

Column Oven



Operator's Manual

90-2215 rev F

SAFETY SYMBOLS



EARTH GROUND



CAUTION - REFER TO MANUAL



CAUTION HIGH VOLTAGE



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1. INTRODUCTION

This operator's manual contains information needed to install, operate, and perform user maintenance on the LC Column Oven.

1.1 Description of the LC Column Oven

The LC Column Oven is engineered to perform equally well as a dependable system for routine analyses or as a sophisticated research instrument. While ideal for HPLC applications, the LC Column Oven is also useful as an oven for general laboratory or industrial use.

1.1.1 Oven Features

The LC Column Oven:

- A novel low dispersion heat exchanger which heats the mobile phase and sample before it enters the column. The injected sample is maintained as a plug through the heat exchanger to insure against peak broadening. The temperature gradient across the column is minimized by the solvent preheating technique; the mobile phase encounters a stationary phase of uniform temperature from one end of the column to the other. (In conventional block-type column heaters or forced air column ovens, large temperature gradients can exist across the column; the mobile phase then encounters a stationary phase of increasing the temperature as it moves along the column. The thermal gradients reduce column efficiency and change selectivity.).
- An open-bed oven design which eliminates the need for specific blocks or inserts for each column size. Up to three 3/8-in. x 30 cm or four 1/4-in. x 30 cm HPLC column can be easily placed inside the oven. The oven chamber is large enough to accommodate a guard column and an analytical column for precise control of temperature conditions. The LC Column Oven has a side mount which accommodates the most popular manual and pneumatic injection valve brackets.
- The LC Column Oven's setpoint temperature can be controlled remotely with an external voltage source. A contact closure between two connections on the back panel initiates remote voltage control. A voltage of 0-10 volts DC will produce a setpoint temperature of 0 - 100°C.
- The LC Column Oven can be controlled remotely with the RS-232 serial communications interface. The setpoint and current temperatures can be read and the setpoint temperature can be written. See chapter 3 for a complete list of commands.

- A thermal safety switch removes power from the heating element if the temperature reaches 118°C. This protects against damage to the column oven.
- The column oven includes a corrosion resistant anodized aluminum column chamber for lightness, strength, and temperature uniformity.

Other features of the LC Column Oven include:

- Inclined chamber and drain tube for leaks
- LED readout on the front panel—displays the setpoint and current temperature in °C or °F, has a HEATING light to indicate when the heating element is receiving power, and a FAULT light to indicate a fault condition has occurred.
- Tactile response, chemically resistant front panel keypad
- Microprocessor advanced control
- Platinum RTD temperature sensor for accuracy and stability
- PID control algorithm

1.1.2 Wetted Materials

Wetted surfaces in the column oven are 316 stainless steel.

1.1.3 Preheater

The column oven preheater provides a uniform temperature across the column over a broad range of flow rates.

1.2 Specifications for the LC Column Oven

Operating Range:	10°C above ambient to 100°C.
Recommended Flow Range:	Up to 8 ml/min.
Temperature Accuracy:	±2°C over entire range. The setpoint changes slightly depending on composition and mobile phase flow rate.
Temperature Repeatability:	±1°C
Temperature Stability:	±0.2°C
Thermal Safety Cutoff:	118°C, self resetting.
Stabilizing Time:	30 minutes to 100°C for “ready” at 2 mL/min. For analyses requiring high precision, wait 30 minutes after the READY light illuminates before beginning an analysis.
Average Cooling Time:	30 minutes to 10°C above ambient at 2 ml/min from 100°C (with cover off).
Column Capacity:	Up to three 3/8-in. x 30 cm. columns or four 1/4-in. x 30 cm. columns.
Column Chamber Material:	Anodized, solvent resistant aluminum.
Line Voltage:	The power entry module on the rear of the cabinet can be set by the user to 100-120 Vac single-fused or 220-240 Vac double-fused, 50/60 Hz operation.
Power Consumption:	120 watts
Overall Dimensions:	5 in. (12.7 cm.) wide x 8 3/4 in. (22.3 cm.) high x 19 1/2 in. (49.5 cm.) long.
Weight:	21 lb. (9.5 kg.)
Remote Inputs:	RS-232 0 to 10VDC setpoint temperature voltage control.
Remote Outputs:	RS-232 Relay contact closure when oven is ready. The contact is rated at 0.25 amp maximum, 100 VDC maximum, and 0.2 ohm.

2. INSTALLATION

2.1 Unpacking and Inspection

Prior to opening the shipping container, inspect it for damage or evidence of mishandling. If it has been damaged or mishandled, notify the carrier before opening the container. Once the container is opened, inspect the contents for damage. Any damage should be reported to the carrier immediately. Save the shipping container. Check the contents against the packing list.

2.2 Location/Environment

The preferred environment for the LC Column Oven is normal laboratory conditions. The area should be clean and have a stable temperature and humidity. The specific temperature and humidity conditions are 10°C to 30°C and 20% to 90% relative humidity. The instrument should be located on a stable flat surface with surrounding space for ventilation and the necessary electrical and fluid connections.

2.3 Electrical Connections

Unpack the LC Column Oven and check the voltage setting on the Power Entry Module on the back panel of the oven (see Figure 2-1). Make certain the voltage setting agrees with the power to be supplied to the unit. An oven which is connected to a 100-120Vac voltage source should have a voltage setting of “115V”, and an oven connected to a 220-240Vac voltage source should have a voltage setting of “230V”. The LC Column Oven can be ordered with either of the two voltage configurations.

