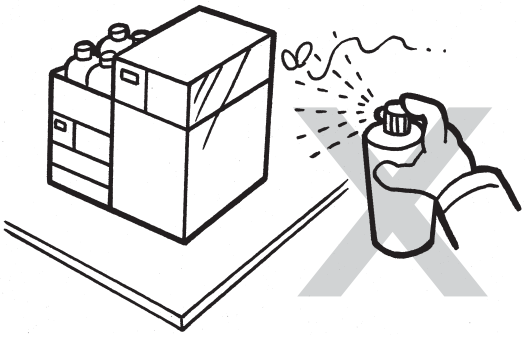
⚠ WARNING

- **Take thorough measures to prevent buildup of static electricity.**
  ☞ "Static Electricity Precautions" P.X
  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 "1.4 Component Parts" or "9.5 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.**

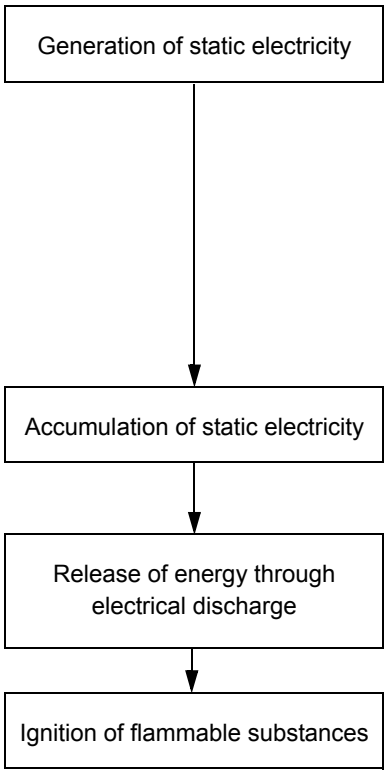
Static Electricity Precautions

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.

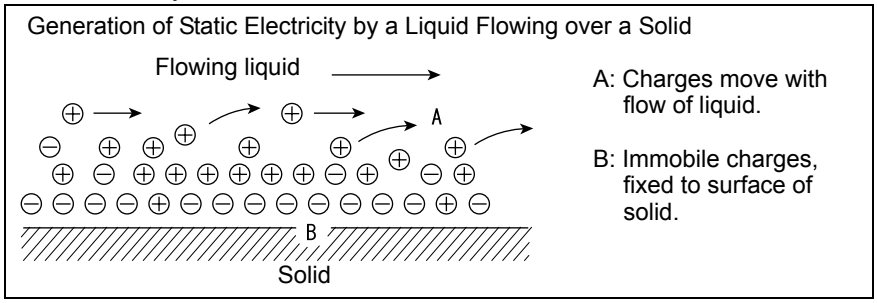
The major cause of these accidents is static electricity. Devising preventative measures for static can be difficult, because the symptoms before an accident vary and can be hard to detect, since such accidents occur as a result of several simultaneous coincidences. Recommended methods for preventing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

■ Typical Cause of Static Electricity Accidents

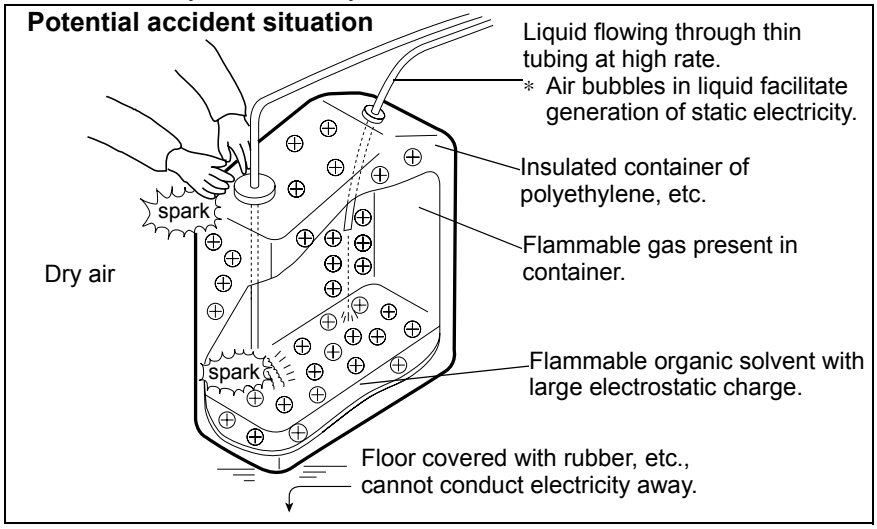
Static electricity accidents are generally caused by this sequence of events:



When liquid is passed through thin tubing at high flow rates, as in liquid chromatograph, the electrostatic charges of the flowing matter generate static electricity.



If electrostatically charged liquid is allowed to accumulate in an electrically insulated container, the charge will gradually increase, and can eventually reach several thousand volts. If this happens and an electrical conductor is brought within a certain distance of the container, electrical discharge will occur, releasing thermal energy which will ignite any flammable gas of sufficient density in the vicinity.



■ 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

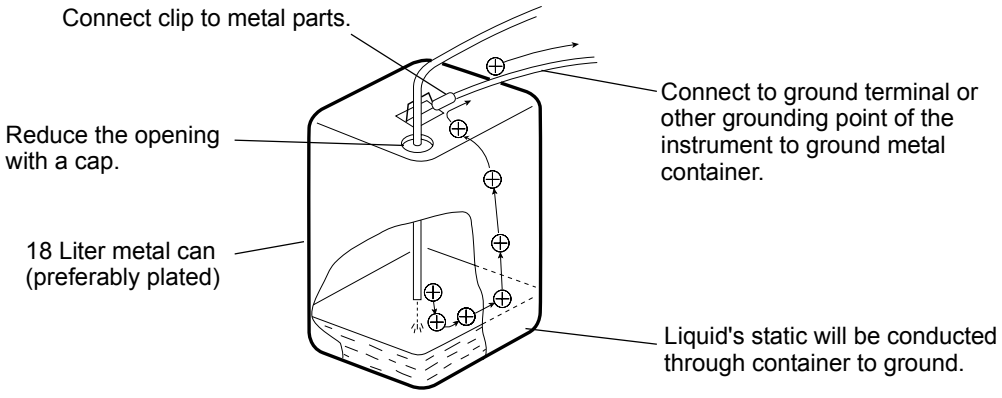
⚠ CAUTION

- **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 (set of 3 caps covering 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 1MΩ.)
- 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.

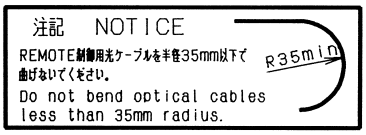
NOTE

- Use only HPLC grade or comparable mobile phase, and filter it with a filter of 0.45µm 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 Maintenance Parts" P. 9-30

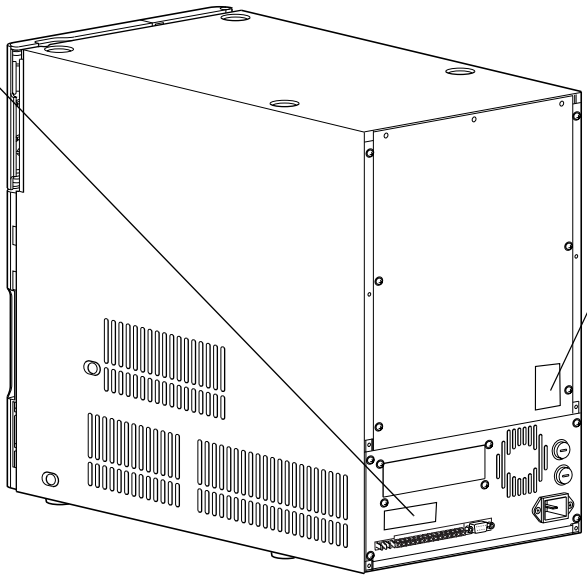
Warning Labels

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.

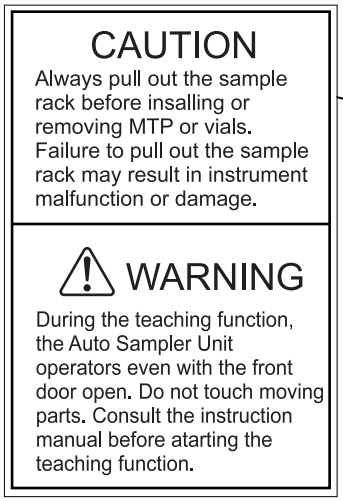
Caution label
(Part No. 228-40357)

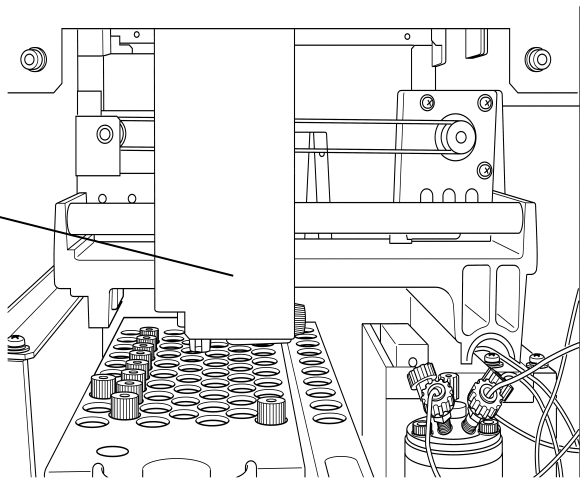


Warning label
(Part No. 228-42603)



Caution, Warning label
(Part No. 228-38924-02)





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1

Configuration

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1.1 Overview

The SIL-20A/20AC autosampler is designed for use with a High Performance Liquid Chromatograph Prominence LC series.
The injection capacity ranges from a volume of 0.1µL up to a maximum of 2,000µL (with the installation of optional accessories).
There are two modes for sample injection; standard injection mode that facilitates condition setting, and bracket sequence analysis mode that the insertion analysis can be performed in a certain cycle. Then it is possible to perform the analysis which suited a purpose by using two modes can be done.
SIL-20AC includes a sample cooler that is able to control the sample temperature from 4 to 40°C.
With this feature, it is possible to perform the continuous analysis of the sample which decomposes at the room temperature while cooling them.

1.2 Sample Injection Modes

This autosampler has two sample injection modes, standard injection mode and repeat injection mode.

1.2.1 Standard Injection Mode

This is the simplest mode for making a standard injection. In this mode, specify the sample vial number, number of injections, injection volume and analysis time in the sample table setting screen (details are in Section "4.2 Creating an Analysis Sequence Table" P. 4-7). Also, set the needle stroke, the rinse volume, the rinsing speed, sampling speed, etc. in the Parameter setting screen.

1.2.2 Bracket Sequence Analysis Mode

This mode can be used to inject a predetermined number of samples repeatedly, at periodic intervals. In this mode, a special repeat injection table is prepared (in addition to the default analysis sequence table). Preparing this repeat injection table allows insertion analysis to be performed at a certain cycle while sampling table for standard injection is being executed.

1.3 Sample Injection

The sequence of operations involved when injecting samples is as shown in the flow and operation diagrams below. Use these diagrams to become familiar with the operation of the instrument.

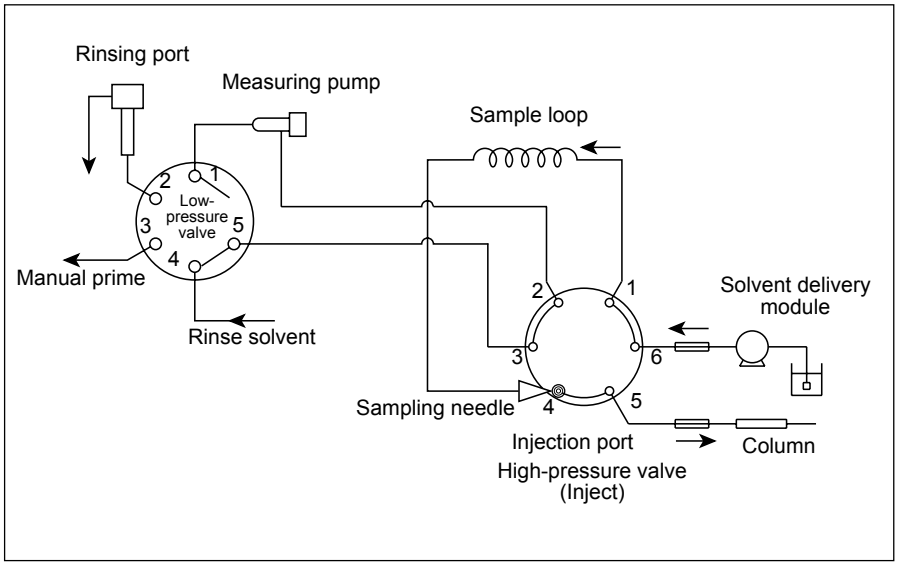


Fig. 1.1

1. Standby (READY)

Mobile phase from the reservoir is pumped, in order, through the high-pressure valve, sample loop, sampling needle, injection port and back through high-pressure valve, before reaching the analysis column. The low-pressure valve is connective at port 4 and 5.

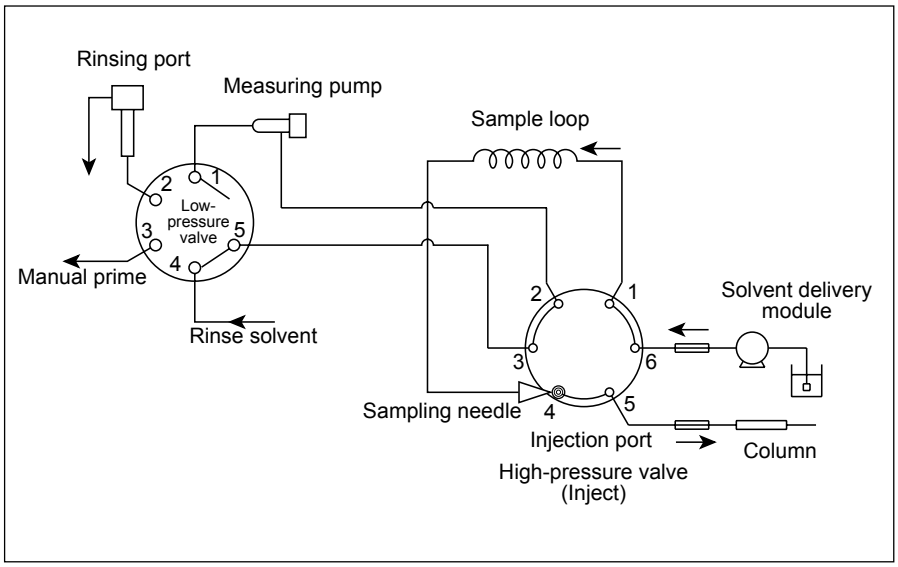


Fig. 1.2

2. Release of pressure in flow line

The high-pressure valve rotates to the load position (60° in the clockwise), and the high-pressure sample-loop mobile phase remaining in the sample loop flows, in order, through the sampling needle, injection port, high-pressure valve, measuring pump, low-pressure valve, and rinsing port, relieving the pressure in the sample loop.

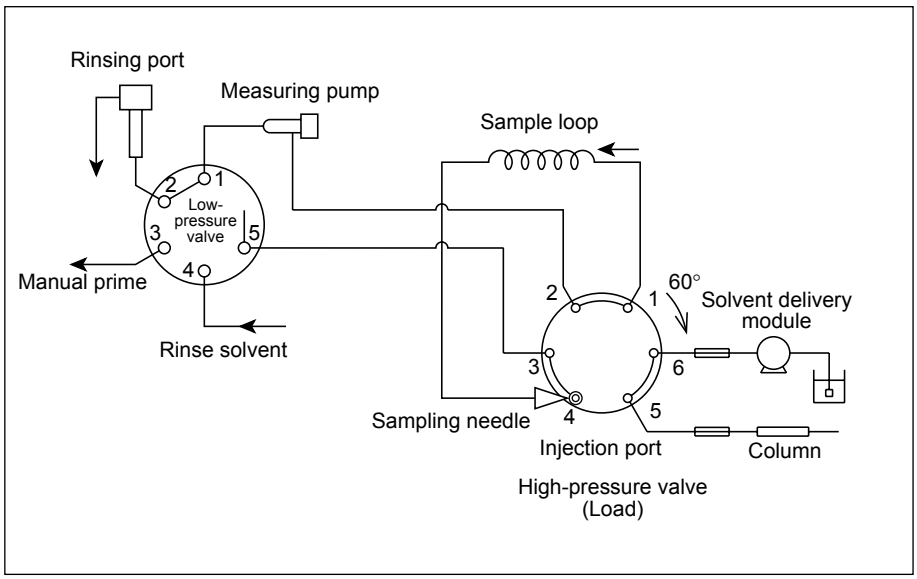


Fig. 1.3

3. Rinsing of sampling needle

The sampling needle is inserted into the rinsing port, where its outer surfaces are rinsed with the rinse solution inside the port.
It is also possible to set the autosampler not to perform rinsing. In addition, using a needle-rinsing pump (optional) allows rinsing to be performed with two types of rinse solutions.

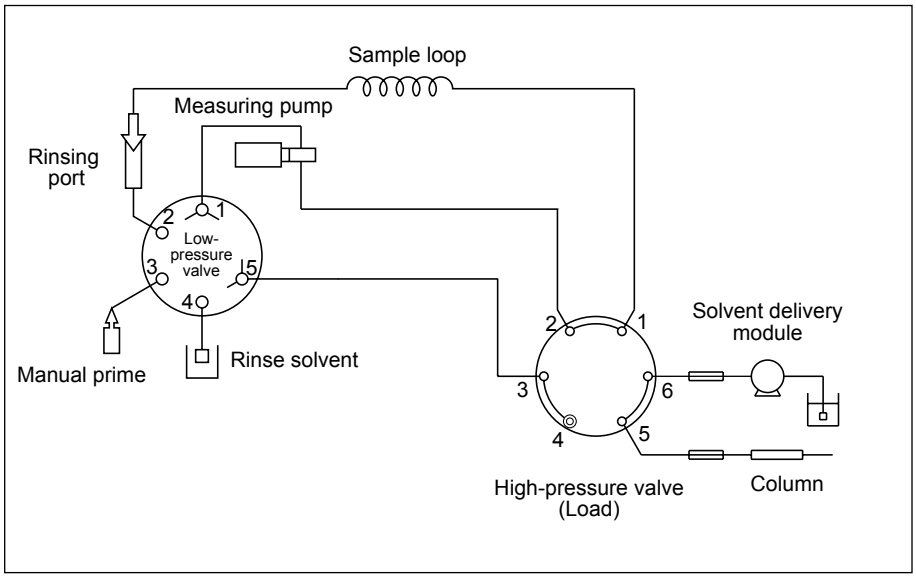


Fig. 1.4

4. Sample aspiration

The low-pressure valve rotates 30° clockwise, and the sampling needle is inserted into the sample vial. Then the measuring pump draws the sample into the sampling needle.

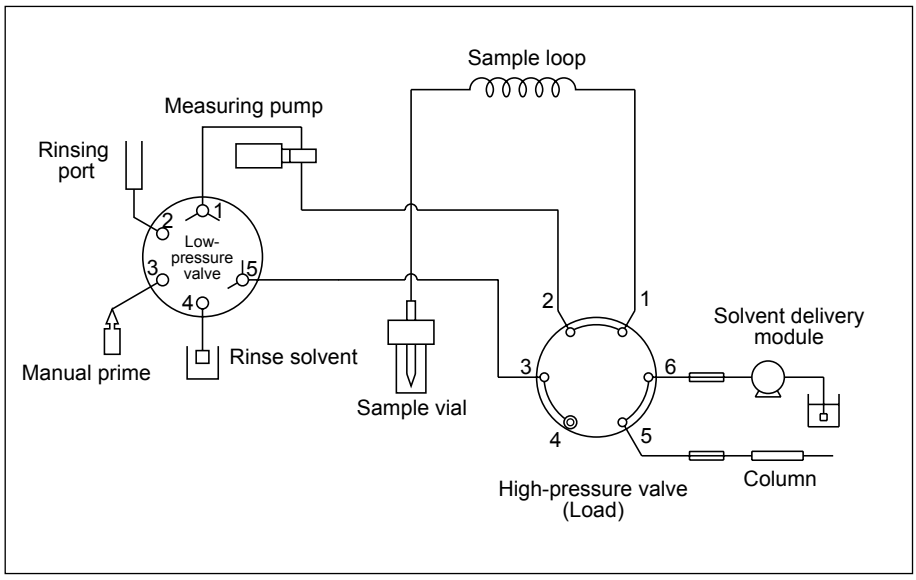


Fig. 1.5

5. Rinsing of sampling needle

The sampling needle is inserted into the rinsing port, where its outer surfaces are rinsed with the rinse solution inside the port.
It is also possible to set the autosampler not to perform rinsing.
With the needle rinsing pump (optional), rinsing can be executed using two kinds of rinse solutions.

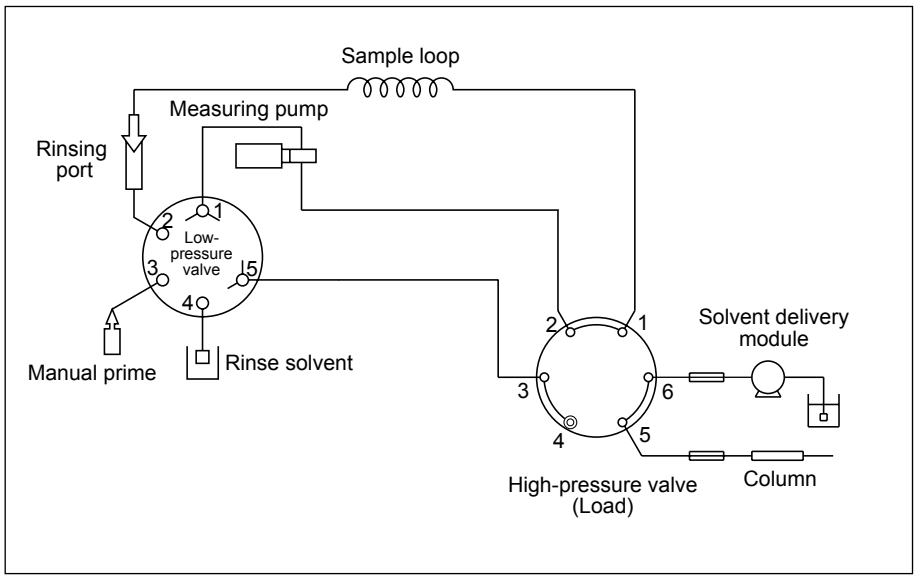


Fig. 1.6

6. Start of analysis

The sampling needle is inserted into the injection port, and the high-pressure valve rotates 60° counterclockwise to the injection position. The sample is injected into the flow lines and, along with the mobile phase, passes through the high-pressure valve and into the column, where analysis begins.

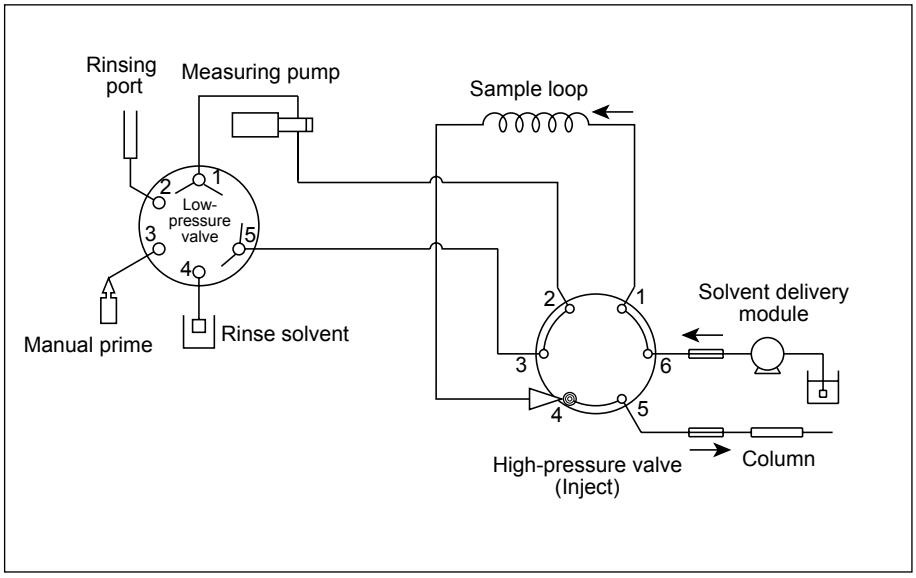


Fig. 1.7

7. Purge of measurement flow line (rinse solution aspiration)

The low-pressure valve rotates 30° counterclockwise. (Port 1 and 2 are connective.) And after the plunger of the measuring pump has returned to the home position, the low-pressure valve rotates 60° clockwise. (Port 4 and 5 are connective.) and the plunger operates to aspirate rinse solution.

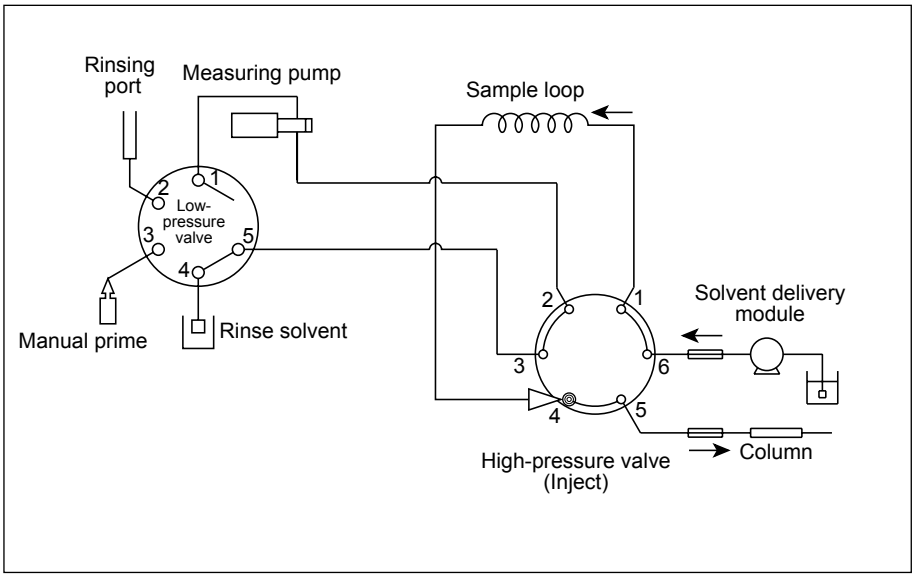


Fig. 1.8

8. Purge of measurement flow line (rinse solution dischargement)

The low-pressure valve rotates 60° counterclockwise. (Port 1 and 2 are connective.)
And measuring pump plunger operates to discharge rinse solution to rinsing port.

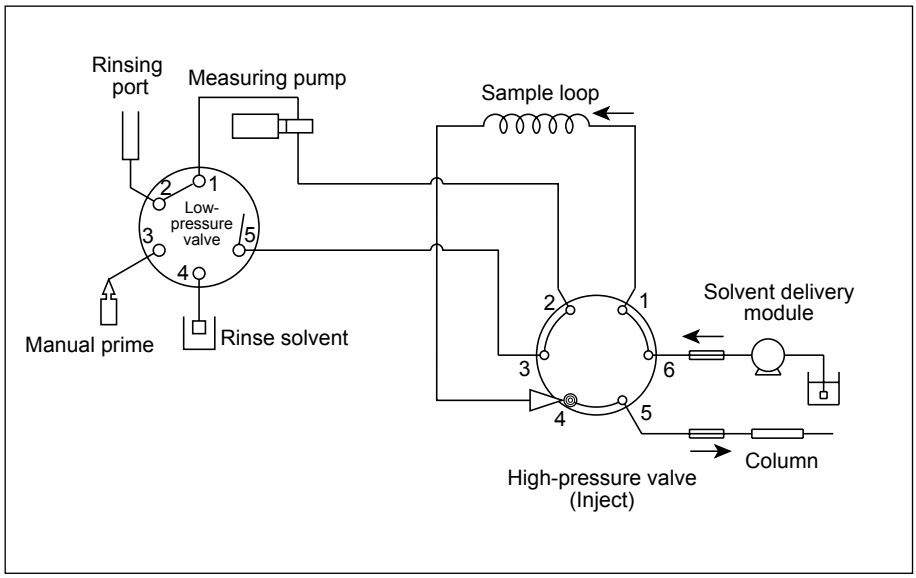


Fig. 1.9

1.4 Component Parts

This instrument consists of the standard parts listed below. Check the parts against this list after unpacking. The standard parts provided depend on the power supply voltage. (See below.) After unpacking, verify that the correct types and quantity of parts have been provided.
The 2-digit numbers in the remark column in the table below indicate the power supply voltages for the part. -31 indicates use with a 100V power supply, -32 is a 120V power supply, and -38 a 220-240V power supply. These 2-digit figures refer to the last two digits in the product number of the instrument. -31 is for products destined for Japan, while -32 and -38 are for use in other countries.

No.	Part	Part No.	Q'ty		Remark
			SIL-20A (228-45006-□)	SIL-20AC (228-45007-□)	
1	Instruction manual SIL-HTA/C USEnglish	228-30975	1	1	-31
	Instruction manual SIL-HTA/C English	228-30976	1	1	-32, -38
2	Parts pack	228-39988-93	1	1	-31, -32, -38
3	Optical cable	070-92025-51	1	1	-31, -32, -38
4	Sample vial 1.5 mL (containing 10 pcs.)	228-38446-91	1	1	-31, -32, -38
5	Cooling rack for 1.5 mL vial	228-44617-92		1	-31, -32, -38
6	Standard rack for 1.5 mL vial	228-37615-92	1		-31, -32, -38
7	Male nut, PEEK	228-18565	2	2	-31, -32, -38
8	Control vial rack	228-44634-91	1	1	-31, -32, -38
9	PTFE tubing (O.D. 7mm)	016-37507	800mm	800mm	-31, -32, -38
10	PTFE tubing (O.D. 8mm)	016-37519	50mm	50mm	-31, -32, -38
11	Silicone tubing	228-25162-03	1	1	-31, -32, -38
12	Fitting set 20A	228-45407-91	1	1	-31, -32, -38
13	Suction filter Assembly	228-39181-93	1	1	-31, -32, -38
14	Drain tubing Assy (ETFE)	228-44608-91	1	1	-31, -32, -38
15	Cover for rinsing port	228-43311	1	1	-31, -32, -38
16	AC power cord (for UL/CSA)	071-60825-01	1	1	-31, -32
17	AC power cord (for VDE)	071-60825-51	1	1	-38
18	L-type drain tubing (for leak)	228-44611-91	1	1	-31, -32, -38
19	Drain tubing adapter	228-43347	1	1	-31, -32, -38
20	Event cable	228-28253-91	1	1	-31, -32, -38
21	Lock catch	037-60314-03	1	1	-31, -32, -38
22	L-type drain tubing	228-43271-92		1	-31, -32, -38
23	L-type drain tubing	228-43271-91	1		-31, -32, -38
24	PEEK tubing 0.13 ID × 600mm	228-40984-92	1	1	-31, -32, -38
25	Clamp, DKN-10GSP	072-60319-01		1	-31, -32, -38

1.5 Optional Parts

Optional units available for this instrument are listed below.
Check the User Manual included with the optional equipment for installation instructions.
For information about other optional units not listed below, contact your Shimadzu representative.

■ Expansion Sample Loop Kit

Used to increase the amount of sample injected

Part	Part No.
Sample Loop Assembly (for 2mL injection)	228-45405-92
Sample Loop Assembly (for 500µL injection)	228-45405-91

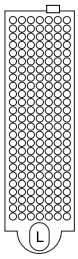
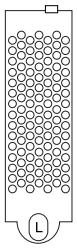
■ Rinsing Pump

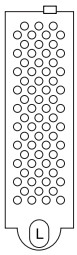
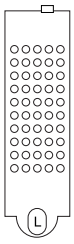
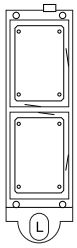
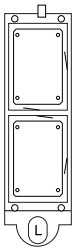
Used to rinse the sampling needle with two or more types of rinse solutions.

Part	Part No.
Rinsing Pump Assembly	228-43042-91

■ Sample Vial Racks, Microtiter Plate Racks

Please select according to the purpose and content of analysis.
Contact your Shimadzu representative regarding recommended microtiter plates.

Name	Screen Display	Sample Vial Type, Volume	Capacity	For Model No.	Part No.
1mL Sample Vial Rack 	1mL-C	Glass 1mL	175 vials	SIL-20A/20AC	228-37614-92
1.5mL Sample Vial Rack 	1.5mL	Glass 1.5mL, Plastic (PP)1mL, 0.2mL	105 vials	SIL-20A	228-37615-92
	1.5mL	Glass 1.1mL Glass w/spacer 0.3mL			228-4540-92

Name	Screen Display	Sample Vial Type, Volume	Capacity	For Model No.	Part No.
1.5mL Sample Vial Cooling Rack 	1.5mL-C	Glass 1.5mL Glass 1.1mL Glass w/spacer 0.3mL	70 vials	SIL-20AC	228-44617-92
	1.5mL-C	Plastic(pp)1mL,0.2mL	70 vials	SIL-20AC	228-44617-92
4mL Sample Vial Rack 	4mL-C	Glass4mL, Plastic (PP) 4mL, 0.3mL to accommodate 4mL sample vials	50 vials	SIL-20A/20AC	228-37616-92
Microtiter Plate Rack 	MTP-96, MTP-384	Microtiter plates (96-well, 384-well)	2 plates	SIL-20A/20AC	228-37545-92
Deep-well MTP Rack 	DWP-96, DWP-384	Dwell-1 Deep-well (96-well)	2 plates	SIL-20A/20AC	228-37546-92
Control Vial Rack	CntR	Glass 1.1mL,1.5mL, Glass w/spacer 0.3mL, Plastic (PP) 1mL, 0.2mL	10 vials	SIL-20A/20AC	228-44634-91
Changer Rack	Changer	Microtiter plates (96-well) Dwell-1 Deep-well (96-well)	1 plate	SIL-20A/20AC	228-43543-91

Temperature Control Performance (for SIL-20AC)

The following table indicates the temperature control performance when using various types of optional sample racks.

Sample Rack Name	Temperature Control Performance*	Remark
Sample vial rack for 1mL vials	Vial bottom temperature = temperature setting ±3°C	
Sample vial cooling rack for 1.5mL vials	Vial bottom temperature = temperature setting ±3°C	
Sample vial rack for 4mL vials	Vial bottom temperature = temperature setting ±3°C	
Microtiter plate rack	Vial bottom temperature = temperature setting ±4°C	Room temperature 24°C or less for 4°C cooling, and room temperature 20°C or greater for 40°C heating.
Deep-well MTP rack	Vial bottom temperature = temperature setting ±4°C	Room temperature 24°C or less for 4°C cooling, and room temperature 20°C or greater for 40°C heating.

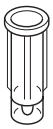
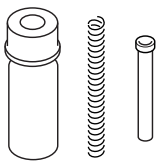
∗Cooling Performance of the Sample Cooler

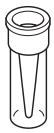
The following table indicates the temperature control performance when using various types of optional sample racks.

Sample Rack Name	Environment	Liquid Volume	Vial used	Measurement site
Sample vial rack for 1mL vials	30°C 70%	Water 700µL	Flat bottom glass vial	Vial bottom center
Sample vial cooling rack for 1.5mL vials	30°C 70%	Water 1mL	Glass vial	Vial bottom center
Sample vial rack for 4mL vials	30°C 70%	Water 3mL	Glass vial	Vial bottom center
Microtiter plate rack	30°C 70%	Water 200µL	Nalge Nunc flat bottom MTP	Well bottom center
Deep-well MTP rack	30°C 70%	Water 1mL	Polyfiltronics MTP	Well bottom center

■ Sample Vials

The following types of sample vials can be used in the sample vial racks.

	Part	Capacity	Material	Part No.	Application	Remark
	4mL Sample Vial 	4 mL	Borosilicate glass	228-21287-91	General	100ea. w/cap and silicone rubber septum
×	4mL Sample Vial	4 mL	Polypropylene	228-31537-91	General	
	1.5 mL Sample Vial 	1.5 mL	Borosilicate glass	228-15652-92	General	
×	1.1 mL Sample Vial 	1.1 mL	Borosilicate glass	228-21283-91	General and small-capacity Needle stroke is less than 50mm	
×	1 mL Sample Vial 	1 mL	Polypropylene Cap: polyethylene	228-35217-91	General and small-capacity Needle stroke is less than 50mm	200ea. w/cap (See TIP " Sample vials" P. 1-14.)
×	0.3 mL Sample Vial 	300µL	Borosilicate glass	228-16847-92	Small-capacity Needle stroke is less than 50mm	100ea. w/cap and silicone rubber septum
	0.3 mL Sample Vial (Spares)	300µL	Borosilicate glass	228-16850-91		100ea.
×	0.3 mL Sample Vial 	300µL	Borosilicate glass	228-21284-91	Small-capacity	100ea. w/spring, used inserted into aforementioned 4mL sample vial
	0.3 mL Sample Vial (Spares)	300µL	Borosilicate glass	228-21285-91		100ea.

Part		Capacity	Material	Part No.	Application	Remark
×	0.2 mL Sample Vial 	200µL	Polypropylene Cap: polyethylene	228-35217-91	Disposable vials for small-capacity analysis Needle stroke is less than 50mm	100ea. w/cap (See TIP " Sample vials" P. 1-14.)
	Silicone Rubber Septum	-	Silicone rubber w/PTFE cover	221-26718-93		100ea.
	PTFE Septum	-	PTFE	228-15655-91		100ea.
	Silicone Rubber Septum	-	Silicone rubber w/PTFE cover	221-21290-91	For 4mL Sample Vials	100ea.
	PTFE Septum	-	PTFE	228-23469-91	For 4mL Sample Vials	100ea.

NOTE

Using Sample Cooler

Sample vials marked with a × may have different thermal conductivity properties due to the shape or material of the sample vial. Consequently, there may be circumstances in which the sample cooler set temperature and the internal temperature of the sample vials may differ.

■ Microtiter Plates

When using a sample cooler, do not use microtiter plates with a raised bottom, shallow wells, and a gap above 2 mm between the bottom of the wells and the bottom of the plate. Using this type of plate will create a gap between the cooling plate on the rack and the microtiter plate or deep-well microtiter plate. Water condensation may occur in this gap, making it impossible to obtain accurate analysis results.

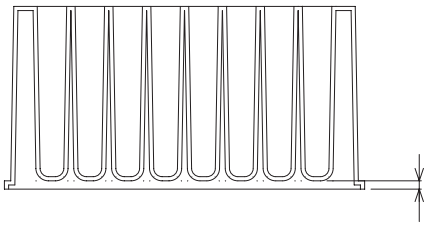


Fig. 1.10

It is recommended that the following microtiter plates or deep-well microtiter plates and corresponding mats are used with this autosampler.

MTP Type	Product
microtiter plate	267245 series (NUNC)
96-deep-well microtiter plate	AXYGEN P-DW-20-C, 278582 (NUNC)
Mat	AXYGEN AM-2ML-RD, Power Seal 676080 (Greiner)

NOTE

Sample vials

Both glass and plastic (polypropylene) sample vials are available for use, however, to prevent problems during analysis the following precautions should be observed when selecting the type of sample vial.

[Glass Sample Vials]

There is a possibility that ionic substances, such as acids or bases, may be adsorbed onto the glass surface. If ionic substances are analyzed under these circumstances, precision will be poor and the reliability of the analysis will be lost. When using glass sample vials, employ a sample solvent to restrict adsorption of the substance. The following kinds of sample solvents are used.

- 10mm to 100mm aqueous perchloric acid solution or a mixture of that and an organic solvent.
  (Use acetonitrile, methanol, or ethanol as the organic solvent.)
- An organic solvent solution of 10mm trifluoroacetic acid (TFA).
  (Use acetonitrile, methanol, or ethanol as the organic solvent. However, trifluoroacetic acid will be detected when detecting absorbance in the 200nm to 220nm range.)

In the event that one of these sample solvents cannot be used, use a plastic sample vial. Note that alkalis and hydrogen fluorides will chemically attack glass.

[Plastic Sample Vials]

The hydrophobic properties of substances are the cause of surface adsorption in plastic sample vials. The precision of analysis will be poor in this situation as well. The higher the polarity of the sample solvent, the greater the effect. The adsorption of hydrophobic substances can be suppressed through the use of low-polarity sample solvents, but if the polarity is too low, the possibility arises of additives in the plastic dissolving off the surface of the sample vial. Consequently, use the following sample solvents.

- Mixtures of water or a buffering solution with an organic solvent.
  The organic solvent content should be 20% to 50% (V/V). (Use acetonitrile, methanol, or ethanol as the organic solvent.)

In the event that one of these sample solvents cannot be used, use a glass sample vial. As discussed above, note that organic solvents promote the deformation of plastic.

■ Rack Changers

Rack changers make it possible to perform analysis with up to 12 microtiter plates or deep-well microtiter plates.

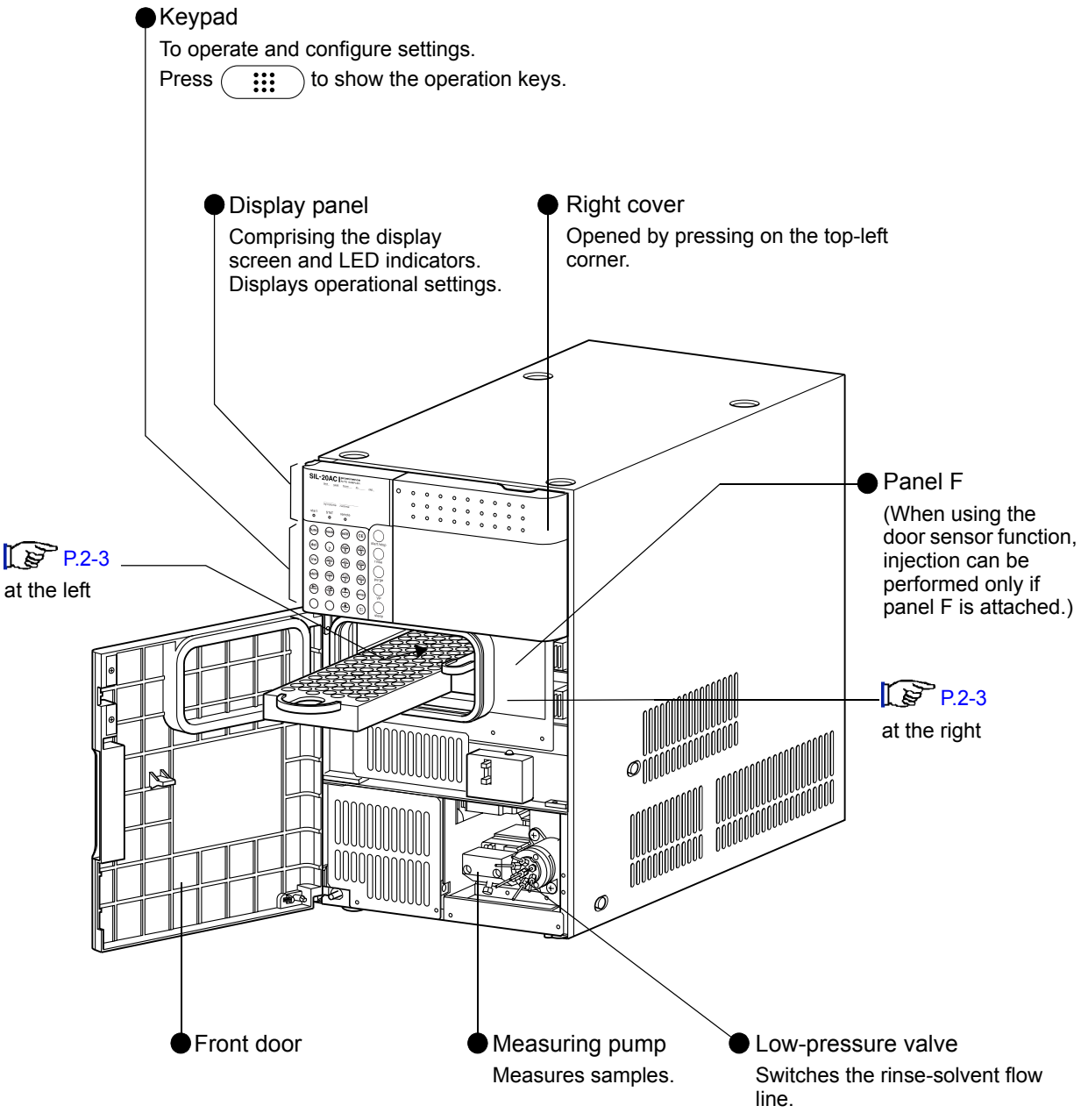
Part	Part No.	Remark
Rack Changer	228-45029-31, 32, 38	For SIL-20A
Cooling Rack Changer	228-45030-31, 32, 38	For SIL-20AC

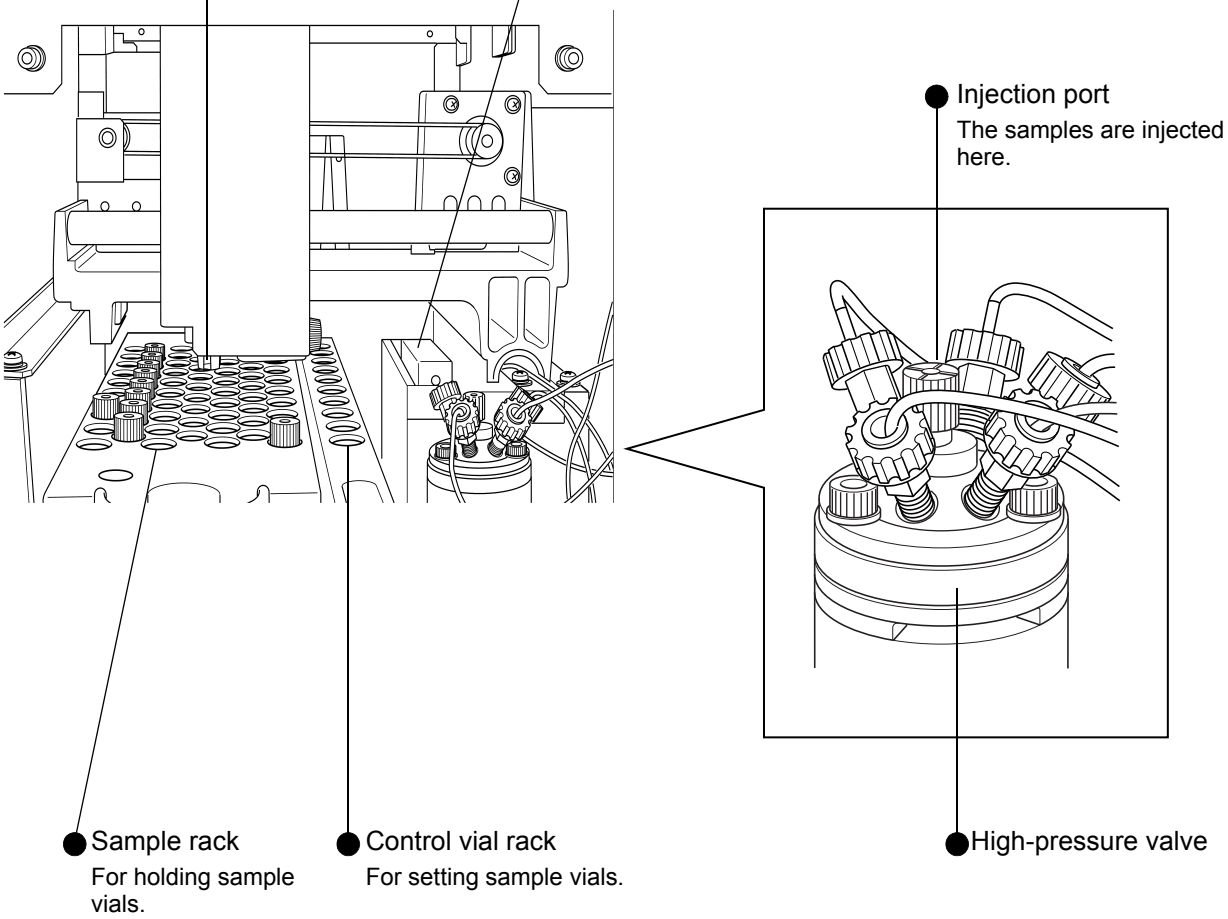
2

Parts Identification and Function

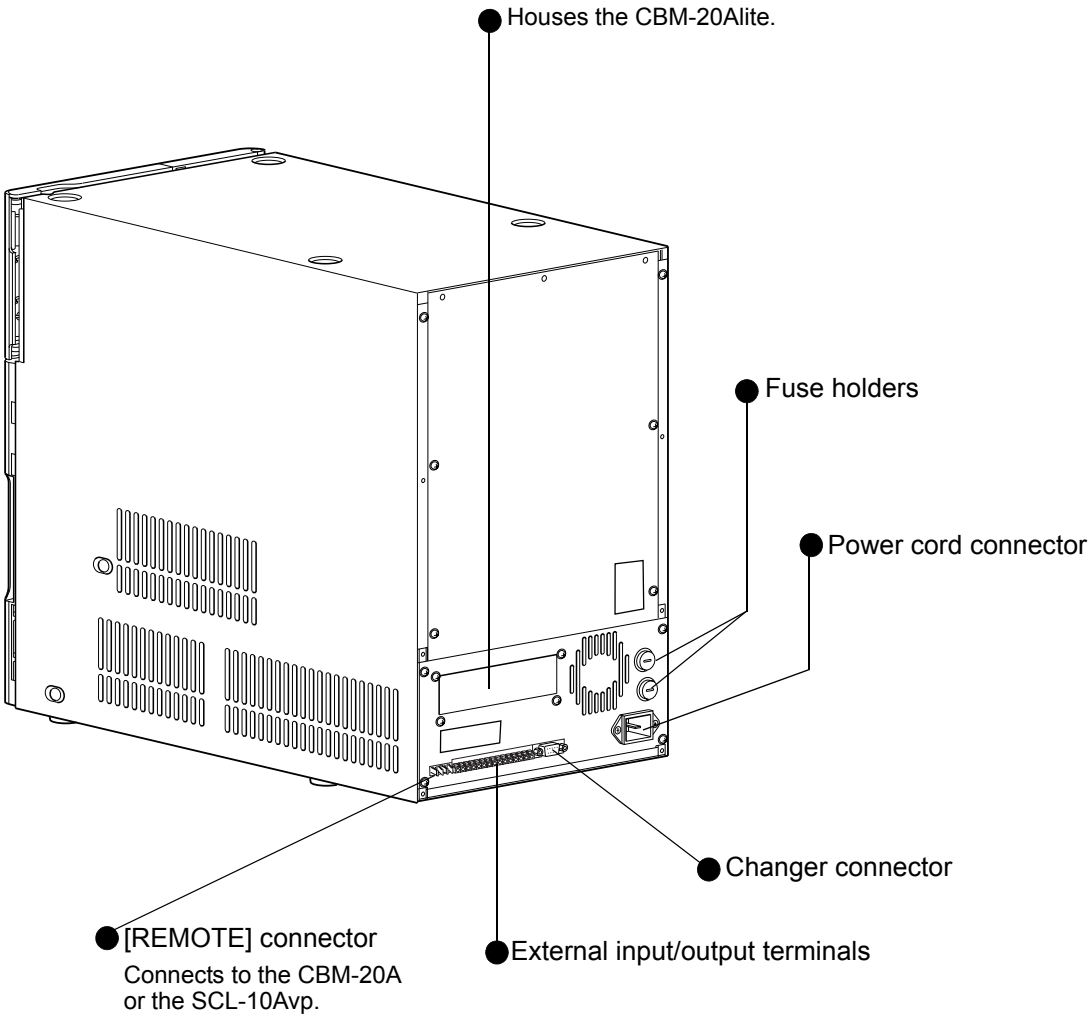
Contents

2.1 Front Section Interior



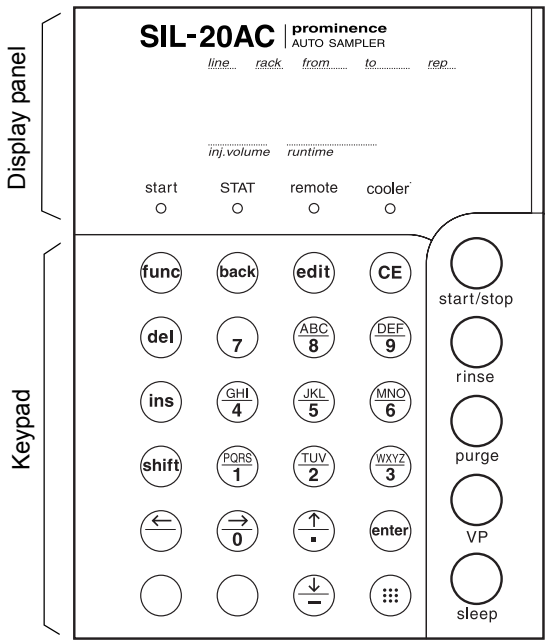

Needle
Aspirates the samples.
Rinsing port
Rinses the needle.
The port on the far side is the standard rinsing port. Here, the needle is dipped in rinse solution and the outside of the needle is rinsed.
The port on the near side is the rinsing pump's rinsing port. Here, the outside of the needle is rinsed with a rinse solution different from the standard one.
Injection port
The samples are injected here.
Sample rack
For holding sample vials.
Control vial rack
For setting sample vials.
High-pressure valve

2.2 Back


Houses the CBM-20Alite.
Fuse holders
Power cord connector
Changer connector
[REMOTE] connector
Connects to the CBM-20A
or the SCL-10Avp.
External input/output terminals

2.3 Names and Functions of Displays and Keypad

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

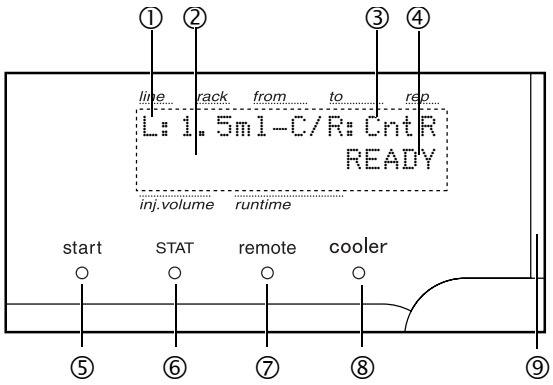


NOTE

The display screen may become hot when in use.

2.3.1 Display Panel

The display panel consists of a display screen and LED indicators.
Names and functions of the screen areas and the indicators are given below.

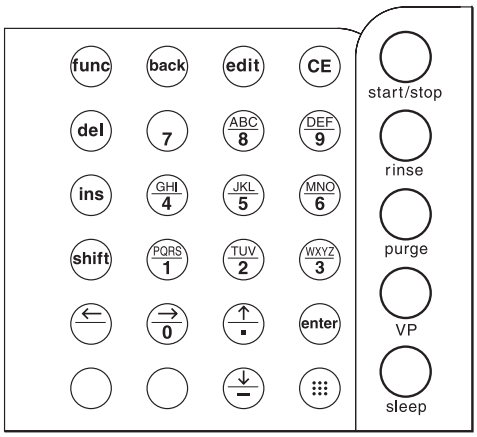


No.	Display or Indicator	Function
①	Rack display	Displays the model of the sample rack set in the autosampler.
②	Status display 1	When connected to a rack changer and using a rack-changer rack, [CHG-LINK] is displayed. When connected to the SCL-10Avp in HT compatible mode, [HT MODE] is displayed.
③	Control vial rack display	Indicates whether or not there is a control vial rack.
④	Status display 2	Displays the status of operation.
⑤	start LED	Illuminates when sample injection starts.
⑥	STAT LED	Priority analysis indicator ON when priority analysis is executed.

No.	Display or Indicator	Function
⑦	remote LED	Remote control mode indicator ON when the instrument is controlled by system controller.
⑧	cooler LED	Illuminates when using a sample cooler (i.e., with the SIL-20AC). Flashes if the monitor temperature is not within 1°C of the set temperature.
⑨	Status indicator	Green : when power is ON. Red : when an error is generated. Orange : during sleep mode

2.3.2 Keyboard

The 27 keys on the keypad are used to operate the instrument and set paramaters.



Key	Name	Function
⁞⁞	Display key	To show the operation keys.
func	Function key	Used to select auxiliary functions. Scrolls backward through VP functions.
back	Back key	Press this key while setting auxiliary functions to go back to the previous setting screen.
edit	Edit key	Activates edit mode for repeat injection table or analysis sequence table (from initial screen).
CE	Clear key	Initializes the screen. ∗ Cancels values input since [Enter] was last pressed. ∗ Clears error messages and cancels alarms.
del	Delete key	Deletes the set line in the repeat injector table or the sample table.
ins	Insert key	For adding lines to the repeat injection or analysis sequence table.

