

**COLUMN OVEN
FOR SHIMADZU HIGH PERFORMANCE
LIQUID CHROMATOGRAPH
CTO-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

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Introduction

Read this manual thoroughly before using the instrument.

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

IMPORTANT

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

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Warranty and After-Sales Service

Warranty

1. Validity

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

2. Term

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

3. Items Not Covered by the Warranty

The warranty does not cover malfunctions that result from:

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

After-Sales Service

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

Replacement Parts Availability

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

Hardware Validation

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

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



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

Hardware Validation Contract

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

Safety Instructions

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

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

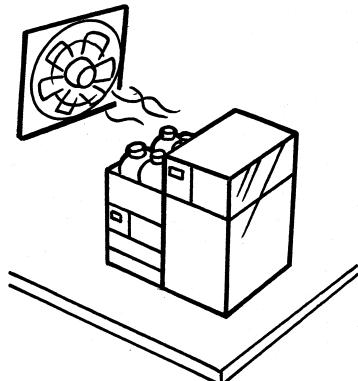
■ Application Precautions

⚠ WARNING This instrument is a column oven 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.
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■ Installation Site Precautions

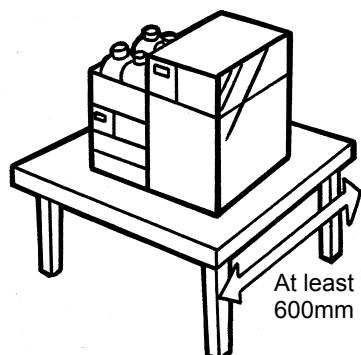
⚠ WARNING

- The solvents used in high performance liquid chromatograph are flammable and toxic. The room where the instrument is installed should be well ventilated; otherwise, solvent vapors could cause poisoning or ignite and cause a fire.
 - High performance liquid chromatograph uses large amounts of flammable organic solvents. Use of open flame in the vicinity of this instrument must be strictly prohibited. Do not install the instrument in the same room with any other equipment that emits or could potentially emit sparks, since sparks could cause a fire.
- Provide fire extinguishers for use in case of fire.
- Provide protective equipment near the instrument.**
If solvent gets into the eyes or on the skin, it must be flushed away immediately. Provide equipment, such as eye wash stations and safety showers, as close to the instrument as possible.



⚠ CAUTION

- The weight of this instrument is 20kg.**
During installation, consider the entire weight combined with other LC components.
The lab table on which this instrument is installed should be strong enough to support the total weight of the LC system. It should be level, stable and have depth of at least 600mm.
Otherwise, the instrument could tip over or fall off the table.
- Avoid installation sites that are exposed to corrosive gases or excessive dust.**
These adverse conditions may be detrimental to maintaining the instrument performance and may shorten its service life.



■ Installation Precautions

⚠ WARNING

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

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

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

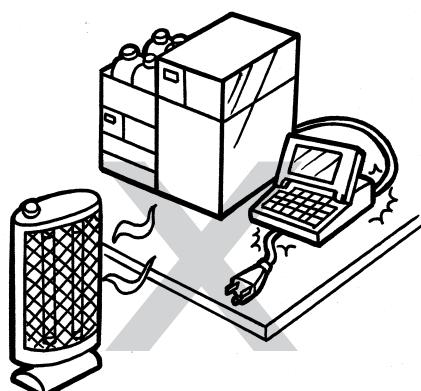
Part No.		Power Supply Voltage (indicated on the instrument)	Power Consumption	Frequency
CTO-20A	CTO-20AC			
228-45009-31	228-45010-31	AC100V (100V~)	500VA	50/60Hz
228-45009-32	228-45010-32	AC120V (120V~)	600VA	50/60Hz
228-45009-38	228-45010-38	AC220-240V (220-240V~)	600VA	50/60Hz

- **Ground the instrument.**

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

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

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



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

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

⚠ CAUTION

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



■ Operation Precautions

⚠ WARNING

- Take thorough measures to prevent buildup of static electricity.

"Static Electricity Precautions" P.IX

Static electricity could result in fires or explosions.



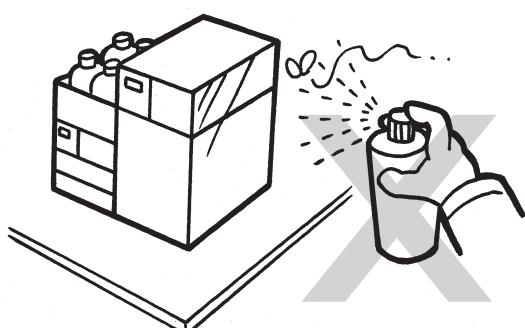
- Always wear protective gloves and protective goggles when handling solvents and samples.

If solvent gets into the eyes, blindness could result.

Should solvent get into the eyes, flush immediately with large amounts of water and get medical attention.



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



- Never use a cracked reservoir bottle.

If a helium degasser is used, pressure is exerted on the reservoir bottles and may cause cracks in the bottles.

It could break the reservoir bottles and cause injury.

- Do not use flammable sprays (hair sprays, insecticide sprays, etc.) near the instrument.

They could ignite and cause a fire.

■ Precautions for Instrument Inspection, Maintenance, Adjustment and Care

⚠ WARNING

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

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

- **Never remove the main cover.**

This may cause injury or malfunction of the instrument.

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



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

Any other fuses could cause a fire.

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

If dust is allowed to accumulate, fire could result.

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

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

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

They could cause discoloration.

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

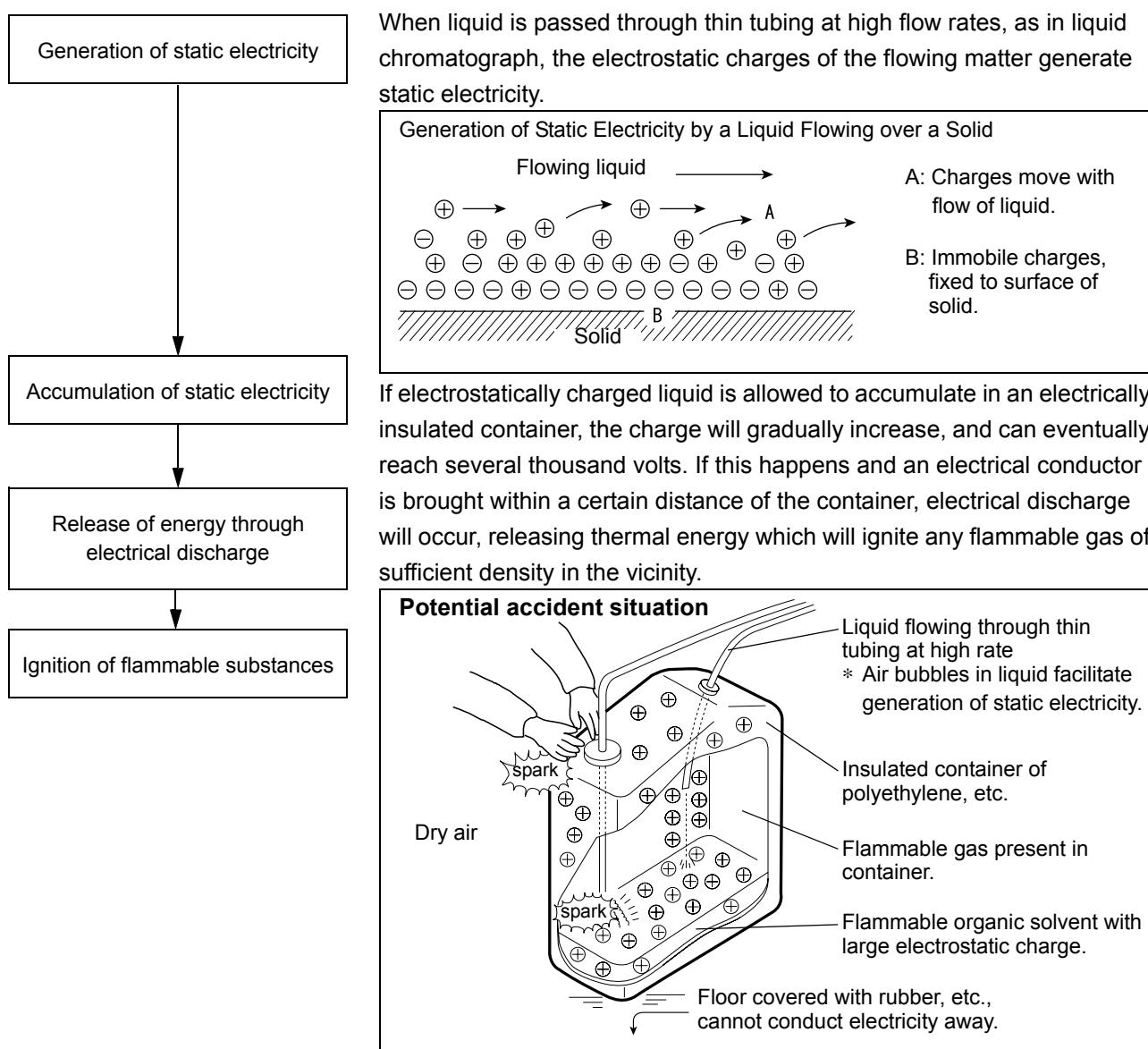
Static Electricity Precautions

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

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

■ Typical Cause of Static Electricity Accidents

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



■ Preventing Static Electricity Accidents

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

⚠ CAUTION

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

Preventive Measure 1

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

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

Accessories for this measure

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

⚠ CAUTION

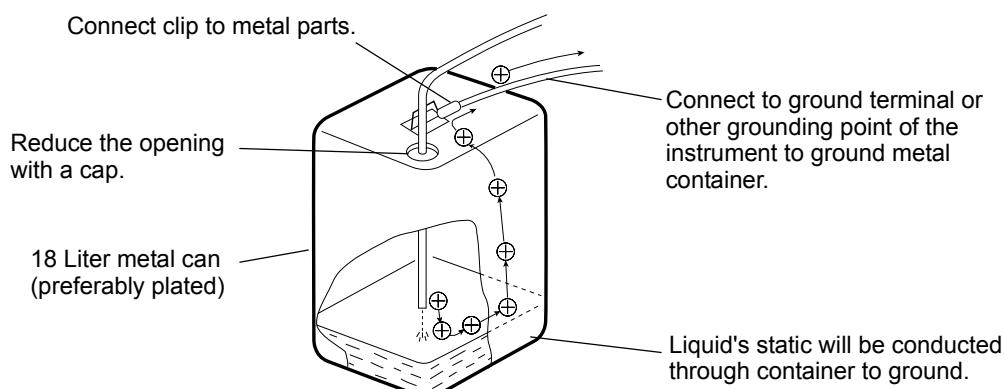
- **Be sure to ground the metal waste container properly.**

If the grounding wire is not properly attached or connected to the ground, static electricity can build up in the container.

- **Some metal containers have surfaces that are laminated or oxidized, and therefore do not conduct electricity. After grounding the metal container, use a tester to verify that electricity is conducted to the ground.**
- **If the liquid to be drained into the waste container is virtually non-conductive (10^{-10} S/m or less), it will be necessary to add properly conductive, and therefore safe, liquid to the tank.**

This conductive liquid may be added beforehand.

Preventive Measures for Static



Preventive Measure 2

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

Accessories for this measure

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

Part No. 228-21354-91

Preventive Measure 3

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

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

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

**CAUTION**

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

Preventive Measure 4

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

**CAUTION**

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

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

Preventive Measure 5

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

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

⚠ CAUTION

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

- Use as small a container as possible to minimize damage in the event of fire.
- Keep the room at a proper humidity.

Ambient humidity exceeding 65% will prevent static.

For Reference

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

Precautions for Mobile Phase Selection and Use



CAUTION

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

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

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

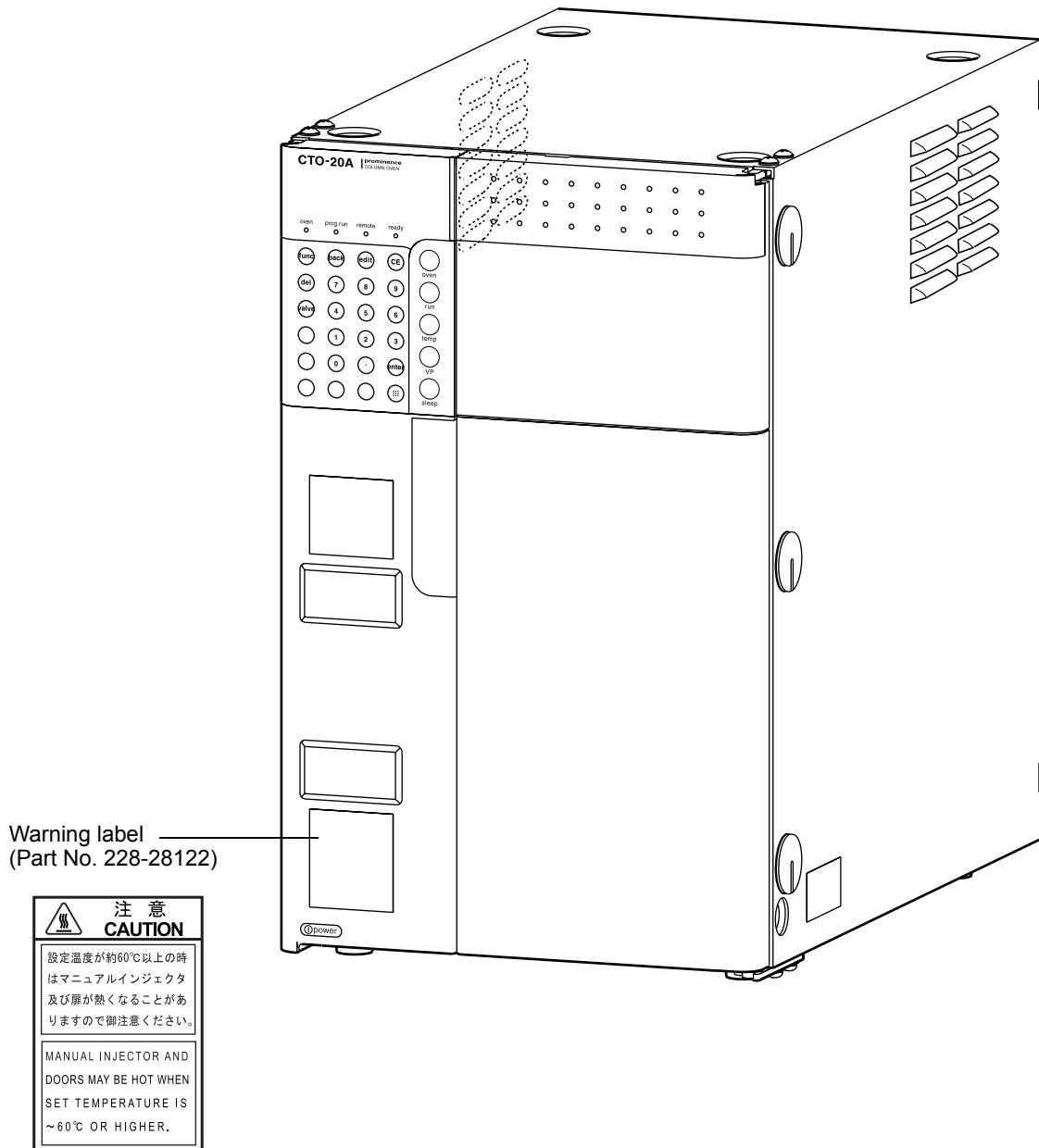
NOTE

- Use only HPLC grade or comparable mobile phase, and filter it with a filter of 0.45µm 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 Mobile Phase Characteristics" P. 9-40

Warning Labels

For safety operation, warning labels are affixed to where special attention is required.

Should any of these labels peel off or be damaged, obtain replacements from Shimadzu Corporation.



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Configuration

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1.1 Overview

The Shimadzu CTO-20A/20AC column ovens were developed to maintain the temperature of the LC system column and flow lines at a constant temperature, in order to provide heightened analysis reproducibility and separation performance. The oven is an air-circulated thermostatic chamber for the Shimadzu High Performance Liquid Chromatography system.

The CTO-20A model column oven regulates temperatures with a heater only, while the CTO-20AC model is additionally equipped with cooling mechanisms that enable it to regulate the oven and flow lines to temperatures below room temperature.

In addition to a column oven, a high performance liquid chromatography system requires, at a minimum, a pump, injector, column, detector, and system controller.

Consult your Shimadzu representative regarding the components that are necessary for your system.

1.2 Features

- The main purpose of this column oven is to keep the column temperature constant. In addition to the column, the oven can also house manual injectors, mixer, column switching valves, and other flow line accessories.
Installing these in the oven isolates them from the influence of ambient temperature and makes for more stable analysis. Shorter plumbing distances also reduce dead volume in the flow lines.
- The oven has a built-in CPU, allowing the set temperature to be controlled by a time program, even when the oven is controlled locally. Use of a system controller (CBM-20A) permits finer control, like starting analysis when temperature stabilizes and stopping analysis when leaks or problems are detected.
- The air circulation ratio of the fan automatically matches the set temperature, to keep temperature constant. At high temperatures, the air circulation ratio is increased to keep the temperature constant, and at temperatures close to the ambient temperature, the air circulation ratio is decreased to suppress heat generation due to the air circulation. The fan speed is controlled so as to remain constant even when there are fluctuations in the power supply. This enables stable temperature regulation.
- Safety is assured by a fuse that automatically shuts off the power if the temperature rises to abnormally high levels, or if a flammable organic solvent leak is detected inside the oven.

1.3 Component Parts

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

Part	Part No.	Q'ty	Remark
Column oven	-	1	
AC power cord (for 100V, 120V)	071-60816-12	1	Not provided with 220-240V spec.
AC power cord (for 220-240V)	071-60825-51	1	Not provided with 100V, 120V spec.
Adapter KPR-14	071-60813	1	Not provided with 120V, 220-240V spec.
Instruction manual (Japanese version)	228-90074	1	Not provided with 120V, 220-240V spec.
Instruction manual (English version)	228-90075	1	Not provided with 100V spec.
Optical cable HFBR3600-1-021	070-92025-51	1	
Vial holders	228-23875	2	
Sample vials	038-00165-11	2	
Column clamps (small)	228-15617-91	2	
Column clamps (large)	228-15617-92	2	
Drain tubing kit	228-43969-91	1	
Ambient temperature sensor	228-34620-92	1	
Event cable	228-28253-91	6	
Signal cable	228-39306-91	1	
Terminals	071-03511-01	12	
Clamp DKN-10GSP	072-60319-01	1	
Note CTO-20A/20AC	228-35779	1	
Label, CTO-20A/20AC	228-46424	1	Listed of auxiliary functions.Put it on conspicuous place.

1.4 Optional Parts

Optional parts which can be added to the column oven are listed below.

For details about available columns, see our Column Catalog.

Option	Part No.	Features
FCV-12AH	228-45013-91	Valve that automatically switches between 2 columns.
FCV-14AH	228-45014-91	Valve that automatically switches between up to 6 columns. Two are required: one at column inlet, one at outlet.
Cooler addition unit	228-45700-91	Unit for upgrading from the CTO-20A (without cooler) to the CTO-20AC (with cooler).
Column clamps	228-28637-91	One column clamp can hold two 6.4-12.7mm outer diameter columns.
Mixer	228-45083-91	A static mixer for high or low pressure gradient elution analysis.
Semi-micro mixer	228-35830-91	A static mixer for semi-micro HPLC.
CMD (Column Management Device)	228-37281-91	Stored column-related information via the CBM-20A system controller.
CMD cable	228-39991-01	To connect between the CMD and this instrument.

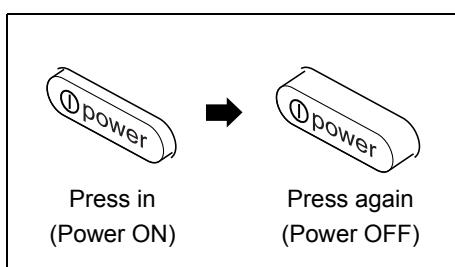
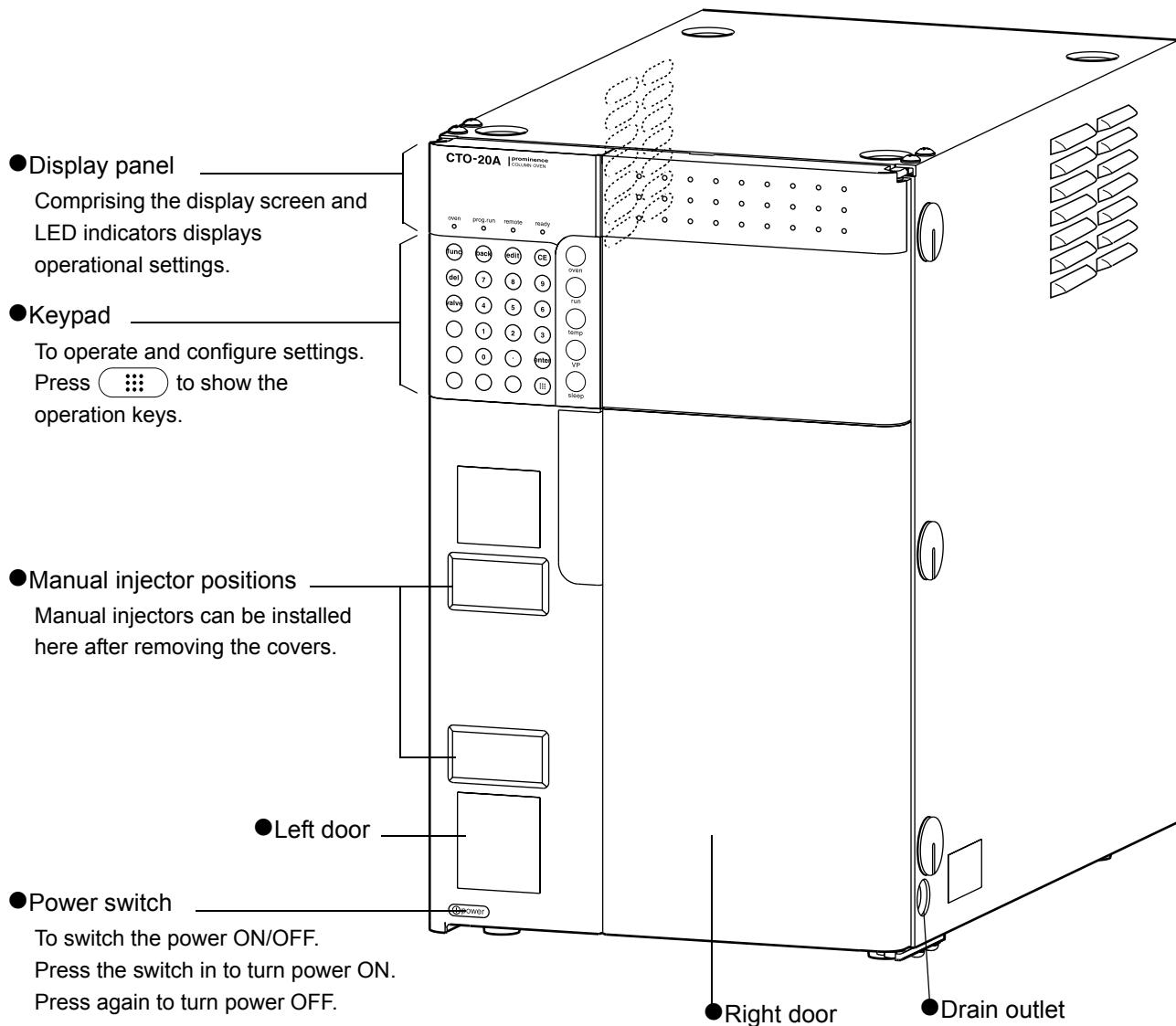
2

Parts Identification and Function

Contents

2.1	Front Cover	2-2
2.2	Opening and Closing the Left Door	2-3
2.3	Interior	2-5
2.4	Back	2-6
2.5	Names and Functions of Displays and Keypad	2-7

2.1 Front Cover



NOTE

When the doors are opened, temperature regulation stops and the "oven" indicator blinks.

Temperature regulation resumes as soon as the doors are closed.

2.2 Opening and Closing the Left Door

⚠ CAUTION

Beware of burns when the operating temperature is high (60°C or over).

If the manual injector is installed on the left door, remove the male nut from the column inlet before opening the door.

 "Plumbing between Manual Injector and Column" P. 9-20

Otherwise, when the left door is opened, the SUS tubing will pull on the column and could damage it.

NOTE

Do not try to force the left door open when it is locked. Doing so could damage the lock. Do not force the lever up if it appears to be stuck. Look behind the left door and check that the tubings (e.g., for the manual injector) are not caught on anything and that they are not pushing against the door. Then, push the left door in slightly while moving the lever up slowly.

2.2.1 Opening the Left Door

Move the lever up, and pull the left door open.

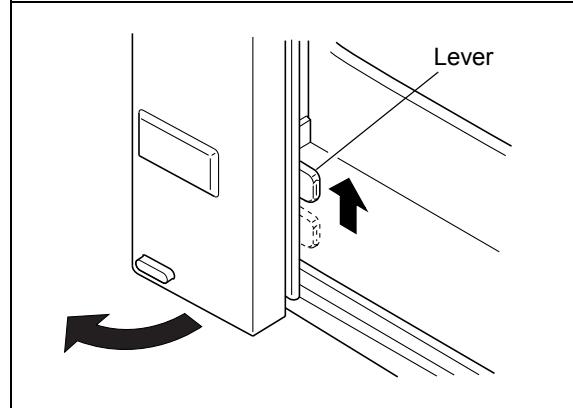


Fig. 2.1

2. Parts Identification and Function

2.2.2 Closing the Left Door

- 1 Close the left door with the lever in the raised position.

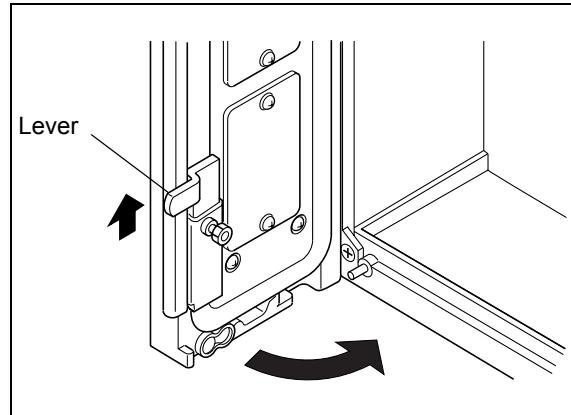


Fig. 2.2

- 2 Move the lever back down after closing the door. This locks the left door.

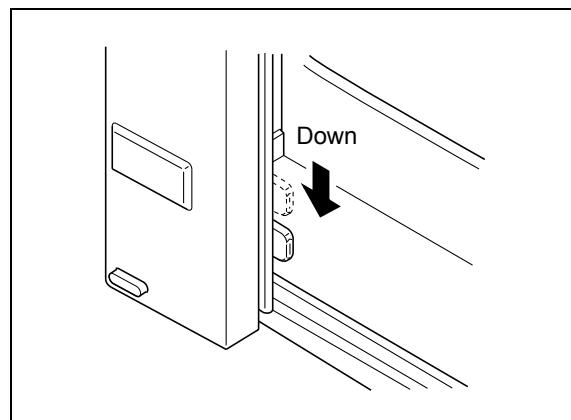


Fig. 2.3

NOTE

The lock can be disabled if not required.
Hand-tighten the screw shown in the figure to keep the lever in the raised position.

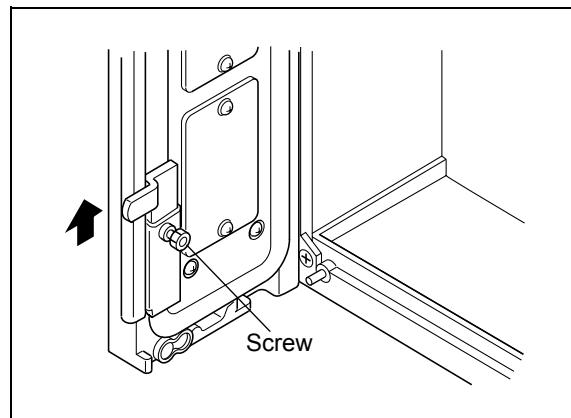
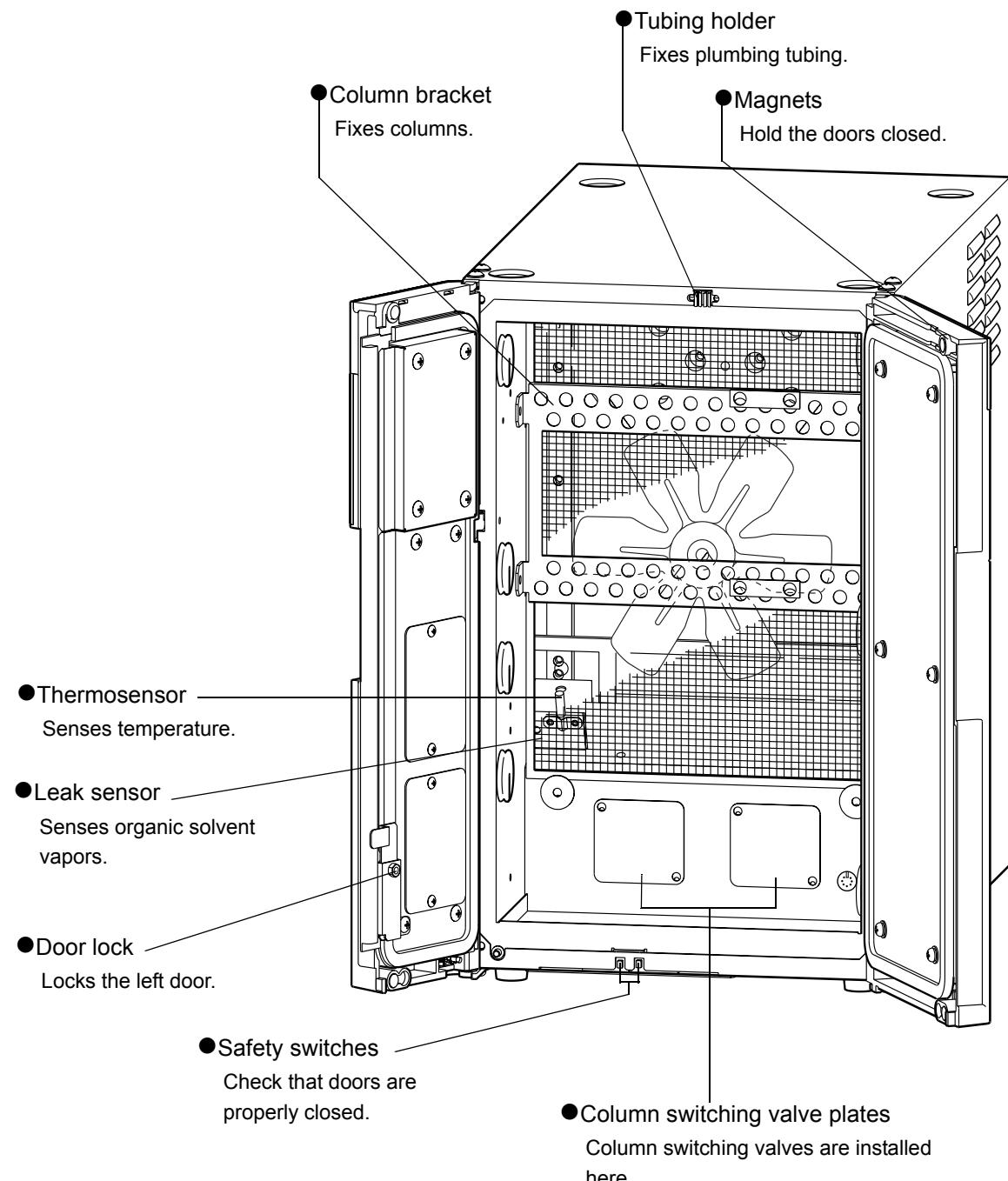
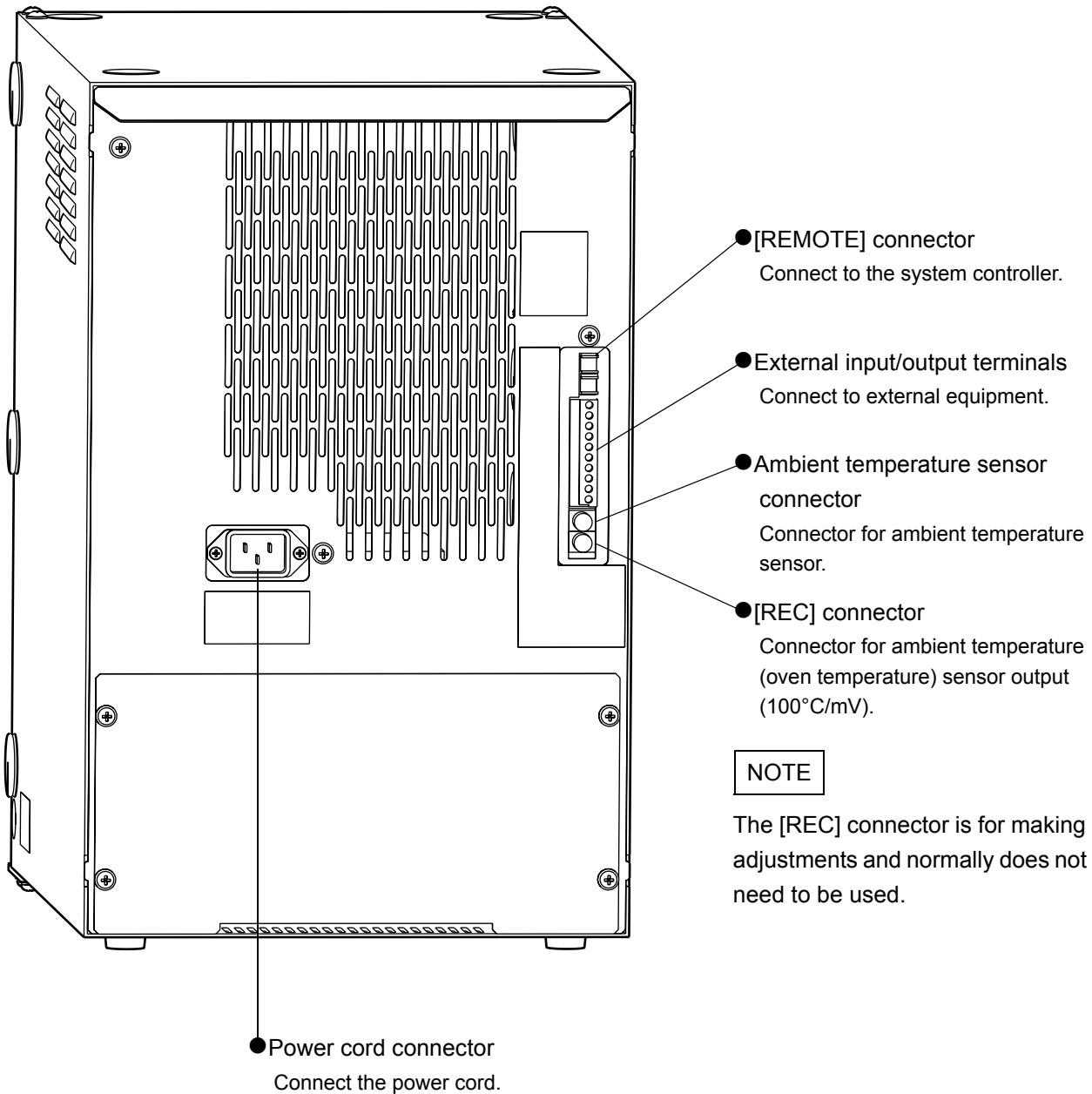


Fig. 2.4

2.3 Interior



2.4 Back

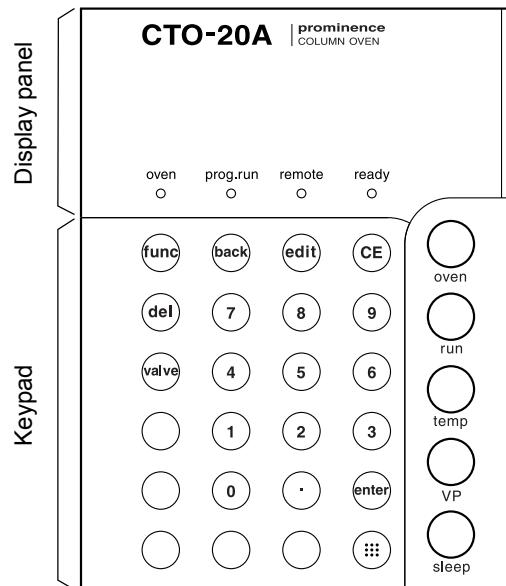


2.5 Names and Functions of Displays and Keypad

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

NOTE

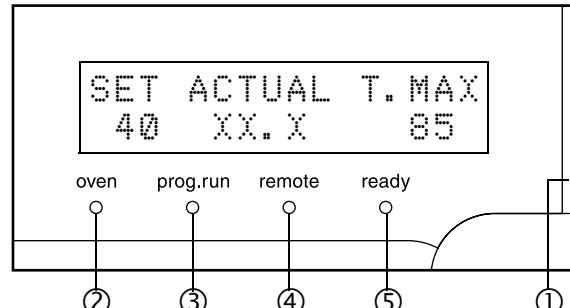
The display screen may become hot when in use.



2.5.1 Display Panel

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

Names and functions of the screen sections and the indicators are listed below.



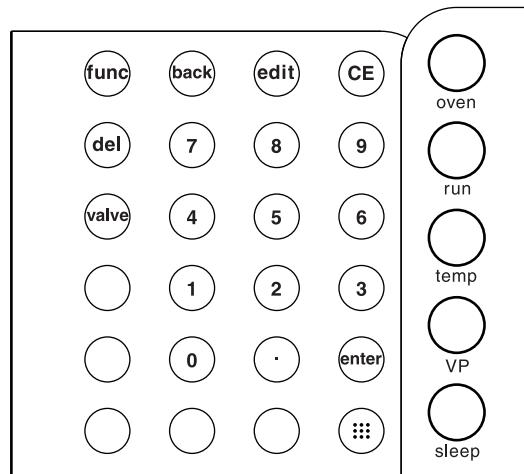
No.	Display or indicator	Function
①	Status Indicator	Green : when power is ON. Red : when an error is generated. Orange : during sleep mode.
②	oven	Oven operation indicator On when temperature regulation starts. * If the door is opened, temperature regulation stops, and the oven operation indicator blinks. Temperature regulation resumes when the door is closed.
③	prog.run	Time program indicator On when time program is running.
④	remote	Remote control mode indicator On when the system controller is used.

2. Parts Identification and Function

No.	Display or indicator	Function
⑤	ready	Ready indicator Turns on during temperature regulation when the difference between the actual temperature and the set temperature stays within the [READY RANGE(°C)] setting for a period longer than the [WAIT TIME(minute)] setting. Turns on unconditionally if the [WAIT TIME] is set to 0.  P.5-20

2.5.2 Keypad

The keys on the keypad on the front of the column oven are used to operate the instrument and set parameters. Functions of each key are listed below.



Key	Indicator	Function
	Display key	To show the operation keys.
	Oven key	For starting and stopping temperature control. Pressing this key starts temperature regulation when control is not being performed and stops it when it is.
	Run key	Starts and stops time programs. Pressing this has no effect if the time program has not been set.
	Temperature key	For switching to the operating temperature setting screen.
	VP key	For selecting VP functions. To switch to VP mode, press this button while the initial screen or time program edit screen is displayed. Press this repeatedly to scroll through VP function groups.
	Sleep key	For switching between normal and sleep modes. Sleep mode turns off the display screen, but operation is not affected.
	Function key	Scrolls forward through parameters. Each time this is pressed, the display switches to next parameter. Pressing this key after selecting a VP function item switches the VP function setting screen to the next item.

Key	Indicator	Function
back	Back key	For switching between setting items. Scrolls backward through parameters. Each time this is pressed, the display switches to the previous parameter. Pressing this key after selecting a VP function item switches the VP function setting screen to the previous item.
edit	Edit key	Activates time program edit mode (from initial or VP screens).
CE	Clear key	Returns the display to preceding menu screen. Clears error messages and cancels alarms.
del	Delete key	Deletes individual lines of the current time program (when writing/editing time programs).
valve	Valve key	For moving to the automatic column switching valve setting screen.
■ - 9	Numeric keypad	Sets the numerical values for the display screen.
enter	Enter key	Registers or executes a command displayed on the screen.

2. Parts Identification and Function

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3

Installation Procedures

Contents

3.1 Column Installation.....	3-2
---------------------------------	-----

3.1 Column Installation

There are two ways of installing the column:

- With column clips. These make removal of the column simple.
- With column clamps. These fasten the column very securely.

3.1.1 Installation with Column Clips

NOTE

Two column clips, for 6.4-9.5mm outer diameter columns, are installed on the bracket at delivery. An additional two column clips (for 9.5-12.7mm outer diameter columns) are included among the accessories as optional.

 "1.3 Component Parts" P. 1-3

- 1 Attach the column clips to the column bracket with the latches.

NOTE

- Two column clips (one upper and one lower) are needed to install one column.
- Attach the upper column clip to the lower row of holes in the upper bracket. This prevents the column from coming into contact with the top of the cover.

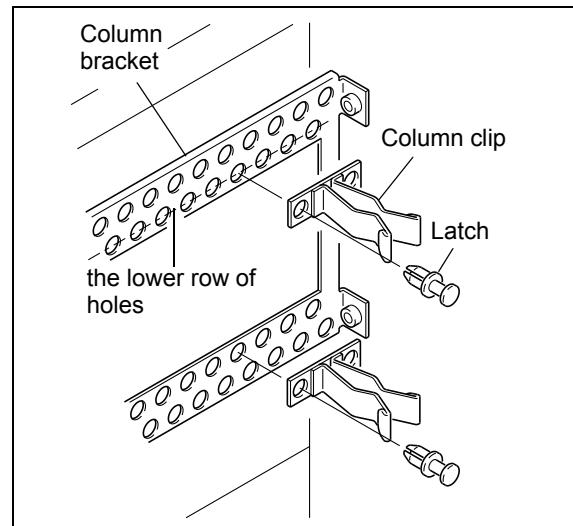


Fig. 3.1

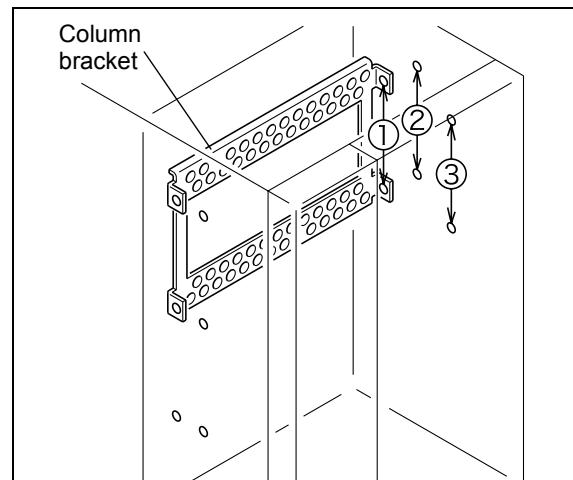


Fig. 3.2

- 2** Orient the column with its outlet at the top (as shown on the right), and push it into the column clips.
Verify that the column is held securely.