If the voltage setting is correct, position the column oven so that there is at least a four inch clearance on all sides of the oven to permit proper ventilation. Then plug the column oven into a properly grounded electrical outlet.

WARNING: Do not bypass the safety ground connection as a serious shock hazard could result.

If the oven does not have the correct voltage configuration, notify your local service representative, to obtain the correct power cord and fuses for your installation.

To change the voltage setting, a small flat-blade screwdriver is the only tool required; proceed as follows:

2.3.1 Converting from 115Vac to 230Vac

1. Remove the power cord from the power entry module (see Figure 2-1) located in the rear of the pump.
2. Using a small, flat-blade screwdriver, carefully pry out the power entry module cover at point A, Figure 2-1. The hinged cover will swing down as shown in Figure 2-2.

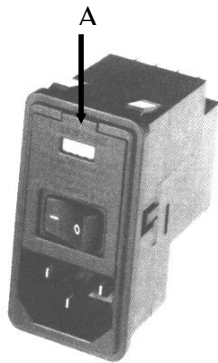


Figure 2-1

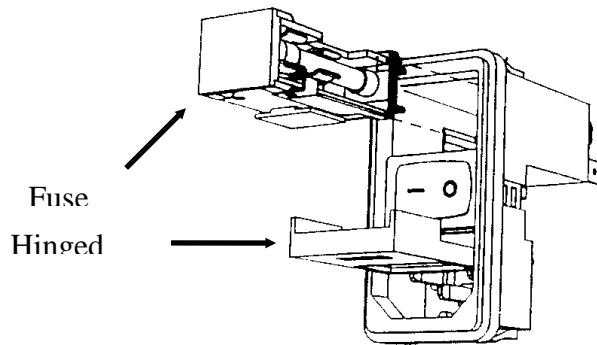


Figure 2-2

3. Using a small, flat-blade screwdriver, carefully pry out at the top of the fuse tray and carefully remove the tray as illustrated in Figure 2-2.
4. Holding the fuse tray in the exact orientation shown in Figure 2-3, observe the small clip shown and grasping at the two sides of the clip gently remove from the tray assembly as shown in Figure 2-3.

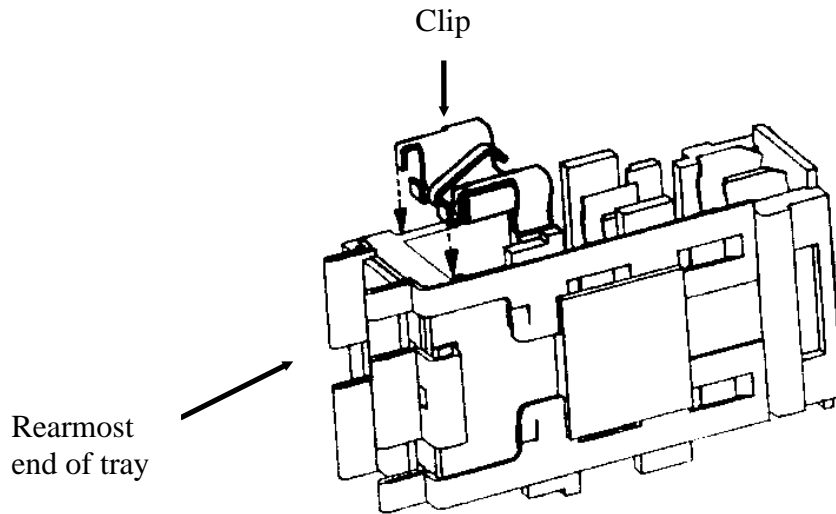


Figure 2-3

5. Remove the fuse present in the fuse tray by gently lifting it up at the rearmost end of the tray (where the metal tabs extend) and removing the fuse from the retaining clip.
6. Place two fuses into the two compartments in the fuse tray. The fuse ratings **must be as shown on the back of the oven cabinet**. The American 1-1/4" long fuses extend for the full length of the tray. The shorter European 20 mm long fuses **must** be placed fully to the rearmost end of the tray (closest to the metal tabs extending from the tray), or contact will not be made and the unit will not operate. **Both** fuses must be present to complete the circuit.
7. With the two proper fuses in the tray, orient the tray with the two fuses at the sides and the **230V marking at the top**, as shown in Figure 2-2, and insert it with the metal tabs first into the top of the power entry module until it is firmly seated in place. It may be necessary to squeeze the two fuses at the rear to permit them to enter the power module housing. Close the power entry module cover by pressing at the top center until it snaps into place. Insert a suitable 230V power cord.

2.3.2 Converting from 230Vac to 115Vac

1. Remove the power cord from the power entry module (see Figure 2-1) located in the rear of the pump.
2. Using a small, flat-blade screwdriver, carefully pry out the power entry module cover at point A, Figure 2-1. The hinged cover will swing down as shown in Figure 2-2.