Key		Name	Function
shift		Shift key	For performing the operations for arrow keys indicated in the top part of the numeric keypad. When this key is pressed, [Shift pressed] appears on the display screen. Press any key or shift again to cancel [Shift pressed].
ABC - WXYZ		Letter keys	For entering the well number when using a microtiter plate or a deep-well microtiter plate.
Shift +	←	Left cursor key	For moving the cursor to the left on table parameter setting screens in the repeat injection or analysis sequence table.
	→	Right cursor key	For moving the cursor to the right on table parameter setting screens in the repeat injection or analysis sequence table.
	↑	Up cursor key	For moving the cursor up on table parameter setting screens in the repeat injection or analysis sequence table.
	↓	Down cursor key	For moving the cursor down on table parameter setting screens in the repeat injection or analysis sequence table.
. - 9		Numeric keypad	For entering numerical values.
enter		Enter key	Validates input values.
–		Minus key	For displaying a minus sign on the cooler temperature setting screen.
start		Start key	Starts sample injection. Stops sample injection.
rinse		Rinse key	For rinsing needle in rinse solution.
purge		Purge key	Pumps rinse solution through flow lines for a specified period of time.
VP		VP key	For switching from initial screen to VP mode.
sleep		Sleep key	Turns off display screen. Has no effect on operation.

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3

Preparation

Contents

3.1 Turning Power ON/OFF

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

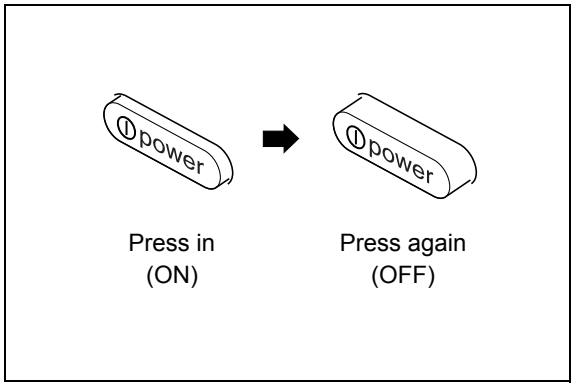
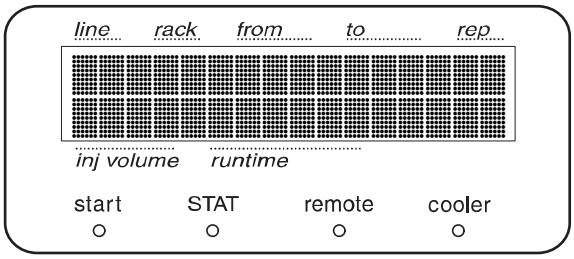
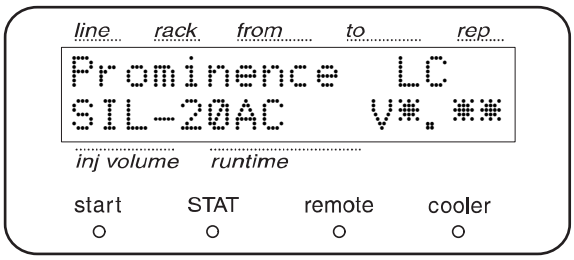


Fig. 3.1

2 When the power is first turned on, all the dots in the display matrix and all the indicators illuminate, as shown on the right.

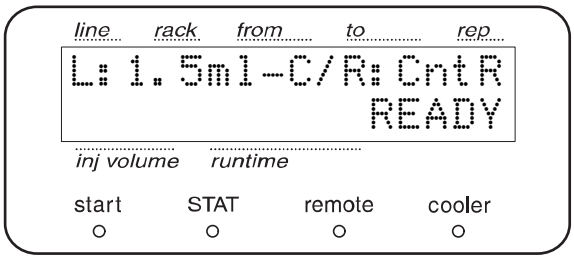


3 The memory is automatically tested, and after the memory check passes, the version number of the control program is displayed momentarily.
The status indicators turns green.
The screen displays the ROM version [V*.**] .



Initial Screen

4 When the sampling needle is in the standby state (in the injection port position), the initial screen on the right appears on the display.



NOTE

- If there is a large amount of data to be backed up, such as when there are many lines set in the sample table, it may take a while before initialization starts.
- If an error is detected, an alarm sounds and an error message appears.

"6.2 Error Messages" P. 6-6

3.2 Rinse Solution and Waste Containers Preparation

Prepare the rinse solution and waste containers before connecting the plumbing.

⚠ WARNING

Do not use cracked or damaged waste container(s). They could be broken.

NOTE

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 be drained, and will leak from the connections.
Check that the drain tubings are attached in the way shown in the following diagram. (The upper outlet is for the rinse solution, the center outlet is for condensation (only with SIL-20AC) and the lower outlet is for liquid leaked inside the equipment.) Attach a drain tubing adapter (accessory) to the mouth of the waste container, and make sure that the tip of the drain tubing connected to the rinse solution outlet is not immersed in the waste.

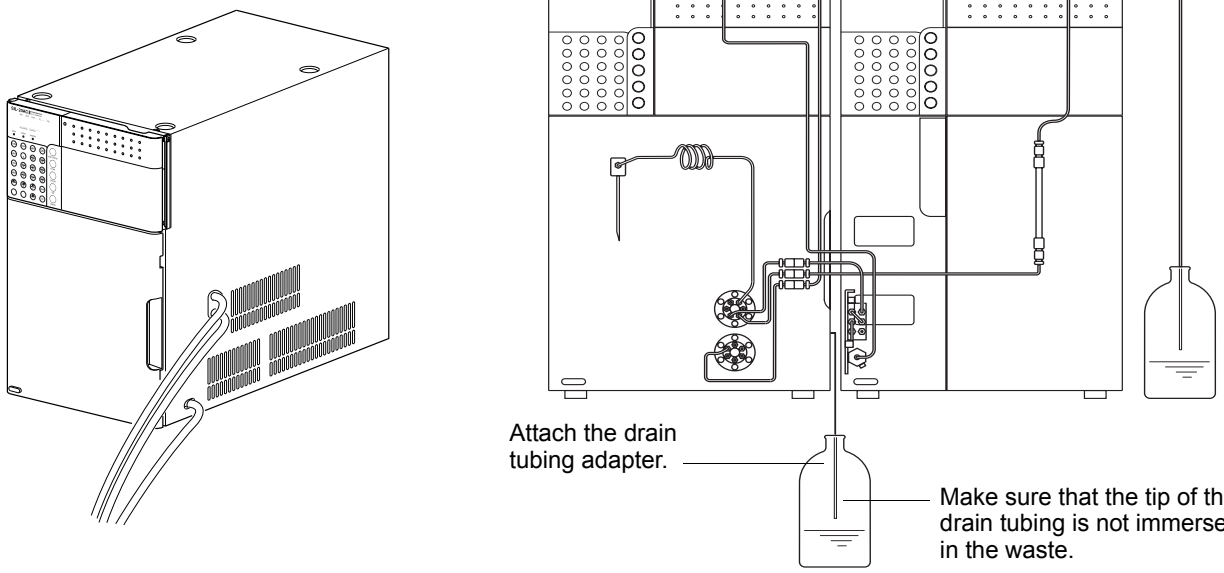


Fig. 3.2

3.3 Rinse Solution Selection

Select the rinse solution as follows, depending on the mobile phase.

■For reversed phase, ion exchange, and aqueous normal phase

- The ratio of methanol to water should be 50/50. If precipitation occurs upon sample contact, select a rinse solution without salts, as for the mobile phase.
- When the target compound is acid, base, or ionic substance, and sample is likely to remain on the outside surface of the needle, add acid such as formic acid and acetic acid to the organic solvent of methanol, acetonitrile, etc., or use a 10mM TFA solution or organic solvent solution, or their mixture solution.

■For non-aqueous normal phase, GPC

- Use the same solvent (s) used for the mobile phase.
- When the target compound is an acid, base, or ionic substance, and rinse mode is required, use a 10mM TFA aqueous solution, an organic solvent solution, or a mixture of both.

3.4 Purging Air Bubbles

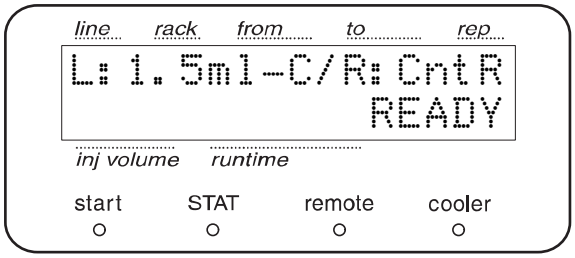
Air bubbles are likely to appear in the tubing when the instrument has been inactive for a prolonged period or when the room temperature changes.
Air bubbles inside the flow lines will adversely affect sample injection precision. Therefore, air bubbles must be purged with the PURGE function when restarting the instrument, or if a change in the room temperature produces air bubbles.
Also, perform the purge operation in the following cases:

- When the autosampler has not been used for a long period
- When the rinse solution has been changed
- When the room temperature has changed

NOTE

When replacing the solvent with an incompatible solvent, first replace with a compatible solvent as an intermediate rinse solution before replacing with the desired solvent.

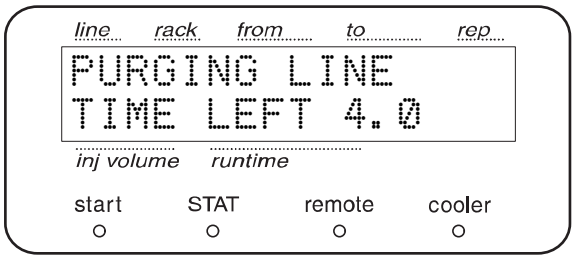
1 Press **CE** to return to the initial screen.



NOTE

When the [RINSE SPEED] is 35µL/s, the purging flow rate is about 0.3mL/min. Recommend to set 25min at [PURGE TIME] for replacing with a new solvent in the flow line completely.
To change the PURGE TIME, refer to "[PURGE TIME]" P. 5-17.

2 Press **purge** .
Rinse solution will be applied to purge the flow lines.



NOTE

To stop purging in mid-operation, press **purge** again. Purging will stop as soon as the pump has discharged all of its rinse solution.

If the rinse solution flow line is connected to a degasser unit with a large internal capacity, the whole flow line may not be filled with rinse solution with one purge operation. In this case, repeat the purge operation 2 or 3 times until rinse solution is discharged from the drain outlet.

3.5 Preparing Samples

⚠ CAUTION

Filter all samples to eliminate debris and undissolved particles.
Solid particles could clog the needle during sampling.
Dilute highly viscous samples before use.
High viscosity samples may not be aspirated successfully.

1 Completely dissolve the sample in a solvent with an identical or similar composition to the mobile phase.

2 Filter the sample.

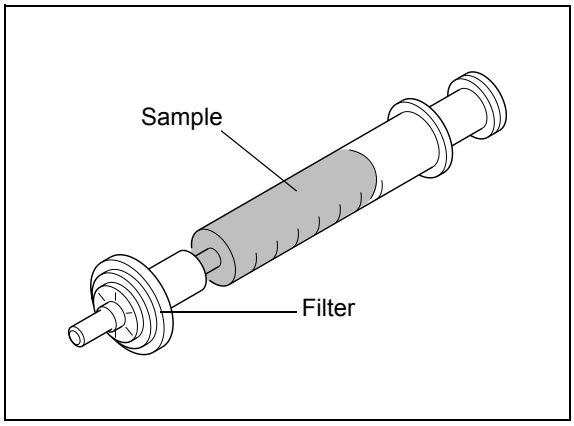


Fig. 3.3

3 Carefully load the sample(s) into a vial or microtiter plate well.

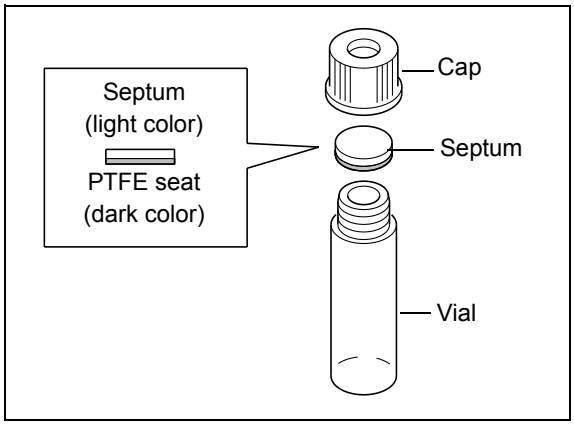


Fig. 3.4

⚠ CAUTION

- When loading into a vial, place the silicon septum on the vial so that the PTFE surface is facing down (liquid side) before attaching the cap.
  If the septum is positioned incorrectly, the solvent may dissolve the silicon rubber.
- Only use vial septum provided by Shimadzu.
  Septum provided by other vendors may produce fragments that could clog the flow line or may prevent successful penetration by the needle.

4

Basic Operation

Contents

4.1 Preparing the Samples

⚠ CAUTION

Condensation may occur with the SIL-20AC (sample cooler model) if the door is left open while the cooler is performing temperature regulation. Also, when using the door sensor, the autosampler will not operate if the front door is open.

4.1.1 Setting Samples in the Sample Rack

Sample racks for 1mL, 1.5mL and 4mL vials are available.

"1.5 Optional Parts" P. 1-9

The upper surface of the rack is marked with numbers at the vial positions. Specify these numbers when setting sample number parameters.

1 Open the door.

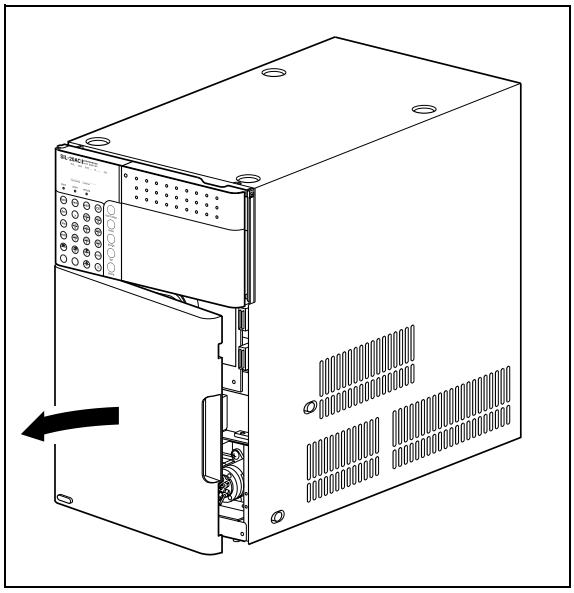


Fig. 4.1

2 Place the vial in the sample rack with the cap facing up.

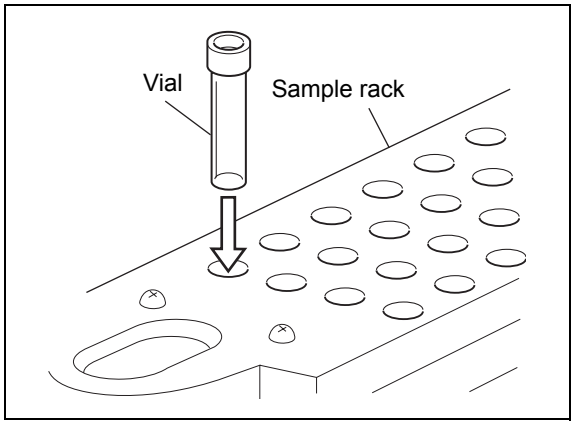


Fig. 4.2

3 Slide the sample rack along the guides all the way to the back of the instrument. The sample rack clicks into place when it is inserted correctly.

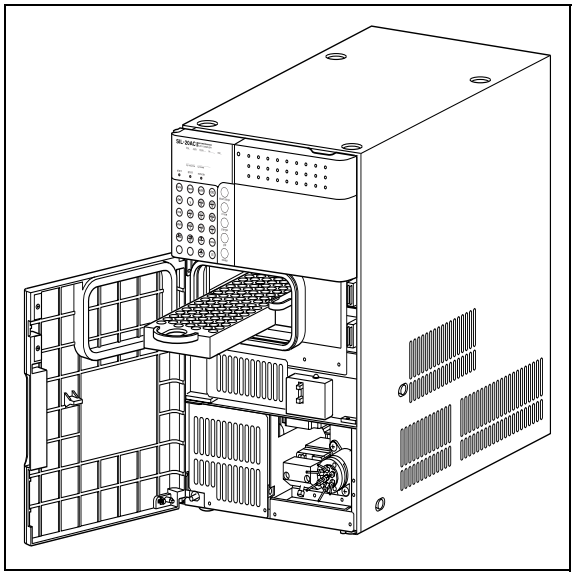


Fig. 4.3

4 Close the door.

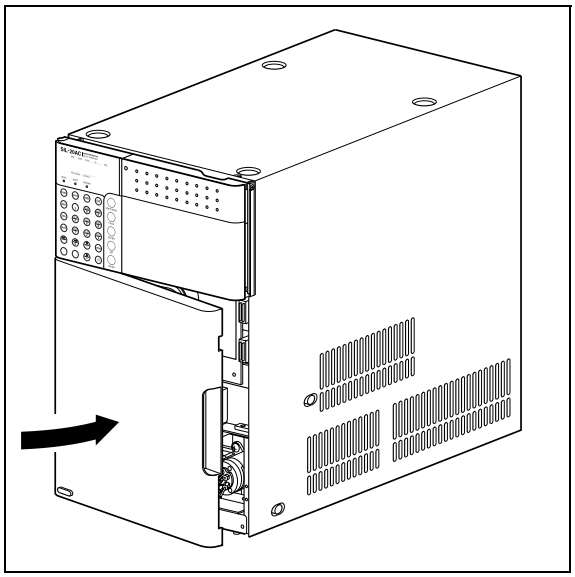


Fig. 4.4

4.1.2 Setting Samples in Microtiter Plates

When a microtiter plate is used for the first time or replaced with a different type of microtiter plate (96-well, 384-well, deep well), the sampling position intervals must be calibrated. This is referred to as the [teaching] procedure.

1 Open the door.

2 Set the microtiter plate(s) in the MTP rack.
Set so that A1 well comes to left front.

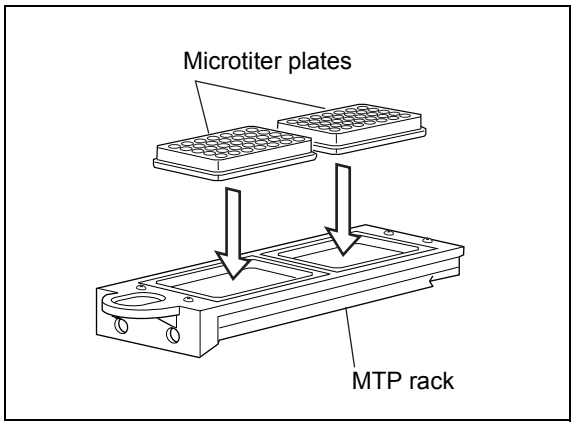


Fig. 4.5

NOTE

Up to two microtiter plates can be used.

3 Slide the MTP rack all the way to the back of the instrument. The MTP rack clicks into place when it is inserted correctly.
"Fig. 4.3 " P. 4-3

4 Close the door.

■ About the MTP Rack

The MTP rack position is as in the right figure.

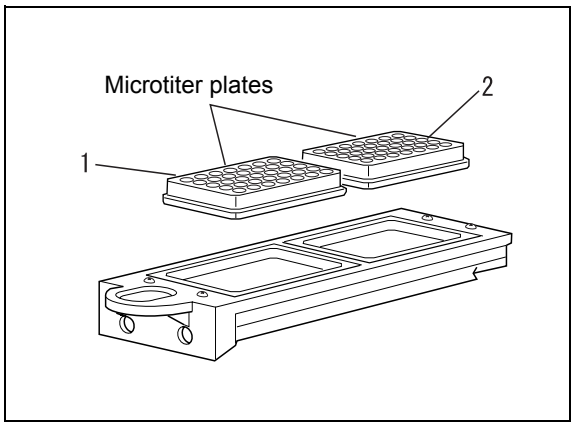


Fig. 4.6

4.1.3 Setting Samples Using a Sample Cooler

If the sample vials are cooled, the cooler LED illuminates.

■ Set the Sample Vial

1 Inject sample into the sample vial.

NOTE

The amount of sample introduced into the vial must not exceed the corresponding height shown on the right. If more than this amount is introduced, sufficient cooling of the liquid may not be possible.

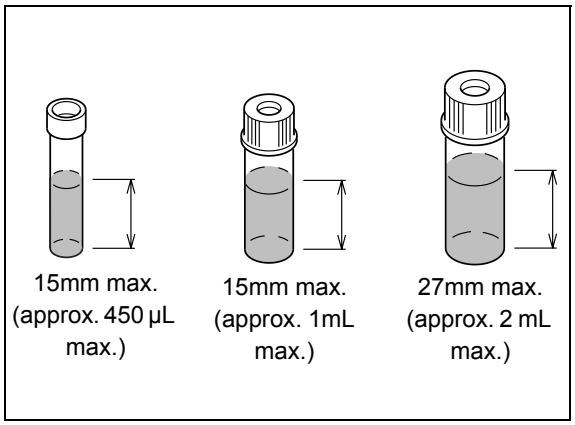


Fig. 4.7

2 Press the latches of both front sides of the cover to open the cover.

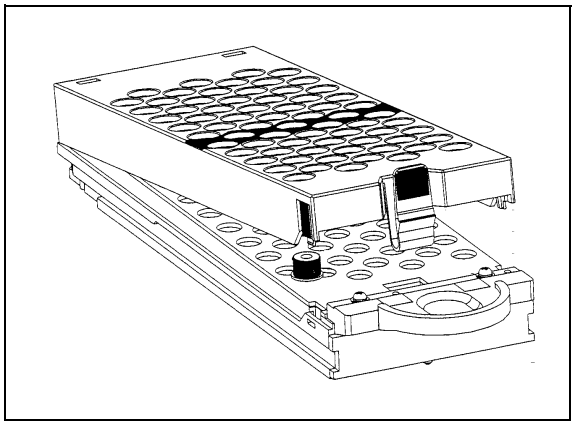


Fig. 4.8

3 Place the vial in the sample rack with the cap facing up.

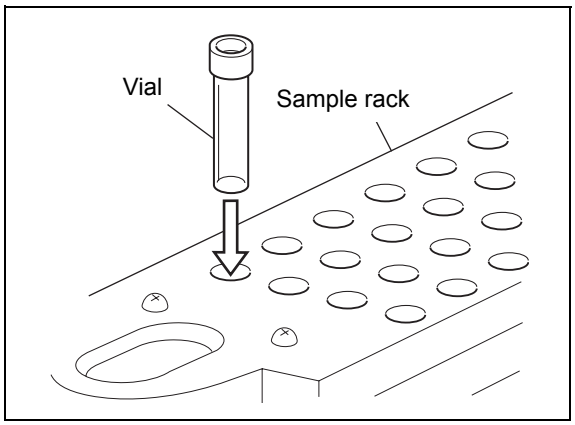


Fig. 4.9

4 Insert the hooks on rear side of the cover into square holes at the rear side on the sample rack.

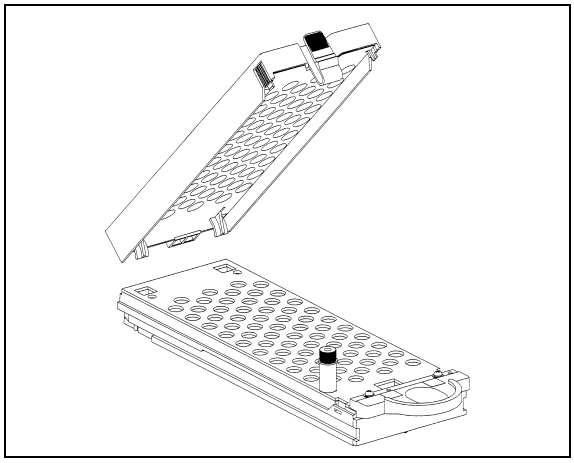


Fig. 4.10

5 The cover clicks if closed correctly.

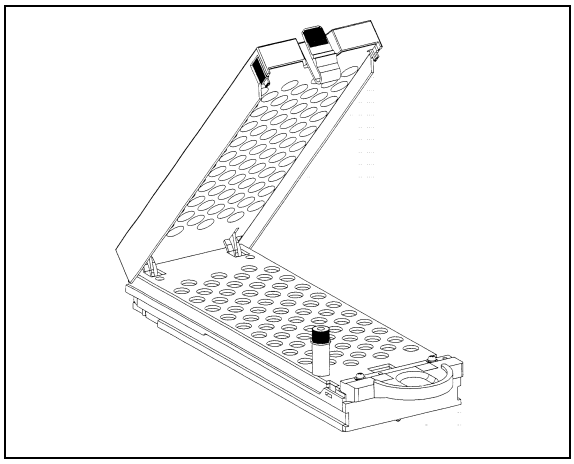


Fig. 4.11

4.2 Creating an Analysis Sequence Table

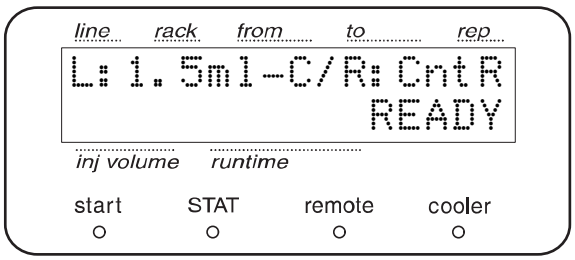
The procedure for creating a sample table is described below using an actual example.

The procedure for creating the following sample table is described using the settings for line 0. The line number is set automatically.

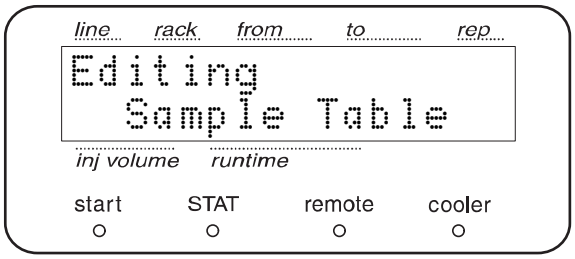
Sample table example

line	rack	from	to	rep	inj volume	runtime
0	1	1	9	10	20	5.00
1	1	20	30	10	10	10.00
2	1	30	39	1	10	30.00

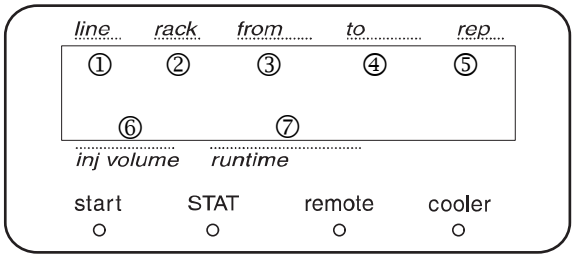
1 Press **CE** to return to the initial screen.



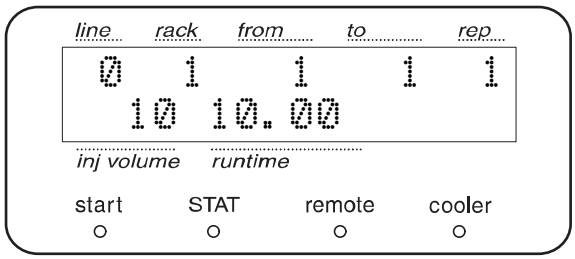
2 Press **edit**.
The analysis sequence table title screen will be briefly displayed, and then replaced by the parameter setting screen.



Explanation of parameter setting screen
① Line number
② Rack number
③ Initial sample vial number
④ Last sample vial number
⑤ Number of repeat injections
⑥ Injection volume (µL)
⑦ Analysis time (min)



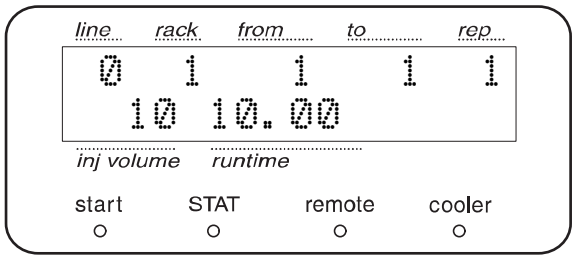
3 Use the numeric keypad to enter the rack number [1], and press (**enter**) .
The cursor will move to the [from] field.



NOTE

When using a rack changer, set rack numbers from 1 to 12.
Enter [0] to inject from the control vial rack.

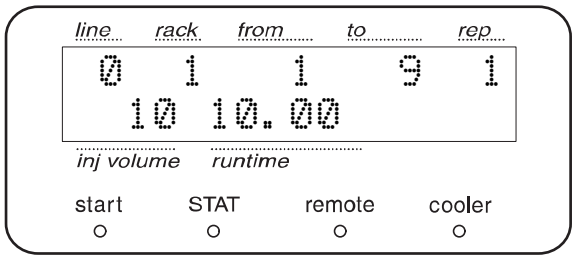
4 Use numeric keypad to enter the number [1] of the first vial to be injected, and press (**enter**) .
The cursor will move to the [to] field.



NOTE

Only the line number and rack number are displayed on a new parameter setting screen.

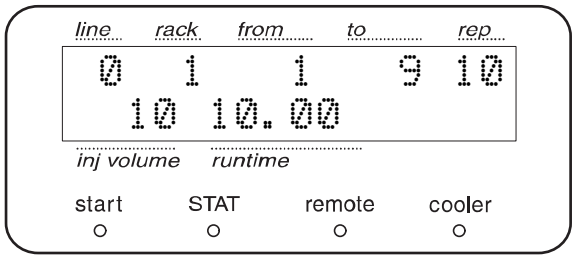
5 Enter [9], the number of the last vial to be injected, by numeric keypad and press (**enter**).
The cursor will move to the [rep] field.



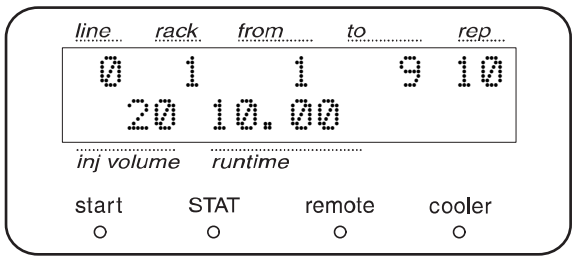
NOTE

If only one vial is to be injected, use the same number as in step 4.

6 Enter [10], the number of injections to be made repeatedly from one sample vial, by numeric keypad and press (**enter**).
The cursor will move to the [inj. volume] field on the second line.



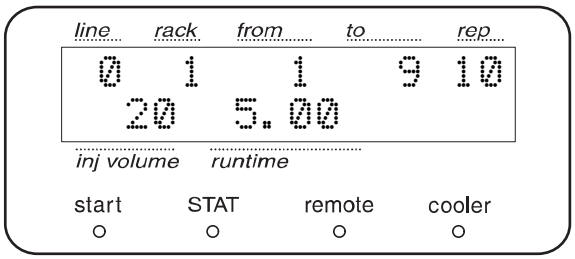
7 Enter the injection volume with numeric keypad, in µL and press (**enter**) .
The cursor will move to the [runtime] field.



NOTE

Injection volumes from 0.1 to 1µL can be entered in 0.1µL increments, and from 1 to 2000µL can be entered in 1µL increments.
In case of setting more than 101µL,set the optional sample loop.

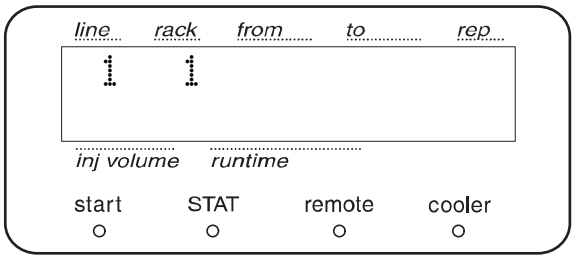
8 Enter the analysis time, in minutes, and press **enter**.
The input values will be validated.



NOTE

Any value between 0.01 and 9999.9 minutes can be set. Values higher than 1000 minutes must be in 0.1 minute increments.

9 Press **enter**.
The sample table on the next line appears.



10 Perform the required settings by repeating steps 1 to 9.

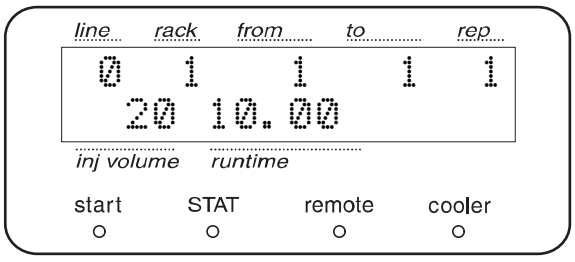
NOTE

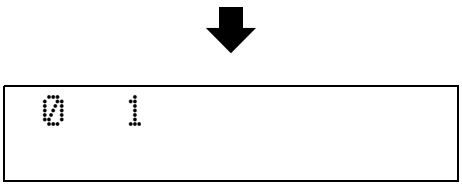
- Up to 99 lines can be set in the sample table. If a repeat injection table is created using the procedure described in "5.4.1 Creating a Repeat Injection Table" P. 5-37, up to 99 lines including the number of insertions can be set.
- If no further lines are required, press **CE**.

11 Press **CE** to go back to the initial screen.

■ Deleting a Line

1 Display the line to be deleted, using the same procedure as when setting parameters. To display lines greater than 1, press **shift**, ↓ and ↑ until the desired line is displayed.





2 Press **del**.
The line displayed will be deleted, and the line that follows will be displayed. If no lines follows, the display will be as shown on the right.

■ Inserting Individual Lines

1 Display the line number where the new line is to be inserted by pressing (shift), (↓) and (↑).

2 Press (ins).
The new line will be added to the table.

4.3 Starting Injection

1 Check that the front door is closed.

2 Press **start**.
The start indicator on the display panel illuminates, and the autosampler injects the first specified sample.

NOTE

When a data processor is used, it takes some time to print analysis results. To allow for this, set the autosampler's analysis time (RUN TIME) to a value slightly longer than that of the data processor's analysis time (STOP TIME). The value should allow time for the report to be printed. Note that starting the data processing unit by the event cable (provided as standard accessory) may fail, if analysis cycle of autosampler is shorter than that of the data processing unit.
For setting [STOP TIME], refer to the data processor's manual.

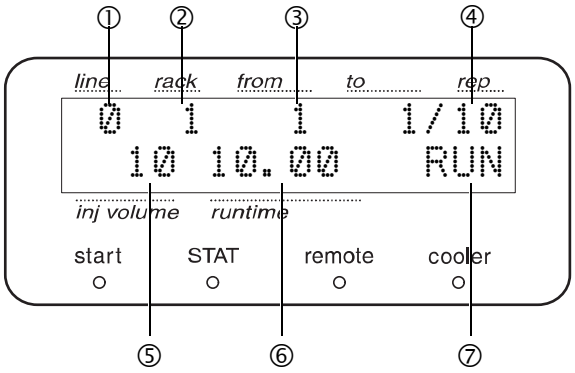
⚠CAUTION

If the open/close door detection is enabled and the door is opened during sample injection, operation ceases.
Operation resumes as soon as the door is closed.

3 During analysis, the display screen indicates the status in the way shown on the right.

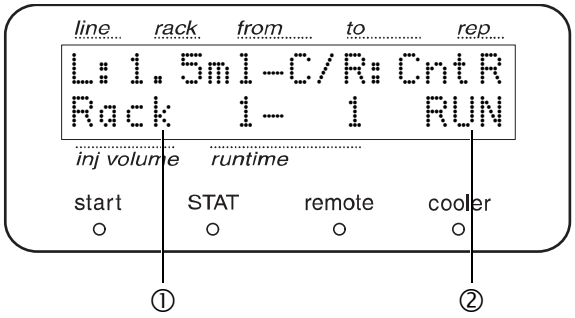
1) Controlled locally:

① Number of the line being executed
② Number of the rack being executed
③ Number of the sample vial being executed
④ Repeat status
⑤ Injection volume
⑥ Elapsed analysis time
⑦ Operating status
([PRET]: Injection; [RUN]: Analysis)



2) Controlled from a system controller:

① When controlled from an SCL-10Avp:
[HT-MODE]
② Operating status and number of sample vial being analyzed
([PRET]: Injection; [RUN]: Analysis)



4.4 Stopping Injection

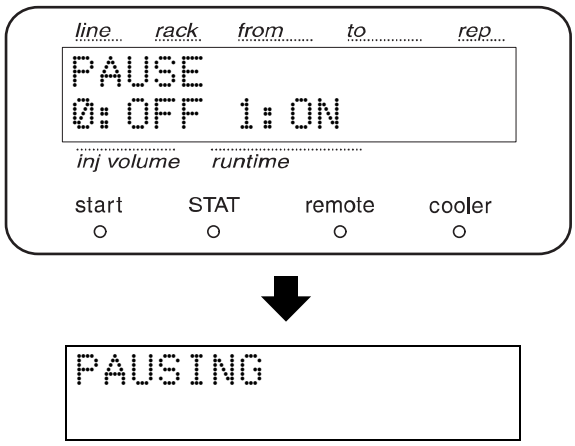
There are two ways to stop the injection process. It can either be stopped temporarily (i.e., paused) or stopped immediately.

■ To Pause the Injection Process Temporarily

1 After selecting the [CONTROL] screen, press **func** repeatedly until [PAUSE] is displayed.

2 Select [1:ON] to return to the initial screen.
(The [start] LED will flash.)
Operation will pause when analysis of the current sample ends.

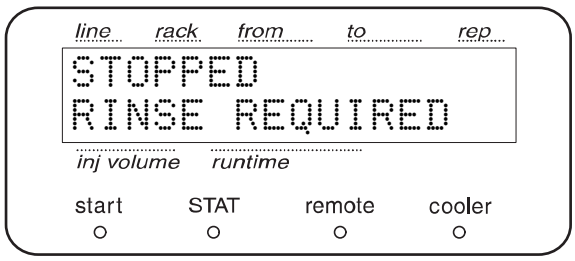
3 When ready to resume operation (starting from the next analysis) press **start** .



■ To Immediately Stop the Injection Process

1 Press **start** during analysis.
The message shown on the right appears on the display, informing the operator that operation has stopped.

2 Before resuming operation, the needle is rinsed.

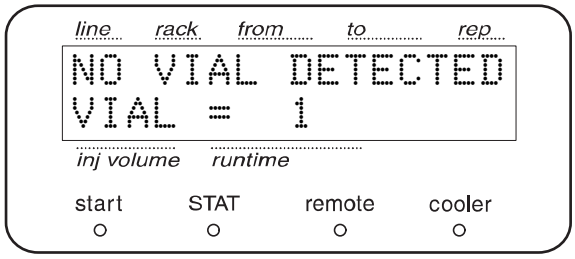


NOTE

When controlling the autosampler from the SCL-10Avp system controller, restart operation by using the system controller's rinse function.

■ Skipping Injection for Specific Sample Vials

If a sample vial registered in the sample table is not set in the sample rack, the injection operation for this vial is skipped and continued from the next vial. When a sample vial is skipped, its number is displayed in the way shown on the right. Press **CE** to clear this display. (When injection from a sample vial in a control vial rack is skipped, [c] is displayed in front of the vial number (e.g., [c1].)



4.5 Finishing Injection

1 Rinse the flow lines.
"4.6 Rinsing" P. 4-14

2 Press the power switch to turn the power off.
"3.1 Turning Power ON/OFF" P. 3-2

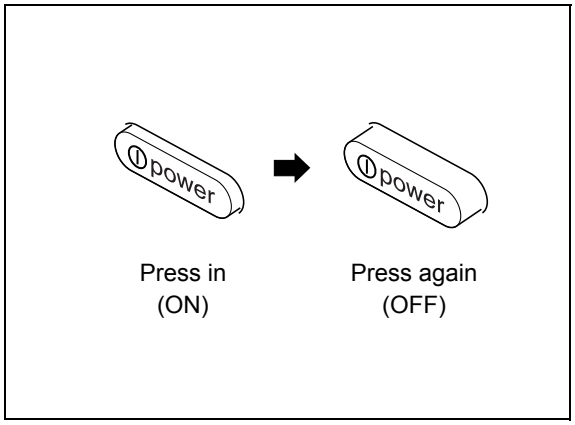


Fig. 4.12

4.6 Rinsing

To ensure long-term, safe, and trouble-free operation, follow these rinsing procedures when analysis have been completed.

⚠ CAUTION

When a buffer solution has been used as a mobile phase or rinse solution, the flow lines must be cleaned with distilled or de-ionized water.
Otherwise, any remaining buffer solution evaporates and crystallizes over time. This residue could damage the instrument or clog the flow lines.

The mobile phase and sample flow lines must be cleaned separately. Follow the procedures below.

4.6.1 Rinsing the Mobile Phase Flow Lines

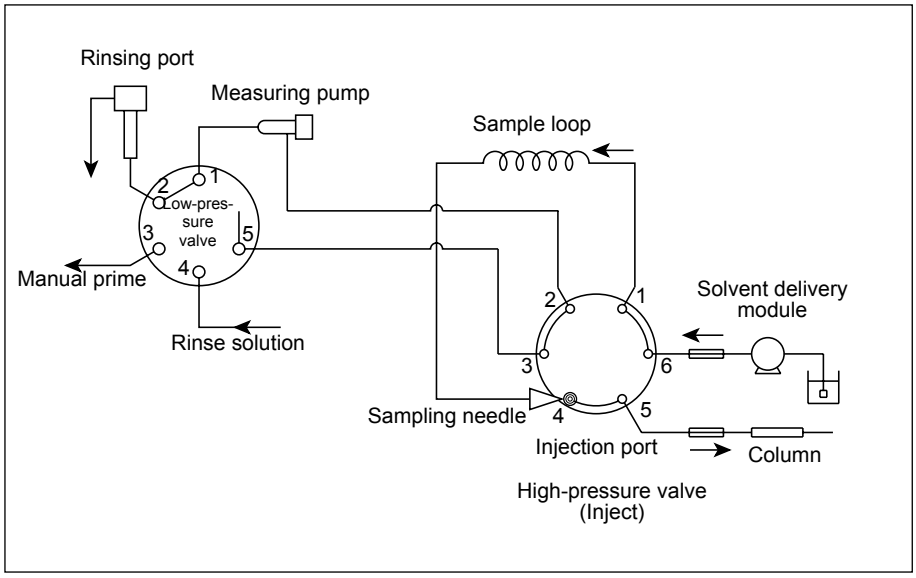


Fig. 4.13

1 Replace the mobile phase in the reservoir with distilled or de-ionized water.

2 Run the pump until the mobile phase in the flow lines (shown in the figure below) has been completely replaced with water.

3 Stop the pump.

4 Replace the water in the reservoir with methanol.

5 Run the pump again, until the water in the mobile phase flow lines has been completely replaced with methanol.

6 Stop the pump.

4.6.2 Rinsing the Sample Flow Lines

1 Replace the water in the rinse solution container with distilled or de-ionized water.

2 Press (purge).
Rinse solution is pumped from the measuring pump, and the flow lines are purged for 25 minutes.

NOTE

The default setting for the purge time is 25 minutes.
Reset this setting if it has been changed.
"3.4 Purging Air Bubbles" P. 3-5

3 Replace the water in the rinse solution container with methanol.

4 Purge the flow lines for another 25 minutes.

4.6.3 Rinsing the High-pressure Valve

When the mobile phase is in the condition of low-flow volume and low-pressure (1MPa or less at 0.1mL/min), the flow line may be clogged with particles scrapped off the rotor seal of the high-pressure valve. Follow the procedure below to solve this.

1 Remove the plumbing at the high-pressure valve's No.5 port (column outlet plumbing).
Check that there is no clog in the upper flow.

2 Clean the column outlet plumbing by reversing the flow.
If the clog cannot be removed, replace the plumbing.

3 Demount the high-pressure valve following the procedure of "8.6 Replacement and Inspection of the High-Pressure Valve Rotor and Stator" P. 8-19.
Clean rotor and stator with an ultrasonic cleaning device.
(For use in the condition above, carry on this operation after approximately 20,000 times injections.)

"8.6 Replacement and Inspection of the High-Pressure Valve Rotor and Stator" P. 8-19

5

Application Operation

Contents

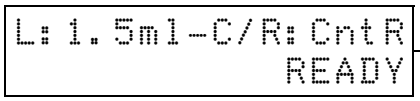
5.1 Display Panel

5.1.1 Types of Screens

Turn 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
- Repeat injection table setting screen or analysis sequence table setting screen

Initial screen



func

Auxiliary function screens P.5-14

Auxiliary function settings.

- Parameter
- Control
- System
- Changer

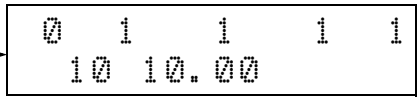
VP

VP function screens P.5-42

VP function settings.

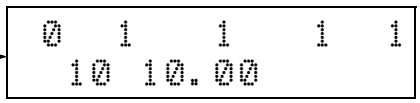
- Product information
- Maintenance information
- Validation support
- Calibration support

edit



Repeat injection table setting screen P.5-37

Used to create repeat injection tables for performing periodic injections.

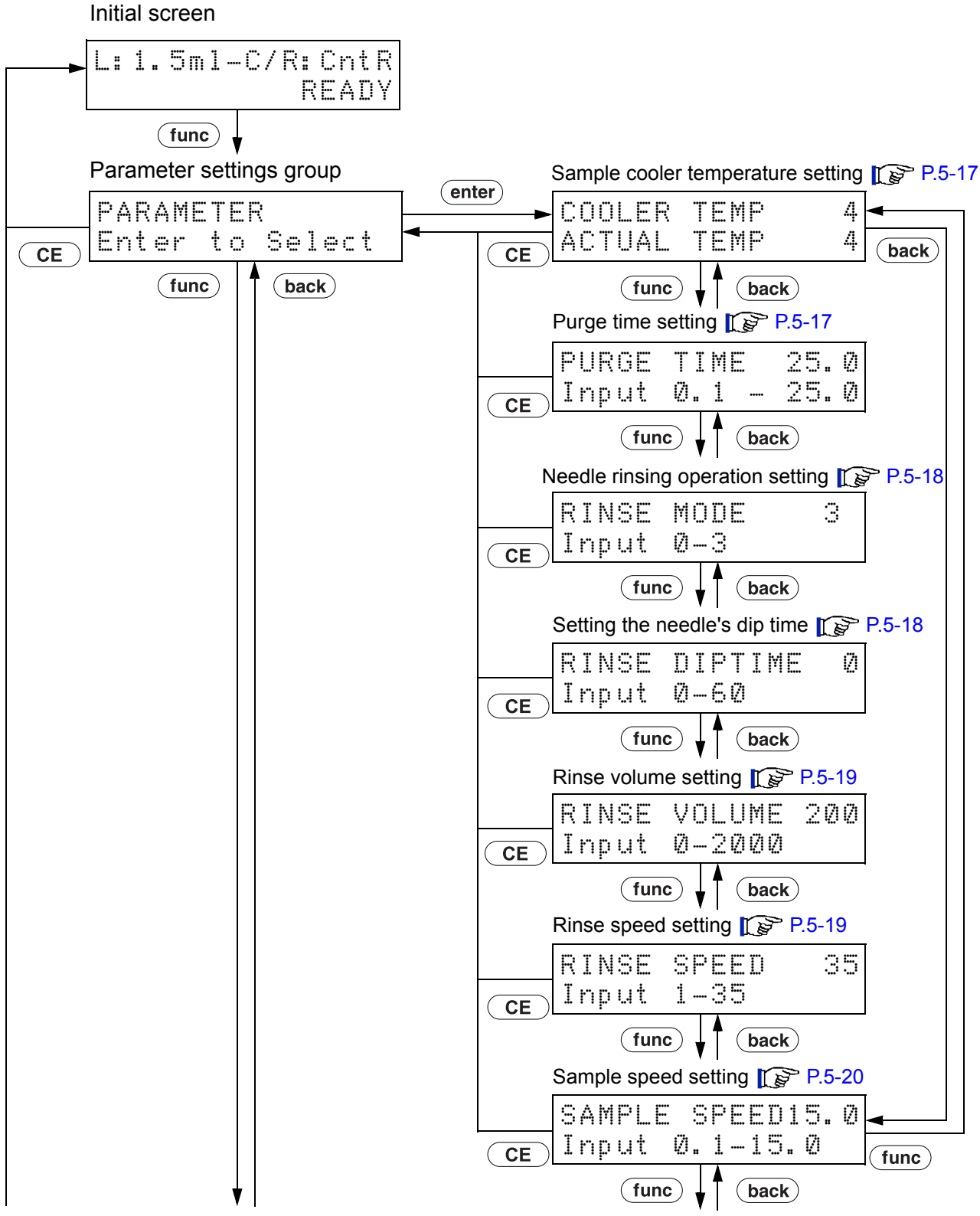


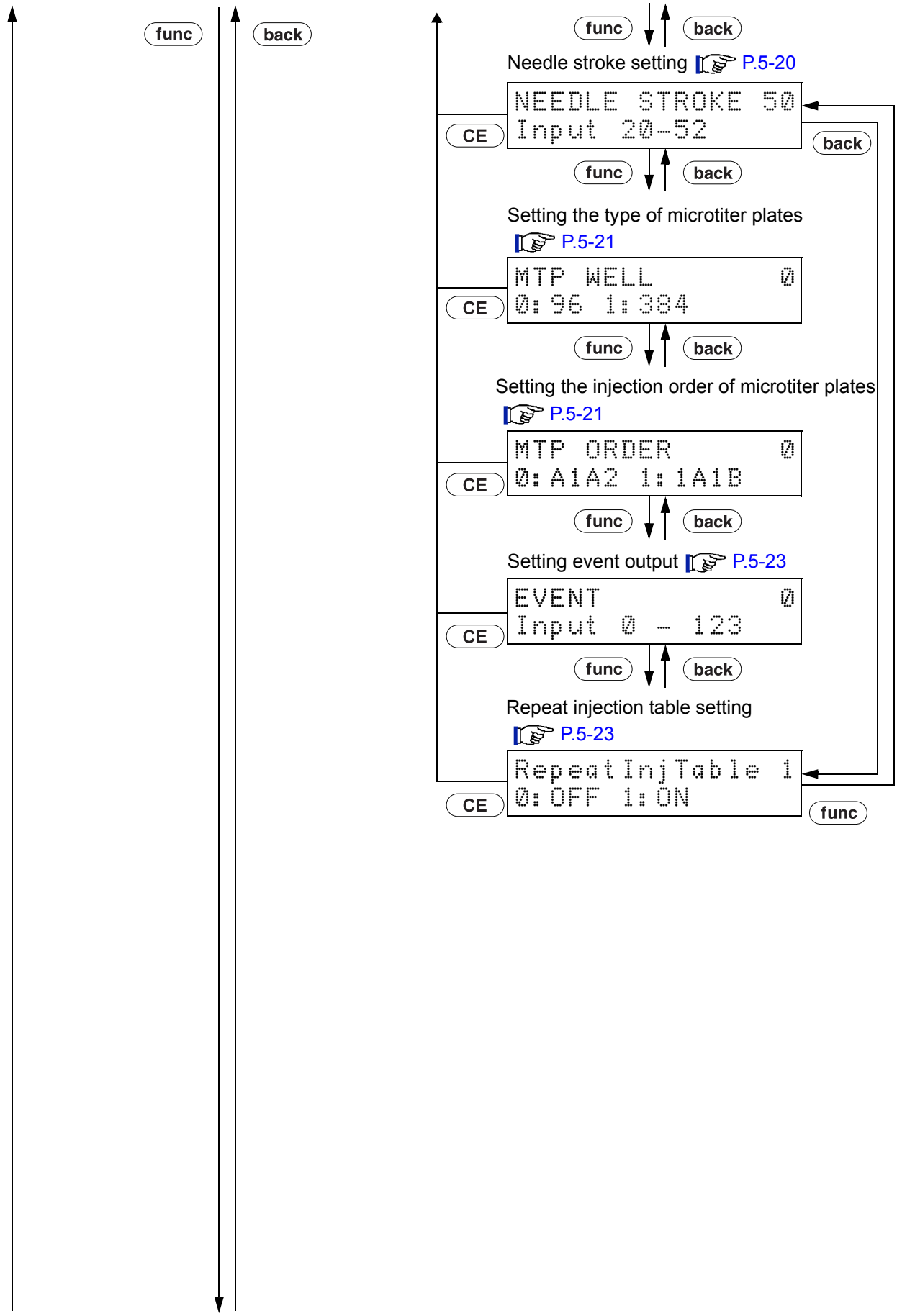
Analysis sequence table setting screen P.5-36

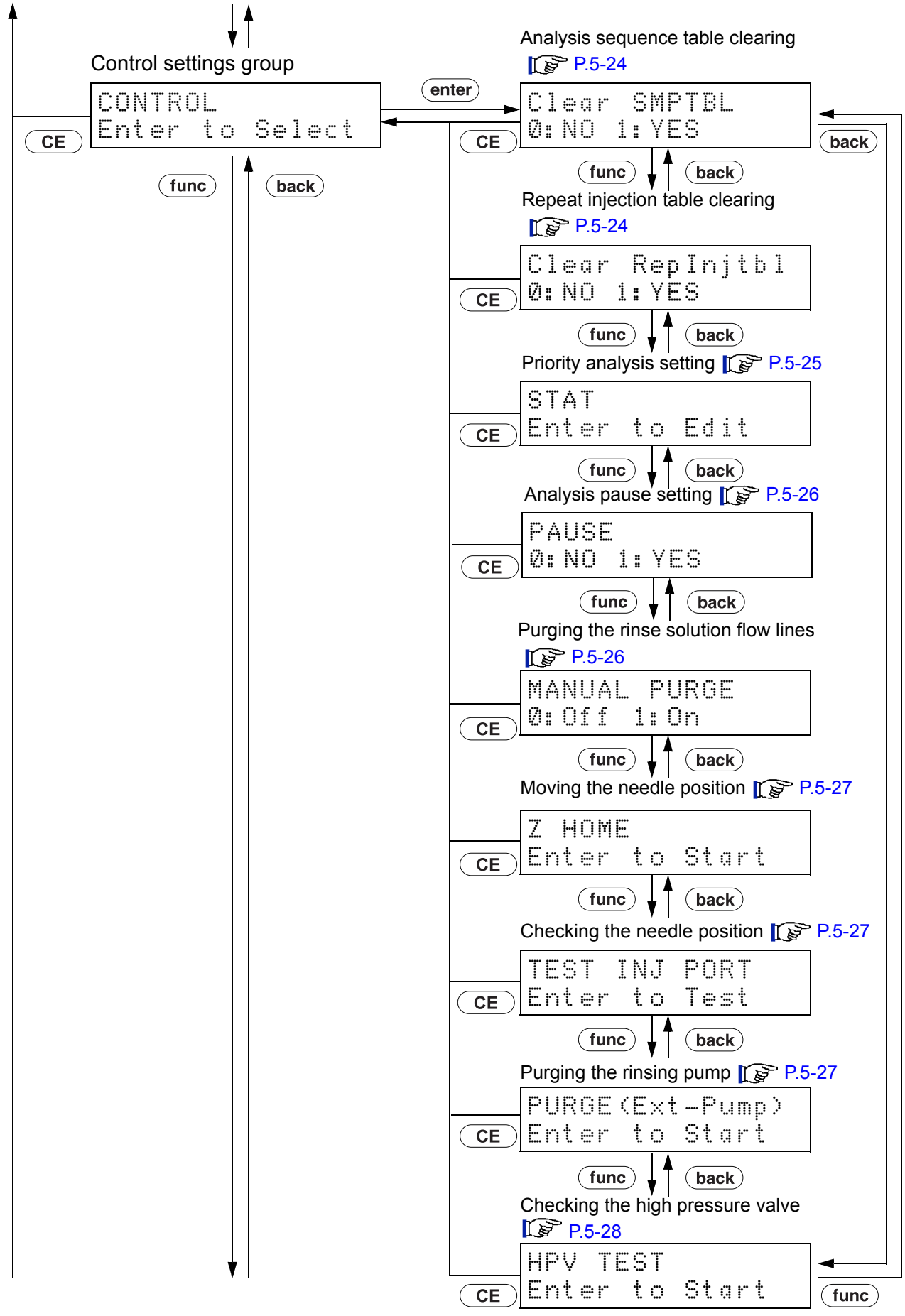
Used to create sample tables for performing analysis with standard injection operations.