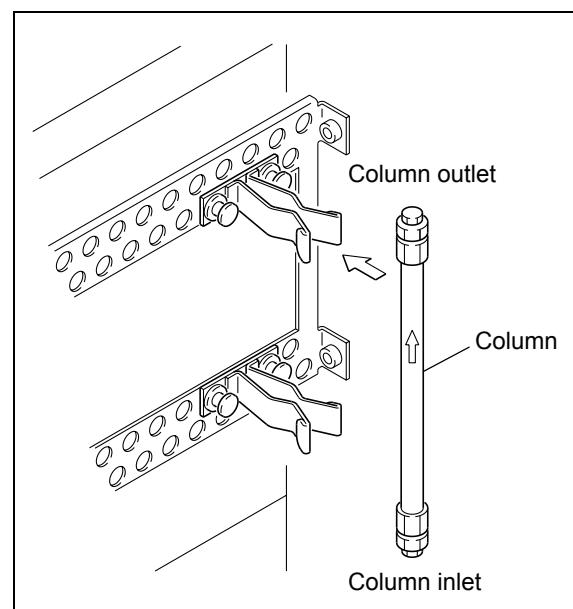


Fig. 3.3

3. Installation Procedures

3.1.2 Installation with Column Clamps (Optional)

- 1** Loosen the screw on the front of the clamp, and remove the cover.
- 2** Attach the column clamp to the column bracket with latches.

NOTE

If the column bracket is installed in positions ① or ② of "Fig. 9.21 " P. 9-16, attach the column clamp to the lower row of holes in the upper bracket. This prevents the column from coming into contact with the top of the oven.

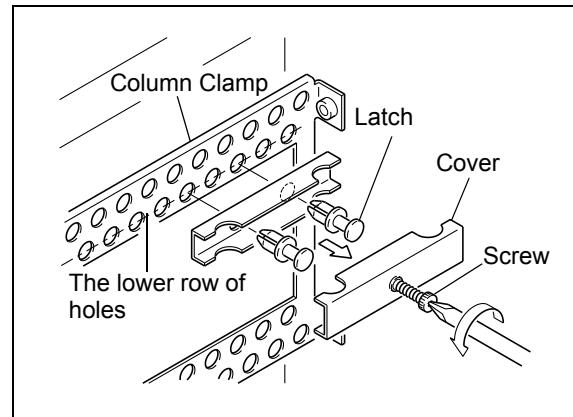


Fig. 3.4

- 3** Replace the column clamp cover, and tighten the cover's screw slightly.
- 4** Orient the column with its outlet at the top, and slide it into one side of the clamp, as shown on the right.

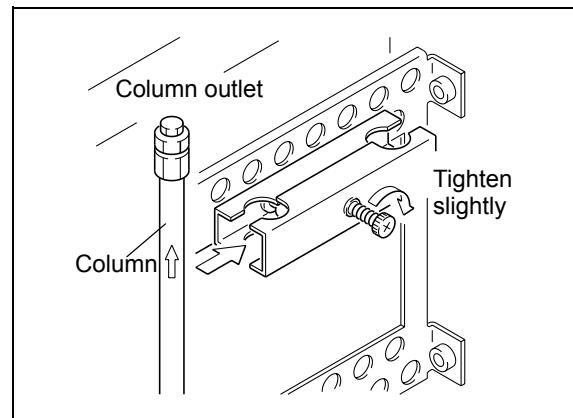


Fig. 3.5

- 5** Finish tightening the cover screw.

Verify that the column is held securely.

NOTE

- Tighten and loosen the cover screw to install and remove columns.
- One column clamp can hold two 6.4-12.7mm outer diameter columns.

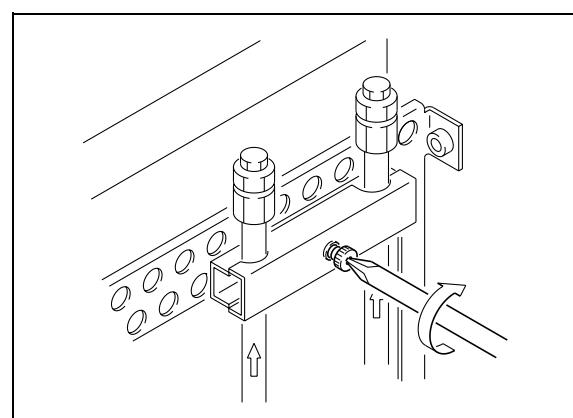


Fig. 3.6

4

Basic Operation

Contents

4.1	Turning Power ON/OFF	4-2
4.2	Setting Operating Temperature [SET TEMP].....	4-3
4.3	Setting Upper Temperature Limit [T.MAX]	4-4
4.4	Operation	4-5

4.1 Turning Power ON/OFF

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

NOTE

Power cannot be turned ON/OFF when the left door is open.

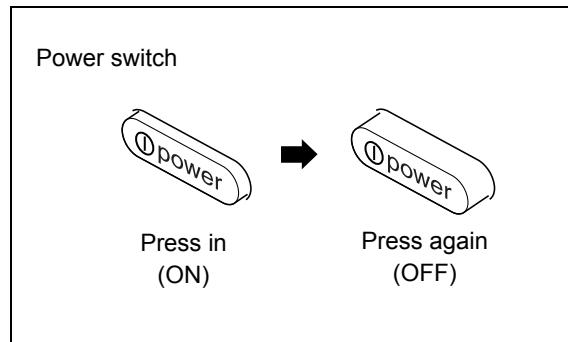
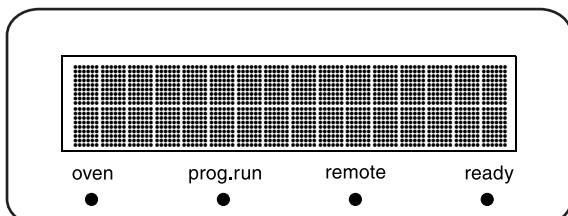


Fig. 4.1

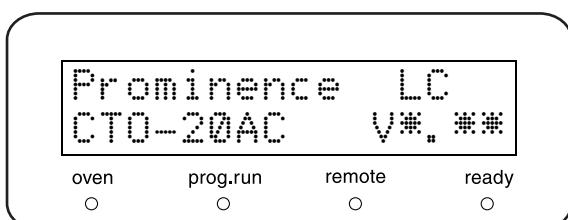
- 2** When the power is turned ON, the following sequence of events occurs:

① Power ON.

② All the dots in the display matrix and all the indicators illuminate as in the right figure.

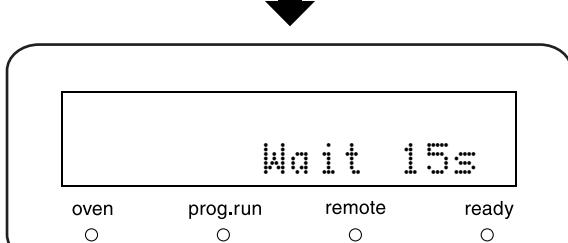


③ The unit memory is automatically checked and the contents are displayed on the screen.
[V*.**] in the example screen shows the ROM version.



④ The [WAIT] time appears. It counts down (in decrements of 1 second) from 15 seconds.

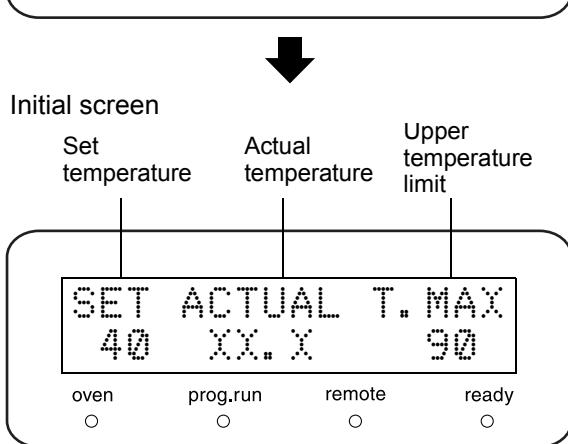
⑤ If no error has been detected at the end of the 15-second [WAIT] time count, [SET], [ACTUAL], and [T.MAX] values appear.



NOTE

- The [SET] and [T.MAX] values on the initial screen are those set the last time the oven was used.
- The actual temperature is the current temperature inside the column oven.
- In the example screen shown here, the set temperature is 40°C and the upper temperature limit is 90°C.
- If an error is detected, an alarm sounds and an error message is displayed.

"6.2 Error Messages" P. 6-3



4.2 Setting Operating Temperature [SET TEMP]

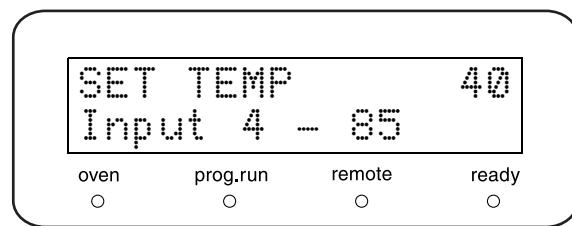
The operating temperature is the temperature set for the column oven during operation.

The initial setting for this temperature is 40°C, but the setting is modifiable as shown below.

* If you do not wish to set a different temperature, press **func** to proceed to the next item.

- 1** From the initial screen, press **func** and **enter**. The operating temperature setting screen is displayed.

* The operating temperature setting screen can also be displayed by pressing **temp**.



- 2** Set the temperature by the numeric keypad, press **enter**.

The setting valid range is 4-85°C.

NOTE

The temperature set here is displayed as the set temperature on the initial screen.

This setting remains in memory when the power is turned off.

- 3** Press **func**.
- And proceed to "[4.3 Setting Upper Temperature Limit \[T.MAX\]](#)".
- * Press **CE** twice to display the initial screen.

4.3 Setting Upper Temperature Limit [T.MAX]

The upper temperature limit is the temperature above which the column oven interior must not rise. If the interior temperature reaches the value set here, operation stops (The initial setting for this limit is 90°C.).

* If you do not wish to set a different temperature, press **func** to proceed to the next item.

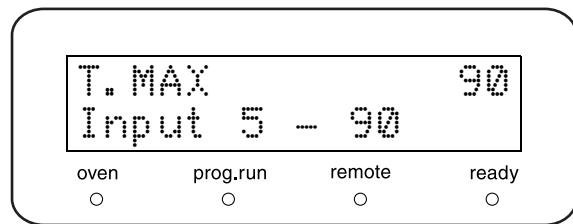
- 1** Set the temperature by the numeric keypad and press **enter**.

The setting valid range is 5 - 90°C.

NOTE

The temperature set here is displayed as the upper temperature limit on the initial screen.

This setting remains in memory when the power is turned off.

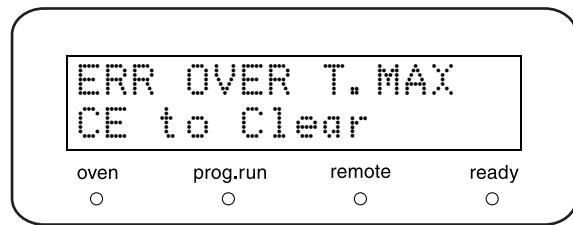


- 2** Press **CE** twice to display the initial screen.

NOTE

If the upper temperature limit is exceeded during temperature regulation, [ERR OVER T.MAX] appears and temperature regulation is stopped.

For corrective action, P.6-3

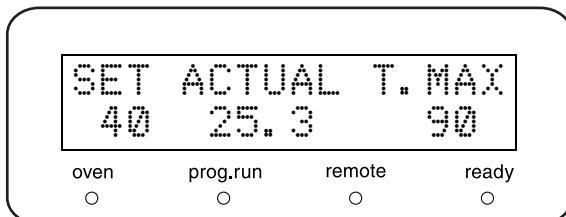


4.4 Operation

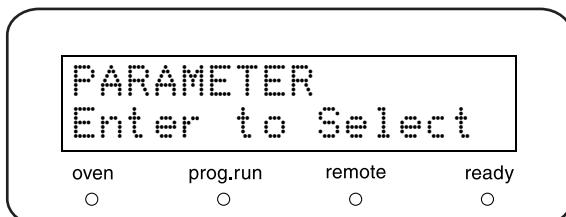
The following is a example operation procedure. An operating temperature of 55°C and an upper temperature limit of 70°C is used in this example.

- 1 Turn the power switch ON.
[SET], [ACTUAL], and [T.MAX]. appear in the display. In the figure to the right, the actual temperature is 25.3°C.

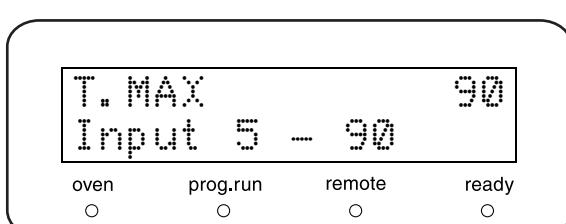
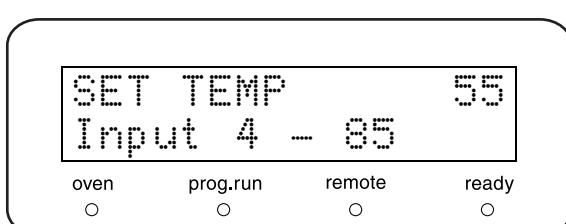
Initial screen



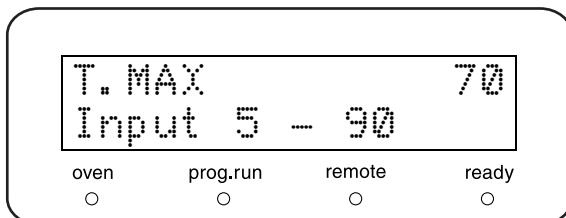
- 2 Press **func**.
The operating temperature setting screen appears.
* To return to the initial screen, press **CE**.
- 3 Press **enter**.
The operating temperature setting screen appears.



- 4 Use the numeric keypad to set the operating temperature to 55°C.
(Press **5** · **5** · **enter**.)
- 5 Press **func**.
The next setting screen (for upper temperature limit) appears.
* To return to the parameter setting screen, press **CE**.

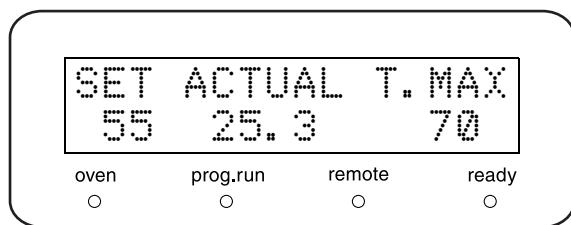


- 6 Use the numeric keypad to set the upper temperature limit to 70°C.
(Press **7** · **0** · **enter**.)



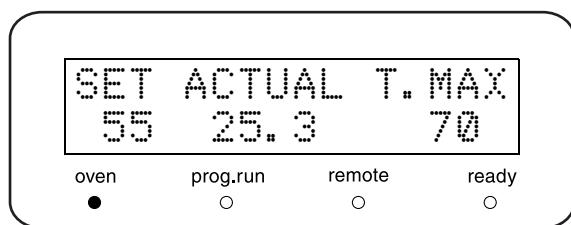
4. Basic Operation

- 7 Press **CE** repeatedly to display the initial screen from any screen.



- 8 Press **oven**.

The [oven] indicator illuminates, and the oven starts operation.



- 9 When the temperature become stable at 55°C, the [ready] indicator illuminates. (If the room temperature is 15-30°C, this should take no more than 15 minutes.) Check that the [ready] indicator illuminates after the column oven's interior temperature has stabilized.



⚠ CAUTION

Beware of burns when the operating temperature is high (60°C or higher).

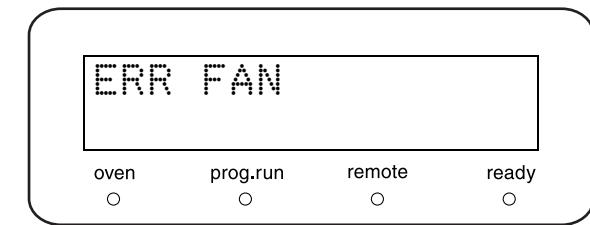
The manual injector handle becomes especially hot.

NOTE

Prevent tubing and other objects from getting through the metal grille inside the column oven. This could damage the fan.

If the fan operates abnormally, [ERR FAN] is displayed.

For corrective action, P.6-4



5

Application Operation

Contents

5.1	Display Panel	5-2
5.2	Parameter in Auxiliary Functions	5-10
5.3	VP Functions	5-22
5.4	Creating Time Programs	5-34
5.5	Control by CBM-20A or CBM-20Alite System Controller	5-48
5.6	Control by SCL-10Avp or SCL-10A System Controller	5-49
5.7	Connection to External Input/Output Terminals	5-50

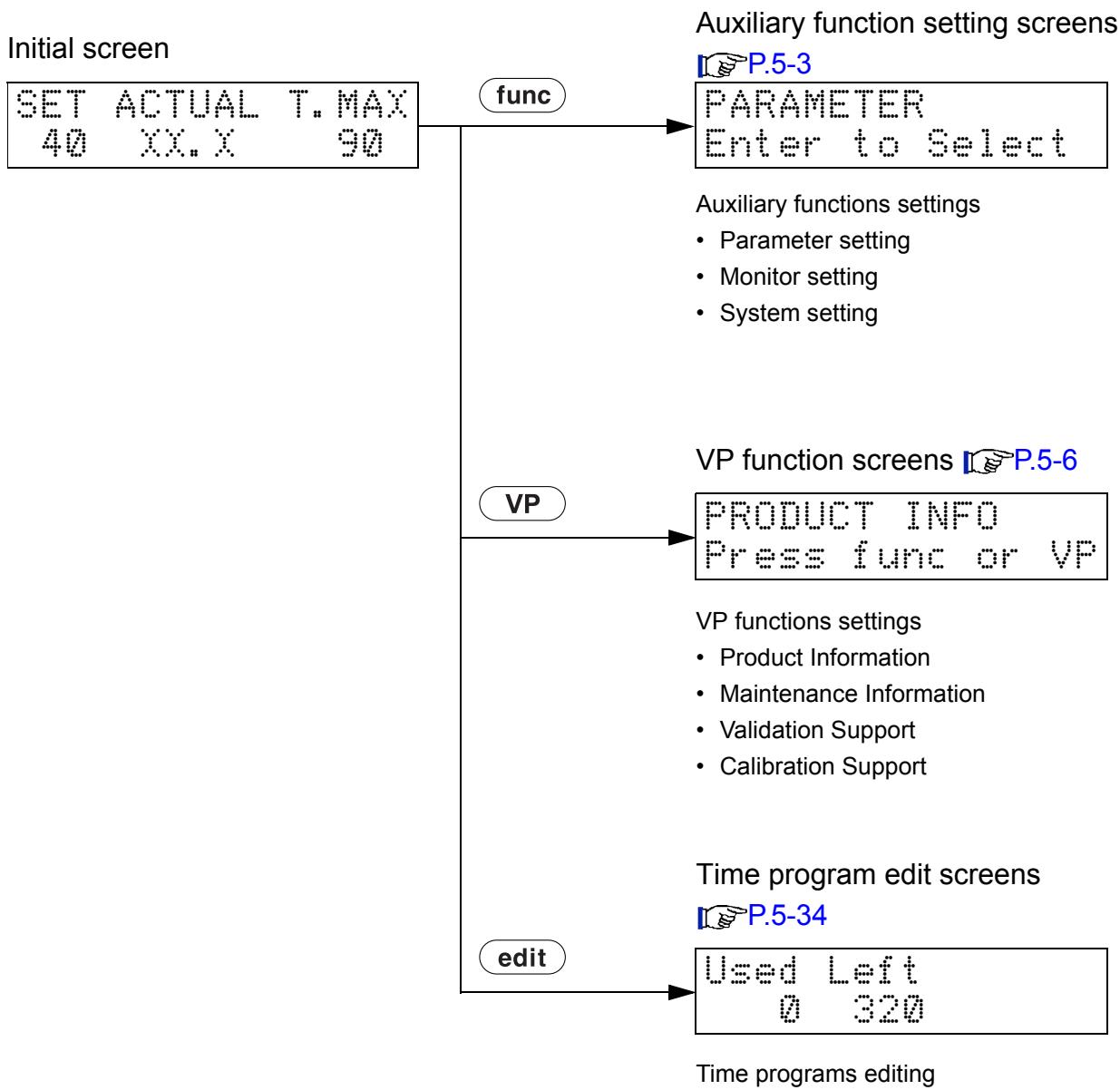
5.1 Display Panel

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 setting screens
- VP function screen
- Time program edit screen



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

5.1.2 Auxiliary Functions Screens

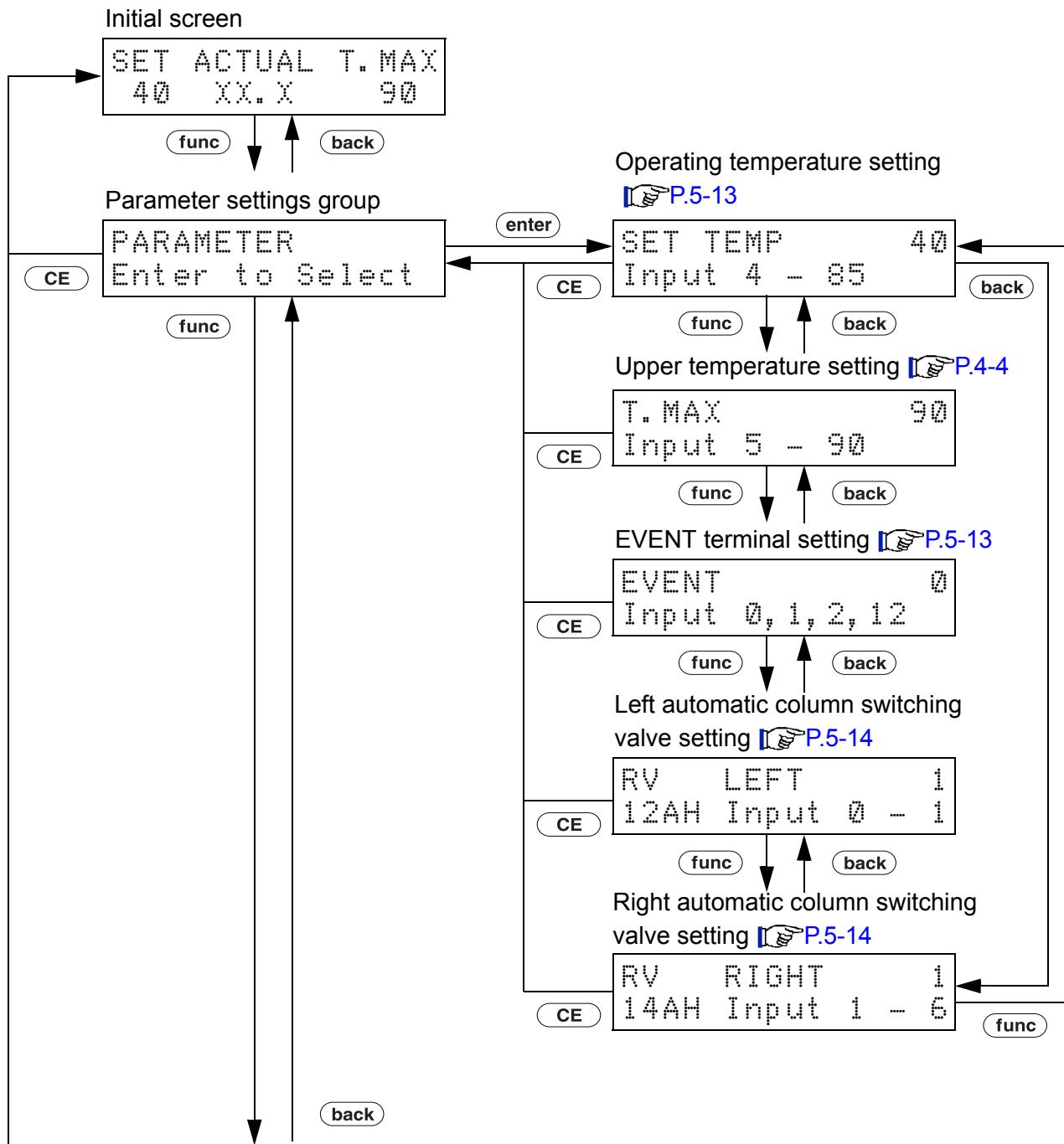
In this section, auxiliary setting screen are shown in the following flow diagrams.

Scroll through the setting screens by pressing **(func)**.

Scroll backward by pressing **(back)**.

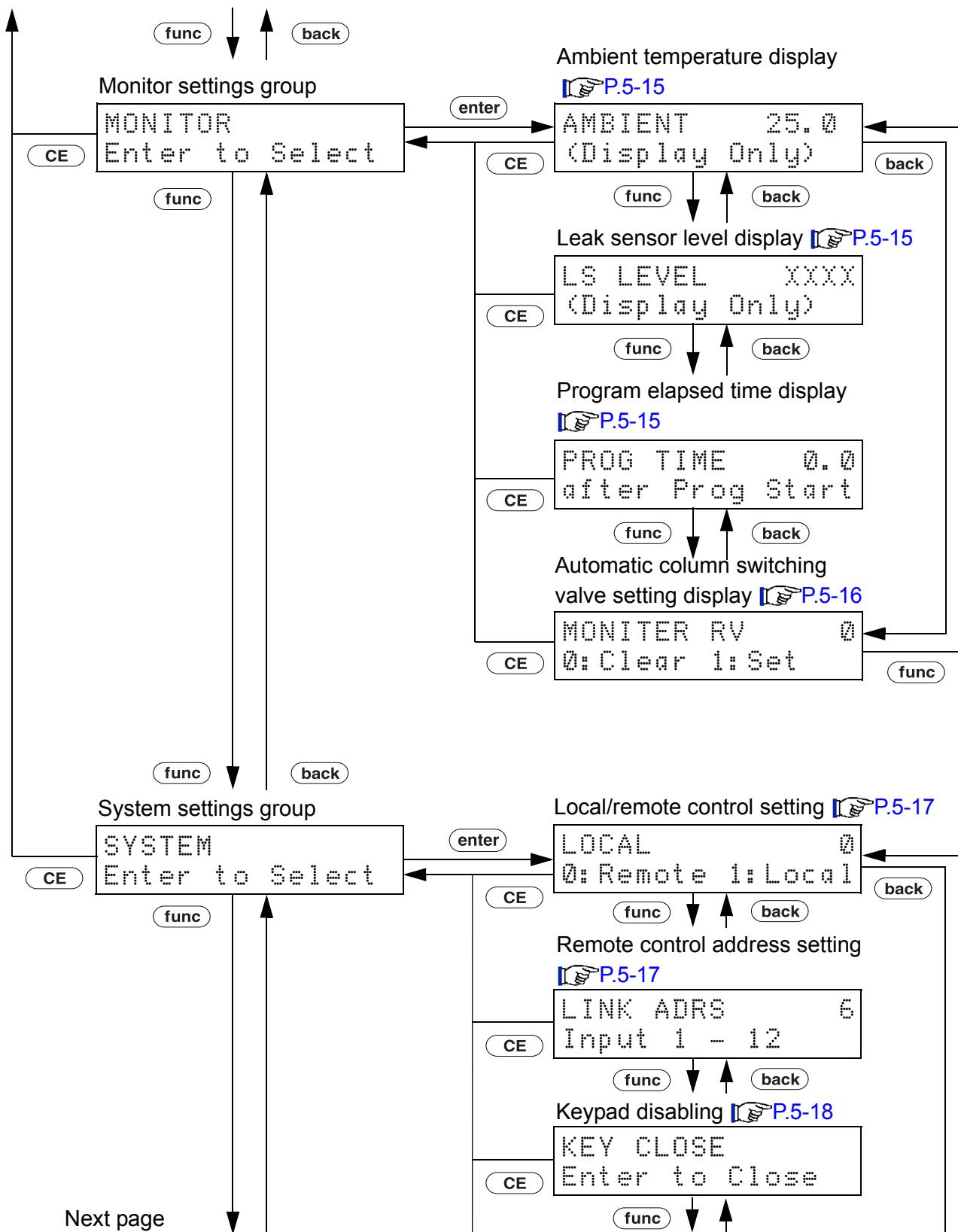
Press **(enter)** to enter the each group.

Return to the initial screen by pressing **(CE)**.

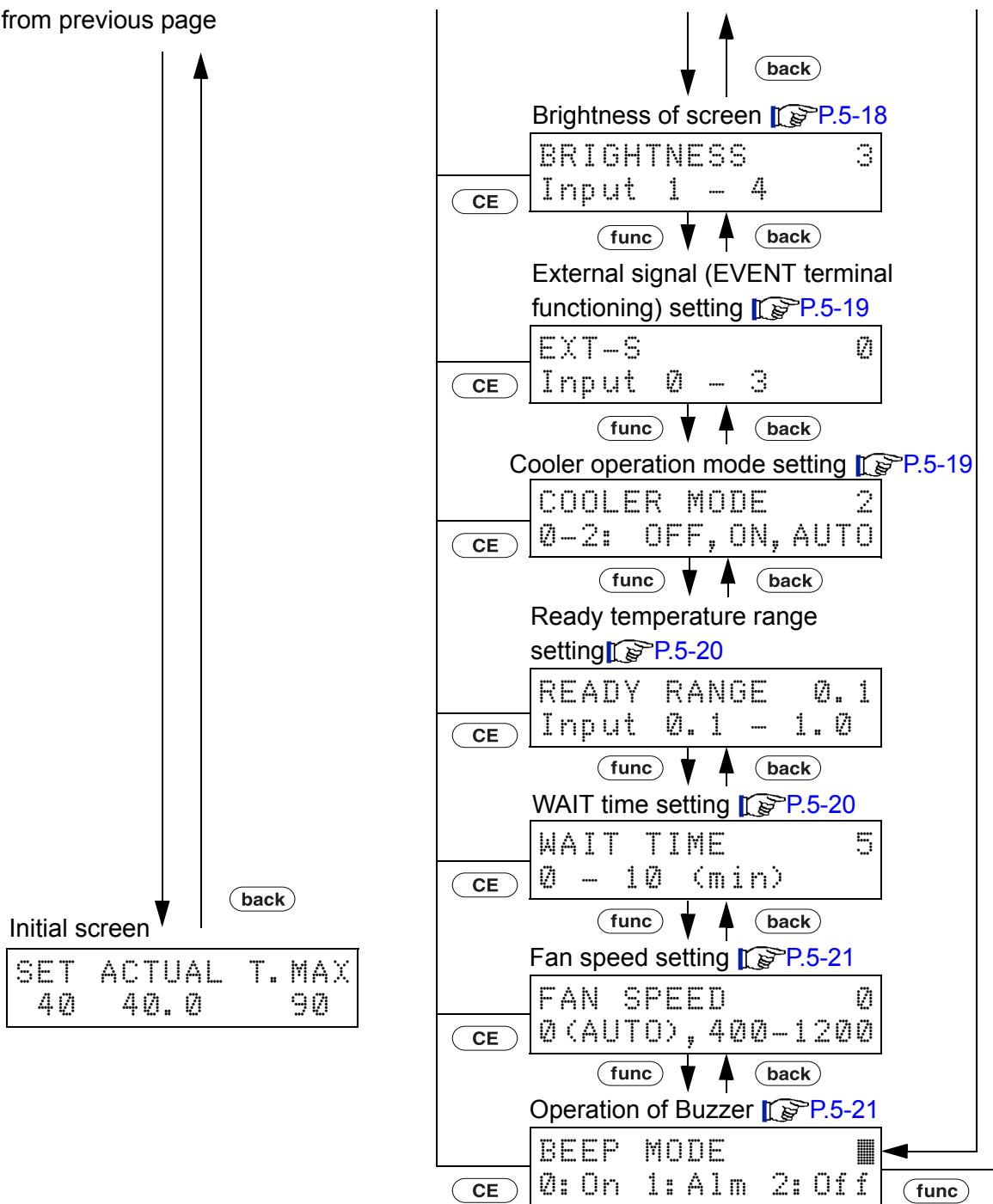


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* COOLER MODE appears only on CTO-20AC.

5.1.3 VP Function Screens

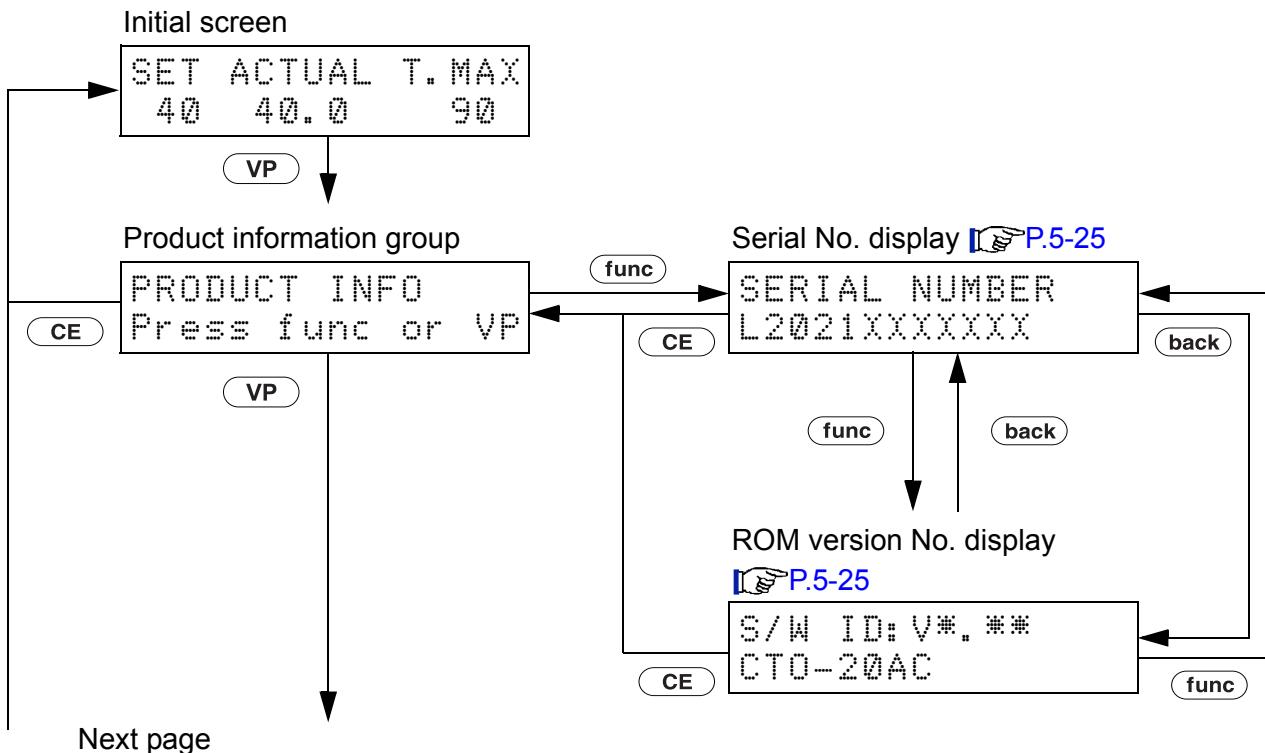
In this section VP function screens are shown in the following flow diagrams.

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

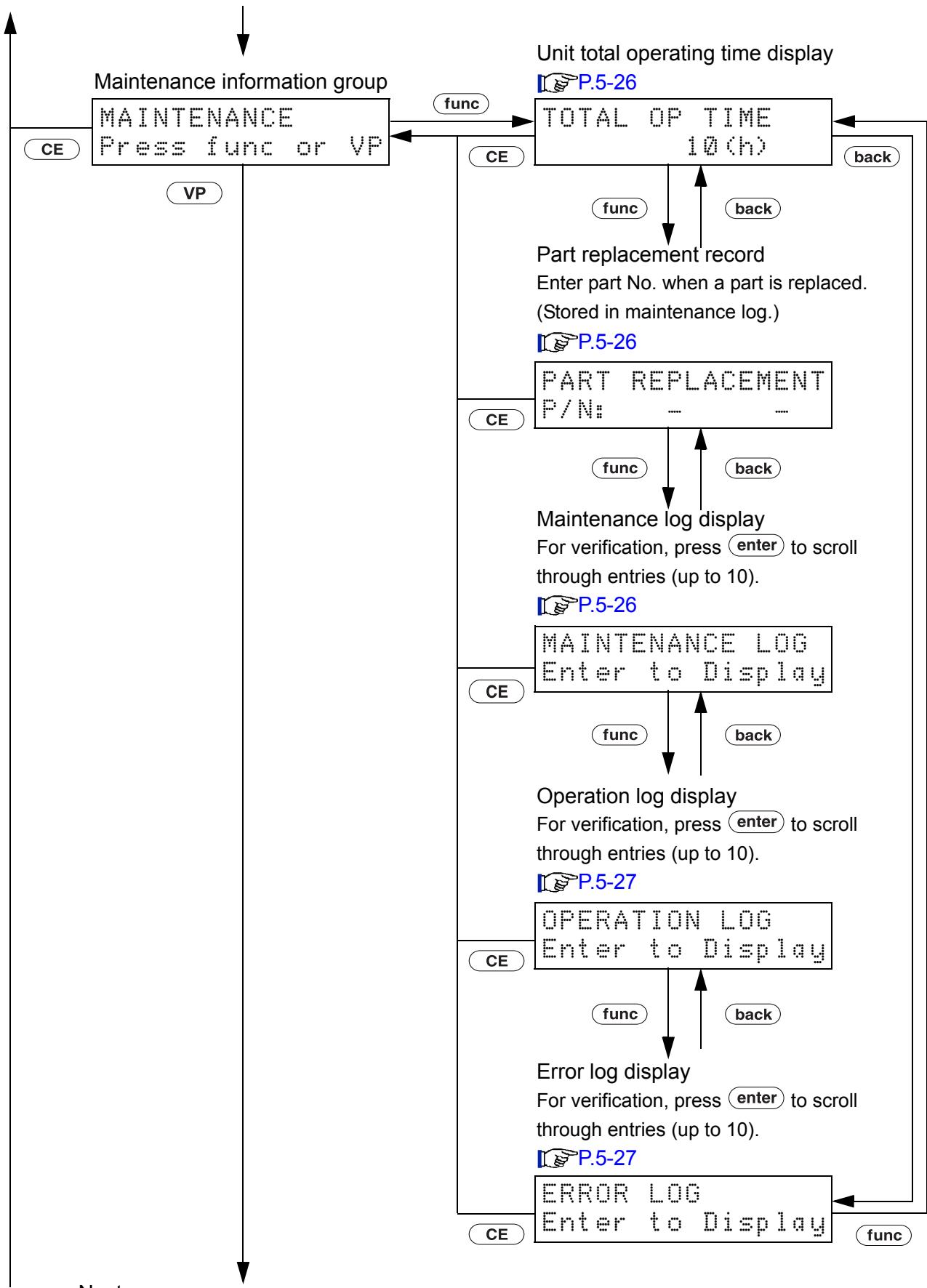
Press **CE** to return to the initial screen.