3. Using a small, flat-blade screwdriver, carefully pry out at the top of the fuse tray and carefully remove the tray as illustrated in Figure 2-2.
4. Remove the fuses present in the fuse tray by gently lifting them up at the rearmost ends of the tray (where the metal tabs extend) and removing the fuses from their retaining clips.
5. Observe the shorting clip placement as shown in Figure 2-3. Place a shorting clip **by hand** onto the tray as follows. **The tray must be oriented as drawn** (the marking PRSR will be at the top of the fuse tray front). **The clip must be oriented as shown with the “finger” at the center pointing toward the front of the tray. Do not bend this finger or the required connections will not be made. Grasping the clip only at the sides**, slide it down into place on the tray. The base of the clip will insert into the cavity in the tray when it is placed in the correct position. Place one fuse into the compartment in the side of the fuse tray opposite the side with the clip. The fuse rating **must be as shown on the back of the pump cabinet**. An 1-1/4” long American fuse will extend for the full length of the tray. A shorter 20 mm long European fuse **must** be placed fully to the rearmost end of the tray (closest to the metal tabs extending from the tray) or contact will not be made and the unit will not operate. Both the clip and the fuse must be present in their proper places or the unit will not operate.
7. With the clip and proper fuse in the tray, orient the tray with the fuse at the side and the **115V marking at the top**, as shown in Figure 2-2, and insert it with the metal tabs first into the top of the power entry module until it is firmly seated in place. It may be necessary to squeeze the fuse at the rear to permit it to enter the power module housing. (If the clip and fuse are on the incorrect sides of the tray, it will not be possible to place the tray into the power entry module). Close the power entry module cover by pressing at the top center until it snaps into place. Insert a suitable 115V power cord.

2.4 Tubing

2.4.1 Tubing Types and Preparation

Tubing (not supplied with the column oven) should have a 1/16" outer diameter. It is available in type 316 stainless steel. Tubing with a 0.020" inner diameter is normally used before the injection valve. Tubing with a 0.010" inner diameter is normally used after the injection valve. The tubing must be cut squarely with no burrs. The

tube itself should not be crimped, and the center hole must be open. A tubing cutter is recommended for cutting stainless steel tubing.

2.4.2 Tubing Connections

Before making the tubing connections in the following paragraphs, keep in mind that **the order of the fluid flowpath inside the column oven is critical to achieving the specified performance of the oven.** Specifically, to achieve the temperature accuracy and repeatability specifications, as well as a low thermal gradient across the column, the flowpath order must be:

1. Injection valve, then
2. Preheater block inlet (either), then
3. Preheater block outlet (either), then
4. Column

If the order of injection valve followed by preheater is reversed or if flow through the preheater is bypassed, temperature accuracy, repeatability, and uniformity in the column will all be impaired.

2.4.3 Tubing Connections for Manual Injection

1. Make certain that the power switch is off.
2. Install the injector as follows:
 - a. Loosen the three setscrews securing the injector handle and remove the handle.
 - b. Mount a mounting bracket on either side of the oven cabinet.
 - c. Secure the valve to the mounting bracket with the two screws supplied with the valve. The valve is most advantageously installed when the numerals at the back of the injector are upright and can be easily read.
 - d. Replace the valve handle and tighten the three handle securing screws.

Note: Between the case and the column tray is a block of high temperature foam insulation. Make the smallest holes or slits possible in this layer of insulation when passing the tubing through it; the holes should be cut for a snug fit. Do not remove the insulation; it aids in achieving stable, repeatable temperature control.

3. Make the tubing connection from the pump to port 2 at the rear of the valve. The holes have plastic plugs in them which prevent oven heat leaks. Remove the appropriate plugs on the side or rear of the cabinet. Using the grommets in the accessory kit, slit each grommet to be used radially with a knife and run the tubing through the grommet. After the tubing has been placed through the corresponding cabinet exterior and interior holes, insert the grommet in place in the cabinet wall. The tubing entering the oven should be sealed enough to prevent free air flow into the oven.

Note: Be sure to clean the ends of the tubing after poking it through the insulation, as small insulation particles may be caught in the tube end. Use of an inline filter is recommended to remove small particulate matter from the solvent stream prior to the injection valve, as the passages through the preheater tubing are necessarily small.

4. Make the connection from port 3 of the injector (the injector outlet) to the preheater block inlet (see Figure 2-4) using CPI type fittings. Make the connection as short as possible using narrow bore tubing (.007 in. I.D.).
5. Connect the output of the preheater block to the column inlet, using as short a piece of small bore tubing as possible.