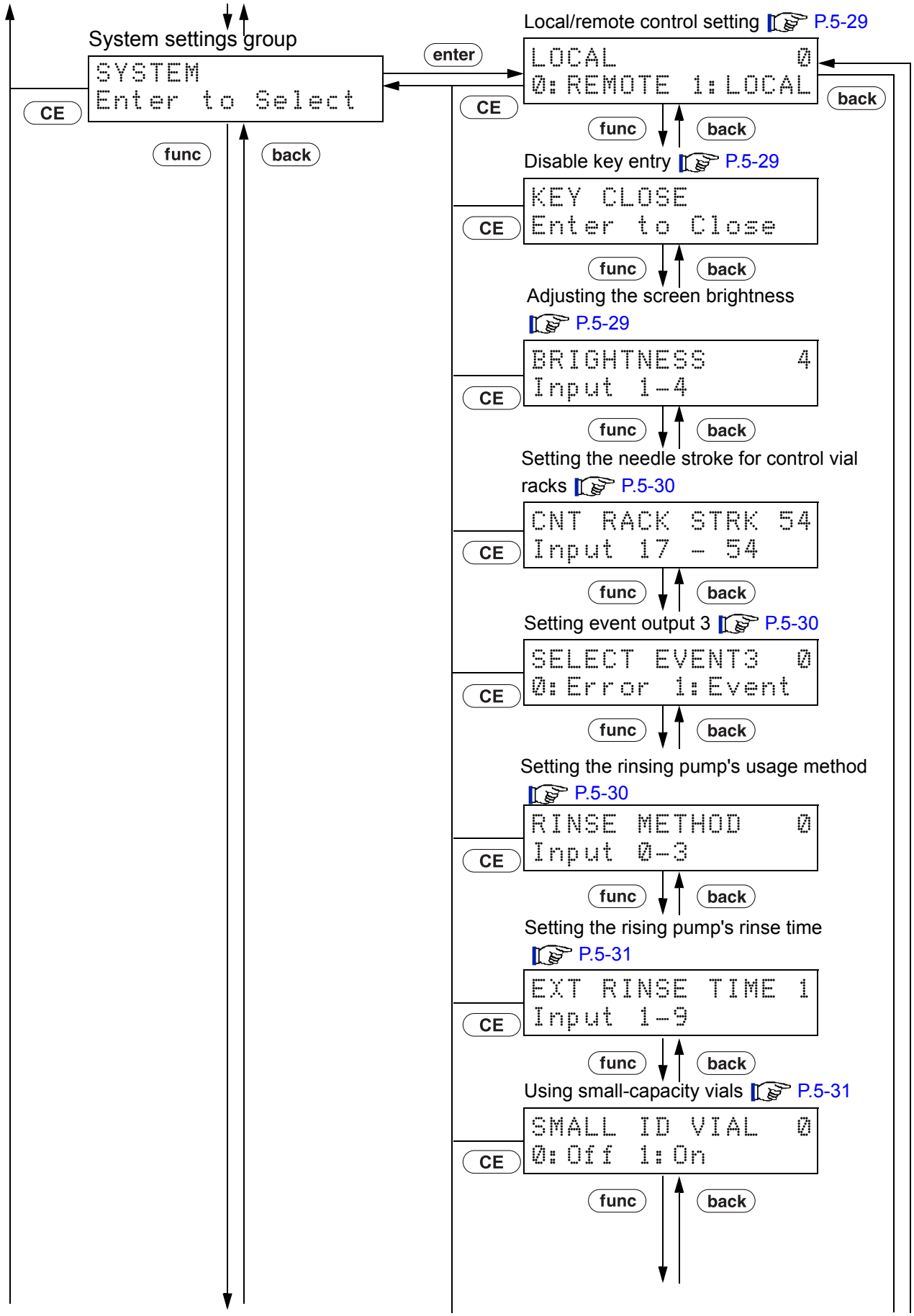
5.1.2 Auxiliary Settings Screens

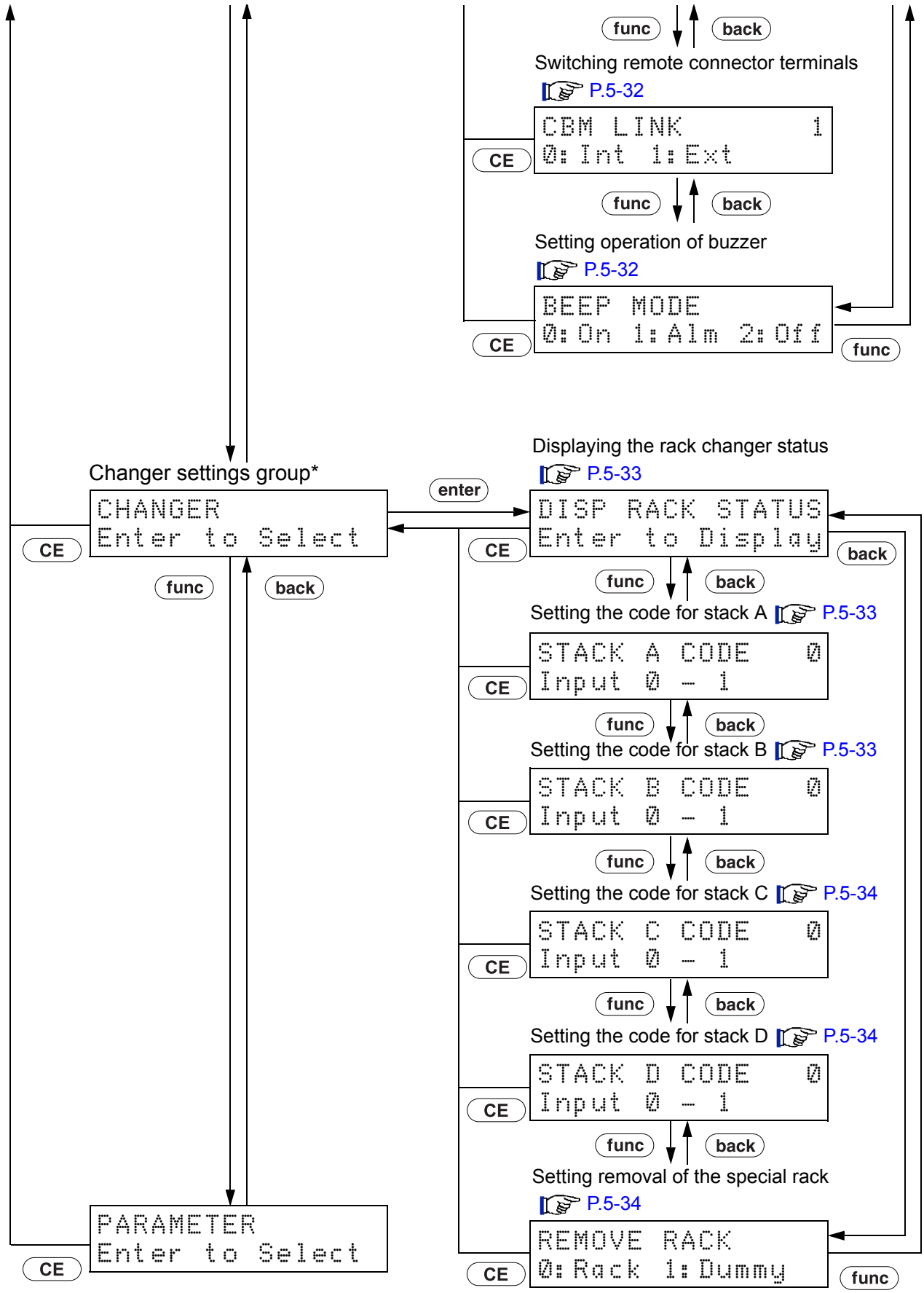
In this section, auxiliary settings screens are shown in the following flow diagrams.
In each screen, press **func** to show the next screen, and press **back** to return.
In auxiliary settings group, press **enter** to enter each group.
Press **CE** to return the initial screen.




func
back
Needle stroke setting P.5-20
NEEDLE STROKE 50
Input 20-52
CE
back
func
back
Setting the type of microtiter plates
P.5-21
MTP WELL 0
0:96 1:384
CE
func
back
Setting the injection order of microtiter plates
P.5-21
MTP ORDER 0
0:A1A2 1:1A1B
CE
func
back
Setting event output P.5-23
EVENT 0
Input 0 - 123
CE
func
back
Repeat injection table setting
P.5-23
RepeatInjTable 1
0:OFF 1:ON
CE
func


Control settings group
CONTROL
Enter to Select
CE
enter
func
back
Analysis sequence table clearing
P.5-24
Clear SMPTBL
0:NO 1:YES
Repeat injection table clearing
P.5-24
Clear RepInjtbl
0:NO 1:YES
Priority analysis setting P.5-25
STAT
Enter to Edit
Analysis pause setting P.5-26
PAUSE
0:NO 1:YES
Purging the rinse solution flow lines
P.5-26
MANUAL PURGE
0:Off 1:On
Moving the needle position P.5-27
Z HOME
Enter to Start
Checking the needle position P.5-27
TEST INJ PORT
Enter to Test
Purging the rinsing pump P.5-27
PURGE(Ext-Pump)
Enter to Start
Checking the high pressure valve
P.5-28
HPV TEST
Enter to Start

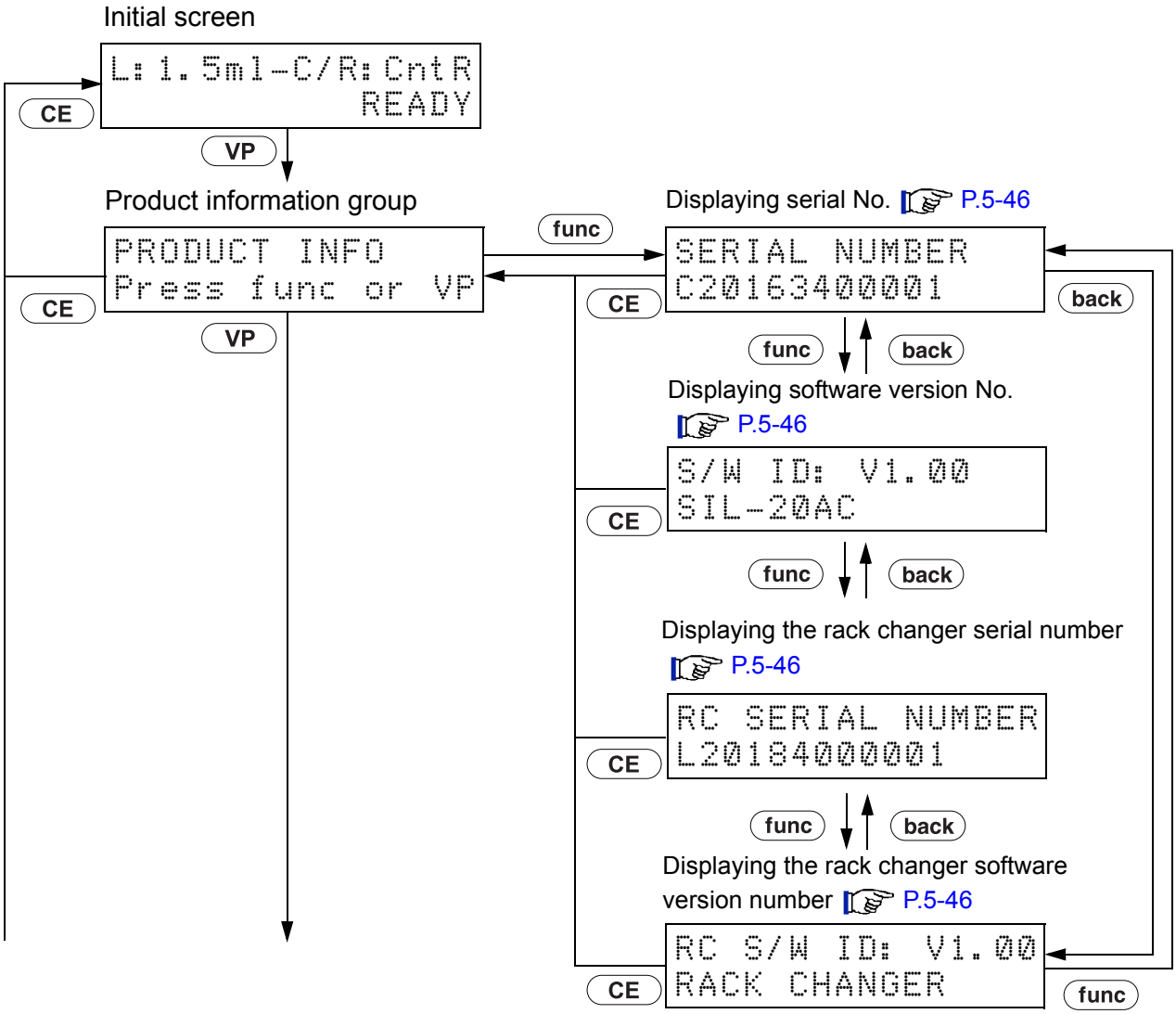

System settings group
SYSTEM
Enter to Select
CE
func
back
enter
Local/remote control setting P.5-29
LOCAL 0
0:REMOTE 1:LOCAL
Disable key entry P.5-29
KEY CLOSE
Enter to Close
Adjusting the screen brightness P.5-29
BRIGHTNESS 4
Input 1-4
Setting the needle stroke for control vial racks P.5-30
CNT RACK STRK 54
Input 17 - 54
Setting event output 3 P.5-30
SELECT EVENT3 0
0:Error 1:Event
Setting the rinsing pump's usage method P.5-30
RINSE METHOD 0
Input 0-3
Setting the rising pump's rinse time P.5-31
EXT RINSE TIME 1
Input 1-9
Using small-capacity vials P.5-31
SMALL ID VIAL 0
0:Off 1:On

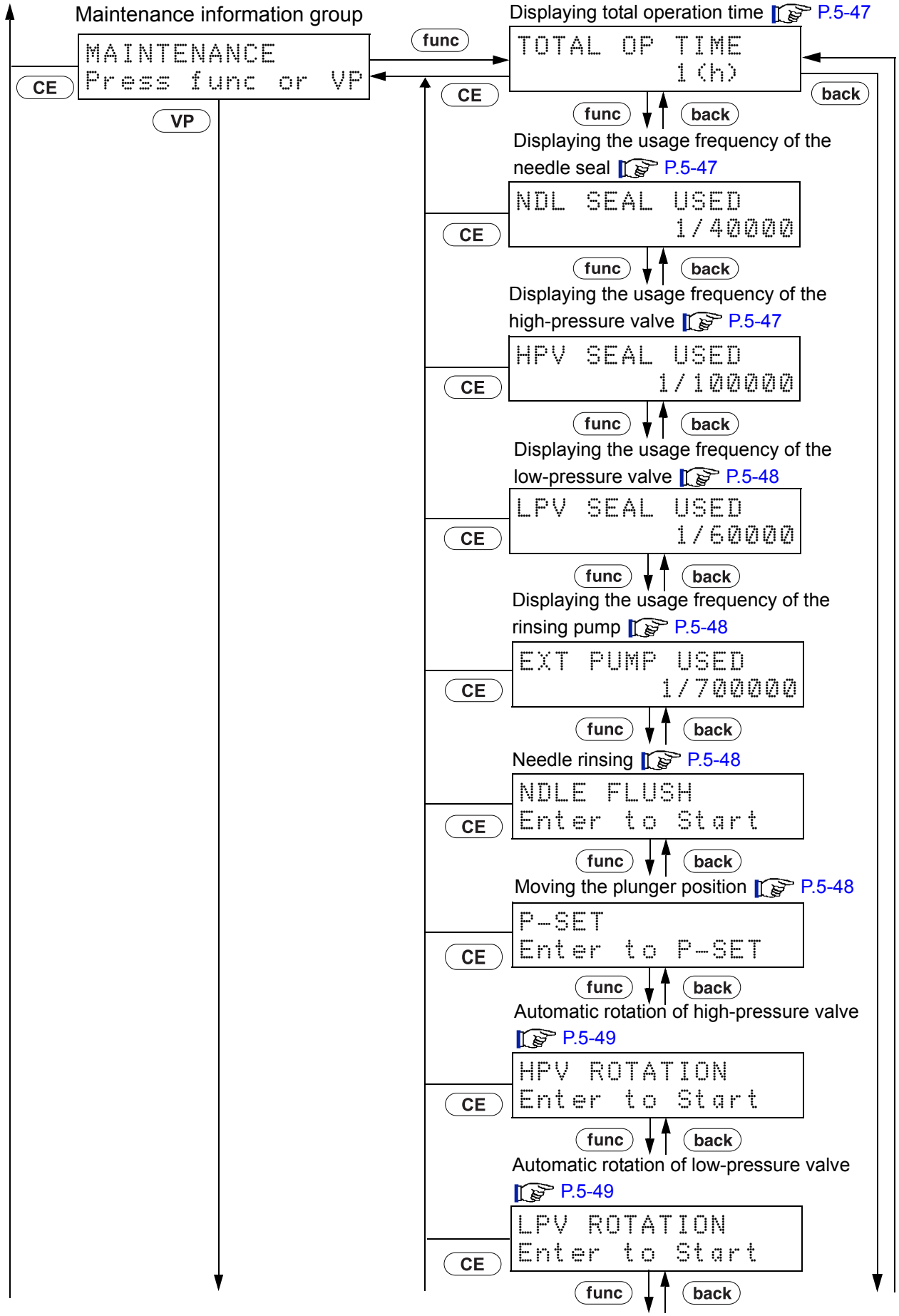


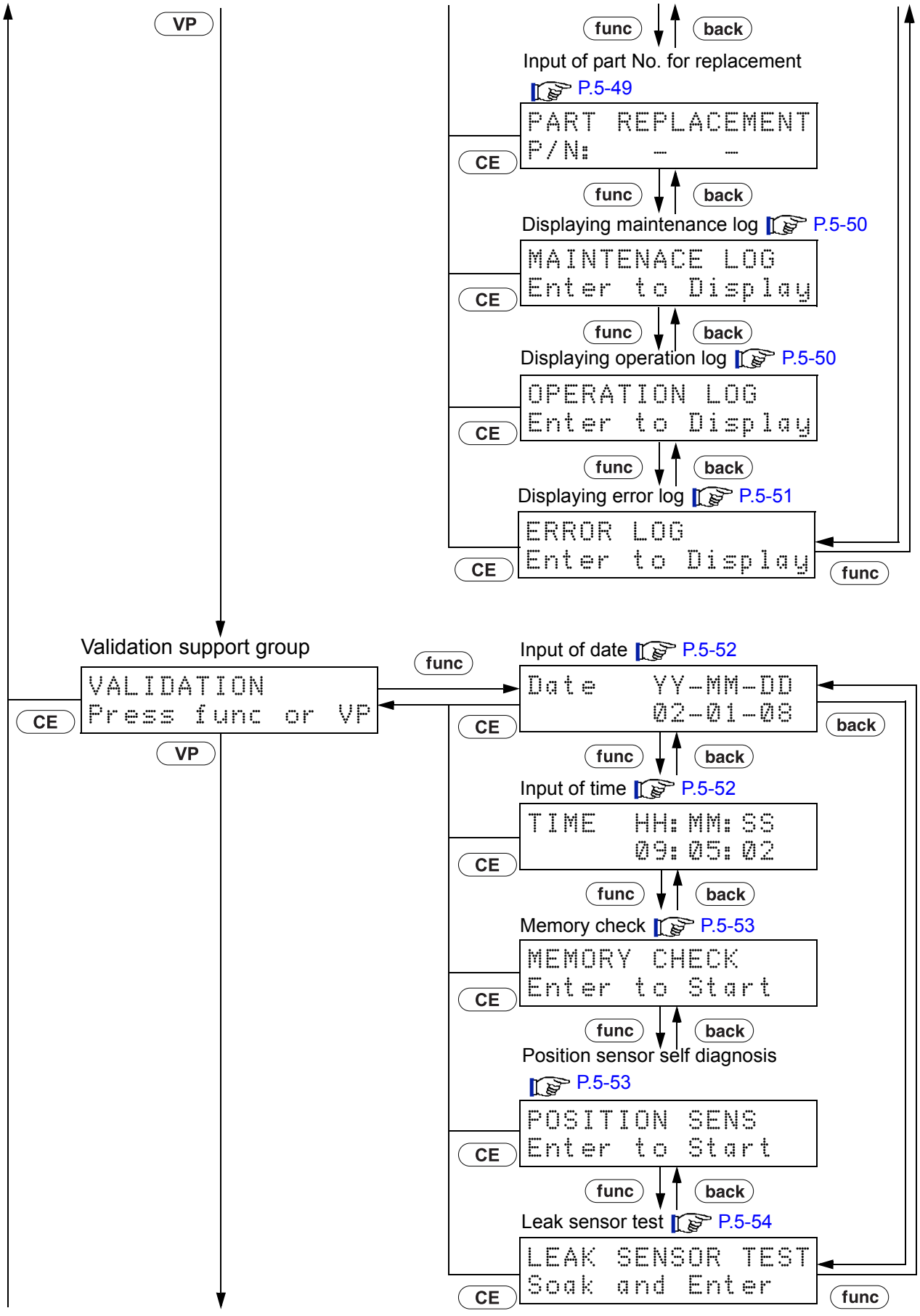
* Displayed only when using the optional rack changer.

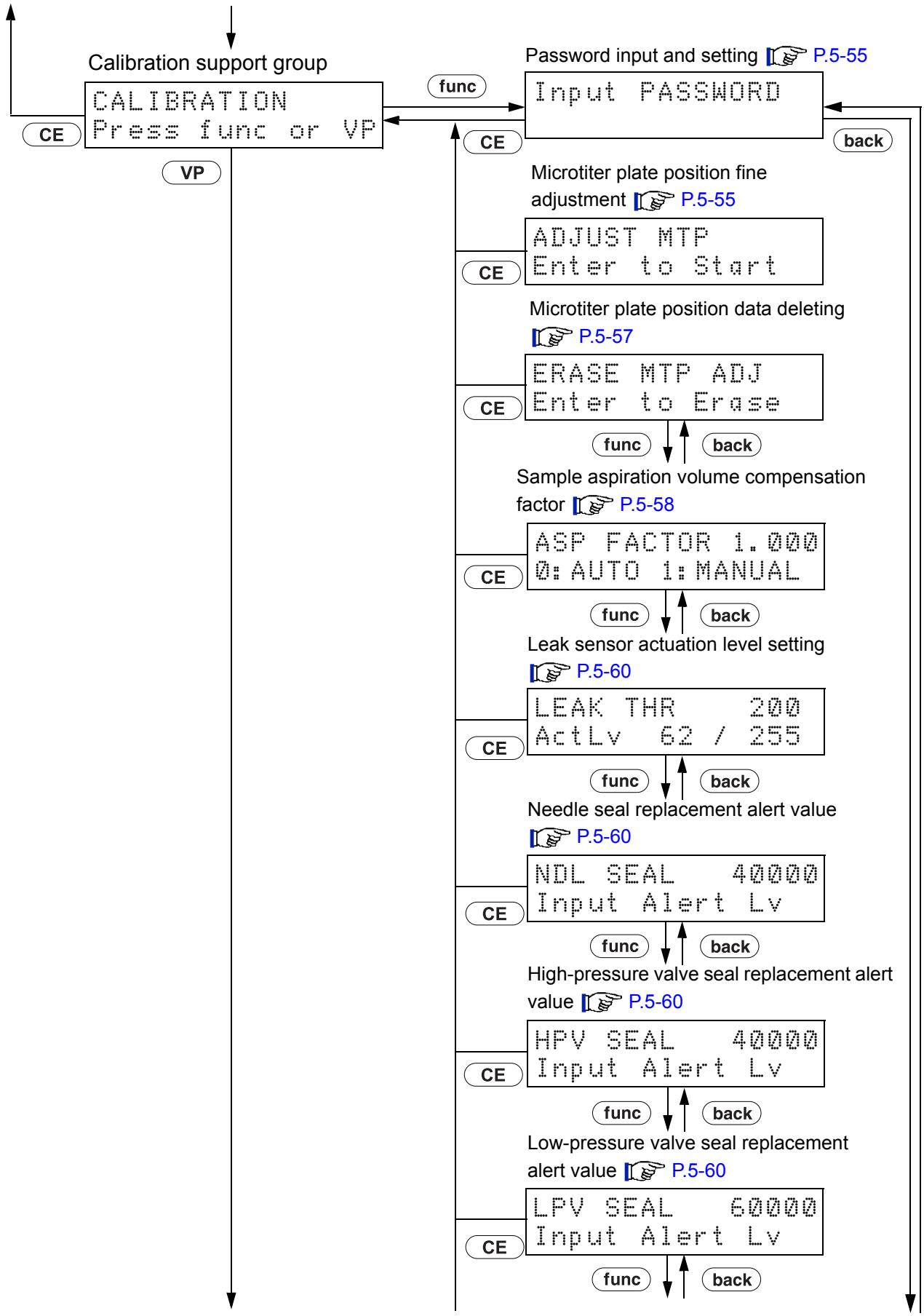
5.1.3 VP Function Screens

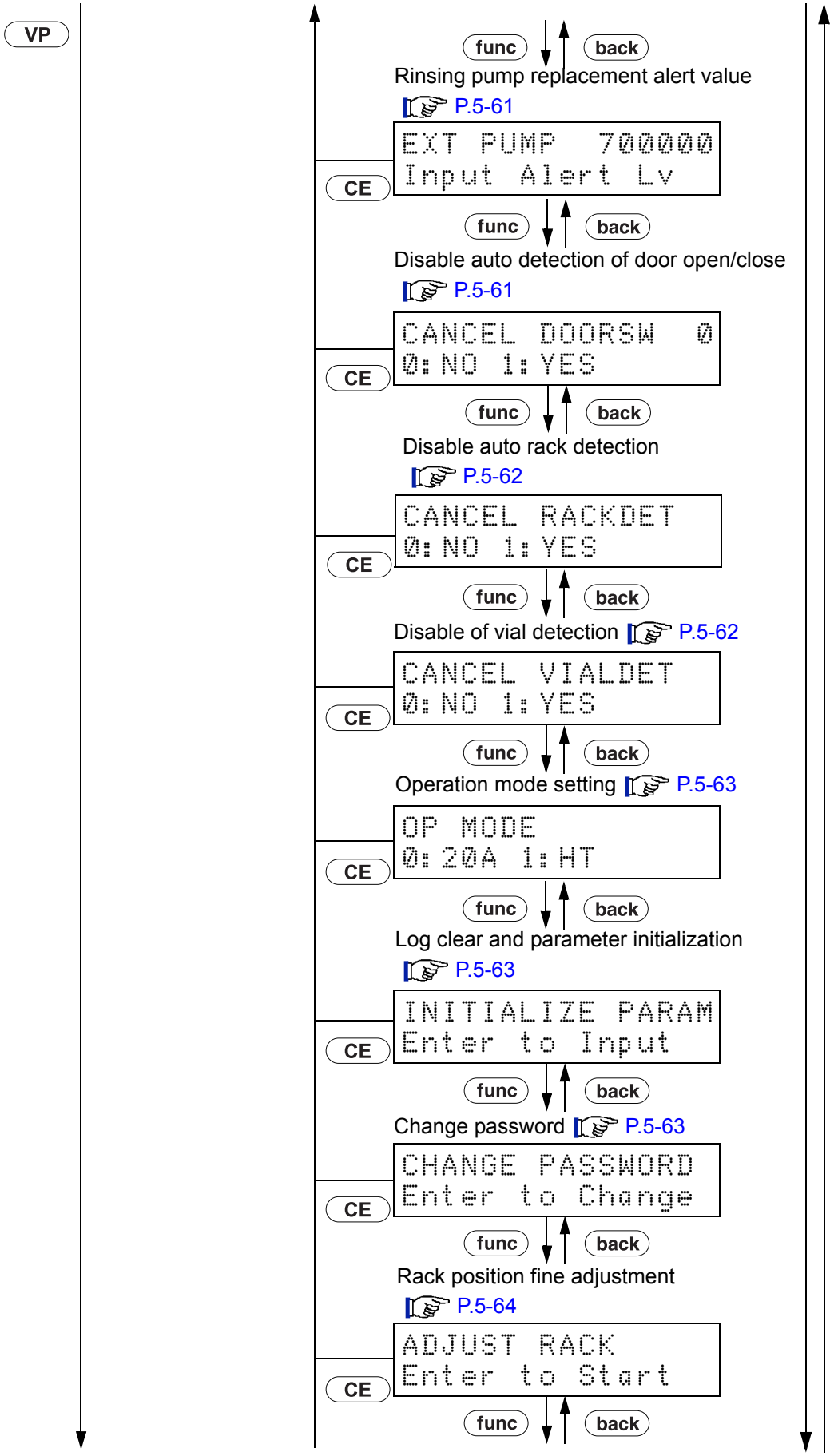
In this section VP function screens are shown in the following flow diagrams.
Press VP on initial screen to show each group screen.
Press CE to return to the initial screen.
Press func or back to switch the settings screen within the groups selected by VP.
Press CE to return to the initial screen in the group.

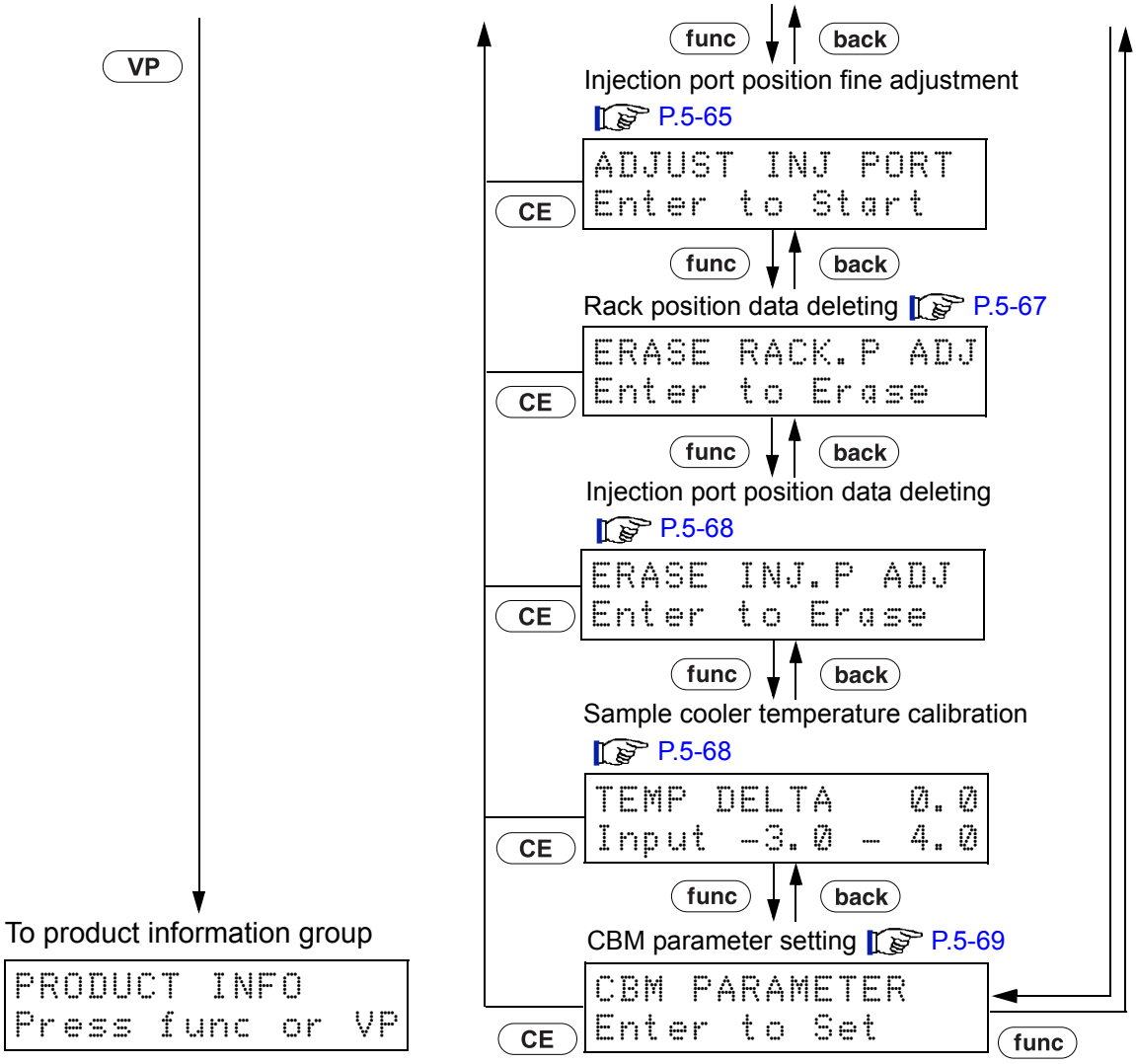



Maintenance information group
MAINTENANCE
Press func or VP
CE
func
VP
Displaying total operation time P.5-47
TOTAL OP TIME
1(h)
back
Displaying the usage frequency of the needle seal P.5-47
NDL SEAL USED
1/40000
Displaying the usage frequency of the high-pressure valve P.5-47
HPV SEAL USED
1/100000
Displaying the usage frequency of the low-pressure valve P.5-48
LPV SEAL USED
1/60000
Displaying the usage frequency of the rinsing pump P.5-48
EXT PUMP USED
1/700000
Needle rinsing P.5-48
NDLE FLUSH
Enter to Start
Moving the plunger position P.5-48
P-SET
Enter to P-SET
Automatic rotation of high-pressure valve P.5-49
HPV ROTATION
Enter to Start
Automatic rotation of low-pressure valve P.5-49
LPV ROTATION
Enter to Start


VP
func
back
Input of part No. for replacement
P.5-49
PART REPLACEMENT
P/N: - -
CE
func
back
Displaying maintenance log
P.5-50
MAINTENACE LOG
Enter to Display
CE
func
back
Displaying operation log
P.5-50
OPERATION LOG
Enter to Display
CE
func
back
Displaying error log
P.5-51
ERROR LOG
Enter to Display
CE
func
Validation support group
func
Input of date
P.5-52
VALIDATION
Press func or VP
CE
Date YY-MM-DD
02-01-08
CE
back
VP
func
back
Input of time
P.5-52
TIME HH:MM:SS
09:05:02
CE
func
back
Memory check
P.5-53
MEMORY CHECK
Enter to Start
CE
func
back
Position sensor self diagnosis
P.5-53
POSITION SENS
Enter to Start
CE
func
back
Leak sensor test
P.5-54
LEAK SENSOR TEST
Soak and Enter
CE
func


Calibration support group
CALIBRATION
Press func or VP
CE
VP
func
Password input and setting P.5-55
Input PASSWORD
CE
back
Microtiter plate position fine adjustment P.5-55
ADJUST MTP
Enter to Start
CE
Microtiter plate position data deleting P.5-57
ERASE MTP ADJ
Enter to Erase
CE
func
back
Sample aspiration volume compensation factor P.5-58
ASP FACTOR 1.000
0:AUTO 1:MANUAL
CE
func
back
Leak sensor actuation level setting P.5-60
LEAK THR 200
ActLv 62 / 255
CE
func
back
Needle seal replacement alert value P.5-60
NDL SEAL 40000
Input Alert Lv
CE
func
back
High-pressure valve seal replacement alert value P.5-60
HPV SEAL 40000
Input Alert Lv
CE
func
back
Low-pressure valve seal replacement alert value P.5-60
LPV SEAL 60000
Input Alert Lv
CE
func
back


VP
func
back
Rinsing pump replacement alert value
P.5-61
EXT PUMP 700000
Input Alert Lv
CE
func
back
Disable auto detection of door open/close
P.5-61
CANCEL DOORSW 0
0:NO 1:YES
CE
func
back
Disable auto rack detection
P.5-62
CANCEL RACKDET
0:NO 1:YES
CE
func
back
Disable of vial detection P.5-62
CANCEL VIALDET
0:NO 1:YES
CE
func
back
Operation mode setting P.5-63
OP MODE
0:20A 1:HT
CE
func
back
Log clear and parameter initialization
P.5-63
INITIALIZE PARAM
Enter to Input
CE
func
back
Change password P.5-63
CHANGE PASSWORD
Enter to Change
CE
func
back
Rack position fine adjustment
P.5-64
ADJUST RACK
Enter to Start
CE
func
back


VP
To product information group
PRODUCT INFO
Press func or VP
func
back
Injection port position fine adjustment
P.5-65
ADJUST INJ PORT
Enter to Start
CE
Rack position data deleting P.5-67
ERASE RACK.P ADJ
Enter to Erase
Injection port position data deleting
P.5-68
ERASE INJ.P ADJ
Enter to Erase
Sample cooler temperature calibration
P.5-68
TEMP DELTA 0.0
Input -3.0 - 4.0
CBM parameter setting P.5-69
CBM PARAMETER
Enter to Set

5.2 Parameter in Auxiliary Functions

There are four groups for auxiliary functions:
Parameter Setting, Control Setting, System Setting and Changer Setting.

5.2.1 List of Auxiliary Functions

The auxiliary functions are listed in the tables below.
☞ "5.1.2 Auxiliary Settings Screens" P. 5-3

■ Parameter Settings Group

Command	Description	Page
COOLER TEMP	For setting the sample cooler temperature. The rack changer (if used) is set to the same temperature.	P.5-17
PURGE TIME	For setting the purge time.	P.5-17
RINSE MODE	For selecting the needle's rinsing method.	P.5-18
RINSE DIPTIME	For entering the needle's rinsing time.	P.5-18
RINSE VOLUME	For setting the volume of rinse solution.	P.5-19
RINSE SPEED	Sets flow rate of rinse solution.	P.5-19
SAMPLE SPEED	Sets flow rate during sample analysis.	P.5-20
NEEDLE STROKE	Sets needle stroke measurement.	P.5-20
MTP WELL	For setting the well number when using a microtiter plate or a deep-well microtiter plate.	P.5-21
MTP ORDER	For setting the sample injection order when using a microtiter plate or a deep-well microtiter plate.	P.5-21
EVENT	For controlling the external output terminals.	P.5-23
Repeat InjTable	For making settings related to interval analysis.	P.5-23

■ Control Settings Group

Command	Description	Page
CLEAR SMPTBL	For deleting the sample table.	P.5-24
CLEAR RepInjtbl	For deleting the sample table used for interval analysis.	P.5-24
STAT	Sets priority analysis.	P.5-25
PAUSE	For pausing the sequence.	P.5-26
MANUAL PURGE	For drawing in rinse solution with the manual syringe.	P.5-26
Z HOME	For raising the needle during transportation.	P.5-27
TEST INJ PORT	For checking that the needle is lowered correctly into the injection port.	P.5-27
PURGE (Ext Pump)	For purging with a second rinse solution using a rinsing pump (optional).	P.5-27
HPV TEST	For checking the high pressure valve.	P.5-28

■ System Settings Group

Command	Description	Page
LOCAL	For separating the autosampler from an external controller.	P.5-29
KEY CLOSE	To lock the keypad, preventing unexpected entries.	P.5-29
BRIGHTNESS	For adjusting the screen brightness.	P.5-29
CNT RACK STRK	For setting the lowering distance of the needle in the control vial rack.	P.5-30
SELECT EVENT3	For switching the function of event output 3 between error output and event output.	P.5-30
RINSE METHOD	For setting the needle's rinsing method when using a rinsing pump (optional).	P.5-30
EXT RINSE TIME	For setting the needle's rinsing time when using a rinsing pump (optional).	P.5-31
SMALL ID VIAL	Set when using small-capacity vials.	P.5-31
CBM LINK	To set a link destination of system controller.	P.5-32
BEEP MODE	To set the operation buzzer.	P.5-32

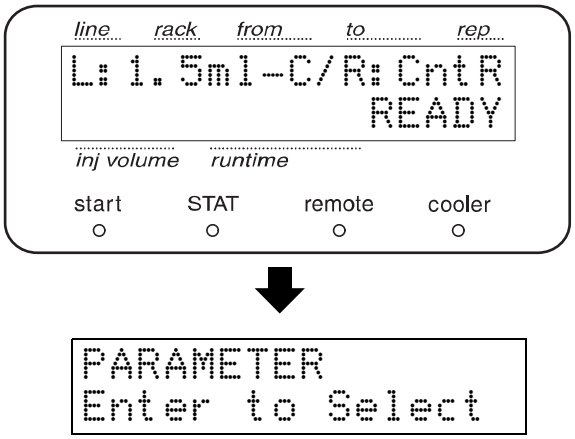
■ Changer Settings Group

Command	Description	Page
DISP RACK STATUS	Displays the status of rack-changer racks 1 to 12.	P.5-33
STACK A CODE	For entering the stack code of rack-changer stack A.	P.5-33
STACK B CODE	For entering the stack code of rack-changer stack B.	P.5-33
STACK C CODE	For entering the stack code of rack-changer stack C.	P.5-34
STACK D CODE	For entering the stack code of rack-changer stack D.	P.5-34
REMOVE RACK	Set when removing the changer rack from the autosampler.	P.5-34

5.2.2 Showing the Auxiliary Function Screens

1 Press **CE**.
Initial screen appears.

2 Press **func**.
* Press **back** to return the previous screen.



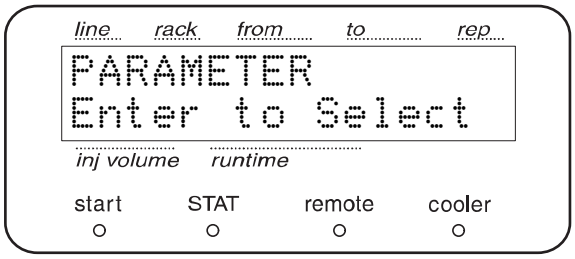
3 After selecting the desired parameter, follow the direction of each parameter described in the next section.

4 To make more setting, press **func** or **back** repeatedly to select the desired parameter.

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

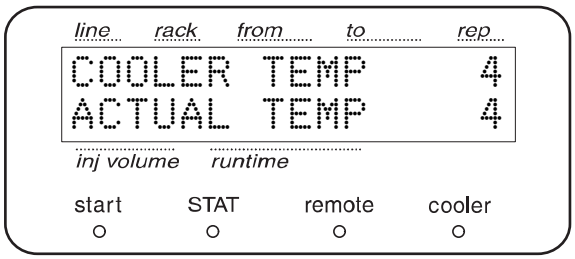
5.2.3 Parameter Settings Group

This group is for setting and selecting the autosampler's parameters.



■ [COOLER TEMP]

Sets the temperature when using a sample cooler. The current cooler temperature is displayed on the second line.



NOTE

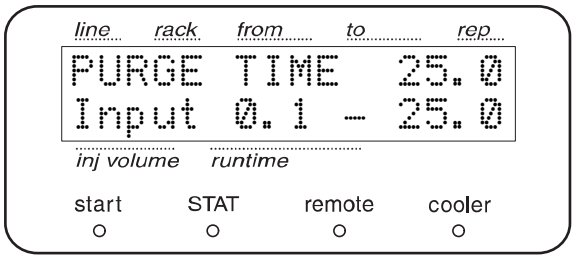
This setting is possible only with the SIL-20AC. The rack changer (if used) is also set to the same temperature.

Enter the temperature by the numeric keypad, and press (**enter**).Temperature regulation by the sample cooler can be stopped by entering [-1].

Set Range	Default value
4-40°C	15°C

■ [PURGE TIME]

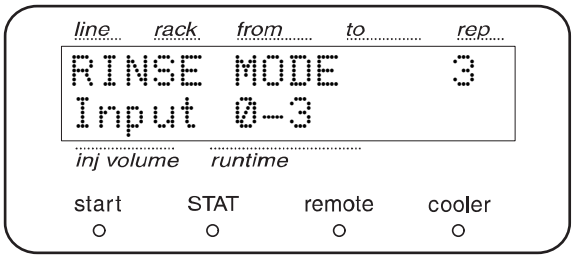
Sets the time for which the flow lines are purged. Enter purge time using the numeric keypad, and press (**enter**).



Set Range	Default value
0.1-25.0 min	25.0 min

■ [RINSE MODE]

Selects the rinsing method used for the needle during sample injection.
Enter the rinse mode number with the numeric keypad and press **enter**.



Set value	Function
0	No rinsing
1	Rinse before aspiration of sample.
2	Rinse after aspiration of sample.
3	Rinse before and after aspiration of sample (default).

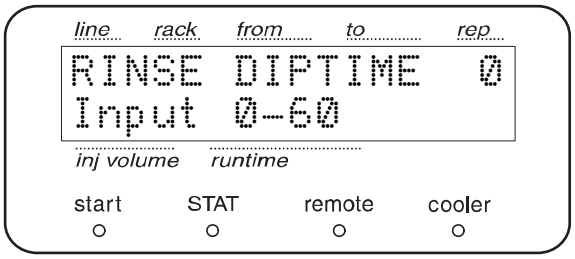
NOTE

When performing rinsing ([RINSE MODE] set to > 0), the [RINSE VOL] (rinse volume) setting must also be changed, to a value greater than 450µL. This will ensure that the rinsing port (capacity approximately 430µL) solvent is replaced by a sufficient volume of clean solvent.

"[RINSE VOLUME]" P. 5-19

■ [RINSE DIPTIME]

Sets the length of time to dip the needle into the rinsing port during needle rinse.
Enter the desired time with the numeric keypad and press **enter**.



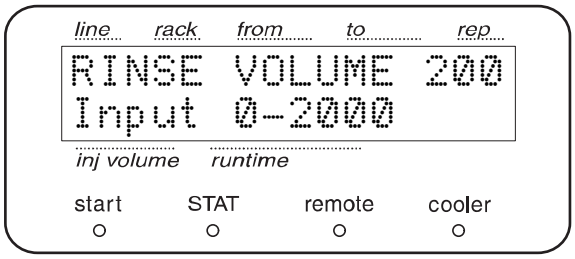
Set Range	Default value
0-60 sec	0 sec

NOTE

When the value is set to 0 sec., the needle is lifted immediately after it is dipped in the rinsing port.

■ [RINSE VOLUME]

Sets the volume of rinse solution that is used for replacement of the rinse solution in the rinsing port. Enter the rinse volume with the numeric keypad and press **enter**.



Set Range	Default value
0-2000µL	200µL

NOTE

If the rinse volume is set to [0], analysis can be performed with a period shorter than the standard period by omitting the purge operation for the measurement flow lines after sample injection.

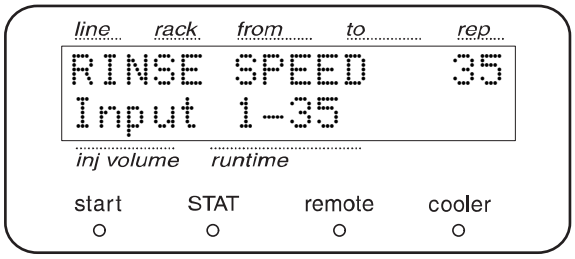
☞ " 7. Purge of measurement flow line (rinse solution aspiration)" P. 1-6 and " 8. Purge of measurement flow line (rinse solution dischargement)" P. 1-7 in "1.3 Sample Injection" P. 1-3.

NOTE

When performing rinsing ([RINSE MODE] set to > 0), the [RINSE VOL] (rinse volume) setting must also be changed, to a value greater than 450µL.

■ [RINSE SPEED]

Sets the discharge rate of the rinse solution during rinsing in µL/sec.



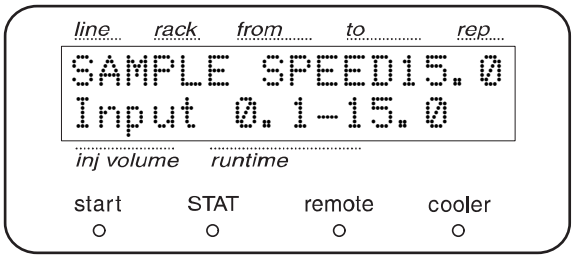
NOTE

Set a small value when using a rinse solution with a high viscosity that is likely to cause bubbles during pumping. Enter the value with numeric keypad and **enter**.

Set Range	Default value
1-35µL/sec	35µL

■ [SAMPLE SPEED]

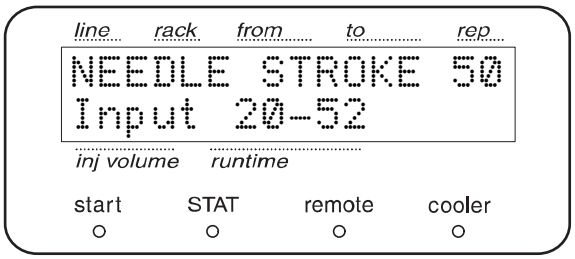
Sets the rate at which the sample is aspirated by the needle in µL/sec.
Enter the value with numeric keypad and **enter**.



Set Range	Default value
0.1-15µL/sec (Increment: 0.1µL/sec, for rates <1.0µL/sec, and 1.0µL/sec, for rates > 1.0µL/sec)	15.0µL/sec

■ [NEEDLE STROKE]

Sets the distance that the needle descends into the sample vial.When the rack is changed, this parameter is automatically reset to the default value (the needle goes to a depth of 2mm from the bottom of the vial). This parameter needs to be adjusted for each of the different rack types.
Enter the value with numeric keypad and **enter**.
The setting ranges for different types of rack are shown in the following table.



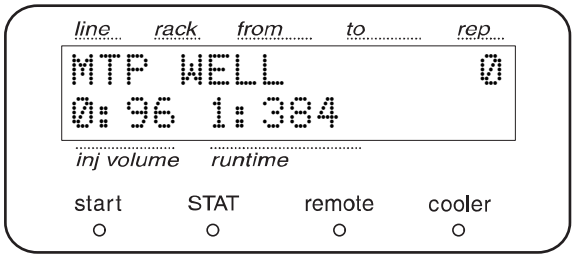
Rack type	Set Range	Default value (Increment : mm)
Sample vial rack for 1mL vials	17-54	51
Sample vial rack for 1.5mL vials	17-54	52
Sample vial cooling rack for 1.5mL vials	17-54	52
Sample vial rack for 4mL vials	17-54	51
Microtiter plate rack	10-52	45
Deep-well MTP rack	10-52	45
Changer rack	10-52	45

Amount of liquid left in the bottom 2 mm of the sample vials.

Rack No.	Capacity	Part No.	Amount of liquid 2mm left at the vial bottom
1mL vial	1mL	228-39699-91	Approx. 65µL
1.5mL vial	1.5mL	228-15652-92	Approx. 150µL
1.1mL vial	1.1mL	228-21283-91	Approx. 5µL
0.3mL vial	300µL	228-16847-92	Approx. 5µL
1mL vial	1mL	228-31600-91	Approx. 25µL
Plastic sample vial	200µL	228-35217-91	Approx. 5µL
4mL vial	4mL	228-21287-91	Approx. 400µL
4mL vial	4mL	228-31537-91	Approx. 400µL
0.3mL vial	300µL	228-21284-91	Approx. 5µL

■ [MTP WELL]

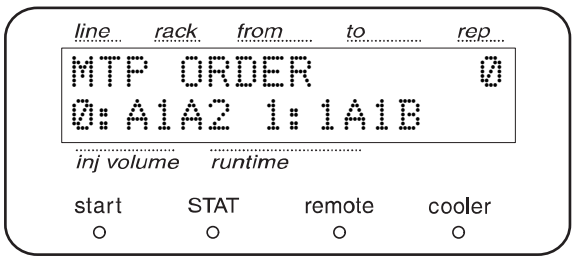
Sets the type of microtiter plates to be loaded in a rack, when microtiter plates are used.
Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	96-well microtiter plate or deep-well microtiter plate is used.)
1	384-well microtiter plate or deep-well microtiter plate is used.)

■ [MTP ORDER]

When injecting samples from a microtiter plate, set whether priority is given to columns or rows. Enter the column priority mode (0:A1A2) or the row priority mode (1:1A1B) with the numeric keypad and press **enter**.

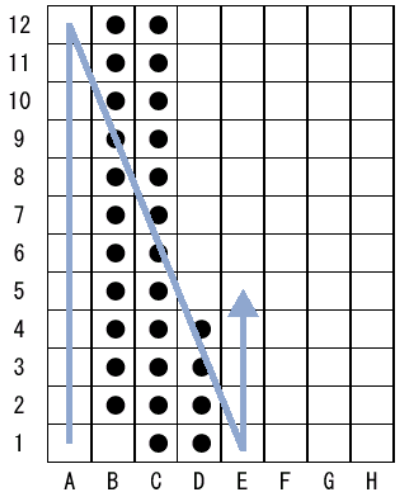


Set value	Type of well continuous processing direction
0	Column priority mode (default value). Injection operation is performed in the order A1, A2...
1	Row priority mode Injection operation is performed in the order 1A, 1B...

[Sample No. setting in the Column priority mode]

When injecting the sample in the Column priority mode, well positions are indicated by entering alphabetical Column letter first, followed by the Row number (e.g.A12).
As a setting example, the setting method when a 96-well microtiter plate is set to Rack 1 position (front of the left rack) and the B2 to B12, C1 to C12, and D1 to D4 wells are analyzed in the order shown in the following figure is described.

With microtiter plate 96-well



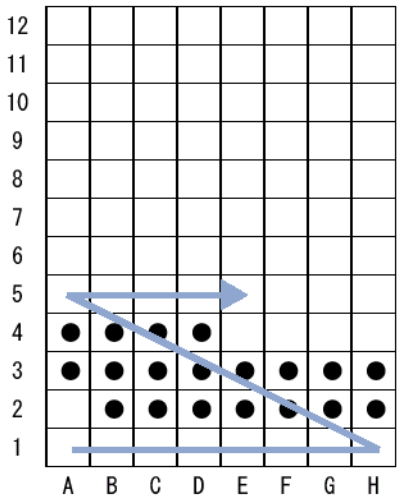
Analysis order of the wells:
B2 to B12, C1 to C12, D1 to D4

Fig. 5.1

[Sample No. setting in the Row priority mode]

When injecting the sample in the Row priority mode, well positions are indicated by entering Row number first, followed by the Column letter (e.g.12A).
This section describes an example of the sequence setting method when a 96-well microtiter plate is set to Rack 1 position (front of the left rack) and 2B to 2H, 3A to 3H, 4A to 4D wells are going to be analyzed in the order shown in the following figure.

With microtiter plate 96-well

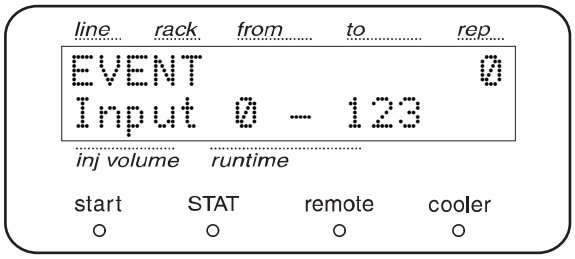


Analysis order of the wells:
2B to 2H, 3A to 3H, 4A to 4D

Fig. 5.2

■ [EVENT]

Sets the contact output for external output terminals. It is used, for example, to switch flow-line switching valves. Set the connector number for which the contacts close.



Set value	Function
0	All terminals are opened.
1	Connector 1's terminals are closed.
2	Connector 2's terminals are closed.
3	Connector 3's terminals are closed.
12	Connector 1, 2's terminals are closed.
13	Connector 1, 3's terminals are closed.
123	Connector 1, 2, 3's terminals are closed.

NOTE

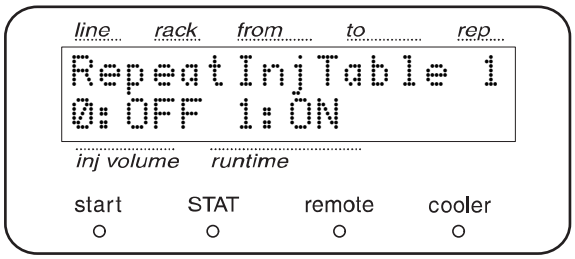
If using connector 3's terminals for the [EVENT] function, select [EVENT] in [SELECT EVENT3].

☞ "[SELECT EVENT3]" P. 5-30

■ [Repeat InjTable]

Sets whether or not [Repeat injection] is used. [Repeat injection] consists of repeatedly executing a repeat injection table at specified line intervals in the analysis sequence table.

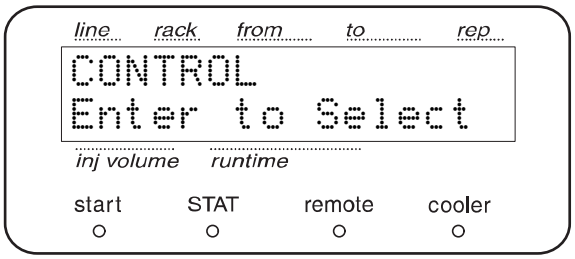
Enter the set value by the numeric keypad, and press **enter**.



Set value	Function
0	Not used (default value).
1	Used.

5.2.4 Control Settings Group

This is the group for system control.

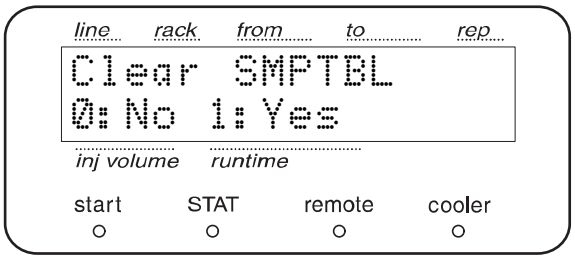


■ [Clear SMPTBL]

Clears the analysis sequence table.

1 From the control setting screen, press **enter**. The [Clear SMPTBL] screen will be displayed.

2 Enter the set value by the numeric keypad and press **enter**.



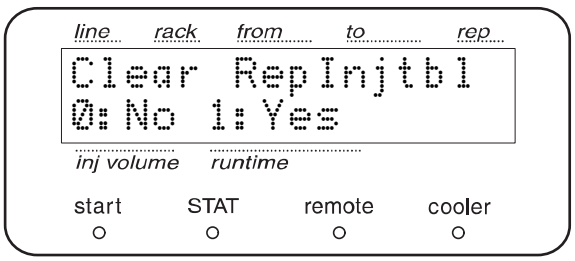
Set value	Function
0	Not cleared the analysis sequence table.
1	Cleared the analysis sequence table.

■ [Clear RepInjtbl]

Clears the repeat injection table.

1 From the control setting screen, press **enter**, and press **func** repeatedly until the [Clear RepInjtbl] screen is displayed.

2 Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	Not cleared the repeat injection table.
1	Cleared the repeat injection table.

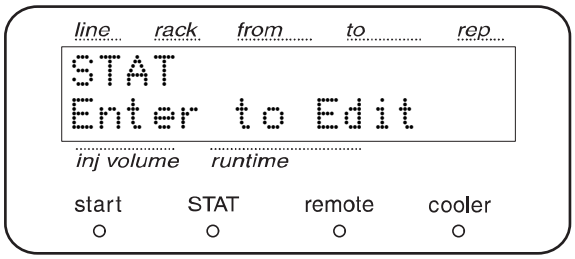
■ [STAT]

Interrupts analysis based on a sample table to perform immediate analysis for one sample.