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

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

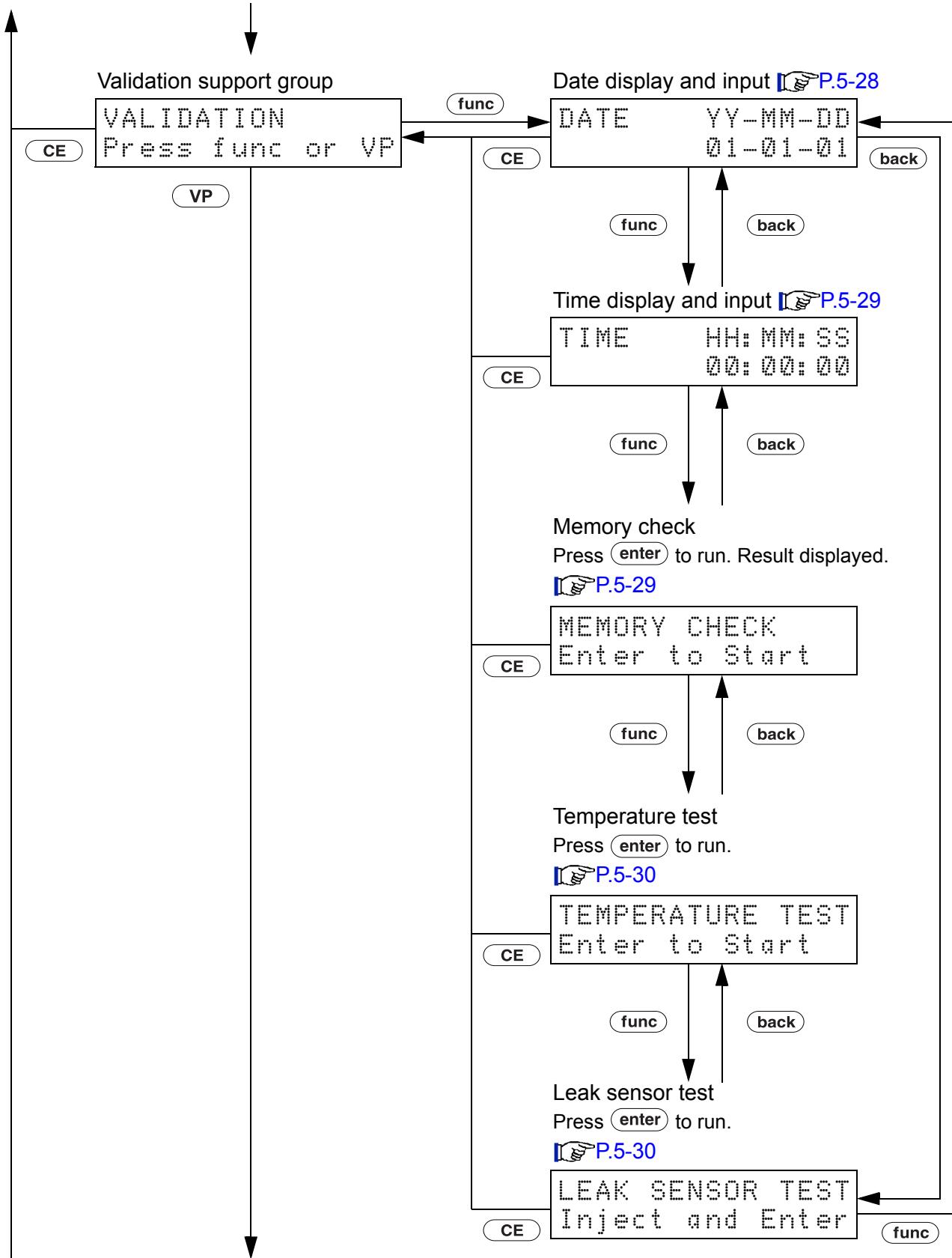


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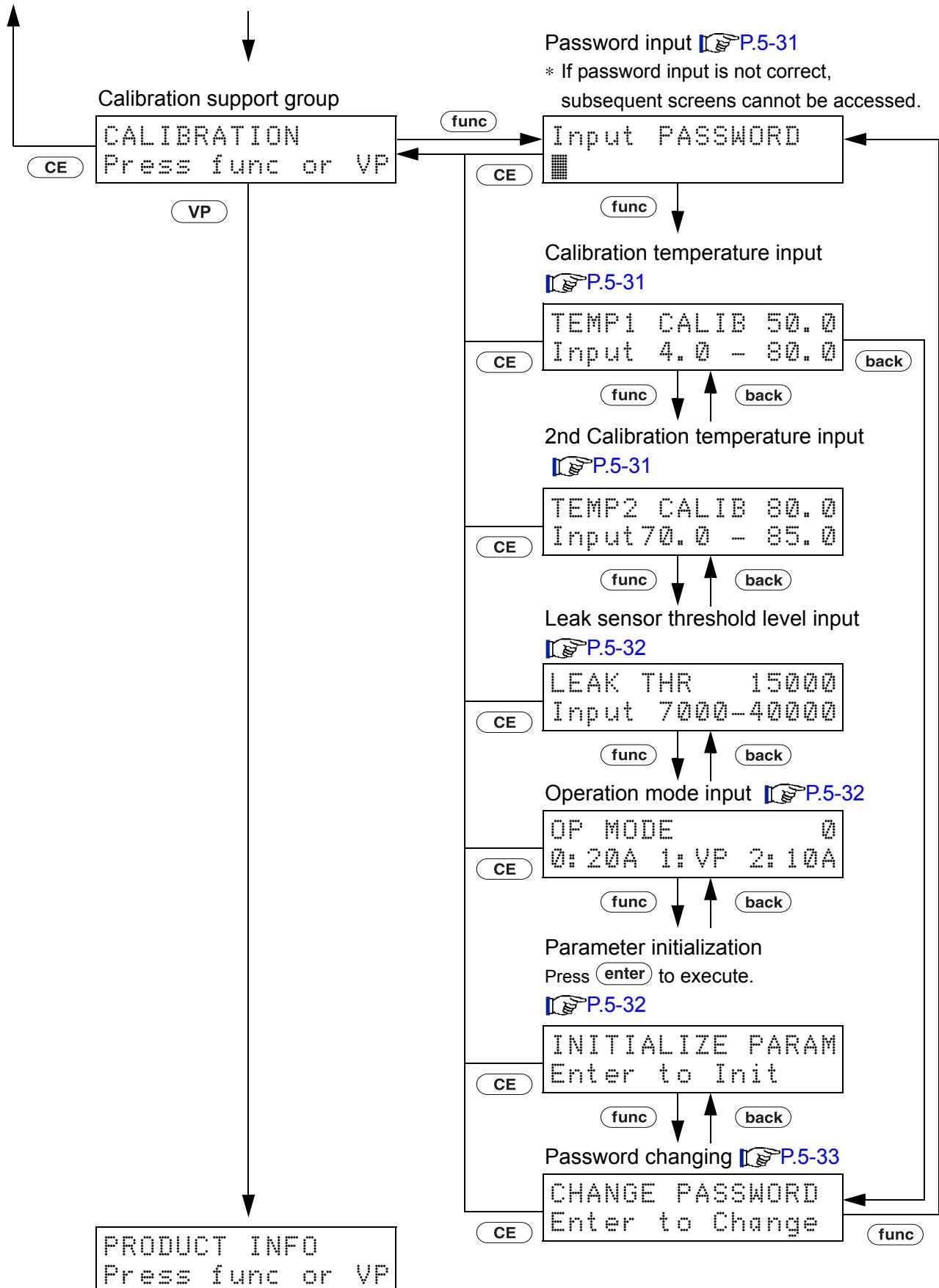
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Password input P.5-31

* If password input is not correct,
subsequent screens cannot be accessed.

Calibration temperature input

P.5-31

TEMP1 CALIB 50.0
Input 4.0 - 80.0

2nd Calibration temperature input

P.5-31

TEMP2 CALIB 80.0
Input 70.0 - 85.0

Leak sensor threshold level input

P.5-32

LEAK THR 15000
Input 7000-40000

Operation mode input P.5-32

OP MODE 0
0: 20A 1: VP 2: 10A

Parameter initialization

Press **enter** to execute.

P.5-32

INITIALIZE PARAM
Enter to Init

Password changing P.5-33

CHANGE PASSWORD
Enter to Change

5.2 Parameter in Auxiliary Functions

There are three groups for auxiliary functions:
Parameter Setting, Monitor Setting and System Setting.

5.2.1 List of Auxiliary Functions

The auxiliary functions are listed below.

 "5.1.2 Auxiliary Functions Screens" P. 5-3

■ Parameter Settings Groups

Command	Default value	Operation	Description	Page
SET TEMP	40 (°C)	Numeric keypad	Sets the operating temperature.	P.4-3
T.MAX	90 (°C)	Numeric keypad	Sets the upper temperature.	P.4-4
EVENT	0	Numeric keypad	Sets ON/OFF for the EVENT terminals.	P.5-13
RV LEFT	0 (1)	Numeric keypad	Sets the position of the left automatic column switching valve.	P.5-14
RV RIGHT	0 (1)	Numeric keypad	Sets the position of the right automatic column switching valve.	P.5-14

* The default values for [RV LEFT] and [RV RIGHT] vary with the valve used.

■ Monitor Settings Groups

Command	Default value	Operation	Description	Page
AMBIENT	-	Display	Displays the ambient temperature.	P.5-15
LS LEVEL	-	Display	Displays the solvent vapor concentration level for actuation of the leak sensor.	P.5-15
PROG TIME	-	Display	Displays time elapsed since start of time program.	P.5-15
MONITOR RV	0	Numeric keypad	Sets the setting position display for the automatic column switching valves.	P.5-16

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

Display : Check the monitor.

 : Press  to activate the function.

Numeric keypad : Press  -  to enter a value and press  to determine the value.

■ System Settings Groups

Command	Default value	Operation	Description	Page
LOCAL	0	Numeric keypad	Sets either local control or control by system controller.	P.5-17
LINK ADRS	6	Numeric keypad	Sets address when control is by system controller.	P.5-17
KEY CLOSE	-	enter	Disables keypad.	P.5-18
BRIGHTNESS	3	Numeric keypad	Sets brightness of screen.	P.5-18
EXT-S	0	Numeric keypad	Sets use of EVENT terminals for external control start signals, etc.	P.5-19
COOLER MODE	2	Numeric keypad	Sets the cooler operation mode.	P.5-19
READY RANGE	1.0	Numeric keypad	Sets the ready range. When the oven temperature is within this range, it is considered to be at the set temperature.	P.5-20
WAIT TIME	5	Numeric keypad	Sets the time to elapse between the oven entering the ready range and being ready for operation.	P.5-20
FAN SPEED	0	Numeric keypad	Sets the fan speed.	P.5-21
BEEP MODE	0	Numeric keypad	To set the operation of buzzer.	P.5-21

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

Display : Check the monitor.

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

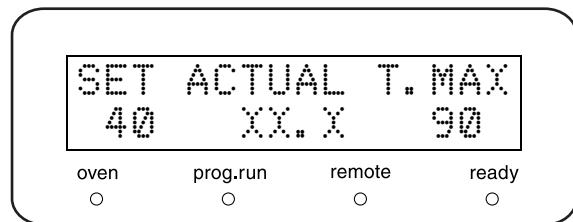
Numeric keypad : Press **-** **9** to enter a value and press **enter** to determine the value.

5. Application Operation

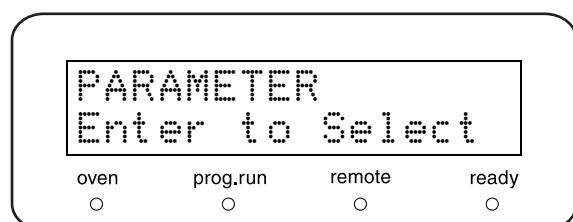
5.2.2 Showing the Auxiliary Function Screen

1 Press **CE**.

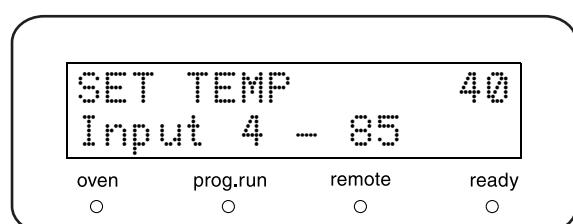
Initial screen appears.



2 Press **func** to show parameter settings group, the first group of the auxiliary function.
Press **func** to move to the other items of the auxiliary function.
* Press **back** to return the previous screen.



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



4 Press **func** and select the desired parameter.
Follow the directions of each parameter described in the next page.

5 Press **func** or **back** to move to other functions.

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

5.2.3 Parameter Settings Group

This setting group is for parameters.

■ [SET TEMP]

 "4.2 Setting Operating Temperature [SET TEMP]" P. 4-3

■ [T.MAX]

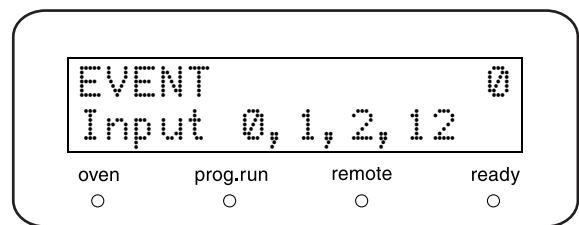
 "4.3 Setting Upper Temperature Limit [T.MAX]" P. 4-4

■ [EVENT]

Sets ON (closed) or OFF (open) for the relay contact of the EVENT terminals located at the back of the column oven.

* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.



2 Enter the values 0, 1, 2, 12 by the numeric keypad, and press **enter**.

Setting	[EVENT1] output	[EVENT2] output
0	Relay 1 OFF	Relay 2 OFF
1	Relay 1 ON	Relay 2 OFF
2	Relay 1 OFF	Relay 2 ON
12	Relay 1 ON	Relay 2 ON

3 Press **func** to go to the next function.

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

■ [RV LEFT, RV RIGHT]

Sets the automatic column switching valves mounted inside the column oven (default value = 1).

[RV LEFT] sets the automatic column switching valve mounted on the left and [RV RIGHT] sets the automatic column switching valve mounted on the right.

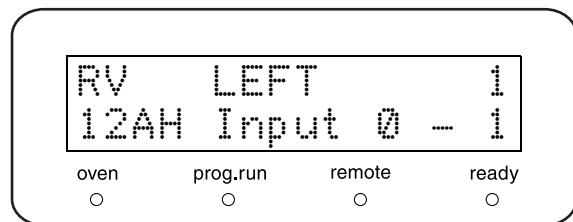
If the FCV-12AH(i) is mounted, the values 0 and 1 can be set, and if the FCV-14AH(i) is mounted, the values 1 to 6 can be set.

The type of valve connected is detected automatically.

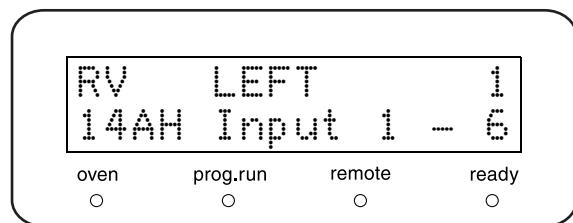
* If not using this function, press **func** to go to the next one.

The automatic column switching valve setting screen can also be displayed by pressing **valve**.

- 1 Read the setting instructions displayed.

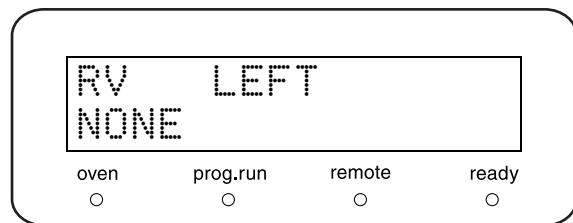


- 2 Enter the values 0, 1, or 1-6 by the numeric keypad, and press **enter**.



- 3 Press **func** to go to the next function.

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



5.2.4 Monitor Settings Group

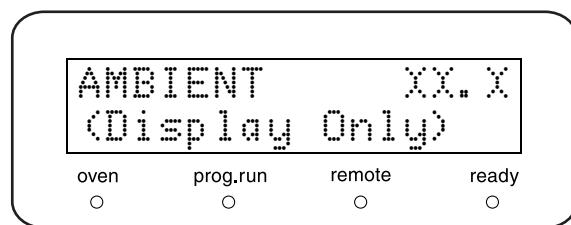
This is the group for monitor setting.

■ [AMBIENT]

Displays the ambient temperature (°C).

* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.



2 Press **func** to go to the next function.

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

■ [LS LEVEL]

Displays the solvent vapor concentration level at which the leak sensor is actuated.

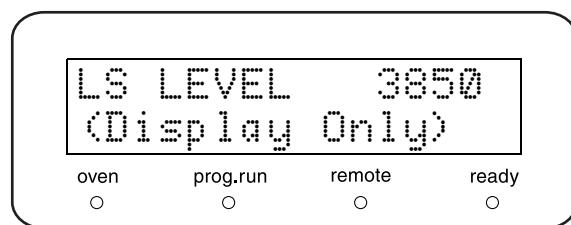
* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.

The leak sensor's concentration detection level is displayed.

NOTE

The detection level cannot be changed by pressing the numeric keypad.



2 Press **func** to go to the next function.

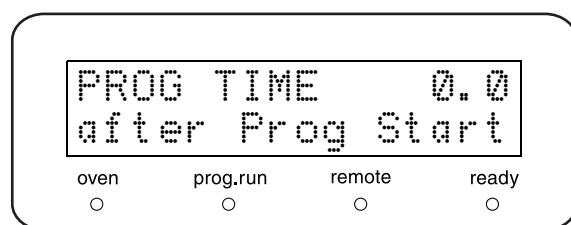
* To return to the initial screen, press **CE** twice.

■ [PROG TIME]

When a time program is running, this displays the time that has elapsed since the program started.

* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.



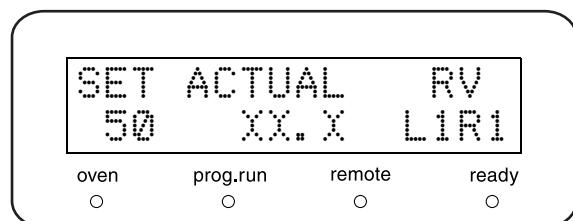
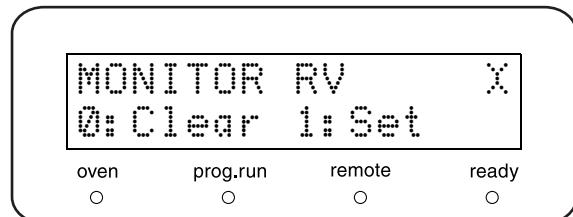
2 Press **func** to go to the next function.

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

■ [MONITOR RV]

Displays the settings for the automatic column switching valves mounted inside the column oven.

- 1 Read the setting instructions displayed.
- 2 Enter **1** by the numeric keypad, and press **enter**.
- 3 The initial screen changes in the way shown on the right, and the settings for the automatic column switching valves are displayed.
If there are no automatic column switching valves connected, [-] (hyphens) are displayed in place of the settings.
 - * Setting [MONITOR RV] to **0** returns the initial screen to its normal state.
- 4 Press **func** to go to the next one.
 - * To return to the initial screen, press **CE** twice.



5.2.5 System Settings Group

This is the group for system settings.

■ [LOCAL]

Sets whether the operating temperature, maximum temperature, and temperature regulation ON/OFF are to be controlled locally (by the oven itself) or by a system controller.

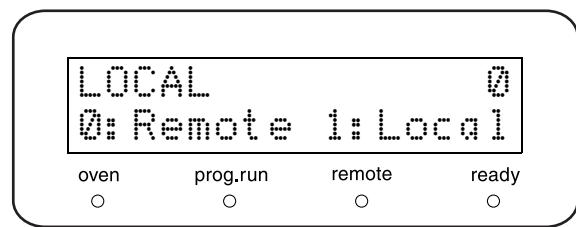
* If not using this function, press **func** to go to the next one.

- 1 Read the setting instructions displayed.

- 2 Enter the values 0 and 1 by the numeric keypad, and press **enter**.

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

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



■ [LINK ADRS]

Sets the address (channel number) when this instrument is controlled by a system controller. (The initial setting is 6.)

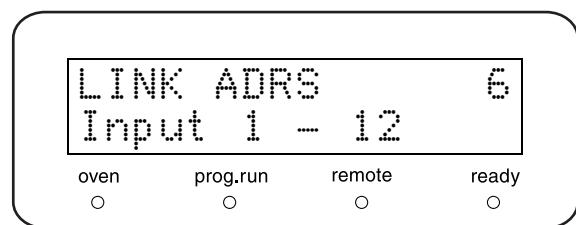
* If not using this function, press **func** to go to the next one.

- 1 Read the setting instructions displayed.

- 2 Enter the values 1-12 by the numeric keypad, and press **enter**.

- 3 Press **func** to go to the next function.

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



■ [KEY CLOSE]

Disables the keypad.

* If not using this function, press **func** to go to the next one.

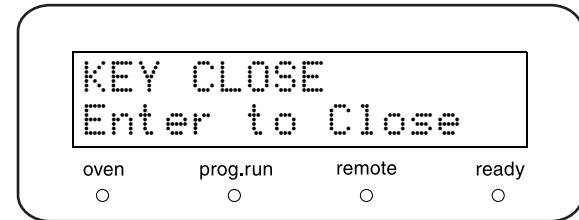
1 Read the setting instructions displayed.

2 Press **enter** to execute the function and return to the initial screen. From this point, keypad input is disabled.

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

3 Press **func** to go to the next function.

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



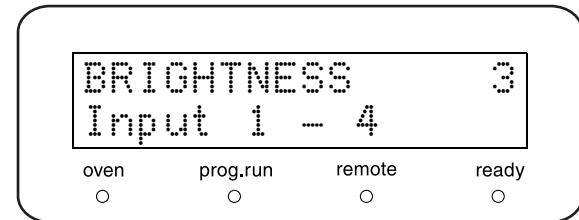
■ [BRIGHTNESS]

Sets the brightness of screen. Value range is 1 to 4 and 4 is the brightest (The default setting is 3.).

* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.

2 Enter the values 1-4 by the numeric keypad, and press **enter**.



3 Press **func** to go to the next function.

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

■ [EXT-S]

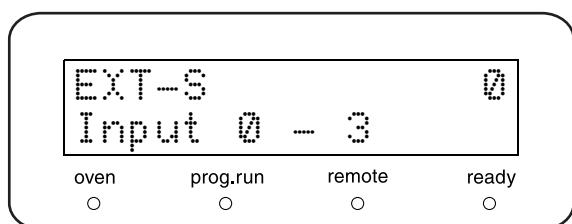
Sets the mode for control of external devices by means of the EVENT terminals (relays 1 and 2) located on the back of the column oven.

* If not using this function, press **func** to go to the next one.

- 1 Read the setting instructions displayed.

- 2 Enter the values 0, 1, 2, and 3 by the numeric keypad, and press **enter**.

Set value	Control mode
0	Relay contacts are controlled by [EVENT] value.
1	Relay contacts 1 [EVENT1] operates as a [T.MAX] error signal.
2	Relay contacts 2 [EVENT2] operates as a [LEAK] error signal.
3	[EVENT1] operates as a [T.MAX] error signal and [EVENT2] operates as a [LEAK] error signal.



5

NOTE

When the [EXT-S] function is used, the [EVENT] parameter(s) set for the [EVENT] terminal(s) employed are non-operative.

- 3 Press **func** to go to the next function.

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

■ [COOLER MODE] (available only for CTO-20AC)

Sets the cooler mode. There is a choice of 3 modes: manual ON, manual OFF, and auto operation. (The default setting is 2.)

Set value	Cooler	Operation
0	OFF	Manual OFF
1	ON	Manual ON
2	AUTO	Auto operation

If auto operation is set, the cooler will come on automatically whenever the set operating temperature changes to a relatively low value (near room temperature plus 10°C).

NOTE

Set Manual ON when using the oven for applications where the cooler is turned on during analysis, such as linear temperature regulation.

5. Application Operation

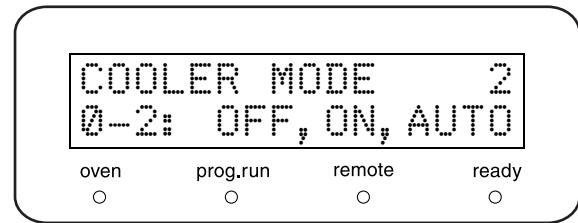
* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.

2 Enter the values 0, 1, and 2 by the numeric keypad, and press **enter**.

3 Press **func** to go to the next function.

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



■ [READY RANGE]

Sets the ready range (°C).

When the oven interior temperature is within this range, it is considered to have reached the set temperature.

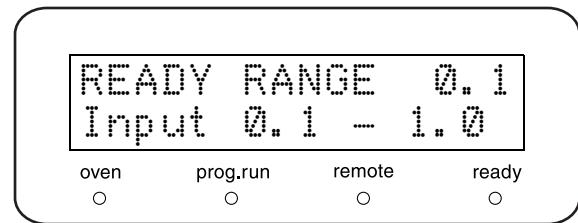
* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.

2 Enter the values 0.1-1.0 by the numeric keypad, and press **enter**.

3 Press **func** to go to the next function.

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



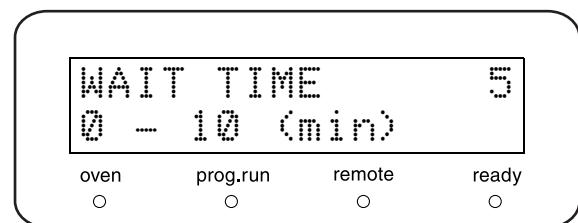
■ [WAIT TIME]

Sets the equilibration time (min.) between the oven attaining the ready range and becoming ready for analysis. This time is set in minutes.

* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.

2 Enter the values 0-10 by the numeric keypad, and press **enter**.



NOTE

A setting of [0] means that the oven is [READY] when it is on.

3 Press **func** to go to the next function.

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

■ [FAN SPEED]

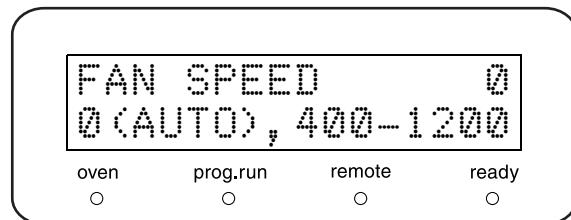
Sets the fan speed. (The default setting is 0.)

If 0 is set, the fan speed is determined automatically according to the set and ambient temperatures. Setting a value other than 0 (400 to 1,200) sets the rate of rotation (unit: rpm).

* If not using this function, press **func** to go to the next one.

1 Read the setting instructions displayed.

2 Enter the values 0, 400-1200 by the numeric keypad, and press **enter**.



NOTE

Set [0] for this parameter, except in the following cases:

- When temperature is regulated to a level close to the room temperature, without a cooler.
- If air currents from the fan affect analysis.

3 Press **func** to go to the next function.

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

NOTE

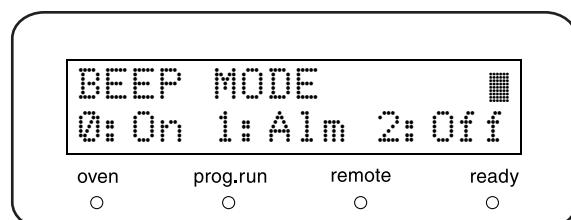
A setting of [1200] for the fan speed in the CTO-20A/20AC is roughly equivalent to a setting of [21] for the fan speed in Shimadzu's previous CTO-10A series ovens.

■ [BEEP MODE]

Sets the operation of buzzer.

Enter a set value and press **enter**.

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



5.3 VP Functions

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

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

5.3.1 List of VP Functions

The VP functions are listed in the tables below.

 "5.1.3 VP Function Screens" P. 5-6

■ Product Information Group

Command	Operation	Function	Page
SERIAL NUMBER	Display	To show the serial number of the instrument.	P.5-25
S/W ID :	Display	To show ROM version number.	P.5-25

■ Maintenance Information Group

Command	Operation	Function	Page
TOTAL OP TIME	Display	To show the total cumulative operating time of the instrument.	P.5-26
PART REPLACEMENT	Numeric keypad	To record the replaced parts number.	P.5-26
MAINTENANCE LOG	enter	To show maintenance log.	P.5-26
OPERATION LOG	enter	To show operation log.	P.5-27
ERROR LOG	enter	To show error log.	P.5-27

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

Display : Check the monitor.

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

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

■ Validation Support Group

Command	Operation	Function	Page
DATE	Numeric keypad	To show/set the date.	P.5-28
TIME	Numeric keypad	To show/set the time.	P.5-29
MEMORY CHECK	enter	To run the memory check.	P.5-29
TEMPERATURE TEST	enter	To run the automatic test of temperature regulation accuracy and stability.	P.5-30
LEAK SENSOR TEST	enter	To run the leak sensor check.	P.5-30

■ Calibration Support Group

Command	Operation	Function	Page
Input PASSWORD* ¹	Numeric keypad	To input password.	P.5-31
TEMP1 CALIB	Numeric keypad	To enter the 1st calibration temperature.	P.5-31
TEMP2 CALIB	Numeric keypad	To enter the 2nd calibration temperature.	P.5-31
LEAK THR	Numeric keypad	To enter leak sensor activation threshold.	P.5-32
OP MODE	Numeric keypad	To select the operation mode.	P.5-32
INITIALIZE PARAM	enter	To initialize parameters.	P.5-32
CHANGE PASSWORD	Numeric keypad	To change password.	P.5-33

*1 If the password is not input correctly, the functions after [TEMP1 CALIB] in the Calibration Support Group cannot be accessed, even if **func** is pressed.

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

Display : Check the monitor.

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

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

5.3.2 Displaying the VP Functions

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

Initial screen

SET ACTUAL T. MAX
40 XXX.X 90
oven prog.run remote ready

- 2 Press **VP** to display the Product Information Group screen.

Group title screen

PRODUCT INFO
Press func or VP

- 3 Pressing **VP** changes the display in the following order: Product Information Group → Maintenance Information Group → Validation Support Group → Calibration Support Group → Product Information Group screen.

VP function screen

SERIAL NUMBER
L2021XXXXXX

- 4 With each group, pressing **func** switches to VP function selection.
* For details about VP functions,
 "5.4.3 Time Program Flow" P. 5-35
"5.4.6 Creating a Typical Time Program2 - Linear Temperature Regulation" P. 5-45

Example

SERIAL NUMBER
L2021XXXXXX

↓ Press **VP**.

MAINTENANCE
Press func or VP

↓ Press **VP** repeatedly.

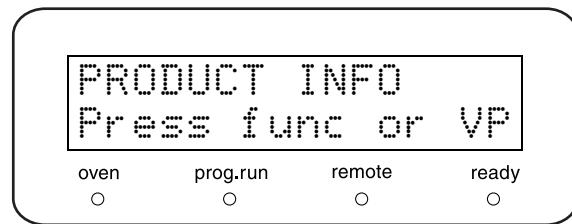
CALIBRATION
Press func or VP

- 5 To move to a different VP Function Group, press **VP** to return to the group title screen, then select the desired group again.

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

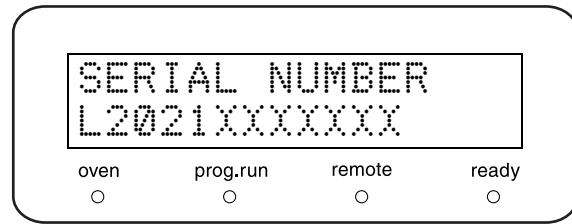
5.3.3 Product Information Group

This group provides the information about the instrument.



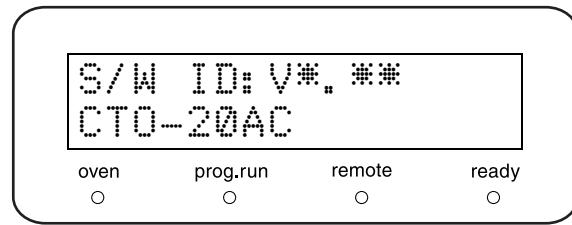
■ [SERIAL NUMBER]

Shows the serial number of this instrument.



■ [S/W ID]

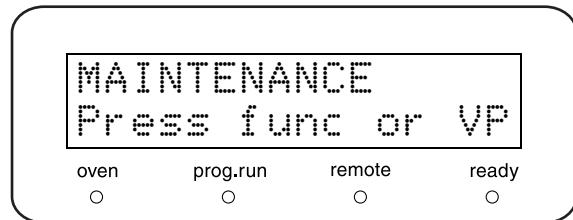
Shows the name of software (same as the model name) and version.



5. Application Operation

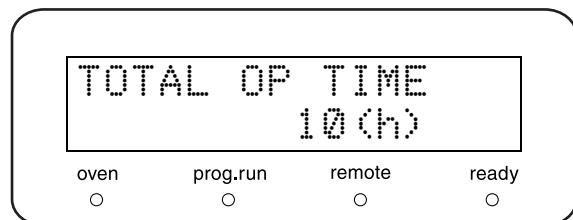
5.3.4 Maintenance Information Group

This group provides the maintenance-related information.



■ [TOTAL OP TIME]

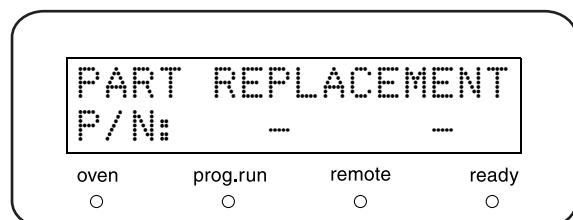
Shows the total operating time of this instrument.



■ [PART REPLACEMENT]

Enter the part No. and press **enter**.

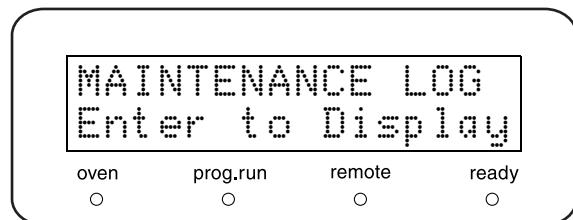
The part No. is recorded in the maintenance log.



■ [MAINTENANCE LOG]

Shows the most recent part replacements (up to 10) entered by the [PART REPLACEMENT] function. Entries consist of Part No. and replacement dates.

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



In the example on the right, the Log1 entry indicates that part No. 012-34567-89 was replaced on July 1, 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.

LOG 1 03-07-01
P/N: 012-34567-89

No more Logs

■ [OPERATION LOG]

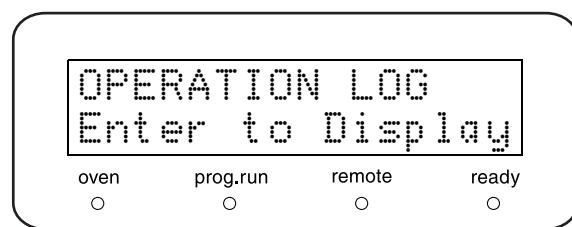
Shows the operation log, which contains the most recent password settings, parameter initializations, etc. (up to 10)

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

In the example screen on the right, the Log1 entry indicates that a password change was made on July 1, 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.



enter

LOG 1 03-07-01
CHANGE PASSWORD

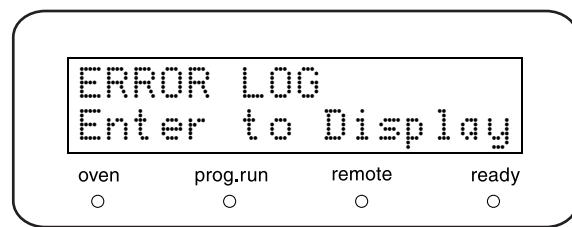
⋮

No more Logs

■ [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.



enter

LOG 1 03-07-01
ERR LEAK DETECT

⋮

No more Logs

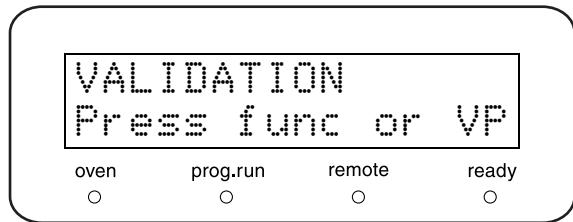
In the example on the right, the Log1 entry indicates that a leak was detected on July 1, 2003.

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.

5.3.5 Validation Support Group

This group checks whether the instrument is running correctly.



■ [DATE]

Shows the current date, or allows it to be set. However, the value returns to the initial value [00-00-00] after turning the power OFF.

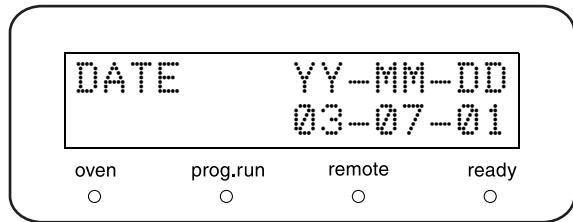
When the instrument is controlled by a system controller (CBM-20A), the date needs not to be set, for it is transmitted automatically during link-up.

The date must be reset each time the power is turned on.

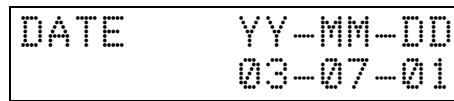
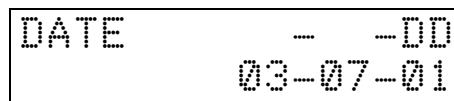
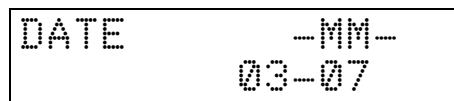
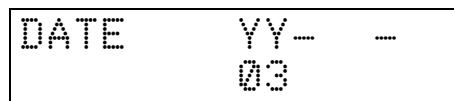
Example: Setting July 1, 2003

- 1 Use the numeric keypad to set the year 03. (Enter only the last two digits.) Then press **enter**.

Date display



Setting



- 2 Use the numeric keypad to set the month 07 (= July).

Then press **enter**.

- 3 Use the numeric keypad to set the day 01. Then press **enter**.

Setting is now complete. The date set will be displayed.

■ [TIME]

Shows the current time, or allows it to be set. However, the value returns to the initial value [00:00:00] after turning the power OFF. When the instrument is controlled by a system controller (CBM-20A), the time needs no setting, for it is transmitted automatically during link-up.

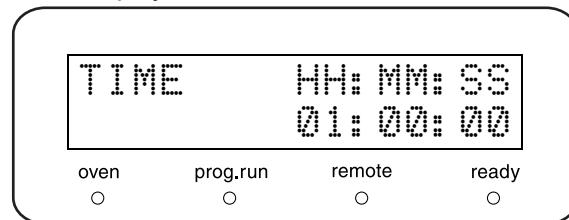
Example: Setting 5:30:55 p.m.

- 1 Use the numeric keypad to set the hour 17. (The unit uses military time.) Then press **enter**.

- 2 Use the numeric keypad to set the minutes 30. Then press **enter**.

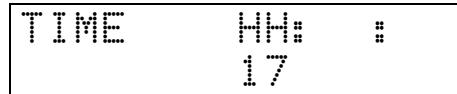
- 3 Use the numeric keypad to set the seconds 55. Then press **enter**.
Setting is now complete. The time set is displayed.

Time display

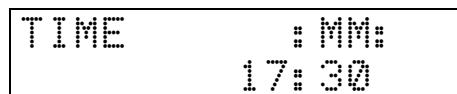


enter

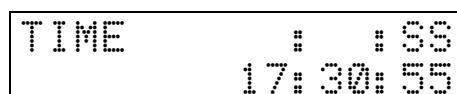
Setting



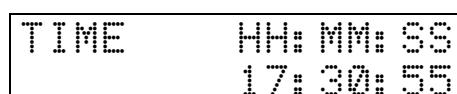
enter



enter



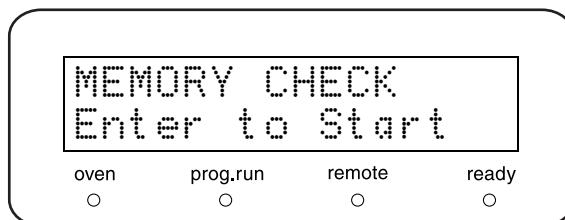
enter to end



■ [MEMORY CHECK]

Runs the memory check on ROM and RAM.

Press **enter** to start.



enter

Results are shown when checking is completed.

- * The ROM/RAM error status will be displayed if an error is found in the ROM or RAM.

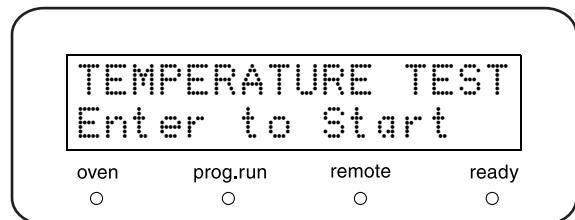
Result



5. Application Operation

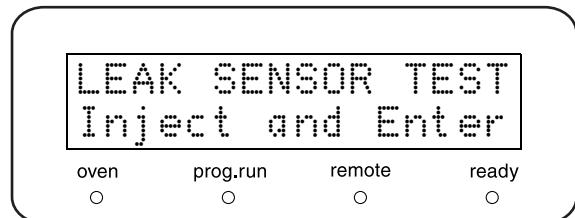
■ [TEMPERATURE TEST]

 "7.5 Validation : Column Oven" P. 7-7



■ [LEAK SENSOR]

 "7.5.7 Leak Sensor Test" P. 7-15

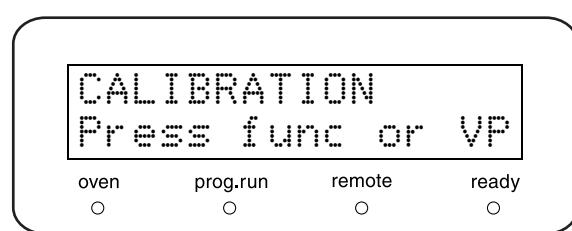


5.3.6 Calibration Support Group

This group calibrates the instrument.

NOTE

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



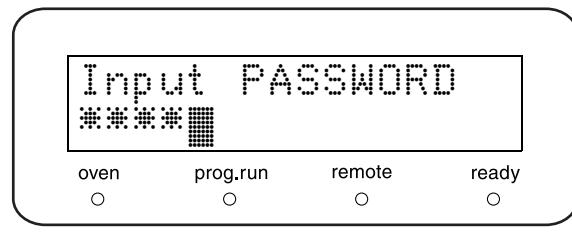
■ [Input PASSWORD]

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

NOTE

Password should be registered by the system manager. Input password one digit at a time using the numeric keypad, and press **enter**.

* Ask your Shimadzu service representative for details about passwords.



enter

If the password input is correct, [TEMP1 CALIB] (the next function) will be displayed.

Next function



If the password input is not input correctly, [TEMP1 CALIB], cannot be accessed. To clear the error, press **enter** and input the password again.

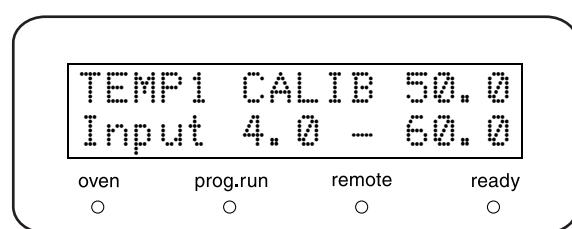
N.G.



■ [TEMP1 CALIB]

Sets the 1st calibration temperature used for calibration. The unit is calibrated.

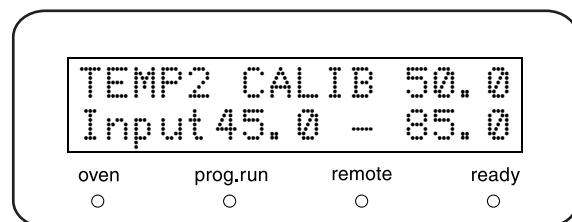
"7.6 Temperature accuracy calibration" P. 7-17



■ [TEMP2 CALIB]

Sets the 2nd calibration temperature used for calibration. The unit is calibrated. Set a value that differs from the 1st calibration temperature by at least 20°C.

"7.6 Temperature accuracy calibration" P. 7-17



■ [LEAK THR]

Sets the leak sensor activation threshold level.

Use the numeric keypad to enter the value and press **enter**.

(The valid range is 7000-40000.)

 "8.2 Adjusting the Leak Sensor Sensitivity" P. 8-3

LEAK THR 15000
Input 7000-40000

oven prog.run remote ready

■ [OP MODE]

When performing control with an earlier system controller (SCL-10A, SCL-10Avp), use the compatibility mode given below.

When using the SCL-20A, control is possible with any setting. Some functions are restricted in the compatibility modes.

Use the numeric keypad to enter the value and press

enter.

OP MODE 0
0: 20A 1: VP 2: 10A

oven prog.run remote ready

Set value	Mode
0	CTO-20A mode
1	CTO-10Avp compatibility mode (When using the SCL-10Avp)
2	CTO-10A compatibility mode (When using the SCL-10A)

■ [INITIALIZE PARAM]

Initializes the parameters (except those of the VP function and [LINK ADRS]), and deletes the time programs.

* To skip this function, press **func**.

1 Read the setting instructions displayed.

2 Press **enter** to execute parameter initialization.

INITIALIZE PARAM
Enter to Init

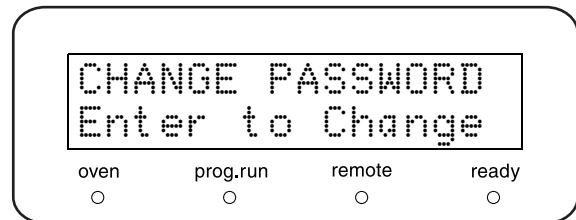
oven prog.run remote ready

■ [CHANGE PASSWORD]

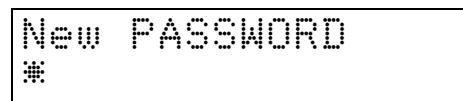
This changes the password.