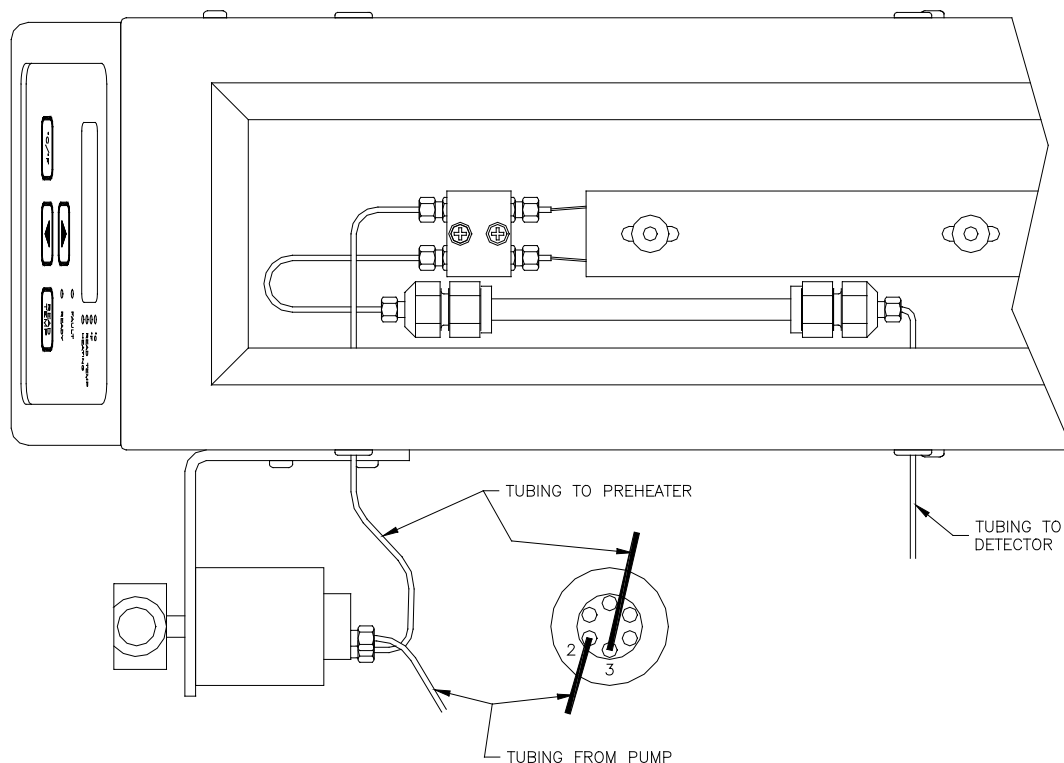


Figure 2-4. Interior View of Oven with Manual Operation Showing Preheater, Column, and Injection Valve Installed

6. Connect another length of small bore tubing from the outlet of the column, through another side or rear hole, using a grommet supplied, to connect to the detector.

Note: To minimize the length of tubing through which the sample must flow before it reaches the detector, you could pass the tubing through the rear wall of the column oven. With most laboratory arrangements, however, it is more practical to have the tubing pass through the oven side panel, it is advisable to provide vent tubes from ports 5 and 6 of the injector valve to waste.

2.4.4 Tubing Connections for an Autosampler

1. Bring the tubing from port 3 (outlet) of the autosampler valve through a hole on the side of the column oven front panel (see Figure 3-1). The holes have plastic plugs in them which prevent oven heat leaks. Remove the appropriate plugs on the side or rear of the cabinet. Using the grommets in the accessory kit, slit each grommet to be used radially with a knife and run the tubing through the grommet. After the tubing has been placed through the corresponding cabinet exterior and interior holes, insert the

grommet in place in the cabinet wall. The tubing entering the oven should be sealed enough to prevent free air flow into the oven.

Note: Be sure to clean the ends of the tubing after poking it through the insulation, as small insulation particles may be caught in the tube end. Use of an inline filter is recommended to remove small particulate matter from the solvent stream prior to the autosampler valve, as the passages through the preheater tubing are necessarily small.

2. Connect the autosampler output tubing to the inlet of the preheater block (see Figure 2-5).
3. Connect the output of the preheater block to the column inlet, using as short a piece of small bore tubing as possible.
4. Connect another piece of small bore tubing from the column outlet, through another side or rear hole, using a grommet supplied, to connect to the detector. (See the note after Step 6 of the “Installation for Manual Operation” above.)
5. Make the “ready” interlock connections between the oven, the pump, the autosampler, and a recording or integrating device. The autosampler will then inject after all the components become ready.

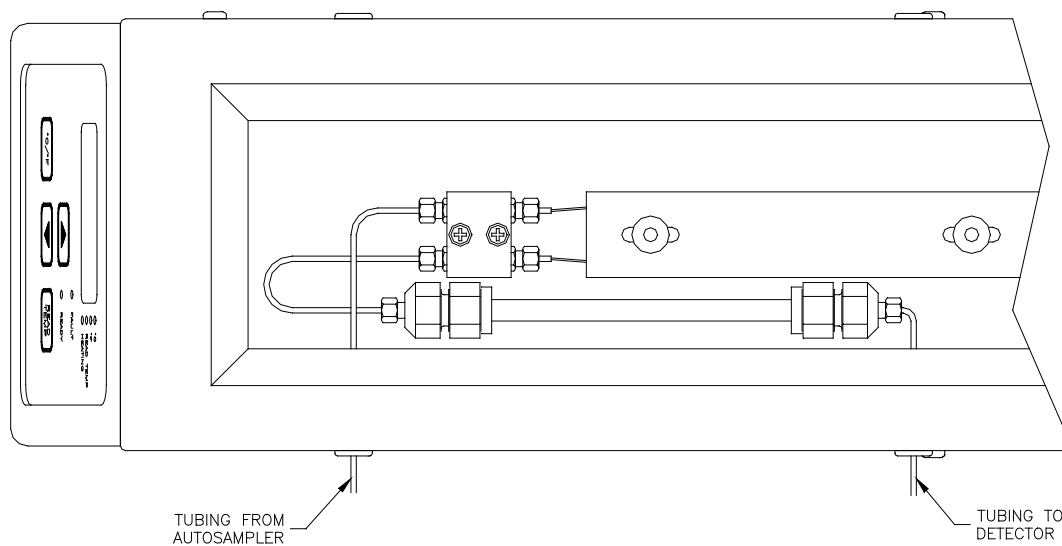


Figure 2-5. Interior view of Oven with Automatic Operation Showing Preheater, Column, and Autosampler Input Line

2.5 Solvents

The materials which form the flowpath components of the oven can be damaged by certain solvents.

2.5.1 Solvents With Harmful Effects

All portions of the LC Column Oven that contact the mobile phase are manufactured of type 316 stainless steel. These materials are extremely sensitive to acid chlorides. Avoid using solvents that contain any amount of hydrochloric acid. For example, the acidic form of tris-(hydroxymethyl) aminomethane HCl contains acid and must not be used. The pH conditions required to duplicate most published separations can be met with the phosphoric form, monotris-(hydroxymethyl) aminomethane phosphate.