NOTE

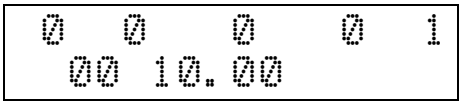
Once a priority analysis has been started, it cannot be canceled.

1 Press (enter) in the control setting screen and press (func) repeatedly until the [STAT] screen appears.

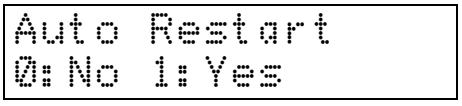


2 Enter the vial number by the numeric keypad and (enter).

3 Enter the injection volume by the numeric keypad and press (enter).



4 Enter the analysis time by the numeric keypad and press (enter).
The next screen specifies how operation is to proceed after the priority analysis ends.



NOTE

To stop priority analysis, press the (CE) to return to the control setting screen.

5 Enter the setting determining the operation after completion of interruption analysis, and press (enter).

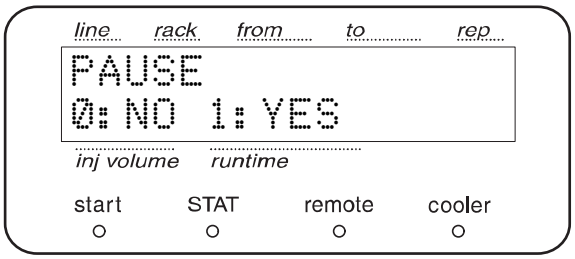
Set value	Function
0	Analysis sequence pauses when priority analysis ends.
1	Analysis sequence resumes when priority analysis ends.

6 The priority analysis will begin as soon as the current sample of the analysis sequence table is analyzed.
The [STAT] LED is illuminated when analysis is being interrupted.

■ [PAUSE]

Stops analysis temporarily.

1 From the control setting screen, press **enter**, and press **func** repeatedly until the [PAUSE] screen is displayed.



2 Enter the set value by the numeric keypad, and press **enter**.
If [1] is selected, execution is stopped after completion of the analysis currently being executed. The [start] LED is illuminated when [1] is selected.

Set value	Function
0	Analysis is not paused.
1	Analysis is paused.

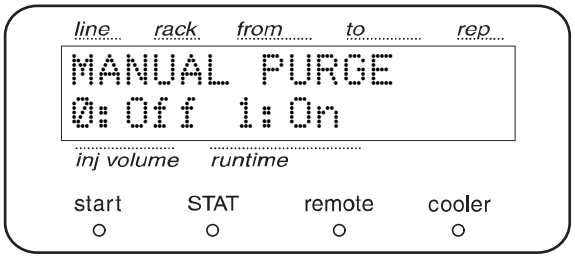
3 Press **start** to restart analysis.

■ [MANUAL PURGE]

Draws in the rinse solution using the manual syringe.
Use the following procedure to perform manual purging.

Set value	Function
0	Stops purging in the manual syringe.
1	Starts purging in the manual syringe.

1 Insert the manual syringe in the tubing projecting from port 3 of the low-pressure valve.



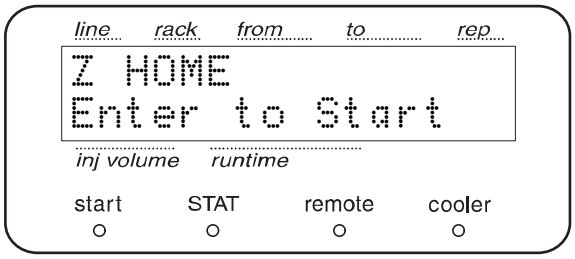
2 Enter the set value [1].

3 Draw in rinse solution with the manual syringe.

4 Enter the set value [0].
Manual purge stops.

■ [Z HOME]

Used when moving the autosampler or not using it for long periods.
Press (enter) to move the needle.
The needle is raised to the highest point and moved to the center of the equipment.



NOTE

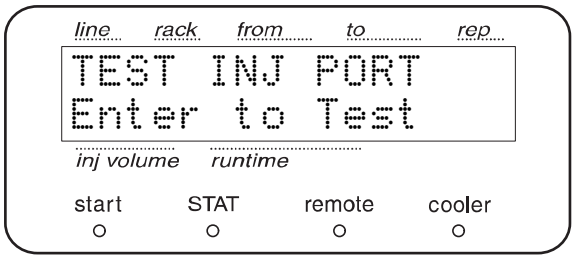
Press (enter) again to return the needle to the injection port.

■ [TEST INJ PORT]

Checks that the needle is lowered correctly into the injection port.

1 Stop the pump.

2 Press (enter).
The tip of the needle moves up and down approximately 2 mm at the position where the needle seal is attached. Check that the needle is lowered correctly into the injection port.



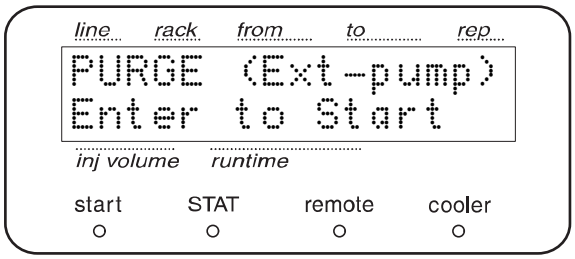
NOTE

Make fine adjustments if the position is incorrect.
"[ADJUST INJ PORT]" P. 5-65

■ [PURGE (Ext-pump)]

Used to draw in rinse solution with the rinsing pump (optional) and rinse the outside of the needle.
Press (enter) to purge.
The following operations are executed.

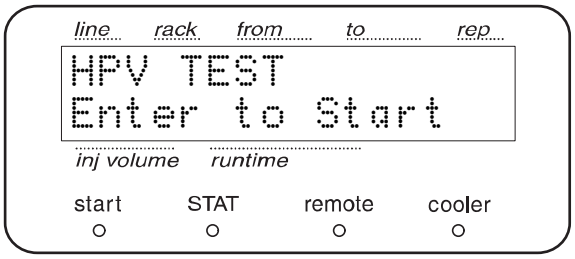
1) The rinsing pump operates for approximately 10 s, and rinse solution is pumped to the rinsing port.
2) The needle moves to the rinsing port.
3) Rinse solution is pumped by the rinsing pump, and the outside of the needle is rinsed for approximately 10 s.
4) The needle returns to the injection port.



■ [HPV TEST]

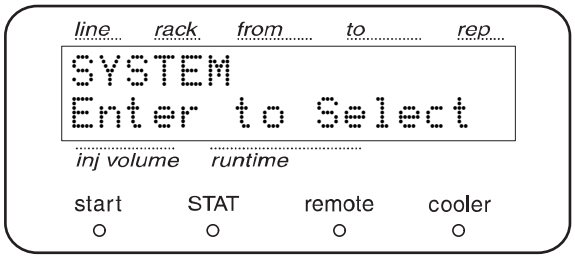
Check the high pressure valve.
After rotating the high pressure valve, output the start signal to the event terminal.
Check the high pressure valve to use this function, if the ghost peak will appear or the carry over will occur.
When you will change or clean the high pressure valve;

☞ "Replacement and Inspection of the High-Pressure Valve Rotor and Stator" P. 8-19.



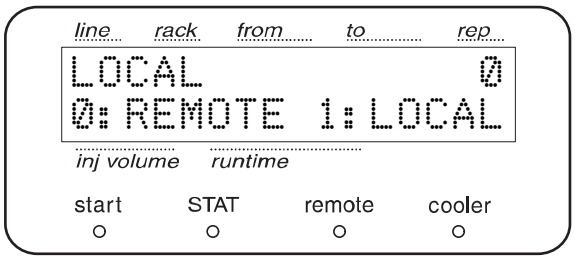
5.2.5 System Settings Group

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**.
After setting, turn off the power and then turn it on again.



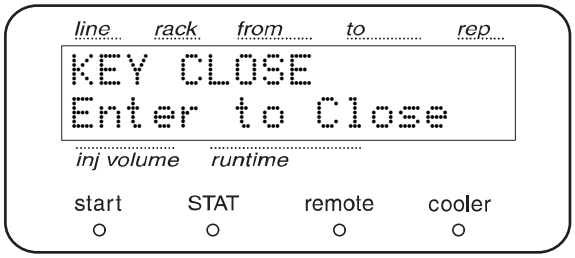
Set value	Mode	Function
0	Remote	Operate via system controller (initial setting)
1	Local	Operate independently (in local mode)

■ [KEY CLOSE]

Press **enter** to prohibit key entry.
After this, key operation is not available.

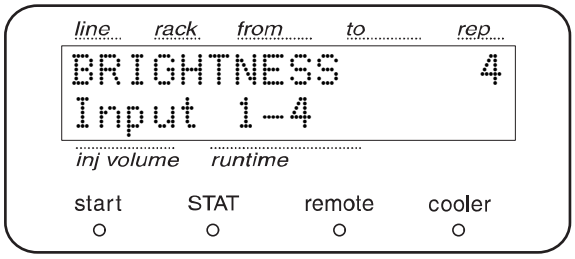
NOTE

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



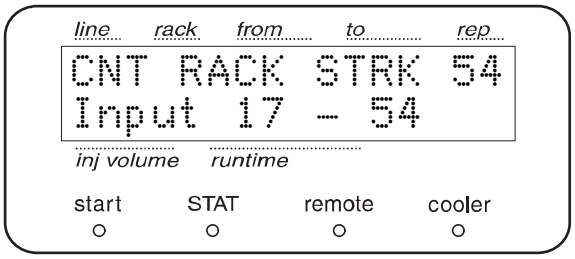
■ [BRIGHTNESS]

Sets the brightness of display screen.
Enter the set value and press **enter**.
Value range is 1 to 4 and 4 is the brightest.



■ [CNT RACK STRK]

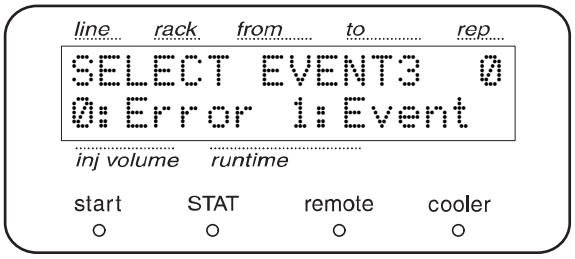
Sets the distance that the needle is lowered to the control vial rack.
Enter the stroke value with the numeric keypad, and press **enter**.



Set range	Default value
17-54	52

■ [SELECT EVENT3]

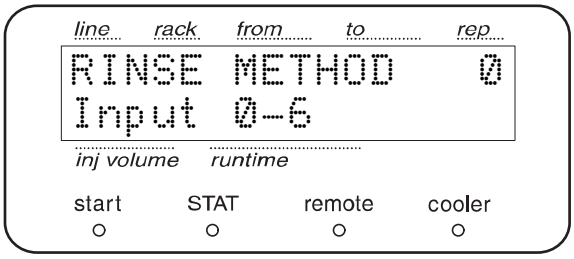
Selects the output of No.3 external output terminals. Used, for example, to switch flow-line valves.
Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	Contacts close when an error occurs (default setting).
1	Used as event output.

■ [RINSE METHOD]

Sets the needle rinsing method when using the optional rinsing pump.
Enter the set value by the numeric keypad and press **enter**.

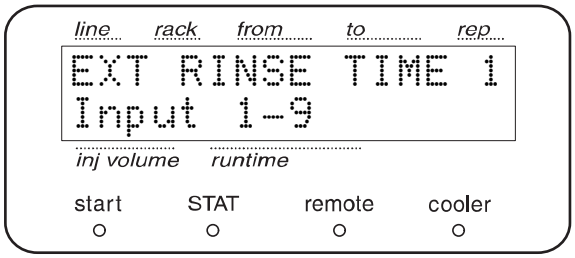


Set value	Function
0	Not used (default setting).
1	The needle is dip-rinsed using only the standard rinsing port.
2	The needle is rinsed using both the standard rinsing port and the rinsing pump. (After the needle is pump-rinsed using the rinsing pump, it is dip-rinsed at the rinsing port.)
3	The needle is rinsed using both the standard rinsing port and the rinsing pump. (After the needle is dip-rinsed at the rinsing port, it is pump-rinsed with the rinsing pump.)

Set value	Function
4	When performing sample injection, the needle is dip-rinsed at the standard rinsing port, and before sample injection starts, it is pump-rinsed with the rinsing pump.
5	Reserved function 1 (Reserved for special purposes and so cannot be used.)
6	Reserved function 2 (Reserved for special purposes and so cannot be used.)

■ [EXT RINSE TIME]

Sets the rinse time for the optional rinsing pump.
Enter the rinse time by the numeric keypad and press **enter**.



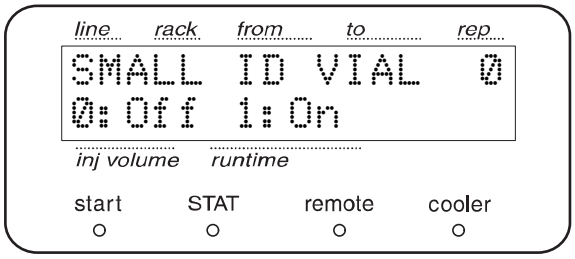
Set range	Default value
1-9 sec	2 sec

NOTE

Approximately 1.5 mL of rinse solution is used in 1 s.

■ [SMALL ID VIAL]

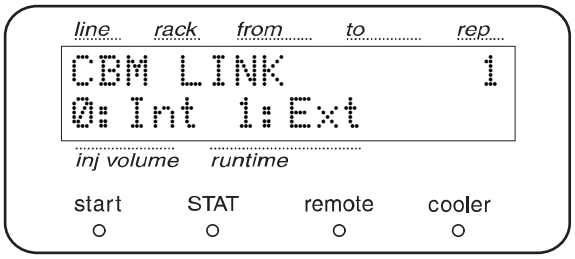
When samples vials with a small capacity are used, atmospheric changes in the sample vials during sample measurement can cause incorrect measurements. This function can be used to reduce the influence of these changes in atmospheric pressure.
Select [1:On] when using small-capacity vials.



Set value	Function
0	Small-capacity vials are not used (default setting).
1	Small-capacity vials are used.

■ [CBM LINK]

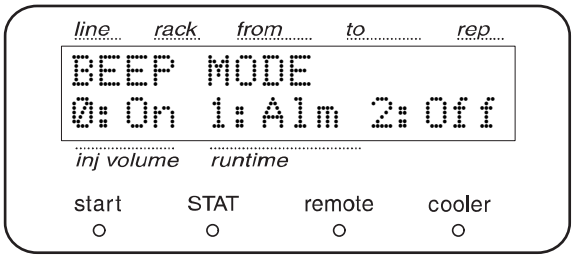
Sets the link destination of system controller.
Enter the desired value, and press **enter**.
After setting, turn off the power and then turn it on again.



Set value	Function
0	Link with CBM-20Alite (option) inside of the instrument.
1	Link with external system controller by optical cable connected to [REMOTE] connector.

■ [BEEP MODE]

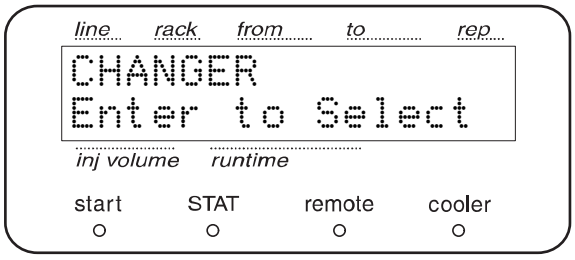
Sets operation of buzzer.
Enter a set value and press **enter**.



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.

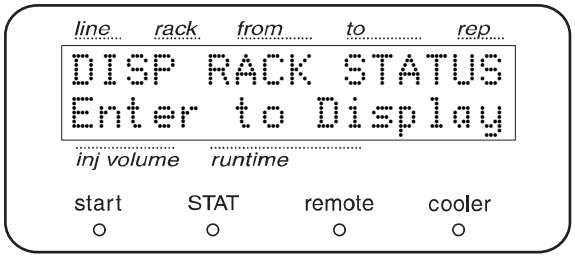
5.2.6 Changer Settings Group

Displayed when using an optional rack changer.



■ [DISP RACK STATUS]

1 From the changer setting screen, press **enter**.
The [DISP RACK STATUS] screen is displayed.

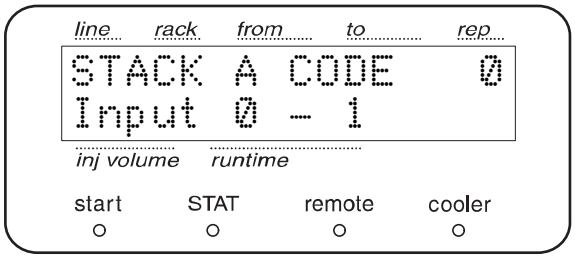


2 Press **enter** to display the status of racks 1 to 12 in order.
The rack number and type are displayed on the first line and the rack status is displayed on the second line.

■ [STACK A CODE]

Enter the set value by the numeric keypad and press **enter**.

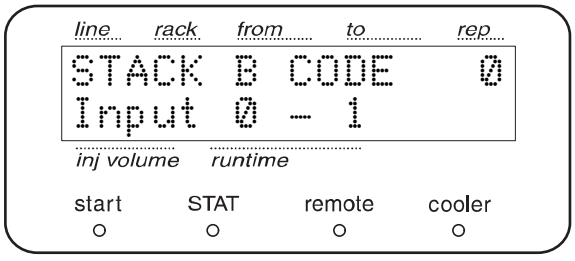
Set value	Function
0	96-well microtiter plate is used.
1	96 deep-well microtiter plate is used.



■ [STACK B CODE]

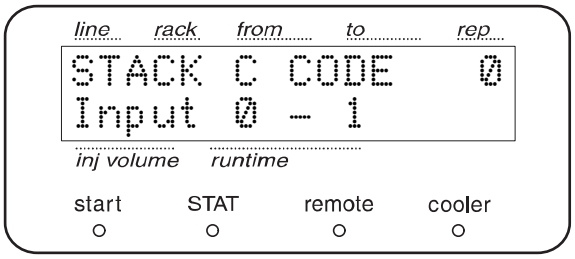
Enter the set value by the numeric keypad and press **enter**.

Set value	Function
0	96-well microtiter plate is used.
1	96 deep-well microtiter plate is used.



■ [STACK C CODE]

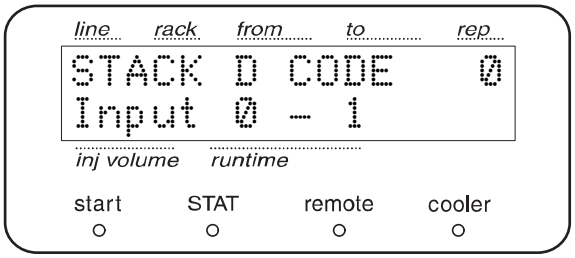
Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	96-well microtiter plate is used.
1	96 deep-well microtiter plate is used.

■ [STACK D CODE]

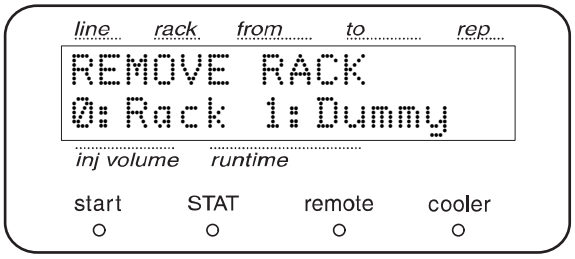
Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	96-well microtiter plate is used.
1	96l deep-well microtiter plate is used.

■ [REMOVE RACK]

Enter the set value by the numeric keypad and press **enter**.



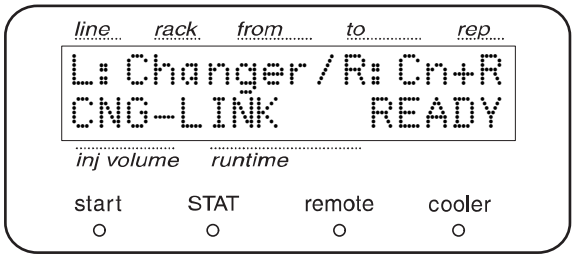
Set value	Function
0	When using the SIL-20A (without sample rack), if there is a rack remaining inside the autosampler, it is returned to the changer.
1	When using the SIL-20AC (with sample rack), the changer rack is removed from the autosampler. If there is a sample cooler, the rack changer's dummy rack is returned to a neutral position.

5.3 Using a Rack Changer

By using a rack changer, analysis is possible from up to 12 microtiter plates or deep-well microtiter plates. Use the rack changer according to the procedure described below.

Refer to the instruction manual for the SIL-20A/20AC autosampler's rack changer

1 Set the changer rack in the autosampler.
Verify the communication between the autosampler and the rack changer.
- The screen shown on the right is displayed.
- The rack changer's [READY] lamp is illuminated.



2 Set the plates in the rack changer.

Stack number	Adapter number (rack number input in the sample table)
Stack A	1, 2, and 3 from the stack front side
Stack B	4, 5, and 6 from the stack front side
Stack C	7, 8, and 9 from the stack front side
Stack D	10, 11, and 12 from the stack front side

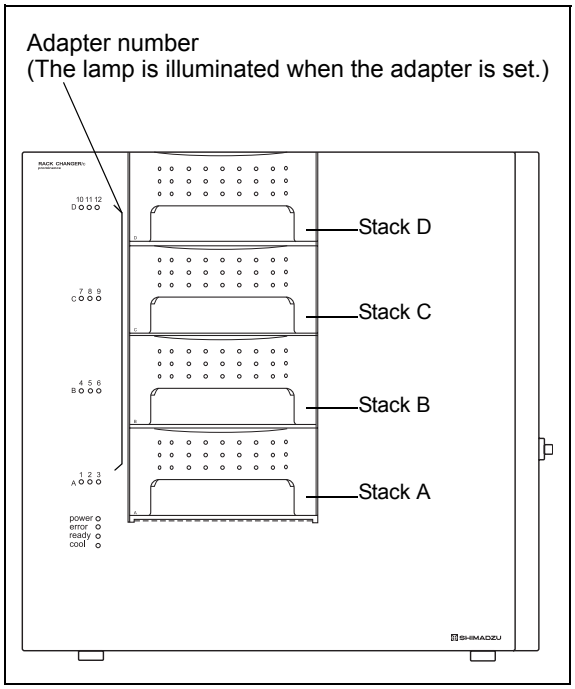


Fig. 5.3

NOTE

When performing injection from a control vial rack, set [0] as the rack number in the sample table.

NOTE

When using an autosampler with a rack changer, analysis is possible using a rack other than the changer rack.
Before removing the changer rack from the autosampler, check that there is no adapter on the rack. If an adapter is left, return it to the rack changer.

"[REMOVE RACK]" P. 5-34

5.4 Setting Bracket Sequence Analysis

When a specific number of samples is to be injected, this mode can be used to inject samples repeatedly, at periodic intervals. In this mode, a special repeat injection table (in additional to the standard injection mode analysis sequence table) is created.
An example of a repeat injection table is provided below.

Analysis based on the following sample injection table and repeat injection table (interval = 4) is performed in the way described below.

Sample injection table

line	rack	from	to	rep	inj vol	runtime
0	1	0	9	10	10	10
1	1	20	30	10	10	30
2	1	30	39	1	10	30
3	1	50	59	10	10	30
4	1	60	60	1	200	30
5	1	70	79	1	100	30
6	1	71	71	1	100	30
7	1	72	72	1	100	30
8	1	73	73	1	100	30

Repeat injection table

line	rack	from	to	rep	inj vol	runtime
0	1	80	80	1	100	30
1	1	81	81	5	100	30
2	1	82	82	1	100	30

Interval = 4

1 First, the repeat injection table (lines 0 through 2) is executed.

2 Next, lines 0 through 3 of the analysis sequence table are executed.
(Since the Interval is 4, the repeat injection table is executed every fourth line of the analysis sequence table.)

3 The repeat injection table (lines 0 through 2) is executed again.

4 Lines 4 through 7 of the analysis sequence table are executed.

5 The repeat injection table (lines 0 through 2) is executed once more.

6 Line 8 of the analysis sequence table is executed. All the analyses have now been completed.

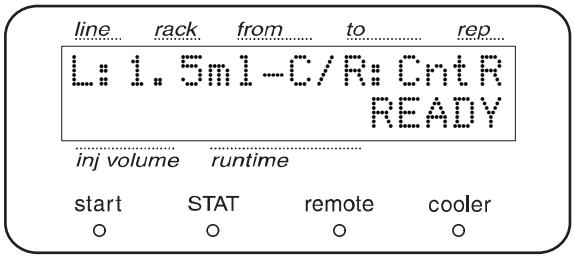
Use the following procedure to create a sample table and repeat injection table for this type of analysis.

5.4.1 Creating a Repeat Injection Table

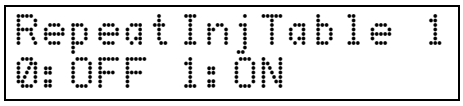
■ Displaying the Setting Screen

1 Press (CE) to return to the initial screen.

2 Press (func) to display the parameter setting screen.

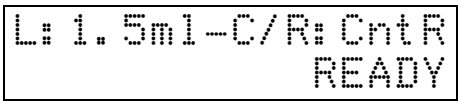


3 From the parameter setting screen, press (enter), and press (func) repeatedly until the [RepeatInjTable] screen is displayed.



4 Enter (1) and press (enter).

5 Press (CE) two times to return to the initial screen.



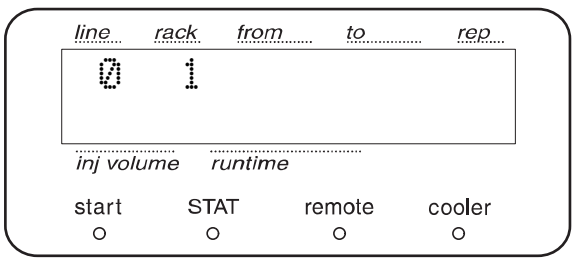
6 Press (edit).
The screen on the right will be briefly displayed, to be replaced by the parameter setting screen.

■ Setting Repeat Injection Table

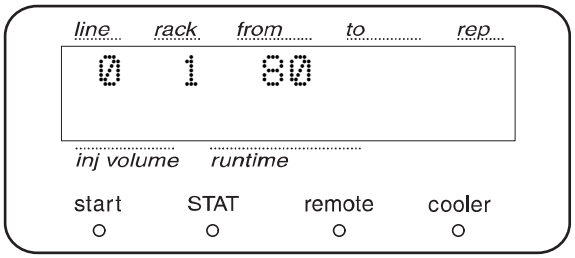
1 Use numeric keypad to enter the rack number, and press (enter).The cursor will move to the [from] field.

NOTE

When using a rack changer, set rack numbers from 1 to 12.



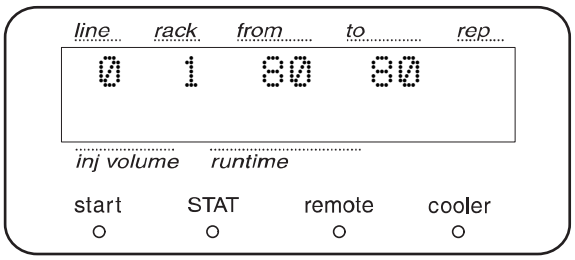
2 Use numeric keypad to enter the number of the first vial to be injected, and press (**enter**).The cursor will move to the [to] field.



NOTE

Only the line number and the first sample number are displayed on a new parameter setting screen.

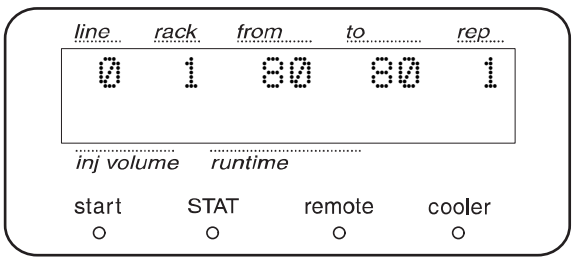
3 Enter the number of the last vial to be injected, and press (**enter**).The cursor will move to the [rep] field.



NOTE

If only one vial is to be injected, use the same number as in step 5.

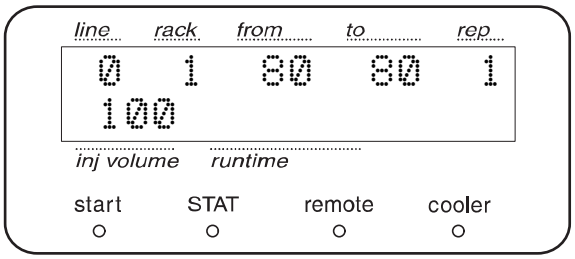
4 Enter the number of injections to be made from each sample vial, and press (**enter**). The cursor will move to the [inj volume] field on the second line.



NOTE

The maximum setting for the number of injections is 30.

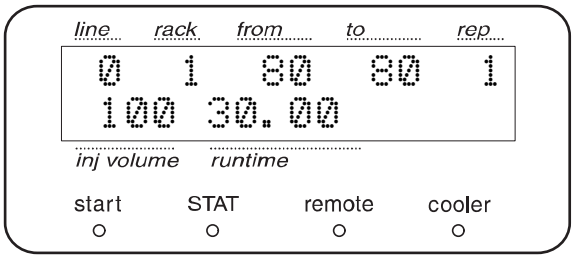
5 Enter the injection volume by the numeric keypad, in µL and press (**enter**).The cursor will move to the [runtime] field.



NOTE

Injection volumes from 0.1 to 1µL can be entered in 0.1µL increments, and from 1 to 2000µL can be entered in 1µL increments.

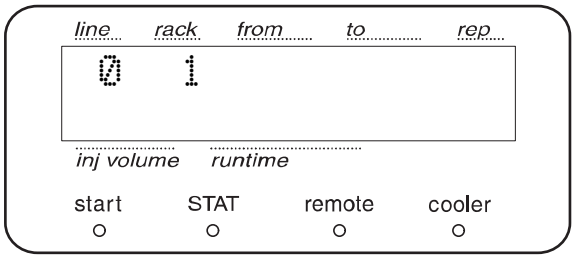
6 Enter the analysis time, in minutes, and press (**enter**).



NOTE

Any value between 0.01 and 9999.9 minutes can be set. Values higher than 1000 minutes must be in 0.1 minute increments.

7 Press **enter**.
The screen for setting the next line appears.



8 Repeat steps 6 to 12 and set the next line.

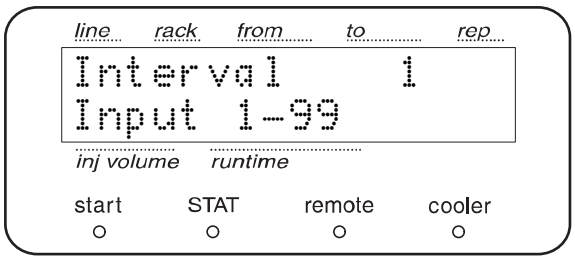
NOTE

- Up to 10 lines can be set in the repeat injection table.
- If no further lines are required, press **CE**.

9 Press **CE** when the table settings have been completed.

■ Setting Interval Conditions

1 Press **enter**.
The [Interval] screen is displayed.

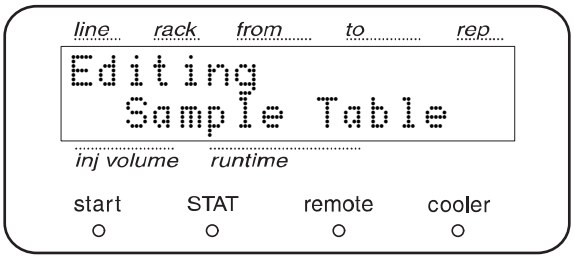


2 Using the numeric keypad, set the interval between insertions in terms of the number of lines in the analysis sequence created with the sample table. In this case, enter **4**. The setting range is from 1 to 99 lines.

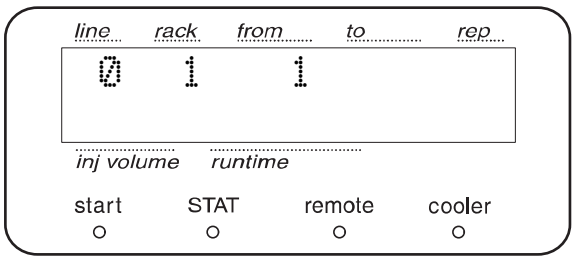
3 Press **enter**.
The input value is validated.

■ Setting Sample Table

1 Press **0** and **edit**.
The sample table screen will be briefly displayed, and then replaced by the parameter setting screen.



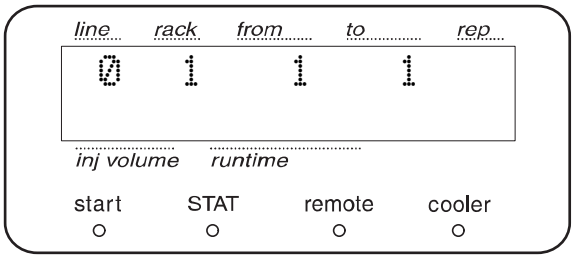
2 Use the numeric keypad to enter the first rack number, and press **enter**.The cursor will move to the [from] field.



NOTE

When using a rack changer, set rack numbers from 1 to 12.

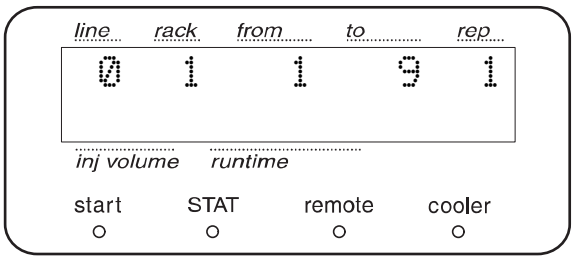
3 Use numeric keypad to enter the number [0] of the first vial to be injected, and press **enter**.
The cursor will move to the [to] field.



NOTE

Only the line number and the first sample number are displayed on a new parameter setting screen.

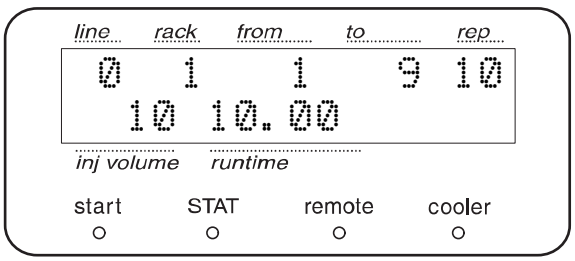
4 Enter the number of the last vial to be injected, and press **enter**.The cursor will move to the [rep] field.



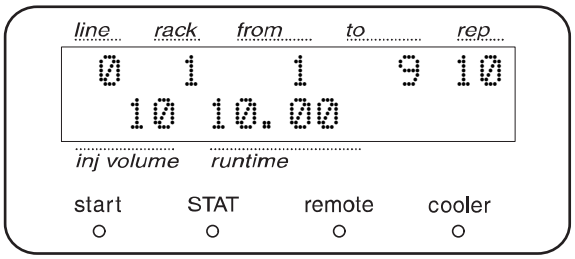
NOTE

If only one vial is to be injected, use the same number as in step 19.

5 Enter the number of injections to be made from each sample vial, and press **enter**.
The cursor will move to the [inj volume] field on the second line.



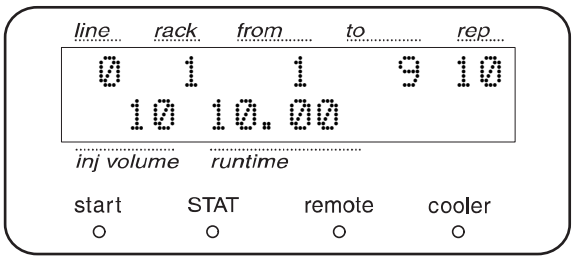
6 Enter the injection volume with numeric keypad, in µL and press **enter**.The cursor will move to the [runtime] field.



NOTE

Injection volumes from 0.1 to 1µL can be entered in 0.1µL increments, and from 1 to 2000µL can be entered in 1µL increments.

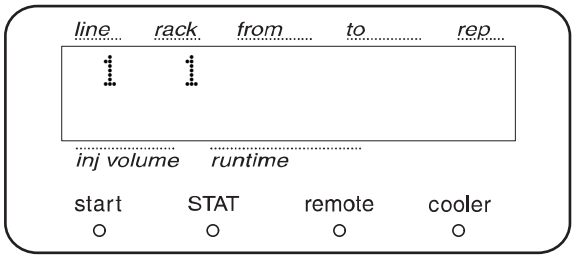
7 Enter the analysis time, in minutes, and press **enter**.



NOTE

Any value between 0.01 and 9999.9 minutes can be set. Values higher than 1000 minutes must be in 0.1 minute increments.

8 Press (enter).
Two lines of the next sample table are displayed.



9 Repeat steps 4 to 10 and set the next line.

NOTE

- Up to 99 lines can be set in the sample table.
  (If a repeat injection table is created, up to 99 lines including the number of repetitions can be set.)
- If no further lines are required, press (CE).

10 Press (CE) to go back to the initial screen.

5

5.4.2 Creating an Analysis Sequence Table during the Analysis

When the repeat injection table is used, a repeat injection table or an analysis sequence table cannot be changed or added during the analysis.
When the repeat injection table is not used, the parameters can be changed or added from the second line under the current analysis. Under the pause state, the parameters can be changed or added from the next line.

5.4.3 Analysis in Repeat Injection Mode

The procedures for sample preparation and configuration of settings are the same as those for standard injection mode. The procedures for performing analysis are almost the same as those for standard injection mode.

5.5 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.

5.5.1 List of VP Functions

The VP functions are listed in the tables below.
"5.1.3 VP Function Screens" P. 5-8

■ Product Information Group

Command	Function	Page
SERIAL NUMBER	Displays the instrment serial number.	P.5-46
S/W ID	Displays the instrment name and ROM version.	P.5-46
RC SERIAL NUMBER	Displays the rack changer's serial number.	P.5-46
RC S/W ID	Displays the rack changer's program version number.	P.5-46

■ Maintenance Information Group

Command	Function	Page
TOTAL OP TIME	Displays the instrument's total operating time.	P.5-47
NDL SEAL USED	Displays needle seal usage.	P.5-47
HPV SEAL USED	Displays HPV rotor seal usage.	P.5-47
LPV SEAL USED	Displays LPV rotor seal usage.	P.5-48
EXT PUMP USED	Displays rinsing pump usage.	P.5-48
NEEDE FLUSH	Rinses needle interior (to remove clogs).	P.5-48
P-SET	Replaces measuring plunger.	P.5-48
HPV ROTATION	Used after HPV rotor replacement.	P.5-49
LPV ROTATION	Used after LPV rotor replacement.	P.5-49
PARTS REPLACEMENT	For entering records of parts replacement.	P.5-49
MAINTENANCE LOG	Displays maintenance log.	P.5-50
OPERATION LOG	Displays operation log.	P.5-50
ERROR LOG	Displays error log.	P.5-51

■ Validation Support Group

Command	Function	Page
DATE	Displays/sets the date.	P.5-52
TIME	Displays/sets the time.	P.5-52
MEMORY CHECK	Runs memory check.	P.5-53
POSITION SENS	Executes self-diagnosis by position sensors.	P.5-53
LEAK SENSOR TEST	Runs check on leak sensor.	P.5-54

■ Calibration Support group

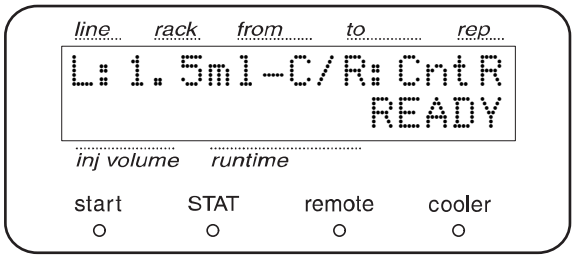
Command	Function	Page
Input PASSWORD	For password input.	P.5-55
ADJUST MTP	For adjusting the position of microtiter plates or deep-well microtiter plates.	P.5-55
ERASE MTP ADJ	For deleting MTP position data.	P.5-57
ASP FACTOR	For correcting the injection volume accuracy.	P.5-58
LEAK THR	For adjusting the sensitivity of the leak sensor.	P.5-60
NDLE SEAL	For changing needle seal replacement alert value.	P.5-60
HPV SEAL	For changing HPV seal replacement alert value.	P.5-60
LPV SEAL	For changing LPV seal replacement alert value.	P.5-60
EXT PUMP	For changing rinsing pump replacement alert value.	P.5-61
CANCEL DOORSW	For setting the safety lock.	P.5-61
CANCEL RACKDET	For setting the rack sensor.	P.5-62
CANCEL VIALDET	For setting the vial sensor.	P.5-62
OP MODE	For setting the mode for communications with the external controller.	P.5-63
INITIALIZE PARAM	For initializing parameters and logs.	P.5-63
CHANGE PASSWORD	For changing password.	P.5-63
ADJUST RACK	For adjusting the rack position.	P.5-64
ADJUST INJ PORT	For adjusting the position of the injection port.	P.5-65
ERASE RACK.P ADJ	For erasing injection port position data.	P.5-67
ERASE INJ.P ADJ	For erasing rack position data.	P.5-68
TEMP DELTA	For correcting the sample cooler temperature.	P.5-68

■ CBM Parameter Group

Command	Function	Page
SERIAL NUMBER	Displays the serial number of CBM-20A.	P.5-69
S/W ID	Displays the program version number of CBM-20A.	P.5-69
INTERFACE	Sets the transmitting protocol between CBM-20A and data processing the instrument.	P.5-69
ETHERNET SPEED	Sets the transmitting speed of ethernet.	P.5-69
USE GATEWAY	Sets whether or not the DHCP function is used. (If setting is unnecessary the screen is not displayed.)	P.5-70
IP ADDRESS	Sets IP address of CBM-20A. (If setting is unnecessary the screen is not displayed.)	P.5-70
SUBNET MASK	Sets subnet mask of CBM-20A. (If setting is unnecessary the screen is not displayed.)	P.5-70
DEFAULT GATEWAY	Sets the gateway address. (If setting is unnecessary the screen is not displayed.)	P.5-71
TRS MODE	Sets condition by serial transmission.	P.5-71

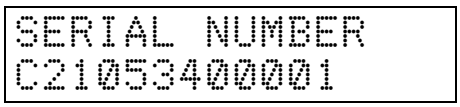
5.5.2 Displaying the VP Functions

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



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

3 Press **func** until the desired function appears.
* To return to the previous screen, press **back**.



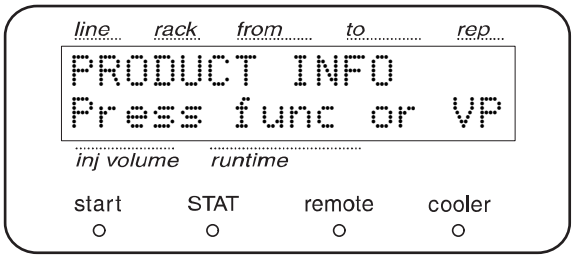
4 Follow the further instructions of the selected function.

5 To select a different VP Function Group, press **VP** repeatedly.To select the desired function, press **func** or **back**.

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

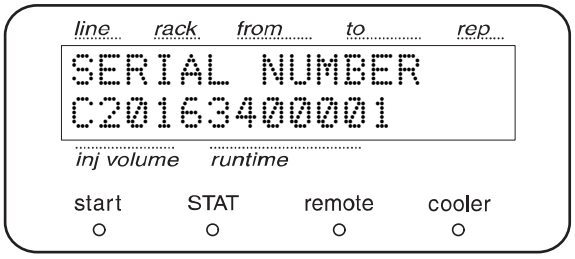
5.5.3 Product Information Group

This group provides the information about the instrument.



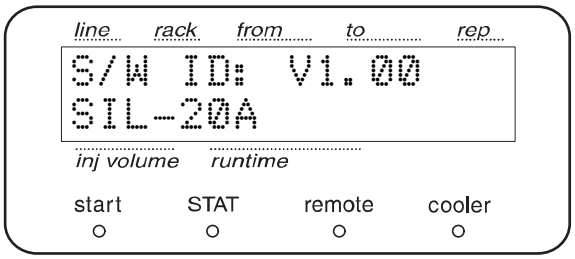
■ [SERIAL NUMBER]

Shows the serial number of this instrument.



■ [S/W ID]

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

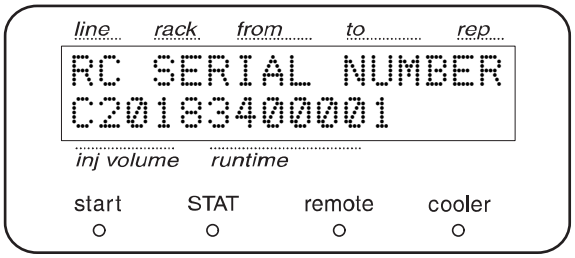


NOTE

The serial number and software version can only be displayed. They cannot be changed.

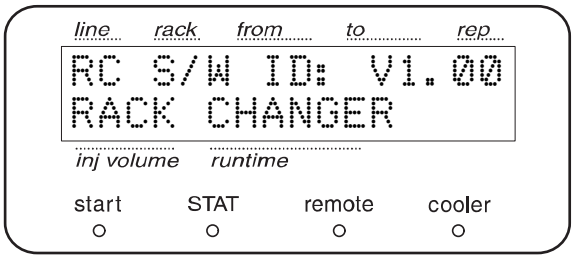
■ [RC SERIAL NUMBER]

Press **func** again to display the rack changer's serial number.



■ [RC S/W ID]

Press **func** again to display the rack changer's software version.

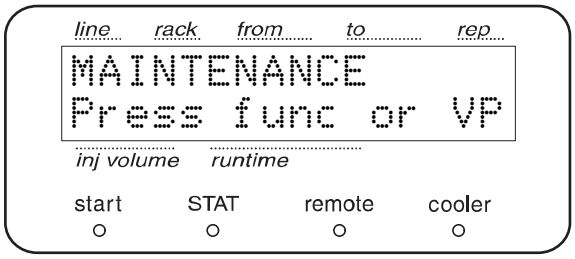


NOTE

Only displayed if a rack changer is connected.
The rack changer's serial number and software version can only be displayed. They cannot be changed.

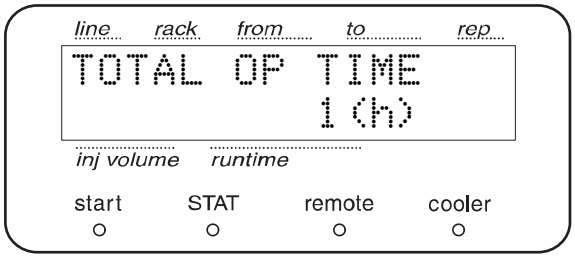
5.5.4 Maintenance Information Group

This group provides the maintenance-related information.



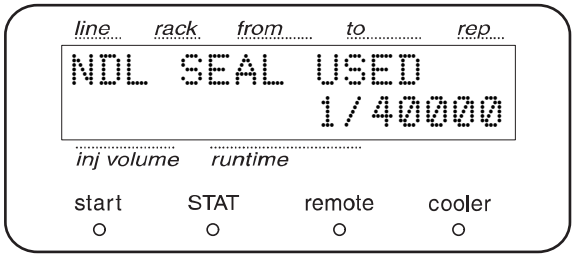
■ [TOTAL OP TIME]

Shows the total operating time of the instrument.



■ [NDL SEAL USED]

Displays the usage frequency and replacement alert value for the needle seal.



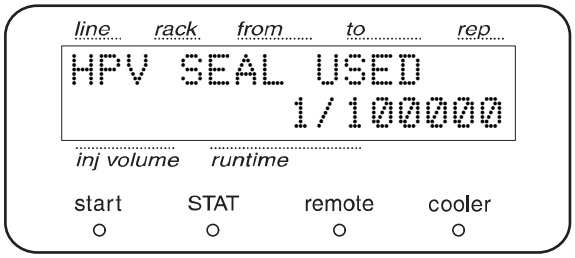
NOTE

After replacing the needle seal, reset the counter to [0] by pressing 0 and enter.

"8.2 Replacement of Needle Seal" P. 8-4

■ [HPV SEAL USED]

Displays the usage frequency and replacement alert value for the high-pressure valve's rotor seal.



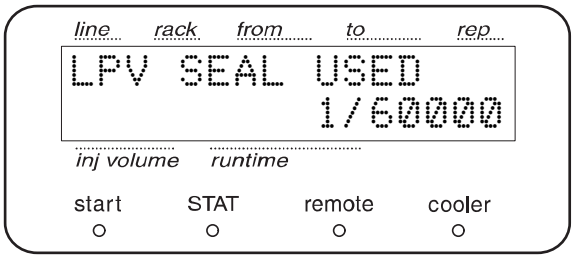
NOTE

After replacing the rotor seal, reset the counter to [0] by pressing 0 and enter.

"8.6 Replacement and Inspection of the High-Pressure Valve Rotor and Stator" P. 8-19

■ [LPV SEAL USED]

Displays the usage frequency and replacement alert value for the low-pressure valve's rotor seal.



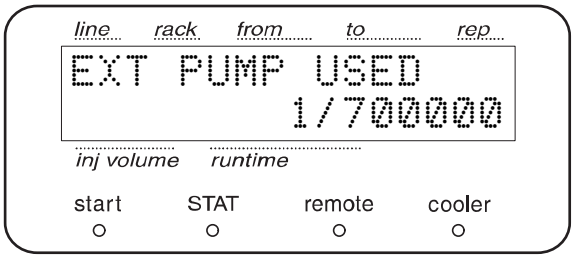
NOTE

After replacing the rotor seal, reset the counter to [0] by pressing 0 and enter.

"8.5 Replacement and Inspection of the Low-Pressure Valve Rotor and Stator" P. 8-15

■ [EXT PUMP USED]

Displays the rinsing pump's usage frequency and replacement alert value.



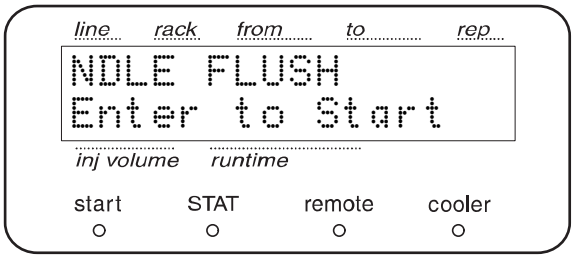
NOTE

After replacing the rinsing pump, reset the counter to [0] by pressing 0 and enter.

■ [NDLE FLUSH]

The screen on the right can be used to rinse the inside of the needle with mobile phase when it is clogged.

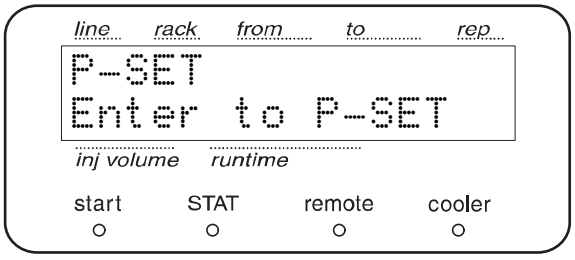
"8.12.1 Rinsing the Needle and Sample loop" P. 8-33



■ [P-SET]

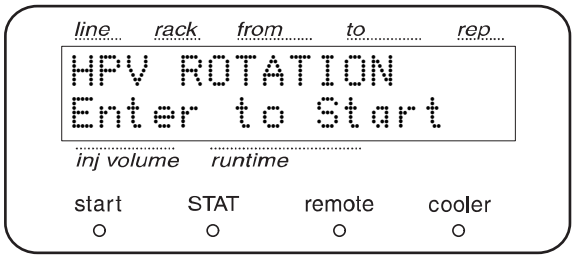
This screen can be used to move the plunger position when replacing the plunger seal.

"8.3 Replacement of Plunger Seal" P. 8-7



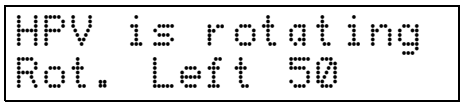
■ [HPV ROTATION]

This screen is used when replacing the high-pressure valve's rotor seal. When this menu is executed, the high-pressure valve rotates 50 times automatically.
It takes approx. 20 minutes to finish the operation.



1 Remove the column and, with the pump connected to the plumbing using, for example, a coupling, pump 2-propanol or methanol at a rate of 2 mL/min.

2 Press **enter**.
The high-pressure valve rotates every several seconds 60° at a time automatically. The left number of rotation is displayed in the second line.

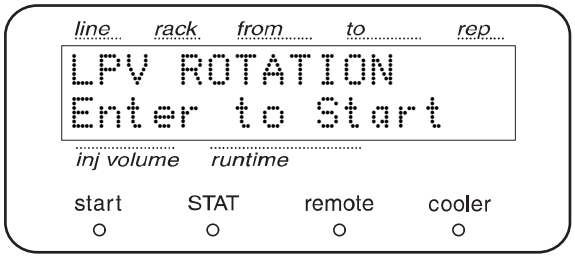


NOTE

If the operation starts once, it cannot be canceled until the 50 times-rotation has been carried out.

■ [LPV ROTATION]

This screen is used when replacing the low-pressure valve's rotor seal. When this menu is executed, the low-pressure valve rotates 50 times automatically.
It takes approx. 20 minutes to finish the operation.



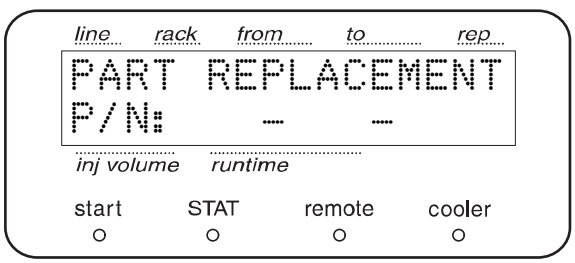
Press **enter** to make the low-pressure valve to rotate every several seconds 60° at a time automatically. The left number of rotation is displayed in the second line.

NOTE

If the operation starts once, it cannot be canceled until the 50 times-rotation has been carried out.

■ [PART REPLACEMENT]

Enters the replaced part No.
The part No. is recorded in the maintenance log.

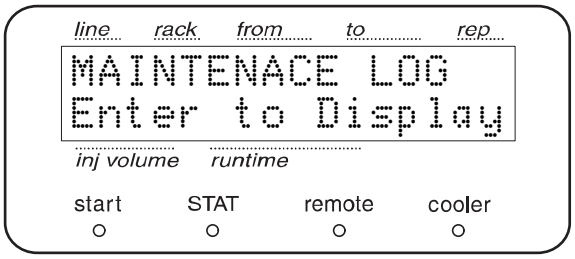


5

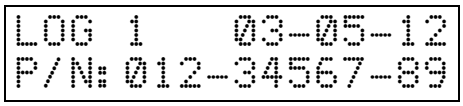
■ [MAINTENANCE LOG]

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

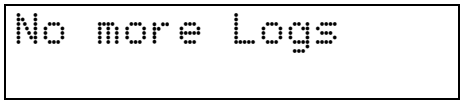
Press (enter) repeatedly to show Log1 to Log10 in sequence, and return to the title screen.



In the example on the right, the Log1 entry indicates that a part No. 012-34567-89 was replaced on May 12,2003.



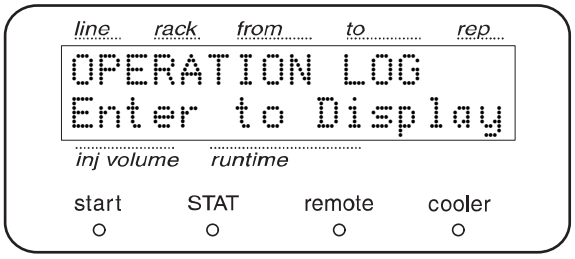
If less than 10 logs are recorded, the screen displays the message as shown on the right.
Press (CE) to return to the title screen.



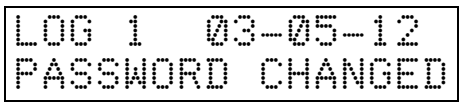
■ [OPERATION LOG]

Shows the operation log, which contains the most recent password settings, parameter initialization, 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, the Log1 entry indicates that a password setting was made on May 12, 2003.

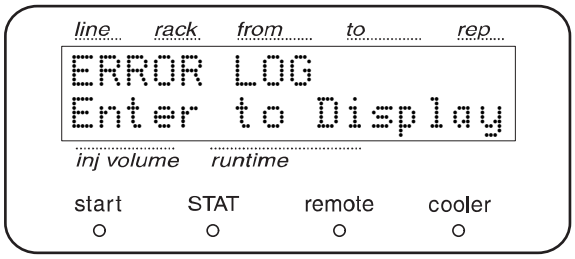


If less than 10 logs are recorded, the screen displays the message as shown on the right.
Press (CE) to return to the title screen.

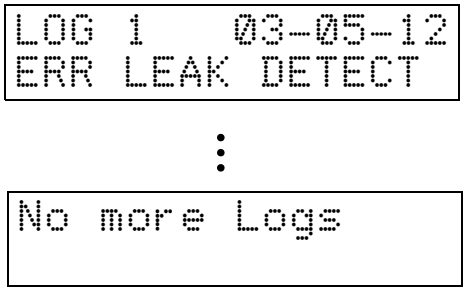
■ [ERROR LOG]

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.