- 1** Press **enter**.

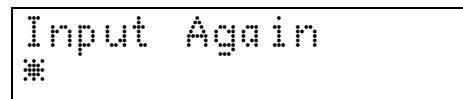
Input screen appears.



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



- 3** To confirm, input the same password again.



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

Valid



If not, [PASSWORD WRONG] appears.

Not valid



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

5

5.4 Creating Time Programs

Time programs can be created to execute commands (oven ON/OFF, program STOP, etc.) automatically at specified times during the oven operation. Times are specified in 0.1 minute increments from the start of operation.

The maximum time setting is 999 minutes.

The column oven time program files have a maximum capacity of 320 operations.

5.4.1 Time Program Command

Function	Description	Setting range	Remark
TEMP	Operating temperature	4-85°C	
TMPL	Linear temperature regulation	4-85°C	Performs linear temperature regulation until the set time elapses.
ON	Oven ON	-	
OFF	Oven OFF	-	
STOP	Ends program.	-	
EVNT	EVENT output ON/OFF	0, 1, 2, 12	
RV-L, RV-R	Controls the automatic column switching valves.	0, 1 or 1-6	
LOOP	Repeats program.	0-255	Setting 0 will repeat program 256 times.

5.4.2 Basics of Programming

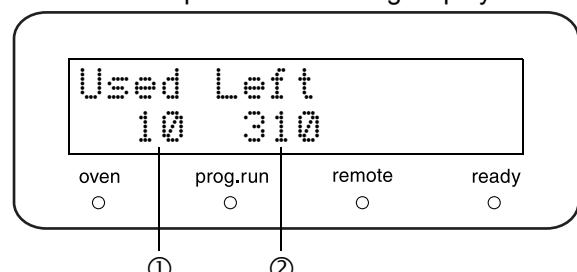
To write or edit time programs, enter the EDIT mode as described below.

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

2 To display the number of steps currently programmed, press **edit**.
The display on the right appears.
 ① Number of steps already used
 ② Number of steps remaining
In this example, 10 steps have been set, and 310 more may be programmed.

Time Program Edit Screens:

Number of steps used/remaining display



5.4.3 Time Program Flow

■ Setting a New Program

The procedure involved when writing time programs is presented below in the following flow diagrams.

Initial screen

```
SET ACTUAL T. MAX
40  XX.X  90
```

Number of programmed
steps screen

```
Used Left
0  320
```

enter

Program setting screen

① Setting the time

```
Time
0.1
```

Enter a Time value using the numeric keypad.*1

enter

② Setting the function

```
Time Func
10.0 TEMP
```

Press **func** repeatedly to display the desired command
(function).

enter

③ Setting the function value

```
Time Func Value
10.0 TEMP      50
```

(Remember that functions [ON], [OFF] and [STOP] have no values associated with them.) Press **enter** after setting the value using the numeric keypad.

Set the next operation
in the program.

*1 Press **back** to return to the previous step.

* The valid time setting range
is 0.1-999.9 minutes.

5.4.4 Setting Functions

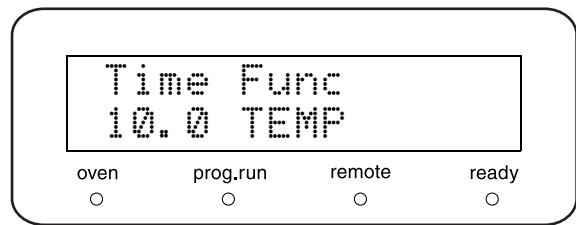
After a time has been set for a program step, a function (command) must be set for it. The following commands are available:

■ [TEMP (Operating Temperature)]

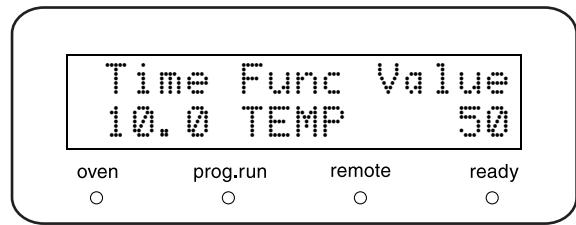
This command sets the column oven temperature.

The setting range is 4- 85°C.

- 1 After setting the time for the step, press **enter**. [Func] appears. Press **func** until [TEMP] is displayed. Then press **enter** to set [TEMP].



- 2 Use the numeric keypad to set the desired temperature (4- 85°C).



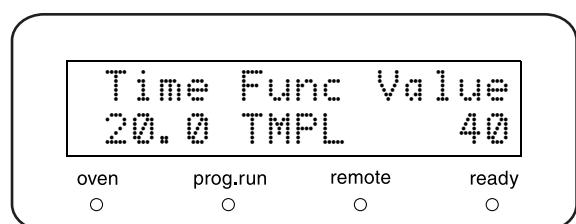
- 3 Press **enter** to proceed to the next step.

■ [TMPL (Setting Linear Temperature Regulation)]

Performs linear temperature regulation up to (or down to) the set temperature until the set time elapses.

The setting range is 4 - 85°C.

- 1 After setting the time for the step, press **enter**. [Func] appears. Press **func** until [TMPL] is displayed. Then press **enter** to set [TMPL].



- 2 Use the numeric keypad to set the desired temperature (4- 85°C).

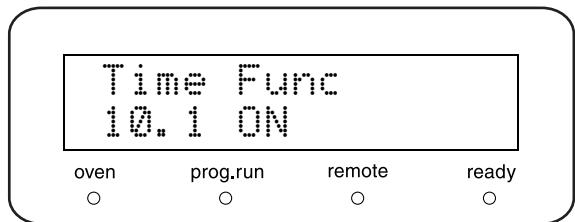
- 3 Press **enter** to proceed to the next step.

■ [ON] (Oven ON) / OFF (Oven OFF)]

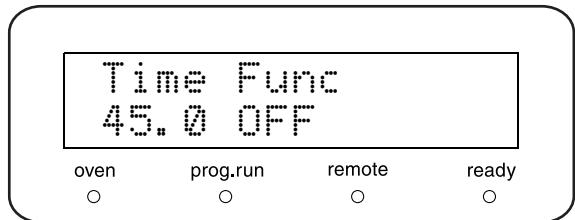
- [ON] . . . Temperature control starts at the time set for the command.
When temperature is controlled, the [oven] indicator is on. The oven temperature is controlled until an [OFF] command is implemented.
- [OFF] . . . Temperature control stops at the time set for the command.
The [oven] indicator goes out.

- 1** After setting the time for the step, press **enter**.
[Func] appears. Press **func** until [ON/OFF] is displayed. Then press **enter** to set [ON/OFF].

ON



OFF



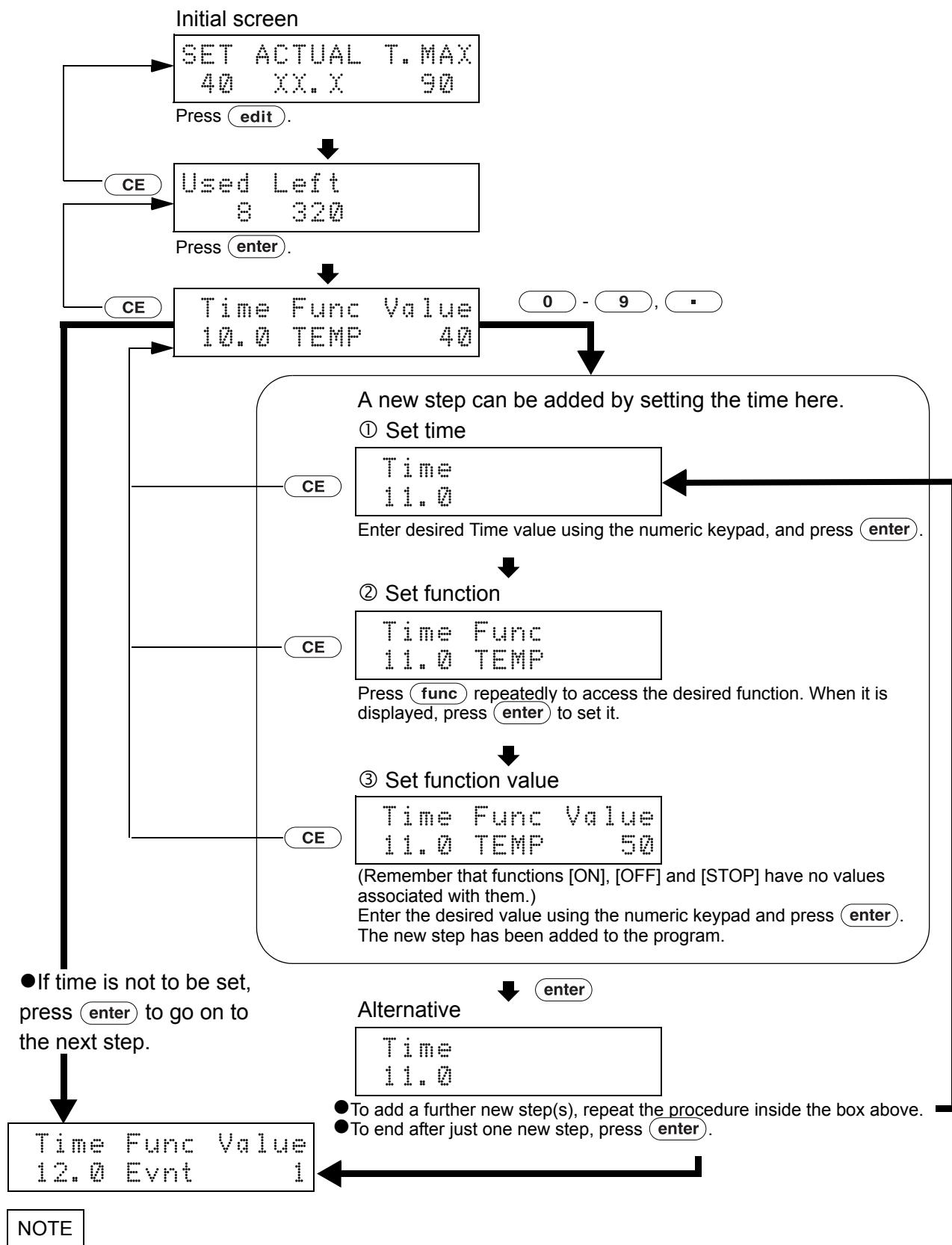
NOTE

[ON] and [OFF] have no values associated with them. Therefore, the display proceeds directly to the next step when **enter** is pressed.

5. Application Operation

■ Adding Steps for Time Program

To add a step during, or after, writing a program follow the chart below.

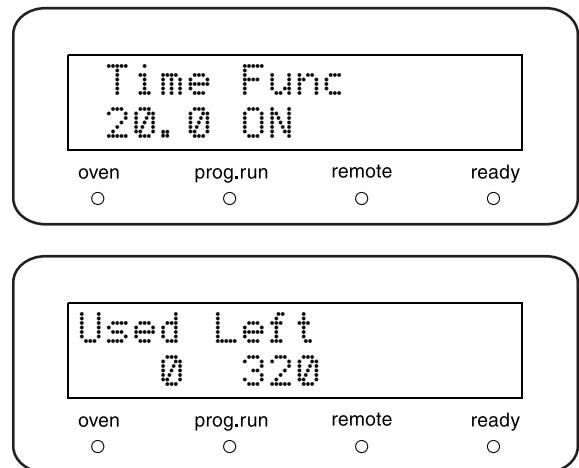


■ Deleting Steps

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

An example to delete the step 1 of the program set in "5.4.5 Creating a Typical Time Program" P. 5-42 is shown as follows:

- 1** Show the step to be deleted.
To display the step, follow the same procedure as creating the programs.
* To delete a subsequent step, press **enter** repeatedly until the step appears.
- 2** Press **del**.
Step 1 will be deleted, and the subsequent step appears. If no steps follow, the display on the right appears.



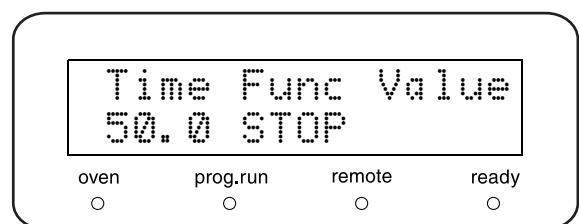
■ STOP (Ending a Time Program)

Always end a time program with a [STOP] command.

NOTE

If there is no [STOP] command, the program will be implemented for the maximum time of 999.

- 1** After setting the time, press **enter**.
[Func] appears. Press **func** until [STOP] is displayed. Then press **enter** to set [STOP].
- 2** Press **CE**. initial screen is displayed, and a time program ends.

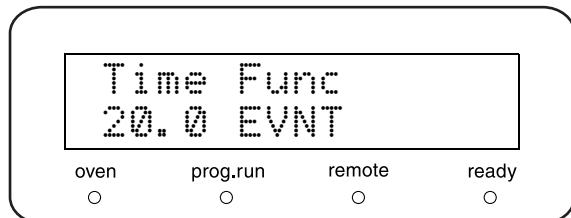


5. Application Operation

■ [EVNT (EVENT Output ON/OFF)]

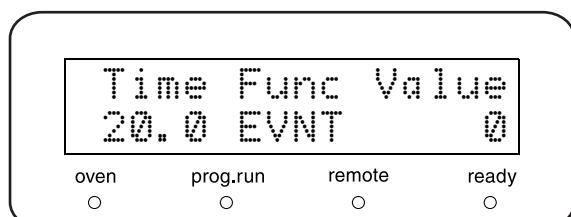
This command synchronizes the operation of external devices with the oven. Operations are synchronized by shorting the EVENT relay terminals. There are two sets; [EVENT1] and [EVENT2].

- 1 After setting the time, press **enter**.
[Func] appears. Press **func** until [EVNT] is displayed. Then press **enter** to set [EVNT].



- 2 Select the values 0, 1, 2, 12 by the numeric keypad. Other values cannot be selected.

Setting	[EVENT1] output	[EVENT2] output
0	Relay 1 OFF	Relay 2 OFF
1	Relay 1 ON	Relay 2 OFF
2	Relay 1 OFF	Relay 2 ON
12	Relay 1 ON	Relay 2 ON



- 3 Press **enter** to proceed to the next step.

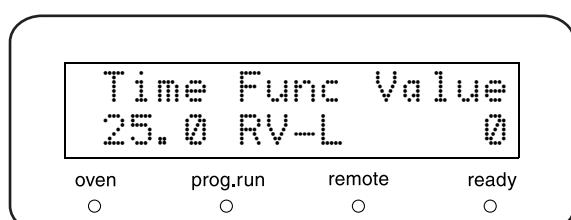
■ [RV-L, RV-R (Setting the Automatic Column Switching Valves)]

Performs setting of the automatic column switching valves mounted inside the column oven.

[RV-L] sets the automatic column switching valve mounted on the left and [RV-R] sets the automatic column switching valve mounted on the right.

If the FCV-12AH(i) is mounted, the values 0 and 1 can be set, and if the FCV-14AH(i) is mounted, the values 1 to 6 can be set.

- 1 After setting the time for the step, press **enter**.
[Func] appears. Press **func** until [RV-L] or [RV-R] is displayed. Then press **enter** to set [RV-L] or [RV-R].
- 2 Configure settings 0, 1 or 1-6 via the numeric keypad.



- 3 Press **enter** to proceed to the next step.

■ [LOOP]

[LOOP] function can register the loop count of time program. The program is repeated the number of times set for the command value.

Time	Func	Value
30.0	LOOP	3
oven	prog.run	remote
○	○	○

The example on the right will run steps ① and ② three times; each 2 step cycle takes 30 minutes. At the end of the third cycle, the program stops.

The [LOOP] command is inserted at the end of a program.

Step	Time (min)	Func	Value
①	15.00	TEMP	40
②	20.00	TEMP	60
③	30.00	LOOP	3

NOTE

- If a setting is changed by the execution of a time program, the new value is valid only until the end of that program.
When the program finishes, the setting returns to the value before program execution.
- Value of [LOOP] command can be set to 255. When [0] is set, time program will be repeated 256 times.
- Steps which follow a [LOOP] command are ignored. The program finishes when execution of the [LOOP] command has been completed. Settings return the values before program execution.

5.4.5 Creating a Typical Time Program

The following example describes the steps involved when creating a time program which automatically implements the temperature program shown on the right.
(In the example, the oven initial set temperature is 50°C.)

Step	Time (min)	Func	Value
1	20	ON	
2	150	TEMP	40°C
3	200	OFF	
4	201	STOP	

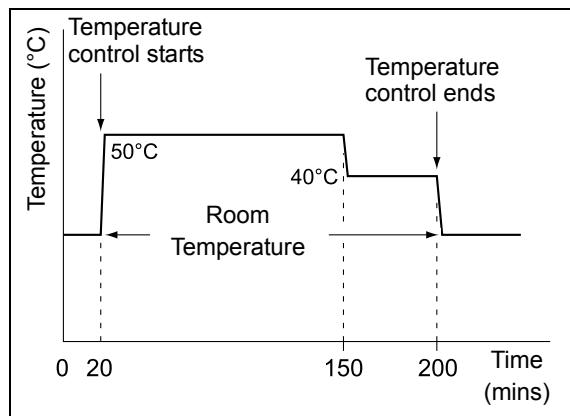


Fig. 5.1

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

Initial screen

SET ACTUAL T. MAX
50 XX.X 90

oven prog.run remote ready
○ ○ ○ ○

- 2 Press **edit**.

The number of steps already created and remaining steps appears.

Number of steps used/remaining display

Used Left
0 320

oven prog.run remote ready
○ ○ ○ ○

- 3 Press **enter**.

The setting screen appears.

Time setting display

Time

oven prog.run remote ready
○ ○ ○ ○

- 4 Using the numeric keypad, set 20 (minutes) for the time. Then press **enter**.

[Func] appears.

Time setting for the 1st step

Time
20.0

oven prog.run remote ready
○ ○ ○ ○

- 5** Press **func** until [ON] is displayed. Press **enter** to set [ON] as the command.
Time setting for 1st step is complete and proceeds to the next step.

Function setting for the 1st step



- 6** [Time] appears on the screen.

The 2nd step



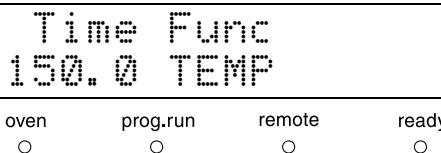
- 7** Using the numeric keypad, set 150 (minutes) for the time. Then press **enter**.
[Func] appears.

Time setting for the 2nd step



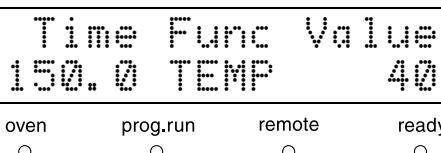
- 8** Press **enter** to set [TEMP] as the command.

Function setting for the 2nd step



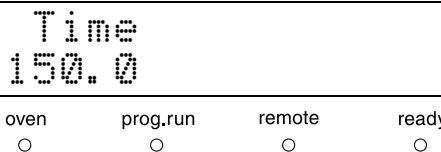
- 9** Using the numeric keypad, set 40 (°C) for the [Value] (temperature). Then press **enter**.
Time setting for 2nd step is complete and proceeds to the next step.

Temperature setting for the 2nd step



- 10** [Time] appears on the screen.

The 3rd step



5. Application Operation

- 11 Using the numeric keypad, set the time (minutes). Then press **enter**. [Func] appears.

Time setting for the 3rd step

Time 200. 0			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 12 Press **func** until [OFF] is displayed. Then press **enter** to set [OFF] as the command. Time setting for 3rd step is complete and proceeds to the next step.

Function setting for the 3rd step

Time Func 200. 0 OFF			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 13 [Time] appears on the screen.

The 4th step

Time 200. 0			
oven	prog.run	remote	ready
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 14 Using the numeric keypad, set the time (minutes). Then press **enter**. [Func] appears.

Time setting for the 4th step

Time 201. 0			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 15 Press **func** repeatedly until [STOP] is displayed. Then press **enter** to set [STOP] as the command. The time program is now complete.

Function setting for the 4th step

Time Func 201. 0 STOP			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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

Initial screen

SET ACTUAL T. MAX 50 XX.X 85			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5.4.6 Creating a Typical Time Program2 -Linear Temperature Regulation

The following example shows how to make linear changes in the operating temperature using a time program.

(In the example, the oven initial set temperature is 50°C.)

Step	Time (min)	Func	Value
1	60	TMPL	80°C
2	120	TMPL	50°C
3	150	STOP	

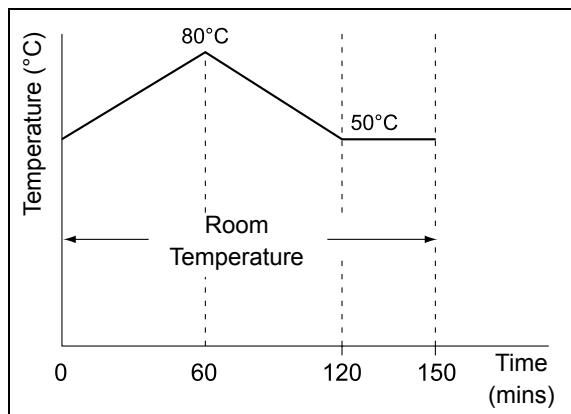
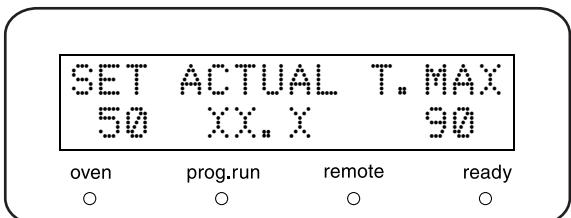


Fig. 5.2

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

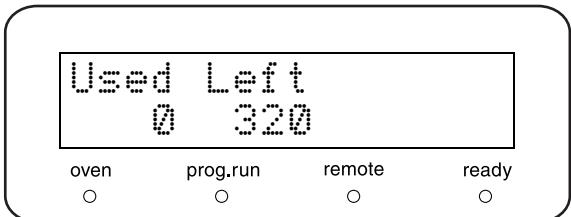
Initial screen



- 2 Press **edit**.

The number of steps already created and remaining steps appears.

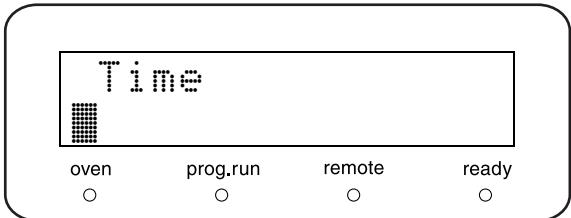
Number of steps used/remaining display



- 3 Press **enter**.

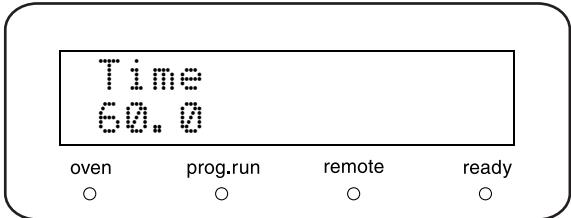
The setting screen appears.

Time setting display



- 4 Using the numeric keypad, set 60 (minutes) for the time. Then press **enter**. [Func] displays.

Time setting for the 1st step



5. Application Operation

- 5 Press **func** until [TMPL] is displayed. Press **enter** to set [TMPL] as the command.

Function setting for the 1st step

Time	Func		
60.0	TMPL		
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 6 Set the temperature (°C) by the numeric keypad and press **enter**.

Time setting for 1st step is complete and proceeds to the next step.

Temperature setting for the 1st step

Time	Func	Value	
60.0	TMPL	80	
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 7 [Time] appears on the screen.

The 2nd step

Time			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 8 Using the numeric keypad, set 120 (minutes) for the time. Then press **enter**.

[Func] appears.

Time setting for the 2nd step

Time			
120.0			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 9 Press **func** repeatedly to display [TMPL].
Press **enter** to set [TMPL] as the command.

Function setting for the 2nd step

Time	Func		
120.0	TMPL		
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

- 10 Using the numeric keypad, set 50 (minutes) for the time. Then press **enter**.

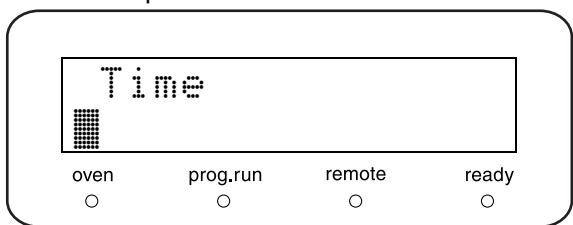
Time setting for 2nd step is complete and proceeds to the next step.

Temperature setting for the 2nd step

Time	Func	Value	
120.0	TMPL	50	
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

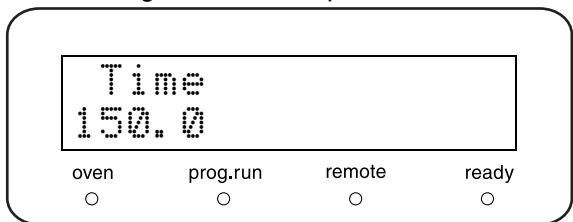
11 [Time] appears on the screen.

The 3rd step



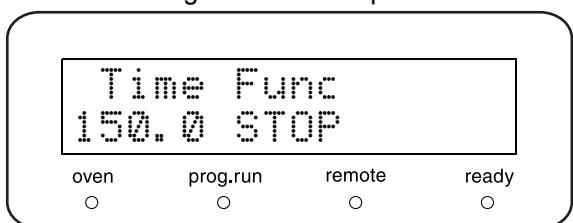
12 Using the numeric keypad, set 150 (minutes) for the time. Then press **enter**.
[Func] appears.

Time setting for the 3rd step



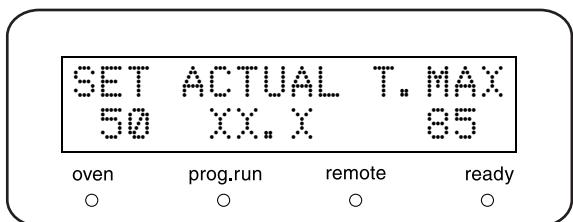
13 Press **func** repeatedly until [STOP] is displayed. Then press **enter** to set [STOP] as the command. The time program is now complete.

Function setting for the 3rd step



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

Initial screen

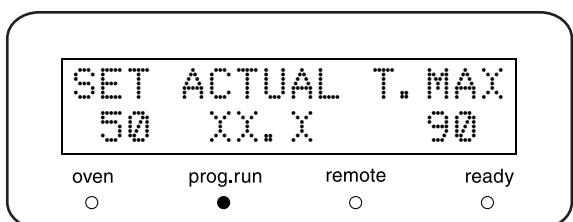


5.4.7 Starting a Time Program

To start a time program, proceed as follows:

Press **run** to start the time program.

[prog.run] indicator illuminates.



5.4.8 Stopping a Time Program

There are two ways to stop the time program:

- Press **run** to stop the running program forcefully.
The [prog.run] indicator goes out.
- Insert [STOP] command of the program. P.5-39

When the program stops, the [prog.run] indicator goes out.

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

5.5.1 Preparation

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

Command	Set value	Reference
LOCAL	0 : Remote	 "[LOCAL]" P. 5-17
LINK ADRS	LINK ADRS	 "[LINK ADRS]" P. 5-17
OP MODE	0 : 20A	 "[OP MODE]" P. 5-32

5.5.2 Basic Parameters

The operating temperature, maximum temperature, automatic column switching valves (L, R), column oven ON/OFF, and the time program are set from the system controller. The Column Management Device (CMD) is also supported.

 "9.1.12 Column Management Device (CMD)" P. 9-33

For details, see the CBM-20A/20Alite Instruction Manual.

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

5.6.1 Preparation

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

Command	Set value	Reference
LOCAL	0 : Remote	 "[LOCAL]" P. 5-17
LINK ADRS	LINK ADRS	 "[LINK ADRS]" P. 5-17
OP MODE	1 : VP *1 2 : 10A *2	 "[OP MODE]" P. 5-32

*1 To connect to SCL-10Avp : the instrument is recognized as CTO-10Avp/ACvp.

*2 To connect to SCL-10A : the instrument is recognized as CTO-10A/C.

5

5.6.2 Basic Parameters

The operating temperature, maximum temperature, column oven ON/OFF, and the time program are set from the system controller.

For details, see the SCL-10Avp or SCL-10A Instruction Manual.

5.6.3 Attention

When this instrument is connected to and operated from the SCL-10Avp or SCL-10A system controller, the oven is controlled in the same way as the CTO-10A/Cvp or the CTO-10A/C and so the following restrictions apply:

- 1) The maximum possible settings for the operating temperature and maximum temperature are 80°C and 85°C respectively.
- 2) The Column Management Device (CMD) cannot be used.
 "9.1.12 Column Management Device (CMD)" P. 9-33

5.7 Connection to External Input/Output Terminals

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

Details of the terminal and wiring are described as follows.

⚠️ WARNING

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

Otherwise, fire, electric shock or malfunction may occur.

5.7.1 External Input/Output Terminals

Connector No.	Signals	Description	Remark
1	COMMON		
2	COMMON	Common terminal for inputting signals.	
3	ERROR (input)	[ERROR EXTERNAL] for the oven is generated by an external contact signal.	
4	PRG. START (input)	[START] input terminal. [START] signal starts the instrument time program. If signal is received while program is running, program is restarted from time [0].	These signals are implemented by shorting the appropriate wire pair between the input command terminal and the common terminal. Duration of shorting (tc) should be as follows. 0.5 sec < tc < 10 sec.
5	OVEN ON (input)	[OVEN ON] input terminal. [OVEN ON] signal starts temperature regulation.	
6	OVEN OFF (input)	[OVEN OFF] input terminal. [OVEN OFF] signal stops temperature regulation.	
7	[EVENT1] (input)	[Event1/2] output terminals. Internal relay contacts which are turned ON/OFF according to a time program or the [EVENT] parameter value.	Contact rating: 30VDC/0.1A
8			
9	[EVENT2] (input)		
10			

5.7.2 Connection of Event Cable

- 1** Insert the event cable plug into the external input/output terminals.

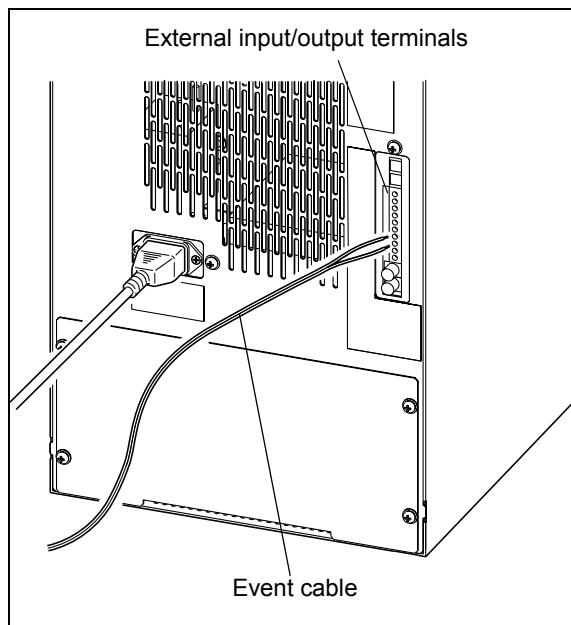


Fig. 5.3

- 2** Referring to the signal column on the previous page, connect the external device leads to the appropriate event cable wires with the connector.

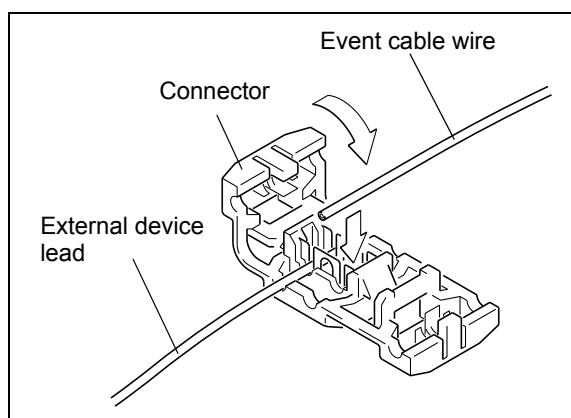


Fig. 5.4

NOTE

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

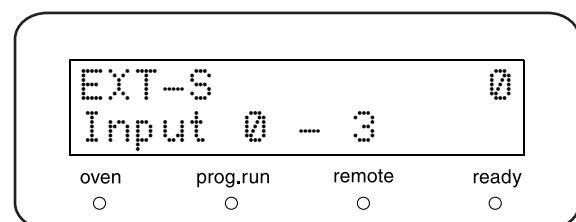
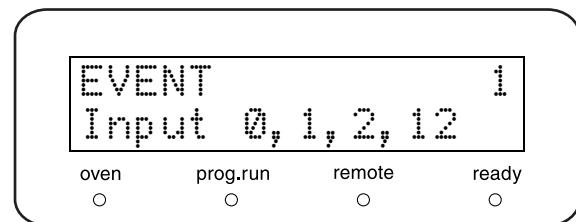
- Cable with single wire: ϕ 0.4 to ϕ 1.2 (AWG26 to 16)
 - Cable with stranded wire: 0.3mm^2 to 1.25mm^2 (AWG22 to 16), diameter of single wire thicker than ϕ 0.18.
- The cable with stranded wire is suitable to prevent disconnection.

NOTE

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

☞ "[EVNT (EVENT Output ON/OFF)]" P. 5-40

☞ "[EXT-S]" P. 5-19



6

Troubleshooting

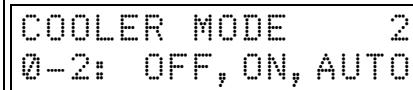
Contents

6.1	Troubleshooting and Corrective Action	6-2
6.2	Error Messages.....	6-3

6.1 Troubleshooting and Corrective Action

This section describes the probable causes of problems that can arise, and the corrective action to be taken to eliminate the causes. For more detailed procedures, refer to the indicated page.

If the problem cannot be resolved even after taking the indicated measures, or if there are problems not included in the following tables, contact your Shimadzu representative.

Symptom	Probable cause	Corrective action	Page
Power does not turn ON even after switching ON power.	Power plug is disconnected.	Connect plug correctly.	P.9-6
	Power cord internal wires are cut.	Replace with a new cord of the same type.	P.1-3
	Power supply does not meet specifications for this instrument.	Use power supply that meets specifications for this instrument.	P.9-5
Key operation is not possible.	 was not pressed. Operation keys are shown to operate.	Press  . Operation keys are shown to operate.	P.2-7
[ready] indicator does not illuminate.	[oven] indicator not on.	Press  . The [oven] indicator illuminates.	P.4-5
	[COOLER MODE] setting is [0]. (CTO-20AC only)	Send "run" signal from system controller. Set [1] or [2] for [COOLER MODE]: 	*1 P.5-19
No error message appears when mobile phase leaks inside oven during temperature regulation.	Sensitivity incorrectly adjusted.	Readjust leak sensor sensitivity.	P.5-32
[COOLER MODE] set ON, but oven interior temperature does not fall to room temperature. The lowest set value is -10°C. (only CTO-20AC)	Insufficient clearance around oven.	Allow for a clearance of at least 100mm in back, at least 20mm on sides.	
	High ambient temperature behind oven.	Eliminate cause of high temperature.	
	Column interior is not properly sealed.	Inspect valve, tubing inlets/outlets, etc.	

*1 Refer to the system controller instruction manual for details.

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.

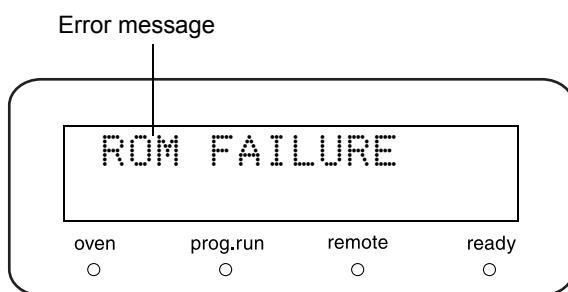
Fatal : The instrument stops operation.

Pressing **CE** will not clear the error message and the alarm sound.

Alarm : The instrument stops temperature regulation.

Press **CE** to clear the error message and the alarm sound.

Warning :  " (Set temp. error)" P. 6-5



Error message	Type	Cause and Action
ROM FAILURE (ROM error)	Fatal	Cause: ROM error (electronic failure) Action: Turn power OFF and contact your Shimadzu representative.
RAM FAILURE (RAM error)	Fatal	Cause: RAM error (electronic failure) Action: Turn power OFF and contact your Shimadzu representative.
ERR OVER T. MAX (Temperature over limit)	Alarm	Cause: The oven temperature has exceeded the value set for [T.MAX]. Action 1: Lower the oven set temperature. Action 2: Set [T.MAX] to a value 5°C higher than the set temperature. An overshoot may occur before the temperature reaches the set value.
ERR EXTERNAL (External error)	Alarm	Cause: The External Control Connections received an error signal.  "5.7 Connection to External Input/Output Terminals" P. 5-50

6. Troubleshooting

Error message	Type	Cause and Action								
ERR LEAK DETECT (Leak detected)	Alarm	<p>Cause: Density of solvent vapor inside column oven has exceeded leak sensor actuation level.</p> <table border="1"> <thead> <tr> <th>Cause</th><th>Action</th></tr> </thead> <tbody> <tr> <td>1. Mobile phase has leaked inside the oven.</td><td>Take action to stop the leak.</td></tr> <tr> <td>2. There is solvent vapor in the air around the unit.</td><td>Provide adequate ventilation for the room.</td></tr> <tr> <td>3. Sensor sensitivity is incorrectly adjusted.</td><td>Readjust the sensitivity.  P.5-32</td></tr> </tbody> </table> <p>Action: Take the appropriate action described in the table above. Then run the fan for 5 minutes with the right door open. The leak sensor is unstable for 60 seconds after starting up the column oven and so errors are not detected during this period.</p>	Cause	Action	1. Mobile phase has leaked inside the oven.	Take action to stop the leak.	2. There is solvent vapor in the air around the unit.	Provide adequate ventilation for the room.	3. Sensor sensitivity is incorrectly adjusted.	Readjust the sensitivity.  P.5-32
Cause	Action									
1. Mobile phase has leaked inside the oven.	Take action to stop the leak.									
2. There is solvent vapor in the air around the unit.	Provide adequate ventilation for the room.									
3. Sensor sensitivity is incorrectly adjusted.	Readjust the sensitivity.  P.5-32									
ERR FAN (Fan error)	Fatal	<p>Cause: Fan speed does not increase to the set value.</p> <p>Action: If the cause is obstruction of the fan by tubing or other object, turn the power off and remove the obstruction. If the object cannot be removed, or if the error is due to some other cause, contact your Shimadzu representative.</p>								
ERR SENSOR H (Thermosensor error)	Fatal	<p>Cause: Thermosensor readings are abnormally high. There may be a short circuit in the sensor.</p> <p>Action: Turn power OFF and contact your Shimadzu representative.</p>								
ERR SENSOR L (Thermosensor error)	Fatal	<p>Cause: Thermosensor readings are abnormally low. The sensor may be disconnected.</p> <p>Action: Turn power OFF and contact your Shimadzu representative.</p>								
COOLER NOT EXIST (Cooler error)	Fatal	<p>(only CTO-20AC)</p> <p>Cause: Cooler is not mounted or the cable is snapping.</p> <p>Action: Turn power OFF and contact your Shimadzu representative.</p>								
ERR LEAK SENS (Leak sensor error)	Fatal	<p>Cause: Leak sensor malfunctions (probably due to broken/disconnected wire).</p> <p>Action: Turn power OFF and contact your Shimadzu representative.</p>								

Error message	Type	Cause and Action
ERR NO RV-L HOME (Left valve home position error)	Fatal	<p>Cause: Rotation error in an automatic column-switching valve.</p> <p>Action: Turn power OFF and contact your Shimadzu representative.</p>
ERR NO RV-R HOME (Right valve home position error)		
WARNING: LOW SET TEMP (Set temp. error)	Warning	<p>An error message is displayed, and an alarm sounds, approximately 10 seconds after occurrence of the error. (Temperature regulation is not stopped.)</p> <p>Cause: Set temperature value is inappropriate, in one of the following ways:</p> <ul style="list-style-type: none"> • When use of cooler is enabled (i.e. [COOLER MODE] set to [1] or [2] in CTO-20AC): <ul style="list-style-type: none"> → Set temperature is room temperature minus 10°C, or lower. • When use of cooler is disabled: <ul style="list-style-type: none"> → Set temperature is lower than the room temperature. <p>Action: ① Press CE. The alarm and the error message will be turned off.</p> <p>② Press temp until [SET TEMP] is displayed.</p> <p>③ Set a temperature higher than the one above. If the operating temperature is not changed, [LOW SET TEMP] appears periodically.</p>

6. Troubleshooting

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7

Hardware Validation

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

Contents

7.1	Overview of Hardware Validation.....	7-2
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7.7	System Validation	7-19
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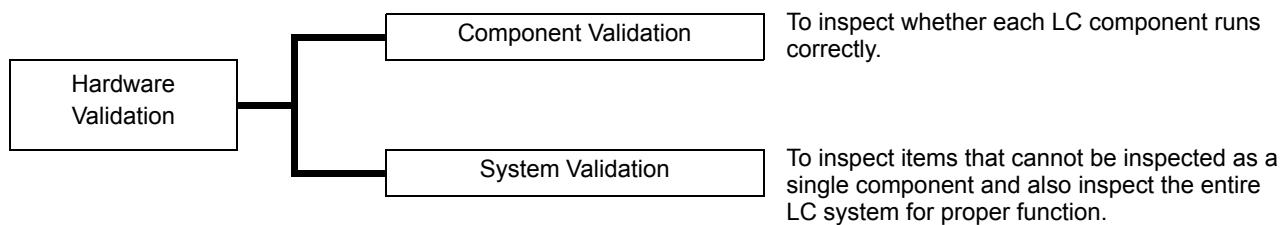
7.1 Overview of Hardware Validation

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

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

NOTE

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

7.3 Validation Precautions

7.3.1 Environment

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

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

7.3.2 Installation Site

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

WARNING

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

CAUTION

- Avoid dust or corrosive gas
Avoid installing the instrument in places subject to excessive dust or corrosive gas since service life and performance levels may be affected.
- Keep away from strong magnetic fields
Do not install the instrument near equipment that generates strong magnetic fields. If the power supply line is subject to high electrical noise, use a commercially-available power surge protector.
- Provide adequate installation surface and space
The weight of CTO-20A is approximately 20kg, and CTO-20AC approximately 23kg. During installation, consider the entire weight combined with other LC components.
The lab table on which this instrument is installed should be strong enough to support the total weight of the LC system. It should be level, stable and have depth of at least 600mm.
If these precautions are not followed, the instrument could tip over or fall off the table.
When components are installed side by side, maintain a keep space of at least 30 mm between the components.
- Regulate room temperature and humidity
The room temperature should be between 4 and 35°C, with minimal temperature variations throughout the course of a day. Humidity should be kept within 20-85%.
- Position instrument properly in the room
Install the instrument in a location that is free from vibration and away from sunlight, and heat/air conditioning drafts.