Some solvents you should specifically avoid are:

Aqua Regia	Hydrochloric Acid (20%)
Bromine	Hydrochloric Acid (37%)
Chlorine Anhydrous	Hydrofluoric Acid (50%)
Copper Chloride	Hydrofluoric Acid (20%)
Ferric Chloride	Hydrofluoric Acid (75%)
Ferrous Chloride	Hydrofluorsilicic Acid (20%)
Freon 12 (wet)	Hydrogen Peroxide
Guanidine	Iodine
Hydrochloride (6M)	Mercuric Chloride
Hydrobromic Acid (20%)	(Dilute Solution)

In addition, some users of HPLC systems have observed that chloroform and carbon tetrachloride slowly decompose to liberate hydrochloric acid, which, as noted above, attacks stainless steel. Do not leave these solvents in the systems for a prolonged period.

You may also want to avoid ammonium hydroxide. Although ammonium hydroxide will not harm the oven, it is likely to damage the stator and rotor in the injection valve.

2.6 Preparation for Storage or Shipping

2.6.1 *Isopropanol Flush*

Disconnect the tubing from the oven after flushing the preheater tube thoroughly with isopropyl alcohol.

2.6.2 *Packaging for Shipping*

CAUTION: Reship in the original carton, if possible. If the original carton is not available, wrap the oven in several layers of bubble wrap and cushion the bottom, top, and all four sides with 2" of packaging foam. Although heavy, an LC Column Oven is a delicate instrument and must be carefully packaged to withstand the shocks and vibration of shipment.

3. OPERATION

3.1 Front Panel Controls and Indicators

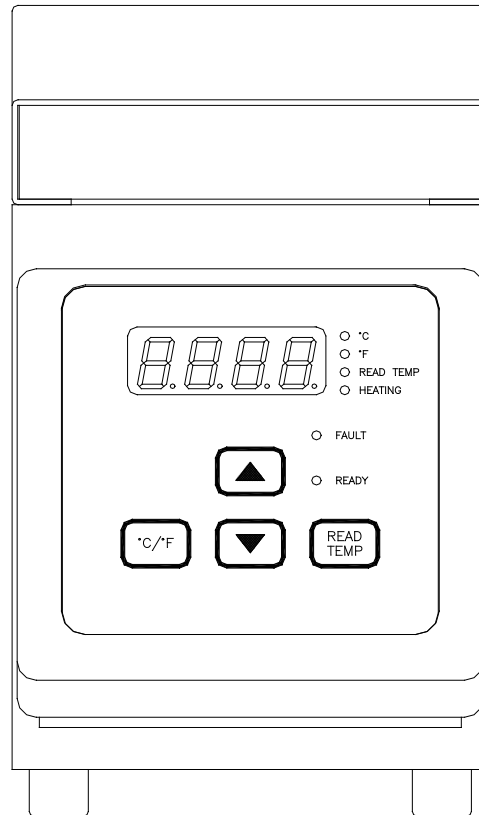


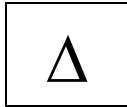
Figure 3-1. LC Column Oven Front Panel

3.1.1 Control Panel

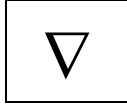
3.1.1.1 Digital Display

The 4-digit display shows the oven's setpoint temperature or current temperature in degrees Celsius or Fahrenheit. It also displays an error message in the event of a fault.

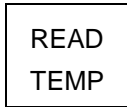
3.1.1.2 Operation Keys



When pressed, this key increases the temperature setpoint.



When pressed, this key decreases the temperature setpoint.



When pressed, the digital display on the front panel displays the current temperature; when released the front panel displays the setpoint temperature.



Use this key to toggle between the Celsius and Fahrenheit modes. Two status lights to the right of the digital display indicate which mode is active.

Fast And Slow Button Repeat On The Up And Down Arrow Buttons: If the UP-ARROW or DOWN-ARROW button is held down for more than approximately one half of a second, the button press will repeat at a slow rate of approximately 10 times a second. Once slow button repeat has begun, fast button repeat can be initiated by using a second finger to press down the second arrow button. During fast button repeat, the button press will repeat at a rate of approximately 100 times a second. Switching back and forth between repeat speeds can be accomplished by pressing and releasing the second arrow button while keeping the first arrow button held down.

3.1.1.3 Status Lights

°C When on, the temperature displayed is in degrees Celsius.

°F When on, the temperature displayed is in degrees Fahrenheit.

READ TEMP When on, the current temperature is being displayed.
When off, the setpoint temperature is being displayed.

HEATING Indicates when power is being applied to the heating element. It will glow steadily when a setpoint temperature above the current temperature is first set. As the oven temperature approaches the setpoint, the light will blink and then go out for a few minutes until the oven settles at its setpoint. When the oven attains equilibrium, the HEATING light will cycle between its blinking state and off state.

FAULT	Blinks when a fault occurs, and an error message is displayed on the digital display.
READY	When on, the column in the oven has reached a stable operating temperature. It turns on about 15 minutes after the column oven has reached its setpoint temperature. The 15-minute interval is appropriate for 1/4-in. and 3/8-in. columns up to 30 cm. in length using flow rates greater than or equal to 1 and 2 ml/min, respectively. If more than one column is used, more time will be necessary after the READY light comes on. As a general rule, allow about 15 minutes for each additional 30 cm. of column before injection.

3.2 Control by Serial Interface

An RS-232C modular jack is provided on the back panel. A computer, with appropriate software, can be used as a remote controlling device for oven operation via this connection.