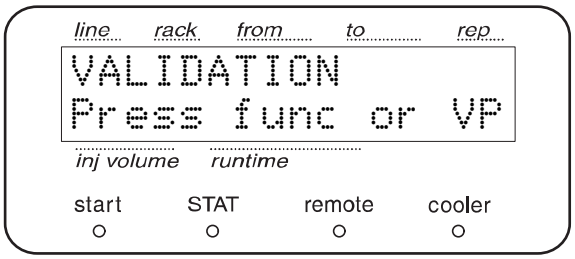
In the example on the right, the Log1 entry indicates that a leak was detected on May 12, 2003.



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.

5.5.5 Validation Support Group

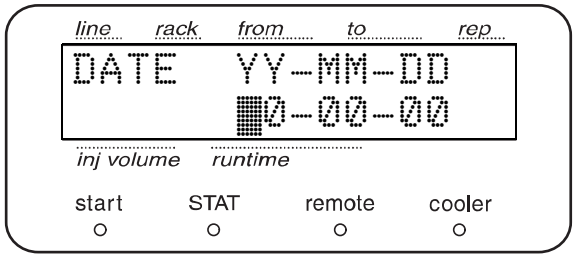
This group checks whether the instrument is running correctly.



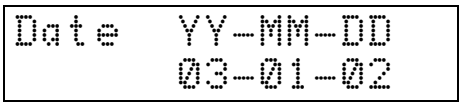
■ [DATE]

Shows/enters the date.
(Only for local control; when control is by a system controller, the date is transmitted during link-up, and cannot be changed.)
Example: Setting January 2, 2003

Date



Input



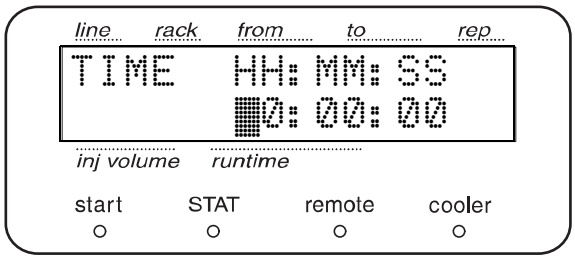
1 Use numeric keypad to first set the year, then the month, then the day. For the year, enter the year of the decade only. For each item, be sure to enter 2 digits (i.e. enter a zero in the tenths column if necessary.).

2 When setting is complete, press **enter**.

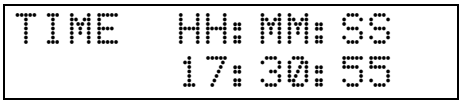
■ [TIME]

Shows/enters the time.
(Only for local control; when control is by a system controller, the time is transmitted during link-up, and cannot be changed.)
Example: Setting 5:30:55 p.m.

Time



Input



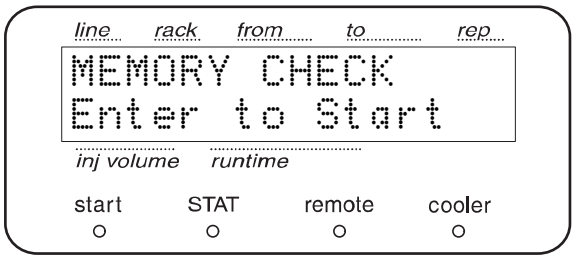
1 Use numeric keypad to first set the hours, then the minutes, then the seconds. The display uses a 24-hour clock. For each item, be sure to enter 2 digits (i.e. enter a zero in the tenths column if necessary.).

2 When setting is complete, press **enter**.

■ [MEMORY CHECK]

Runs the memory check on ROM and RAM.

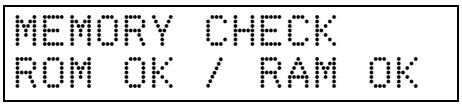
Press **enter** to start.
Results are shown when checking is completed.



NOTE

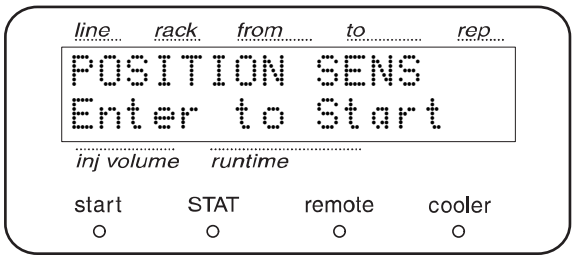
If a rack changer is connected, the rack changer's memory check result is also displayed.

Result



■ [POSITION SENS]

When **enter** is pressed, the sensors inside the autosampler (i.e., for the needle's X direction, the rack's Y direction, the needle's Z direction, the high-pressure valve, the low-pressure valve, and the pump) perform automatic operation checks.



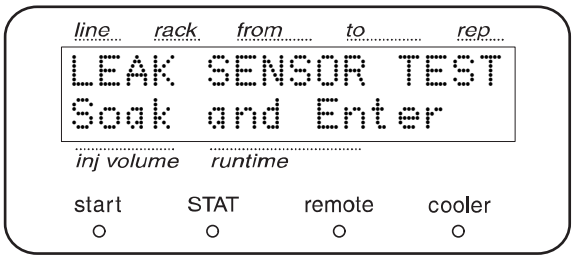
During the checks, the message on the right is displayed.

The results of the checks are displayed upon completion. If there is an error, an error message for the place with the error is displayed.

■ [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**.
If the sensor detects a leakage, [GOOD] will be shown. If not, [NO GOOD] will be shown.

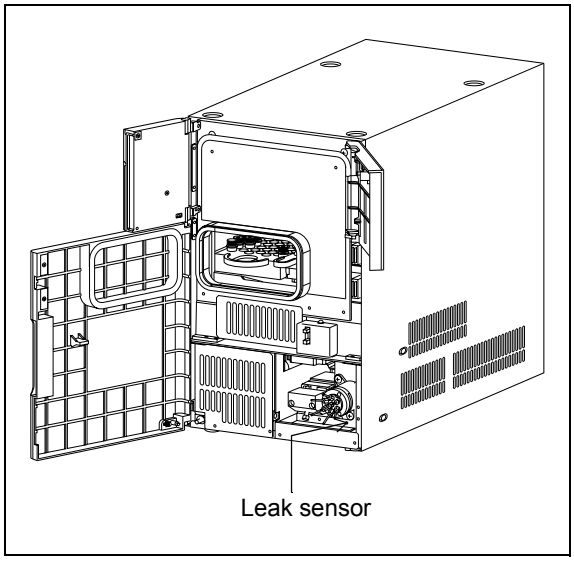


Fig. 5.4

3 Carefully wipe the thermosensor body at the lower side of the leak sensor until it is completely dry.

> **⚠ CAUTION**
>
> The sensor must be dry when exiting this screen, or leak sensor errors may occur.

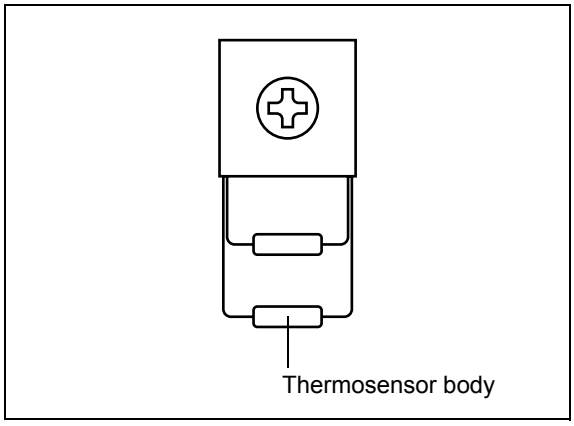
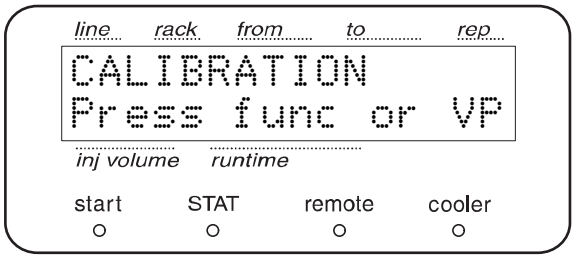


Fig. 5.5

4 Press **func** to return to the [DATE] screen.
Press **back** to return to the previous screen.
Press **CE** to return to the initial screen.

5.5.6 Calibration Support Group

This group calibrates the instrument.



NOTE

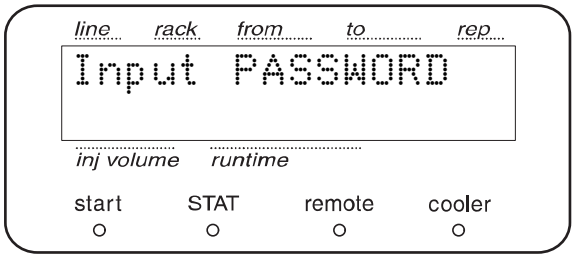
The instrument is adjusted before leaving the factory.
Do not change values unnecessarily.

■ [Input PASSWORD]

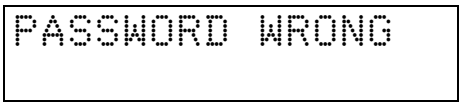
Password should be registered by a system manager.
Input five numbers and press (enter).

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

If the password is input correctly, [ADJUST MTP] function (subsequent function) appears.



If the password is not input correctly, the subsequent functions cannot be accessed.



■ [ADJUST MTP]

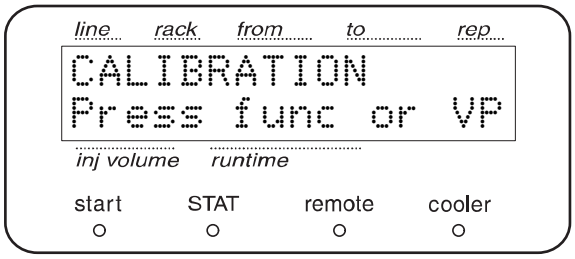
⚠WARNING

During this adjustment, operation will not stop when the door is open. Do not reach into the auto injector during this procedure; you could be injured.

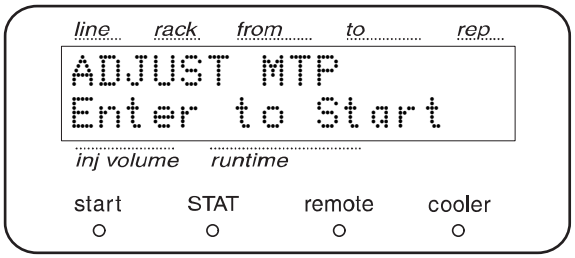
1 Place the microtiter plate on the rack.

2 Press (VP) in the initial screen repeatedly until the screen on the right is displayed.

3 Input the password correctly.



4 Press (enter).
The [ADJUST MTP] screen is displayed.



5 Press (enter).
The needle moves close to hole A1 in the near-side microtiter plate (the left position of the rack) and stops.

6 Using the arrow keys, adjust the right or left and front or rear position so that the needle is lowered into the center of hole A1.
(The vertical direction is set with the [NEEDLE STROKE] auxiliary function.)

Arrow key	Direction of needle movement
←	The needle moves 0.1 mm to the left.
→	The needle moves 0.1 mm to the right.
↑	The needle moves all the way up.
↓	The needle descends 10mm. (moves approx. 6mm, only when the needle is at the uppermost part.)
func	The needle moves forwards 0.1mm.
back	The needle moves backwards 0.1mm.

7 Press (enter).
The position is determined, the finely adjusted position is stored in memory, and the needle moves close to hole A1 of the rear-side microtiter plate (the deep, left position of the rack) and stops.

NOTE

To stop time adjustment, press (CE).
The needle moves to the front.

8 Move the needle laterally in the way described in step 6. Using the arrow keys, move it to the position where the tip of the needle is aligned with the center of hole A1.

9 Press (enter) to confirm the position. The fine adjustment point will be memorized and the rack moves to the front.
The needle moves close to H1 (when using a 96-well plate) or P1 (when using a 384-well plate).

10 Move the as step 6.
Using (func) and (back), move the edge of needle so that it comes to the center of hole.

11 Press (enter) to confirm the position. The fine adjustment point will be memorized.
The fine adjustment finishes, and the needle moves to the injection port.

12 Press (func) to display the next screen.
Press (back) to return to the previous screen.
Press (CE) to return to the initial screen.

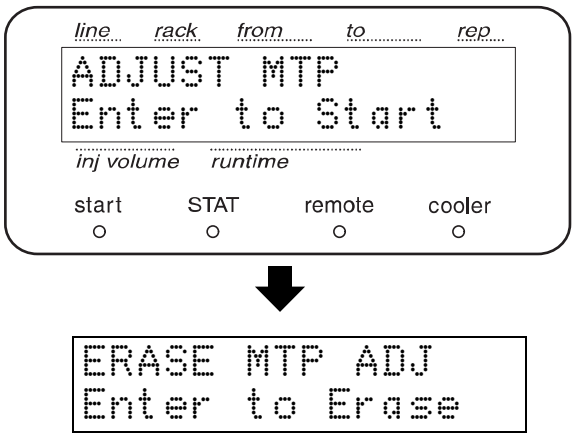
NOTE

The data set with the teaching function is stored in memory for each type of rack (i.e., rack for microtiter plates or deep-well microtiter plates, or changer rack).

■ [ERASE MTP ADJ]

This screen is used to bring the microtiter plate position data set in [ADJUST MTP] (microtiter plate teaching) to the initial state.

1 Input the password correctly and press (enter).
The [ADJUST MTP] screen will be displayed.



2 Press (func).
The [ERASE MTP ADJ] screen will be displayed.

3 Press (enter).
Select the data to be erased.

4 Press (func) to display the next screen.
Press (back) to return to the previous screen.
Press (CE) to return to the initial screen.

NOTE

When using a microtiter-plate rack, it is necessary to readjust the position of the microtiter-plate rack with the [ADJUST MTP] screen.

"[ADJUST MTP]" P. 5-55

- When executing this function, the data of the set microtiter plate is initialized.
  (The data for other microtiter plates and deep-well microtiter plates rack is not erased.)
- Before erasing all data for microtiter plates, deep-well microtiter plates, and changer racks, remove the rack from the autosampler.

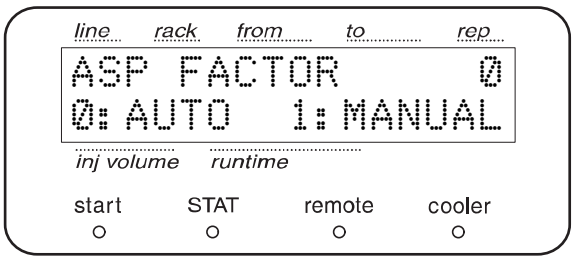
■ [ASP FACTOR]

First, select the method of determining [AUTO] or [MANUAL] (enter the compensation factor directly). The factor can be entered using a gravimetric method or it can be entered directly.

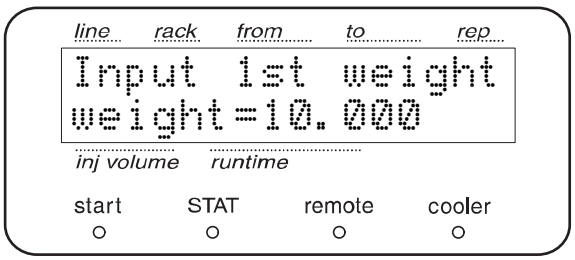
1) [AUTO] (This factor is calculated automatically.)

Determines the sample aspiration volume compensation factor. The factor is calculated as follows: A vial is filled with at least 1mL of distilled water, and ten 50µL volumes of the water are aspirated consecutively from the vial. The vial is then weighed (by the operator) to determine the decrease in weight of the water. This weight is converted into a volume value and used as the compensation factor.

1 Press **0**, **enter** to start the procedure.



2 Using a calibrated scale, weigh a vial filled with distilled water. Then enter the weight (mg) with numeric keypad.

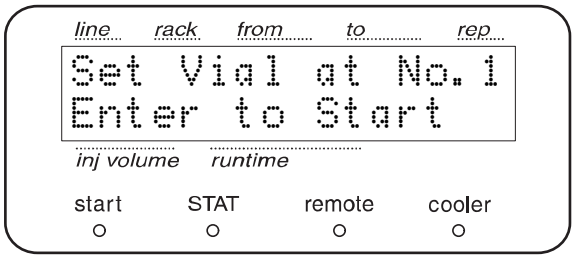


3 Open the door.

4 Place the distilled water vial into rack position No.1.

5 Close the door.

6 Press (enter).
The sequence of 10 aspirations will begin.

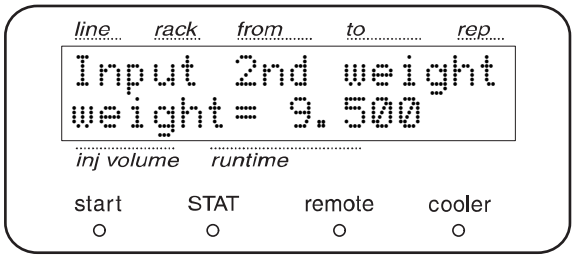


NOTE

During the aspirations, the operation cannot be canceled.

7 When all the aspirations have been completed, the message on the right appears. Open the door and remove the vial.

8 Weigh the vial again.

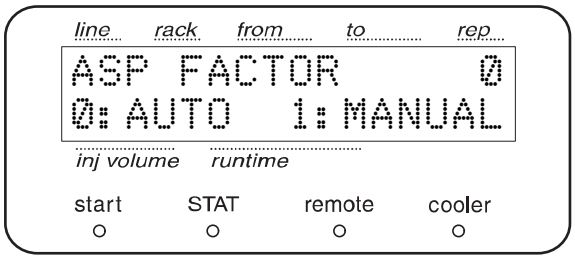


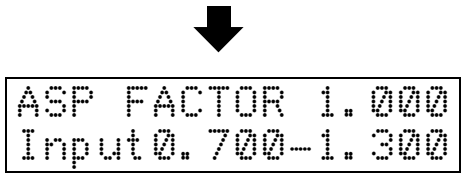
9 Then enter the weight (mg), and press (enter).
The compensation factor is displayed on the screen.

10 Press (enter).
The [ASP FACTOR] screen will be displayed.

2) [MANUAL] (Enter the compensation factor directly.)

1 Press (1), (enter) to start the procedure.





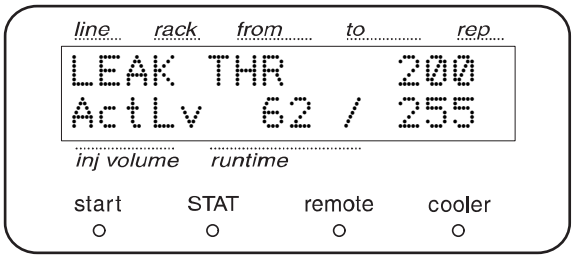
2 Set the compensation factor and press (enter).
Min: 0.700
Max: 1.300

■ [LEAK THR]

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

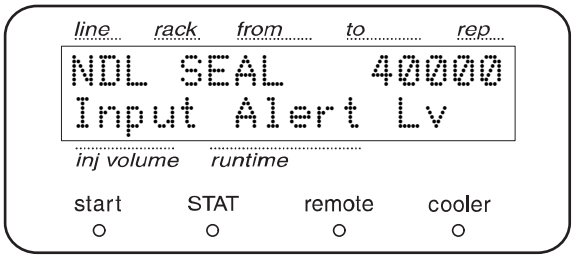
NOTE

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.



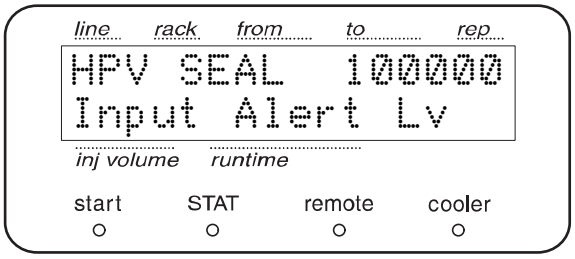
■ [NDL SEAL]

Changes the needle seal replacement alert level (i.e.total number of injections before an alert is issued), indicating that the needle seal needs to be replaced.
Use numeric keypad to enter the new value and press (enter).
Default value: 40000 (times)



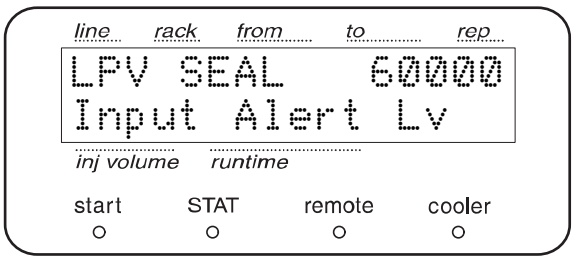
■ [HPV SEAL]

Changes the high-pressure valve seal replacement alert level (i.e.total number of injections before an alert is issued), indicating that the needle seal needs to be replaced.
Use numeric keypad to enter the new value and press (enter).
Default value: 100000 (times)



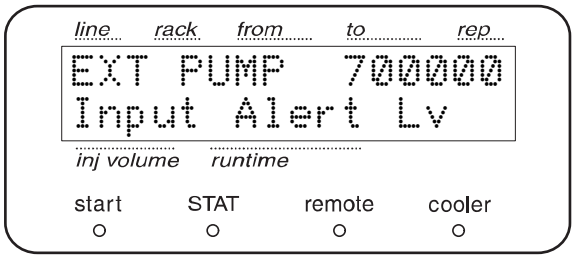
■ [LPV SEAL]

Changes the low-pressure valve seal replacement alert level (i.e.total number of injections before an alert is issued), indicating that the needle seal needs to be replaced.
Use numeric keypad to enter the new value and press (enter).
Default value: 60000 (times)



■ [EXT PUMP]

Changes the rinsing pump (optional) seal replacement alert level (i.e.total number of injections before an alert is issued), indicating that the needle seal needs to be replaced.
Use numeric keypad to enter the new value and press (enter).
Default value: 700000 (second)



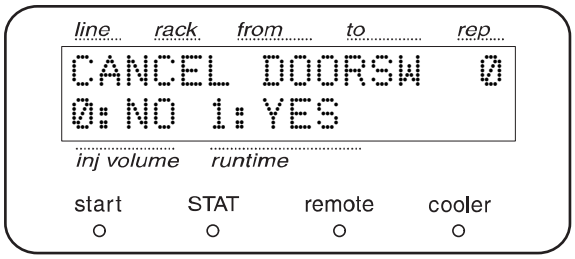
■ [CANCEL DOORSW]

This function cancels open/close door detection.
When this function is enabled (detection is off), opening the door will not stop the injection operation.

NOTE

When the value is set to [1], opening the door or removing the panel F will stop the injection operation.

Enter the set value and press (enter).



Set value	Function
0	Automatic door open/close detection is enabled.
1	Automatic door open/close detection is disabled.

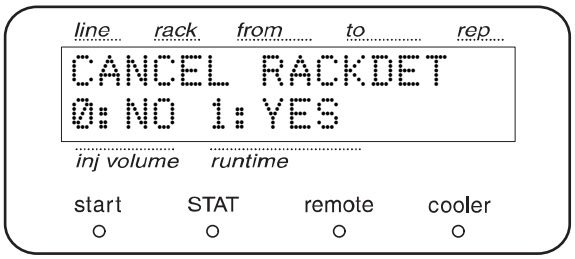
⚠CAUTION

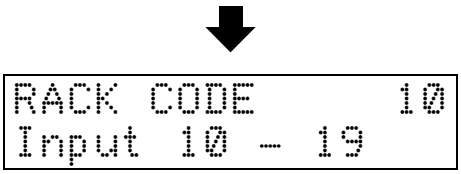
Do not reach into the auto injector while it is operating. You could be injured.

■ [CANCEL RACKDET]

If the automatic rack position sensor is not working properly (i.e., due to a broken sensor or sensor detection block), the automatic rack position detection function can be disabled.
Select a numerical key.
Enter the set value and press **enter**.

Set value	Function
0	Automatic rack position detection is enabled.
1	Automatic rack position detection is disabled.





⚠ CAUTION

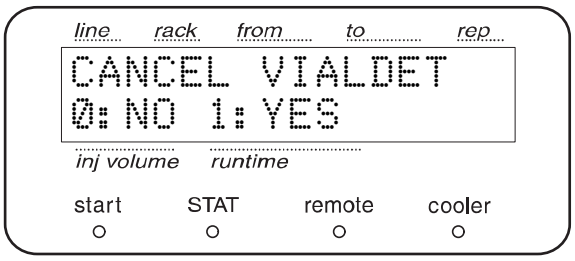
When the automatic rack position detection is disabled, enter the rack code number and confirm it with [Enter].

Rack type	Input value
Sample vial rack for 1mL	12
Sample vial rack for 1.5mL	10
Sample vial cooling rack for 1.5mL	11
Sample vial rack for 4mL	13
96-well microtiter plate rack	14
384-well microtiter plate rack	15
96-deep-well rack	16
384-deep-well rack	17
Changer rack	18
Reserved	19

■ [CANCEL VIALDET] (Cancellation of automatic vial detection)

Use numerical keypad to enter the value, and press **enter**.

Set value	Function
0	Vial automatic detection is enabled.
1	Vial automatic detection is disabled.

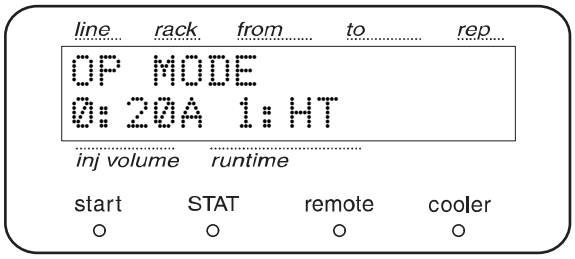


■ [OP MODE]

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

Enter the number and press (enter).
After setting, turn off the power, and then turn it on again.

Value	System controller
0	CBM-20A, CBM-20Alite
1	SCL-10Avp



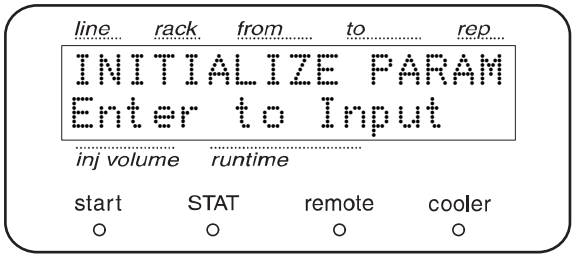
NOTE

When [1:SCL-10Avp] is set, operation is more limited.
"5.7 Control by SCL-10Avp System Controller" P. 5-73

■ [INITIALIZE PARAM]

Initializes the parameters and deletes the time programs.

Press (enter) to return to the default value and to delete the time programs.



NOTE

The [TOTAL OP TIME], [NDL SEAL USED], and [HPV SEAL] valves are not erased.

■ [CHANGE PASSWORD]

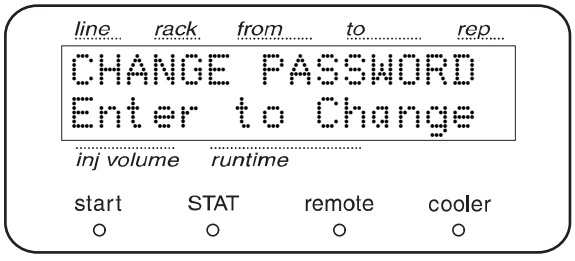
Changes the password set.

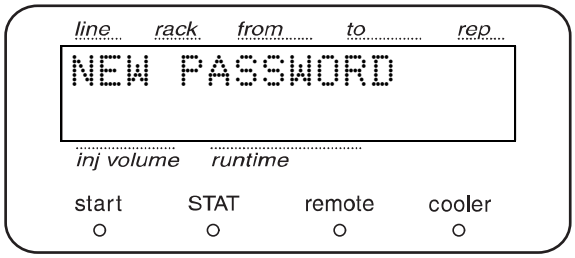
1 Press (enter).
The input screen appears.

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

3 To confirm, input the same password again.

4 The new password is enabled.





NOTE

If a wrong password is entered, you are returned to the password input screen.
Press (enter) and return to step 2.

■ [ADJUST RACK]

⚠WARNING

During this adjustment, operation will not stop when the door is open. Do not reach into the autosampler during this procedure; you could be injured.

NOTE

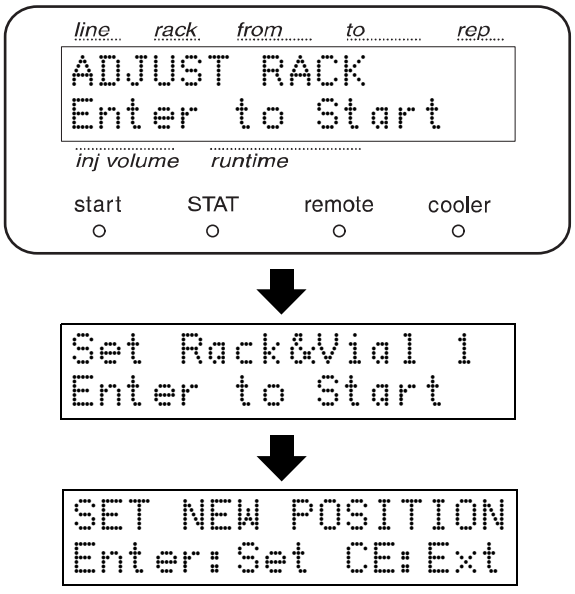
In case of using the cooling rack for 1.5mL, after removing the rack cover, set the sample rack into autosampler.
As it is not detected the rack code automatically, set the rack code.
☞ "[CANCEL RACKDET]" P. 5-62
After adjusting, set the "[CANCEL RACKDET]" P. 5-62 paramater to automatic detection.

1 Press (enter).
Set a sample vial in position 1 of the rack used (1.5mL, 1mL, or 4mL rack). Do not attach a septum to the sample vial.

2 Press (enter).
The needle stops above position 1 of the rack.

3 Using the arrow keys, adjust the lateral and longitudinal positions so that the needle is lowered into the center of the sample vial.
∗Adjustment of the vertical position is unnecessary.

Arrow key	Direction of needle movement
←	The needle moves 0.1 mm to the left.
→	The needle moves 0.1 mm to the right
↑	The needle moves all the way up.
↓	The needle moves down 6.0mm



Arrow key	Direction of needle movement
func	The needle moves forwards 0.1 mm.
back	The needle moves backwards 0.1 mm.

NOTE

If the needle position is difficult to view, loosen the panel F screws (on the front of the autosampler) and remove panel F.

4 Press (enter).
Adjustment is completed and the needle moves to the injection port.

NOTE

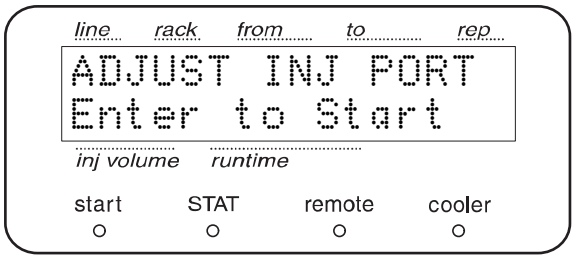
Reattach panel F if it was removed.

■ [ADJUST INJ PORT]

⚠WARNING

During this adjustment, operation will not stop when the door is open. Do not reach into the autosampler during this procedure; you could be injured.

1 Press (enter).
The needle stops at the front central position of the rack.
Loosen the screws at 5 locations on the front of the autosampler by hand and remove panel F.



2 Loosen the screws in the top part of the Z mount on the left and right and in the bottom part on the right by hand. Pull the cover forwards to remove it.
Press (enter).

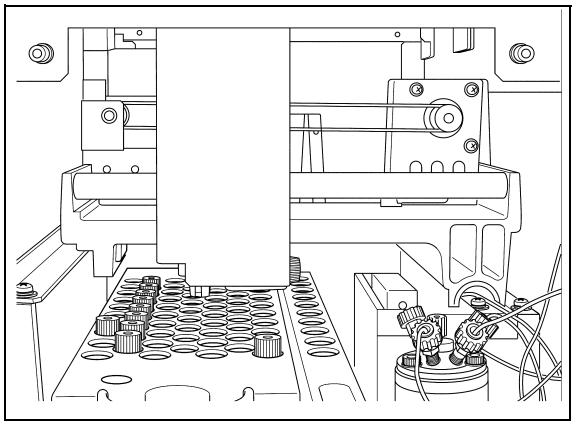
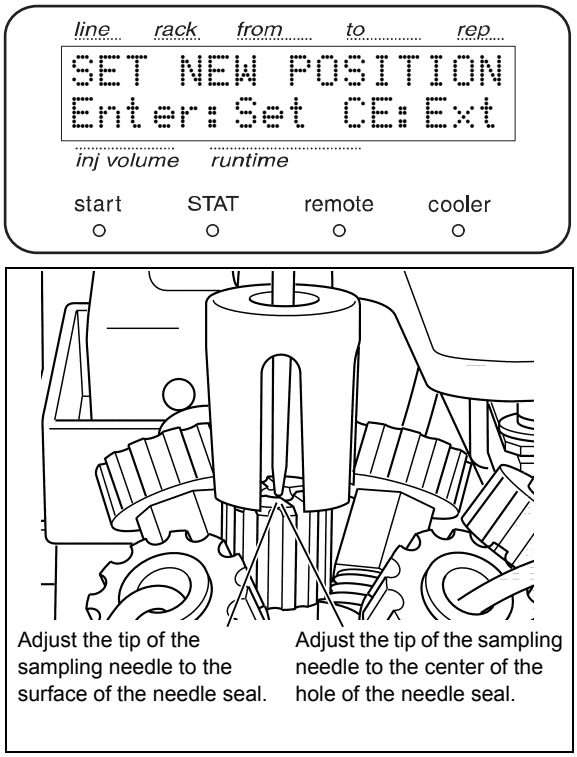


Fig. 5.6

3 Use the arrow keys to adjust the position so that the tip of the needle is at the center of the upper side of the injection port.

Arrow key	Direction of needle movement
←	The needle moves 0.1 mm to the left.
→	The needle moves 0.1 mm to the right.
↑	The needle moves all the way up.
↓	The needle moves down 0.2mm. (moves approx. 6mm, only when the needle is at the uppermost part.)
func	The needle moves forwards 0.1 mm.
back	The needle moves backwards 0.1 mm.



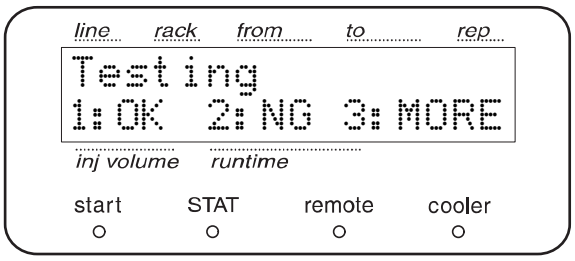
Adjust the tip of the sampling needle to the surface of the needle seal.

Adjust the tip of the sampling needle to the center of the hole of the needle seal.

Fig. 5.7

4 Press **enter**.
In order to check that the position has been entered correctly, the tip of the needle moves up and down approximately 2 mm at the position where the seal is attached. Check that the needle is lowered smoothly into the injection port as "Fig. 5.9".

Set value	Function
1	The needle position is stored in memory.
2	Needle adjustment is performed again.
3	The needle position is checked again.



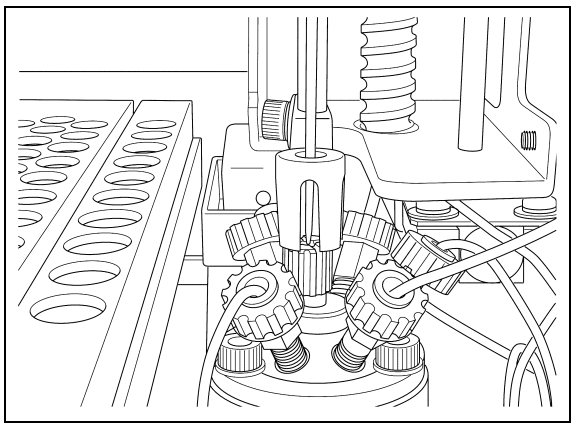
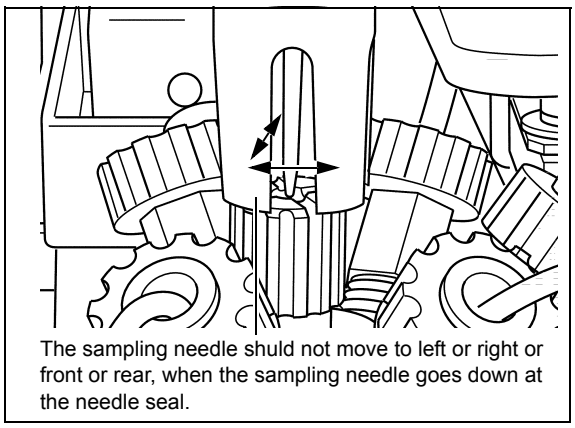


Fig. 5.8

5 Enter the set value [1].
The position is determined, the finely adjusted position is stored in memory.
The needle stops at the front central position of the rack. Attach the Z-mount cover.

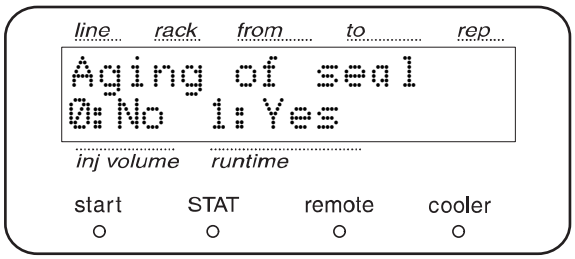
6 Press (enter).
The fine adjustment finishes and the needle moves to the injection port.
Reattach the panel, and secure it with the screws.



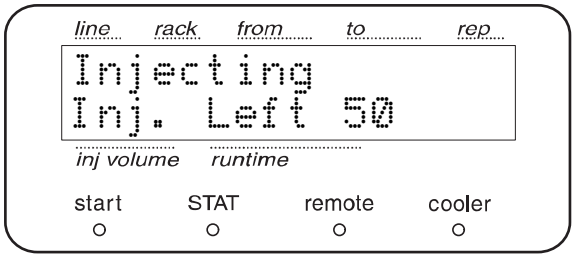
The sampling needle shuld not move to left or right or front or rear, when the sampling needle goes down at the needle seal.

Fig. 5.9

7 The screen is displayed as the right drawing.
If the needle or needle seal has been changed, the seal surface must be aged so that liquid does not leak.
Select [Yes] in the screen on the right.
* If the needle or needle seal has not been replaced, this step is not necessary.



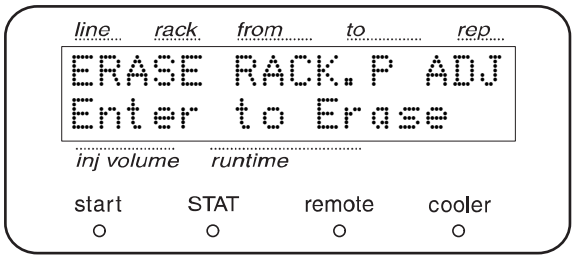
Move the needle up and down 50 times.



■ [ERASE RACK.P ADJ]

Use this function to initialize the rack position data.

Press (enter).
The rack position data is erased.



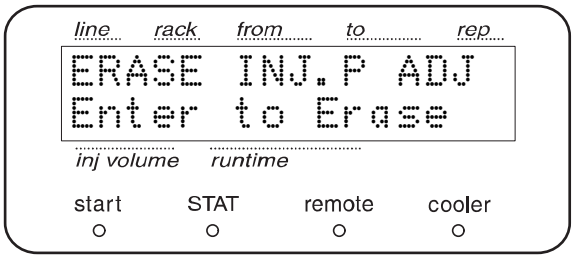
NOTE

When data has been erased, the rack position must be readjusted in the [ADJUST RACK.P] screen.
"[ADJUST RACK]" P. 5-64

■ [ERASE INJ.P ADJ]

Use this function before replacing the needle or needle seal.

Press **enter**.
The injection port position data is erased.



NOTE

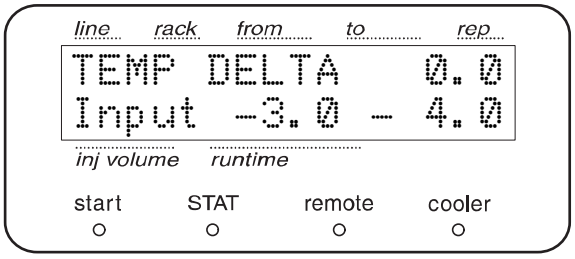
When data has been erased, the injection port position must be readjusted in the [ADJUST INJ.P] screen.
"[ADJUST INJ PORT]" P. 5-65

■ [TEMP DELTA]

Calibrates the sample cooler temperature.

Enter the calibration value (the difference from the true temperature) using the numeric keypad.

Set range	Step
-3 - 4°C	0.1°C

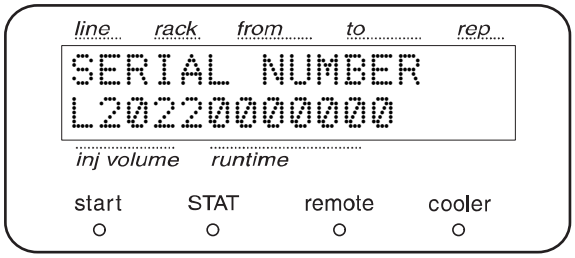


5.5.7 CBM Parameter Group

This group is for setting CBM parameters.

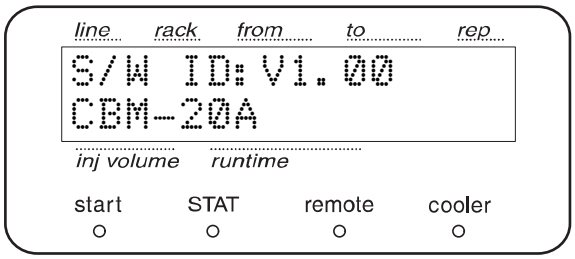
■ Displaying the Serial Number [SERIAL NUMBER]

The CBM-20A's serial number is displayed on the second line.



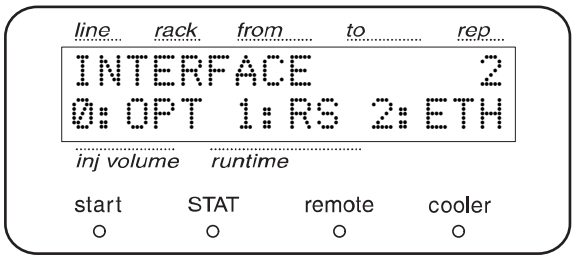
■ Displaying the S/W Version Number [S/W ID]

The program version number is displayed on the first line and the name of the system controller is displayed on the second line.



■ Setting Transmitting Protocol between CBM-20A and Data Processing Unit [INTERFACE]

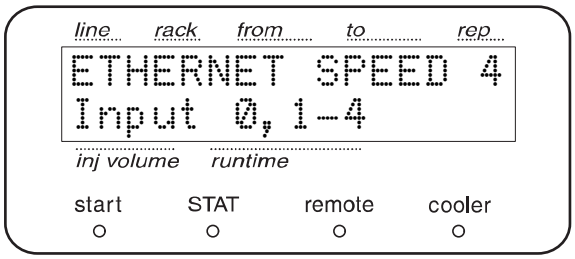
The current setting is displayed on the first line.
Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	Connects with optical cable.
1	Connects with serial transmission (RS-232C).
2	Connects with Ethernet.

■ Setting Transmitting Speed of Eathernet [ETHERNET SPEED]

The current setting is displayed on the first line.
Enter the set value by the numeric keypad and press **enter**.



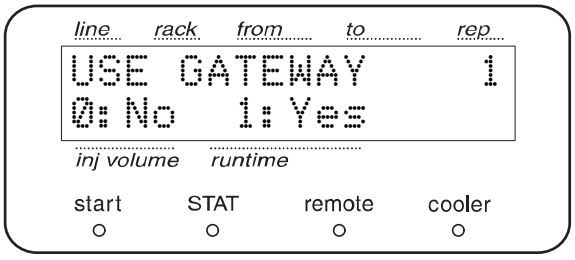
Set value	Function
0	Realizes automatically.
1	Sets to 10Mbps, Half Duplex.
2	Sets to 10Mbps, Full Duplex.
3	Sets to 100Mbps, Half Duplex.
4	Sets to 100Mbps, Full Duplex.

■ Setting Used/Not used of Default Gateway [USE GATEWAY]

NOTE

Depending on the setting for the system controller, this item may not require setting and so therefore may not be displayed.

The current setting is displayed on the first line.
Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	Not used.
1	Used.

■ Setting the IP Adress [IP ADDRESS]

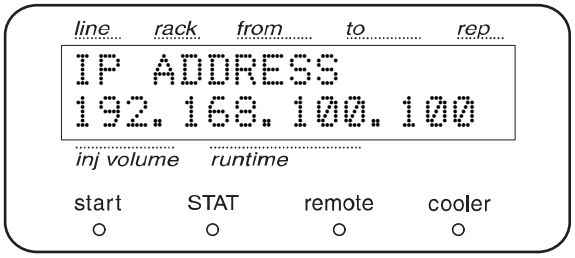
NOTE

Depending on the setting for the system controller, this item may not require setting and so therefore may not be displayed.

The current setting is displayed on the second line.
Enter the set value by the numeric keypad and press **enter**.

NOTE

Obtain the setting from your network administrator.



■ Setting the Subnet Mask [SUBNET MASK]

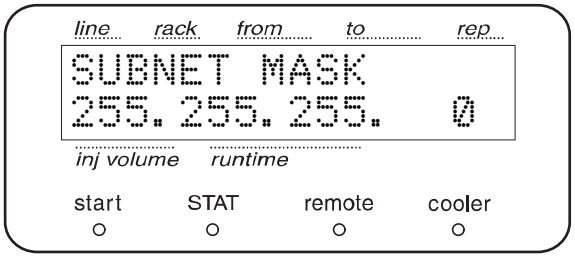
NOTE

Depending on the setting for the system controller, this item may not require setting and so therefore may not be displayed.

The current setting is displayed on the second line.
Enter the set value by the numeric keypad and press **enter**.

NOTE

Obtain the setting from your network administrator.

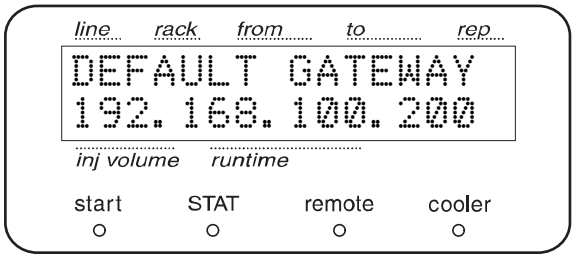


■ Setting the Default Gateway [DEFAULT GATEWAY]

NOTE

Depending on the setting for the system controller, this item may not require setting and so therefore may not be displayed.

The current setting is displayed on the second line.
Enter the set value by the numeric keypad and press **enter**.

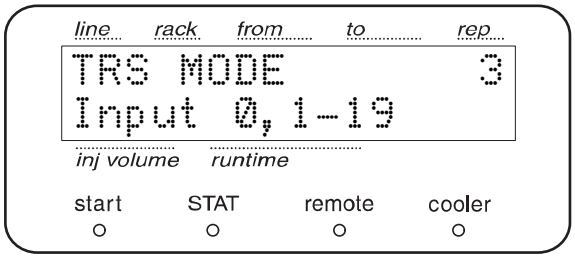


NOTE

Obtain the setting from your network administrator.
When using the DHCP function, [---] is displayed as the address setting.

■ Setting the Serial Communication [TRS MODE]

The current setting for serial communications is displayed in the first line.
Enter the set value by the numeric keypad and press **enter**.



Set value	Function
0	The communications setting is not changed (default value).
1	Cannot be used (reserved).
2	Connects with CLASS-VP.
3	Connects with LCsolution.
4-10	Not used (reserved).
11	Connects with C-R8A.
12	Connects with C-R7A/C-R5A.
13	Connects with C-R4A.
14	Connects with C-R6A (without extended ROM board).
15	Connects with C-R6A (with extended ROM board).
16-19	Not used (reserved).

5.6 Control by CBM-20A or CBM-20Alite System Controller

5.6.1 Preparation

To control the instrument by the CBM-20A or CBM-20Alite system controller, set the parameters as follows: Set [LOCAL] to [0: Remote], [OP MODE] to [0: 20A].

Command	Set Value	References
LOCAL	0: Remote	"[LOCAL]" P. 5-29
OP MODE	0: 20A	"[OP MODE]" P. 5-63

5.6.2 Basic Parameters

The basic setting conditions and the analysis sequence are set with the CBM-20A/20Alite's analysis sequence screen.
Refer to the CBM-20A/20Alite instruction manual for details.

5.7 Control by SCL-10Avp System Controller

5.7.1 Preparation

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

Command	Set Value	References
LOCAL	0 : Remote	"[LOCAL]" P. 5-29
OP MODE	1 : HT *1	"[OP MODE]" P. 5-63

*1 To connect to SCL-10Avp : the instrument is recognized as SIL-HTA/C.

5.7.2 Required Firmware and Hardware

- The SCL-10Avp's firmware must be at least version 6.03.
  Upgrade the firmware using the firmware upgrade kit.
- With old versions of the SCL-10Avp that do not have the [ROM INSTALLED] label attached on the right side, internal circuits (PCBs) must be changed.
  Upgrade the hardware using the hardware upgrade kit.

NOTE

The SIL-20A/20AC cannot be controlled from 10A-series system controllers (i.e., the SCL-10A or the CBM-10A).

5.7.3 Attention

When using a control vial rack, set the rack number in the following way.

- 1mL rack, 1.5mL standard rack, 1.5mL cooling rack, or 4mL rack:
  When performing sample injection from the control vial rack, set the rack number to [2].
- Microtiter-plate rack or deep-well microtiter-plate rack:
  When performing sample injection from the control vial rack, set the rack number to [3].
  When injecting from position 1 in the control vial rack, set [A01] or [01A], and when injecting from position 10, set [A10] or [10A].
  If the control vial rack's vial number is set to [11] or a higher number or [B01-H12], sample injection stops due to an error.

NOTE

- With SCL-10Avp, none of the VP functions, except [PRODUCT INFORMATION], can be used. Use the VP functions of the SIL-20A/20AC itself.
- To display system check reports on screen, execute the VP function [PRODUCT INFORMATION], and display the system check reports on the screen of the SCL-10Avp.
- The rack changer (optional) cannot be used with HT compatible mode.
  When using a rack changer, use CBM-20A/20Alite.
- When using a rinsing pump (optional), set the parameters with the SIL-20A/20AC's auxiliary functions.
- Display and setting of CBM-20A parameters is not possible.

"5.5.7 CBM Parameter Group" P. 5-69

6

Troubleshooting

Contents

6.1 Troubleshooting and Corrective Action

This section describes the probable causes of problems that can arise, and the corrective actions 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 disconnected.	• Connect plug correctly.	P.9-7
	Power cord internal wires are cut.	• Replace with a new cord of the same type.	P.9-7
	Power supply does not meet specifications for this instrument.	• Use power supply that meets specifications for this instrument.	P.9-6
	Fuse blown.	• Replace the fuse.	P.8-31
No peaks.	Mobile phase is not flowing.	• Check whether pump is functioning normally. Take corrective action as necessary.	∗1
	Insufficient amount of sample in vials.	• Add more sample to vials.	
	Injection program incorrect.	• If program is user-written, check and correct the contents.	P.4-7
	Sample path injection flow lines clogged.	• Inspect flow lines for clogging. Replace plumbing if clogs are found.	
	Column performance has deteriorated.	• Check column performance under known analysis conditions. If performance has deteriorated, replace column.	
	Detector is not functioning normally or is not connected.	• Check whether detector is functioning normally. Take corrective action as necessary.	∗1

∗1 Refer to the instruction manual for the relevant component.

Symptom	Probable Cause	Corrective Action	Page
Peak retention time fluctuates.	Pump flow rates unstable.	• Check whether pump is functioning normally. Take corrective action as necessary.	∗1
	Column temperature is fluctuating.	• Use a column oven.	∗1
	Column performance has deteriorated.	• Check whether column oven is functioning normally. Take corrective action as necessary. • Check column performance under known analysis conditions. If performance has deteriorated, replace column.	
	Composition of mobile phase varies.	• Replace mobile phase, and check composition of new mobile phase.	
	Room temperature fluctuating.	• Install the instrument in a room with minimal temperature variations.	
	There is clogging in the sampling needle or the plumbing.	• Clean the high-pressure valve by a reversing the flow direction. • Clean by reversing the flow direction. If the problem persists, replace the sampling needle or the plumbing.	P.8-34 P.8-29
Peak shapes are abnormal (peaks are broad, or tailing, etc.).	Column performance has deteriorated.	• Check column performance under known analysis conditions. If performance has deteriorated, replace column.	P.1-3
	Plumbing connections between pump and column were reversed.	• Reconfigure the plumbing.	P.9-12
	Dead volume exists between flow line connections.	• Check connections for dead volume. Reconfigure connections to eliminate dead volume.	P.9-8
	Flow lines leaking.	• See "In Case of Leaking" in this section.	P.6-5
	There is clogging in the sampling needle or the plumbing.	• Clean the flow lines by reversing the flow direction. • Clean the interior of the sampling needle with a mobile phase <NDLE FLUSH> • Clean by reversing the flow direction. If the problem persists, replace the sampling needle or the plumbing.	P.8-34 P.8-29
Ghost peaks appear.	No rinse solution.	• Check whether rinse solution is present.	
	[RINSE VOL] parameter is too low.	• Increase the [RINSE VOL] setting.	
	Previous mobile phase remains in injection port.	• Clean the flow lines.	
	Previous rinse solution remains in rinse flow lines.	• Clean the flow lines.	

∗1 Refer to the instruction manual for the relevant component.

Symptom	Probable Cause	Corrective Action	Page
Poor reproducibility.	Flow lines are not being rinsed sufficiently, or there is no rinse solution.	• [PURGE] or [RINSE] the flow lines. • Add rinse solution. • Operate [PUMP HEAD FLUSH]	
	Composition or flow rate of mobile phase varies	• Check pump and mobile phase.	∗1
	Needle seal is worn.	• Replace the needle seal.	P.8-4
	Flow lines leaking.	• See "In Case of Leaking" in this section.	P.6-5
	Room temperature is fluctuating.	• Install the instrument in a room with minimal temperature fluctuations.	
	Column performance has deteriorated.	• Check column performance under known analysis conditions. If performance has deteriorated, replace column.	
Baseline drifting.	Flow lines dirty.	• Thoroughly clean the instrument and detector flow lines.	
	Faulty detector.	• Check whether detector is functioning normally. Take corrective action as necessary.	∗1
	Room temperature is fluctuating.	• nstall the instrument in a room with minimal temperature fluctuations.	
	Flow rates fluctuate.	• Check whether pump is functioning normally. Take corrective action as necessary.	∗1
Large pressure fluctuation when high-pressure valve is switched.	High-pressure valve is clogged.	• Disassemble and clean high-pressure valve. • If disassembly and cleaning does not unclog the valve, replace the rotor and stator seal.	P.8-19
	High-pressure valve does not rotate to the correct positions.	• The message shown below is displayed. Contact your Shimadzu representative. <NO HPV HOME>	
	Flow rate (of the mobile phase) is too high.	• Replace the outlet tubing with a PEEK tubing of inner diameter 0.25 mm.	
	Flow lines clogged.	• Rinse the flow lines with reverse flow. • Check the flow lines and replace the tubing if any clogging is found.	P.8-34
Column inlet pressure is too high.	Column is clogged.	• Check column pressure. If column is clogged, replace it.	
	Flow lines clogged.	• Rinse the flow lines with reverse flow. • Inspect the flow line. Clean or Replace any clogged plumbing.	P.8-34

∗1 Refer to the instruction manual for the relevant component.

■ In Case of Leaking

Symptom	Probable Cause	Corrective Action	Page
High-pressure valve leaking.	Rotor and stator sealing ability has deteriorated.	• Replace the rotor seal, inspect the stator and replace it if necessary. ∗2	P.8-19
Low-pressure valve leaking.	Rotor and stator sealing ability has deteriorated.	• Inspect the rotor and stator and replace them if necessary. ∗2	P.8-15
Flow line connections leaking.	Male nuts are loose or stripped.	• Tighten male nuts. • If tightening does not stop the leak, replace the male nuts and ferrules.	P.9-9

∗2 The high-pressure valve stator and the Low-pressure valve stator are made of ceramic.
If there are no visible scratches, they do not need to be replaced.

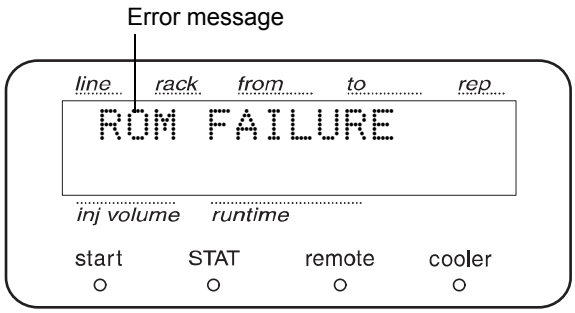
6.2 Error Messages

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.
The error message is not cleared by pressing CE.
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.
NO NEEDLE HOME X (Needle X motor slip error)	Fatal	Cause: Needle's X-axis (sideways) movement is incorrect. Action: Turn the power OFF and contact your Shimadzu representative.
NO NEEDLE HOME Y (Needle Y motor slip error)	Fatal	Cause: Needle's Y-axis (forward/backward) movement incorrect. Action: Turn the power OFF and contact your Shimadzu representative.
NO NEEDLE HOME Z (Needle Z motor slip error)	Fatal	Cause: Needle's Z-axis (up/down) movement incorrect. Action: Turn the power OFF and contact your Shimadzu representative.