7.4 Equipment Required for Validation

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

■ Testing Equipment

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

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

7. Hardware Validation

■ Standard Reagents for Validation

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

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

■ Hardware Testing Supplies

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

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

7.5 Validation : Column Oven

7.5.1 Check Terms

Check terms for the column oven 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	Setting Temperature Accuracy and Regulation Accuracy (40/50°C) Check	Checks the difference between setting temperature at 40/50°C and actual temperature. Checks also temperature regulation accuracy.
7.5.6	Setting Temperature Accuracy and Regulation Accuracy (Room Temperature -5°C) Check	Checks the difference between setting temperature at 40/50°C and actual temperature. Checks also temperature regulation accuracy. (Only for CTO-20AC)
7.5.7	Leak Sensor Test	Checks the operation of leak sensor.

7.5.2 ROM, RAM Self Diagnosis

7

■ Objective

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

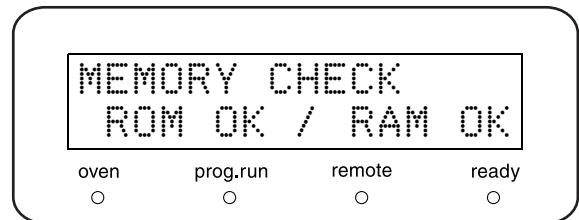
■ Check Procedure

1 Turn the power switch ON.

2 Press **VP** three times to display [VALIDATION].

3 Press **func** three times to display [MEMORY CHECK].

4 Press **enter**.
 "MEMORY CHECK" P. 5-29



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

7. Hardware Validation

7.5.3 Firmware Version Check

■ Objective

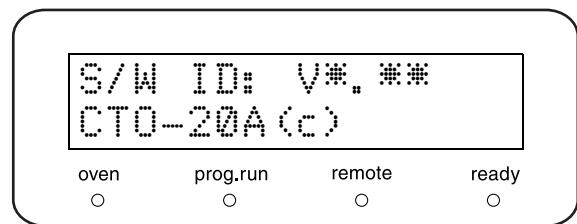
To check the version of firmware.

■ Check Procedure

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

- 2 Press **func** two times to display the version number.

 ["\[S/W ID\]" P. 5-25](#)



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

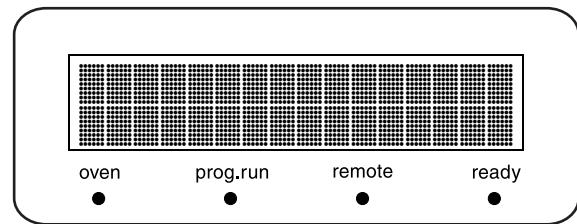
7.5.4 Display, LED Test

■ 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 Setting Temperature Accuracy and Regulation Accuracy (40/50°C) Check

■ Objective

It checks that temperature is regulated to the set value.

Specifically, it measures the temperature near the control thermosensor in the column oven, and compares it to the set temperature.

■ Items Required for Check

Item		Description
Digital thermometer	Thermosensor	Use a platinum resistor that has either been validated, or calibrated according to a prescribed procedure.
	Digital multimeter	Use a multimeter that has input terminals for a platinum resistor, and can print out temperature readings as digital values.

■ Connection of Check Items

- 1 Calibrate the thermosensor (platinum resistor) to be used, and measure the compensation value.
(There is no need to calibrate the thermosensor each time it is used, but it should be calibrated periodically using a prescribed procedure.)
- 2 Attach the thermosensor (platinum resistor) to the column bracket inside the oven, in front of the oven's platinum sensor.
Use the thermal insulation material inside the tubing hole.

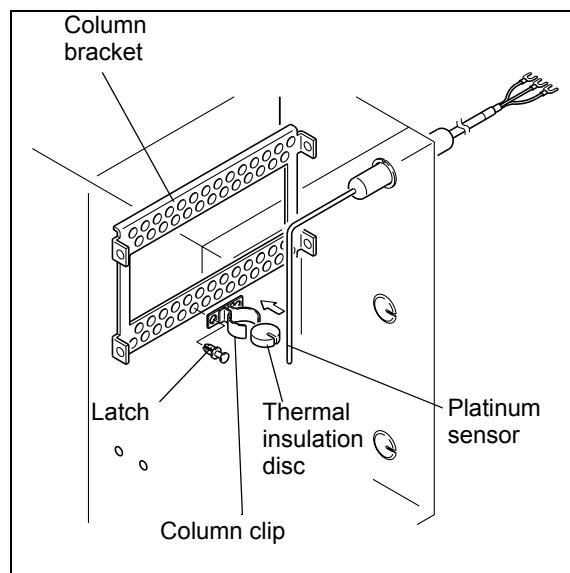


Fig. 7.1

7. Hardware Validation

- 3** Connect the thermosensor (platinum resistor) leads to the digital multimeter input terminals.

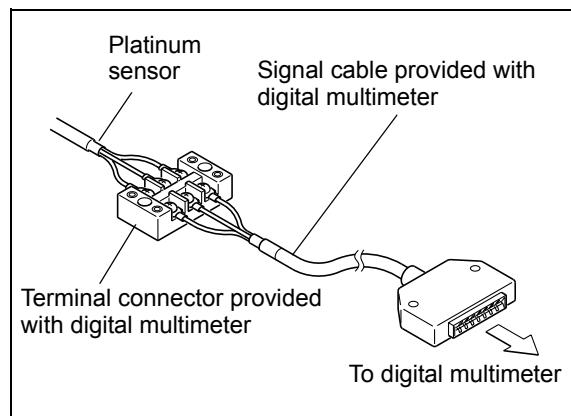
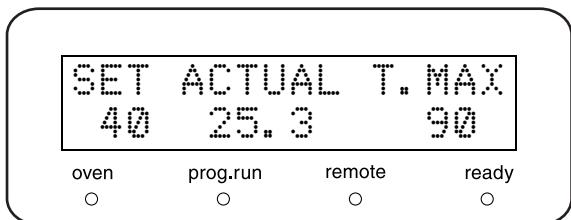


Fig. 7.2

■ Check Procedure

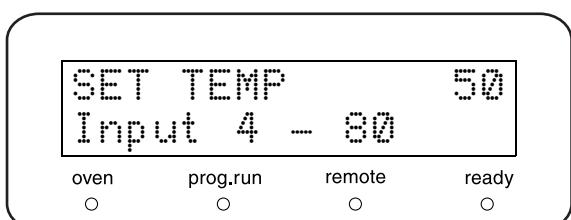
- 1** Turn the power ON.

The initial screen will be displayed.



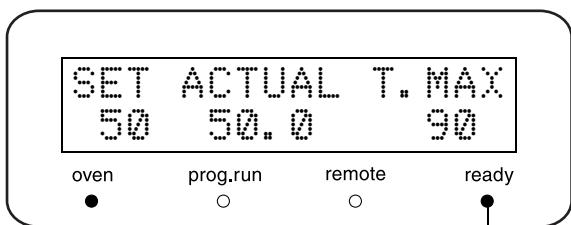
- 2** Press **temp**.

[SET TEMP] will be displayed.



- 3** Use the numeric keypad to set the temperature to 50°C or 40°C and press **enter**.

- 4** Press **oven**. Temperature regulation will start.



- 5** Press **CE** repeatedly until the initial screen displayed.

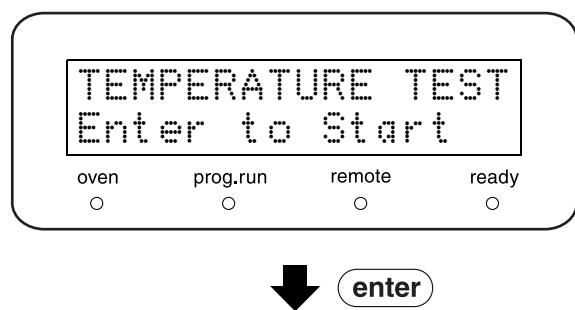
- 6** When the [ready] indicator illuminates, wait 10 minutes.

NOTE

When running the [TEMPERATURE TEST], set [WAIT TIME] to 5 minutes and [READY RANGE] to 0.1.

How to set P.5-30

- 7** Press **VP** 3 times and **func** 4 times on the initial screen.
[TEMPERATURE TEST] appears.



- 8** Press **enter**. Self-diagnosis starts.
During diagnosis, the display is as shown on the right and, after one minute, the diagnosis result for temperature stability is displayed.

During diagnosis

Now Testing Temp
Wait 1 Minute

⋮

CHECK CRITERIA:
Temperature regulation Accuracy at 40/50°C is $dT \leq 0.2^\circ\text{C}$.
[STABILITY GOOD] appears.

- 9** Press **enter**.

Result

T=50.0 dT=0.10
STABILITY GOOD



enter

- 10** To check temperature, enter the temperature measured by the digital thermometer. Observe the result displayed.

Setting

REF TEMP 50.1



enter

CHECK CRITERIA:
Temperature accuracy at 40/50°C is $\pm 2.0^\circ\text{C}$.
[ACCURACY GOOD] appears.

In case of NG,

"7.6 Temperature accuracy calibration" P. 7-17

O.K.

ACCURACY GOOD

N.G.

ACCURACY NG
Calibrate CTO

7

7. Hardware Validation

7.5.6 Setting Temperature Accuracy and Regulation Accuracy (Room Temperature -5°C) Check

■ Objective

It checks that temperature is regulated to the set value.

Specifically, it measures the temperature near the control thermosensor in the column oven, and compares it to the set temperature.

■ Items Required for Check

Item		Description
Digital thermometer	Thermosensor	Use a platinum resistor that has either been validated, or calibrated according to a prescribed procedure.
	Digital multimeter	Use a multimeter that has input terminals for a platinum resistor, and can print out temperature readings as digital values.

■ Connection of Check Items

- 1 Calibrate the thermosensor (platinum resistor) to be used, and measure the compensation value.
(There is no need to calibrate the thermosensor each time it is used, but it should be calibrated periodically using a prescribed procedure.)
- 2 Attach the thermosensor (platinum resistor) to the column bracket inside the oven, in front of the oven's platinum sensor. Use the thermal insulation material inside the tubing hole.

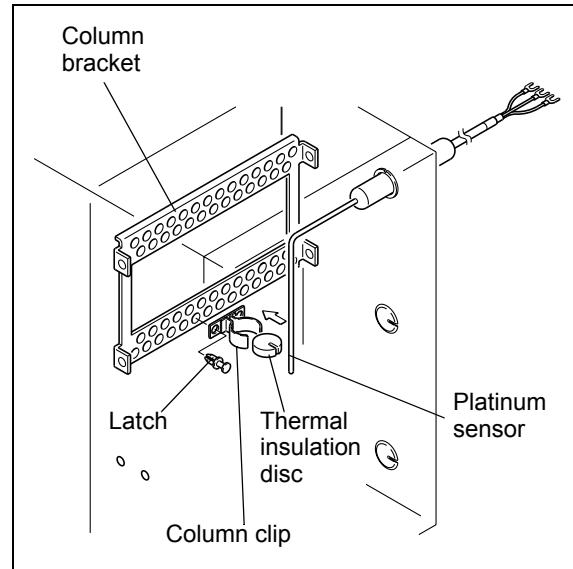


Fig. 7.3

- 3** Connect the thermosensor (platinum resistor) leads to the digital multimeter input terminals.

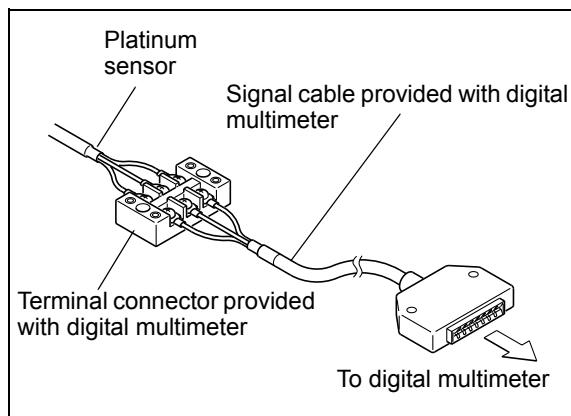
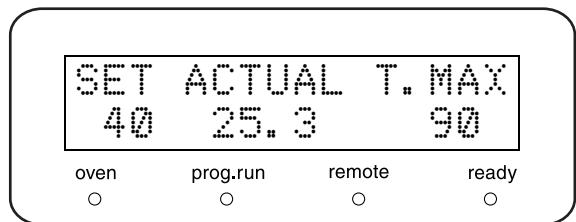


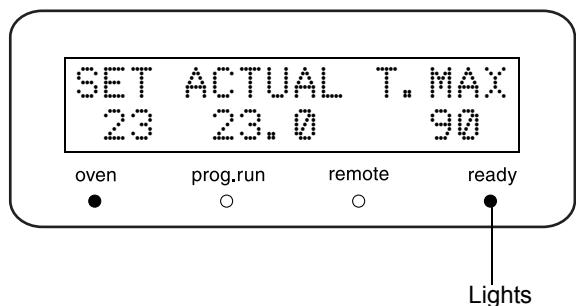
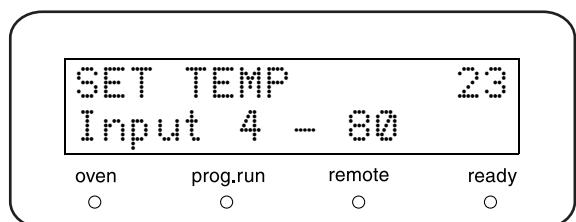
Fig. 7.4

■ Check Procedure

- 1** Turn the power ON.
The initial screen will be displayed.



- 2** Press **temp**.
[SET TEMP] will be displayed.
- 3** Use the numeric keypad to set the temperature to -5°C and press **enter**.
- 4** Press **oven**. Temperature regulation will start.
- 5** Press **CE** repeatedly until the initial screen displayed.
- 6** When the [ready] indicator illuminates, wait 10 minutes.



NOTE

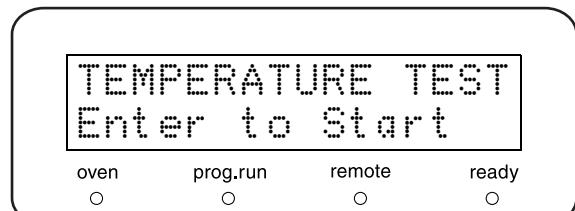
When running the [TEMPERATURE TEST], set [WAIT TIME] to 5 minutes and [READY RANGE] to 0.1.
How to set P.5-30

7. Hardware Validation

- 7 Press **VP** 3 times and **func** 4 times on the initial screen.
[TEMPERATURE TEST] appears.

- 8 Press **enter**. Self-diagnosis starts.
During diagnosis, the display is as shown on the right and, after one minute, the diagnosis result for temperature stability is displayed.

CHECK CRITERIA:
Temperature Regulation Accuracy at room temperature - 5°C is $dT \leq 0.2^{\circ}\text{C}$.
[STABILITY GOOD] appears.



During diagnosis

Now Testing Temp
Wait 1 Minute

⋮

- 9 Press **enter**.

- 10 To check temperature, enter the temperature measured by the digital thermometer. Observe the result displayed.

CHECK CRITERIA:
Temperature accuracy at room temperature - 5°C is $\pm 2.0^{\circ}\text{C}$.
[ACCURACY GOOD] appears.

Result

T=50.0 dT=0.10
STABILITY GOOD



Setting

REF TEMP 50.1



In case of NG,

"7.6 Temperature accuracy calibration" P. 7-17

O.K.

ACCURACY GOOD

N.G.

ACCURACY NG
Calibrate CTO

7.5.7 Leak Sensor Test

■ Objective

To check the operation of leak sensor.

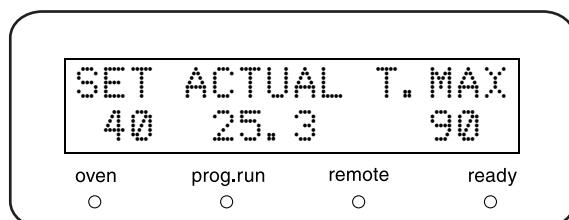
■ Items Required for Check

Item	Description
Syringe	Capacity at least 100µL
Methanol	1mL

■ Check Procedure

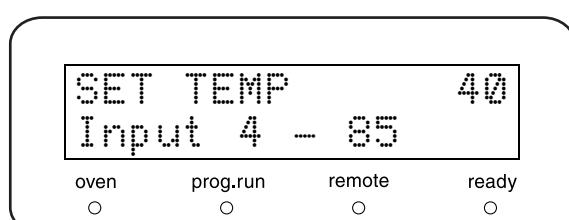
1 Turn the power ON.

The initial screen appears.



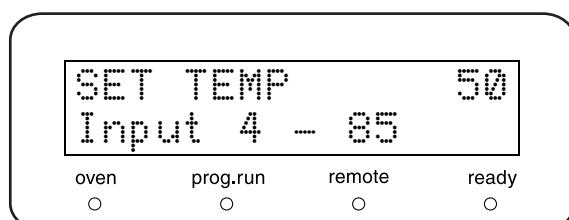
2 Press **temp**.

[SET TEMP] will be displayed.



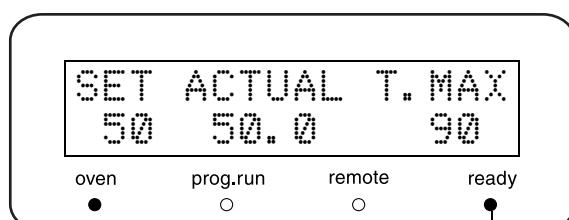
3 Use the numeric keypad to set the temperature to

50°C or 40°C and press **enter**.



4 Press **oven**. Temperature regulation starts.

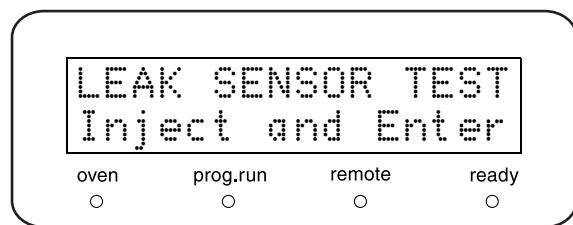
Press **CE** repeatedly until the initial screen appears.



5 When the [ready] indicator illuminates, wait for 10 minutes.

7. Hardware Validation

- 6 Press **VP** 3 times and **func** 5 times on the initial screen. [LEAK SENSOR TEST] appears.



After injecting the solvent, press **enter**.

- 7 Using a syringe, inject approximately 100 µL of methanol into the oven via the drain outlet at the bottom of the right side of the column oven, and press **enter**.

Now Testing Sens
LS Level: XXXXX

- 8 The diagnosis result is displayed within approximately 20 seconds.

O.K.

LEAK SENSOR TEST
SENSOR GOOD

CHECK CRITERIA:
[SENSOR GOOD] appears.

In case of NG,

"8.2 Adjusting the Leak Sensor Sensitivity" P. 8-3

N.G.

LEAK SENSOR TEST
SENSOR NO GOOD

Injection (100µL)

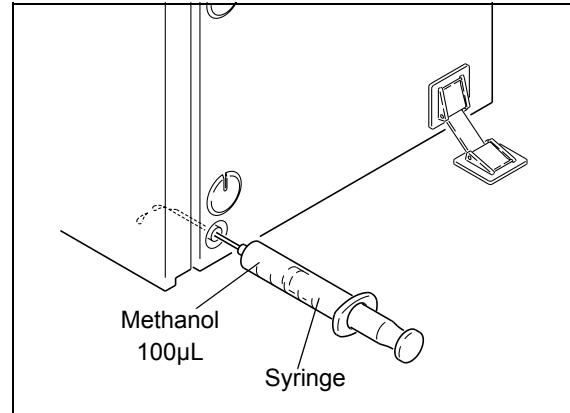


Fig. 7.5

7.6 Temperature accuracy calibration

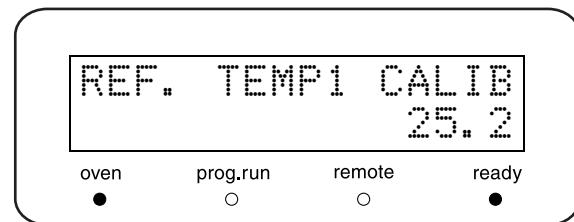
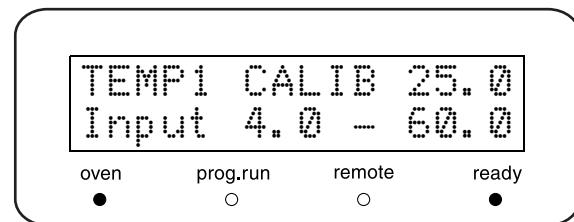
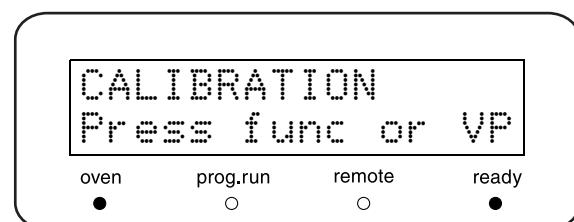
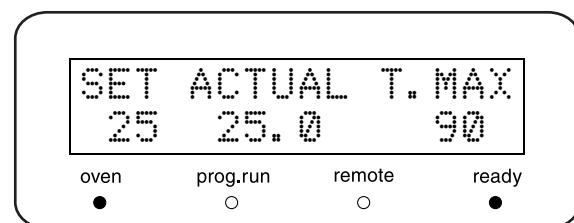
If the result of the temperature test described in "7.5.5 Setting Temperature Accuracy and Regulation Accuracy (40/50°C) Check" P. 7-9, "7.5.6 Setting Temperature Accuracy and Regulation Accuracy (Room Temperature - 5°C) Check" P. 7-12 is [NO GOOD], recalibration is necessary.

1-point calibration or 2-point calibration can be performed at any temperature. If the oven is always to be used at the same temperature, 1-point calibration at that temperature is sufficient. If the oven is to be used at a wide range of temperatures, 2-point calibration is recommended.

The first calibration temperature must be no greater than 60°C and the second calibration temperature must be at least 20°C higher than the first calibration temperature. Before delivery, the CTO-20A and the CTO-20AC are calibrated at 40°C and 60°C and at 25°C and 60°C respectively.

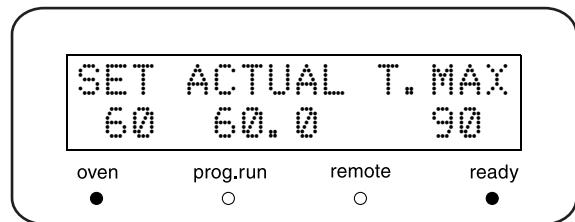
The procedure for performing temperature calibration at 25°C and 60°C is described below.

- 1** Perform temperature regulation at the first calibration temperature (25°C) and wait until the [ready] indicator is illuminated.
- 2** Perform the temperature accuracy check described in "7.5.5 Setting Temperature Accuracy and Regulation Accuracy (40/50°C) Check" P. 7-9, "7.5.6 Setting Temperature Accuracy and Regulation Accuracy (Room Temperature -5°C) Check" P. 7-12 at the first calibration temperature (25°C) and record the result.
- 3** Press the **VP** until [CALIBRATION] (Calibration Support VP Group) is displayed.
- 4** Display [TEMP1 CALIB] in calibration group of VP functions.
 **P.5-31**
- 5** Enter the temperature (25°C) set in step 1.
- 6** [REF. TEMP1 CALIB] appears.
- 7** Enter the temperature read from the thermosensor as the correction parameter in step 2.
(This completes the procedure for 1-point calibration.)



7. Hardware Validation

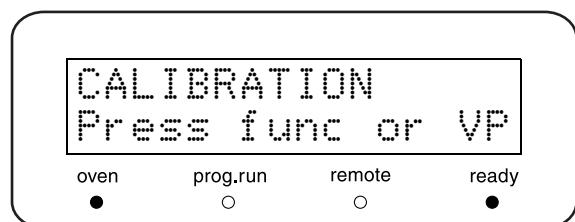
8 Perform temperature regulation at the second calibration temperature (60°C) and wait until the [ready] indicator is illuminated.



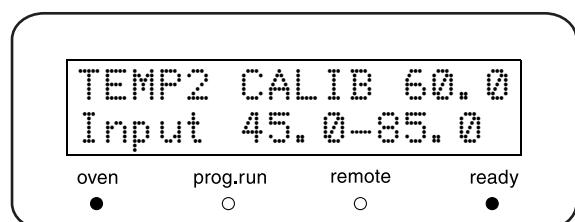
9 Perform the temperature accuracy check described in "[7.5.5 Setting Temperature Accuracy and Regulation Accuracy \(\$40/50^{\circ}\text{C}\$ \) Check](#)" P. 7-9, "[7.5.6 Setting Temperature Accuracy and Regulation Accuracy \(Room Temperature \$-5^{\circ}\text{C}\$ \) Check](#)" P. 7-12, at the second calibration temperature (60°C) and record the result.

10 Display [TEMP2 CALIB] in Calibration Group of VP functions.

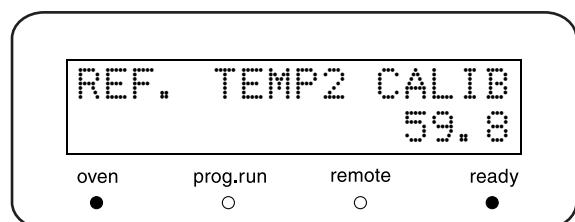
[P.5-31](#)



11 Enter the temperature (60°C) set in step 9.



12 [REF. TEMP2 CALIB] appears.



13 Enter the temperature read from the thermosensor as the correction parameter in step 9.

14 This completes the procedure for temperature accuracy calibration.

This setting result remains in memory even if the power is turned off.

7.7 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).

7.7.1 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.

7

■ Items Required for Validation

Item	Description
Mobile phase	Mixture of water and methanol (3/2, v/v) * Both the water (distilled) and the methanol should be HPLC grade.
Column	Shim-pack VP-ODS (Part No. 228-34937-91), LUNA C18 (2) (Part No. 00F-4252-E0) or equivalent ODS column (Particle size 5µm, Column Dimension : I.D. 4.6mm × length 150mm)
Sample	20mg/L caffeine solution (included in Caffeine set (5 concentrations) Part No. 228-45725-91) <Preparation> Weigh 20mg of anhydrous caffeine, transfer to a 100mL volumetric flask and dilute to volume with water. Transfer 1mL of the solution to a 10mL volumetric flask, and dilute to volume with water.
Water	HPLC grade, or equivalent
2-propanol	HPLC grade, or equivalent

■ Checking and Preparing the LC System

- 1** Check all the wiring connections in the LC system. Refer to individual component instruction manuals for details. If a Chromatopac is used, it should be connected to the detector with the signal cable connector provided with the Chromatopac, and the signal cable should then be connected to the integrator terminal of the detector.
- * If the system normally uses Chromatopac or LC workstation, the connections used for regular analysis will be satisfactory.

- 2** Check the LC system plumbing. Ensure that the tubing between (a) the autosampler outlet and the column inlet, (b) the column outlet and the detector inlet, has an I.D. of less than 0.3mm, and is shorter than 300mm. Keep the liquid volume that is not in the column as low as possible.

- 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. 7.6").

< 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.

< 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.

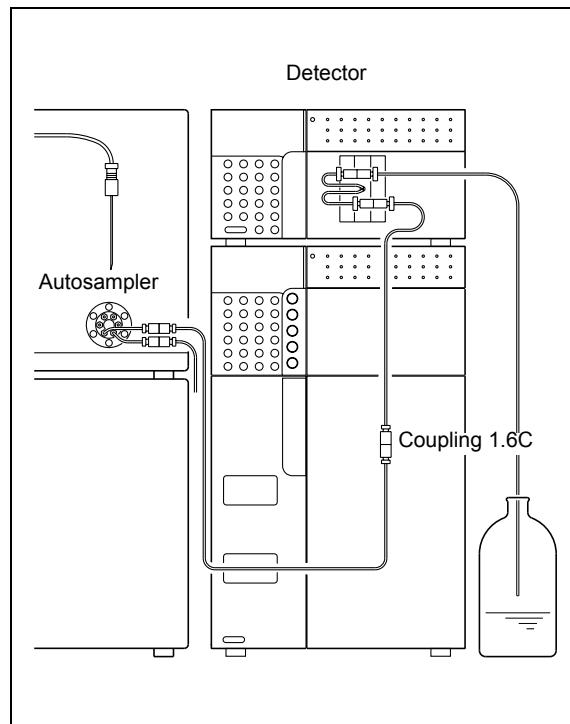


Fig. 7.6

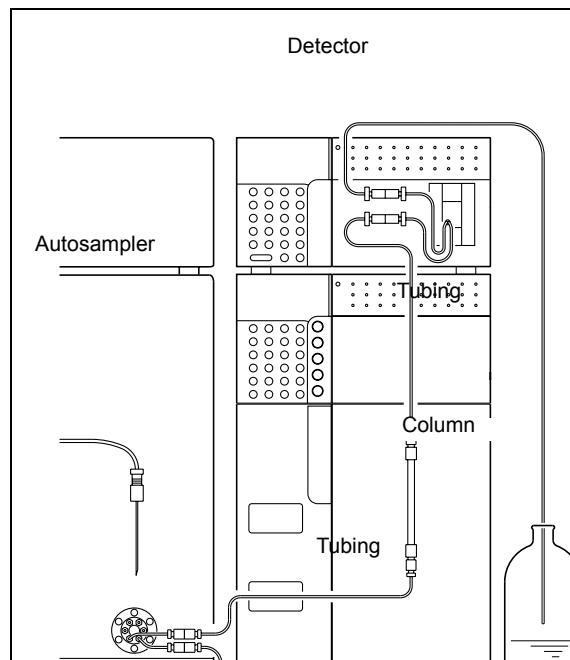


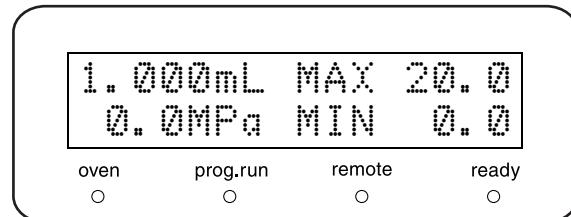
Fig. 7.7

- 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. 7.7").

■ Validation Procedure

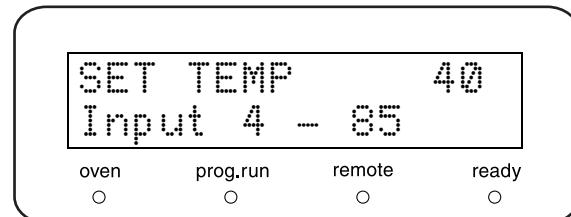
- 1** Set the pumping flow rate to 1mL/min.
See the pump's instruction manual for setting procedures.

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

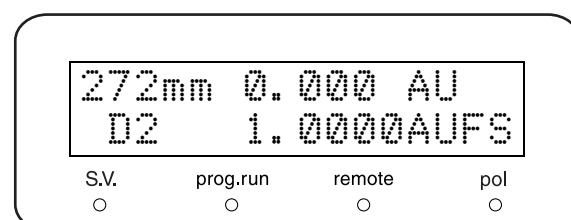


- 3** Press **pump** on the pump keypad, and **oven** on the column oven keypad. Pumping and temperature regulation will start.
Verify that liquid flows through the detector outlet tubing, and that there are no leaks from any of the connections.

- 4** Set the detector parameters.
 "Parameter Settings for Isocratic System Validation" P. 7-22

See the detector's instruction manual for setting procedures.

Detector display screen



- 5** Set the autosampler parameters.
 "Parameter Settings for Isocratic System Validation" P. 7-22

See the autosampler's instruction manual for setting procedures.

- 6** Set the data processor parameters.
 "Parameter Settings for Isocratic System Validation" P. 7-22

See the data processor's instruction manual for setting procedures.

7. Hardware Validation

7 Monitor the baseline.

When the baseline has stabilized, press the detector **zero** key, then inject 10 μ L of mobile phase, and verify that no peaks are observed.

8 Inject 10 μ L of the test standard six times, and analyze the data obtained.

9 From the peak data obtained from the six analyses, derive the relative standard deviation (coefficient of variation [C.V.]) for: retention time and peak area ("Fig. 7.8").

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

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

$$\bar{X} = (X_1 + X_2 + \dots + X_{n-1} + X_n)/n$$

n : Number of analyses

X₁..X_n : Retention time (or areas) of each peak

\bar{X} : Average

SD : Standard deviation

RSD : Relative standard deviation

C.V. : Coefficient of variation

Fig. 7.8

■ Parameter Settings for Isocratic System Validation

The parameters to be set for the various devices when validation analysis of an isocratic system is performed are given below.

• Pump	Flow rate	: 1mL/min
	P.Max	: 20.0MPa
• Column oven	Oven temperature	: 40°C
• Time program	5.00 STOP	
• Autosampler	RINSE VOLUME	: 200 μ L
	RINSE SPEED	: 35 μ L/s
	SAMPLING SPEED	: 15 μ L/s
	RINSE MODE	: 0 (No needle rinsing)
• Detector	Wavelength	: 272nm
	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%.

7.7.2 Validation of Gradient LC System

■ Objective

An analysis is performed and the retention time and peak area are obtained for each peak. The data is then examined to check for repeatability. Reproducible data validates the system.

Generally, the system being validated consists of a minimum of the following components: pump, column oven, autosampler, detector, system controller and data processor.

■ Items Required for Validation

Item	Description
Mobile phases	A: Distilled water B: Methanol A /B =60%/40% * Both the water (distilled) and the methanol should be HPLC grade.
Column	Shim-pack VP-ODS (Part No. 228-34937-91), LUNA C18 (2) (Part No. 00F-4252-E0) or equivalent ODS column (Particle size 5µm, Column Dimension : I.D. 4.6mm × length 150mm)
Sample	20mg/L caffeine solution (included in Caffeine set (5 concentrations) Part No. 228-45725-91) < Preparation > Weigh 20mg of anhydrous caffeine, transfer to a 100mL volumetric flask and dilute to volume with water. Transfer 1mL of the solution to a 10mL volumetric flask, and dilute to volume with water.
Water	HPLC grade, or equivalent
2-propanol	HPLC grade, or equivalent

■ Checking and Preparing the LC System

- 1 Check all the wiring connections in the LC system. Refer to individual component instruction manuals for details. If a Chromatopac is used, it should be connected to the detector with the signal cable connector provided with the Chromatopac, and the signal cable should then be connected to the integrator terminal of the detector.
* If the system normally uses Chromatopac or LC workstation, the connections used for regular analysis will be satisfactory.

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

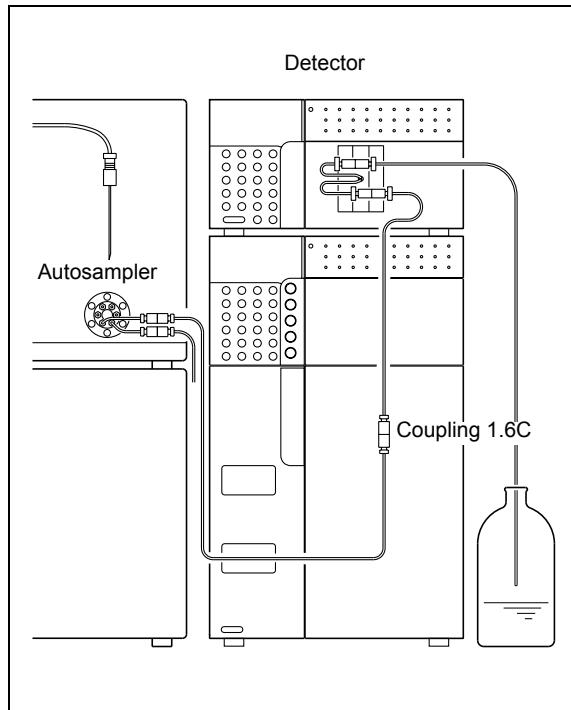


Fig. 7.9

7. Hardware Validation

- 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. 7.9").

< 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.

< 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. 7.10").

■ 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.

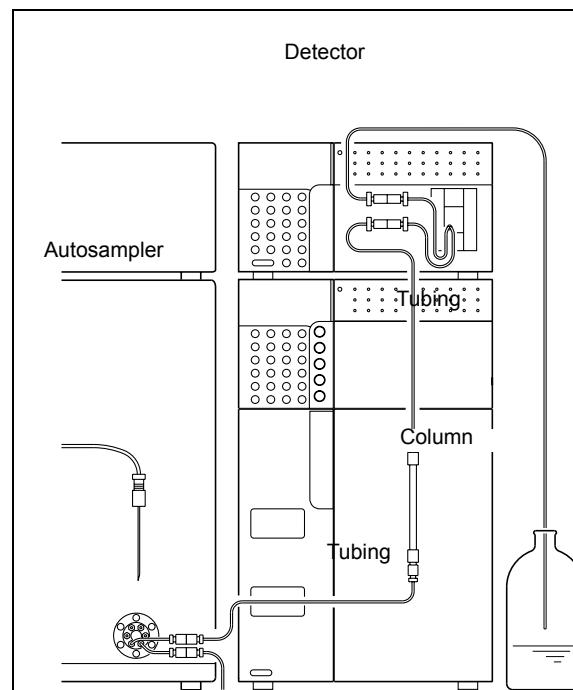


Fig. 7.10

Pump's display screen

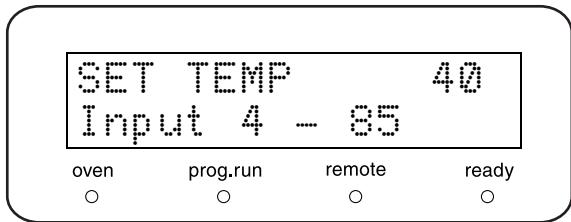
1. 000mL MAX 20.0
0. 0MPa MIN 0.0

pump prog.run remote G.E.

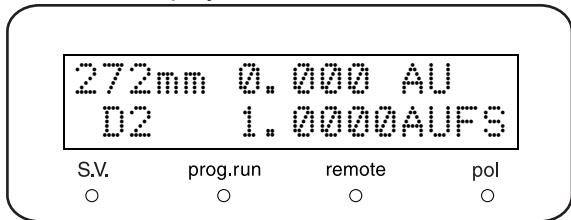
A: 60.0 B: ■ 40.0
C: 0.0 D: 0.0

- 2** Set the column oven temperature to 40°C.
See the column oven's instruction manual for setting procedures.
- 3** Press **pump** on the pump panel, and **oven** on the column oven panel. Pumping and temperature regulation will start.
Verify that liquid flows through the detector outlet tubing, and that there are no leaks from any of the connections.
- 4** Set the detector parameters.
 "Parameter Settings for Gradient System Validation" P. 7-26
See the detector's instruction manual for setting procedures.
- 5** Set the autosampler parameters.
 "Parameter Settings for Gradient System Validation" P. 7-26
See the autosampler 's instruction manual for setting procedures.
- 6** Set the data processor parameters.
 "Parameter Settings for Gradient System Validation" P. 7-26
See the data processor's instruction manual for setting procedures.
- 7** Monitor the baseline.
When the baseline has stabilized, press the detector **zero** key. Then inject 10 μ L of mobile phase and verify that no peaks are observed the second time.
- 8** Inject 10 μ L of the test sample six times, and analyze the data obtained.
- 9** From the peak data obtained from the six analyses, derive the relative standard deviation (coefficient of variation [C.V.]) for: retention time and peak area ("Fig. 7.11").

Column oven's display screen



Detector's display screen



7

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

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

$$\bar{X} = (X_1 + X_2 + \dots + X_n)/n$$

n : Number of analyses

X₁..X_n : Retention time (or areas) of each peak

\bar{X} : Average

SD : Standard deviation

RSD : Relative standard deviation

C.V. : Coefficient of variation

Fig. 7.11

7. Hardware Validation

■ 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%.

7.8 If Validation Fails

Should the system fail to satisfy any of the system validation check criteria, or should a component fail to satisfy any of the component validation check criteria, proceed as follows.

- Check whether any consumable items have reached the end of their service life:
The cause of failure to satisfy check criteria could be a consumable part that is no longer usable. Check consumable parts and replace them if necessary.
- Perform troubleshooting:
It is possible that some minor problem (such as air bubbles) has caused the system to fail the criteria. Perform troubleshooting to check for such problems, and take action to eliminate any problems found. For troubleshooting procedures for individual system components, see the applicable instruction manuals.
- If a cause cannot be determined, contact your Shimadzu representative:
If you are unable to determine the cause of the failure, or if you are unclear about troubleshooting or corrective action procedures, contact your Shimadzu representative.

7. Hardware Validation

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8

Maintenance

8.1	Periodic Inspection and Maintenance	8-2
8.2	Adjusting the Leak Sensor Sensitivity	8-3
8.3	Exterior Cleaning.....	8-7

8.1 Periodic Inspection and Maintenance

It is necessary to perform periodic inspections of this instrument to ensure its safe use.

It is possible to have these periodic inspections performed by Shimadzu service representatives on a contractual basis.

For information regarding the maintenance inspection contract, contact your Shimadzu representative.

WARNING

- Unless the instructions here specified, turn off the power always and unplug the instrument prior to performing inspections and maintenance. Otherwise, fire, electric shock or malfunction may occur.

CAUTION

- When replacing parts, use only the parts listed in "[1.3 Component Parts](#)" and "[9.3 Maintenance Parts](#)". If any other parts are used, injury or malfunction may occur.
- Never remove the main cover. Otherwise, injury or malfunction may occur. Contact your Shimadzu representative to remove the main cover.

8.1.1 Prior to Inspection and Maintenance

- Replace the mobile phase in the flow lines with water.
- Wipe away any dirt from the doors 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

Inspection/Maintenance Item	1 year	2 year	3 year	6 year	Remark
Fan operation inspection	x				Visual inspection to check that fan rotates normally.

8.1.3 Check after Inspection and Maintenance

After inspection and maintenance, check any leakage during pumping.

 ["6.1 Troubleshooting and Corrective Action" P. 6-2](#)

8.2 Adjusting the Leak Sensor Sensitivity

NOTE

Adjustment of the leak sensor sensitivity should be performed by the system manager.

The leak sensor detects mobile phase leaks.