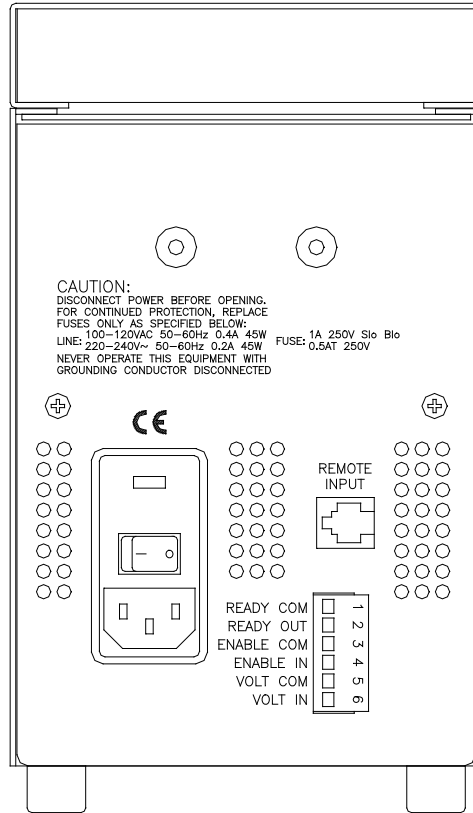


Figure 3-2. LC Column Oven Rear Panel

3.2.1 Serial Communications Protocol

9600 baud

8 data bits

no parity

1 stop bit

3.2.2 Serial Port Connector

Connector: RJ11, 6-pin, modular telephone jack

Pinout:

Pin	Description
1	Ground
2	DSR (input)
3	RXD (input)
4	TXD (output)
5	DTR (output)
6	Ground

3.2.3 Handshaking

DSR input: logic high (3 to 15 volts); oven can transmit.
logic low (-3 to -15 volts); oven will not transmit.

DTR output: logic high (9.0 volts typical); oven ready to receive.
logic low (-9.0 volts typical); oven busy.

3.2.4 Pump to Computer Wiring

Use the following chart for interfacing the LC Column Oven REMOTE INPUT serial I/O port to either a 25-pin or 9-pin serial I/O COM port on the computer.

Oven (RJ11)	Function	IBM (DB25) ^a	IBM (DB9) ^b
1, 6	Ground	7	5
2	DSR (Input to oven)	20	4
3	RXD (Input to oven)	2	3
4	TXD (Output from oven)	3	2
5	DTR (Output from oven)	6	6

^a Jumper pins 4, 5, and 8 on DB25.
^b Jumper pins 1, 7, and 8 on DB9.

3.2.5 Command Interpreter

The LC Column Oven's high level command interpreter receives and responds to ASCII commands. The oven will not send a message except when prompted, and it will send a response to every valid command as described below. The response to an invalid command is "Er/".

Each command is characterized by a unique two-letter command code, and only one command can be issued per line. Case is not important; that is, the command codes "PR" "Pr" "pR" and "pr" are all equivalent. Response strings sent by the oven are terminated by the "/" character. The command packets are as follows:

Command	Response	Comments
CR	OK/	Clear Ready: Turns off the READY indicator on the front panel, opens the “ready” relay contact, and resets the “ready” timer.
ID	OK,vx.xx LC Column Oven/	Identifies the EPROM revision x.xx and oven type.
RS	OK,s,xxx.x,u/	Read status: s = 0 Idle s = 1 Trying to achive setpoint s = 2 Ready xxx.x = The current temperature u = C Temperature in Celsius u = F Temperature in Fahrenheit
RT	OK,xxx.x/	Read Temperature: xxx.x = The temperature setpoint
SI	OK/	Set Idle: Sets the oven to 0°C (or 32°F) and disables the keypad.
SR	OK/	Set Ready: Turns on the ready indicator on the front panel and closes the “ready” relay contact.
SS,x	OK/	Sets the temperature units: x = 0 for degrees Celsius x = 1 for degrees Fahrenheit
TT,xxxx	OK/	Sets the temperature setpoint to xxx.x degrees. The temperature units must first be set with the SSx command.
KD	OK/	Disables the keypad.
KE	OK/	Enables the keypad. (Default status at power-up is enabled.)

3.3 Control by DC Voltage

The setpoint temperature can also be controlled remotely by connecting pins 3 and 4 of the REMOTE INPUT terminal block connector at the rear of the oven (see Figure 3-2) and providing a signal of 0 to 10 Vdc across pins 5 (positive) and 6 (negative ground reference) of the connector. 0 Vdc corresponds to 0°C and 10 Vdc corresponds to 100°C. The current requirement of the voltage input is 0.001 amp maximum.

3.4 Operation with a Manual Injection Valve

1. Install the Rheodyne 7125 Injection Valve as described in Chapter 2 of this manual. Also make all connections to the pump, preheater, column, and detector, as described in Chapter 2.
2. Establish solvent flow through the system and carefully check for leaks.
3. Make sure the column oven cover is in place and turn the power switch on the back panel to the on position.
4. Set the oven temperature between 10°C above ambient and 100°C, using the front panel up-arrow and down-arrow keys.
5. The HEATING indicator light will blink periodically when the oven temperature has reached equilibrium, and the READY lamp will light when the column in the oven has reached a stable operating temperature. (See the discussion of the READY light in the Status Lights table, above.)
6. When the READY indicator lights, inject the sample.