Error Message	Type	Cause and Action
NO HPV HOME (HPV motor slip error)	Fatal	Cause: High-pressure valve's rotational position incorrect. Action: Turn the power OFF and contact your Shimadzu representative.
NO LPV HOME (LPV motor slip error)	Fatal	Cause: Low-pressure valve's rotational position incorrect positions. Action: Turn the power OFF and contact your Shimadzu representative.
NO PUMP HOME (Pump motor slip error)	Fatal	Cause: Measuring pump does not operate correctly. Action: Turn the power OFF and contact your Shimadzu representative.
ERR P.FILE (P.FILE error)	Alarm	Cause: Sample injection was performed incorrectly. Action: Perform re-analysis after correcting the error(s) of the rack type and/or vial No. of the sample to be injected.
NO VIAL DETECTED (Vial not detected error)	Alarm	Cause: No sample vial was placed in the rack position. Action: During an analysis sequence, the missing vial will be ignored and analysis will proceed using the next vial specified.
ERR LEAK DETECT (Leak detection error)	Alarm	Concentration of organic mobile phase vapor inside the instrument has exceeded the leak sensor actuation level. Cause: Organic mobile phase is leaking inside the instrument. Action: Stop the leak. Cause: Sensor is too sensitive. Action: Adjust the leak sensor actuation level. "[LEAK THR]" P. 5-60
NDLE PROTECTED (Foreign substance detection error)	Fatal	Cause: A foreign substance was detected at the tip of the needle. Action: Check for foreign substances inside the autosampler.
NO PUMP ADJUSTED (Pump motor fine adjustment error)	Fatal	Cause: Measuring pump does not operate correctly. Action: Turn the power OFF and contact your Shimadzu representative.
ERR SLIP X (Needle X slip error)	Fatal	Cause: Needle's X-axis (sideways) movement is incorrect. Action: Turn the power OFF and contact your Shimadzu representative.

Error Message	Type	Cause and Action
ERR SLIP Y (Needle Y slip error)	Fatal	Cause: Needle's Y-axis (forward/backward) movement is incorrect. Action: Turn the power OFF and contact your Shimadzu representative.
ERR COOLER (Cooler error)	Fatal	Cause: There is an error in the sample cooler's cooling unit. Action: Turn the power OFF and contact your Shimadzu representative.
ERR HEATER (Heater error)	Fatal	Cause: There is an error in the sample cooler's heating unit. Action: Turn the power OFF and contact your Shimadzu representative.
ERR TEMP SENSOR (Temperature sensor error)	Fatal	Cause: There is an error in the sample cooler's temperature sensor. Action: Turn the power OFF and contact your Shimadzu representative.
SYSTEM ERROR (System error)	Fatal	Cause: There is an error in the autosampler's internal circuits. Action: Turn the power OFF and contact your Shimadzu representative.
DOOR IS OPEN (Door open/close display)	Warning	Cause: The front door is open or panel F has been removed. Action: Close the front door or attach panel F.

7

Hardware Validation

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

Contents

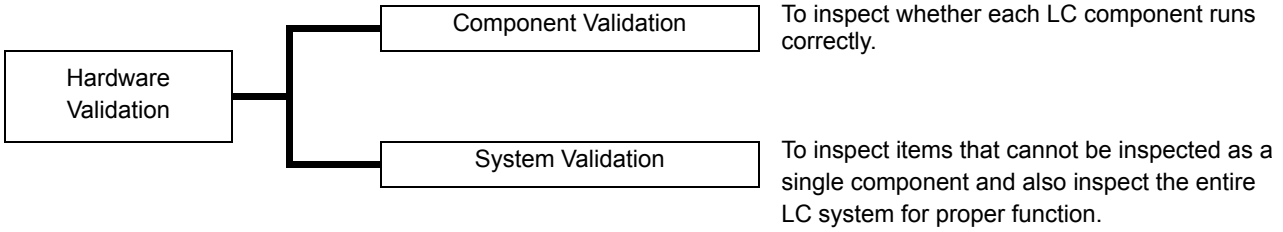
7.1 Overview of Hardware Validation

7.1.1 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 After Maintenance

After any maintenace, 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 Validation Precautions

7.3.1 Environment

Instrument performance may be affectd 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 SIL-20A is approx. 27kg and SIL-20AC approx. 30kg. 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 ±1.0°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 ±0.5°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 ±0.6°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 ±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" ±0.3sec 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.

■ 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: Autosampler

7.5.1 Check Terms

Check terms for the autosampler validation are listed below.

	Check Term	Description
7.5.2	ROM, RAM Self Diagnosis	Checks whether the memory (ROM, RAM) functions correctly.
7.5.3	Firmware Version Check	Checks the version of firmware.
7.5.4	Display, LED Test	Checks the operation of display and LEDs.
7.5.5	Movement and Position Sensor Check	Checks the movement and sensor parts of SIL-20A/20AC.
7.5.6	Injection Volume Accuracy Test	Checks the accuracy of injection volume.
7.5.7	Leak Sensor Test	Checks the operation of leak sensor.
7.5.8	Temperature Accuracy Test	Checks the accuracy of the set temperature of sample cooler. (Only for SIL-20AC)

7.5.2 ROM, RAM Self Diagnosis

■ Objective

To check whether the memory (ROM, RAM) functions correctly.

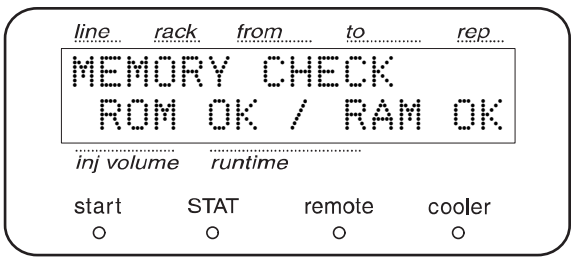
■ Check Procedure

1 Turn the power switch ON.

2 Press **VP**.
[VALIDATION] appears.

3 Press **func**.
[MEMORY CHECK] appears.

4 Press **enter**.
☞"[MEMORY CHECK]" P. 5-53



CHECK CRITERIA : [ROM OK / RAM OK] is displayed on the screen.

7.5.3 Firmware Version Check

■ Objective

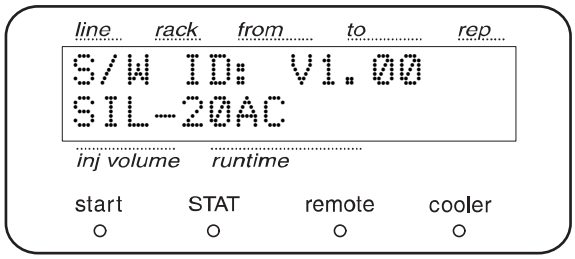
To check the version of firmware.

■ Check Procedure

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

2 Press **func**.
[S/W ID] appears.

☞ "Displaying the S/W Version Number [S/W ID]" P. 5-69



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

7.5.4 Display, LED Test

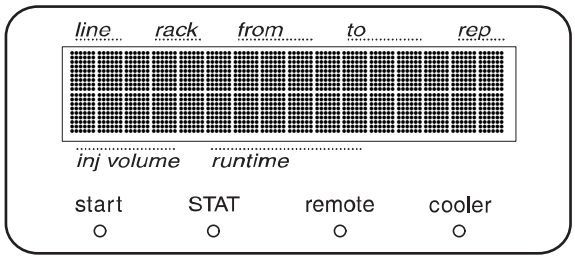
■ Objective

To check the operation of display and LEDs.

■ Check Procedure

1 Turn the power switch ON.

2 Check that all the dots on the screen and LEDs on the keypanel illuminate right after turning ON the power.



CHECK CRITERIA : All the dots and LEDs on the screen illuminate.

7.5.5 Movement and Position Sensor Check

■ Objective

To check the movement and sensor parts of SIL-20A/20AC.

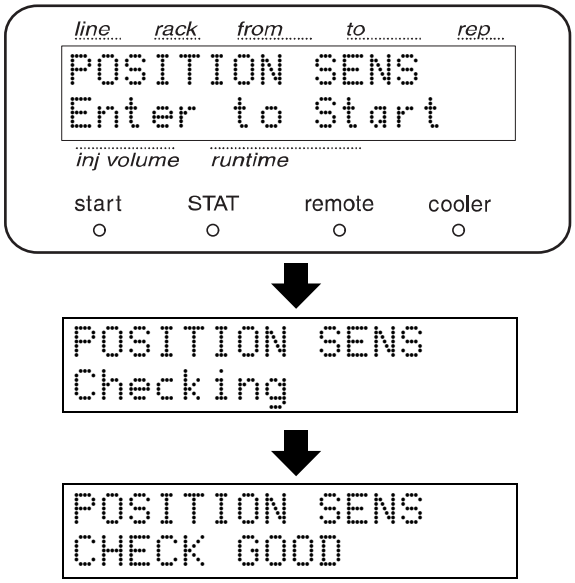
☞ "[POSITION SENS]" P. 5-53

■ Check Procedure

1 Press **VP**.
[VALIDATION] appears.

2 Press **func**.
[POSITION SENS] appears.

3 Press **enter**.



CHECK CRITERIA : [SENSOR GOOD] appears on the screen.

7.5.6 Injection Volume Accuracy Test

■ Objective

To check the accuracy of injection volume.

■ Check Procedure

1 Prepare the parts as follows.

a) Isocratic or gradient LC system
b) Mobile phase and cleaning liquid: Water
Note: Degas mobile phase and cleaning liquid by the degasser before using.
c) Column : Resistor tube (I.D.0.1mm × 4m)
d) Sample : Water
e) Balance : able to perform measurement with 0.001g precision and calibrated.

2 Install all the plumbing of the LC system as described in each instruction manual.

3 Connect the resistor tube between the autosampler and the inlet of the detector.

4 Clean the flow line with an appropriate solvent.

5 Replace the mobile phase and cleaning liquid with water to purge.

6 Set the flow rate to 1mL/min, and start pumping.

7 Verify that the mobile phase flows out from the detector outlet and that there are no leaks anywhere in the flow line.

8 Set the analysis condition as follows.

Injection volume	:	50µL
Number of injections	:	10 times
Run time	:	1min

9 Put 1mL of water into a vial. Measure the weight of the vial by a calibrated balance and make a note of it.

10 Set the vial in the sample rack and start analysis.

11 Measure the weight of the vial after analysis by a calibrated balance and make a note of it.

12 Measure the weight decrease of water in the vial between before and after analysis and calculate injection volume at one time.

Injection volume accuracy can be calculated as follows.

(How to calculate)

> Injection volume accuracy (%) =
> (Measured injection volume / (Set injection volume×Number of injection) -1) ×100
>
> Measured injection volume:
> Total volume actually injected during the set number of injection operations.

CHECK CRITERIA : Injection volume accuracy is within ± 5.0%.
If the check criteria is not passed, refer to "[ASP FACTOR]" P. 5-58 to calibrate.

7.5.7 Leak Sensor Test

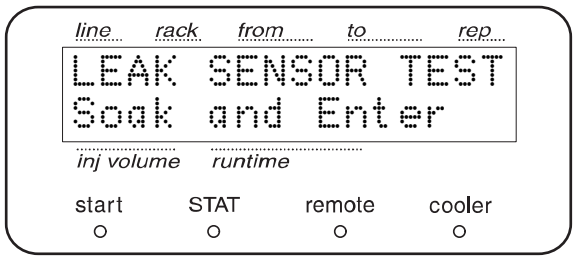
■ Objective

To check the operation of leak sensor.

■ Check Procedure

1 Press **VP** on the initial screen.
[VALIDATION] appears.

2 Press **func**.
[LEAK SENSOR TEST] appears.
☞ "[LEAK SENSOR TEST]" P. 5-54

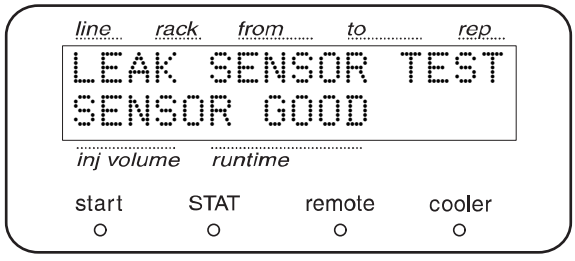


3 Use a syringe filled with water to wet the thermosensor at the bottom of the leak sensor.

NOTE

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

4 In about 10 seconds, press **enter** to display the test result.



CHECK CRITERIA : [SENSOR GOOD] appears on the screen.

7.5.8 Temperature Accuracy Test

■ Objective

Obtain the difference between the set temperature and actual temperature. (Only for SIL-20A)

■ Check Procedure

1 Put the below specified volume of water into selected vial, and put a cap and a septum on it. Set the vial at the below specified place.

Vial capacity	:	Vial of 1.5mL
Water capacity	:	1mL
Specified place	:	32

2 Attach the cooling rack to the main body of SIL-20AC. Insert the calibrated temperature sensor into the in step1. set vial. The sensor must penerate the septum and its tip touches the bottom of vial.
When carrying on the operation above, be careful not to bend the tip of the temperature sensor. Also be careful of pulling sensor cable to prevent the sensor from coming off during temperature measurement.

3 Set the set temperature of sample cooler as 10°C, and start cooling. Keep the front door closed.

4 Read the thermometer and make a note of the temperature after more than 30 minutes from the start of cooling. Calibrate the actual temperature depending on the result of temperature measurement deviation from the temperature sensor's inspection sheet and make a note of the temperature after calibrating.

CHECK CRITERIA
As follows, provided that room temperature is less than 30°C, and humidity less than 60%.
Set temperature accuracy : Set temperature ±3.0°C
(When using microtiter plate, Set temperature ±6.0°C)

<Footnote>

The procedure of calculating the calibration (temperature measurement deviation) is as follows.

If the calculated calibration value is to be A3,

$$A3 = \frac{A2-A1}{T2-T1} \times (T3 - T1) + A1$$

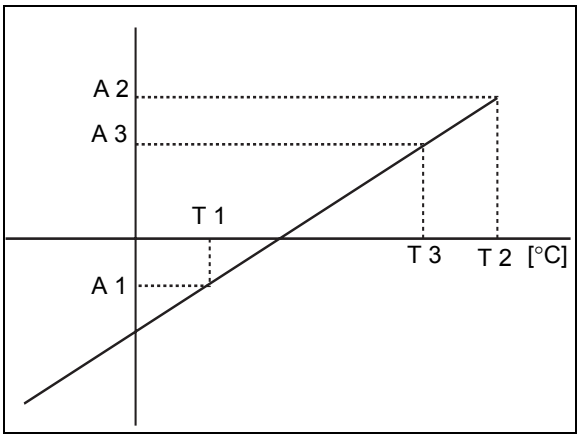


Fig. 7.1

* If the judgement that the calibration value at every interval is linear, use the formula above to calculate the calibration value for this interval. The calibration value here means the deviation [°C] from the JIS table in the inspection sheet for thermocouple or resistance tube.

7.5.9 If Check Criteria Is Not Passed

If the result of the "7.5.1 Check Terms" P. 7-7 cannot pass the check criteria, take the following measures.

■ Check the Service Life of Comsumables

Check for wear in the following parts, and replace them if necessary.

Part Name	Page
Needle seal	"8.2 Replacement of Needle Seal" P. 8-4
High-pressure valve's rotor, stator	"8.6 Replacement and Inspection of the High-Pressure Valve Rotor and Stator" P. 8-19
Low-pressure valve's rotor, stator	"8.5 Replacement and Inspection of the Low-Pressure Valve Rotor and Stator" P. 8-15

■ Check the Flow Lines

- Ensure that the instrument has not been placed directly under a heating or air conditioning vent. The room temperature should fluctuate little. If the instrument is in the condition above, move the instrument.
- Replace an old vial septum with new ones. An old septum can cause cross contamination.
- Ensure that there are no leaks at plumbing connections.
  If there are any leaks, implement appropriate measures for it.
- Ensure that the pressure difference is minimal when the high-pressure valve rotates.
  If not, the needle or plumbing may be clogged. Reverse the flow to clean, or replace it.

■ Check Other Components

- Check the pump.
  A faulty pump can cause wide variations in the peak retention times.
- Check the detector.
  Check for detector abnormalities by looking at the noise and drift level, light source intensity, and the wavelength value.

If the check criteria is not passed after checking terms above, or if troubleshooting or corrective action procedures are unclear, contact your Shimadzu representative.

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 detector integrator terminals.

* 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.

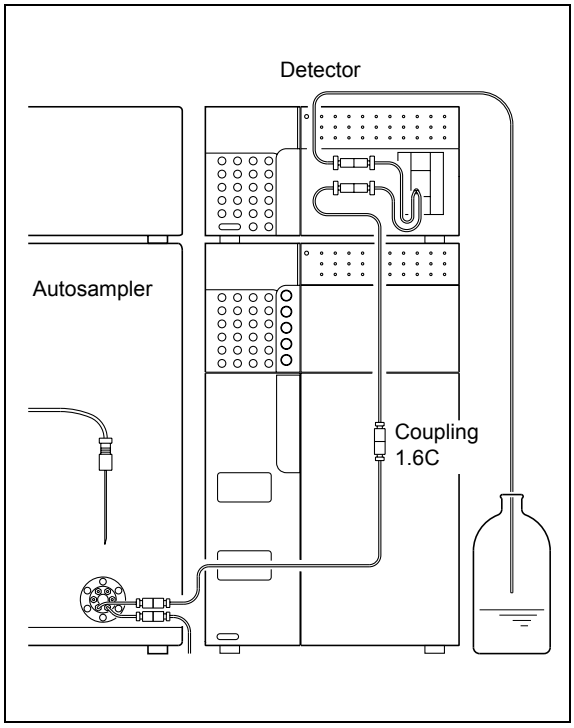


Fig. 7.2

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. 7.2").

< 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.

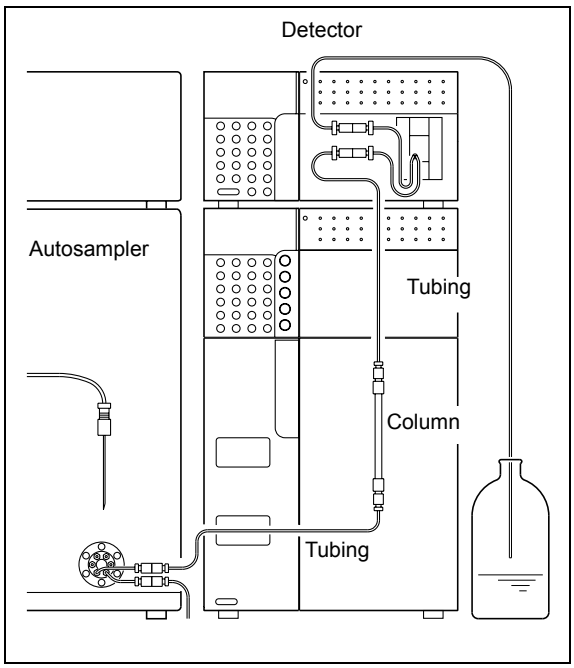


Fig. 7.3

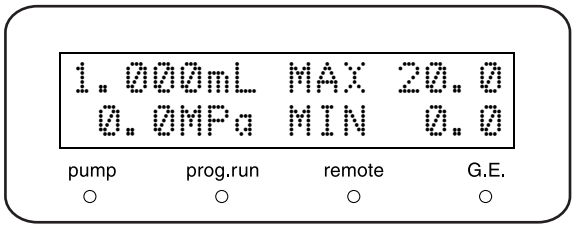
<For a system that has been using a mixture of a water solution and an organic solvent as mobile phase, or water plus an organic solvent miscible with water (methanol, acetonitrile, etc.)>
Clean the flow lines with water. Pass water through the flow lines for 10 minutes, at a rate of 2mL/min.

4 When cleaning is finished, pour mobile phase (mixture of water and methanol (3/2, (v/v)) into the reservoir, and reconnect the column with the LC system ("Fig. 7.3").

■ Validation Procedure

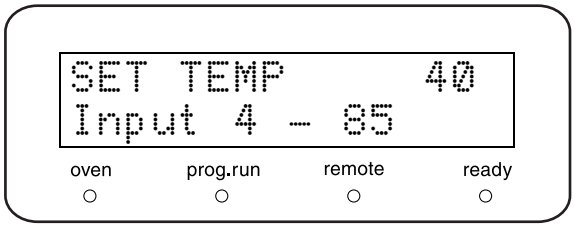
1 Set the pumping flow rate to 1mL/min.
See the pump's instruction manual for setting procedures.

Pump display screen



2 Set the column oven temperature to 40°C.
See the column oven's instruction manual for setting procedures.

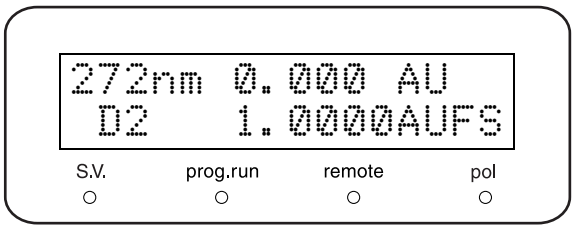
Column oven's display screen



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.

4 Set the detector parameters.
☞ "Parameter Settings for Isocratic System Validation" P. 7-18
See the detector's instruction manual for setting procedures.

Detector display screen



5 Set the autosampler parameters.
☞ "Parameter Settings for Isocratic System Validation" P. 7-18
See the autosampler's instruction manual for setting procedures.

6 Set the data processor parameters.
☞ "Parameter Settings for Isocratic System Validation" P. 7-18
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 10µL of mobile phase, and verify that no peaks are observed.

8 Inject 10µL 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. 7.4").

$$RSD(C.V.)=(SD/\overline{X}) \times 100$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(Xi-\overline{X})^2}{n-1}}$$

$\overline{X} = (X1 + X2 \bullet\bullet\bullet\bullet Xn - 1 + Xn)/n$

n	: Number of analyses
$X1 \bullet\bullet Xn$	: Retention time (or areas) of each peak
$\overline{X}$	: Average
SD	: Standard deviation
RSD	: Relative standard deviation
$C.V.$	: Coefficient of variation

Fig. 7.4

■ 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	: 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%.

7.6.2 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 detector integrator terminals.

∗ If the system normally uses Chromatopac or LC workstation, the connections used for regular analysis will be satisfactory.

2 Check the LC system plumbing.
In particular, ensure that the tubing between (a) the autosampler plumbing outlet and the column inlet, and (b) the column outlet and the detector inlet, has an I.D. of thinner than 0.3mm, and is shorter than 300mm. keep the liquid volume that is not in the column as low as possible.

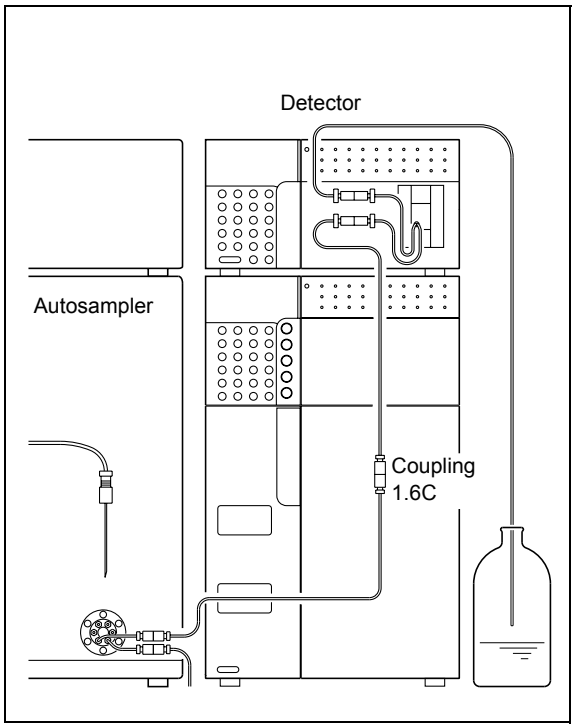


Fig. 7.5

3 Clean the system flow lines. There are different cleaning cases as described below.Before cleaning the flow lines, be sure to remove the column from the system, and connect the column inlet and outlet with a coupling 1.6C ("Fig. 7.5").

< 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.

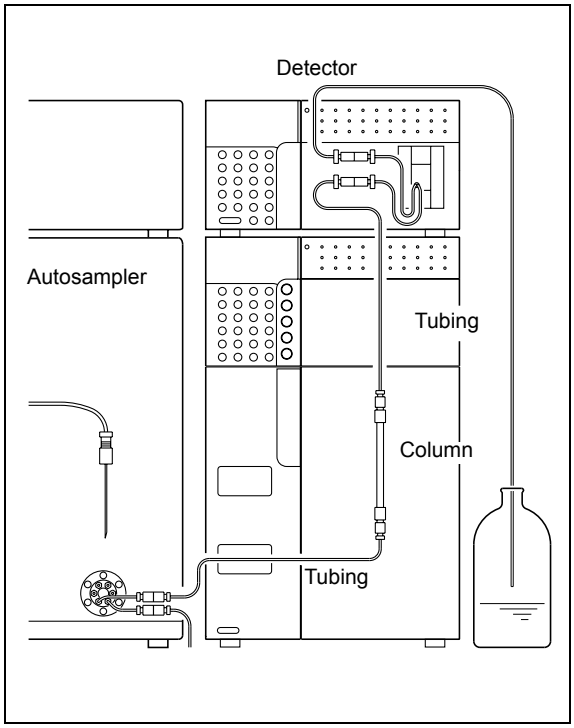


Fig. 7.6

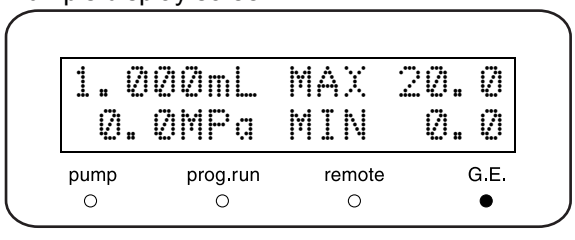
< For a system that has been using a mixture of a water solution and an organic solvent as mobile phase, or water plus an organic solvent miscible with water (methanol, acetonitrile, etc.) >
Clean the flow lines with water. Pass water through the flow lines for 10 minutes, at a rate of 2mL/min.

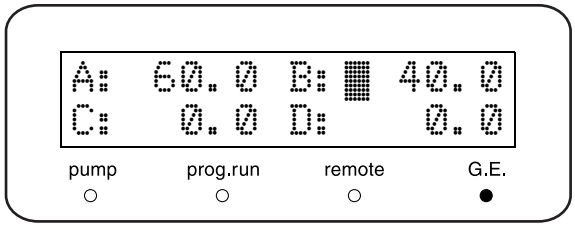
4 When cleaning is finished, pour mobile phase (A: water, B: methanol) into the reservoir, and reconnect the column with the LC system ("Fig. 7.6").

■ 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.

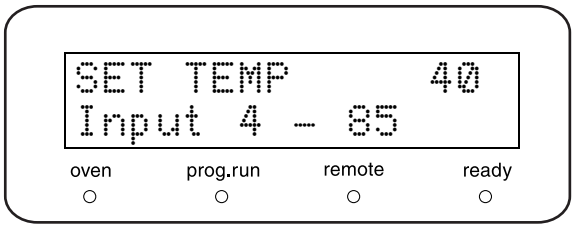
Pump's display screen





2 Set the column oven temperature to 40°C.
See the column oven's instruction manual for setting procedures.

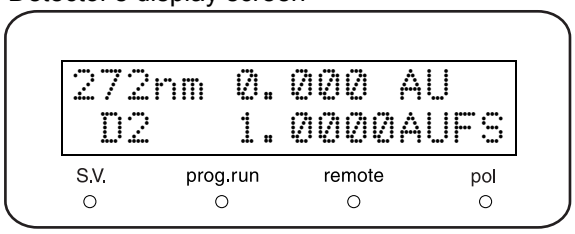
Column oven's display screen



3 Press **pump** on the pump 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. 7-22
See the detector's instruction manual for setting procedures.

Detector's display screen



5 Set the autosampler parameters.
☞ "Parameter Settings for Gradient System Validation" P. 7-22
See the autosampler's instruction manual for setting procedures.

6 Set the data processor parameters.
☞ "Parameter Settings for Gradient System Validation" P. 7-22
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 10µL of mobile phase and verify that no peaks are observed the second time.

8 Inject 10µL 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. 7.7").

$$RSD(C.V.)=(SD/\overline{X}) \times 100$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(Xi-\overline{X})^2}{n-1}}$$

$\overline{X} = (X1 + X2 \bullet\bullet\bullet\bullet Xn - 1 + Xn)/n$

n	: Number of analyses
$X1 \bullet\bullet Xn$	: Retention time (or areas) of each peak
$\overline{X}$	: Average
SD	: Standard deviation
RSD	: Relative standard deviation
$C.V.$	: Coefficient of variation

Fig. 7.7

■ 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.

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8

Maintenance

Contents

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 inspection and maintenance. Otherwise, fire, electric shock or malfunction may occur.

⚠ CAUTION

- When replacing parts, use only the parts listed in "1.4 Component Parts" and "9.5 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 not guarantee periods, but are presented only as guidelines. These will vary depending on usage conditions.

Inspection/Maintenance Item	1 year	2 years	3 years	6 years	Remark	Page
Replacement of needle seal		×			Replace after approximately 40,000 injections.	P.8-4
Replacement of plunger seal		×				P.8-7
Replacement of measuring pump plunger		×				P.8-12
Replacement of low-pressure valve rotor	×				Replace after approximately 60,000 injections.	P.8-15

Inspection/Maintenance Item	1 year	2 years	3 years	6 years	Remark	Page
Replacement of low-pressure valve stator				×		P.8-15
Replacement of high-pressure valve rotor			×		Replace after approximately 100,000 injections.	P.8-19
Replacement of high-pressure valve stator				×		P.8-19
Replacement of sample loop		×			Replace after approximately 40,000 injections.	P.8-24
Cleaning and inspection (replacement) of solvent filter	×				Rinsed particulates in mobile phase clog the filter in prolonged use.	P.8-27
Needle replacement		×			Replace after approximately 40,000 injections.	P.8-29
Fuse replacement			×			P.8-31
Replacement of panel (SIL-20AC only)					Replace if there is excessive condensation at the sample cooler.	P.8-32
Lubricating oil		×			Applied to all driving units. (Ask your Shimadzu representative to perform replacement.)	
Rinsing pump				×	Replace after 6 years (approx. 700,000 seconds).	

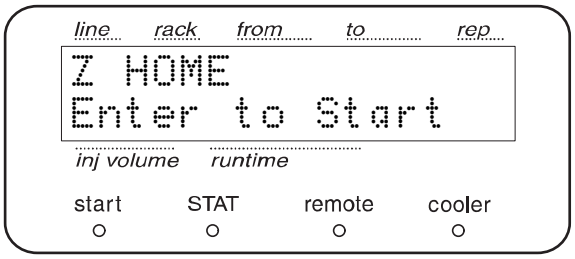
8.2 Replacement of Needle Seal

Necessary parts

Part	Part No.
Needle seal PEEK	228-42325-01

8.2.1 Removing the Needle Seal

1 From the control setting screen, press **func** until the [Z HOME] screen on the right is displayed.



2 Press **enter**.
The needle rises to the highest position and then moves to the center of the autosampler.

3 Turn OFF the instrument.

4 Open the door, and remove the sample racks.

5 Loosen the screws and then slide the panel F a little to the right before pulling it forward to remove it.

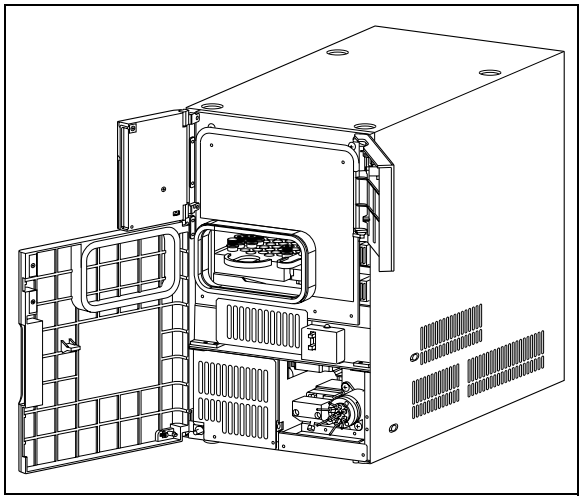


Fig. 8.1

6 Remove all of the high-pressure valve's plumbing.

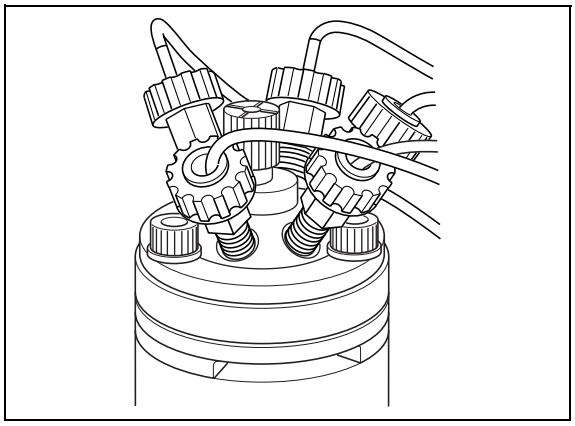


Fig. 8.2

7 Loosen the needle seal by hand and remove it.

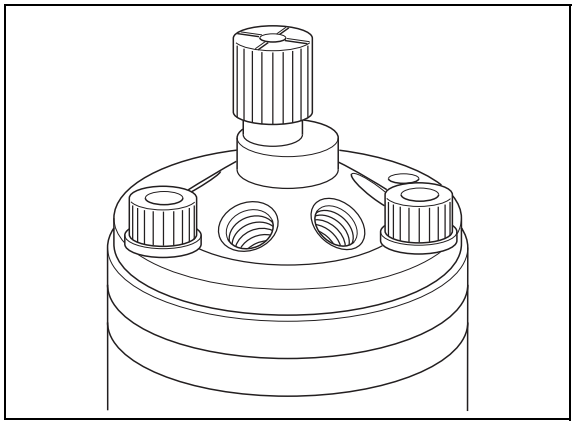


Fig. 8.3

8.2.2 Attaching the Needle Seal

1 Insert the new needle seal into the high-pressure valve and tighten it by hand so that it is fixed. Reattach the plumbing removed in step 6 of "8.2.1 Removing the Needle Seal" P. 8-4.

⚠CAUTION

Do not use a spanner or some other tool to attach the needle seal. Doing so may damage the seal.

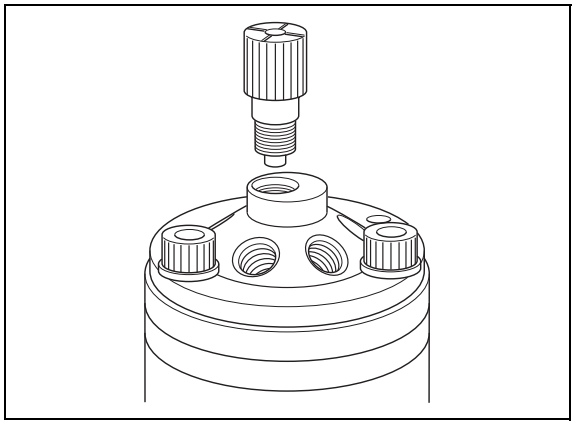


Fig. 8.4

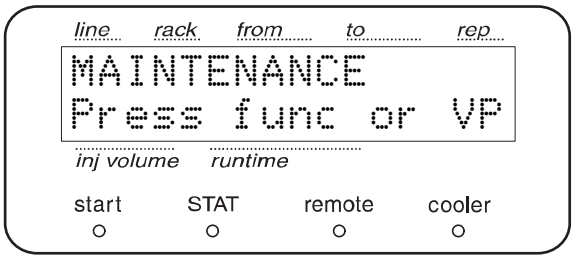
NOTE

Make sure that the plumbing does not interfere with the Z mount.

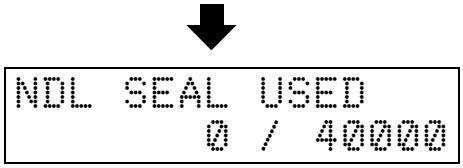
2 Return the plumbing to its original state and reattach the panel so that the autosampler is hermetically sealed.

3 Turn ON the instrument.

4 From the initial screen, press **VP** twice.
The maintenance information group screen is displayed.



5 Press **func**.
The needle seal's usage frequency and replacement alert value are displayed.



6 Press **0** and **enter**.
Reset the counter to [0].

> **⚠ CAUTION**
>
> If the panel F has not been reattached properly, condensation may occur in the sample cooler.

7 Close the door.

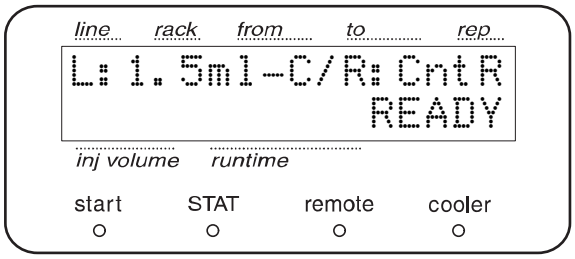
8.3 Replacement of Plunger Seal

Necessary parts

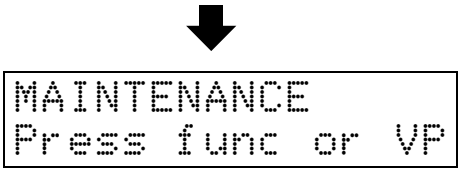
Part	Part No.
Plunger seal	228-35145

8.3.1 Before Removing Pump Head

1 Press (CE) until the initial screen appears.

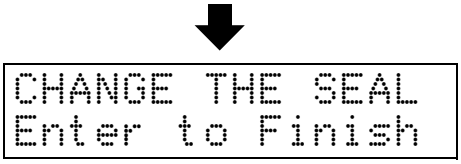


2 Press (VP) repeatedly until the Maintenance Information screen on the right is displayed.



3 Press (func) repeatedly until the [P-SET] screen on the right is displayed.

4 Press (enter).
The plunger will be fully retracted.



8.3.2 Removing the Pump Head

1 Open the door.

2 Using the wrench provided, loosen and remove the flow line male nuts at the top and bottom of the pump head.

3 Using the Allen wrench provided, loosen the two hex socket head bolt in the pump head, and remove the pump head.

4 Ease the pump head out gently, keeping it aligned with the plunger at all times.

⚠ CAUTION

If the pump head is pulled out forcefully, the plunger could be bent.

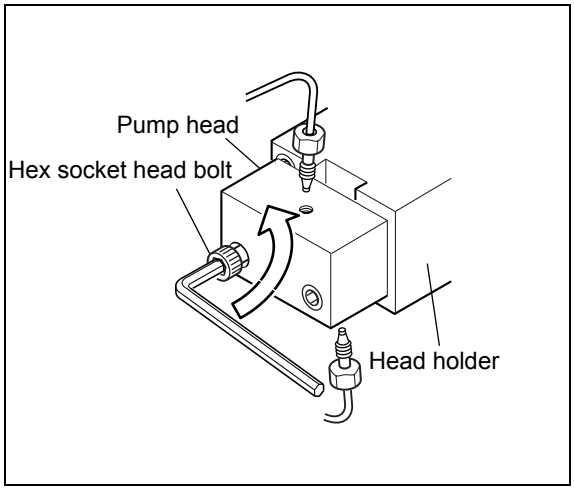


Fig. 8.5

8.3.3 Replacing the Measuring Pump Seal

1 Remove the seal holder gently to prevent damage to the plunger.

2 Using the seal installer/remover tool, remove the measuring pump seal attached on the inside of the seal holder.

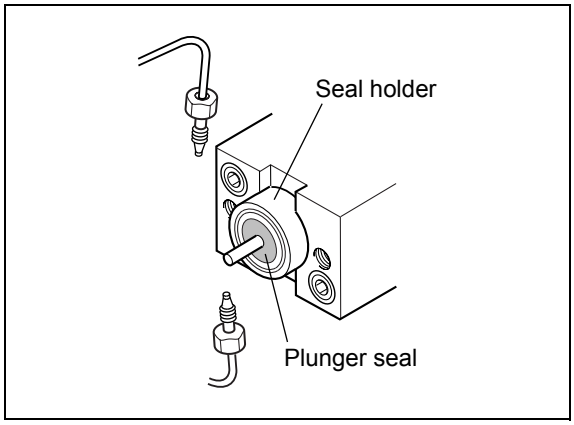


Fig. 8.6

3 Insert the flanged end of the seal installer/remover tool into the seal.

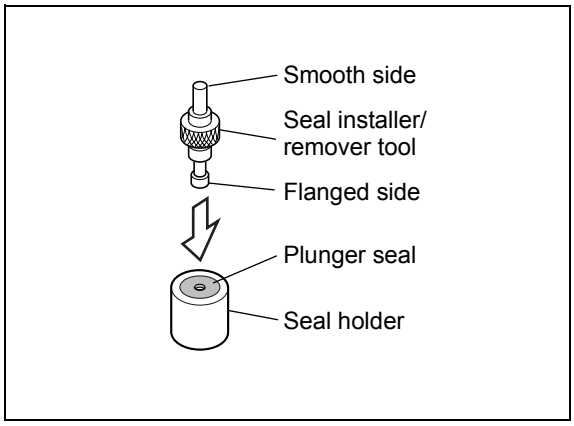


Fig. 8.7

4 Pull out the tool to remove the used seal.
The measuring pump seal is removed from the seal holder.

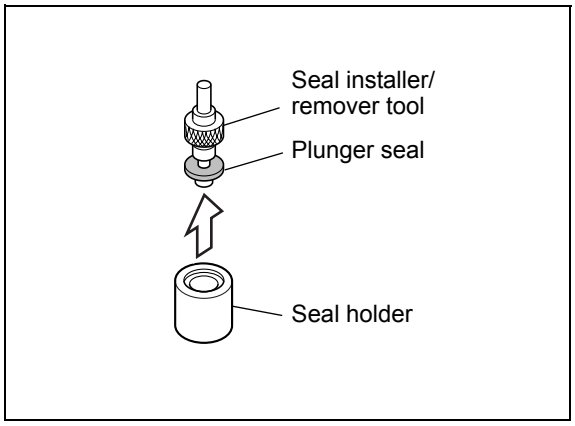


Fig. 8.8

5 Remove any contamination present on the pump head and measuring pump head.
Cleaning the Measuring Pump Head Wipe the inside of the pump head and seal holder with a clean piece of gauze soaked in 2-propanol.

> **⚠ CAUTION**
>
> If any material remains on these surfaces, the plunger cannot maintain a seal.

6 Place the new seal on the straight end of the installer/remover.

7 Lower the seal into the seal holder, then remove the seal installer/remover tool.

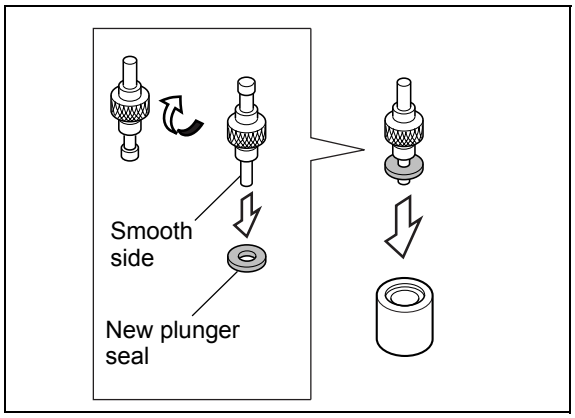


Fig. 8.9

8.3.4 Installing the Pump Head

1 Ease the pump head in gently, keeping it aligned with the plunger at all times.

> **⚠ CAUTION**
>
> If the pump head is pushed in forcefully, the plunger could be bent.

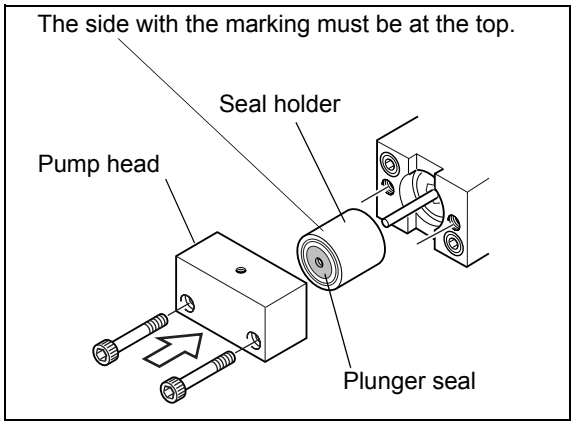


Fig. 8.10

2 Place the two hex socket head bolts into the holes in the pump head, and screw them in alternately and uniformly with provided Allen wrench.

NOTE

Screw the bolts in alternately 90°. At the end, tighten the bolts securely with the Allen wrench.

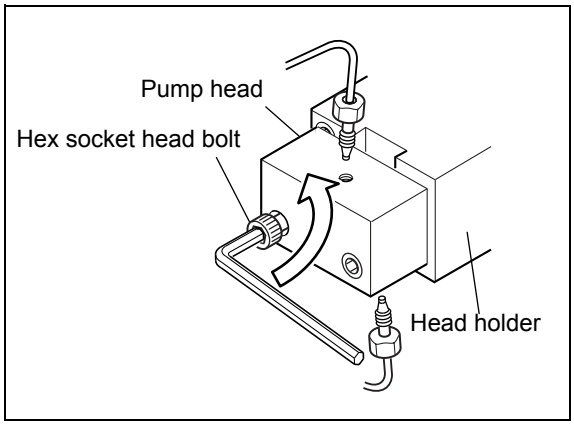


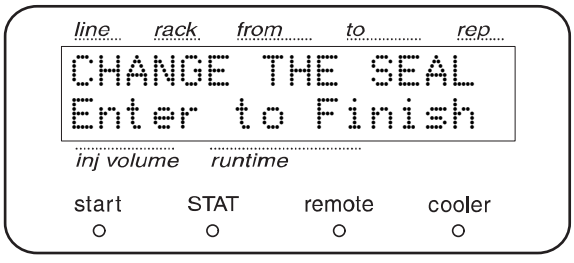
Fig. 8.11

3 Reconnect the tubing to the top and bottom of the pump head, and tighten the nuts.

4 Close the doors.

5 Press (**enter**).
Return the plunger to the original position.

6 Press (**purge**).
Start purging of the flow lines.



8.3.5 Check after Replacement

After replacing a plunger seal, check the following:

- There is no leakage from the gap between the pump head and the head holder.
- There is no leakage from the rinse flow line.

NOTE

When not even after replacement of the plunger seals, the surfaces of the plunger may be scratched or nicked, in which case the plunger must be replaced.

☞"8.4 Replacement and Inspection of the Measuring Pump Plunger" P. 8-12

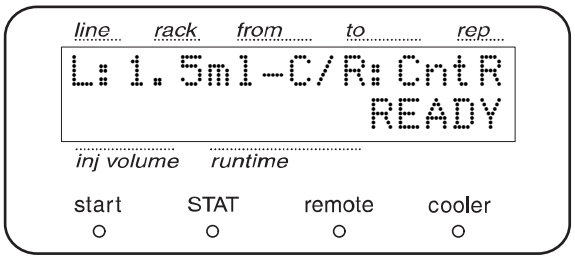
8.4 Replacement and Inspection of the Measuring Pump Plunger

Necessary parts

Part	Part No.
Measuring pump plunger Assembly	228-35010-91

8.4.1 Before Removing the Measuring Pump Plunger

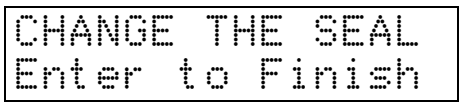
1 Press **CE** repeatedly to display the initial screen.



2 Press **VP** repeatedly to display the Maintenance Information screen on the right.

3 Press **func** repeatedly to display the [P-SET] screen on the right.

4 Press **enter**.
The plunger will be fully retracted.



8.4.2 Replacing the Measuring Pump Plunger

1 Open the door.

2 Using the Allen wrench provided, loosen and remove the flow line male nuts at the top and bottom of the pump head.

3 Using the Allen wrench provided, loosen the two hex socket head bolts in the pump head.

4 Ease the pump head out gently, keeping it aligned with the plunger at all times.

⚠ CAUTION

If the pump head is pushed out forcefully, the plunger could be bent.

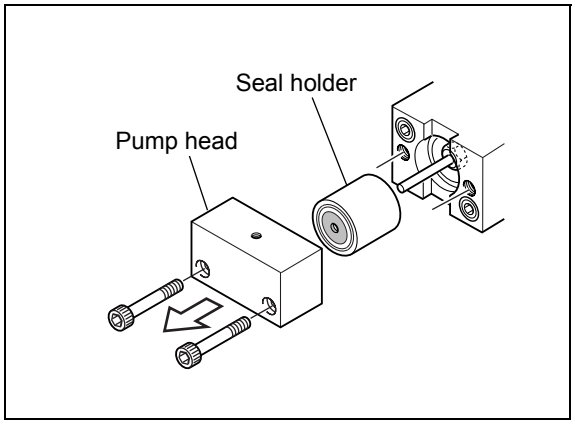


Fig. 8.12

5 Using the plunger tool (Part No. 228-34672-02), rotate the plunger holder counterclockwise and remove it.

⚠ CAUTION

When sliding the plunger tool onto the plunger holder, be careful not to damage the plunger.

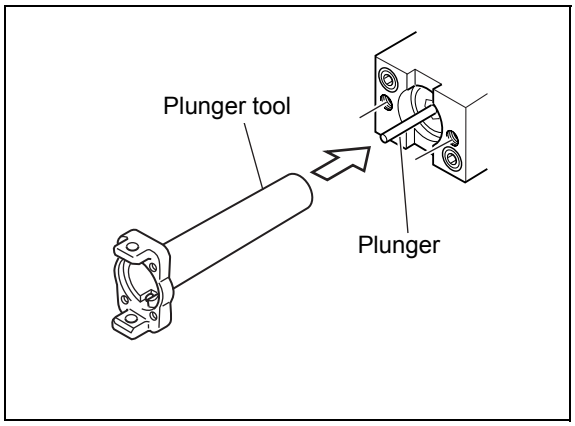


Fig. 8.13

6 Inspect the plunger for visible nicks or scratches.
- Replace the plunger assembly if it is damaged.
- If it is not damaged but there is contamination present, remove the contamination. Wipe the inside of the pump head and seal holder with a clean piece of gauze soaked in 2-propanol.

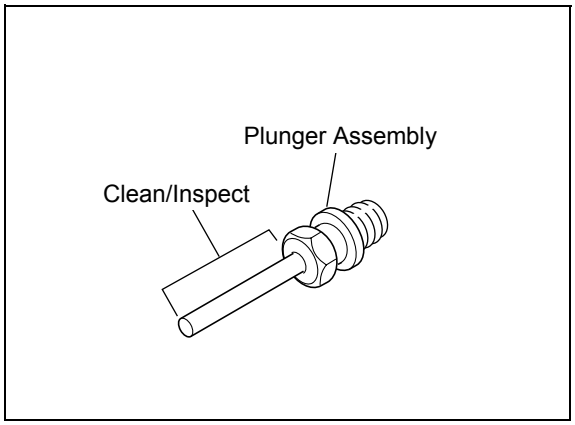


Fig. 8.14

⚠ CAUTION

The measurement accuracy may be reduced if there is any seal residue or other matter on the plunger.

8.4.3 Installing the Measuring Pump Plunger

1 Hold the plunger assembly between the thumb and fingers, and hand-tighten it into the pump body.

2 Use the plunger tool to thoroughly tighten theplunger assembly.

3 Ease the pump head in gently, keeping it aligned with the plunger at all times.

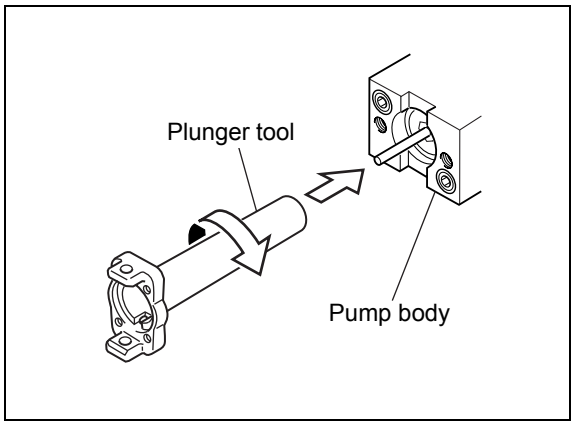


Fig. 8.15

⚠CAUTION

If the pump head is pushed in forcefully, the plunger could be bent.

4 Place the two hex socket head bolts into the holes in the pump head, and screw them in alternately and uniformly with provided Allen wrench.

NOTE

Screw the bolts in alternately 90°. At the end, tighten the bolts securely with the Allen wrench.

5 Reconnect the tubing to the top and bottom of the pump head, and tighten the nuts.

6 Close the doors.

7 Perform all tubing connection.

8 Return the plunger to the original position by pressing (enter) .

9 Press (purge) to start purging of the flow lines.

8.4.4 Check after Replacement

After replacing the measuring pump plunger seal, check the following:

- There is no leakage from the gap between the pump head and the head holder.
- There is no leakage from the rinse flow line.

8.5 Replacement and Inspection of the Low-Pressure Valve Rotor and Stator

⚠ CAUTION

If liquid is leaked from the low-pressure valve, first check that the rotor is not damaged in the way described in steps 1 to 6. If there is no damage, carefully wipe the rotating and sliding surfaces of the rotor and stator with a clean piece of gauze soaked in 2-propanol. Dirt or dust on the sliding surfaces may adversely affect the sealing and cause liquid to be leaked. If liquid leakage persists, replace the rotor and stator.

Necessary parts

Part	Part No.
Low-pressure valve rotor	228-36923
Stator 5PV	228-36917-01

8.5.1 Removing the Low-Pressure Valve Rotor and Stator

1 Turn the power switch OFF and open the door.

2 Lower the rinse solution container to a position lower than the low-pressure valve.

3 Using a wrench, loosen and remove all of the flow line male nuts from the housing.

4 Loosen and remove the three hex socket head bolts with the M4 Allen wrench.

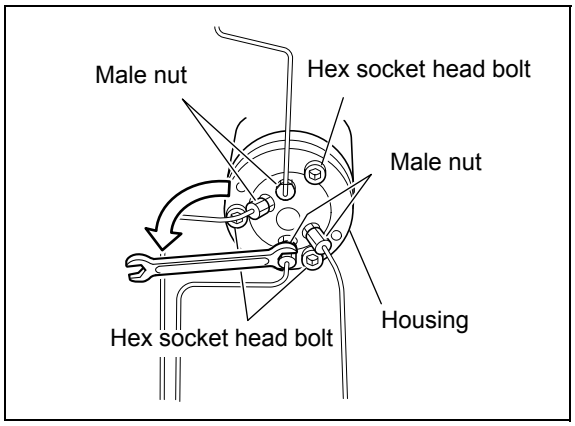


Fig. 8.16

5 Remove the stator, ring and housing. As they are not connected, be careful not to drop any of the pieces when lifting them from the instrument.

NOTE

Remove the ring and housing slowly to prevent the stator from dropping out of the housing.

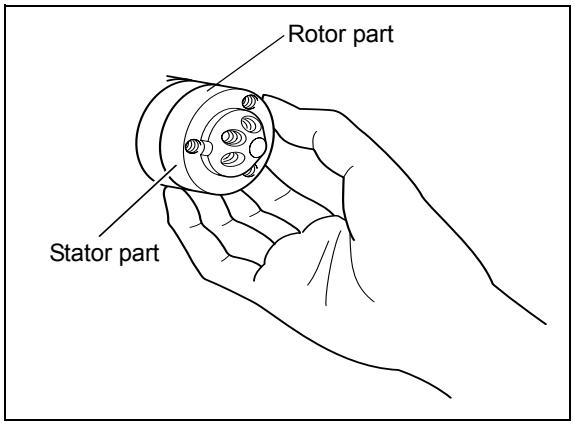


Fig. 8.17

6 Grip the rotor securely, and pull it out of the instrument.

NOTE

When handling the rotor, try to only touch the outer circumference. When returning the rotor to the instrument, wipe all sliding contact surfaces with isopropanol.

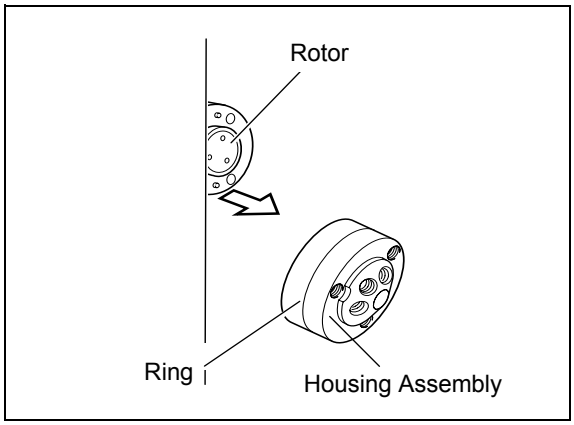


Fig. 8.18

7 Inspect the rotor and stator for visible nicks or scratches. If the rotor or stator is damaged, replace the parts.

8 Place the rotor, stator and housing in 2-propanol, and sonicate them for five minutes.

8.5.2 Installing the Low-Pressure Valve and Stator

1 Align the notch in the rotor with the mark on the shaft, and push the rotor all the way back onto the shaft.

NOTE

When handling the rotor, try to only touch the outer circumference. When returning the rotor to the instrument, wipe all sliding contact surfaces with isopropanol.