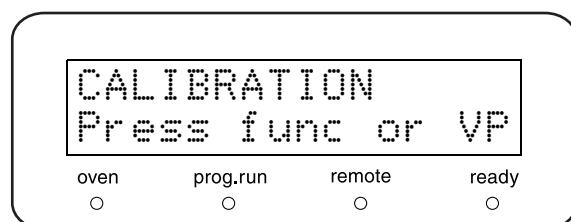
An error is generated, and temperature regulation stops, if the value of the signals output by the leak sensor exceeds the level set for the [LEAK THR].

The leak sensor is influenced by the concentration of organic solvent gas around the instrument. Be sure to perform sensitivity adjustment in a well-ventilated room with clean air.

8.2.1 Adjustment Procedure

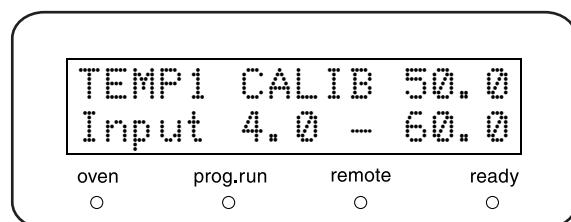
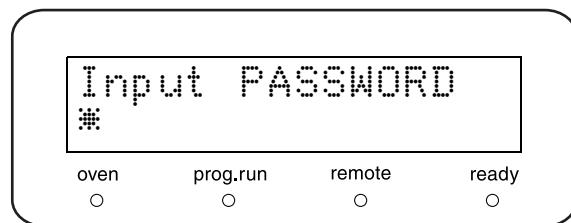
If an error message fails to appear when the mobile phase leaks, or if an error message appears, although there is no leakage, the leak sensor sensitivity must be adjusted. Perform adjustment using the following procedure.

- 1** Starting from the initial screen, press **VP** until [CALIBRATION] is displayed.



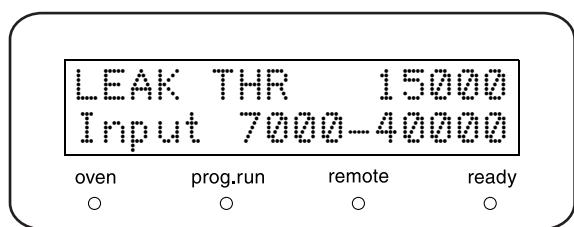
- 2** Press **func**.
[Input PASSWORD] will be displayed.

3 Input the correct password.
[TEMP1 CALIB] (the next function) will be displayed.



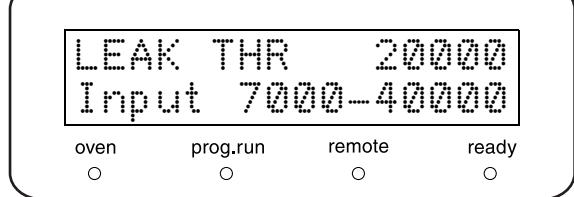
8. Maintenance

4 Press **func** until [LEAK THR] is displayed.



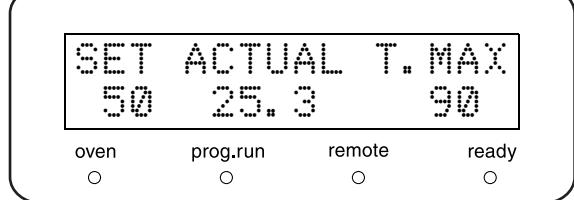
5 Using the numeric keypad, set a sufficiently large value (in general, a value between 20,000 and 30,000 should be sufficient) for the threshold value.

Setting of sensor threshold level (20000)



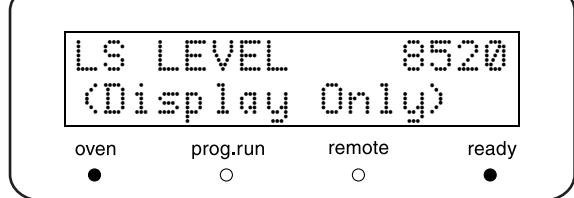
6 Press **CE** to return to the initial screen. If the set temperature displayed on the initial screen is not 50°C, press **temp** and change it to [50] with the numeric keypad.
 "4.4 Operation" P. 4-5

Setting of operating temperature (50°C)



7 Press **oven**. Wait for the temperature to stabilize. When the temperature has stabilized, the [ready] indicator illuminates. Press **func** → **func** → **enter** → **func** until [LS LEVEL] is displayed.

After temperature stabilizes



8 Draw 50µL of methanol into the provided syringe.

Injection of methanol (50µL)

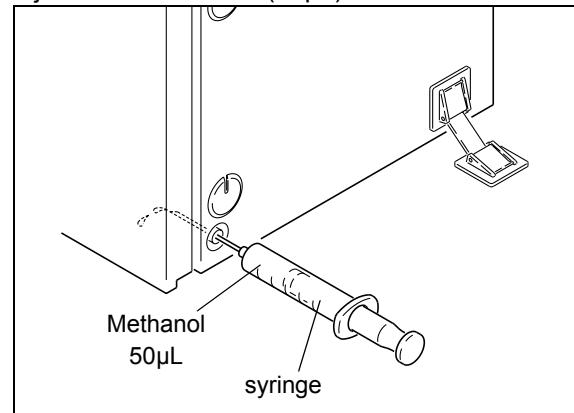


Fig. 8.1

- 10** Record the maximum leak sensor value displayed.
In the example screen on the right, the maximum value is [13834].

Maximum value display

LS LEVEL 13834
(Display Only)

oven prog.run remote ready

- 11** Then repeat steps 1-4, so that [LEAK THR] is displayed once more.

LEAK THR 15700
Input 7000-40000

oven prog.run remote ready

- 12** Using the numeric keypad, set the hundred's digit and higher digits to the values of the corresponding digits in the maximum leak sensor value recorded in step 10.
In the example screen on the right, [13800] has been set.

Setting of sensor threshold level (13800)

LEAK THR 13800
Input 7000-40000

oven prog.run remote ready

- 13** Press **enter** to save the value permanently.

- 14** Run the [LEAK SENSOR TEST] (procedure on "7.5.7 Leak Sensor Test" P. 7-15). If [SENSOR GOOD] appears as the test result, adjustment is complete.

8. Maintenance

8.2.2 Corrective Action When Leakage Occurs

WARNING

Before taking corrective action for solvent leaks, ensure that there are no open flames or other source of fire in the vicinity, and that the room is adequately ventilated.

Vapor from the leak could ignite if exposed to a source of fire, and the vapor could cause poisoning if ventilation is inadequate.

If the concentration of the solvent vapor inside the column oven rises to the leak sensor threshold level, the sensor is actuated and [ERR LEAK DETECT] is displayed. If this occurs, press **CE** to clear the error message, and perform the procedure below.

- 1** Open the doors, and locate the leak. (To open the left door, [P.2-3](#))
- 2** Wipe away the leakage.
- 3** Close the left door, and run the fan for 5 minutes with the right door open.
- 4** Close the right door, and press **oven** to start temperature regulation.
If the [ERR LEAK DETECT] message does not reappear, operation can be resumed. If reappears, clear the error message by pressing **CE** and repeat steps 1-3 above.

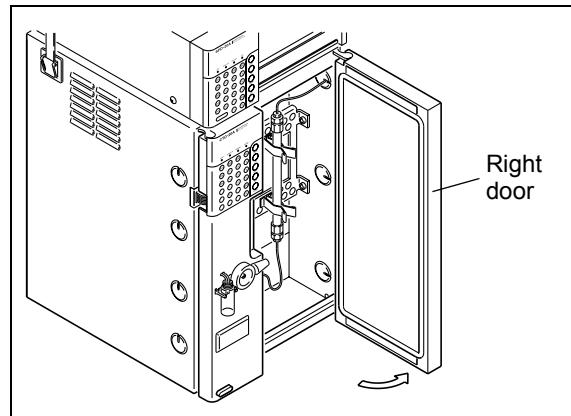
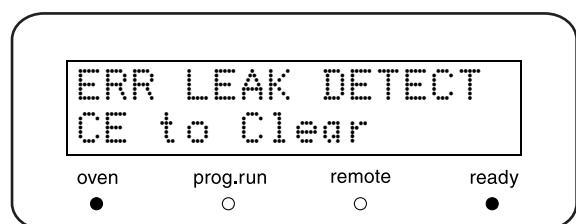


Fig. 8.2



8.3 Exterior Cleaning

If the instrument cover or front panel becomes dirty, wipe it clean with a soft dry cloth or tissue paper.

For persistent stains, clean the exterior using the following procedure.

- 1** Dip a piece of cloth in a dilute neutral detergent and twist firmly to remove excess liquid. Use this cloth to scrub the soiled area of the exterior surface of the instrument.
- 2** Dip a piece of cloth into water and twist firmly to remove excess liquid. Use this cloth to wipe away all the remaining detergent. Use a dry cloth to remove all moisture from the exterior surface of the instrument.

NOTE

Do not allow spilled water to remain on the instrument surface, and do not use alcohol or thinner-type solvents to clean the surfaces. These can cause rusting and discoloration.

8. Maintenance

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9

Technical Information

Contents

9.1	Installation	9-2
9.2	Specifications	9-35
9.3	Maintenance Parts	9-36
9.4	Introduction to HPLC System.....	9-37
9.5	Mobile Phase Characteristics.....	9-40

9.1 Installation

9.1.1 Installation Site

■ Suitable Sites and Preparation

To ensure safe operation, install the instrument in a suitable location that satisfies the following conditions.

WARNING

- Ample ventilation

The solvents used with the HPLC system are often flammable and toxic.

Therefore, the room where the instrument is installed must be well-ventilated.

- No fire sources used near the instrument

The solvents used with the HPLC are often flammable. Therefore, the use of open flame where the instrument is installed must be strictly prohibited. Also, do not install in the same room with equipment that emits or could potentially emit sparks.

- Fire extinguishers permanently available

Have fire extinguishers permanently available in case of fire.

- Protective equipment provided near the instrument

If solvent gets into the eyes or onto the skin, it must be flushed away immediately.

Provide equipment, such as eye wash stations and safety showers, as close to the instrument as possible.

CAUTION

- Avoid dust or corrosive gas

To ensure a long service life of the instrument and preserve its performance levels, avoid installing it in places subject to large amounts of dust or corrosive gas.

- Keep away from equipment generating strong magnetic fields

To ensure proper operation, do not install the instrument in places subject to strong magnetic fields.

If the power supply line is subject to high electrical noise, install a surge protector.

- Install the instrument in the location that satisfies the following conditions to preserve the performance:

- room temperature is between 4 and 35°C, with minimal temperature variation through a day.
- air currents from heating or air conditioning equipment are not directed on the instrument.
- sunlight does not shine directly on the instrument.
- there is no vibration.
- humidity stays within 20 - 85%.
- place without condensation

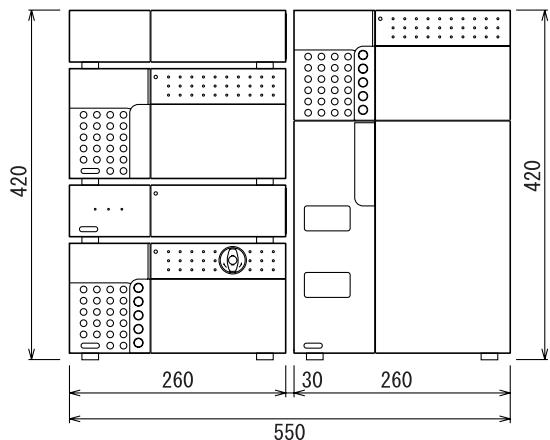
■ Required Installation Space

⚠ CAUTION

- The weight of CTO-20A is approximately 20kg, and CTO-20AC approximately 23kg. During installation, consider the entire weight combined with other LC components. The lab table on which this instrument is installed should be strong enough to support the total weight of the LC system. It should be level, stable and have depth of at least 600mm. If these precautions are not followed, the instrument could tip over or fall off the table.
- Keep at least 100mm between the rear of the instrument and the wall. This allows for sufficient air circulation to provide cooling and prevent the instrument from overheating and impairing the performance.

Typical system configurations and required installation spaces are shown in the figures below.

● System 1 (with Manual Injector)



● System 2 (with Autosampler)

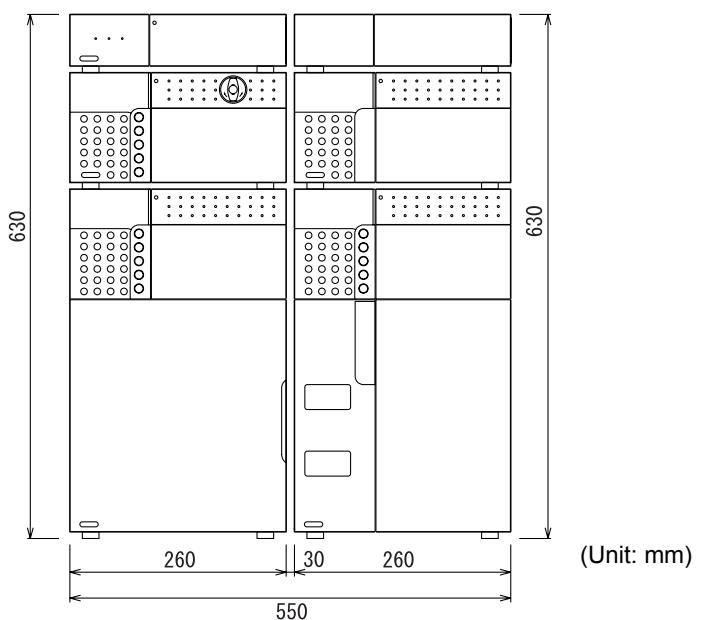


Fig. 9.1

9.1.2 Installation

■ Installation

The instrument is designed for stacking with other Shimadzu HPLC components.

 "9.4 Introduction to HPLC System" P. 9-37

CAUTION

When the LC-20A series components are stacked on each other, the clearance between the components is only 5 mm.

Use caution to avoid pinching your fingers between the components.

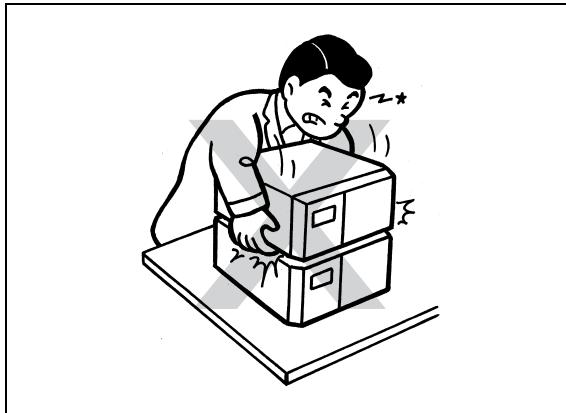


Fig. 9.2

■ 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. 9.3".

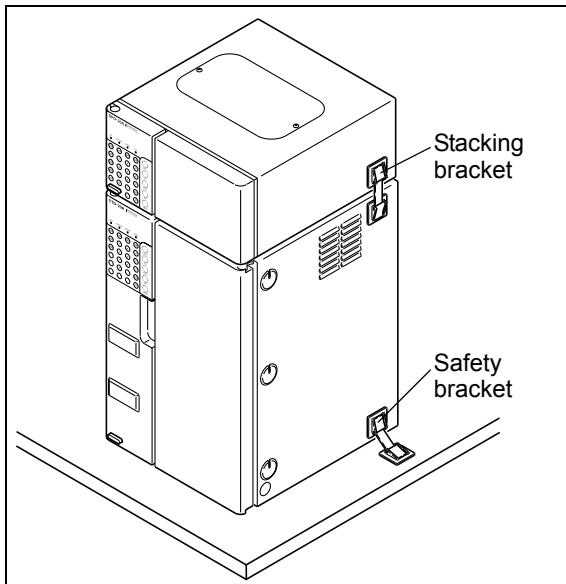


Fig. 9.3

9.1.3 Power Supply Connection

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

Part No.		Power supply voltage (indicated on the instrument)	Consumption	Frequency
CTO-20A	CTO-20AC			
228-45009-31	228-45010-31	AC100V (100V~)	500VA	50/60Hz
228-45009-32	228-45010-32	AC120V (120V~)	600VA	50/60Hz
228-45009-38	228-45010-38	AC 220-240V (220-240V~)	600VA	50/60Hz

⚠️ WARNING

The power supply voltage is indicated on the cover of the fuse holder on the back of the unit. Be sure to connect the unit to a power supply of the voltage indicated.

Use of any other voltage could result in fire, electric shock or malfunction.

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.

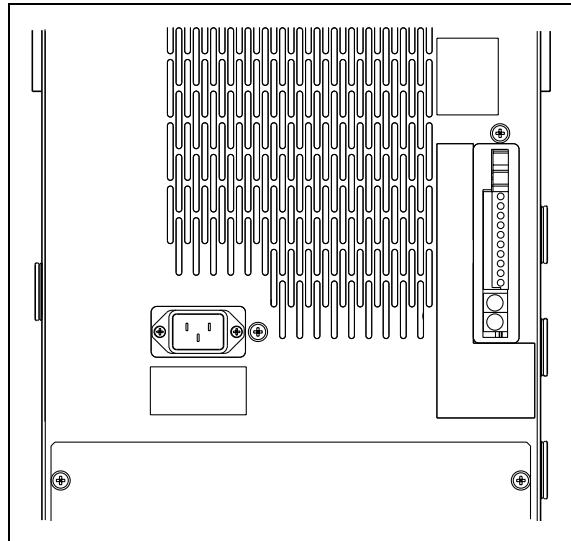


Fig. 9.4

■ Connection to Power Outlet

⚠ WARNING

Handle the power cord with care, and observe the following precautions to avoid cord damage, fire, electric shock or instrument malfunction.

- Do not place heavy objects on the cord.
- Keep hot items away from the cord.
- Do not modify the cord.
- Do not bend the cord excessively or pull on it.
- To unplug the instrument, pull the plug itself, NOT the cord.

If the cord is damaged, replace it immediately.

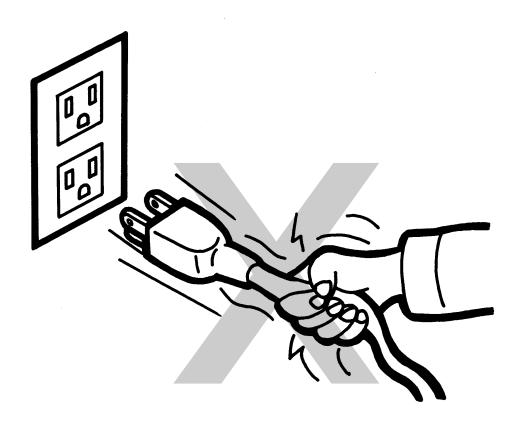


Fig. 9.5

⚠ CAUTION

Before plugging in the instrument, make sure that the power switch is OFF.

- 1 Insert the connector of the power cord into the power cord connector at the back of the instrument.
- 2 Insert the plug of the power cord into the power supply outlet.

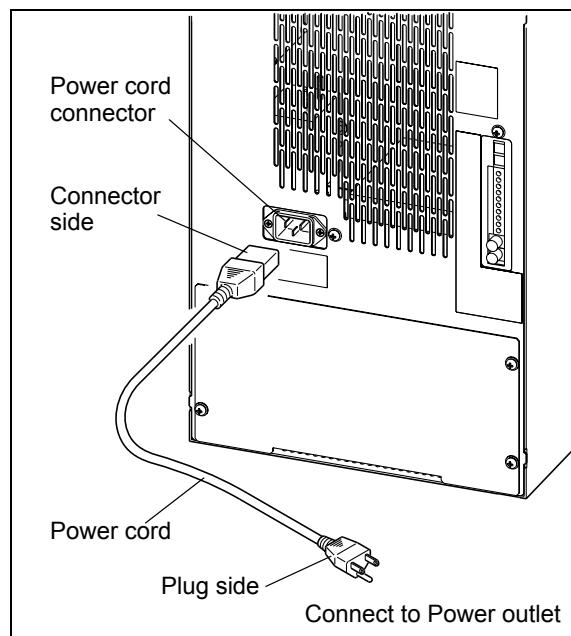


Fig. 9.6

■ 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 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 Nut PEEK
- PEEK ferrules
- PTFE ferrules

■ Cutting 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.

NO T E

Cut up the tubing so that the cut surface is at a right angle.

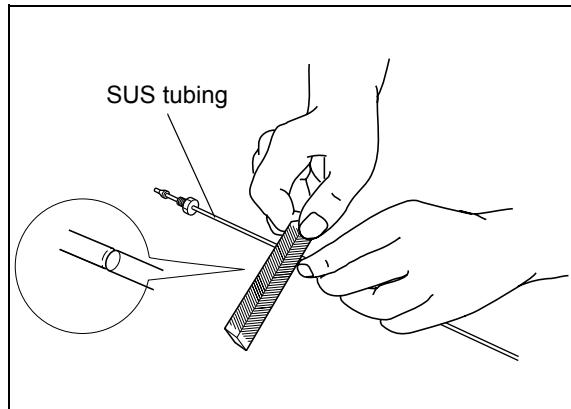


Fig. 9.7

- 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.

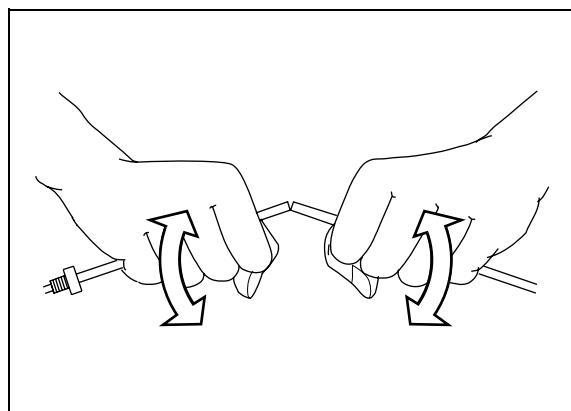


Fig. 9.8

⚠ 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.

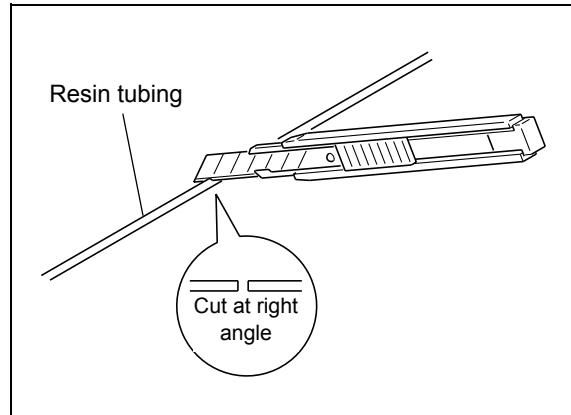


Fig. 9.9

■ Connecting 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.

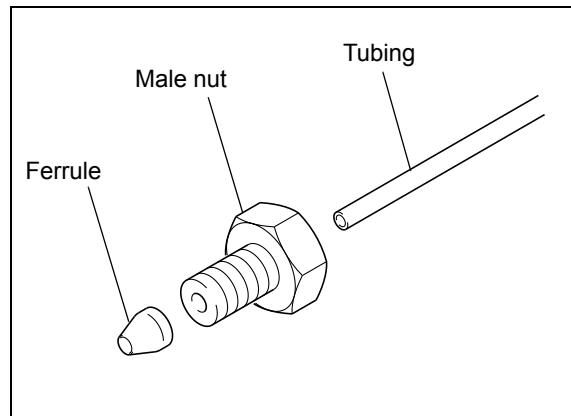


Fig. 9.10

- 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.

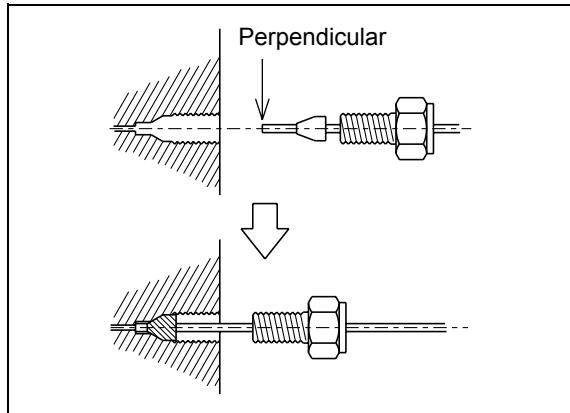


Fig. 9.11

⚠ 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.

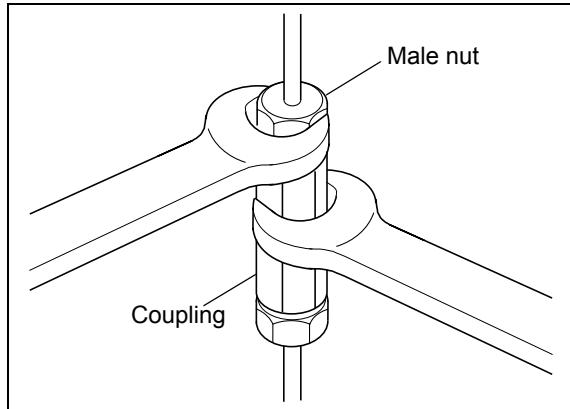


Fig. 9.12

- 3** Loosen and move the male nut slightly to verify that the ferrule is secured on the tubing.

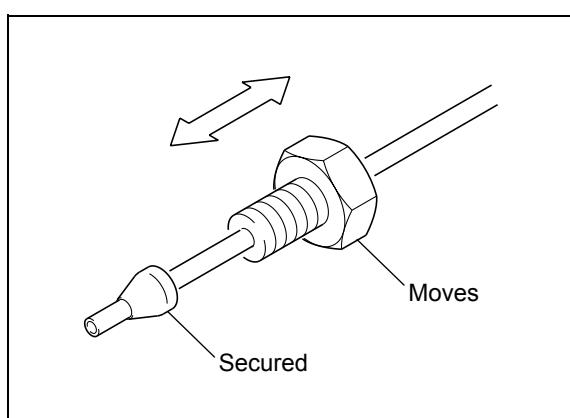


Fig. 9.13

■ Protective Plugs

Inlets and outlets of the instrument are fitted with protective plugs (bushings, stop plugs, caps and similar items) to keep out dirt and dust during shipment.

When the inlet and outlet are not connected to other thing, keep the protective plugs on. Otherwise, dirt and dust may cause clogging of the instrument.

Keep the plugs, and replace them when the instrument will be left not in use for a long time.

NOTE

- For stop plugs:
Use the wrench provided to unscrew and screw in the plugs.
- For resin plugs:
Remove and replace the plugs by hand.

9.1.5 Plumbing

⚠ CAUTION

- Before plumbing, turn OFF the power supply to all the system components and unplug them.
 - For plumbing, use the appropriate parts listed in "1.3 Component Parts".
 - Connect only tubings described in the instructions.
- Otherwise, injury or equipment failure may cause.

The necessary plumbing is as follows:

- Plumbing for other components..... Plumbing for manual injector, column and other components along the flow lines.
- Connecting Leakage Drain Tubing Plumbing to evacuate. If leaks occur in any of the instrument in a stack, this tubing directs down the liquid collected on the receiving tray of this instrument, and from there to a waste container.

NOTE

When an auto injector is used, a manual injector is not necessary.

For details, see the auto injector instruction manual.

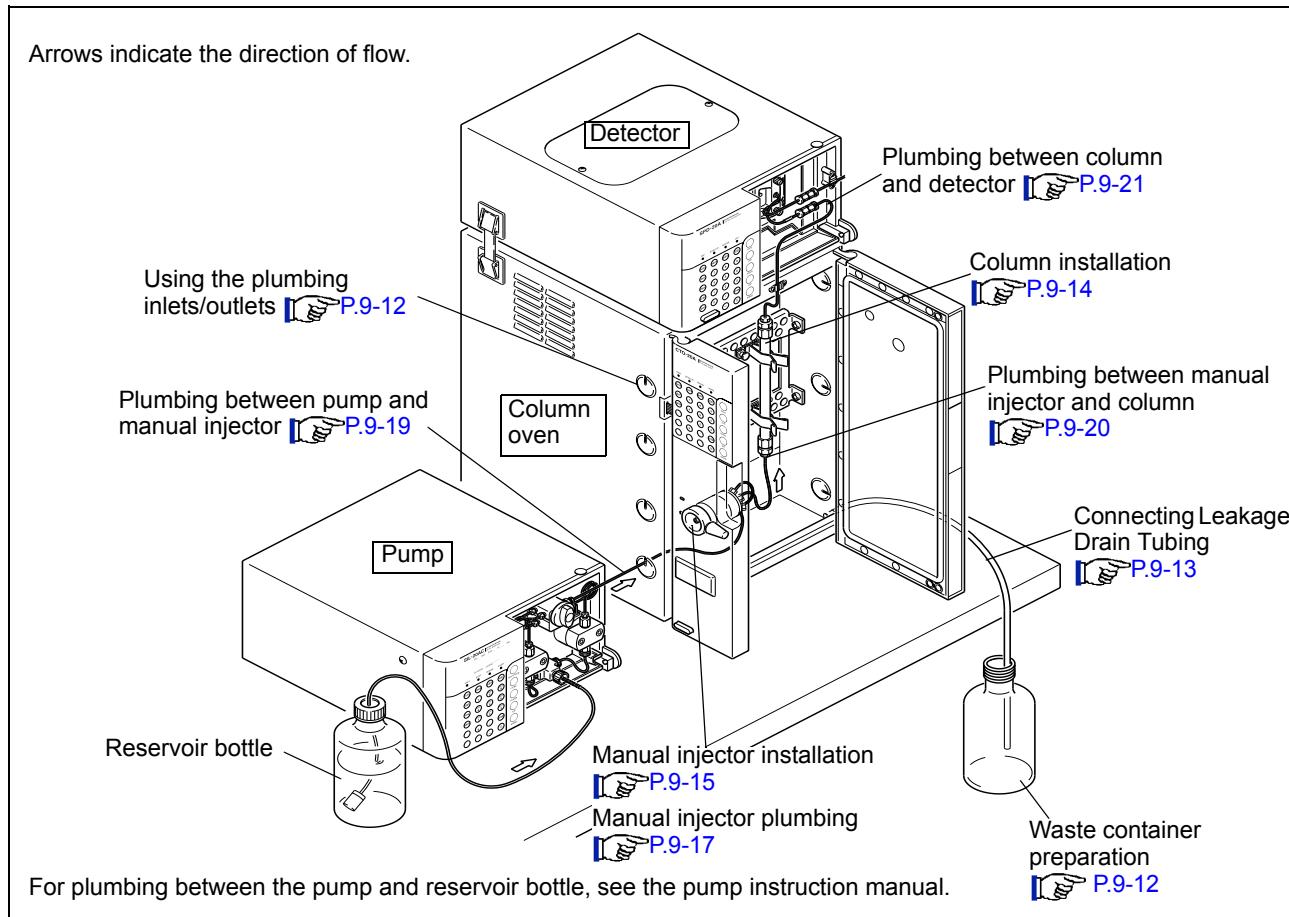


Fig. 9.14

9. Technical Information

■ Reservoir and Waste Container Preparation

Before connecting the plumbing, prepare waste container.

⚠ WARNING

Do not use cracked or damaged bottles.

⚠ 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.

■ Using the Plumbing Inlets/Outlets

The column oven has a total of seven inlets/outlets, located on its left and right sides, for routing tubing from other system components.

Choose the inlets/outlets comfortable to plumb.

1 Open the doors.

For the procedure for opening the left door,
 "2.2 Opening and Closing the Left Door" P. 2-3

2 Using a \ominus screwdriver, pry off the inner and outer plumbing inlet/outlet caps.

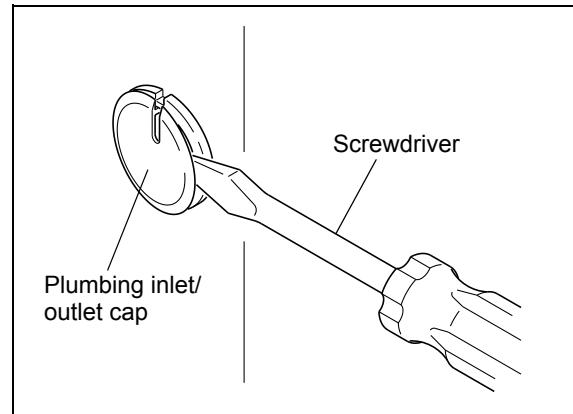


Fig. 9.15

3 Remove the thermal insulation disc.

4 Route the tubing through the notches in the inner and outer caps and the thermal insulation disc.

5 Replace the inner and outer caps and the thermal insulation disc into the plumbing inlet/outlet.

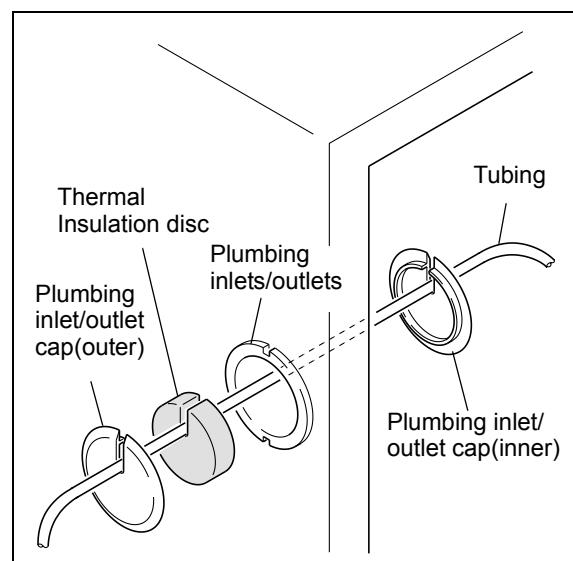


Fig. 9.16

■ Connecting Leakage Drain Tubing

- 1** Insert one end of the drain tubing (provided) into the drain located on the oven's bottom right.
- 2** Insert the other end of the drain tubing into the waste container.

NOTE

To ensure a smooth flow of liquid, insert the drain tubing into the container with its tip pointing downward.

NOTE

If other system components are installed on top of the oven, connect separate drain plumbing for them (see the relevant instruction manuals for details).

Leakage from other components must not be allowed to drain onto the oven.

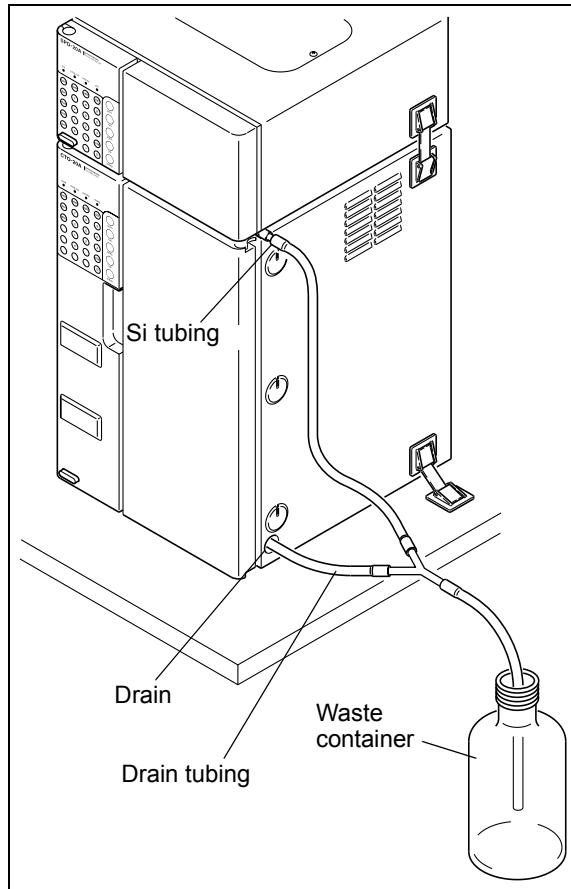
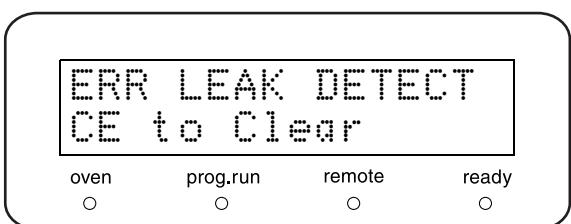


Fig. 9.17

NOTE

Make sure the waste bottle is empty when placing the drain tubing into it. If there is any organic solvent inside the bottle initially, the leak sensor could erroneously signal a leak.



Post-plumbing check

Pour water into the drain pan, and verify that the water drains to the waste bottle, without any backflow.

9.1.6 Column Bracket Installation

There are two ways of installing the column:

- With column clips : These make removal of the column simple.
- With column clamps: These fasten the column very securely.

NOTE

If 300mm column clips are used, up to six columns can be installed in the oven.

Column clips and clamps are attached to the column bracket with latches.

■ Positioning the Column Brackets

The column bracket can be installed in three different positions.

- The figure on the right shows the bracket in position ① (standard position). This is the bracket position at delivery.
- The bracket can be moved to position ② or ③ as required to accommodate various devices and accessories.

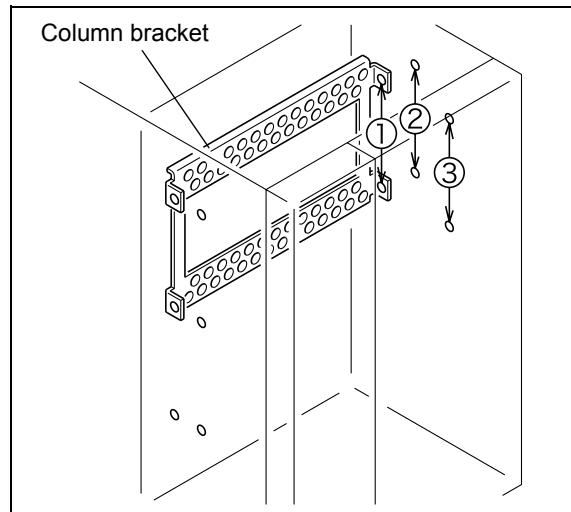


Fig. 9.18

■ Installing Latches

Press on the latch until it clicks.

The latch is now locked in place.

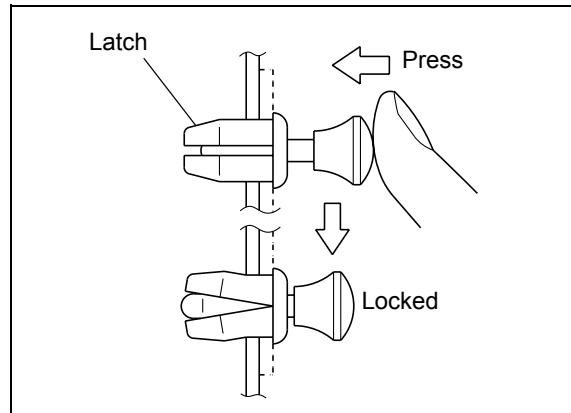


Fig. 9.19

9.1.7 Manual Injector Installation

Use the manual injectors listed below.

Option name	Part No.	Features
Manual injector Type 7725	228-32210-91	Manual injector for general purpose analysis. Standard sample loop: 20µL
Manual injector Type 7725i	228-32210-93	Same as type 7725, but with a position sensing switch. Can send signals synchronized with injection of samples to system controller or Chromatopac.
Semi-micro manual injector Type 8125	228-23200-91	Manual injector for semi micro volume range. Standard sample loop: 5µL. Includes position sensing switch. Can send signals synchronized with injection of samples to system controller or Chromatopac.
Non-metallic manual injector Type 9725	228-32650-91	Has liquid-contacting parts made of non-metallic materials. Maximum use temperature: 60°C
Non-metallic manual injector Type 9725i	228-32650-93	Same as type 9725, but with a position sensing switch. Can send signals synchronized with injection of samples to system controller or Chromatopac.

The manual injector can be installed in either of two manual injector positions in the left door.

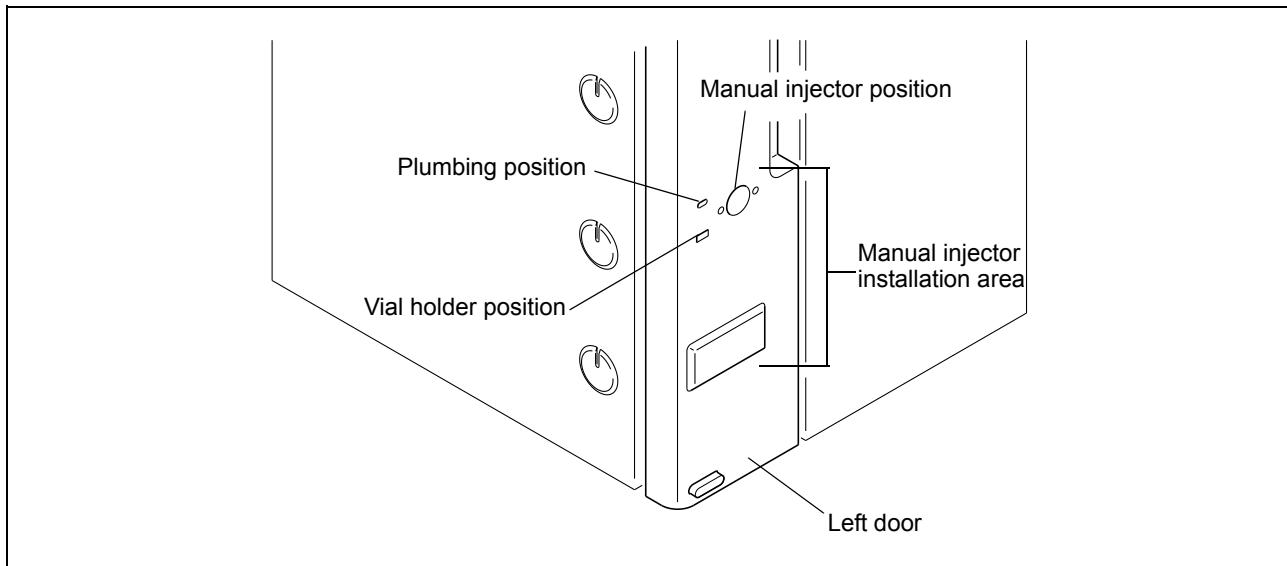


Fig. 9.20

9. Technical Information

1 Use a \ominus screwdriver to pry off the plastic cap on the front of the left door.

2 Open the doors.

(To open the left door,  "2.2 Opening and Closing the Left Door" P. 2-3)

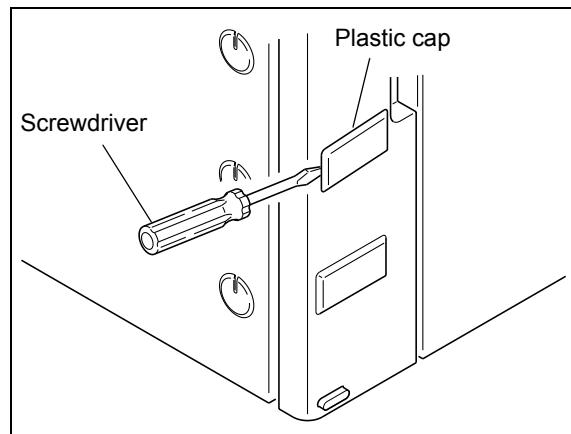


Fig. 9.21

3 Remove the screws in the stainless steel cover on the back of the left door. Then remove the cover and the thermal insulation disc.