3.5 Operation with an Autosampler

1. Make the plumbing connections from the autosampler to the oven preheater, column, and detector as described in Chapter 2. Also make certain that the “ready” connections have been made. The “ready” relay contact, which is normally open, closes when the “ready” condition occurs. It is found between pins 1 and 2 on the REMOTE INPUT terminal block connector and is used to prohibit sample injection before all components are ready.
2. Establish solvent flow through the system and check carefully for leaks.
3. Make sure the column oven cover is in place and turn the power switch on the back panel to the on position.
4. Set the oven temperature as desired.
5. Set up the autosampler and place it in run mode.
6. A sample will be automatically injected when the oven and all other components become ready.

4. THEORY OF OPERATION

4.1 Mechanical Operation

4.1.1 Liquid System Flowpath

The flowpath of the LC Column Oven is described in Chapter 2.

4.2 Electronic Control

4.2.1 Microprocessor Control

The oven is controlled by microprocessor circuitry which (1) applies power to the heating element, (2) interfaces with the keyboard/display, (3) receives signals from the temperature sensor, and (4) provides external input/output and remote control interfacing. Firmware programming is stored in an EPROM.

The LC Column Oven uses a PID control algorithm to precisely control the temperature at different flow rates. A platinum resistance sensor, which is known for its accuracy, linearity, and dependability, is used for temperature sensing feedback. The control temperature can be manually set with the front panel buttons from 10°C above ambient to 100°C, or remotely by providing an external contact closure and a 0.00 - 10.0 Vdc input which is equivalent to 0-100°C. (For example, 5.0V = 50°C.)

A “ready” circuit is used to predict when a column in the oven has reached thermal equilibrium. Empirical evidence indicates that columns with moderate to high flow rates will reach equilibrium within 15 minutes after the column oven itself settles onto the control setpoint. The microprocessor detects when the platinum sensor falls within a 0.2°C window around the setpoint, and then adds a 15 minute delay. At the end of the 15 minutes, the READY light is lit and the “ready” relay is energized, closing the “ready” relay contact.

The heating element is mounted below the oven chamber. A bimetal high temperature (118°C) thermostat is used to prevent damage to the unit should a component failure call for constant heat while unattended. If the power switching transistor is short-circuited, the control circuit cannot disable it. The thermostat is used directly in the heater line to limit the temperature to approximately 118°C if failure should occur. The thermostat is closed by cooling to 101°C.

4.2.2 DC Power Supply

Power for the column oven is provided by an isolation transformer which has taps to accommodate voltages of 100-120 or 220-240 Vac. Selection is accomplished by changing the setting on the power entry module. The transformer input is protected by one fuse for 100-120 Vac operation and two fuses for 220-240 Vac operation. A fused

linear rectifier circuit provides 35 Vdc to drive the heating element. A linear ± 9 Vdc supply and a switching 5 Vdc supply are also provided to power control and display circuits.

4.2.3 Remote Interfacing

Instead of using the front panel buttons, you can control the oven temperature remotely via a serial communications port. An RS-232 modular jack is provided on the back panel. See Section 3.2 for information on oven operation via this connection; or, see Section 3.3 for DC voltage control. Also, see Section 1.2 and Section 3.5 for a description of the “ready” relay output signal.

5. MAINTENANCE

Cleaning and minor repairs of the LC Column Oven can be performed as outlined below.

5.1 Cleaning the Oven

1. Disconnect the column inlet tube and from the column.
2. Direct the column inlet tube (the tube from the injector outlet) to a waste beaker.
3. Set the flow rate to maximum.
4. Turn the injector to the INJECT position.
5. Pump 100% isopropanol through the pump, oven, and injector for 3 minutes.
6. Pump 100% filtered, distilled water through the pump, oven, and injector for 3 minutes.

WARNING: Use standard laboratory procedures and extreme care when handling strong acids and bases.

7. Pump a 20% nitric acid/water solution through the pump, oven, and injector for 3 minutes.
8. Flush the pump, oven, and injector with 100% filtered, distilled water for at least 3 minutes.
9. Pump 100% isopropanol through the pump, oven, and injector for 3 minutes.

The system is now prepared for any mobile phase or short- or long-term shutdown.

5.2 Fuse Replacement

One or two fuses protect the LC Column Oven. The fuses are located in the power entry module at the rear of the cabinet and are in series with the AC input line.

Troubleshooting the fuses is straightforward. If the power cord is plugged in and the on/off power entry switch is on and the front panel display does not light-up, check the fuses in the power entry module. To gain access to these fuses, gently pry off the cover plate with a small flat-bladed screwdriver. Replace with fuses of the correct rating: one 2 A slow-blo fuse for 100-120 Vac ovens, or two 1 A slow-blo fuses for 220-240 Vac ovens.