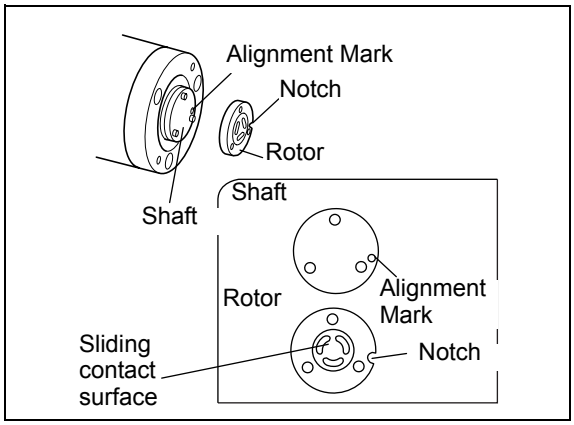


Fig. 8.19

2 Reassemble the housing in the order indicated in the figure to the right.

NOTE

Assembling the Stator, Packing and Housing
With the protrusion of the stator facing the ring, assemble the stator, packing and housing to that the holes are aligned.

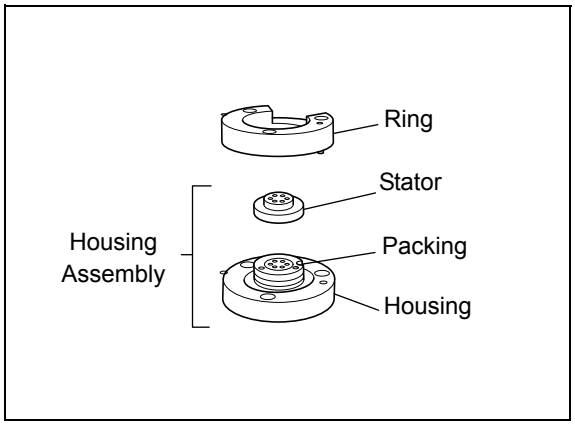


Fig. 8.20

3 With the stator facing out of the instrument, insert the ring and housing into the body. Be careful not to drop the stator.

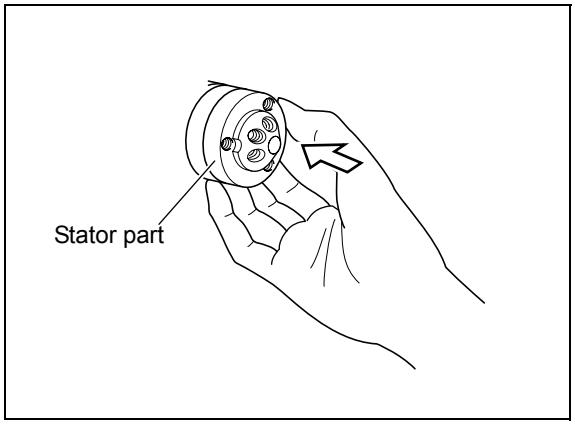


Fig. 8.21

4 Screw the three hex socket head bolts into the housing, tightening them gradually with the Allen wrench provided.

NOTE

Alternately tighten three hex socket head bolts 90° at a time. Ensure that the hex socket head bolts are secured firmly. Use the long end of the Allen wrench as a handle to tighten them securely.

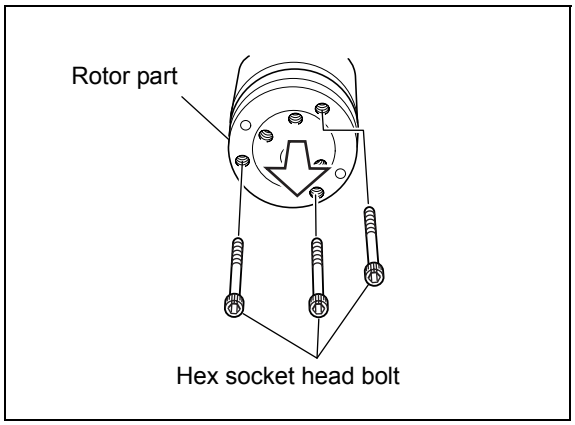


Fig. 8.22

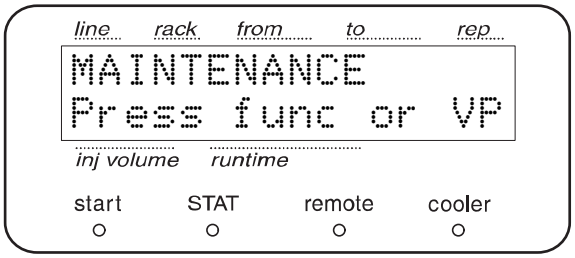
5 Reconnect the flow line tubing that was disconnected in step number 3.

6 Close the door.

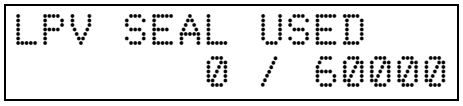
8.5.3 Resetting the Usage Frequency

1 Reset the low-pressure valve rotor counter.

2 Turn the power ON and press (VP) repeatedly until the Maintenance Information screen on the right is displayed in the initial screen.



3 Press (func) repeatedly until the [LPV SEAL USED] screen on the right is displayed.
The usage frequency and replacement alert value of the low-pressure valve's rotor seal are displayed on the screen.



4 Press (0) and (enter).
Reset the counter to [0].

5 Press (CE) to return to the initial screen.

6 Press (purge) to start purging of the flow lines.

8.6 Replacement and Inspection of the High-Pressure Valve Rotor and Stator

⚠CAUTION

If liquid has leaked from the high-pressure valve, first check that the rotor is not damaged as described in steps 1 to 6. If there is no damage, carefully wipe the rotating and sliding surfaces of the rotor and stator with a clean piece of gauze soaked in 2-propanol. Dirt or dust on the sliding surfaces may adversely affect the sealing and cause liquid to be leaked. If liquid leakage persists, replace the rotor and stator.

Necessary Parts

Part	Part No.
High pressure valve rotor	228-41310-92
Stator HPV Assembly	228-45408-91

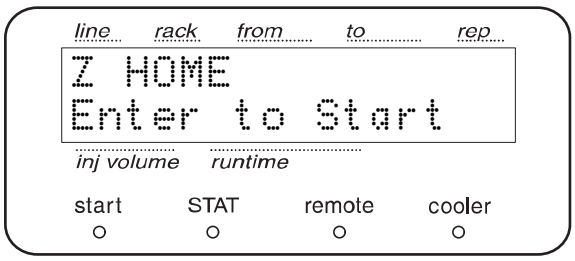
8.6.1 Before Removing the High-Pressure Valve Rotor and Stator

1 From the control setting screen, press (enter) and press (func) repeatedly until the [Z HOME] screen is displayed.

2 Press (enter).
The needle rises to the highest position and then moves to the center of the autosampler.

3 Turn the power switch OFF, and unplug the instrument.

4 Open the front door and the panels on the right and left, and remove panel F.
Remove the tubings from the high-pressure valve ports.



8.6.2 Removing the High-Pressure Valve Rotor and Stator

1 Using a wrench, loosen and remove all of the flow line male nuts from the housing.

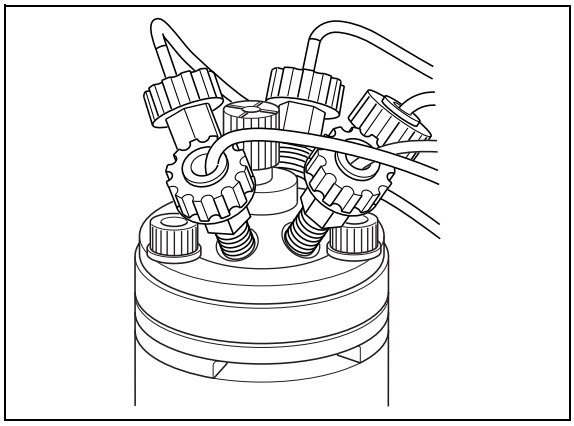


Fig. 8.23

2 Loosen and remove the three hex socket head bolts with the M4 Allen wrench.

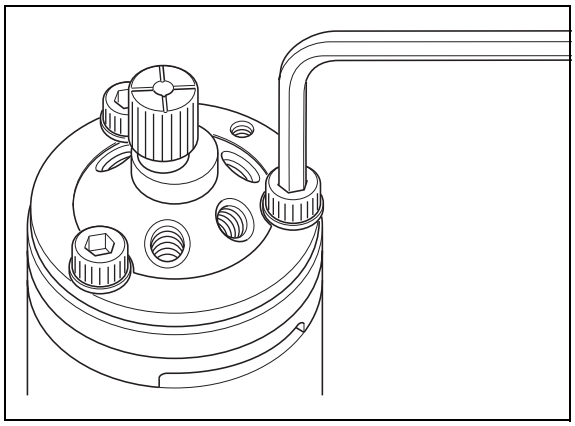


Fig. 8.24

3 The high-pressure valve stator is composed of ceramic and PEEK housings. Grasp the PEEK housing, and remove the ring and housing.

NOTE

The stator can easily fall out of the stator assembly. Use care when removing the ring and stator.

4 Grip the rotor securely, and pull it out of the instrument.

NOTE

When handling the rotor, try to touch only the outer circumference.

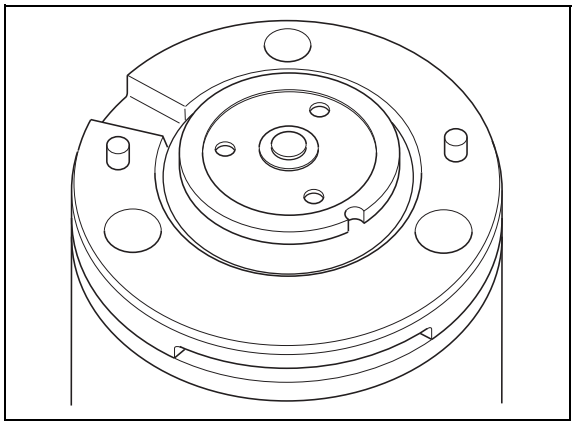


Fig. 8.25

5 Inspect the rotor and stator for visible nicks or scratches.
If the rotor or stator is damaged, replace the parts.
Replace the rotor together with the packing.

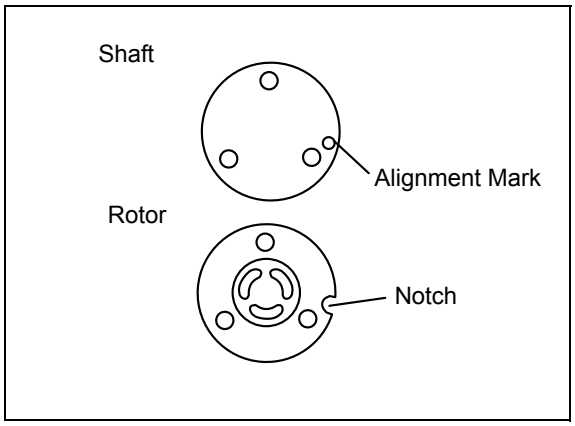


Fig. 8.26

6 Immerse the rotor, stator and housing in 2-propanol, and sonicate for 5 minutes.

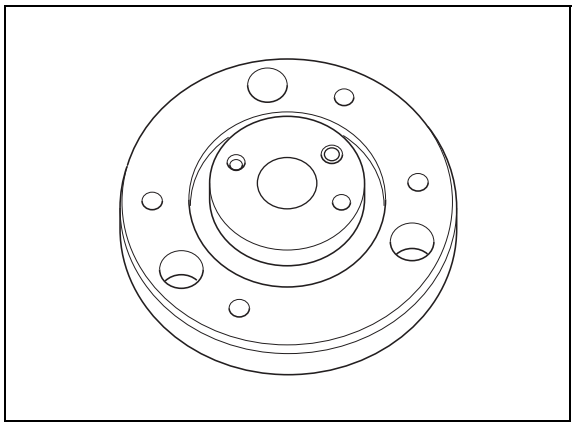


Fig. 8.27

8.6.3 Installing the High-Pressure Valve and Stator

1 Align the notch in the rotor with the mark on the shaft, and push the rotor all the way back onto the shaft.

NOTE

When handling the rotor, try to touch only the outer circumference. When returning the rotor to the instrument, wipe all sliding contact surfaces with isopropanol.

2 Insert the stator and, taking care not to drop them, attach the ring and the housing to the high-pressure valve.

3 Insert the three hex socket head bolts into the housing, and tighten with the Allen wrench.

NOTE

Insert the three hex socket head bolts, ensuring that they are straight and properly engage the threads of the valve before tightening. Alternately tighten the three hex socket head bolts 90° at a time until snug. Tighten firmly using the long end of the Allen wrench as a handle.

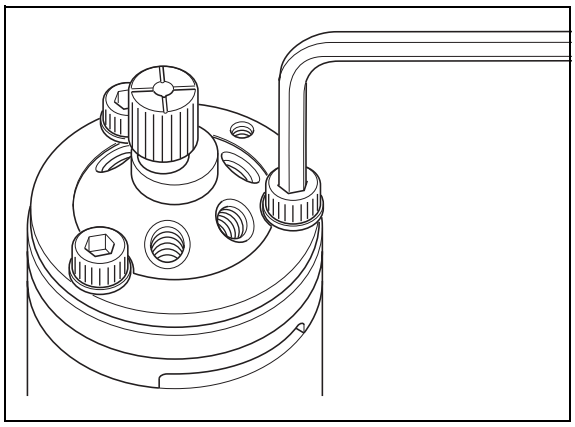


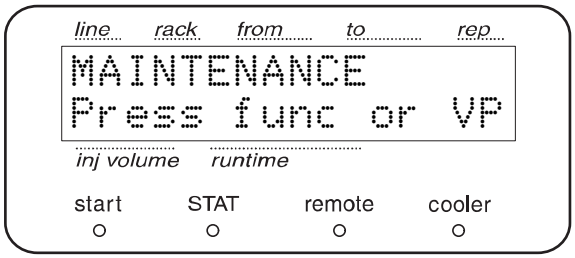
Fig. 8.28

4 Return the tubings and panel F removed in step 2 of "8.6.1 Before Removing the High-Pressure Valve Rotor and Stator" to the original state.

8.6.4 Resetting the Usage Frequency

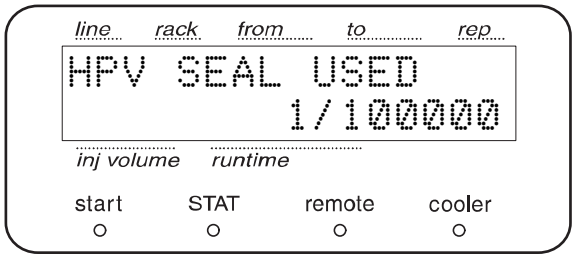
1 Check that there is a gap of approximately 3 mm between the bottom side of the mount and the tubings connected to the high-pressure valve.

2 Turn the power ON and press **VP** two times in the initial screen.
The Maintenance Information screen will be displayed.



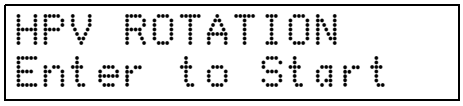
3 Press **func** repeatedly until the [HPV SEAL USED] screen on the right is displayed.

The usage frequency and replacement alert value of the high-pressure valve's rotor seal are displayed on the screen.



4 Press **0** and **enter**.
Reset the counter to [0].

5 Press **func** repeatedly until the [HPV ROTATION] screen is displayed.
Pump 2-propanol at a rate of approximately 2 mL/min.



6 Press **enter**.
The high-pressure valve switches over automatically once every few seconds. The number of rotations remaining is displayed on the second line.

NOTE

When using a new rotor and stator, abrasion powder may be generated initially. For this reason, perform the steps 5. and 6.

NOTE

Once operation has started it cannot be stopped until all 50 rotations have been completed. Abrasion powder may be generated initially and so be sure to remove the column before the operation.

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

8 Close the door.

9 Press **purge** to start purging of the flow lines.

8.7 Sample Loop Replacement

⚠CAUTION

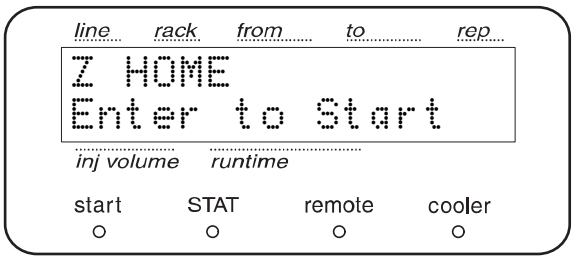
Carry out the replacement, process, and attachment of the sample loop correctly. Or, instrument capability could be worsened or the life of sample loop could be shortened.

Necessary parts

Part	Part No.
Sample loop Assembly	228-45402-91

8.7.1 Before Removing the Sample Loop

1 From the control setting screen, press **enter** and press **func** repeatedly until the [Z HOME] screen is displayed.



2 Press **enter**.
The needle rises to the highest position and then moves to the center of the autosampler.

3 Turn the power switch OFF.

4 Unplug the instrument.

8.7.2 Removing the Sample Loop

1 Open the front door and remove panel F from the autosampler.

2 Loosen the male nut at port 1 of the high-pressure valve, which secures the sample loop, by hand and remove it.

3 Unscrew and remove the three screws from the Z mount cover, and remove the cover.

4 Using a wrench, unscrew and remove the male nut on the other end of the sample loop (opposite the sampling needle).

5 When using the SIL-20A, remove the sample loop from the hooks (two places) at the right top of the front section of the autosampler.
When using the SIL-20AC, remove the sample loop from the hooks (two places) on the back of the front upper section of the resin cover inside the autosampler.

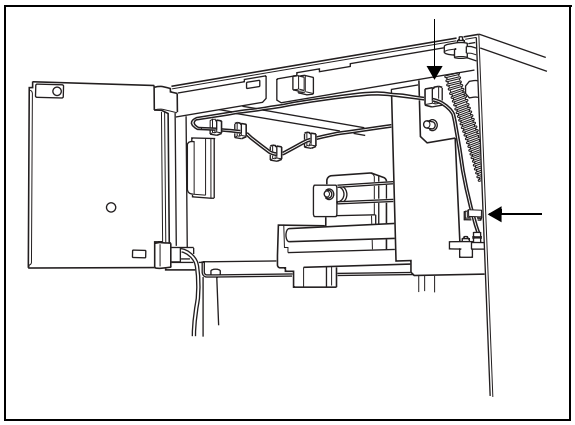


Fig. 8.29

6 Remove the sample loop from the hooks on the left side of the autosampler's interior.
At this time, remember the position where the sample loop’s band is positioned (The position is hanged on the hook attached in the back.).

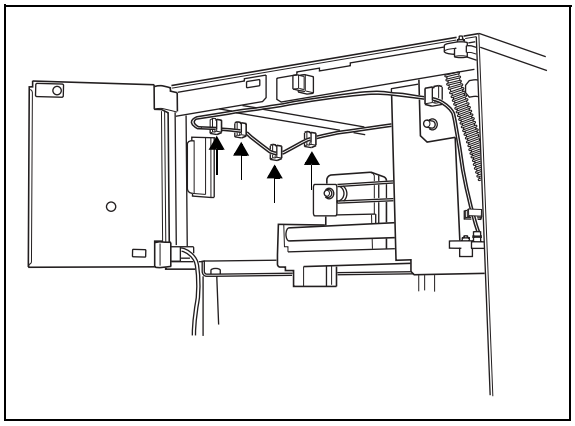


Fig. 8.30

7 Remove the sample loop from the hook at the back of the Z mount, and then take the sample loop out of the autosampler.

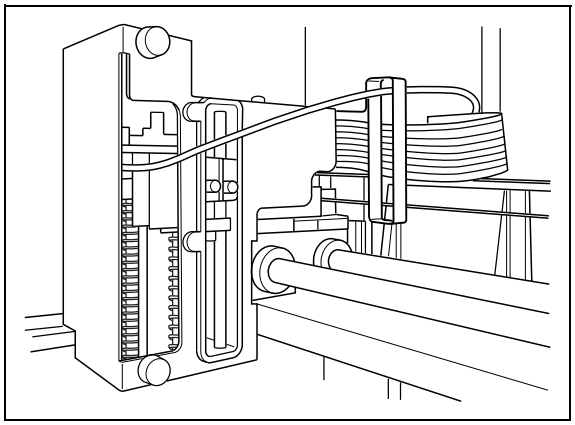


Fig. 8.31

8.7.3 Installing the Sample Loop

1 Pass the new sample loop through the square holes at the back of the Z mount, and insert it through the positioning hook on the right side of the Z mount.

2 Attach a male nut and a ferrule to the sample loop, and secure to the joint on the sampling needle side using a spanner.

3 After attaching the part positioned with the sample loop's band to the hook in the back on the left side of the autosampler's interior, secure the sample loop to the hooks at the center and front in sequence.

4 Secure the sample loop to the hooks (two places) in the top section at the front of the autosampler.

5 Secure the sample loop, with the male nut and (PEEK) ferrule attached, to port 1 of the high-pressure valve.

6 Adjust the plumbing for the sample loop attached to port 1 in the way shown on the right.
When using the SIL-20AC (with sample cooler), bend downwards along the right side of the high-pressure valve and run it along the right side of the resin cover.

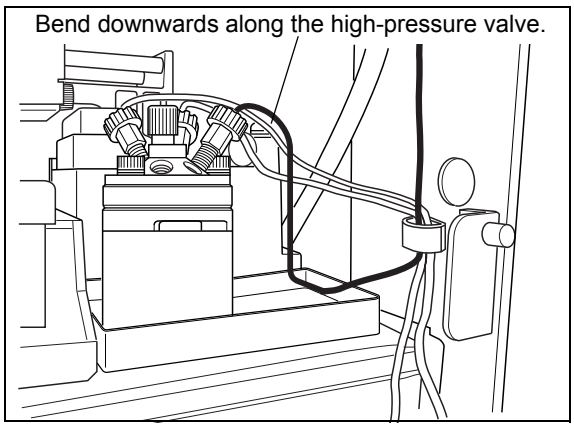


Fig. 8.32

7 Replace the Z mount cover, and tighten with its screws.

8 Replace the panel F, and close the front door.

9 Reinsert the power plug and turn the power ON.

10 During initialization, open the panel at the top right of the autosampler and make sure that there is no interference between the sample loop and other parts. In particular, make sure that there is no interference between the port 1 of the high-pressure valve and the bottom of the Z mount.

8.8 Inspection (Replacement) and Ultrasonic Bath Cleaning of Suction Filter

Necessary parts

Part	Part No.
Suction filter SUS	228-21984-01

8.8.1 Removing the Suction Filter

1. Turn the power switch OFF.
2. Unplug the instrument.
3. Pull the SUS suction filter out of the tubing.
4. Put the suction filter in a bath of 2-propanol, and clean with an ultrasonic cleaning device for 5 minutes.

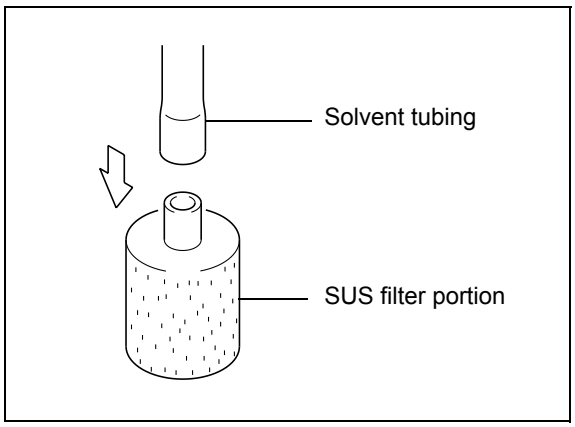


Fig. 8.33

8.8.2 Installing the Suction Filter

1. Insert the SUS suction filter back into the tubing.

NOTE

Widening the end of the tubing by inserting a pen or object with a conical tip makes it easier to insert the filter into the tubing.

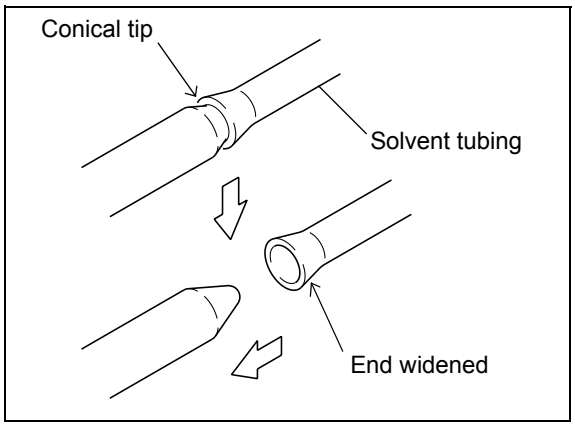


Fig. 8.34

2 Plug in the instrument.

3 Turn the power switch ON.

4 Press (purge) to start purging of the flow lines.

5 Check that air bubbles do not accumulate inside the solvent tubing.
If bubbles build up, remove the suction filter using the above procedure and replace it with a new one.

8.9 Needle Replacement

Necessary parts

Part	Part No.
Needle Assembly	228-41024-93

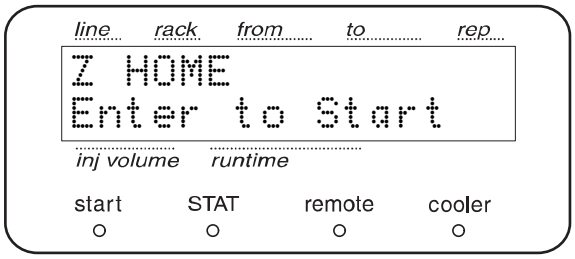
8.9.1 Before Replacing the Needle

1 From the control setting screen, press (enter) and press (func) repeatedly until the [Z HOME] screen is displayed.

2 Press (enter).
The needle rises to the highest position and then moves to the center of the autosampler.

3 Turn the power switch OFF.

4 Unplug the instrument.



8.9.2 Removing the Needle

1 Open the front door and remove front panel from the autosampler.

2 Loosen the 3 mounting screws, and pull the Z mount's cover forward to remove it.

3 Unscrew and remove the male nut of the needle Assembly with a wrench.

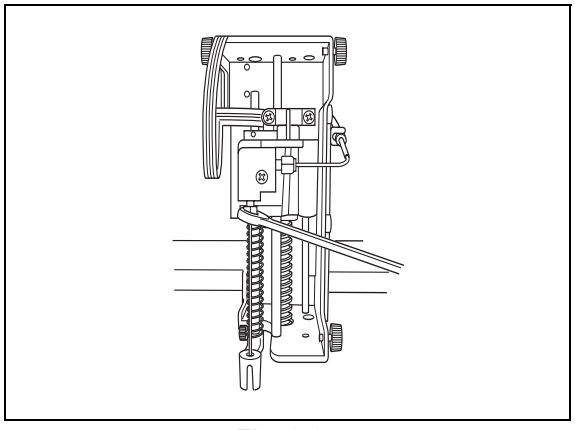


Fig. 8.35

8.9.3 Installing the Needle

1 Insert and tighten the male nut and ferrule of the new sampling needle assembly.

⚠CAUTION

- Insert the sampling needle fully into the connection, then tighten with a wrench. A gap in the connection creates dead volume and peak broadening.
- Tighten the nut well. A loose fitting mary leak.
- Be sure to use the correct ferrule (Ferrule 1.2F) that cones with the new sampling needle assembly. Using a normal size ferrule (Ferrule 1.6F) may cause a leak.

2 Replace the Z mount cover, with its screws.

3 Return the keyboard to the instrument.

4 Plug the instrument.

5 Turn the power switch ON.

6 Open the autosampler's right cover, and check the position at which the needle is lowered into the injection port. Adjust the needle position if it is incorrect.

☞ "[ADJUST INJ PORT]" P. 5-65

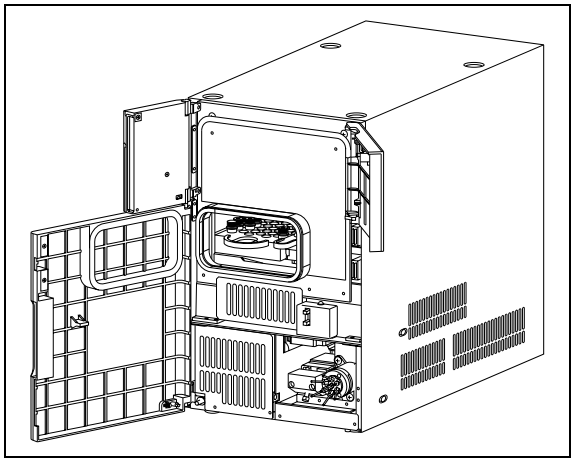


Fig. 8.36

8.10 Replacement of Fuse

⚠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 of the fuses is:

Necessary parts

Model name	Part	Part No.
SIL-20A (228-45006-31, -32, -38)	Fuse 250V 3.15AT	072-02004-21
SIL-20AC (228-45007-31, -32, -38)	Fuse 250V 6.3AT	072-02004-24

1 Turn the power OFF.

2 Remove the fuse holder at the back of the autosampler using, for example, a coin.

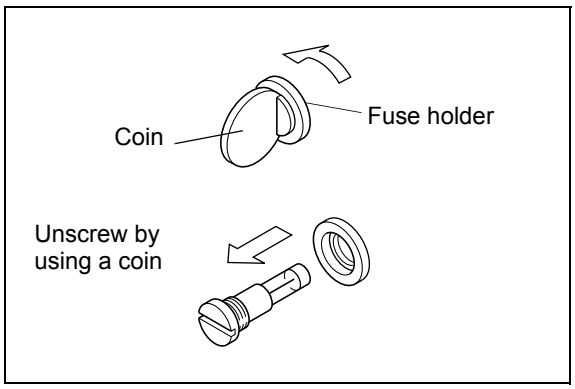


Fig. 8.37

3 Place new fuses into the fuse holder.

4 Push the fuse holder in and fix by using a coin.

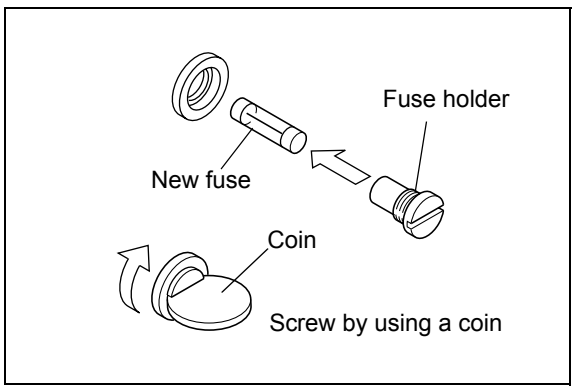


Fig. 8.38

8.11 Replacing the Panel

Necessary parts

Part	Part No.
Panel F Assembly	228-37512-91

1 Turn the power OFF.

2 Open the door.

3 Loosen the panel mounting screws with a screw driver, slide the panel right, and pull it forward to detach it. Remove the panel.

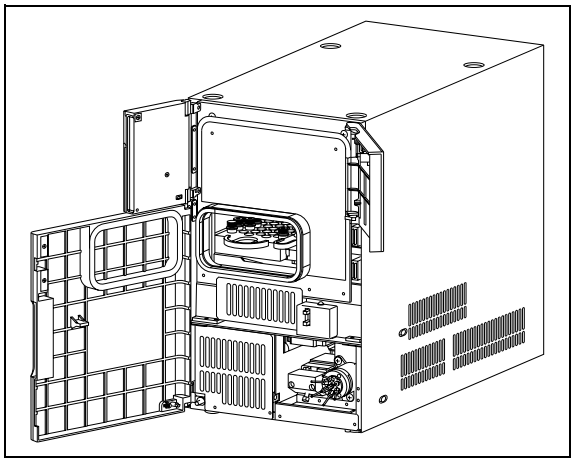


Fig. 8.39

4 Install a new panel.

⚠ CAUTION

Install the panel securely.
Or, the condensation could be formed when air enters the sample cooler.

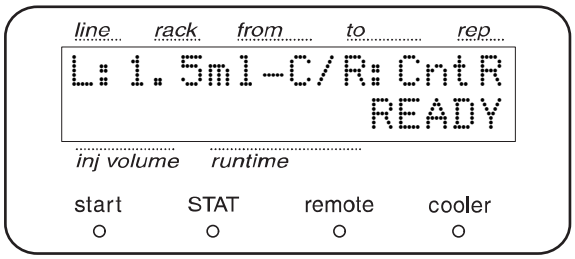
5 Close the door.

8.12 Rinsing the flow lines

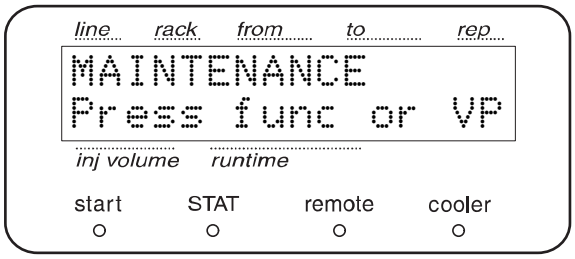
If there is clogging inside the needle or the sample loop, or if there is contamination on the needle surface, the inside and outside of the needle can be rinsed with the mobile phase.

8.12.1 Rinsing the Needle and Sample loop

1 Press **CE** to display the initial screen.

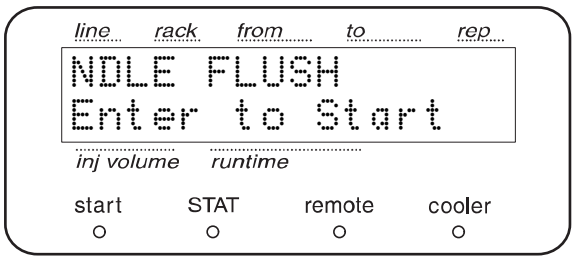


2 Press **VP** repeatedly until the Maintenance Information screen on the right is displayed.

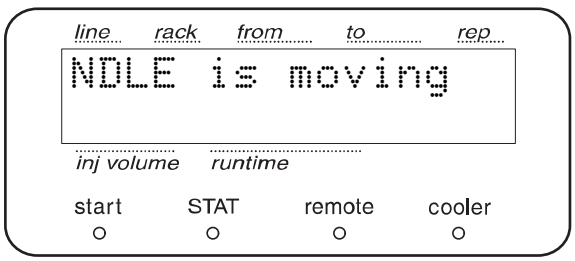


3 Press **func** repeatedly until the [NDLE FLUSH] screen on the right is displayed.

4 Press **pump** on the pump.
Start pumping at 2mL/min for 5 seconds and then stop pumping.



5 Press **enter**.
The screen on the right is displayed, the needle moves to the rising port, and the high-pressure valve switches to [INJ]. (The pump and the needle become connected.)



6 Pump mobile phase with the pump to wash away any clogging or contamination in the needle.

⚠CAUTION

Replace the needle if it is not possible to remove the clogging or the contamination.
"8.9 Needle Replacement" P. 8-29

7 When rinsing the inside of the needle is completed, stop the pump by pressing **pump**.

8 Press (enter).
The next screen is displayed and the needle returns to the injection port.

9 Press (CE) to return to the initial screen.

8.12.2 Reverse Cleaning of the Flow Lines

⚠CAUTION

If clogging is observed in flow lines inside the autosampler, it may be possible to remove the clogging by pumping with the inlet tubing and outlet tubing connected in reverse.

1 Disconnect the inlet tubing (tubing IN) and the outlet tubing (tubing OUT).
Tubing cover (blue) is provided to the tubing IN tip.

2 Connect the tubing OUT to the solvent delivery module or mixer.
The mobile phase comes out of the inlet tubing. Collect the liquid with, for example, a beaker.

3 Solvent delivery module 2-propanol into the auto-sampler from the solvent delivery module at 2-5mL/min.

4 Return the plumbing to the original state.

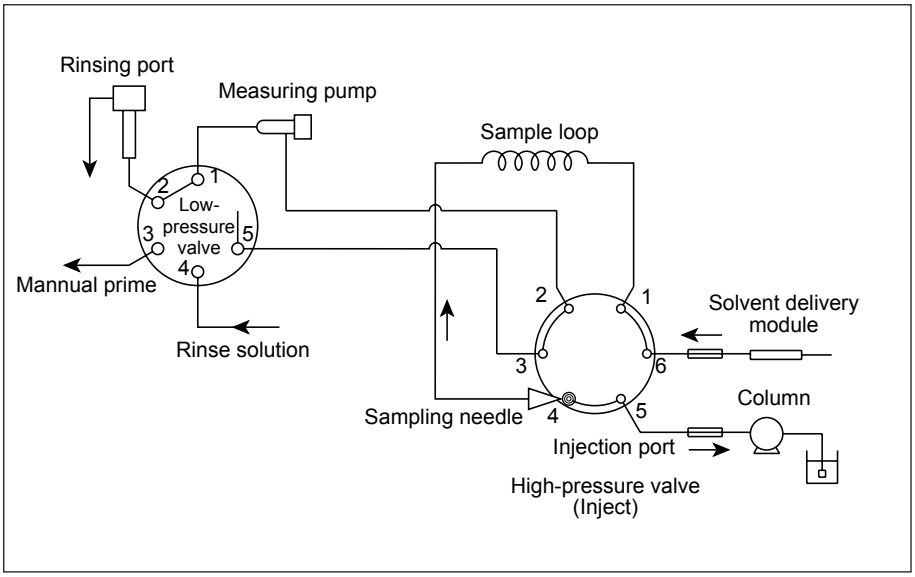


Fig. 8.40

8.13 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.

8.14 Maintenance for Long Periods without Use

If the autosampler is not used for a long period, raise the needle to prevent a reduction in the service life of the needle seal.

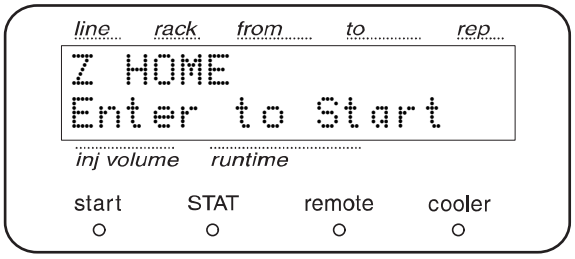
8.14.1 Moving the Needle

1 Turn the power ON.

2 From the control setting screen, press **enter** and press **func** repeatedly until the [Z HOME] screen is displayed.

3 Press **enter**.
The needle rises to the highest position and then moves to the center of the autosampler.

4 Turn the power OFF.



9

Technical Information

Contents

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

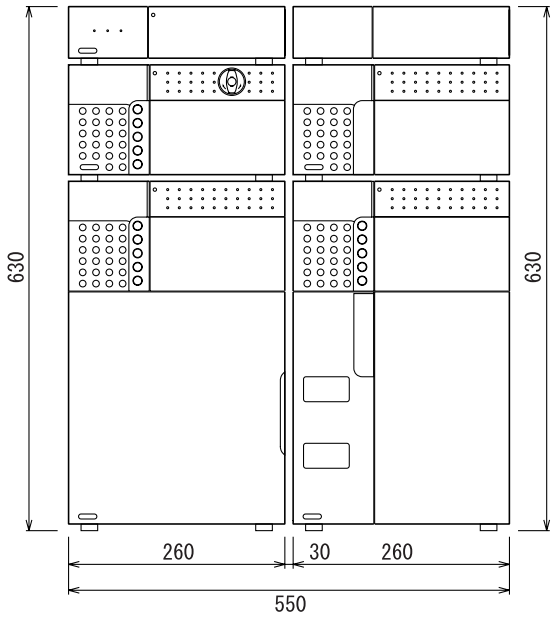
■ Required Installation Space

⚠ CAUTION

- The weight of SIL-20A is approx. 27kg and SIL-20AC approx. 30kg
  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.

● High-pressure gradient system with autosampler



(Unit : mm)

Fig. 9.1

9.1.2 Installation

■ Removing the Shipping Screw

The autosampler drive component is secured during shipment by a shipping screw. After installing the instrument, remove the shipping screw.

1 Remove the shipping metal plate setting the front low side.

2 Open the door.

3 Remove the panel.

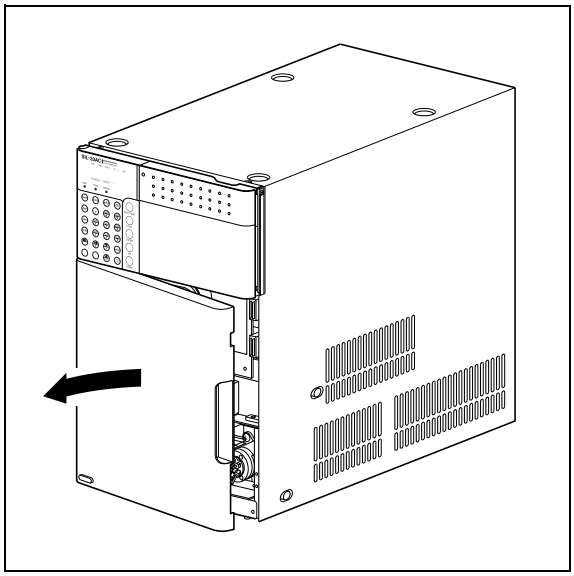


Fig. 9.2

4 Loosen the screw using a an Allen wrench and remove the bracket.

NOTE

The screw and bracket may be required again when transporting the autosampler and so be sure not to loose them.

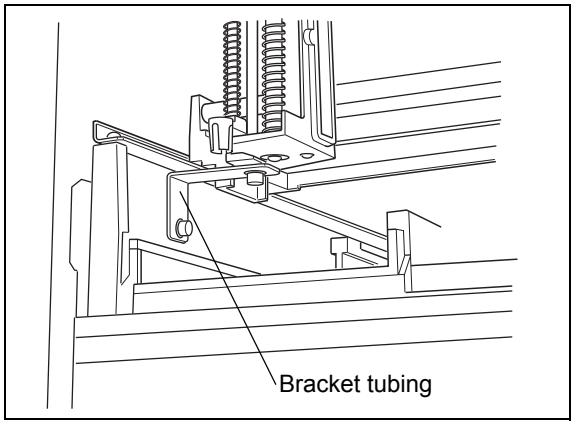


Fig. 9.3

5 Remove the protective septum attached to the needle tip.

6 Attach the cover to the rinsing port.

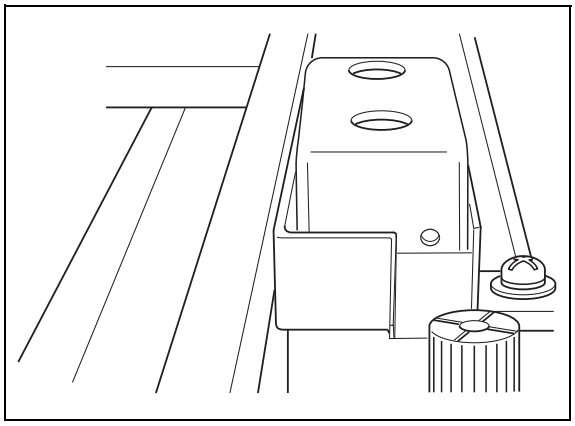


Fig. 9.4

7 Reinstall the panel.

8 Close the door.

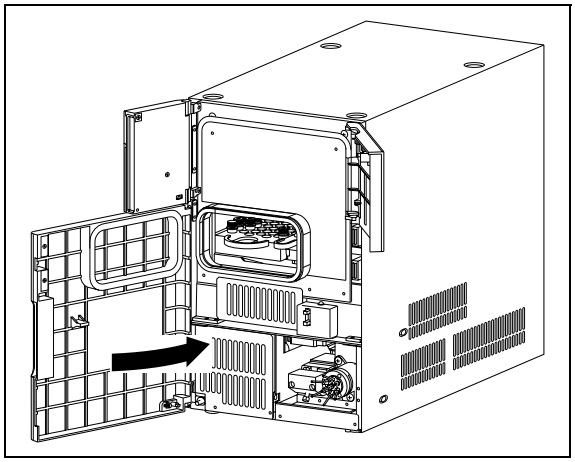


Fig. 9.5

■ Installation

The SIL-20A is designed for stacking with other Shimadzu HPLC components.
☞ "9.6 Introduction to HPLC System" P. 9-37

⚠CAUTION

There is only a 5 mm gap at the bottom of the autosampler.
Take care not to catch your fingers in the modules.

NOTE

Always install this instrument on the left side of the column oven.

■ 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. 9.6".

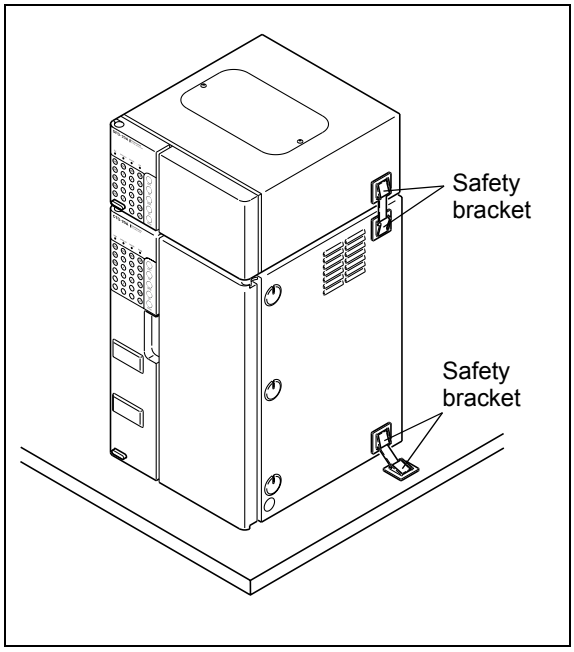


Fig. 9.6

.

9.1.3 Power Supply Connection

The following table shows the electrical voltage, power consumption, and frequency.

SIL-20A

Part No.	Power Supply Voltage (indicated on the instrument)	Consumption	Frequency
228-45006-31	AC100V ± 10% (100V~)	100VA	50/60Hz
228-45006-32	AC110 - 120V ± 10% (120V~)		
228-45006-38	AC220 - 240V ± 10% (220-240V~)		

SIL-20AC

Part No.	Power Supply Voltage (indicated on the instrument)	Consumption	Frequency
228-45007-31	AC100V ± 10% (100V~)	300VA	50/60Hz
228-45007-32	AC110 - 120V ± 10% (120V~)		
228-45007-38	AC220 - 240V ± 10% (220-240V~)		

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.

■ Connecting to the 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.

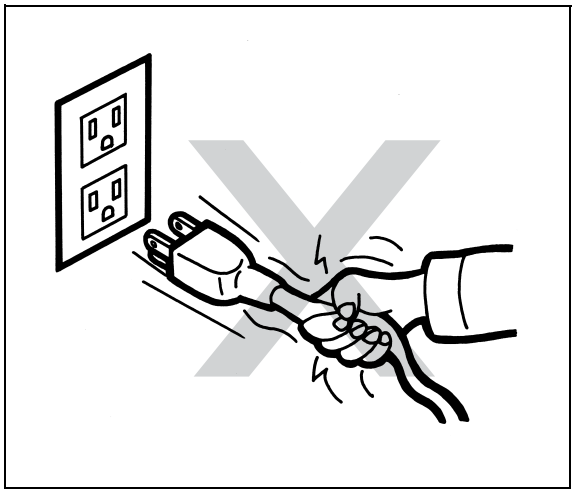


Fig. 9.7

⚠ 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.

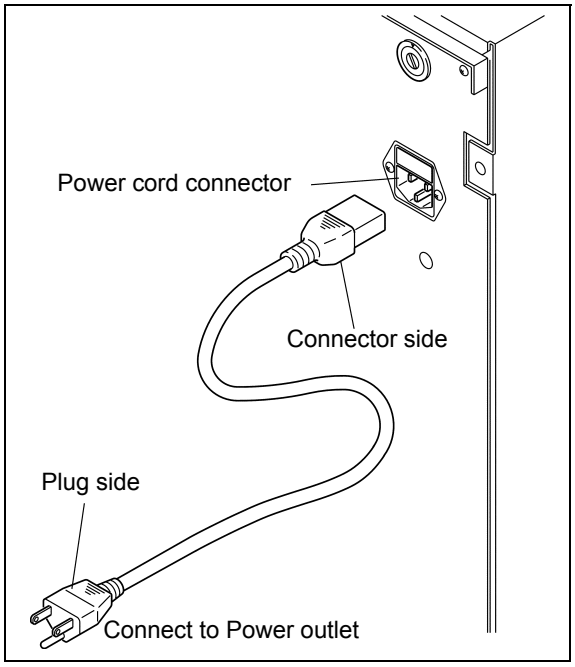


Fig. 9.8

■ 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 Tubings and Connectors

The tubing and connectors used for the plumbing are made of stainless steel (SUS) or resin as follows.

Stainless steel (SUS)

- Stainless tubing, 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 nuts PEEK
- PEEK ferrules
- PTFE ferrules

■ Cutting the Tubings

Cut provided tubing to the proper lengths for installation.

Cutting SUS Tubings

1 Position the provided file (for cutting SUS tubing) 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.

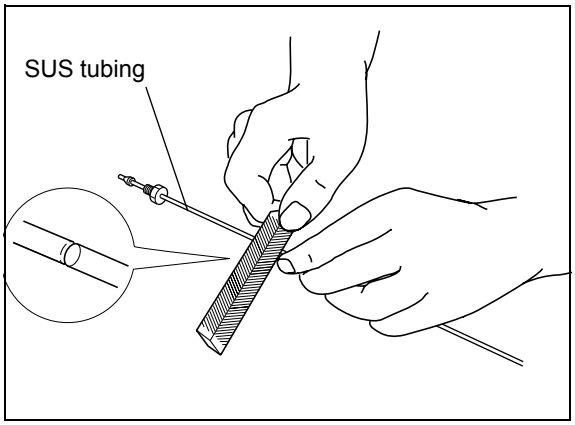


Fig. 9.9

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.

3 File the cut surface to make smooth and straight.

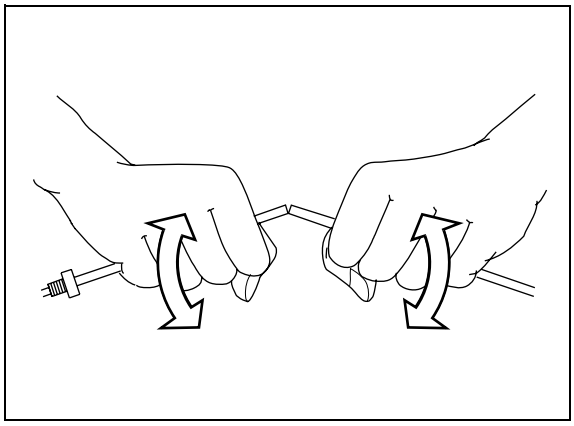


Fig. 9.10

⚠ 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 Tubings

Cut off the resin tubing at a right angle using a cutter.

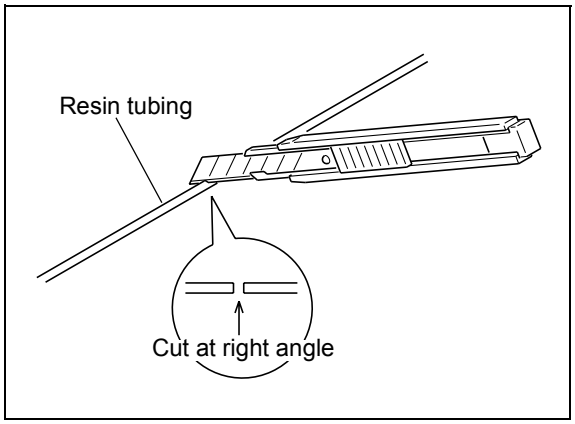


Fig. 9.11

■ Connecting the Tubings

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.

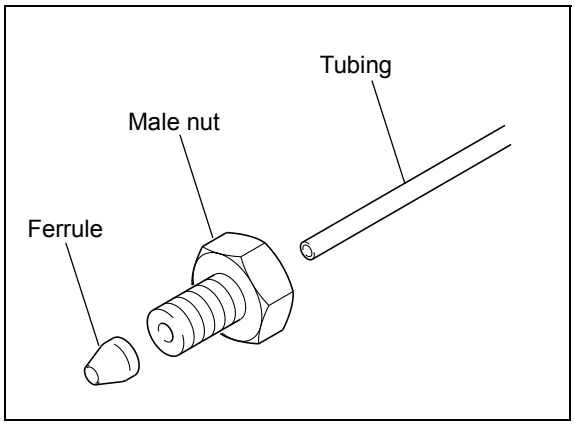


Fig. 9.12

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.

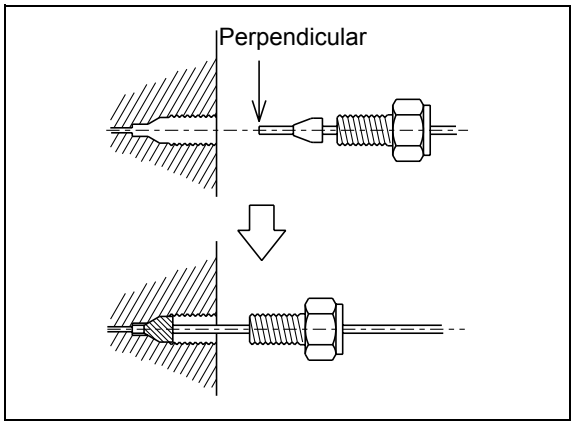


Fig. 9.13

⚠ 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 (provided) 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.

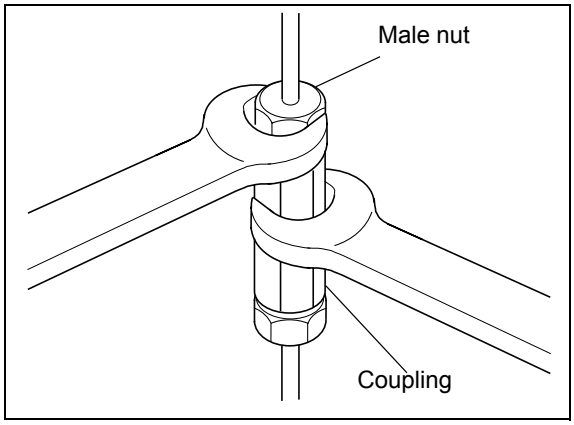


Fig. 9.14

3 Loosen and move the male nut a slightly, to verify that the ferrule is secured to the tubing.

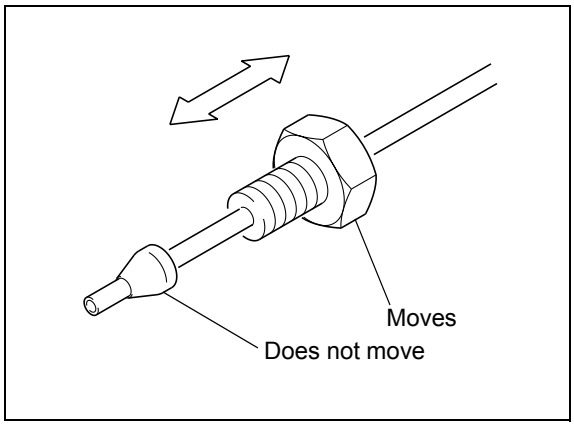


Fig. 9.15

■ Protective Plugs

nlets 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 "1.4Component Parts".
- Connect only the tubing described in the instructions.

Otherwise, injury or equipment failure may cause.

The necessary plumbing is as follows:

- Inlet tubing plumbing
  Connects the instrument to the pump or mixer. (Becomes part of mobile phase flow line.)
- Outlet tubing plumbing
  Connects the instrument to column. (Becomes flow line for sample solvent and sample.)
- Solvent filter plumbing
  Connected to rinse solution container (Becomes flow line for rinse solution, between rinse solution container and drain valve.)
- Rinse solution drain plumbing
  Drains rinse solution from the rinsing port.
- Water condensation drain tubing plumbing
  (only for cooler model)
  Drains water condensation from the sample cooler.
- Leakage drain tubing plumbing
  If leakage occurs in any of the system devices, this tubing directs leakage to a waste container.

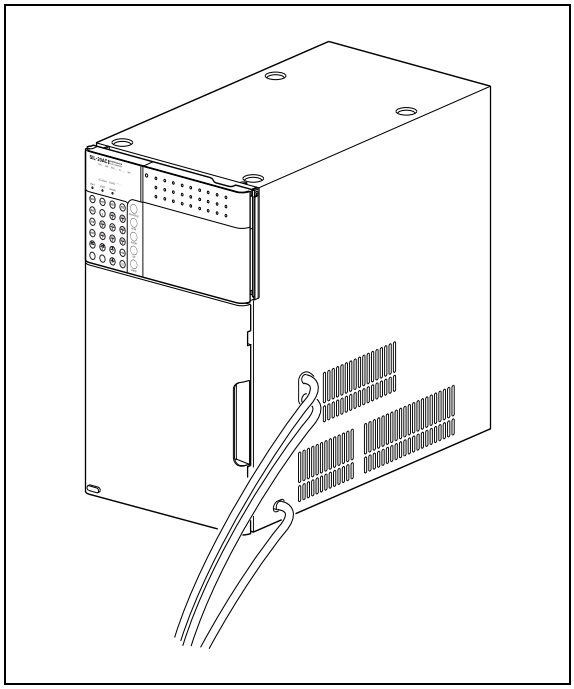


Fig. 9.16

■ Rinse Solution and Waste Container Preparation

Prepare the rinse solution and waste containers before connecting the plumbing.