NOTE

Do not remove the plastic cap from the manual injector position that you do not use.

This will affect the unit's temperature regulation performance.

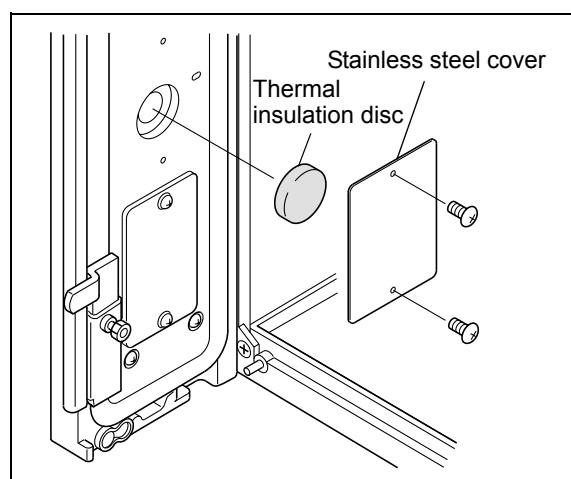


Fig. 9.22

4 Insert the manual injector into the hole, and secure it in place with the screws.
(For details on handling the manual injector, see the instruction manual for the manual injector.)

NOTE

If the injector has a position sensing switch, route the switch signal cable through the tubing outlet and connect it to the switch.

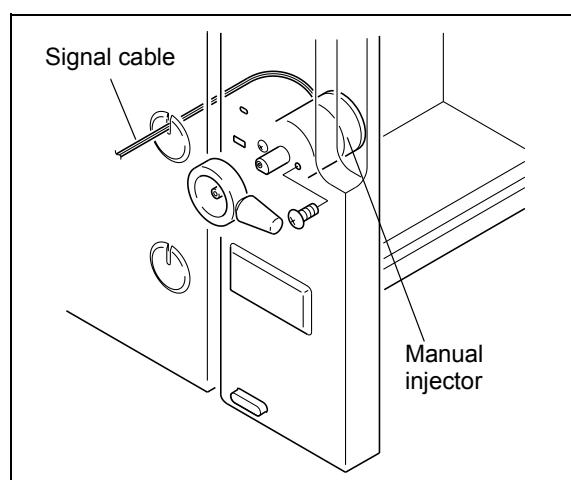


Fig. 9.23

- 5** Insert one of the vial holders provided into the vial holder hole.

- 6** Insert one of the vials provided into the vial holder.

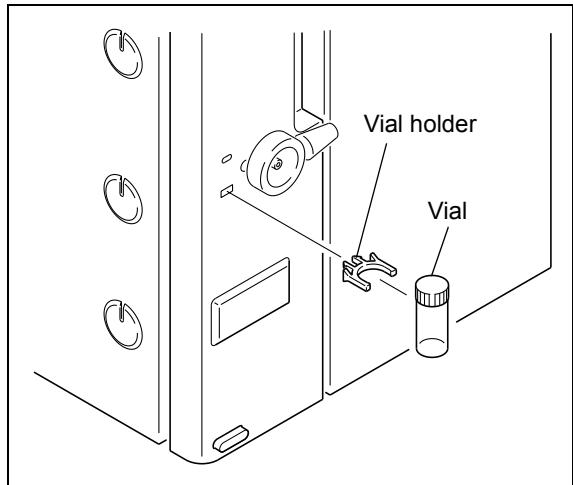


Fig. 9.24

9.1.8 Flow Line Plumbing

This section describes the plumbing for a basic system, including this column oven.

"9.1.5 Plumbing" P. 9-11

■ Manual Injector Plumbing

NOTE

For connecting ports 1 to 6 of the manual injector, use the male nuts (with long bushing) and ferrules, provided as manual injector standard accessories.

- 1** Screw the sample loop male nuts (with long bushing) into ports 1 and 4 of the manual injector.
- 2** Install a male nut (with long bushing) and ferrule to one end of each of the two waste liquid tubing sections. Then attach the tubing and ferrules into ports 5 and 6 of the manual injector. Tighten the nuts.

Back of manual injector

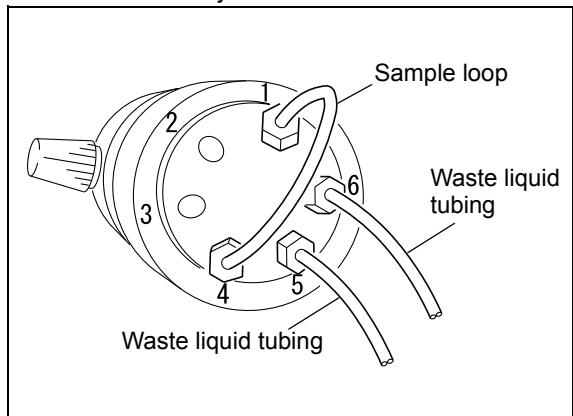


Fig. 9.25

9. Technical Information

3 Unscrew and remove the vial cap.

4 Route the other ends of the waste liquid tubing through the tubing opening and into the vial.

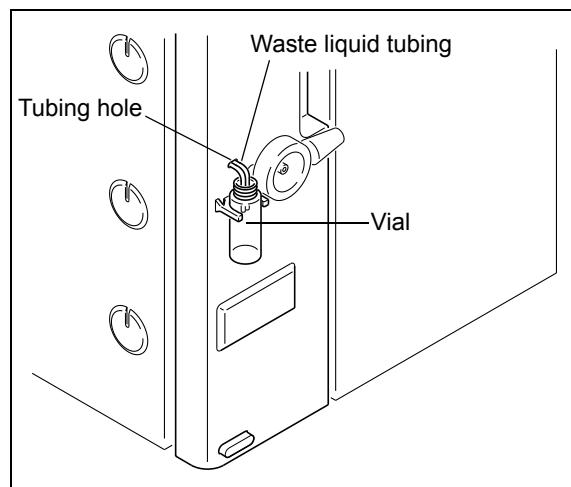


Fig. 9.26

NOTE

To prevent liquid from flowing out due to the siphon effect, position the ends of the waste liquid tubing level with the needle port.

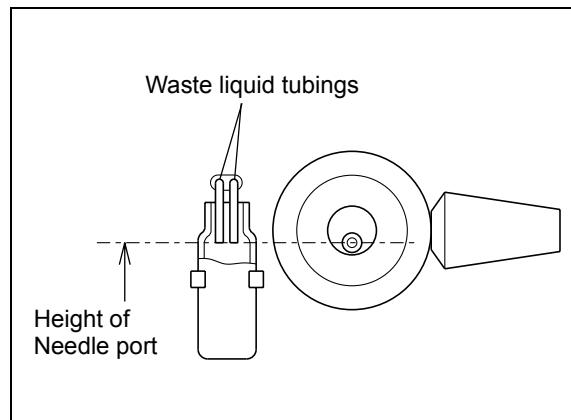


Fig. 9.27

NOTE

The waste liquid tubing should be straight, and perpendicular to the left door. If the tubing curves outward, it could lodge against the side of the unit and prevent closing of the left door.

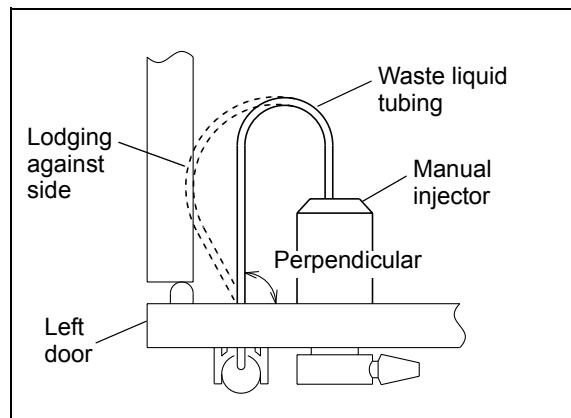


Fig. 9.28

■ Plumbing between Pump Unit and Manual Injector

- 1** Cut the 1.6 O.D. × 0.3 I.D. SUS tubing (standard accessory of the pump) long enough to connect the pump outlet and port 2 of the manual injector.
- 2** Attach male nut and ferrule to both ends of the SUS tubing.
 - Pump outlet end:
1.6MN male nut and 1.6F ferrule provided as pump standard accessories.
 - Manual injector end:
Male nut (long bushing) and ferrule (provided as manual injector standard accessories).
- 3** Insert the ends of the SUS tubing into the pump outlet and port 2 of the manual injector, and tighten the male nuts.

NOTE

The SUS tubing should have some extra length. Otherwise, it will not bend easily, and may prevent the front door from closing.

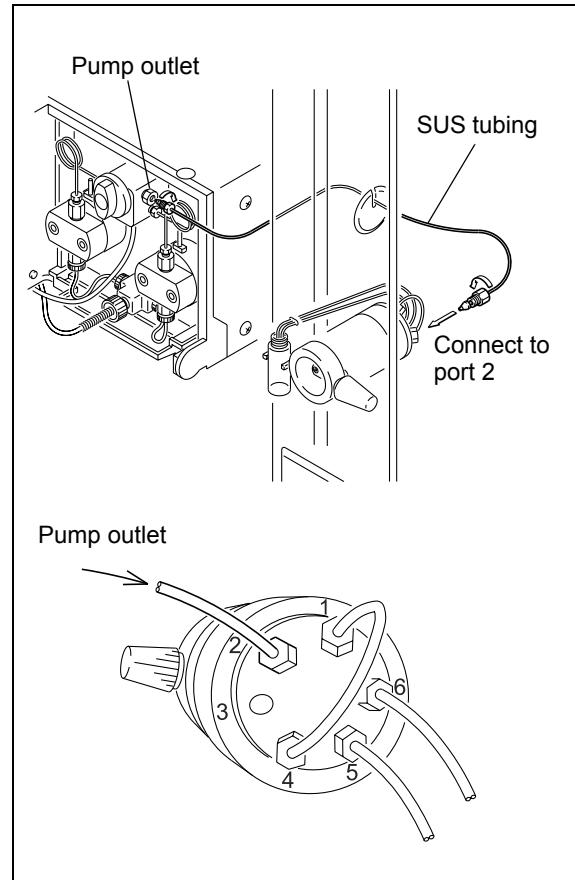


Fig. 9.29

9. Technical Information

■ Plumbing between Manual Injector and Column

- 1** Cut the 1.6 O.D. × 0.3 I.D. SUS tubing (standard accessory of the pump) to a length appropriate for connecting port 3 of the manual injector and the column inlet.

NOTE

The SUS tubing should have a little extra length. Otherwise, it may pull on the column when the left door is opened.

- 2** Place a male nut and ferrule on both end of the SUS tubing.

- Manual injector end:
Male nut (long bushing) and ferrule (provided as standard accessories of the manual injector)
- Column inlet end:
Male nut and ferrule (provided as standard accessories of the pump)

- 3** Unscrew and remove the stop plug from the column inlet.

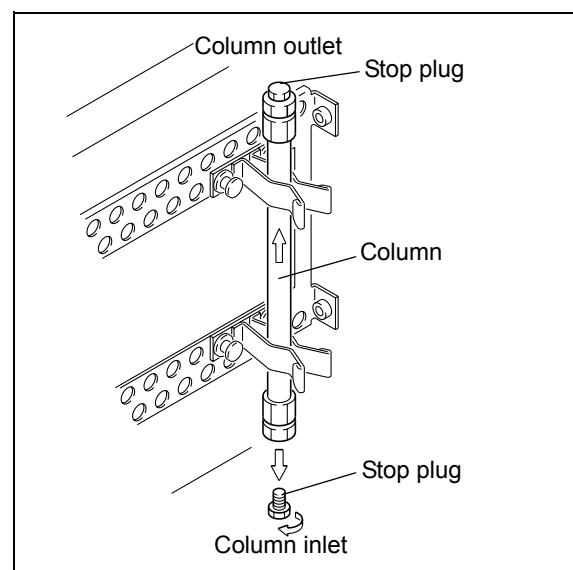


Fig. 9.30

- 4** Insert the ends of the SUS tubing into port 3 of the manual injector and the column inlet, and tighten the male nuts.

NOTE

If the SUS tubing has no extra slack, unscrew and remove the male nut from the column inlet before opening the left door.

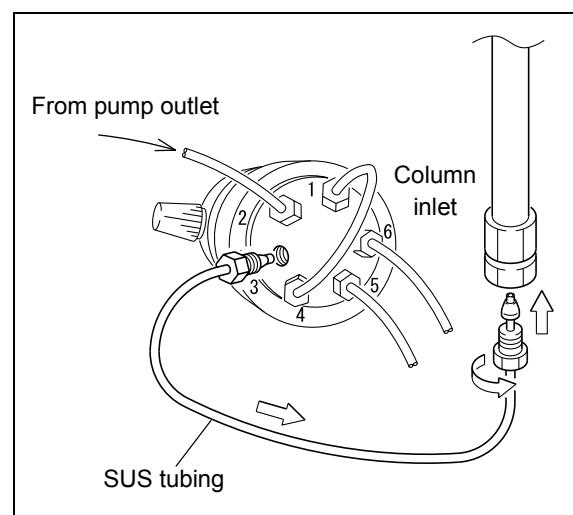


Fig. 9.31

■ Plumbing between Column and Detector

The figure below shows the flow line from the column outlet to the detector and the waste container. Use the accessories provided with the detector to connect this tubing. (For more detailed plumbing procedure, see the relevant sections of the detector instruction manual.)

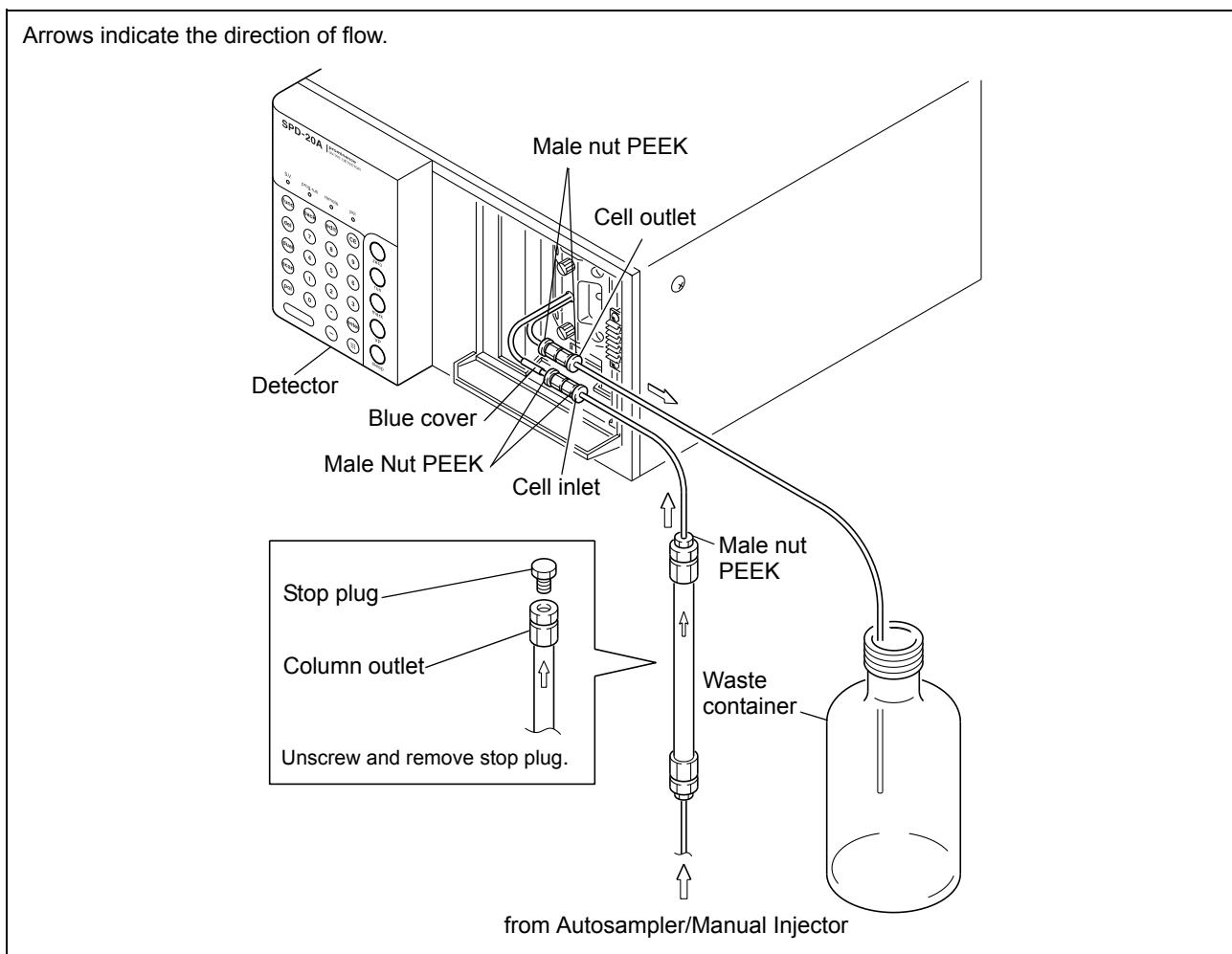


Fig. 9.32

9.1.9 Installation and Plumbing of Mixer (Option)

A special SUS mixer with excellent solvent mixing performance is available for use with a gradient elution system.

Procedures for installing and plumbing the mixer are given below.

■ Preparation of Mixer

The mixer may be plumbed to accommodate three volumes; 0.5mL, 1.7mL and 2.6mL.

Select the appropriate capacity for the application. (The standard plumbing, installed at delivery, is for 2.6mL capacity.)

The capacity of the semi-micro mixer is fixed at 0.1 mL.

- 1 Remove the mixer cover.

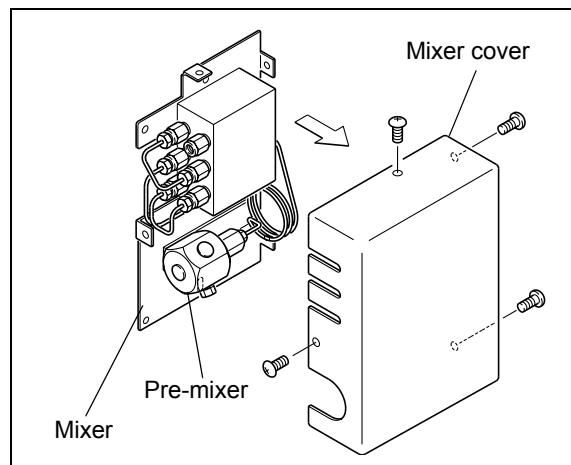


Fig. 9.33

- 2 Configure the mixer tubing using the following illustrations.

NOTE

Attach caps to ports which are not used, to prevent dirt or dust entering through them.

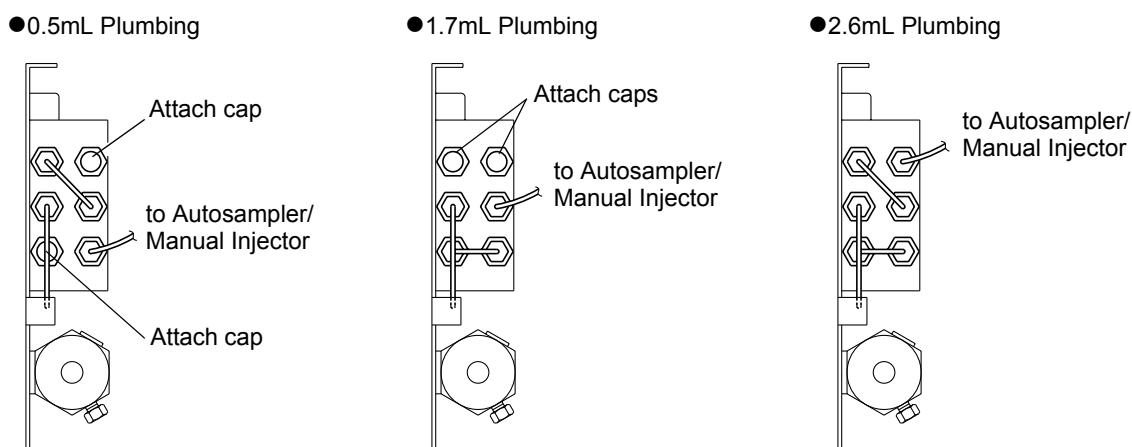


Fig. 9.34

■ Mounting the Mixer on the Instrument

The mixer can be installed in any of the following three positions:

- In the left oven interior
- In the right oven interior
- On the right of the pump

Installing the mixer on this instrument is described here. For installing of the mixer on a pump system, see the pump system instruction manual.

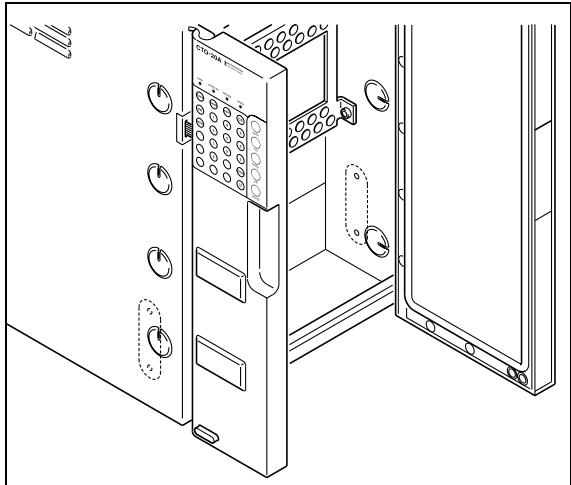


Fig. 9.35

Install the mixer on the right or left holes inside the oven, and tighten the screws (provided with the mixer) to secure it.

- Left interior.....This is the standard installation position.

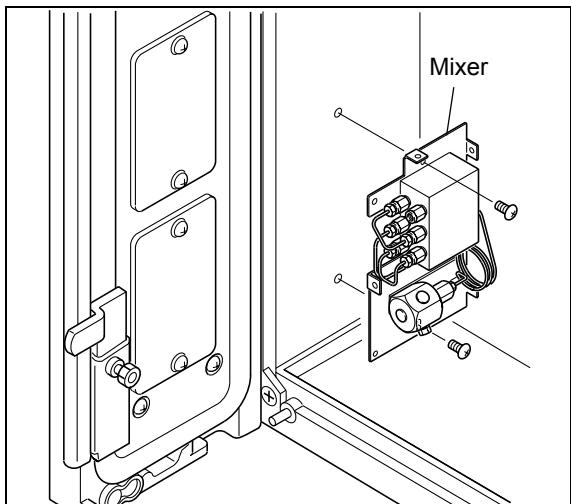


Fig. 9.36

- Right interiorThis installation position is used when a manual injector with position sensing switch is installed.

(In this position, the mixer is installed upsidedown, as shown in the figure on the right.)

NOTE

If a manual injector has been installed on the left door, install the mixer on the right. This facilitates both maintenance and door usage.

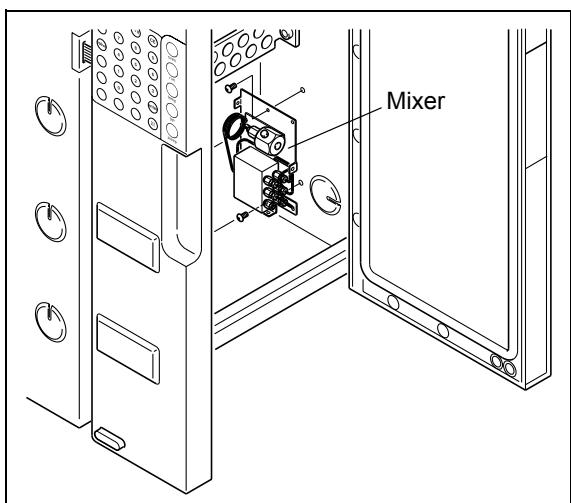


Fig. 9.37

■ Mixer Plumbing (in Low-Pressure Gradient System)

- 1** Install the mixer on this instrument and remove the premixer caps from inlets A and B.

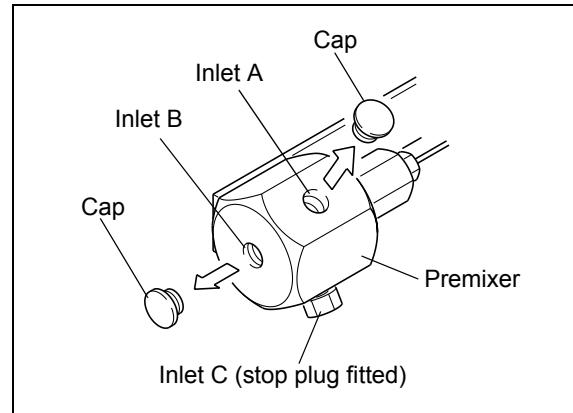


Fig. 9.38

- 2** Screw the stop plug provided with the mixer into inlet A of the premixer.

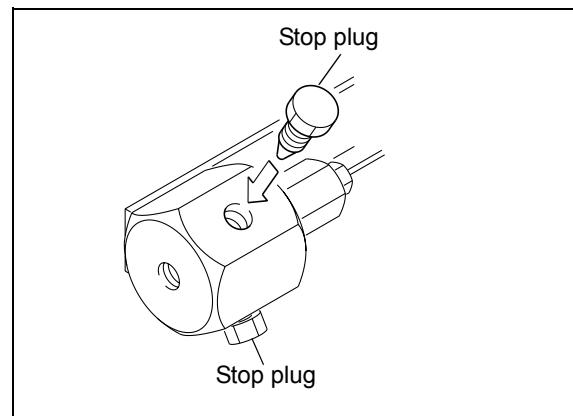


Fig. 9.39

- 3** Cut the two 1.6 O.D. × 0.3 I.D. SUS tubing sections provided with the mixer long enough to connect for the following:
- Pump outlet and premixer inlet
 - Mixer outlet and injector

- 4** Attach the 1.6MN male nuts and 1.6F ferrules provided with the mixer to both ends of each SUS tubing.

- 5** Attach the ends of one tubing section and ferrule into the pump outlet and premixer inlet B, and screw in the male nuts.

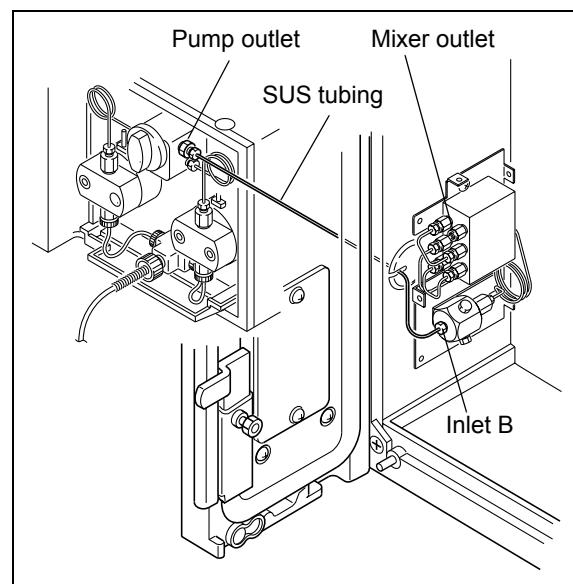


Fig. 9.40

- 6** Attach the ends of the other tubing and its ferrule into the mixer outlet and port 2 of the manual injector, and screw in the male nuts.

NOTE

If an autosampler is used, see its instruction manual for procedures.

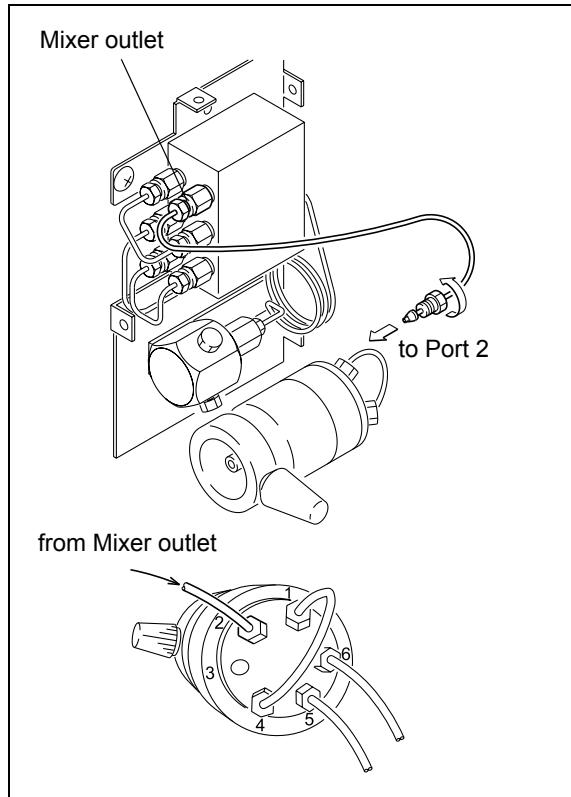


Fig. 9.41

■ Mixer Plumbing (in High-Pressure Gradient System)

- 1** Remove the premixer caps from inlets A and B.
- 2** Cut the 1.6 O.D. × 0.3 I.D. SUS tubing provided with the mixer to sections long enough for plumbing.
- 3** Attach the 1.6MN male nuts and 1.6F ferrules provided with the mixer to both ends of each SUS tubing section.
- 4** Connect the pump outlet to the premixer inlets A and B with the SUS tubing.

NOTE

For 3 mobile phases, also unscrew and remove the stop plug from inlet C, and connect inlet C to the pump 3 outlet with more SUS tubing.

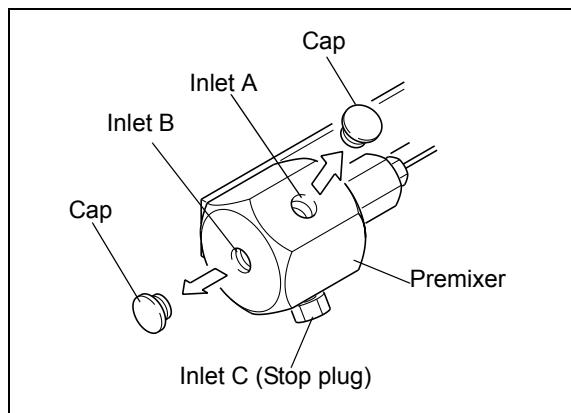


Fig. 9.42

9. Technical Information

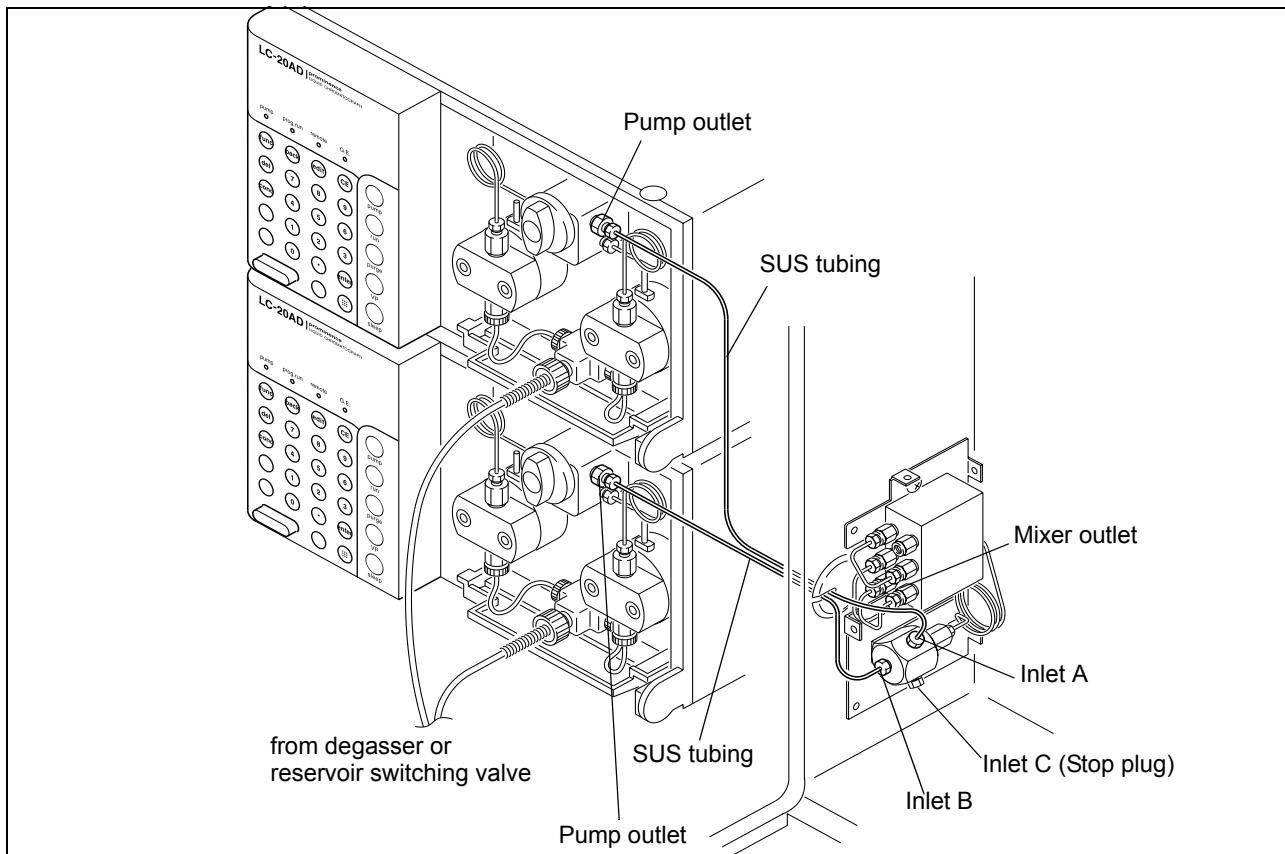


Fig. 9.43

- 5** Attach the ends of the third tubing section and ferrule into the mixer outlet and port 2 of the manual injector, and screw in the male nuts.

NOTE

If an autosampler is used, see its instruction manual for procedures.

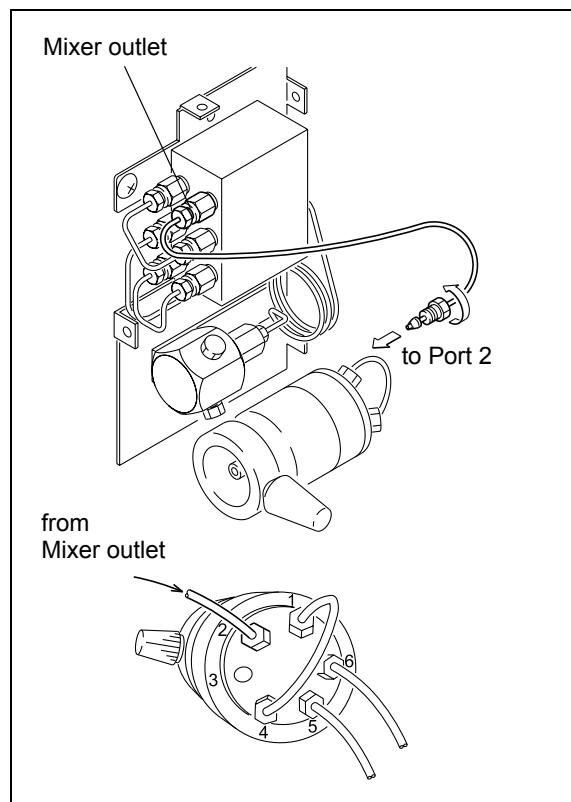


Fig. 9.44

9.1.10 Wiring

⚠ WARNING

- Before performing wiring, turn OFF all components and unplug the power cables.
- Do not use any other than specified cables for wiring.
- Do not perform any other than the indicated wiring operations.

Failure to observe the above cautions could result in fire, electric shock or instrument malfunction.

■ Connectors

- [REMOTE] connector For connection to the system controller.
- Ambient temperature sensor connector . For connection to the ambient temperature sensor accessory.
* Be sure to connect the ambient temperature sensor accessory.
- External input/output terminals For connection to external equipment.
For connection instructions
 ["5.7 Connection to External Input/Output Terminals" P. 5-50](#)
- [REC] connector For connection of the (column oven) temperature sensor's output signal (100°C/mV).
This connector is used for making adjustments and normally does not need to be used.

Use the connectors above needed for the system. Connection instructions are provided on the following pages.

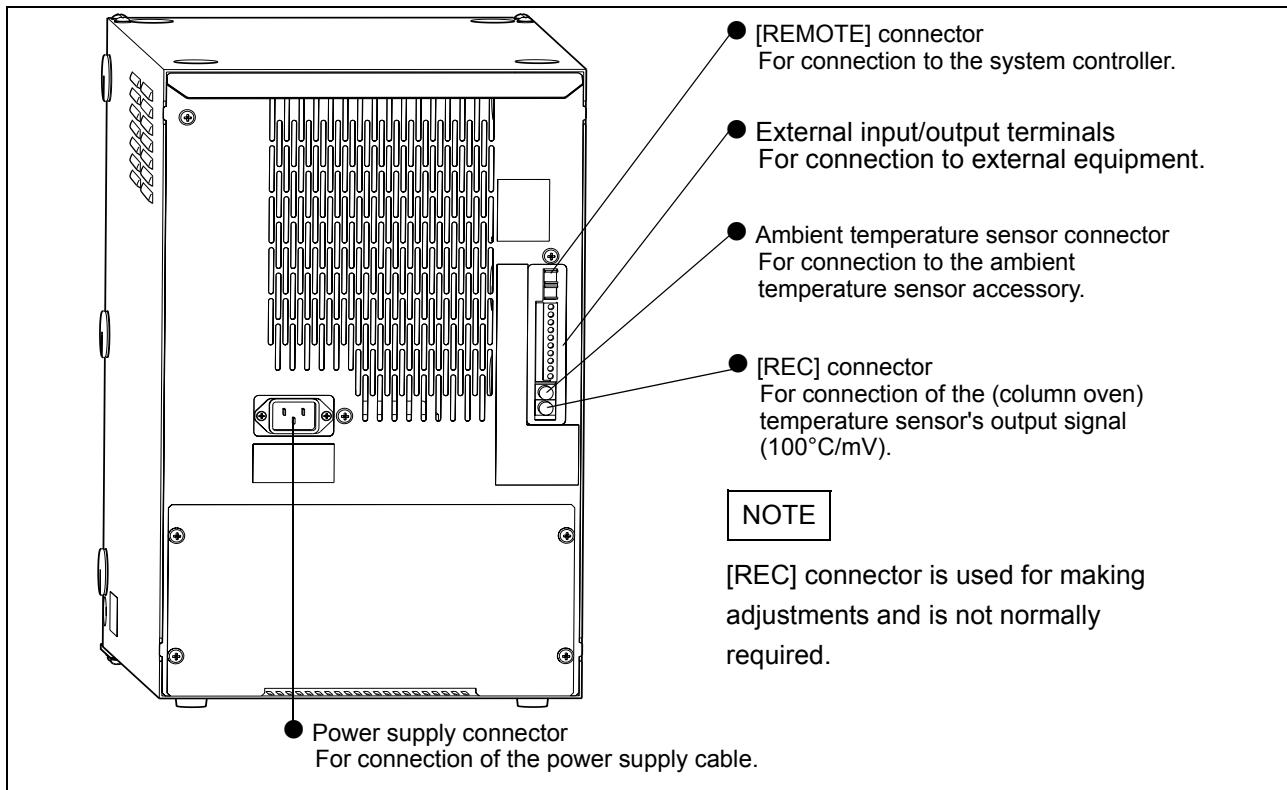


Fig. 9.45

■ Connecting the Optical Cable

The optical cable provided with this instrument is a two-way assembly for both transmission and reception of signals, and is connected to the [REMOTE] connector.

Instructions and precautions for connecting the optical cable are provided below.

- 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.

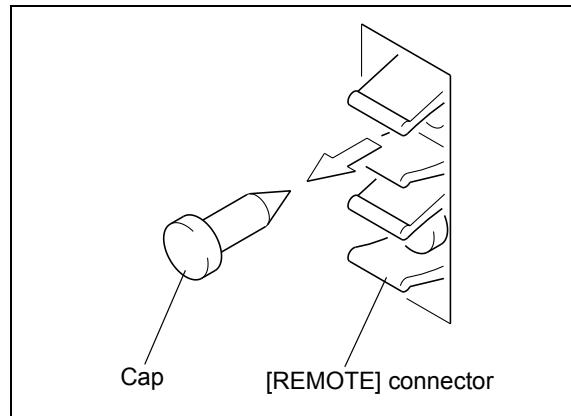


Fig. 9.46

- 2 Insert the optical cable plug into the [REMOTE] connector until it clicks into place.

! CAUTION

- Make sure there is no dirt or dust on the plug. Dirt or dust on the plug will get inside the [REMOTE] connector.
- Be careful not to insert the plug across two different channels.

Failure to follow these precautions above could result in malfunction or communication problems.

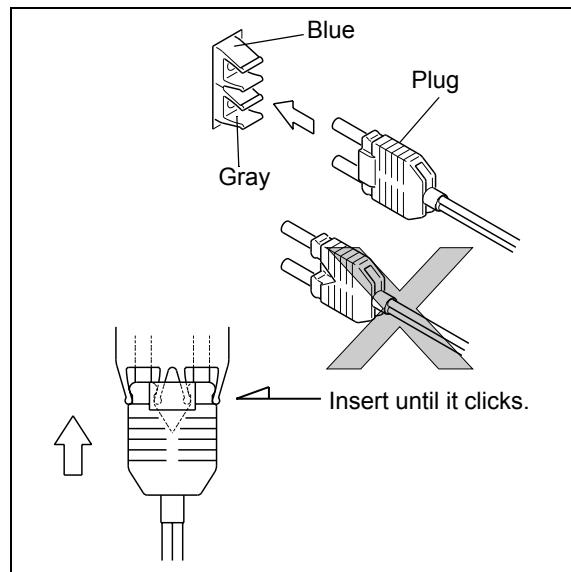


Fig. 9.47

! CAUTION

- Do not bend the optical cable less than 35 mm in radius.
- When inserting and removing the plug, grip the plug itself, not the cable.
- Do not bend the cable where it joins the plug.

Failure to follow these above precautions could result in damage to the plug or a broken wire in the cable.