6. TROUBLESHOOTING

Quick Guide to Problem Solving

PROBLEM	PROBABLE CAUSE	SOLUTION
1. No heating. Front panel display is not lit.	Oven not plugged in. Fuse blown in Power Entry Module on back panel.	Plug in oven to AC outlet Replace fuse.
2. FAULT light is blinking. Error code "P Lo" is displayed on the front panel indicating an under power condition.	The voltage setting of the Power Entry Module on back panel of the oven does not match the power source to which the power cord is connected.	Change the voltage setting on the Power Entry Module to match the voltage being supplied to the oven.
3. FAULT light is blinking. Error code "P Hi" is displayed on the front panel indicating an over power condition.	The voltage setting of the Power Entry Module on back panel of the oven does not match the power source to which the power cord is connected.	Change the voltage setting on the Power Entry Module to match the voltage being supplied to the oven.
4. FAULT light is blinking. Error code "Lo" is displayed on the front panel indicating an under temperature condition.	The temperature sensor is defective. Oven Control Board 2 is defective.	With the power cord disconnected, use an ohmmeter to measure across pins 1 and 4 then across pins 2 and 3 of the connector labeled "TO RTD." At a room temperature of 23°C the resistance should be approximately 109 ohms at both places. If the resistance is much greater or less than this, replace the column tray. The heating element, temperature sensor, and over temperature cutout switch are all bonded to the column tray and are replaced as a single item. Replace Oven Control Board 2.
5. FAULT light is blinking. Error code "Hi" is displayed on the front panel indicating an over temperature condition.	The temperature sensor is defective. Oven Control Board 2 is defective.	With the power cord disconnected, use an ohmmeter to measure across pins 1 and 4 then across pins 2 and 3 of the connector labeled "TO RTD." At a room temperature of 23°C the resistance should be approximately 109 ohms at both places. If the resistance is much greater or less than this, replace the column tray. The heating element, temperature sensor, and over temperature cutout switch are all bonded to the column tray and are replaced as a single item. Replace Oven Control Board 2.

6. No heating. Front panel display is lit. HEATING light lit when the setpoint temperature is set to 100°C.	The heating element or over temperature cutout switch is defective. Oven Control Board 2 is defective.	With the power cord disconnected, use an ohmmeter to measure across pins 1 and 2 of the connector labeled "TO HEATER." The resistance should be approximately 9 ohms. If the resistance is much greater or less than this, replace the column tray. The heating element, temperature sensor, and over temperature cutout switch are all bonded to column tray and are replaced as a single item. Replace Oven Control Board 2.
7. Temperature at preheater, measured with surface probe, is not within 2°C of the setpoint temperature when the READY light is on.	Oven Control Board 2 needs calibration	Recalibrate Oven Control Board 2.
8. READY light does not come on. HEATING light blinks periodically.	Oven not ready.	Wait longer.
9. READY light does not come on, HEATING light is off, and the current temperature is above the setpoint temperature but not above 101°C.	The oven was previously set to a higher temperature than the current setpoint.	Wait for the column tray to drop down to the setpoint temperature; the column tray will cool down faster if the oven lid is removed.
10. Oven reaches equilibrium at the setpoint temperature, but the READY light stays off.	Front Panel Board 3 is defective.	Replace Front Panel Board 3.
11. Front panel display is lit. HEATING light is not lit or blinking periodically, but the oven starts heating-up when the setpoint temperature is set to 100°C.	Front Panel Board 3 is defective.	Replace Front Panel Board 3.
12. No heating. Front panel display is lit. HEATING light not lit when the setpoint temperature is set to 100°C.	Oven Control Board 2 is defective.	Replace Oven Control Board 2.
13. READY light comes on and then goes off, and HEATING light is blinking.	Oven lid not on tightly. Flow rate too high (>8 ml/min). Oven Control Board 2 is defective.	Position lid properly. Reduce flow rate. Replace Oven Control Board 2.
14. Oven works correctly in manual mode but not in remote mode.	No contact closure between pins 3 and 4 of the REMOTE INPUT terminal block connector. External voltage input calibration incorrect. Oven Control Board 2 is defective.	Close contacts. Recalibrate V-SPAN trimpot. Replace Oven Control Board 2.
15. Leaking around preheater block.	High backpressure forcing a leak.	Retighten inlet and outlet fittings. Retighten fittings which connect preheater tubing to block. Check for blockage (see next item).

16. System has very high backpressure.	<p>High column backpressure.</p> <p>Blockage of preheater tubing</p>	<p>Disconnect column and check pressure. If pressure falls to under 500 psi with same flow rate, replace column.</p> <p>Disconnect inlet to preheater block and try backflushing.</p> <p>Flush the preheater tube with a compatible high-strength solvent.</p> <p>Replace the preheater.</p>
17. Preheater does not provide enough heat.	<p>Flowpath not from injector to preheater to column.</p> <p>Flow rate too high (>8 ml/min).</p> <p>Too many columns.</p> <p>Incorrect Calibration</p> <p>Heating element defective.</p>	<p>Correct flowpath.</p> <p>Reduce flow rate.</p> <p>Reduce the number of columns or wait longer for oven equilibration.</p> <p>Recalibrate oven.</p> <p>Replace column tray.</p>

7. LIST OF PARTS

7.1 Replacement Parts

<u>Part No.</u>	<u>Description</u>
01-1274	0.010" ID x 1/16" OD capillary tubing
01-1276	0.030" ID x 1/16" OD capillary tubing
12-0645	Front Panel Board 3 printed circuit board assembly
20-0205	Oven Control Board 2 printed circuit board assembly
20-0581	Preheater Plate with Imbedded Preheater Tube
20-1373	Drain Tube
21-0140	1/16" gland nut (for outlet tubing)
21-0142	1/16" ferrule (for outlet tubing)
90-1288	Feet
93-1616	2 A slow-blo fuse (for 100 - 120 Vac operation)
93-1615	1 A slow-blo fuse (for 220 - 240 Vac operation)
93-1685	6-Pin Terminal block Connector

7.2 Accessory Parts

<u>Part No.</u>	<u>Description</u>
12-0671	6-Pin Modular to 25-Pin D-Type adapter
12-0672	6-Pin Modular to 9-Pin D-Type adapter
12-0677	6-Pin Modular cable, 5 feet long