⚠WARNING

Do not use cracked or damaged waste container(s). They could be broken.

⚠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.

■ Rinse Solution Selection

Select the rinse solution as follows, depending on the mobile phase.

For reversed phase, ion exchange, and aqueous normal phase

- The ratio of methanol to water should be 50/50. If precipitation occurs upon sample contact, select a rinse solution without salts, as for the mobile phase.
- When the target compound is acid, base, or ionic substance, and sample is likely to remain on the outside surface of the needle, add acid such as formic acid and acetic acid to the organic solvent of methanol, acetonitrile, etc., or use a 10 mM TFA solution or organic solvent solution, or their mixture solution.

For non-aqueous normal phase, GPC

- Use the same solvent (s) used for the mobile phase.
- When the target compound is an acid, base, or ionic substance, and rinse mode is required, use a 10mM TFA aqueous solution, an organic solvent solution, or a mixture of both.

■ Plumbing the Inlet/Outlet Tubing

The inlet and outlet tubing, which emerges from the right side of the instrument, is connected to ports 5 and 6, respectively, of the high-pressure valve. Instructions for plumbing these connections are given below.

Inlet tubing

connected to pump or mixer

Outlet tubing

connected to column

NOTE

The Inlet tubing is added the blue cover of the tubing.

■ Plumbing between Inlet Tubing and Pump or Mixer

Screw the inlet tubing into the pump outlet or mixer outlet.

NOTE

- The inlet tubing is connected to the pump outlet in an isocratic system, and to the mixer in a gradient system. (For details, see the instruction manual for the pump or column oven.)

■ Plumbing between Outlet Tubing and Column

1 Unscrew and remove the stop plug from the column inlet.

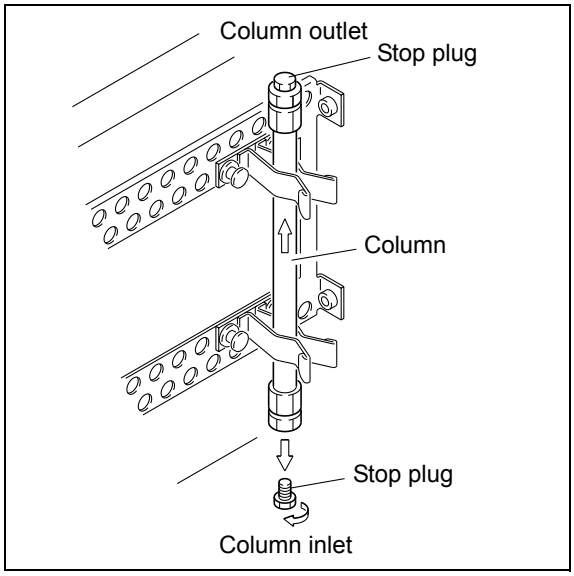


Fig. 9.17

2 Screw the outlet tubing into the column inlet.

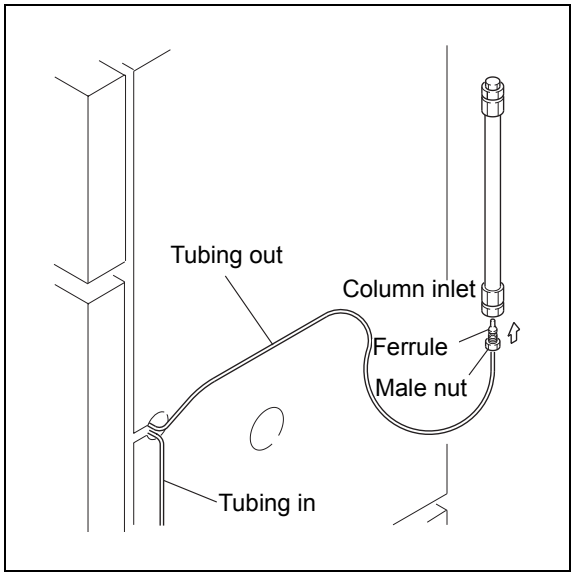


Fig. 9.18

■ Plumbing the Rinse Solution Drain Tubing (standard accessory)

⚠ CAUTION

The volume of waste liquid produced per analysis is about 200µL, under default conditions (default values). If a large number of samples is analyzed continuously, provide a larger waste container. If the container is too small, it will overflow.

1 Attach the drain tubing (provided) etc. as in the right figure.
Normally, connect the tubings as in Fig. 9.19. If the rinse solution with low polarity is used, however, connect the tubings as in Fig. 9.20. The numbers in the figures correspond to the ones on P.1-8.

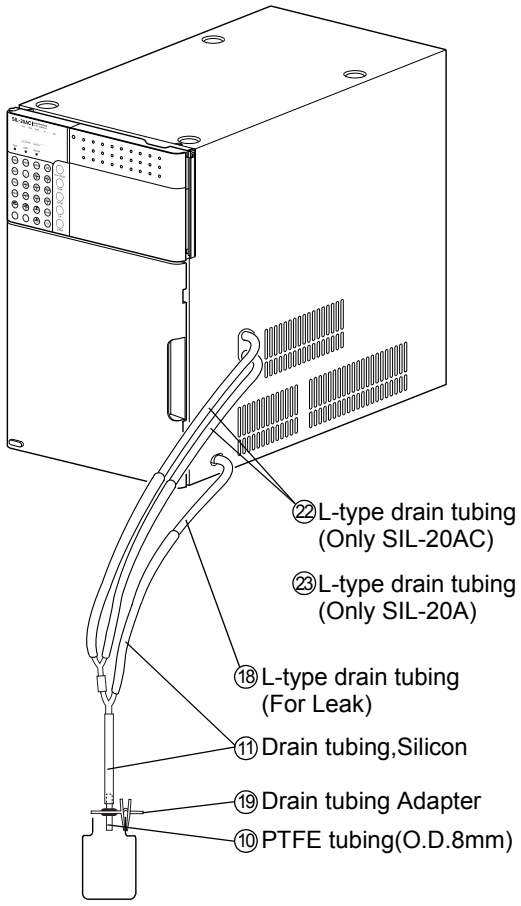
⚠ CAUTION

Be careful not to bend the drain tubing.
If the tubing is bent, liquid leak from the rinsing port may occur.

NOTE

The rinsing port's drain outlet is visible through the hole in the instrument's left side.

(When the waste liquid is a solution such as water, buffer, alcohl like as methanol or etc. and acetonitrile and so on.)



The numbers are from the list on P.1-8

Fig. 9.19

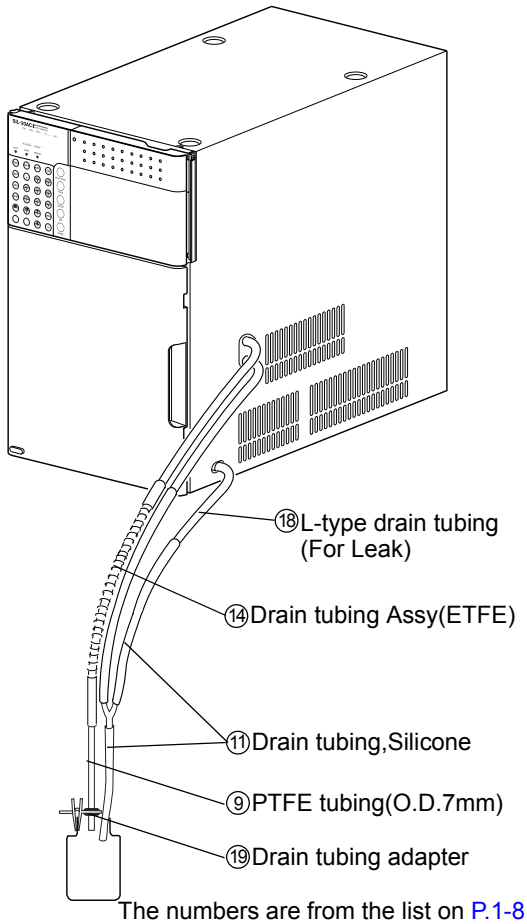
9

2 Adjust the length of the silicone tubing by cutting it with a cutter so that it extends to the waste container inlet. In case of plumbing in Fig. 9.20, insert the PTFE tubing (part No. ⑨) into the drain tubing adapter directly.

3 Attach the drain tubing adapter to the drain bottle inlet.

> **⚠ CAUTION**
>
> The end of the drain tubing must not be submerged into the waste liquid. Waste liquid will leak from the rinsing port. If necessary, tape the tubing to the container's rim to prevent submersion.

(When the waste liquid contains a polar solvent such as chloroform, tetrahydrofuran (THF) or etc..)



The numbers are from the list on P.1-8

Fig. 9.20

9.1.6 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 malfunction to the instrument.

■ 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.

1 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.

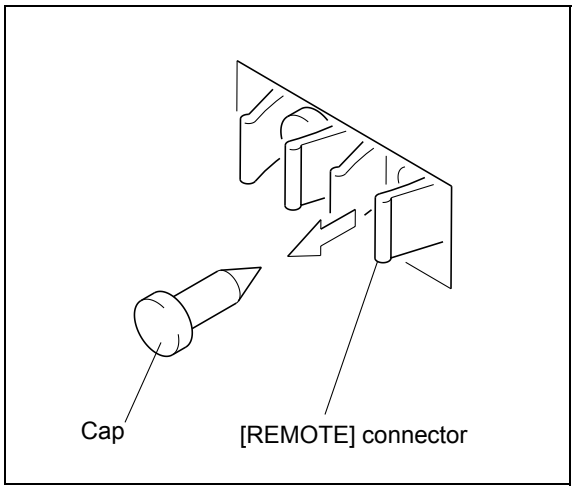


Fig. 9.21

2 Insert the optical cable plug into the [REMOTE] terminal so that 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.

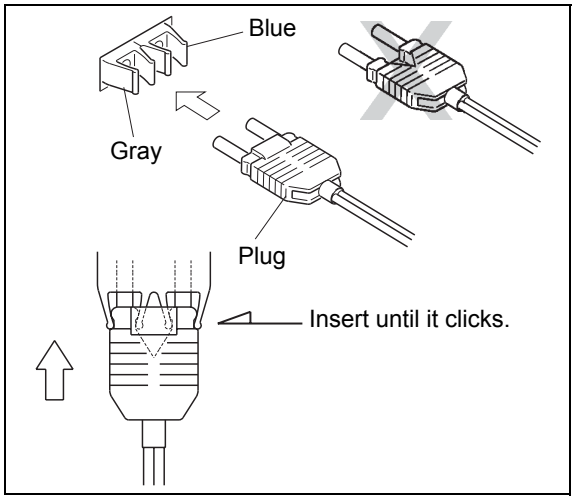


Fig. 9.22

⚠ 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.

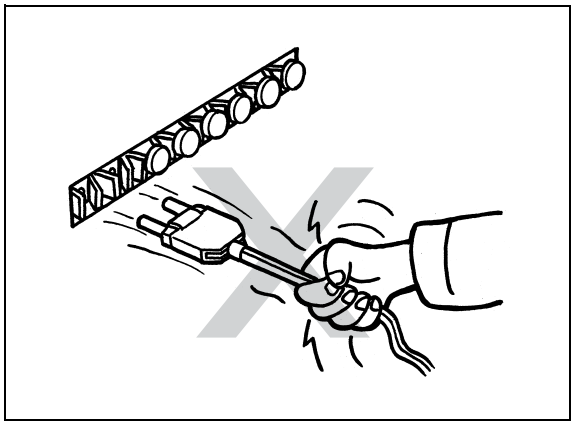


Fig. 9.23

■ Connection to System Controller

Referring to "Connecting the Optical Cable" P. 9-17, use the optical cable to connect the auto injector [REMOTE] terminal to the system controller's Channel 1 (SIL) [REMOTE] terminal.

9.1.7 Installation of Optional Equipment

For details (types and part Nos.) on the options described below, refer to "1.5 Optional Parts" P. 1-9.

■ Rack and Vials

Procedures for installing the sample rack and loading sample vials are given in "4.1 Preparing the Samples" P. 4-2.

9.1.8 Transporting the Instrument

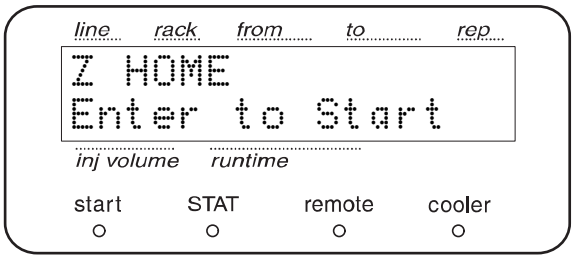
Perform the following process before transporting this instrument.
For details on changing the needle position, refer to "[Z HOME]" P. 5-27.

1 From the control setting screen, press **enter** and press **func** repeatedly until the [Z HOME] screen is displayed.

2 Press **enter**.
The needle rises to the highest position and then moves to the center of the autosampler.

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

4 Turn the power OFF.



5 Open the door, and remove the sample racks.

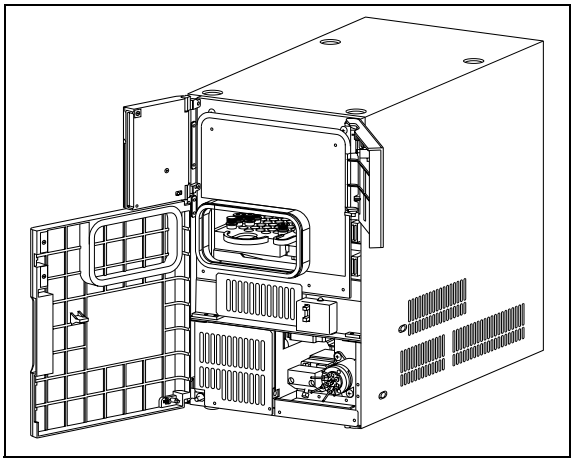


Fig. 9.24

6 Remove the panel F.

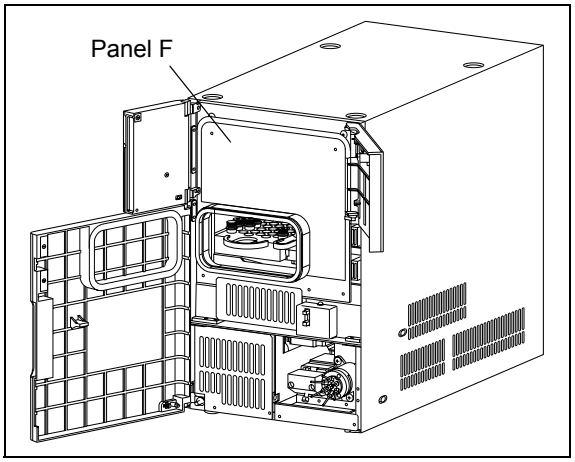


Fig. 9.25

7 Tighten the shipping screw using an Allen wrench and fix the Z-truck.

> **⚠ CAUTION**
>
> Be careful not to bend the needle while using the screwdriver and hex key.

NOTE

The bracket and the shipping screw should be used to secure the autosampler drive when relocating this instrument. Place the screw in a safe location so it will not be lost.

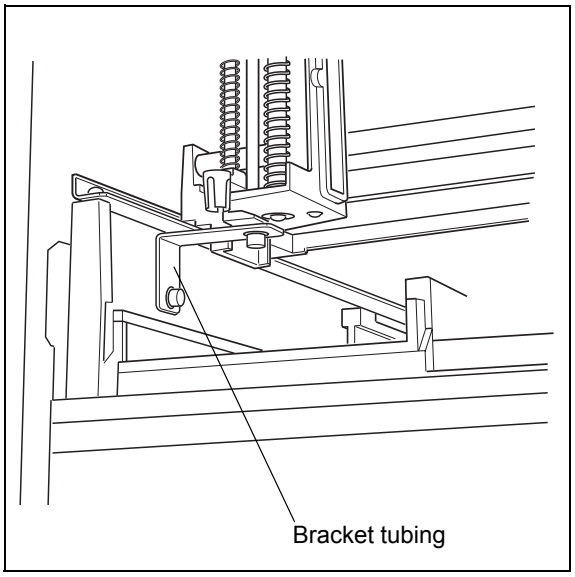


Fig. 9.26

8 Attach the needle protection septum to the hole of the vial detection block.

9 Remove the rinsing port cover.

10 Close the door.

11 Attach the shipping metal plate to front low side.

12 Move the instrument.

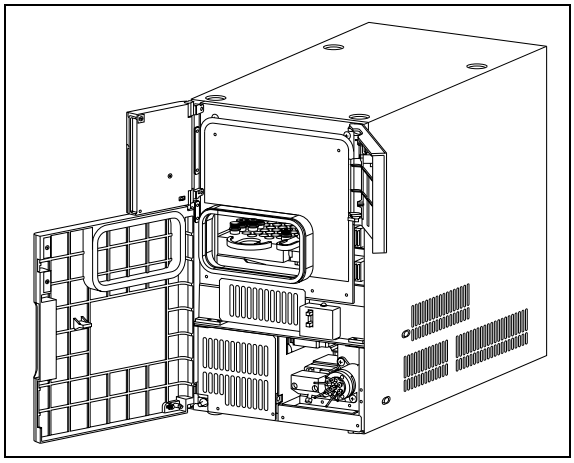


Fig. 9.27

9.1.9 Installation of Ambient Temperature Sensor (Only SIL-20AC)

If the temperature fluctuation will be large, use the clamp (No.25 of the component parts) to secure the ambient temperature sensor cable at a location near the instrument with minimal temperature flunctuation.

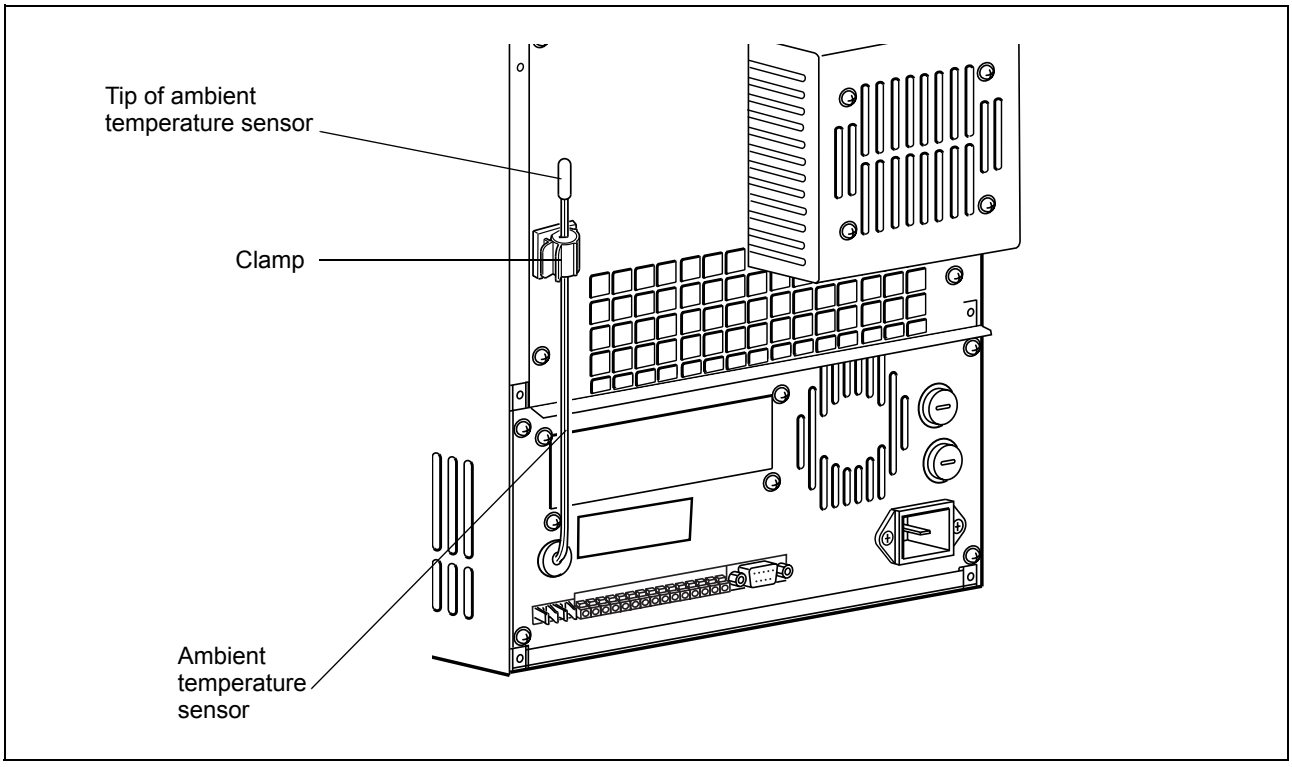


Fig. 9.28

NOTE

If the tip of the ambient temperature sensor touches the instrument's rear cover, the sensor cannot correctly sense the temperature.

9.2 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.

⚠CAUTION

- 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.

9.2.1 Event Cable

Signals	Description	Remark
START (output) (injected)	Relay contact output. Switches ON/OFF when the autosampler starts analysis.	Contact rating: 30VDC/1A
EVENT1 (output)	Relay contact output. Output switched by [EVENT] setting.	
EVENT2 (output)	Relay contact output. Output switched by [EVENT] setting.	
EVENT3/ERROR (output)	Relay contact output or error output. Output switched by [EVENT] setting.	
RSVD	For factory adjustment. Not used.	
READY (input)	When this contact is closed, the autosampler becomes ready to start injection operation. Used to start injection operation in synchronization with external devices.	
STOP (input)	Injection operation stops when this contact is closed.	
CHANGER	Connected when using a rack changer.	

9.2.2 Connection of Event Cable

1 Peel the cable about 10mm.
* This is not required with the remote cable provided.

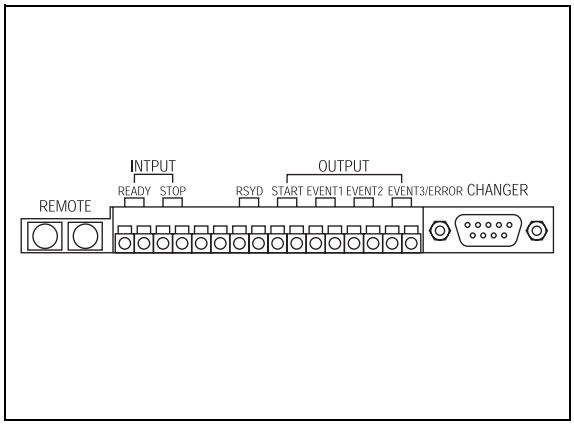


Fig. 9.29

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 supplies 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.

9.3 Plumbing of the SIL-20A/20AC

The plumbing inside of the SIL-20A/20AC has been changed from that of conventional auto injectors, in order to reduce peak diffusion outside the column, and for the compatibility with semi-micro HPLC. In particular, the inner diameter of the tubings through which the sample is prepared with 0.13mm i.d. tubing.
This modification improves chromatographic resolution especially for peaks of short retention times, even when conventional columns of 4.6mm i.d. are used. Additionally, it has a significant benefit in transition to the semi-micro column (2mm i.d.), for which plumbing of small diameters is essentially important and the use of semi-micro HPLC is expected to expand more and more from now on, in terms of connection with MS, and in consideration of environmental issues.

On the other hand, such narrow bore tubing may be clogged with small particles such as dust in the sample. While the 0.25mm i.d. tubing is effective in this regard, it should be used when resolution in peaks of short retention time is not so important, or when semi-micro HPLC is not to be used. Please follow the guidelines for changing the plumbing as shown below.

9.3.1 Notes on the Inner Diameter of Plumbing

■ Effects of the Inner Diameter on Chromatographic Resolution

In the following two cases, the inner diameter of the plumbing affects the spread of peaks in chromatograms (i.e., the peak resolution).

For a constant inner diameter of columns

The shorter the retention time of the peak is, the more the resolution depends on the inner diameter of plumbing.)
The following is a comparison of NTP (number of theoretical plates) of a 4.6mm i.d. column when 0.3mm i.d. and 0.13mm i.d. tubings were used. This shows that plumbing of a large inner diameter can degrade NTP for peaks of relatively short retention time, even with conventional columns.

[Analysis Conditions]
Column : STR-ODS II (4.6mm × 150mm)
Flow rate : 1.0mL/min
Mobile phase : Methanol / water = 1/1
Column temperature : 40°C
Autosampler : SIL-10ADvp

[Analysis Result Example]

Sample	Retention Time (min)	k'	NTP when 0.13mm i.d. tubing is used	NTP when 0.3mm i.d. tubing is used	NTP Decrease
Uracil	1.72	0.08	5,100	2,800	45%
Caffeine	2.32	0.45	7,000	4,100	41%
Phenol	3.51	1.19	10,200	7,000	31%
Methyparaben	4.22	1.64	9,800	7,300	26%
Ethylparaben	6.71	3.20	10,400	9,200	12%

A decrease in NTP is more significant for peaks of short retention time (small k'). Therefore it should be noted that the resolution of peaks eluting early in the chromatogram may be degraded when 0.3mm i.d. plumbing is used for the sample path.

The smaller the inner diameter of the column is

The smaller the inner diameter of the column is, the more the resolution depends on the inner diameter of plumbing. When a 2mm i.d. semi-micro column is used together with 0.3 i.d. plumbing, decrease in NTP is remarkable even for peaks of longer retention time (large k'). An example of this effect is shown below.

[Analysis Conditions]
Column : STR-ODS II (2mm × 150mm)
Flow rate : 0.2mL/min
Mobile phase : Methanol / water = 85/15
Column temperature : 40°C
Autosampler : SIL-10ADvp

[Comparison of the Number of Theoretical Plate]

Sample	Retention Time (min)	k'	NTP when 0.13mm i.d. tubing is used	NTP when 0.3mm i.d. tubing is used	NTP Decrease
Naphthalene	3.72	1.48	6,900	3,000	57%
Acenaphthene	5.63	2.75	8,400	4,700	44%
Fluoranthene	7.27	3.84	8,900	5,800	34%
Pyrene	7.97	4.31	9,200	6,300	32%

Thus in the case of semi-micro columns (2mm i.d.), decrease in NTP is more remarkable than conventional columns (4.6mm i.d.), and it should be noted that NTP is degraded even for peaks of long retention time (large k') when 0.3mm i.d. plumbing is used.

9.3.2 Possible Troubles Due to Plumbing of Small Diameters

The most probable trouble with plumbing of small diameters is clogging. This comes from the fact that the inner diameter (0.13mm) is approx. half the size of conventional tubings (0.3mm i.d.) and hence cross sectional area is 1/4. The following 8 items are conceivable causes of clogging.

(1) Insoluble matters in the mobile phase
(2) Insoluble matters in the sample
(3) Suspended particles or dust in the environment
(4) Flakes of the needle seal in the injection port
(5) Flakes of vial septum
(6) Particles from the rotor seal of the high-pressure valve
(7) Particles from the pump system
(8) Particles inside of tubing

The countermeasures for each of the causes are show below.
The details are shown in "9.3.3 Causes of the Trouble and the Countermeasures" P. 9-25.

9.3.3 Causes of the Trouble and the Countermeasures

The problems that are prone to occur with LC in general, and their countermeasures, are given below. The following is the summary of the countermeasures for each item. When clogging is found, check those points and take necessary measures.

Cause of Clogging	Countermeasures	Necessary Apparatus
(1) Insoluble matters in the mobile phase	Mobile phases should be filtered prior to use especially when buffer solutions are used, because insoluble matters in the salts can cause clogging. Recommend the customer to filter buffer solutions using a commercially available filtering apparatus and membrane filters with the pore size of 0.45µm or less. This is also important for the protection of columns.	• Filtering apparatus with a filter holder • Membrane filter (pore size 0.45µm or less)
(2) Insoluble matters in the sample	Similarly, insoluble matters in the sample can cause clogging in the plumbing or column. If there are clouds in the sample or insoluble matters are visible, filter the sample solution using commercially available disposable filters before analysis. Such filters are available also from Shimadzu.	Disposable filter (Refer to p.114 - 115 of Shimadzu Column Catalogue for details.)
(3) Suspended particles or dust in the environment	Dust in the environment can enter the flow line from the injection port and cause clogging. However usually this is unlike to happen as far as the instrument is operated with the cover and door closed. Avoid dusty areas when it is necessary to open the cover for the purpose of maintenance etc.	
(4) Flakes of the needle seal in the injection port	If a deviation of the needle position occurs by any reason, the needle can scrape the needle seal and resulting flakes may cause clogging. The needle position can be checked through upward and downward motion by pressing [Z HOME]. In case a deviation of the position is found, perform teaching of the needle on the injection port.	

Cause of Clogging	Countermeasures	Necessary Apparatus
(5) Flakes of vial septa	Flakes of vial septa can cause clogged plumbing. Various kinds of septum are commercially available and they differ in material and coating. Shimadzu's genuine septa have been passed consecutive injection tests and organic solvent resistance tests, but some customers use septa from different vendors, from the view point of price. Although usually septa is laminated with a film (PTFE for example) resistant of organic solvents to prevent producing flakes, it may happen that flakes fall off when the needle go through the septum, which may results when clogging. In the event of such troubles, please recommend the customer to use Shimadzu's genuine septa and vials.	
(6) Particles scraped off the rotor seal of the high-pressure valve	As the rotation of the high-pressure valve is repeated, particles are produced through the initial wear of the PEEK rotor seal. These particles are so fine that it seldom causes clogging when plumbing, but it can result when clogging at the inlet of the column. When replacing the PEEK rotor seal with a new one, remove the particles caused from the initial wear, by delivering isopropanol or methanol at 2mL/min with the high-pressure valve rotated referring to Section 10.1.6 in the instruction manual.	• Methanol or 2-propanol
(7) Particles from the pump system	The following are possible causes of particles from the pump system. (1) Particles on the flow line parts, such as the suction filter and line filter. (2) Particles from worn plunger seals. To remove particles (1), it is always necessary, when these parts are replaced, to rinse the pump with methanol or isopropanol for 15 minutes at 5mL/min prior to making the connection with the SIL. The particles (2) are trapped in the line filter of the pump; replace the line filter at a regular interval.	• Methanol or 2-propanol
(8) Particles inside of tubing	When plumbing tubings are replaced with new ones, especially tubings that are not pre-cut, they should be rinsed enough before making connections. Deliver methanol or isopropanol for 15 minutes at 5 mL/min for rinsing.	• Methanol or 2-propanol

Although wide-bore tubing can be used for plumbing to avoid clogging, the above-mentioned matters which may cause clogging will be then trapped at the column inlet instead. Consequently this can not be an essential solution for customers, and it is therefore not a desirable countermeasure. For this reason, it is necessary to give advice to the customer according to the above causes and countermeasures.
These precautions are also the case when the SIL-20A/20AC is connected to other vendor's HPLC. Note that similar attention should be paid to other vendor's pumps and plumbing, and take necessary countermeasures.

9.3.4 General Guidelines for Changing the Plumbing

After checking the items described in "9.3.3 Causes of the Trouble and the Countermeasures" P. 9-25, determine whether or not replacement is necessary by considering the application.
In the following examples no problem arises if the tubing is the 0.3mm i.d. tubing, because use of plumbing of small diameters has little advantage in such cases.

■ When a manual injector is connected downstream from the SIL-20A/20AC.

In this case, band broadening due to plumbing matters little, because usually conventional columns (4.6 - 6mm i.d. or more) are used.

■ When only columns of wide bore (6mm i.d. or more) are used.

In this case, the plumbing contributes little to band broadening, and it has little influence to analysis data.

■ When analysis through-put has priority over protection of columns from clogging (i.e. sample filtration).

When column clogging from particles in samples is acceptable to the customer, due to situations such that a massive amount of samples should be analyzed in a short time, use of wide bore plumbing helps minimize equipment downtime due to clogged tubing.

9.3.5 Procedures of Replacement of the Plumbing

The tubing with the small inner diameter (0.125mm) provided with the SIL-20A/20AC is for use at the following place:

- Between the high-pressure valve (port 5) and the column (600 mm)

NOTE

Points to note when connecting the PEEK tubing with an SUS ferrule and male nut:
Use the following as rough guide for the degree of tightening required to tighten the male nut with a spanner.

- 6-mm male nut: Tighten securely by hand and tighten another 120 (approx.) with a spanner.
- 8-mm male nut: Tighten securely by hand and tighten another 90 (approx.) with a spanner.

After connecting the PEEK tubing, pull the tubing to check that it does not come out.

⚠CAUTION

If the male nut is tightened excessively, the end of the tubing may be crushed and cause clogging or it may be cracked.

9.4 Specifications

9.4.1 Sample Injection

Item		Specification
Injection system		Variable injection volume type (zero sample loss during injection)
Injection volume setting range		0.1 to 100µL (standard), 1 to 2000µL (optional) (0.1 to 0.9µL in 0.1µL increments, 1 to 2000µL in 1µL increments)
Number of samples processed	SIL-20A: Model without sample cooler	175 (w/1mL sample vials), 105 (w/1.5mL sample vials), 50 (w/4mL sample vials), 192 (w/2 microtiter plates each with 96 wells), 768 (w/2 microtiter plates each with 384 wells), 192 (w/2 Deep well MTP each with 96 wells)
	SIL-20AC: Sample cooler model	175 (w/1mL sample vials), 70 (w/1.5mL sample vials), 50 (w/4mL sample vials), 192 (w/2 microtiter plates each with 96 wells), 768 (w/2 microtiter plates each with 384 wells), 192 (w/2 Deep well MTP each with 96 wells)
Sample vials		1.5mL glass, 1.1mL glass, 1mL glass, 4mL glass, 0.3mL glass (w/plastic spacers), 0.3mL glass (4mL vial storage type), 1mL plastic, 0.2mL plastic, 4mL plastic, 96-well microtiter plate, 384-well microtiter plate, 96-deep well
Injection volume repeatability		RSD < 0.3% (at 10µL injection)
Carryover		Less than 0.005% (using naphthalene chlorohexidine analysis conditions)
Injection volume accuracy		±1% (at 50µL injection, n = 10)
Number of repeat injections		1 - 30 times/sample
Analysis time setting		0.01 minute steps (< 1000 minutes), 0.1 minute steps (> 1000 minutes)
Number of sample table steps		100 steps max
Sample aspiration rate		0.1-15µL/sec (0.1µL/sec increments)
Rinse aspiration rate		Variable (1 to 35µL/sec, 1µL/increments)
Applicable pressure		20.0MPa max.
Sample cooler (SIL-20AC only)	System	Direct cooling system (environment conditions: room temperature below 30°C with humidity less than 70% when the cooler temperature is set to 4°C), dehumidification function built-in
	Temperature setting range	4 to 40°C (can be cooled down to 4°C when the room temperature is below 30°C and the humidity is below 70%.)
	Temperature accuracy	±3°C (For microtiter plate, ± 6°C for deep wel plate. Not cooled below 1°C.)

9.4.2 Others

<table>
<tr><td>Item</td><td colspan="4">Specification</td></tr>
<tr><td>Liquid contact materials</td><td colspan="4">Stainless (SUS316L, SUS316), ceramic, PTFE, EFTE, FEP, GFP, sapphire, PEEK</td></tr>
<tr><td>Ambient temperature</td><td colspan="4">4-35°C</td></tr>
<tr><td>Ambient temperature</td><td colspan="4">20-85%</td></tr>
<tr><td>pH range</td><td colspan="4">1-14</td></tr>
<tr><td>Dimensions and weight</td><td colspan="4">W260 × H415 × D500mm, 27kg (SIL-20A), 30kg (SIL-20AC)</td></tr>
<tr><td rowspan="12">Power supply</td><td colspan="4">SIL-20A</td></tr>
<tr><td>Part No.</td><td>Power Supply Voltage
(indicated on the instrument)</td><td>Power consumption</td><td>Frequency</td></tr>
<tr><td>228-45006-31</td><td>AC100V ± 10% (100V~)</td><td rowspan="3">100VA</td><td rowspan="3">50/60Hz</td></tr>
<tr><td>228-45006-32</td><td>AC110 - 120V ± 10% (100 - 120 V~)</td></tr>
<tr><td>228-45006-38</td><td>AC220 - 240V ± 10% (220 - 240V~)</td></tr>
<tr><td colspan="4">SIL-20AC</td></tr>
<tr><td>Part No.</td><td>Power Supply Voltage
(indicated on the instrument)</td><td>Power consumption</td><td>Frequency</td></tr>
<tr><td>228-45007-31</td><td>AC100V ± 10% (100V~)</td><td rowspan="3">300VA</td><td rowspan="3">50/60Hz</td></tr>
<tr><td>228-45007-32</td><td>AC110 - 120V ± 10% (100 - 120V~)</td></tr>
<tr><td>228-45007-38</td><td>AC220 - 240V ± 10% (220 - 240V~)</td></tr>
<tr><td>Error display</td><td colspan="4">Exists (Error display and stop at the time of malfunction)</td></tr>
</table>

9.5 Maintenance Parts

9.5.1 Consumable Parts

Part	Part No.	Remark
NEEDLE SEAL, PEEK 20A	228-42325-01	
COATED NEEDLE ASSY 20A	228-41024-93	
GFP SEAL 42429	228-35145	
ROTOR, HPV, PEEK	228-41310-92	
ROTOR, LPV, PEEK	228-36923	
SUCTION FILTER, SUS	228-21984-01	

9.5.2 Replacement Parts

■ Fuse

Part	Part No.	Remark
Fuse, 218 3.15	072-02004-21	
Fuse, 218 06.3	072-02004-24	

■ Electrical Parts

Part	Part No.	Remark
PCB ASSY, SIL-XP MAIN	228-43400-92	
PCB ASSY, SIL-XP COOL	228-43410-91	
PCB ASSY, DOOR SENSOR	228-43420-91	
PCB ASSY, CV SENSOR	228-43420-92	
PCB ASSY, V SENSOR	228-43430-91	Back of measuring pump, for high-pressure valve, low-pressure valve
PCB ASSY, HV SENSOR	228-43430-92	
PCB ASSY, PUMP SENSOR	228-43435-91	Upside of measuring pump
PCB, LC2K-RACK-G ASSY	228-37360-92	
PCB ASSY, SIL ENC X	228-43425-91	
PCB ASSY, SIL ENC Y	228-43425-92	
PCB, LC2K-XHP-G ASSY	228-37365-92	

Part	Part No.	Remark
PCB, LC2K-INJ2-G ASSY	228-37320-92	
PCB, LCXP-KEY ASSY	228-45600-91	
PCB ASSY, OPTION PUMP	228-43440-91	For rinsing pump (optional)
Cable, SIL-XHP-G	228-43477-91	
Cable, SIL-YHP-G	228-43477-92	
ASSY, HARNESS MAIN-INJ2	228-45403-91	
ASSY, FPC-Z	228-37541-91	
Cable, VALVE SENSOR	228-43463-91	
Cable, HV SENSOR	228-43464-91	
Cable, RACK SENSOR	228-43465-91	
Cable, DOOR SENSOR	228-43466-91	
Cable, LCXP-KEY	228-42042-05	
Cable, OPTION PUMP	228-43468-91	
Cable, COOL	228-45484	
SIL-XP SW ASSY	228-43470-91	
Cable, 24V SWPS	228-43471-91	For SIL-20A
Cable, 24V SWPS	228-43471-92	For SIL-20AC
Cable, INLET-FH L	228-43476-91	
Cable, INLET-FH N	228-43476-92	
Cable, INLET-EARTH	228-43473-91	
Fuse, 218 004	072-02004-22	Two used with PCB ASSY, SIL-XP COOL
Fuse, 218 06.3	072-02004-24	Used with PCB ASSY, SIL-XP COOL

■ Control Parts

Part	Part No.	Remark
Control panel, SIL-20A	228-43200-96	
Control panel, SIL-20AC	228-43200-97	

■ XY Truck

Part	Part No.	Remark
BRG, DDR-1760X2ZZ	228-40539	
BRG, DDLF-950ZZ	228-22608	
Motor X	228-36362-02	
Slit 3	228-43369	
Snapring E3	026-66203	
Snapring, SUS, E4	026-66204	

■ Z Truck

Part	Part No.	Remark
Motor Z	228-36607-01	
Belt Z	228-36792-11	
Spring UF6-45 (For detection plate)	034-01615-09	
Spring (For detection plate)	228-43158-03	
Z Screw-20A	228-43102	
Z Cover with JP Label	228-43251-91	
Z Cover with EN Label	228-43251-92	
Spring (Z NUT)	228-43158	

■ Autosampler Base Parts

Part	Part No.	Remark
Motor Y-20A	228-43198-01	
Belt Y	228-36358	
Block Rack Holder ASSY	228-36651	
Spacer Rack	023-65102-05	
Rack Guide	228-36652	
Rack Plate ASSY	228-43029-91	For SIL-20A
Rack Plate ASSY	228-43029-92	For SIL-20AC

■ Valve Assy

Part	Part No.	Remark
Motor 6V_20A	228-37521-93	
Motor 5PV-20A	228-37521-94	
High-pressure valve assy	228-43034-91	
Leak Sensor 20A	228-39247-93	
Motor, PUMP 20A	228-36444-03	
Belt PUMP	228-36792-10	
Sensor Block	228-36336-01	
Bearing CRT9-17	228-35008	
Plunger ASSY	228-35010-91	
Stator, 5PV	228-36917-01	
Low-pressure valve ASSY 20A	228-37506-92	
Packing, 5PV	228-38654	
20A panel F	228-43133	

■ Common Parts

Part	Part No.	Remark
Screw, PC Pan Head M3 × 8	020-03044	
Screw, SUS Flat Head M4 × 8	020-12125	
Screw, SUS Truss Head M3 × 6	020-37043	
Screw, SUS Truss Head M2 × 4	020-37051-01	
Screw, SUS Truss Head M4 × 8	020-37054	
Screw, SUS Truss Head M4 × 10	020-37055	
Screw, SUS Sems P3BK M3 × 6	020-46534	
Screw, SUS Sems P3BK M3 × 8	020-46535	
Screw, SUS Sems P3BK M3 × 10	020-46536	
Screw, SUS Sems P3BK M4 × 6	020-46546	
Screw, SUS Sems P3BK M4 × 8	020-46547	
Screw, SUS Sems P3BK M4 × 35	020-46555	
Screw, SUS Sems P4BK M3 × 10	020-46636	
Screw, SUS Sems P3BK M4 × 16	020-46653	
Tapping Screw, SUS Flat Head 3 × 6	021-60416-01	
Bolt, SUS, Hex Socket Head M4 × 20	022-27049	
Bolt, SUS, Hex Socket Head M4 × 30	022-27053	
Bolt, SUS, Hex Socket Head M4 × 35	022-27054	
Bolt, SUS, Hex Socket Head M4 × 10	022-27618	
Nut, SUS #1 M3	023-04030	
Nut, SUS #1 M4	023-04040	
Nut, SUS #3 M3	023-04130	
Nut, SUS Domed Cap M3	023-33130	
Washer, SUS Plain (Small) M3	023-66030	
Washer, SUS Plain (Small) M4	023-66040	
Washer, SUS Plain M3	023-66130	
Washer, SUS Spring M3	023-77030	
Washer, SUS Spring M4	023-77040	
Screw, Type of Fix	228-34771	

■ Parts for SIL-20AC ONLY

Part	Part No.	Remark
Heat Insulator 1	228-43118-01	
Heat Insulator 2	228-43118-02	
Heat Insulator 3	228-43118-03	
Heat insulating material, rack plate sub	228-43119	
Heat insulating material, cover	228-43120	
Rack Plate Heat Insulator	228-43121	
Rack Heat Insulator	228-43123	
Rack Peltierfin Heat Insulator	228-43124	
Peltier Unit, COOLING	228-43125-91	
Heater, SIL-20A ASSY	228-43461-91	
Insulator, BFG-30 D-3	060-49780-06	
Heat Sink, HSC100	060-49902	Total volume: 100g
Peltier ASSY (Dry)	228-43030-91	For dehumidifier of SIL-20AC
Dew Tray	228-38090	
Thermistor SIL-20A ASSY C	228-43460-91	For Rack plate assy of SIL-20AC
Thermistor SIL-20A ASSY D	228-43460-92	For dehumidifier of SIL-20AC
Ambient temperature sensor ASSY	228-43462-91	
Heat Insulator Sheet	228-43122	
20A panel F	228-43031-91	For SIL-20AC

■ Others

Part	Part No.	Remark
PTFE Tubing $\phi 7 \times \phi 6$	016-37507	
FEP Tubing _NFL016	016-37722-06	
Rubber Pad	228-25436	
Syringe Needle, Lock	046-00002	
Syringe, L-208	046-00038-01	
Spanner 6×8	086-03003	
Spanner 8×10	086-03006	
Allen wrench, 3mm	086-03804	
Allen wrench, 4mm	086-03805	
Ferrule, PTFE 3.0F-T	228-12493	
Syringe, Adapter	228-15672-91	

Part	Part No.	Remark
Ferrule	228-16000	
Male Nut, 1.6MN	228-16001	
Male Nut, 1.6MN, W6	228-16001-03	
Coupling, 1.6C	228-16004-13	
Needle ASSY Syringe	28-18216-91	
ETFE Tubing, 1.6 × 1.0	228-18495-03	Order by the mm
Male Nut 1.6MN(PEEK)	228-18565	
SUS316TP1.6 × 0.3 × 600L	228-22306-00	
Seal Installation Tool	228-25142	
Drain Tubing, L	228-28094	
Tubing Joint, T	228-28162	
Tubing Joint, Straight	228-28163	
Ferrule 1.2F	228-28430	
PEEK Tubing 1.6 × 0.13	228-32999-01	Order by the mm
Plunger Tool	228-34672-02	
Male Nut Needle	228-36689	
Sample Loop ASSY	228-45402-91	
Bushing, 3PEEK	228-39084	
Suction Filter ASSY	228-39181-93	
Tubing Holder	228-39621	
Lubricating Oil, DAPHNE-220C, 3ML	228-40593-91	
Grease, DAPHNE POLYLEX-#2,3ML	228-40638-91	
PEEK Tubing, 0.13ID × 600	228-40984-94	
Wiring clamp kit	228-45404-91	Quantity: 10
PTFE Tubing 3 × 2	670-10321-03	
FEP Tubing 3 × 1.5	670-10321-05	
Fitting set 20A (1PC)	228-45407-91	For HPV
Fitting set 20A (5PC)	228-45407-92	For HPV
Drain tubing clamp	228-43347	
Cover for rinsing port	228-43311	

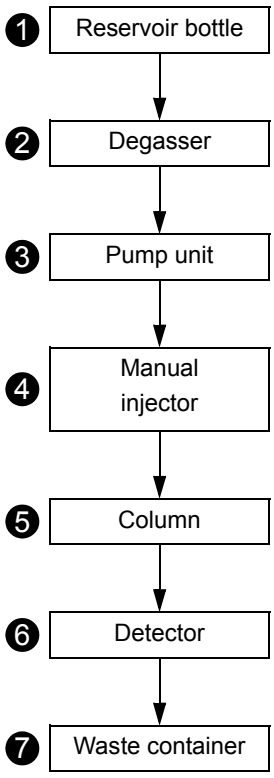
9.6 Introduction to HPLC System

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.

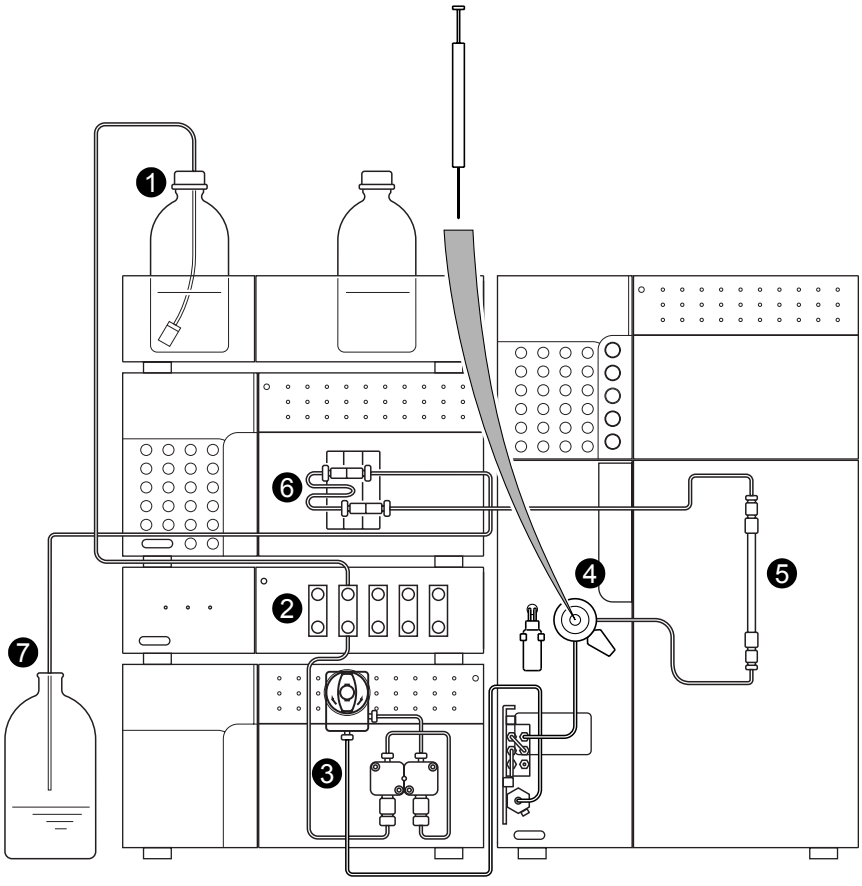
9.6.1 Example of a Simple (Isocratic) System

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



❶Mobile phase is drawn out of the reservoir bottle and pumped through the tubing by the pump.
❷The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
❸The pump sends the mobile phase through the manual injector, column and detector, in that order, and finally into the waste container.
❹Samples are injected into the system by the manual injector, with a syringe.
❺In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
❻The detector detects the components eluted from the column, and sends the signal data to a Chromatopac or PC.
❼Mobile phase from the detector drains into the waste container.

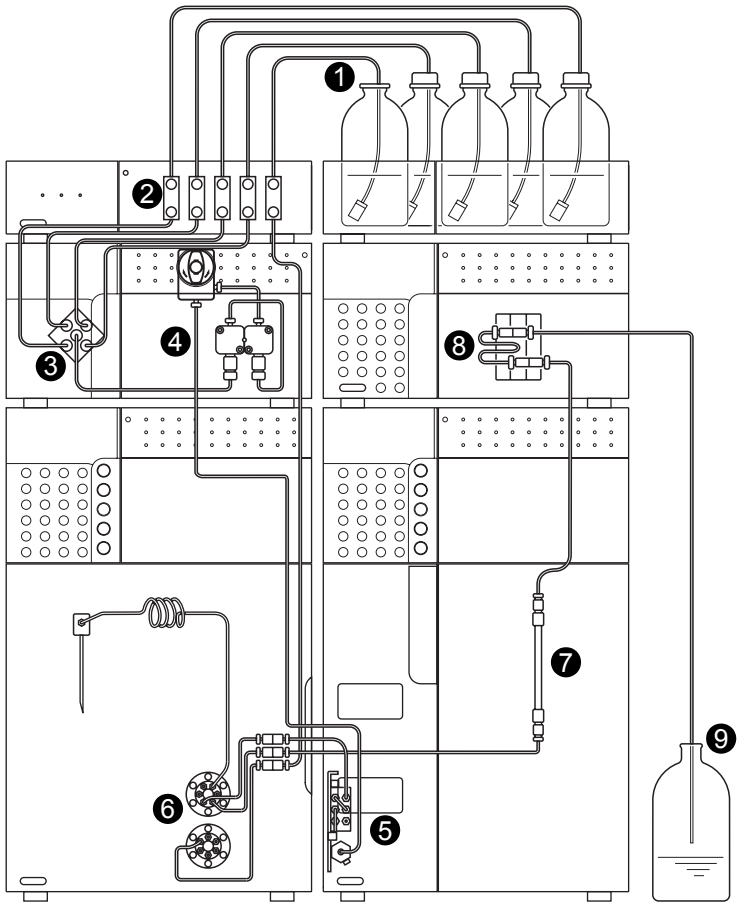
9.6.2 Example of Autosampler System (1)

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

❶ Reservoir bottle
↓
❷ Degasser
↓
❸ Low-pressure gradient unit*
↓
❹ Pump unit
↓
❺ Mixer
↓
❻ Autosampler
↓
❼ Column
↓
❽ Detector
↓
❾ Waste container

■ Function of Components



❶Mobile phase is drawn out of the reservoir bottles and pumped through the tubing by the pump.
❷The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
❸The 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.)
❹The pump sends the mobile phase through the autosampler, column and detector, in that order, and finally into the waste container.
❺The mixer enhances the mixing efficiency of the mobile phases. This item is required for low or high-pressure gradient system.
❻The autosampler automatically injects the sample into the flow lines. By adding a rack changer, it is possible to automatically change the autosampler racks.
❼In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
❽The detector detects the components separated in the column, and sends the signal data to a Chromatopac or PC.
❾Mobile phase from the detector drains into the waste container.

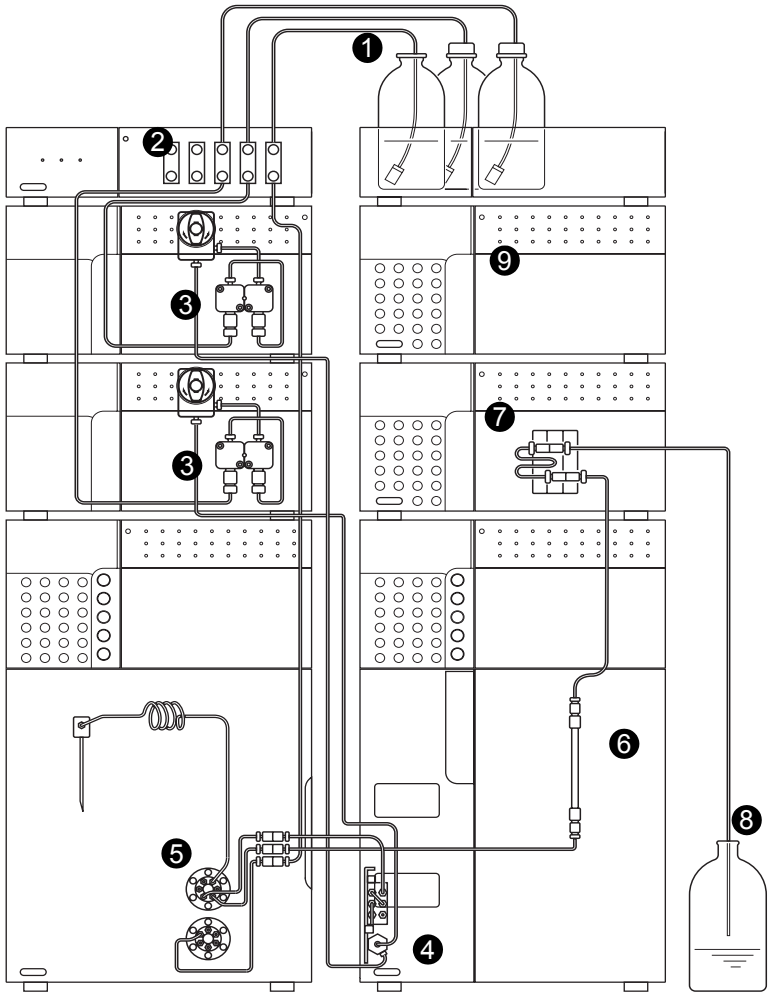
9.6.3 Example of Autosampler System (2)

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

❶ Reservoir bottle
↓
❷ Degasser
↓
❸ Pump unit
↓
❹ Mixer
↓
❺ Autosampler
↓
❻ Column
↓
❼ Detector
↓
❽ Waste container

■ Function of Components



❶Mobile phase is drawn out of the reservoir bottles and pumped through the tubing by the pump.
❷The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
❸The pump sends the mobile phase through the autosampler, column and detector, in that order, and finally into the waste container.
❹The mixer enhances mixing efficiency of the mobile phases.
❺The autosampler automatically injects the sample into the flow lines. By adding a rack changer, it is possible to automatically change the autosampler racks.
❻In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
❼The detector detects the components eluted from the column, and send the signal data to a Chromatopac or PC.
❽Mobile phase from the detector drains into the waste container.
❾The 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.

9.7 Mobile Phase Characteristics

	(1) Solvent (*) η<.5cP, > 45°C (**) η<.5cP, < 45°C	(2) Source	(3) UV Cutoff	(4) R.I.$_{25°}$	Boiling Point (°C)	Viscosity (cP, 25°C)	(5) p'	(6) $e°_a$	(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 Dielect. const (Function proportional to strength)
2	Isooctane(*) (2,2,4-trimethylpentane)	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	l-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	Tricresy 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
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		

	(1) Solvent (*) η<.5cP, > 45°C (**) η<.5cP, < 45°C	(2) Source	(3) UV Cutoff	(4) $R.I._{25°}$	Boiling Point (°C)	Viscosity (cP, 25°C)	(5) p'	(6) $e°_a$	(7) Water Solubility %W in 20°C Solvent	(8) Dielectric Constant e^{20}	(9) p'+0.25e
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	Dimethylforfmamide	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-pyrolidone	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	
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°C) and low viscosity (*0.5cP).
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, Mallinkrodt Chemical, Fischer Scientifie, 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.Blown, *Reversed-Phase High-Performance Liquid Chromatography, Wiley Interscience, 1982.*

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