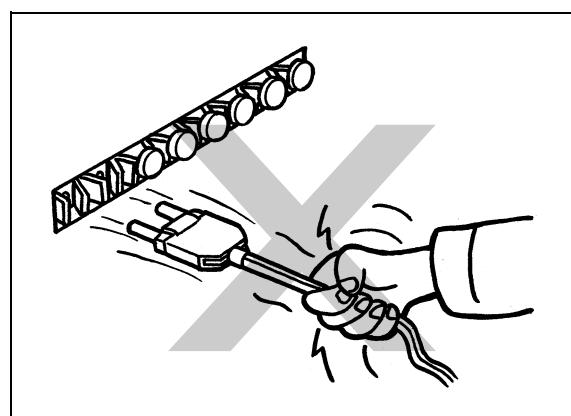


Fig. 9.48

■ Connection to System Controller

- 1** Referring to "Connecting the Optical Cable", connect the pump and system controller [REMOTE] connector with the optical cable.
 "Connecting the Optical Cable" P. 9-28

NOTE

Channels between 3 and 8 of the system controller [REMOTE] connector are typically used for this purpose.

- 2** Plug in the pump, and turn the power switch on.

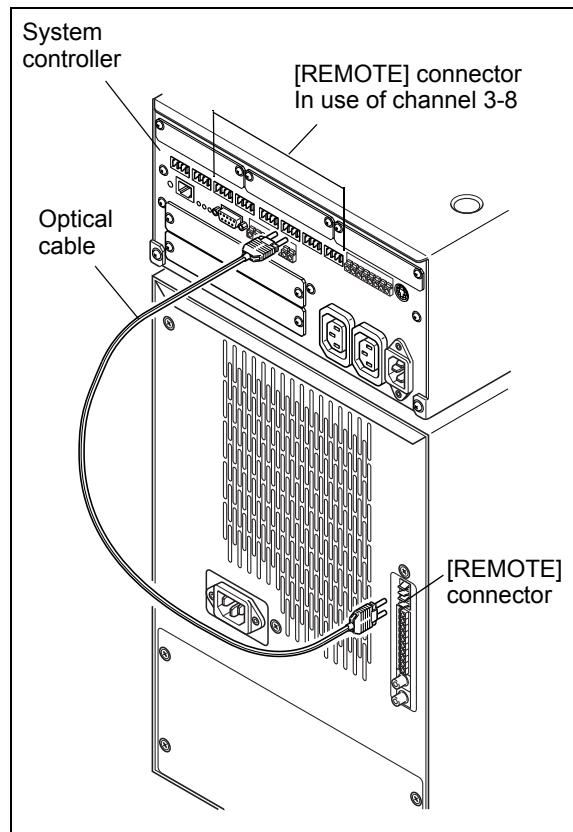


Fig. 9.49

- 3** Check the [LINK ADRS] and [LOCAL] parameters.

 "5.2.5 System Settings Group" P. 5-17

- [LINK ADRS]: Enter the system controller REMOTE channel number.
- [LOCAL]: Enter [0] (Remote mode).

LINK ADRS		6	
Input 1 - 12			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

LOCAL		0	
0: Remote 1: Local			
oven	prog.run	remote	ready
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

■ Installation of Ambient Temperature Sensor Accessory

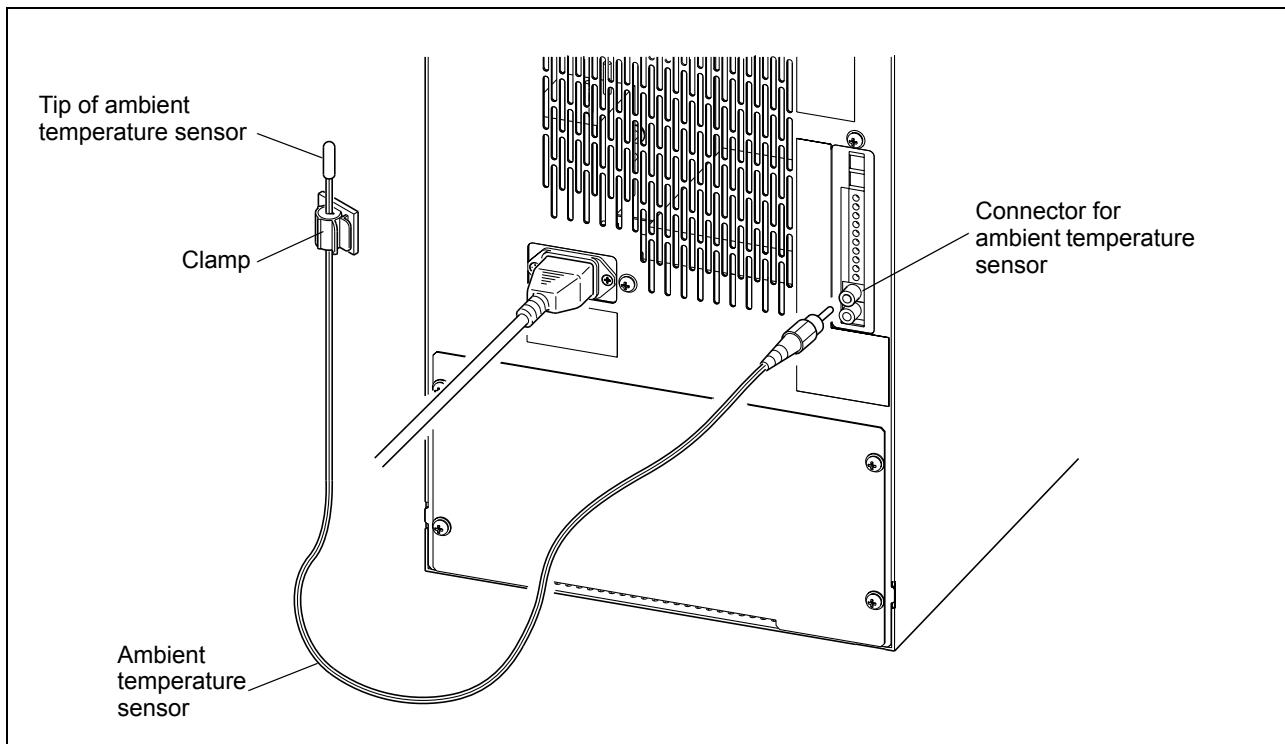


Fig. 9.50

- 1** Insert the ambient temperature sensor plug into the connector for the ambient temperature sensor marked [AMB.T].
- 2** Use the clamp to secure the ambient temperature sensor cable at a location near the instrument with minimal temperature fluctuation.

NOTE

If the tip of the ambient temperature sensor touches the unit's rear cover, the sensor cannot correctly sense the temperature.

9.1.11 Installation of Auto Column Switching Valve

The following two types of optional column switching high-pressure valves can be installed inside the oven.

- High-pressure flow line switching valve (FCV-12AH): Single high-pressure valve for switching between two columns
- Column switching valves (FCV-14AH): Dual high-pressure valves for switching between six columns

WARNING

Installation of these valves is dangerous (due to electrical hazards). Do not install the valves yourself. Have them installed by your Shimadzu service representative.

The installation positions and flow paths of the valves are shown below for your reference.

For more detailed information, see the valves' instruction manuals.

■ High-pressure Flow Line Switching Valve (FCV-12AH)

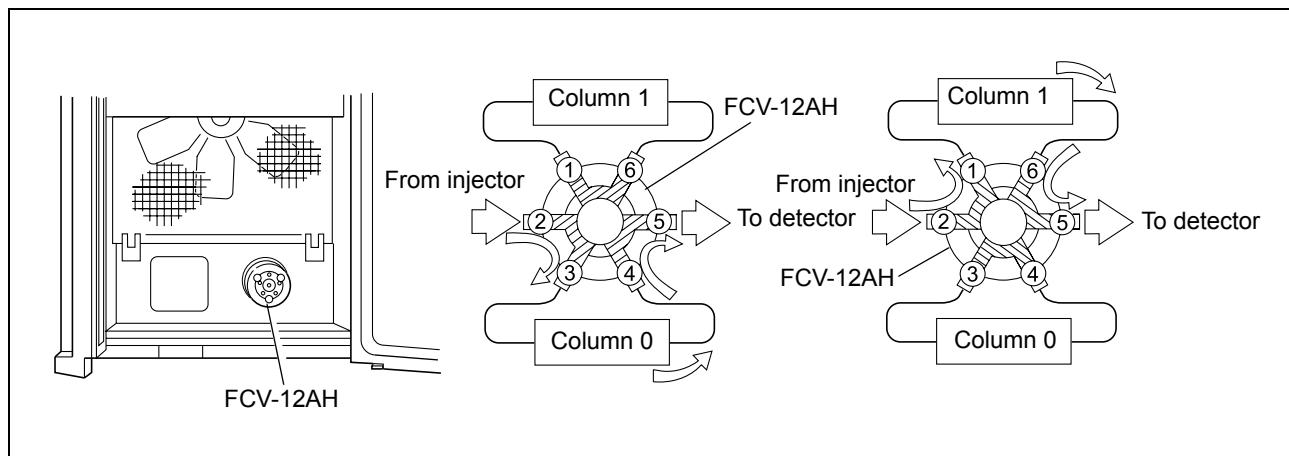


Fig. 9.51

9

■ Column Switching Valve (FCV-14AH)

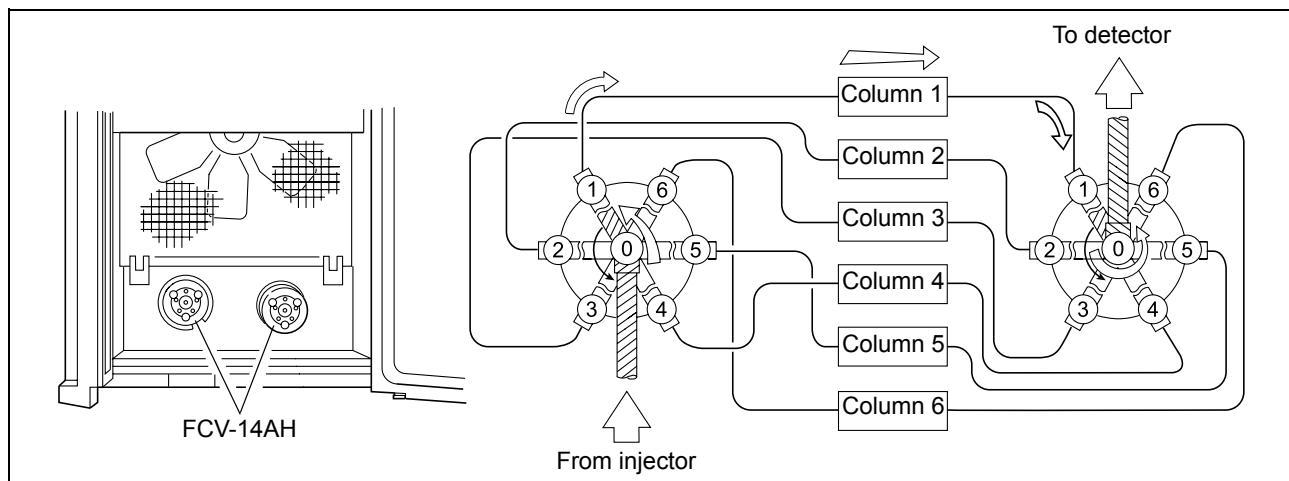


Fig. 9.52

■ Connection to Chromatopac

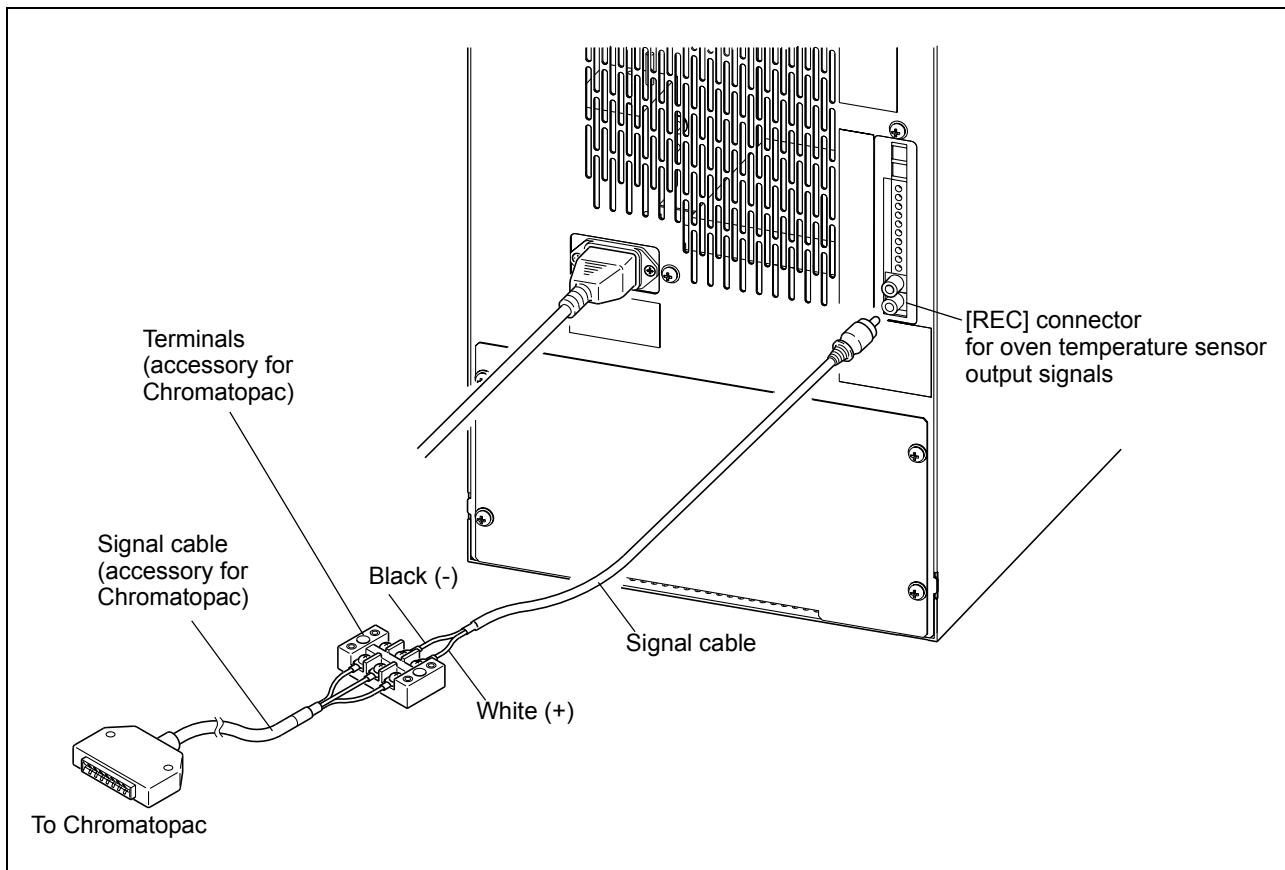


Fig. 9.53

- 1 Connect the signal cable (provided) to the column oven [REC] connector. Then make the connections to the Chromatopac as shown in the figure above.

9.1.12 Column Management Device (CMD)

The Column Management Device (hereafter referred to as CMD) (Part No. 228-37281-91) is an optional component that makes it possible to record information related to column management in the device itself and check the information on screen. Refer to the CBM-20A System Controller Instruction Manual for details on how to check the recorded information in this way.

- 1** Attach the CMD to the column.

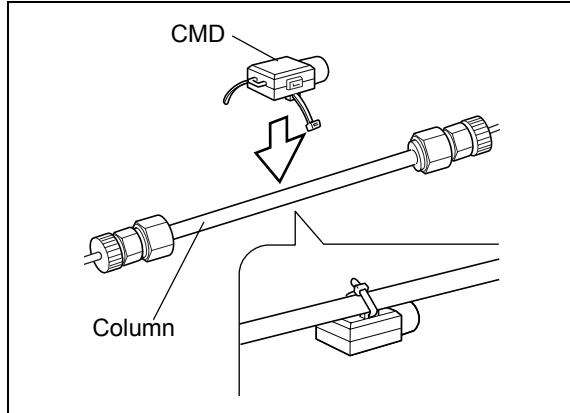


Fig. 9.54

- 2** Set the column with the CMD attached.

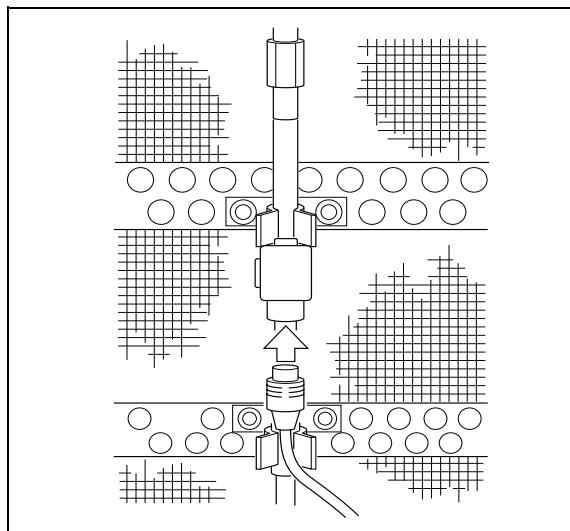


Fig. 9.55

- 3** Insert the CMD cable (Part No. 228-39991-01) in the CMD.

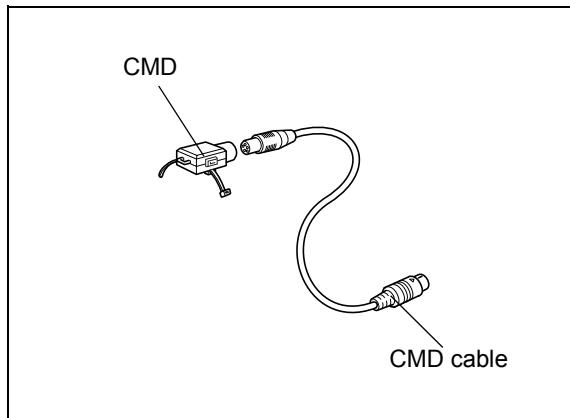


Fig. 9.56

- 4** Insert the tip of the CMD cable (Part No. 228-39991-01) in the CTO-20A/20AC.

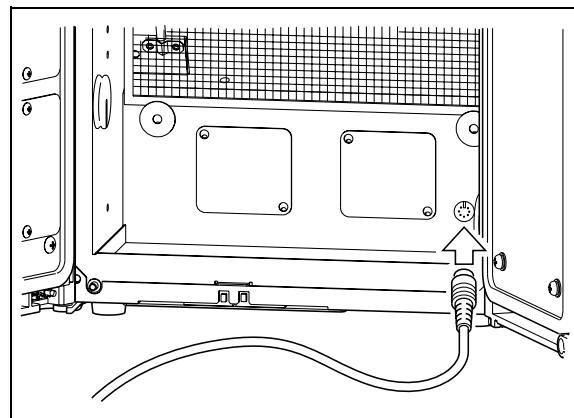


Fig. 9.57

NOTE

- **Removing the CMD Cable**

The CMD cable can be inserted into the oven while the oven's power supply is ON. Do not, however, remove the CMD cable from the oven during analysis. Doing so may result in the loss of data.

- **CMD**

Do not detach the CMD from a column when removing the column from the CTO-20A/20AC after finishing analysis. Store the column with the CMD attached. When the column's service life expires, however, the CMD can be detached and used with other columns after performing initialization.

9.2 Specifications

Item	Specification	
	CTO-20A	CTO-20AC
Type	Forced air circulation	
Temperature control range	(Room temperature ^{*1} + 10°C) - (85°C)	(Room temperature ^{*1} - 10°C) - (85°C)
Temperature setting range	4°C - 85°C in 1°C steps	
Temperature control precision	± 0.1°C	
Ambient temperature range	4 - 35°C	
Interior dimensions	W 220mm × D 95mm × H 365mm	
Safety measures	<ul style="list-style-type: none"> Upper temperature limit can be set, to prevent overheating. Also equipped with thermal fuses. Equipped with leak sensor for detecting mobile phase leaks. 	
Regulation of speed of air circulation fan	Automatically regulated in accordance with temperature.	
Time program functions	Changing set temperature, starting/stopping temperature regulation, ON/OFF Event output, executing program loops. Up to 320 steps. 0.1 to 999.9 minutes, linear temperature regulation	
Dimensions	W 260mm × D 420mm × H 415mm	
Weight	20kg	23kg
Power supply	AC 100V 500VA	228-45009-31
	AC 120V 600VA	228-45009-32
	AC 220-240V 600VA	228-45009-38
		228-45010-31
		228-45010-32
		228-45010-38

*1 Room temperature means the ambient temperature at the CTO-20A/AC.

9.3 Maintenance Parts

9.3.1 Replacement Parts

Part	Part No.	Remark
PCB ASSY, CTO-20A (with ROM)	228-41880-91	For 20A, with ROM
PCB ASSY, CTO-20AC (with ROM)	228-41880-92	For 20AC, with ROM
PCB ASSY, CTO-X	228-41860-92	without ROM
CTO PW switch ASSY	228-41874-91	
Fuse 5AT 250V	072-02004-23	(in common for 100V, 200V)
Power switch for cooler	074-80427-31	
Peltier module, CTO-20A	228-43126	
Column clip Assy B5	228-15617-91	For 6.5 - 9.5mm diameter column
Column clip Assy B8	228-15617-92	For 9.5 -12.7mm diameter column (optional)
Bushing, D4250-9130	037-38760-04	
Cap	228-23851-02	Plumbing inlet/outlet cap
Thermo fuse DM110	072-01843-14	Mounted under the motor
Optical cable HFBR3600-1-021	072-92025-51	For connection to system controller
Leak sensor	061-84301	
PCB, LC-20-KEY Assy	228-45600-91	Keypad
Thermosensor Assy	228-34618-91	For sensing oven temperature
Ambient temperature sensor Assy	228-34620-92	For sensing ambient temperature
Terminal for event cable	228-35307-91	10pcs
PC-3 MINI Assy	228-23926-92	For CTO-20AC
Motor, Assy	228-41878-91	
Keyboard cable	228-42042-03	

9.4 Introduction to HPLC System

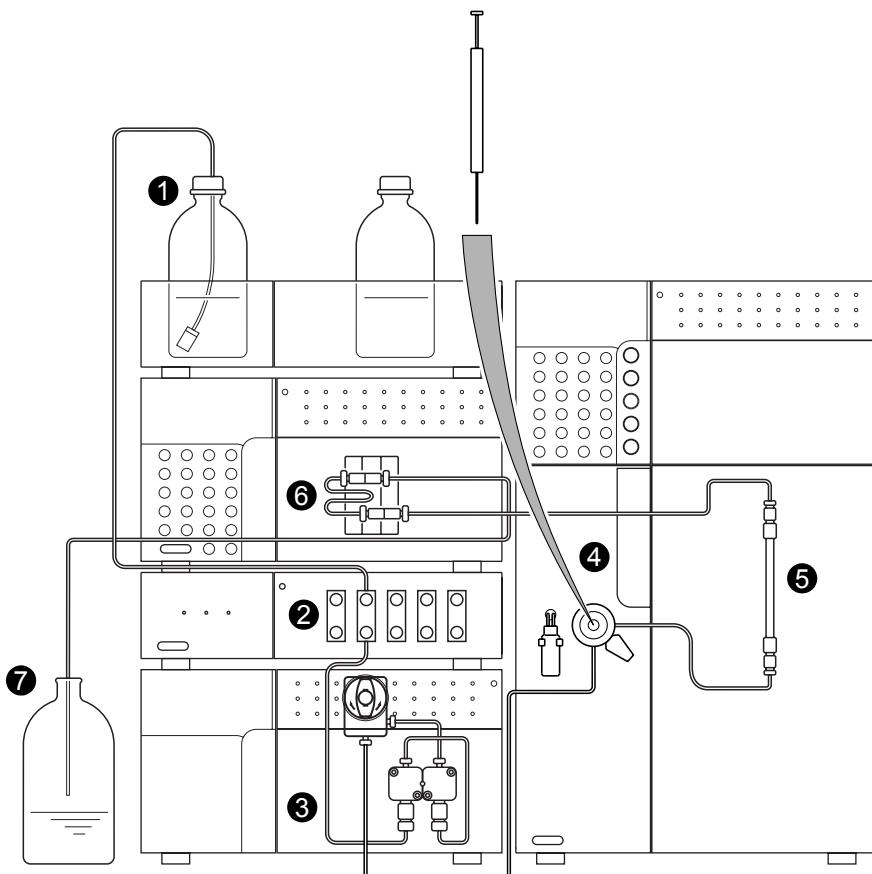
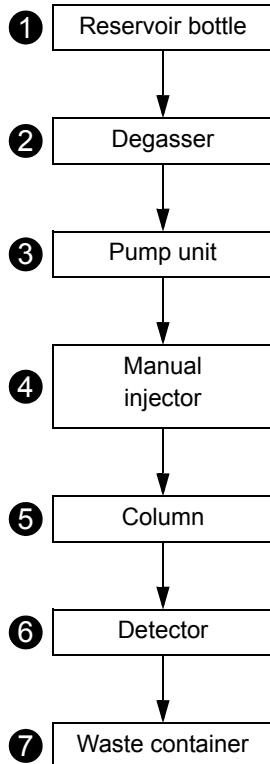
The Prominence LC (LC-20A) series components are for use with Shimadzu high performance liquid chromatography (HPLC) systems, which are designed to provide high accuracy and high sensitivity analyses. Example system configurations are provided below, along with descriptions of the operations of the various components.

9.4.1 Example of a Simple (Isocratic) System

Each component of the system is controlled locally. This is a simple system composed of the minimum number of components for stable analysis.

■ Solvent Flow

■ Function of Components

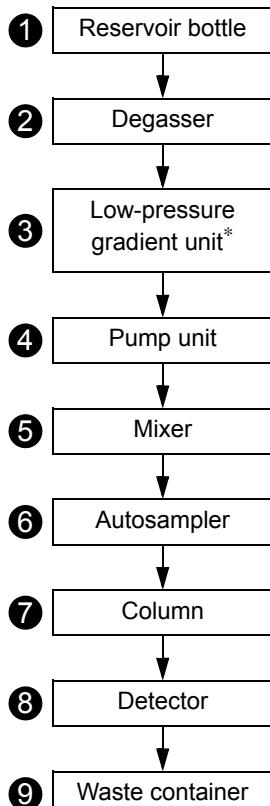


- ① Mobile phase is drawn out of the reservoir bottle and pumped through the tubing by the pump.
- ② The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
- ③ The pump sends the mobile phase through the manual injector, column and detector, in that order, and finally into the waste container.
- ④ Samples are injected into the system by the manual injector, with a syringe.
- ⑤ In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
- ⑥ The detector detects the components eluted from the column, and sends the signal data to a Chromatopac or PC.
- ⑦ Mobile phase from the detector drains into the waste container.

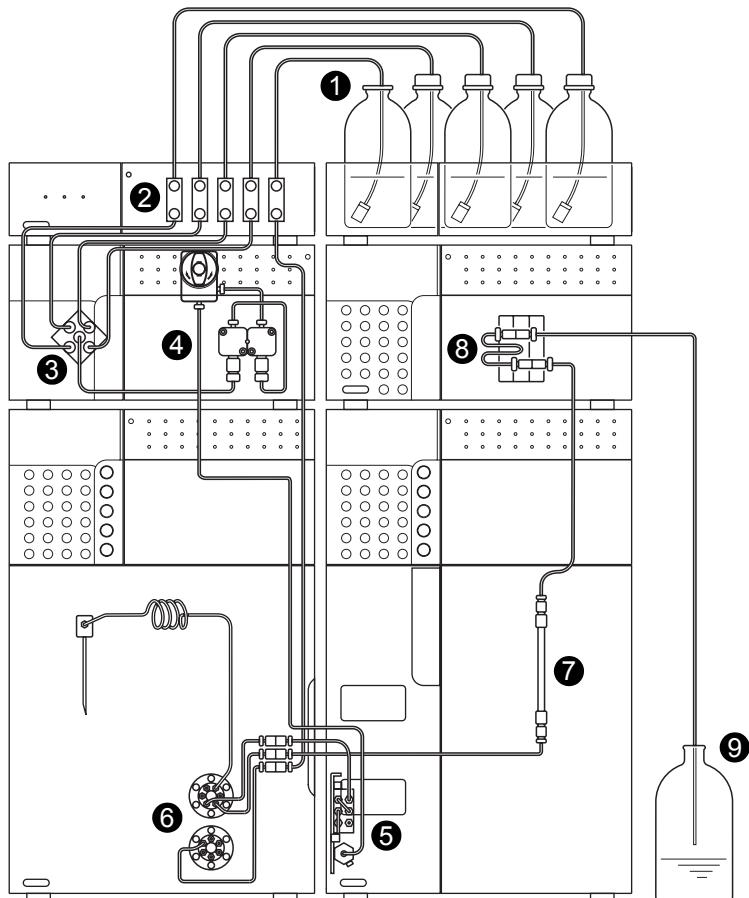
9.4.2 Example of Autosampler System (1)

Centralized control of all the components by a CBM-20Alite system controller enhances ease operation and is well suited for automated analyses. The CBM-20Alite can control a maximum of 5 LC components. Since it is installed in the pump unit or autosampler, the system requires a smaller space.

■ Solvent Flow



■ Function of Components



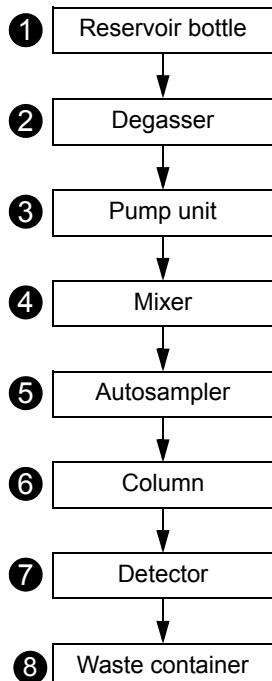
- ① Mobile phase is drawn out of the reservoir bottles and pumped through the tubing by the pump.
- ② The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
- ③ The low-pressure gradient unit mixes up to 4 mobile phases that have been degassed by the degasser.
(*This item is necessary for a low-pressure gradient system.)
- ④ The pump sends the mobile phase through the autosampler, column and detector, in that order, and finally into the waste container.
- ⑤ The mixer enhances the mixing efficiency of the mobile phases. This item is required for low or high-pressure gradient system.
- ⑥ The autosampler automatically injects the sample into the flow lines. By adding a rack changer, it is possible to automatically change the autosampler racks.
- ⑦ In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
- ⑧ The detector detects the components separated in the column, and sends the signal data to a Chromatopac or PC.
- ⑨ Mobile phase from the detector drains into the waste container.

9.4.3 Example of Autosampler System (2)

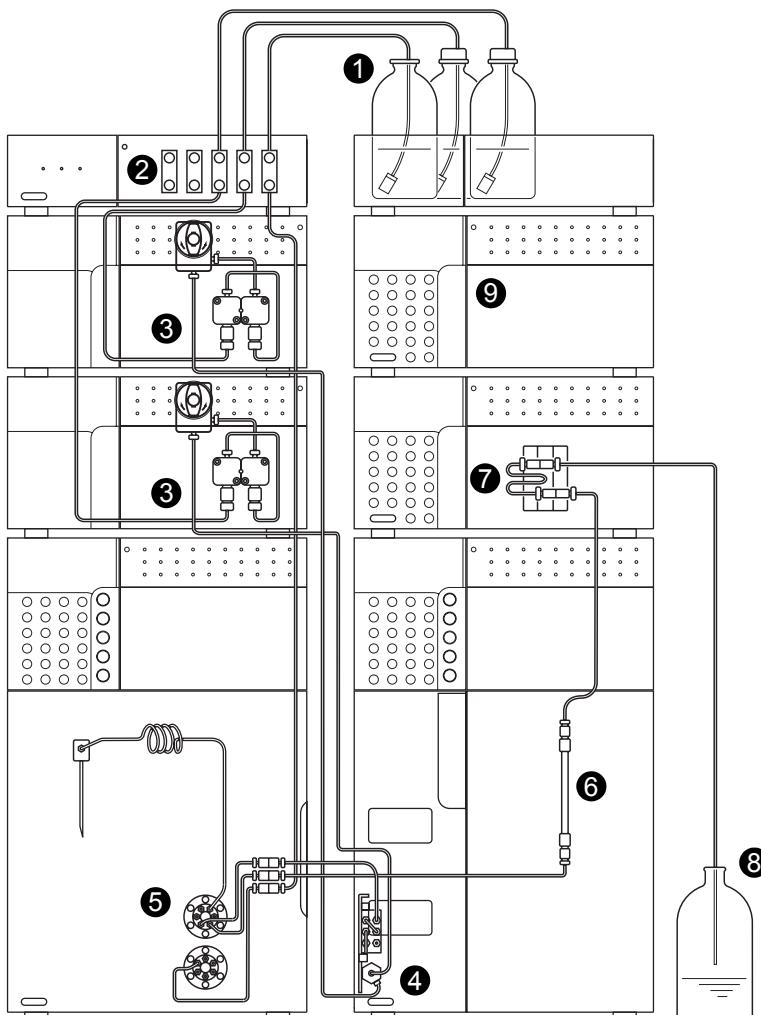
The CBM-20A system controller can control a maximum of 8 LC components (12 LC components as an option).

Use the same type of pumps for high-pressure gradient system.

■ Solvent Flow



■ Function of Components



- ① Mobile phase is drawn out of the reservoir bottles and pumped through the tubing by the pump.
- ② The degasser removes dissolved air from the mobile phase, preventing air bubbles and consequent rise, drift or other baseline irregularities caused by dissolved air.
- ③ The pump sends the mobile phase through the autosampler, column and detector, in that order, and finally into the waste container.
- ④ The mixer enhances mixing efficiency of the mobile phases.
- ⑤ The autosampler automatically injects the sample into the flow lines. By adding a rack changer, it is possible to automatically change the autosampler racks.
- ⑥ In the column, the components are separated by means of the mutual interactions of the mobile phase and the column packing (stationary phase).
- ⑦ The detector detects the components eluted from the column, and send the signal data to a Chromatopac or PC.
- ⑧ Mobile phase from the detector drains into the waste container.
- ⑨ The CBM-20A system controller can control a maximum of 8 LC components (12 LC components as an option) including a maximum of 4 pump units.

9.5 Mobile Phase Characteristics

	(1) Solvent (*) $\eta < .5 \text{ cP}$, $> 45^\circ\text{C}$ (**) $\eta < .5 \text{ cP}$, $< 45^\circ\text{C}$	(2) Source	(3) UV Cutoff	(4) R.I. 25°	Boiling Point ($^\circ\text{C}$)	Viscosity (cP, 25°C)	(5) p'	(6) $e^\circ\text{a}$	(7) Water Solubility %W in 20°C Solvent	(8) Dielectric Constant e^{20}	(9) $p' +$ $0.25e$
1	FC-78 (*) FC-75 (Fluorescent solvent) FC-43	(LC specific)	210nm 210 (opaque under 210)	1.267 1.276 1.291	50 102 174	0.4 0.8 2.6	<-2 <-2 <-2	-25 -25 -25		1.88 1.86 1.9	p' and Dielect. const. (Function proportional to strength)
2	Isooctane(*)(2,2,4-tri methylpentane)	LC	197	1.389	99	0.47	0.1	0.01	0.011	1.94	0.1
3	n-Heptane(*)	LC	195	1.385	98	0.40	0.2	0.01	0.010	1.92	0.5
4	n-Hexane(*)	LC	190	1.372	69	0.30	0.1	0.01	0.010	1.88	0.5
5	n-Pentane(**)	LC	195	1.355	36	0.22	0.0	0.00	0.010	1.84	0.5
6	Cyclohexane	LC	200	1.423	81	0.90	-0.2	0.04	0.012	2.02	0.5
7	Cyclopentane(*)	LC	200	1.404	49	0.42	-0.2	0.05	0.014	1.97	0.6
8	I-Chlorobutane(*)	LC	220	1.400	78	0.42	1.0	0.26		7.4	2.8
9	Carbon disulfide	LC	380	1.624	46	0.34	0.3	0.15	0.005	2.64	1.7
10	2-Chloropropane(**)	LC	230	1.375	36	0.30	1.2	0.29		9.82	3.7
11	Carbon tetrachloride	LC	265	1.457	77	0.90	1.6	0.18	0.008	2.24	2.3
12	n-Butyl ether		220	1.397	142	0.64	2.1	0.25	0.19	2.8	2.4
13	Triethylamine			1.398	89	0.36	1.9	0.54		2.4	2.4
14	Bromoethane(*)			1.421	38	0.38	2.0	0.35		9.4	4.3
15	i-Propyl ether(*)		220	1.365	68	0.38	2.4	0.28	0.62	3.9	3.2
16	Toluene	LC	285	1.494	110	0.55	2.4	0.29	0.046	2.4	2.9
17	p-Xylene		290	1.493	138	0.60	2.5	0.26		2.3	3.0
18	Chlorobenzene			1.521	132	0.75	2.7	0.30		5.6	4.1
19	Bromobenzene			1.557	156	1.04	2.7	0.32		5.4	4.1
20	Iodobenzene						2.8	0.35			
21	Phenyl ether			1.580	258	3.3	3.4			3.7	3.7
22	Phenetole			1.505	170	1.14	3.3			4.2	4.9
23	Ethyl ether(**)	LC	218	1.350	35	0.24	2.8	0.38	1.3	4.3	4.0
24	Benzene	LC	280	1.498	80	0.60	2.7	0.32	0.058	2.3	3.6
25	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

	(1) Solvent (*) $\eta < .5 \text{ cP}$, $> 45^\circ\text{C}$ (**) $\eta < .5 \text{ cP}$, $< 45^\circ\text{C}$	(2) Source	(3) UV Cutoff	(4) R.I. 25°	Boiling Point ($^\circ\text{C}$)	Viscosity (cP, 25°C)	(5) p'	(6) $e^\circ\text{a}$	(7) Water Solubility %W in 20°C Solvent	(8) Dielectric Constant ϵ^{20}	(9) $p' +$ $0.25e$
34	t-Butanol			1.385	82	3.6	4.1	0.7	miscible	12.5	
35	n-Butanol	LC	210	1.397	118	2.6	3.9	0.7	20.1	17.5	8.3
36	n-Propanol	LC	240	1.385	97	1.9	4.0	0.82	miscible	20.3	
37	Tetrahydrofuran(*)	LC	212	1.405	66	0.46	4.0	0.57	miscible	7.6	
38	Propylamine(*)			1.385	48	0.35	4.2		miscible	5.3	
39	Ethylacetate(*)	LC	256	1.370	77	0.43	4.4	0.58	8.8	6.0	5.8
40	i-Propanol	LC	205	1.384	82	1.9	3.9	0.82	miscible	20.3	
41	Chloroform(*)	LC	245	1.443	61	0.53	4.1	0.40	0.072	4.8	5.6
42	Acetophenone			1.532	202	1.64	4.8			17.4	8.7
43	Methylethyl	LC	329	1.376	80	0.38	4.7	0.51	23.4	18.3	9.1
44	Cyclohexanone			1.450	156	2.0	4.7			18.3	9.1
45	Nitrobenzene			1.550	211	1.8	4.4			34.8	13.2
46	Benzonitrile			1.536	191	1.2	4.8			25.2	10.9
47	Dioxane	LC	215	1.420	101	1.2	4.8		miscible	2.2	
48	Tetramethyl urea	LC	265	1.449	175		6.0	0.56		23.0	10.7
49	Quinoline			1.625	237	3.4	5.0			9.0	7.4
50	Pyridine			1.507	115	0.88	5.3		miscible	12.4	
51	Nitroethane		380	1.390	114	0.64	5.2			0.9	
52	Acetone(*) Benzyl alcohol	LC	330	1.356 1.538	56 205	0.30 5.5	5.1 5.7	0.71	miscible	13.1	8.8
53	Tetramethyl guanidine						6.1	0.6			
54	Methoxyethanol	LC	210	1.400	125	1.60	5.5		miscible	19.9	
55	Tris(cyanoethoxy) propane	GC					6.6	0.56			
56	Propylene carbonate	LC					6.1				
57	Ethanol	LC	210	1.359	78	10.8	4.3		miscible	24.6	
58	Oxydipropionitrile	GC					6.8				
59	Aniline			1.584	184	3.77	6.3			6.9	8.1
60	Acetic acid			1.370	118	1.1	6.0		miscible	6.2	
61	Acetonitrile(*)	LC	190	1.341	82	0.34	5.8		miscible	37.5	
62	N,N-dimethylaceta-mide	LC	268	1.436	166	0.78	6.5	0.88		37.8	
63	Dimethylformamide	LC	268	1.428	153	0.80	6.4			36.7	
64	Dimethylsulfoxide	LC	268	1.477	189	2.00	7.2	0.62	miscible	4.7	
65	N-methyl-2-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	

9. Technical Information

	(1) Solvent (*) $\eta < .5 \text{ cP}$, $> 45^\circ\text{C}$ (**) $\eta < .5 \text{ cP}$, $< 45^\circ\text{C}$	(2) Source	(3) UV Cutoff	(4) R.I. $_{25^\circ}$	Boiling Point $(^\circ\text{C})$	Viscosity $(\text{cP}, 25^\circ\text{C})$	(5) p'	(6) $e^\circ\text{a}$	(7) Water Solubility $\%W_{in 20^\circ\text{C}}$ Solvent	(8) Dielectric Constant ϵ^{20}	(9) $p' +$ $0.25e$
71	Ethylene glycol			1.431	182	16.5	6.9		miscible	37.7	
72	Formamide			1.447	210	3.3	9.6		miscible	111	
73	Water	LC		1.333	100	0.89	10.2			80	

- (1) An asterisk (*) indicates solvents most suitable for LC, with low boiling points ($> 45^\circ\text{C}$) and low viscosity ($< 0.5 \text{ cP}$).
 Double asterisks (**) indicates solvents with a very low viscosity and boiling point.
- (2) "LC" indicates that a grade of solvent specifically for LC is commercially available from companies like the following:
 Burdick & Jackson, Baker Chemical, Mallinckrodt Chemical, Fischer Scientific, Waters Associate, Manufacturing Chemists. Inc.
 "GC" indicates that a solvent is used as a stationary phase for gas chromatography, and can be purchased from companies selling GC columns and stationary phases. (These solvents are used as stationary phase in liquid-to-liquid LC.)
- (3) The wavelength below which the solvent becomes opaque.
 (4) Refractive index at 25°C .
 (5) Polarity parameter of solvent.
 (6) Solvent's strength parameter in relation to liquid-to-solid adsorption in alumina.
 (7) Water solubility (%W) at 20°C of solvent used in liquid-to-solid adsorption.
 (8) Value at 20°C .
 (9) Function consisting of P' (proportional to solvent strength) plus the dielectric constant, in ion chromatography.

Source: A.Krstulovic and P.R.Brown, *Reversed-Phase High-Performance Liquid Chromatography*, Wiley Interscience, 1982.

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